User's Manual

WT5000
Precision Power Analyzer
Getting Started Guide

YOKOGAWA

Yokogawa Test & Measurement Corporation

IM WT5000-03EN

1st Edition

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/

List of Manuals

Thank you for purchasing the WT5000 Precision Power Analyzer. This instrument is capable of measuring parameters such as voltage, current, and power with high precision.
This getting started guide primarily explains the handling precautions and basic operations of this instrument. To ensure correct use, please read this manual thoroughly before operation. Keep this manual in a safe place for quick reference in the event that a question arises.
The following manuals, including this one, are provided as manuals for this instrument. Please read all manuals.

Manual Title	Manual No.	Description
WT5000 Precision Power Analyzer Features Guide	IM WT5000-01EN	The supplied CD contains the PDF file of this manual. This manual explains all the instrument's features other than the communication interface features.
WT5000 Precision Power Analyzer User's Manual	IM WT5000-02EN	The supplied CD contains the PDF file of this manual. The manual explains how to operate this instrument.
WT5000 Precision Power Analyzer Getting Started Guide	IM WT5000-03EN	This manual. This guide explains the handling precautions and basic operations of this instrument.
WT5000 Precision Power Analyzer Communication Interface User's Manual	IM WT5000-17EN	The supplied CD contains the PDF file of this manual. The manual explains the instrument's communication interface features and instructions on how to use them.
WT5000 Precision Power Analyzer	IM WT5000-92Z1	Document for China

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 functions. 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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1st Edition: September 2018 (YMI)

Revisions

- 1st Edition: September 2018

Checking the Contents of the Package

Unpack the box, and check the following 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.

WT5000

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.

MODEL	Suffix			Specifications
WT5000				Precision Power Analyzer
Language	-HE			English menu
	-HJ			Japanese/English menu
Power cord[1]		-D		UL/CSA standard and PSE compliant, maximum rated voltage: 125 V
		-F		VDE standard, Korean standard, maximum rated voltage: 250 V
		-H		Chinese standard, maximum rated voltage: 250 V
		-N		Brazilian standard, maximum rated voltage: 250 V
		-Q		British standard, maximum rated voltage: 250 V
		-R		Australian standard, maximum rated voltage: 250 V
		-T		Taiwanese standard, maximum rated voltage: 125 V
		-Y		No power cord included[2]
Options			/M1	32 GB internal memory
(option)			/MTR1	Motor evaluation function[1]
			/DA20	20-channel D/A output[3]
			/MTR2	Motor evaluation function 2[3, 4]

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

2 Prepare a power cord that complies with the standard specified by the country or region that the instrument will be used in.

3 The /DA20 and /MTR2 options cannot be installed on the same instrument.

4 To add the /MTR2 option, you need to add the /MTR1 option.

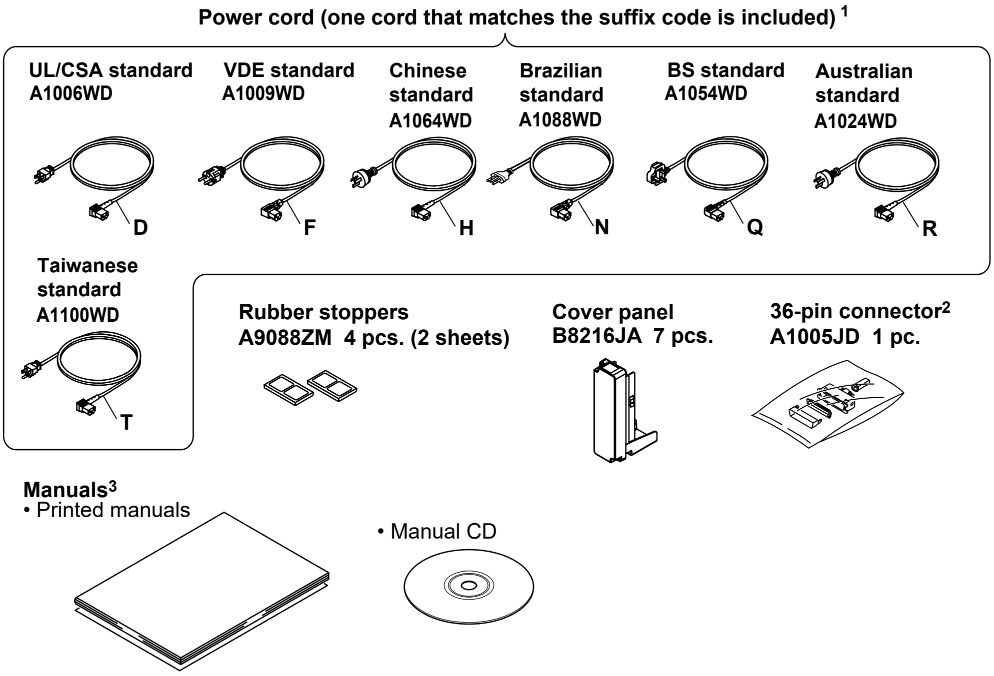
For products whose suffix contains “Z,” an exclusive manual may be included. Please read it along with the standard manual.

No. (Instrument number)

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

WT5000 Standard Accessories

The following accessories are included. Check that all contents are present and undamaged.



Standard accessories are not covered by warranty.

1 Make sure that the attached power cord meets the designated standards of the country and area that you are using it in. If the suffix code is -Y, a power cord is not included.

2 Included with models that have 20-channel D/A output (/DA20)

3 Manuals

Item	Model or Part No.	Quantity	Notes
Printed manuals	IM WT5000-03EN	1	Getting Started Guide (this guide)
	IM WT5000-92Z1	1	Document for China
	PIM 113-01Z2	1	List of worldwide contacts
Manual CD	B8215ZZ	1	For details, see the following table.

Manual CD

The English folder in the manual CD contains the PDF files shown below. The CD also contains Japanese manuals.

File Name	Manual Title	Manual No.
Features Guide & Users Manual.pdf	WT5000 Precision Power Analyzer Features Guide	IM WT5000-01EN
	WT5000 Precision Power Analyzer User's Manual	IM WT5000-02EN
Communication Interface.pdf	WT5000 Precision Power Analyzer Communication Interface User's Manual	IM WT5000-17EN

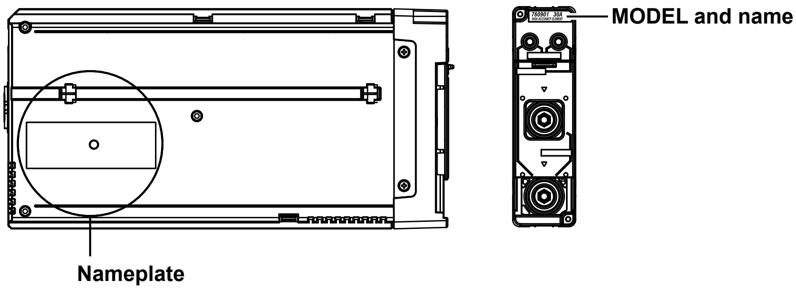
To view the PDF files above, you need Adobe Reader.

Input Elements (sold separately)

Check that the product that you received is what you ordered by referring to the model name on the input element.

MODEL	Name
760901	30A High Accuracy Element
760902	5A High Accuracy Element

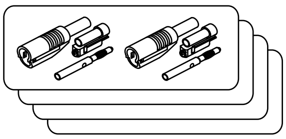
Example: 760901



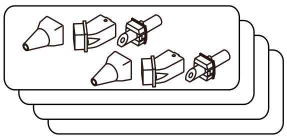
Input Element's Standard Accessories.

The following accessories are included. Check that all contents are present and undamaged.

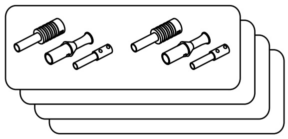
Safety terminal adapter set[1, 2]
B9317WB(black)/B9317WC(red)
(for voltage input)



High Current Safety Terminal Adapter Set[1, 3]
A1650JZ(black)/A1651JZ(red)
(for 30 A current input)

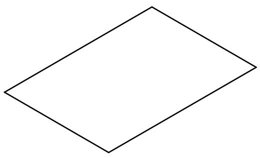


Current Safety Terminal Adapter Set[1, 4]
B8213YA(red)/B8213YB(black)
(for 5 A current input)



Hexagonal wrench[2]
B9317WD

Manual
IM 760901-01EN



Standard accessories are not covered by the input element warranty.

1 For the assembly procedure, see section 2.7.
2 An adapter set is included for every 760901 and 760902 input element.
3 An adapter set is included for every 760901 input element.
4 An adapter set is included for every 760902 input element.

Optional Accessories (Sold separately)

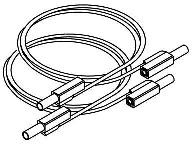
The optional accessories below are available for purchase separately. For information about ordering accessories, contact your nearest YOKOGAWA dealer.

- Use the accessories specified in this manual. Moreover, use the accessories of this product only with Yokogawa products that specify them as accessories.
- Use the accessories of this product within the rated range of each accessory. When using several accessories together, use them within the specification range of the accessory with the lowest rating.

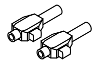
Item	Model/ Part No.	Maximum Rated Voltage to Ground	Notes	Manual No.
Measurement lead	758917	1000 V CAT II	Two pieces in one set Used with the 758922 or 758929 adapter (sold separately). Cable length: Approx. 0.75 m	—
Safety terminal adapter set	758923	600 V CAT II	Two pieces in one set	—
	758931	1000 V CAT II	Two pieces in one set With hexagonal wrench (B9317WD)	IM 758931-01
Current safety terminal adapter set	761953	1000 V CAT II	Two pieces in one set	IM 761953-01
High current safety terminal adapter set	761951	1000 V CAT II	Two pieces in one set	IM 761951-01
Safety terminal adapter set	761952	1000 V CAT II	Two pieces in one set	IM 761952-01
Alligator clip adapter set	758922	300 V CAT II	Two pieces in one set For the 758917 measurement lead	—
	758929	1000 V CAT II	Two pieces in one set For the 758917 measurement lead	—
BNC cable	366924	—	42 V or less. Total length: Approx. 1 m.	—
	366925	—	42 V or less. Total length: Approx. 2 m.	—
Safety BNC cable	701902	1000 V CAT II	Cable length: Approx. 1 m	—
	701903	1000 V CAT II	Cable length: Approx. 2 m	—
External sensor cable	B9284LK	—	For connecting to the external current sensor input terminal of this instrument. Cable length: Approx. 0.5 m.	—
Conversion adapter	758924	1000 V CAT II	BNC-4 mm socket adapter	—

Accessories (sold separately) are not covered by warranty.
The minimum purchase quantity is 1 piece.
The maximum rated voltage to ground is an rms value.

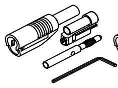
Measurement lead (approx. 0.75 m) 758917



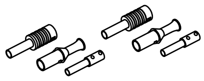
Safety terminal adapter set 758923



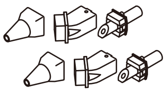
Safety terminal adapter set 758931



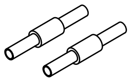
Current safety terminal adapter set 761953



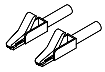
High current safety terminal adapter set 761951



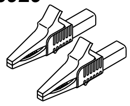
Safety terminal adapter set 761952



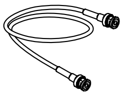
Alligator clip adapter set 758922



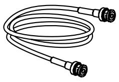
Alligator clip adapter set 758929



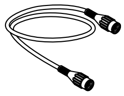
BNC cable (approx. 1 m) 366924



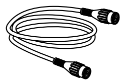
BNC cable (approx. 2 m) 366925



Safety BNC cable (approx. 1 m) 701902

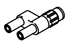


Safety BNC cable (approx. 2 m) 701903



External sensor cable (approx. 0.5 m) B9284LK

Conversion adapter 758924



Conventions Used in This Manual

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 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 the proper operation of the instrument.

Unit

k: Denotes 1000.	Example: 100 kHz
K: Denotes 1024.	Example: 720 KB (file size)

Character Notations

Menu Names and Panel Keys in Bold Characters

Indicate controls such as menu commands, tabs, and buttons that appear on the screen and front panel keys

Safety Precautions

This product is designed to be used by a person with specialized knowledge.
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.
This manual is part of the product and contains important information. Store this manual in a safe place close to the instrument so that you can refer to it immediately. Keep this manual until you dispose of the instrument.

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.

Electric shock, danger

Protective earth ground or protective earth ground terminal

Ground or the functional ground terminal (do not use as the protective earth ground terminal)

Alternating current

Direct current

Both direct and alternating current

ON (power)

OFF (power)

Power-on state

Power-off 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
This instrument 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
Make sure that the power supply voltage matches the instrument's rated supply voltage and that it does not exceed the maximum voltage range of the power cord to use.

Use the Correct Power Cord and Plug
To prevent electric shock or fire, use the power cord for the instrument. 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. Further, do not use this power cord with other instruments.

Connect the Protective Ground Terminal
Make sure to connect the protective earth to prevent electric shock before turning on the power. The power cord to use 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 gases 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.

Connect Cables Correctly

This instrument 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 instrument 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 terminals of this instrument 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.

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

- The input terminals are not abnormally hot.

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.

Manual CD

Never play this manual CD, which contains the user's manuals, in an audio CD player.
Doing so may cause loss of hearing or speaker damage due to the large sounds that may be produced.

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 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.

French

AVERTISSEMENT

Utiliser l’instrument aux seules fins pour lesquelles il est prévu
Cet instrument est un instrument de mesure de puissance pouvant mesurer des paramètres tels que la tension, le courant et la puissance. Ne pas utiliser cet instrument à des fins autres que la mesure de puissance.

Inspecter l’apparence physique
Ne pas utiliser l’instrument si son intégrité physique semble être compromise.

Vérifier l’alimentation
Assurez-vous que la tension d’alimentation correspond à la tension d’alimentation nominale de l’appareil et qu’elle ne dépasse pas la plage de tension maximale du cordon d’alimentation à utiliser.

Utiliser le cordon d’alimentation et la fiche adaptés
Pour éviter tout risque de choc électrique, utiliser exclusivement le cordon d’alimentation prévu pour cet instrument. La fiche doit être branchée sur une prise secteur raccordée à la terre. En cas d’utilisation d’une rallonge, celleci doit être impérativement reliée à la terre. Par ailleurs, ne pas utiliser ce cordon d’alimentation avec d’autres instruments.

Brancher la prise de terre
Avant de mettre l’instrument sous tension, penser à brancher la prise de terre pour éviter tout choc électrique. Le cordon d’alimentation à utiliser est un cordon d’alimentation à trois broches. Brancher le cordon d’alimentation sur une prise de courant à trois plots et mise à la terre.

Ne pas entraver la mise à la terre de protection
Ne jamais neutraliser le fil de terre interne ou externe, ni débrancher la borne de mise à la terre. Cela pourrait entraîner un choc électrique ou endommager l’instrument.

Ne pas utiliser lorsque les fonctions de protection sont défectueuses
Avant d’utiliser l’instrument, vérifier que les fonctions de protection, telles que le raccordement à la terre et le fusible, fonctionnent correctement. En cas de dysfonctionnement possible, ne pas utiliser l’instrument.

Ne pas utiliser dans un environnement explosif
Ne pas utiliser l’instrument en présence de gaz ou de vapeurs inflammables. Cela pourrait être extrêmement dangereux.

Ne pas retirer le capot, ni démonter ou modifier l’instrument
Seul le personnel YOKOGAWA qualifié est habilité à retirer le capot et à démonter ou modifier l’instrument. Certains composants à l’intérieur de l’instrument sont à haute tension et par conséquent, représentent un danger.

Relier l'instrument à la terre avant de le brancher sur des connexions externes
Toujours relier l'instrument à la terre avant de le brancher aux appareils à mesurer ou à une commande externe. Avant de toucher un circuit, mettre l'instrument hors tension et vérifier l'absence de tension.

Catégorie de mesure
Cet instrument appartient à la catégorie de mesure II. Ne pas l'utiliser pour réaliser des mesures de catégorie III ou IV.

Installer et utiliser l'instrument aux emplacements appropriés
- Ne pas installer, ni utiliser l'instrument à l'extérieur ou dans des lieux exposés à la pluie ou à l'eau.
- Installer l'instrument de manière à pourvoir immédiatement le débrancher du secteur en cas de fonctionnement anormal ou dangereux.

Brancher les câbles correctement
L'instrument est capable de mesurer directement les tensions et les courants élevés. L'utilisation d'un transformateur de tension ou d'un transformateur de courant avec cet instrument permet de mesurer des tensions et des courants encore plus élevés. Lors de la mesure d'une tension ou d'un courant élevé, la capacité de l'appareil mesuré devient élevée. Si les câbles sont incorrectement branchés, une surtension ou une surintensité risque de se produire dans le circuit soumis à la mesure. Cela pourrait non seulement endommager l'instrument et l'appareil mesuré, mais aussi entraîner un choc électrique et un incendie. Toujours brancher les câbles correctement et vérifier les points suivants.

Avant de procéder à une mesure (avant de mettre l'appareil mesuré sous tension), vérifier que :
- Les câbles ont été correctement branchés sur les bornes de l'instrument.
  Les câbles de mesure de la tension n'ont pas été malencontreusement branchés sur les bornes d'entrée de courant.
  Les câbles de mesure du courant n'ont pas été malencontreusement branchés sur les bornes d'entrée de tension.
  Pour la mesure d'alimentation multiphase, vérifier que le câblage est correct.
- Les câbles ont été correctement branchés sur le secteur et sur l'appareil à mesurer.
  Vérifier qu'il n'y a pas de court-circuit entre les bornes ou les câbles.

Pendant la mesure (ne jamais toucher les bornes et les câbles branchés lorsque l'appareil à mesurer est sous tension), vérifier que :
- Les bornes d'entrée ne chauffent pas anormalement.

Après la mesure (tout de suite après avoir mis l'appareil mesuré hors tension) :
Si vous avez mesuré une tension ou un courant élevé, une puissance résiduelle peut rester un certain temps dans l'appareil mesuré, même après sa mise hors tension. La puissance résiduelle peut entraîner un choc électrique, par conséquent, après avoir mis l'appareil hors tension, il convient d'attendre avant de toucher les bornes d'entrée. La durée pendant laquelle la puissance résiduelle reste dans l'appareil mesuré varie selon les appareils.

Manuel CD

Ce CD contient les manuels d’utilisation. Ne jamais insérer ce CD dans un lecteur de CD audio. Cela pourrait entraîner une perte d’audition ou l’endommagement des enceintes en raison du volume potentiellement élevé des sons produits.

Accessoires

Utiliser les accessoires spécifiés dans ce manuel. En outre, utiliser les accessoires de ce produit uniquement avec des produits Yokogawa pour lesquels ils sont spécifiés comme accessoires.
Ne pas utiliser d’accessoires défectueux.

ATTENTION

Limitations relatives à l’environnement opérationnel

Ce produit est un produit de classe A (pour environnements industriels). L’utilisation de ce produit dans un zone résidentielle peut entraîner une interférence radio que l’utilisateur sera tenu de rectifier.

Regulations and 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 of 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 Test & Measurement Corporation for this product in the EEA. To contact Yokogawa Europe B. V., see the separate list of worldwide contacts, PIM 113-01Z2.

關於在台灣銷售

This section is valid only in Taiwan.

關於在台灣所販賣的符合其相關規定的電源線 A1100WD 的限用物質含量信息，請至下麵的網址進行查詢

http://tmi.yokogawa.com/gs/service-support/product-compliance/

Contents

Chapter 6 Specifications

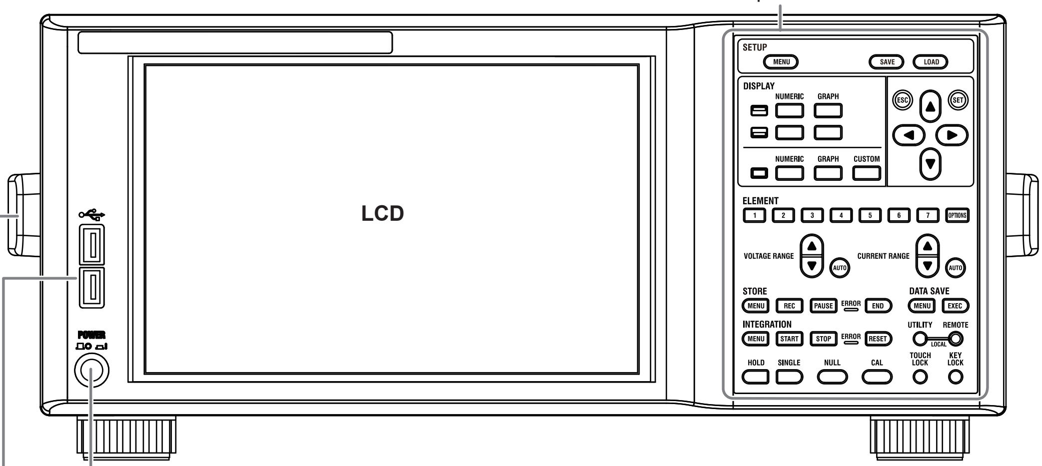
Appendix

1.1 Front Panel, Rear Panel, and Top Panel

Front Panel

Handle

Setup and execution keys
Explanation → section 1.2



Power switch

USB ports for peripherals
Use to connect a USB keyboard, mouse, or memory device.
Usage explanation → section 3.4 and the user's manual

Rear Panel

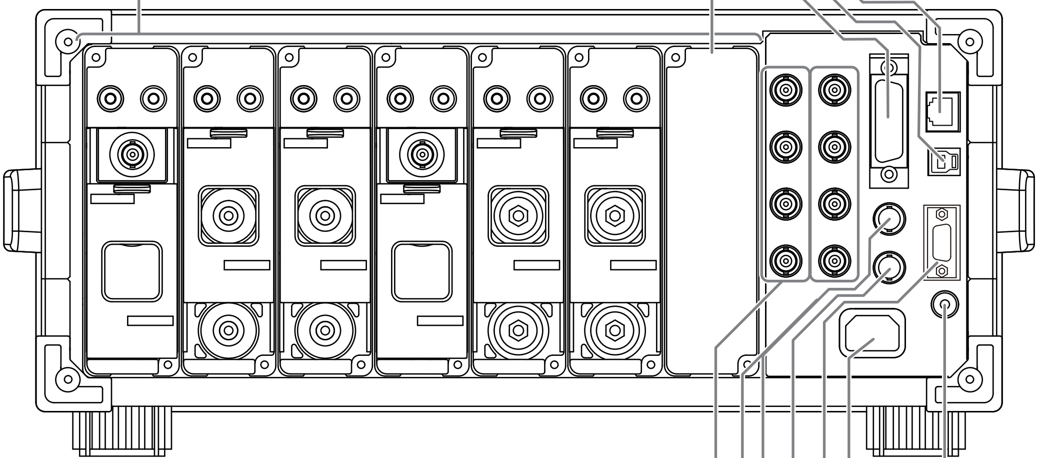
GP-IB port
Use to communicate with the instrument through the GP-IB interface.
→ Communication Interface User's Manual

USB port for PCs
Use to connect to a PC that has a USB port.
→ Communication Interface User's Manual

Input element installation slots
There are seven slots.
→ section 2.3

Ethernet port
Use to connect a network
→ Features Guide and Communication Interface User's Manual

Protection cover panel for empty slots
Attach it when there is no input element in the slot.



Models with the motor evaluation function 1 option

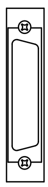
Torque signal/rotation signal/auxiliary input connector (option) ⚠
Receives signals from a torque meter, rotation sensor, or sensor during motor evaluation.
→ section 4.1

Models with the motor evaluation function 2 option

Torque signal/rotation signal/auxiliary input connector (option) ⚠

Models with the 20 channel D/A output option

D/A output and remote control connector (option) ⚠



D/A output
Transmits DC voltage (an analog signal) that corresponds to the numeric data. → section 4.5

Remote control
Receives control signals for holding values; performing single measurements; and starting, stopping, and resetting integration. → section 4.5

Functional ground terminal ⚠
Use this in a noisy environment to reduce operation errors and adverse effects on measurements caused by noise. → section 2.2

Power inlet ⚠
→ section 2.4

VIDEO OUT (WXGA) output connector ⚠
Transmits image signals. → section 4.4

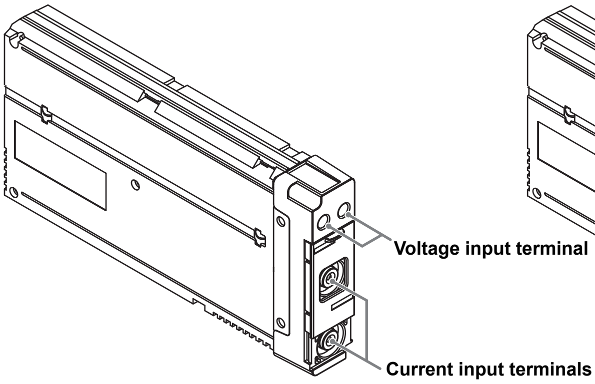
External start signal I/O connector ⚠
Use to perform master and slave synchronized measurement.
→ section 4.3

External clock input connector ⚠
- Receives the synchronization source (signal), which determines the measurement period.
→ section 4.2
- Receives the external PLL source (signal) for harmonic measurement.
→ section 4.2
- Receives the external trigger source (signal) for waveform display.
→ section 4.2

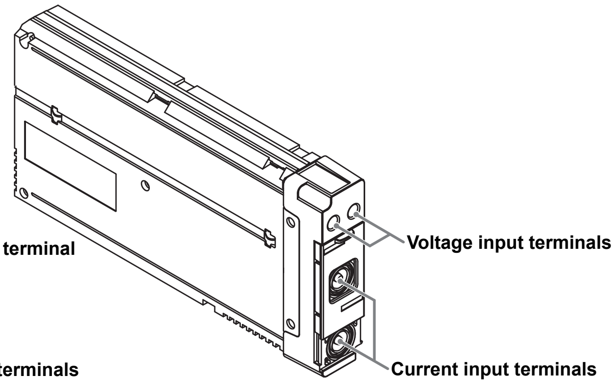
Input Elements

The following two input elements are available.

30A High Accuracy Element
(Model: 760901)



5A High Accuracy Element
(Model: 760902)

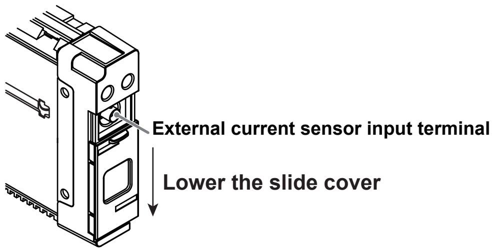


Voltage input terminals ⚠

For connecting voltage measurement cables
→ sections 2.8 to 2.11

External current sensor input terminal ⚠

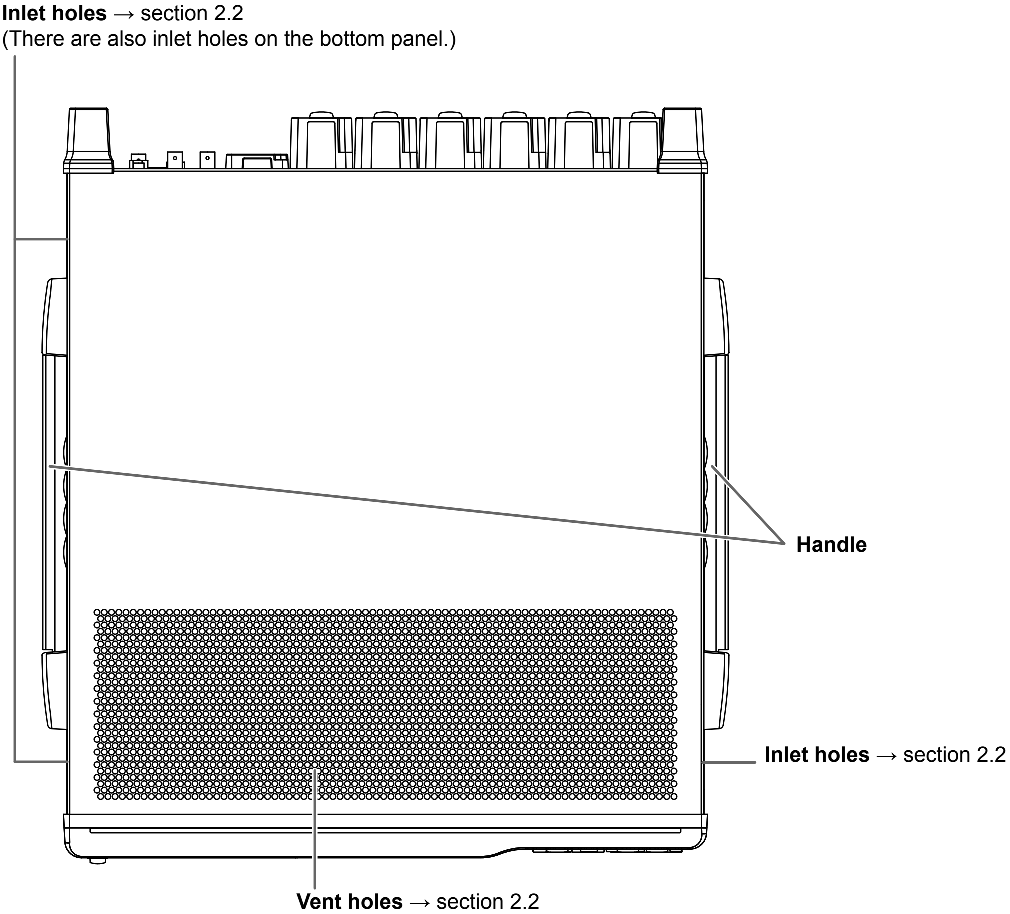
For connecting cables from an external current sensor
→ section 2.10



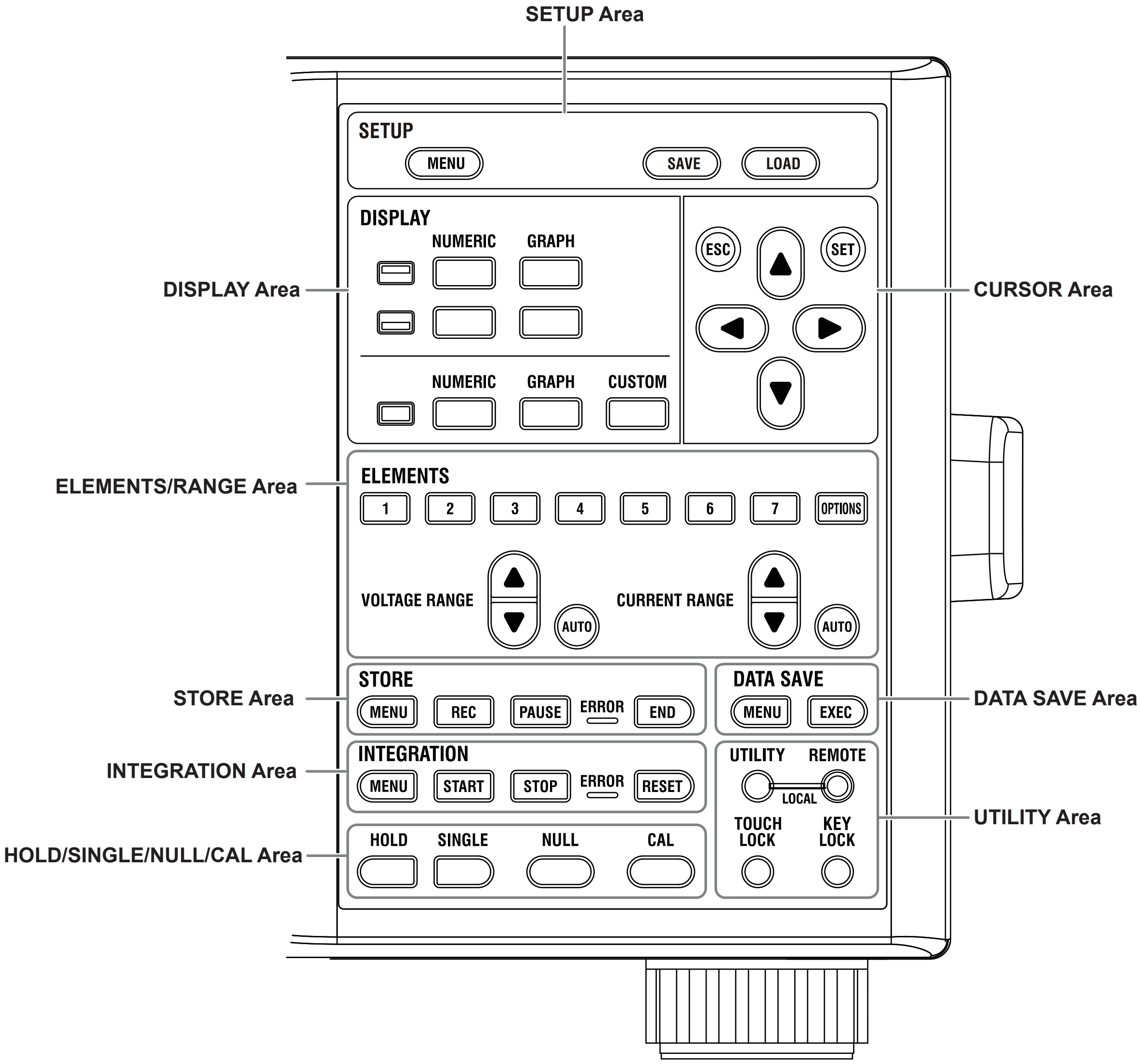
Current input terminals ⚠

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

Top Panel


Inlet holes → section 2.2
(There are also inlet holes on the bottom panel.)
Handle
Inlet holes → section 2.2
Vent holes → section 2.2

1.2 Panel Keys



SETUP Area

MENU Key

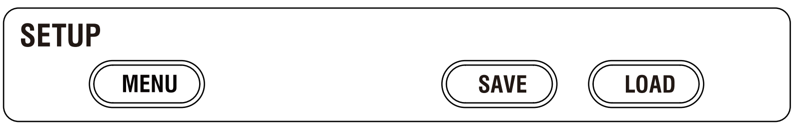
Press this key to show the setup menu.

SAVE Key

Press this key to show a menu for saving setup parameters.

LOAD Key

Press this key to show a menu for loading setup parameters.



DISPLAY Area

NUMERIC Key (top half of the split display)

Press this key to show numeric data in the top half of the split display.

GRAPH Key (top half of the split display)

Press this key to show graphs (waveforms, trends, bar graphs, vectors) in the top half of the split display.

NUMERIC Key (bottom half of the split display)

Press this key to show numeric data in the bottom half of the split display.

GRAPH Key (bottom half of the split display)

Press this key to show graphs (waveforms, trends, bar graphs, vectors) in the bottom half of the split display.

NUMERIC Key (full screen)

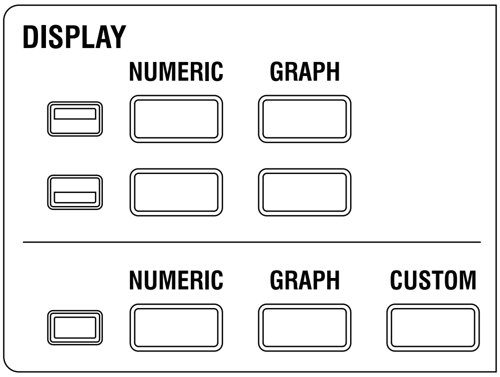
Press this key to show numeric data in full screen.

GRAPH Key (full screen)

Press this key to show graphs (waveforms, trends, bar graphs, vectors) in full screen.

CUSTOM Key (full screen)

The CUSTOM key cannot be used currently. Nothing will appear even if you press this key.



Functions Common to All Keys

Pressing a key causes the key to light.

Functions Common to the NUMERIC Keys

Pressing the key repeatedly causes the display format of the numeric display to switch as follows: All Items → 4 Items → 8 Items → 16 Items → Matrix → Hrm List Single → Hrm List Dual → All Items → …

Functions Common to the GRAPH Keys

Pressing the key repeatedly causes the display to switch as follows: waveform → trend → bar graph → vector → waveform → ...

CURSOR Area

ESC Key

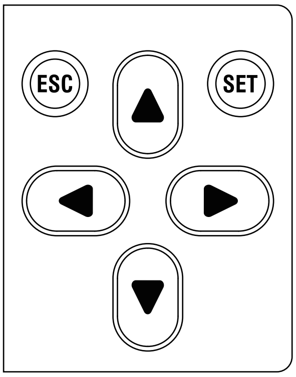
- Press this key to clear a menu or dialog box.
- If lower level menus are displayed, the menu is cleared one level at a time.

SET Key

Press this key to confirm the parameter selected with the arrow keys or the entered value.

Arrow Keys (▲▼◀▶ keys)

- Press the ◀ and ▶ keys to move the cursor between digits when entering a number.
- Press the ▲ and ▼ keys to increase and decrease the number you are entering. Press these keys also to select settings.



ELEMENTS/RANGE Area

1 to 7 Keys

- Press this key to select the input element that you want to select the measurement range for.
- The selected element key lights.
- When you select the wiring system, input elements that are assigned to the same wiring unit are selected at the same time.

OPTIONS Key

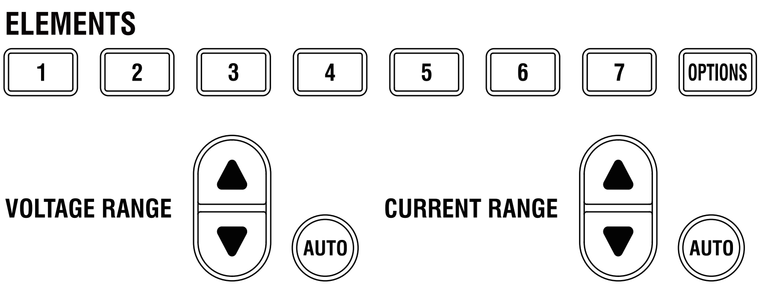
- On models with the motor evaluation option, press this key to show a menu for configuring the motor evaluation function or auxiliary input function.
- Press this key to show the motor evaluation function (option) in the input information area of the display.

▲ and ▼ Keys

- Press these keys to select the voltage range, current range, or external current sensor range.
- The ranges selected with these keys are valid when the AUTO key described below is not illuminated (when the fixed range feature is being used).

AUTO Key

- Press AUTO to activate the auto range feature. When this feature is active, the AUTO key is lit. The auto range feature automatically sets the voltage, current, and external current sensor ranges depending on the amplitude of the received electrical signal.
- Press AUTO again to activate the fixed range feature. The AUTO key turns off.



STORE Area

MENU Key

Press this key to show a store menu.

REC Key

Press this key to start storing data and create a file. While storing, this key lights.

PAUSE Key

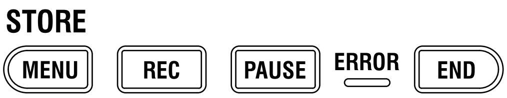
Press this key to pause the storage operation. While paused, this key blinks.
When storage is complete, this key lights.

ERROR LED

This LED blinks when a storage error occurs.

END Key

Press this key to end the storage operation and close the file.



DATA SAVE Area

MENU Key

Press this key to show a data save menu.

EXEC Key

Press this key to save data.

INTEGRATION Area

MENU Key

Press this key to show an integration menu.

START Key

Press this key to start (execute) integration. While integration is in progress, this key lights.

STOP Key

Press this key to stop integration. While stopped, this key blinks.
When integration is complete, this key lights.

ERROR LED

This LED blinks when an integration error occurs.

RESET Key

Press this key to reset integration.

HOLD/SINGLE/NULL/CAL Area

HOLD Key

- Press this key to switch from updating the display after each data update interval to stopping the series of display operations and holding the display of the numeric data. When HOLD is on, the key lights.
- If you press the key again, the hold operation is released, and the updating of the numeric data display resumes.

SINGLE Key

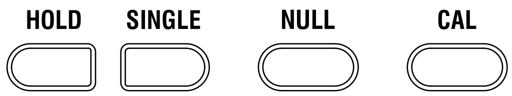
Press SINGLE while data is being held to take a single measurement at the set data update interval, update the data, and hold the data again.

NULL Key

- Press this key to execute the null function. When the null function is on, the key lights.
- Press the key again to release the null function.

CAL Key

Press this key to execute zero-level compensation. When zero level compensation is executed, the instrument creates a zero input condition in its internal circuitry and sets the zero level to the level at that point.



UTILITY Area

UTILITY Key

- Press this key to show a utility menu.
- In remote mode (the REMOTE LED is lit), press this key to change to local mode, which enables front panel key operation.

REMOTE LED

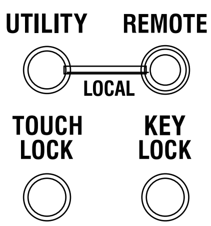
When the instrument is set to remote mode through the communication interface, the LED lights.

TOUCH LOCK Key

- Press this key to lock touch panel operations. The key lights.
- Press the key again to clear that state.

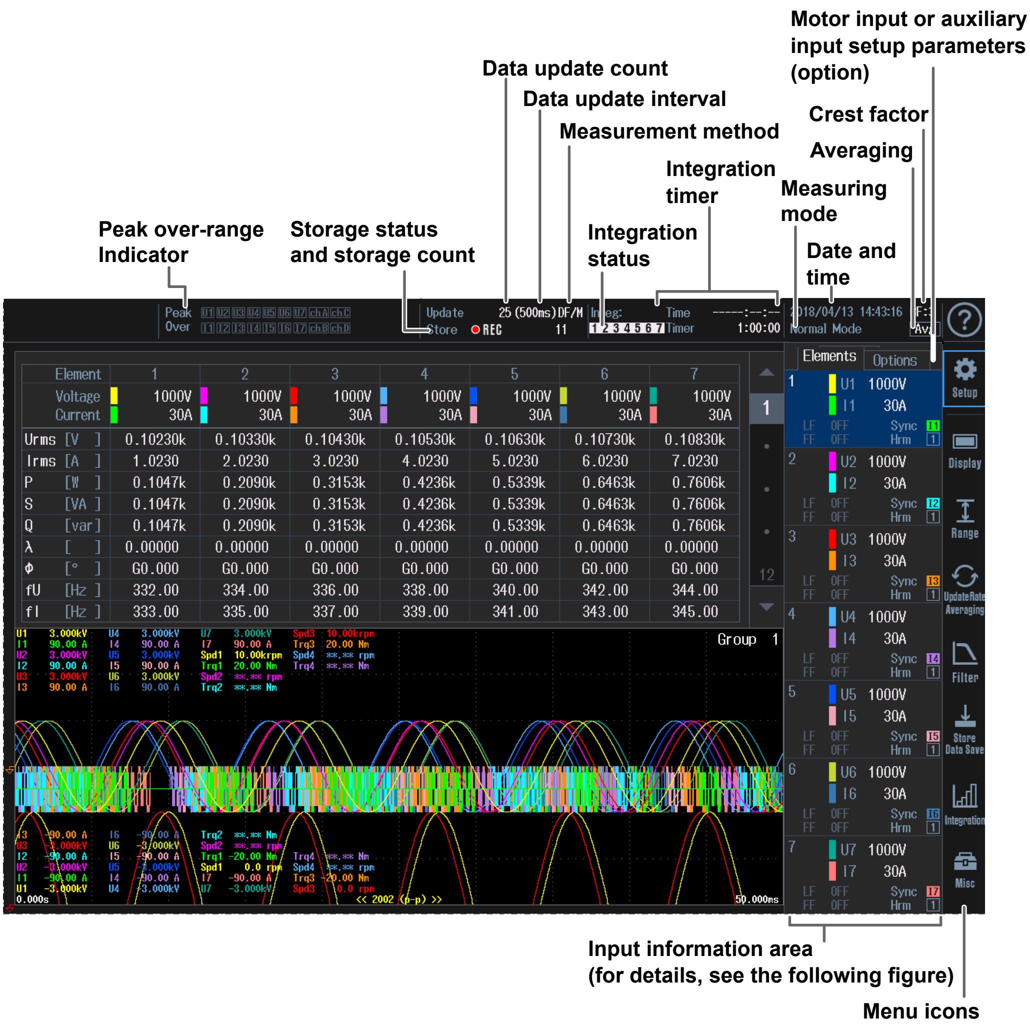
KEY LOCK key

- Press this key to lock the keys on the front panel. The key lights.
- Press the key again to clear that state.

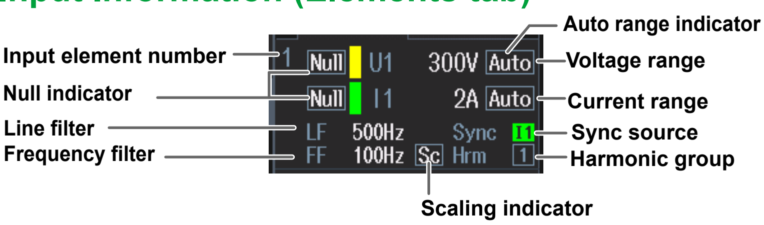


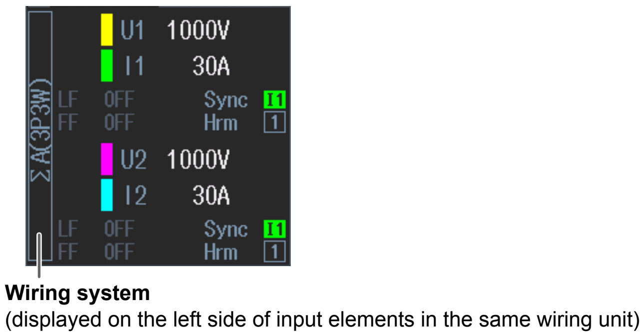
1.3 Screens

Display Example When Measuring Power (Numeric and waveform displays)



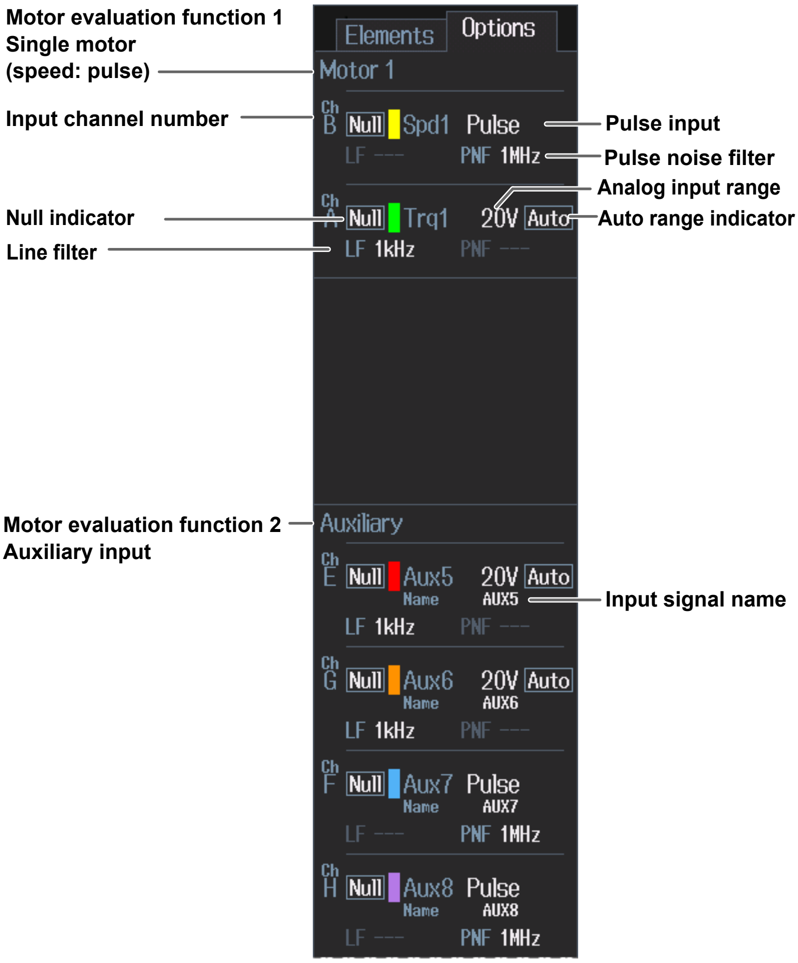
Input Information (Elements tab)





Input Information (Options tab)

Display example when motor evaluation function 1 is set to single motor (speed: pulse) and motor evaluation function 2 is set to Auxiliary



Non-Numeric Displays

--OL--

Overload indicator
Displayed if the measured value exceeds 140%[1] of the measurement range for crest factor CF3 or CF6.
Displayed if the measured value exceeds 280%[2] of the measurement range for crest factor CF6A.
1 160% for the 1000 V range at CF3 and 500 V range at CF6
2 320% for the 500 V range at CF6A

--OF--

Overflow indicator
Displayed if the measured or computed result cannot be displayed using the specified decimal place or unit.

No-data indicator
Displayed if a measurement function is not selected or if there is no numeric data.

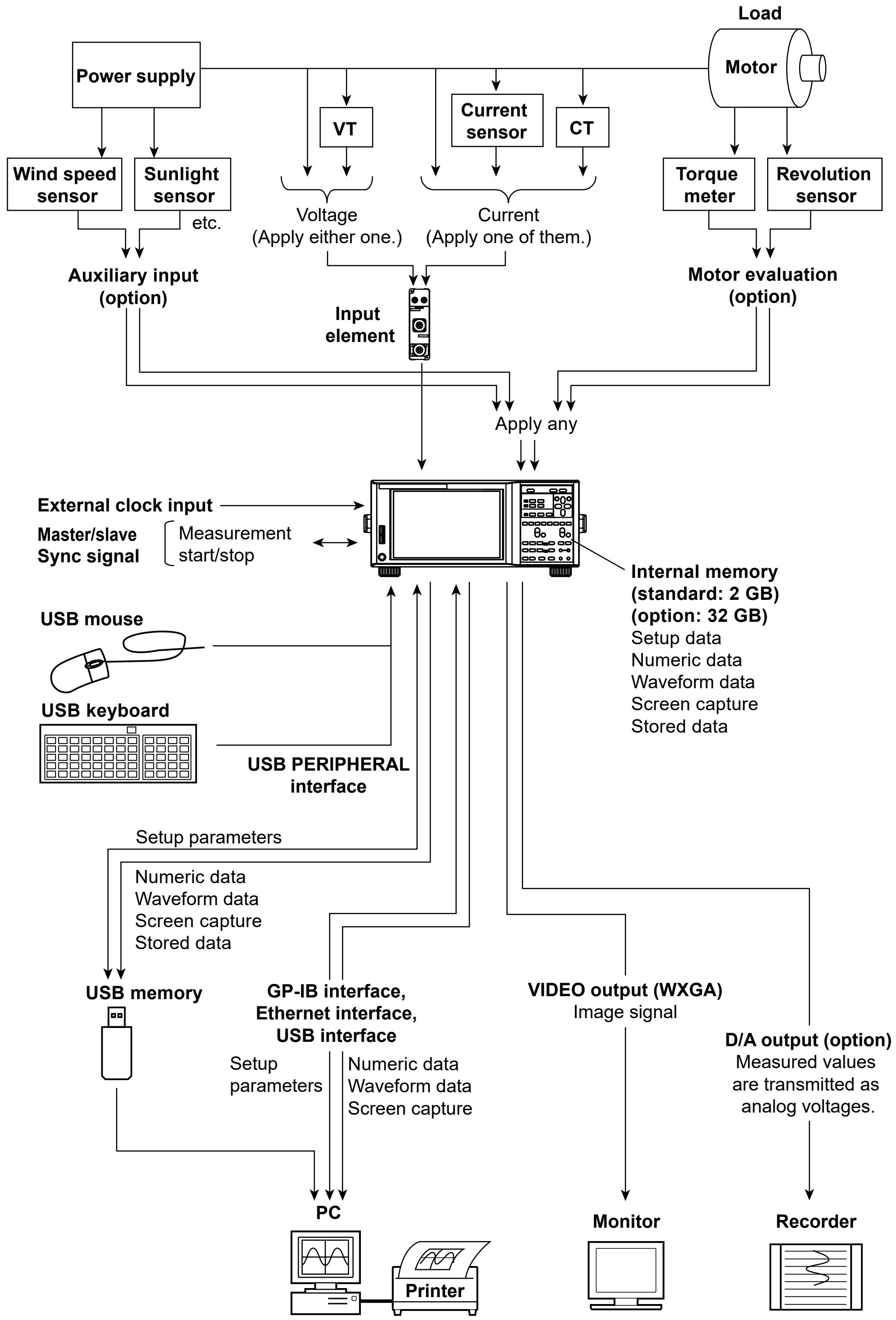
Error

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

Note

The instrument's LCD may have a few defective pixels. For details, see section 6.3, "Display."

1.4 System Configuration



2.1 Handling Precautions

Safety Precautions

If you are using this instrument for the first time, make sure to thoroughly read the safety precautions given on pages ix to xv.

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 or if you are using the instrument in a location where the power supply specifications are different, purchase a power cord that matches the specifications of the region that the instrument will be used in.

Operating Environment and Conditions

This instrument complies with the EMC standard under specific operating environment and operating conditions. If the installation, wiring, and so on are not appropriate, the compliance conditions of the EMC standard may not be met. In such cases, the user will be required to take appropriate measures.

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.

Do Not Damage the LCD

Because the LCD is very vulnerable and can be easily scratched, do not allow any sharp objects near it. Also it should not be exposed to vibrations and shocks.

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.

When Carrying the Instrument

The instrument should only be carried by two persons. Firmly grasp the handles on the side of the case. The instrument can weigh as much as approximately 18 kg. Take care to avoid injury while moving the instrument.

WARNING

- When you hold or put away the handle, be careful not to get your hand caught between the handle and the case.
- When you carry the instrument, be careful not to get your hand caught between the wall, installation surface, or other objects and the instrument.

French

AVERTISSEMENT

- Lorsque vous attrapez ou rabattez la poignée, veillez à ne pas vous coincer la main entre la poignée et l'instrument.
- Lorsque vous déplacez l'instrument, veillez à ne pas vous coincer la main entre l'instrument et le mur, la surface d'installation ou tout autre objet.

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.
In addition, if storage device is inserted in the instrument, be sure to remove the storage device before you move the instrument.

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. These can cause discoloring and deformation.

2.2 Installing the Instrument

WARNING

- 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.

CAUTION

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

French

AVERTISSEMENT

- Ne pas installer, ni utiliser l'instrument à l'extérieur ou dans des lieux exposés à la pluie ou à l'eau.
- Installer l'instrument de manière à pourvoir immédiatement le débrancher du secteur en cas de fonctionnement anormal ou dangereux.

ATTENTION

Ne pas boucher les orifices d'entrée ou de sortie de l'instrument pour éviter toute surchauffe et panne éventuelle.

Installation Conditions

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

Flat, Even Surface

Install 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.
- Install the instrument as to avoid hot air from a heat source being sucked in through the inlet holes.

Ambient Temperature and Humidity

Ambient temperature: 5°C 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: 20% RH to 80% 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 6.
- 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.

Storage Location

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

When storing the instrument, avoid the following places.

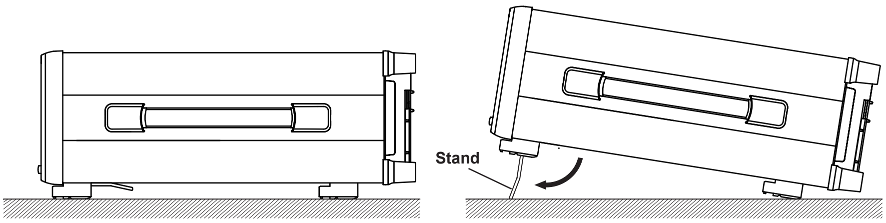
- Where the level of mechanical vibration is high
- In direct sunlight
- Where there are corrosive or explosive gases
- Where an excessive amount of soot, dust, salt, or iron is present
- Near a strong source of heat or moisture
- Where water, oil, or chemicals may splash onto the instrument

We recommend that the instrument be stored in an environment where the temperature is between 5°C and 40°C.

Installation Orientation

Desktop

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



Rubber Stoppers

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. Two sets of rubber stoppers (four stoppers) are included in the package.

WARNING

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

CAUTION

Do not apply excessive force or shock to the stand. Doing so may break the stand support.

French

AVERTISSEMENT

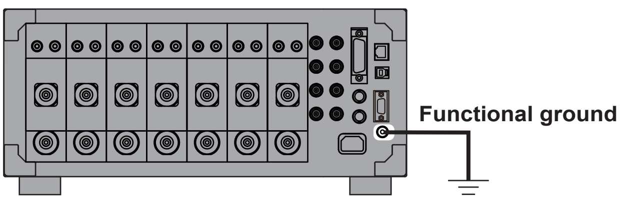
- Lorsque vous rabattez le support, veillez à ne pas vous coincer la main entre le support et l'instrument.
- Lorsque vous manipulez le support, soutenez toujours l'instrument fermement. Prenez les précautions suivantes.
  - Ne manipulez le support que lorsque l'instrument est placé sur une surface stable.
  - Ne manipulez pas le support lorsque l'instrument est incliné.
- Ne pas placer l'instrument dans des positions autres celles indiquées ci-dessus. Ne pas empiler l'instrument.

ATTENTION

Évitez d'appliquer une force excessive ou des chocs sur le support. Le système de soutien du support peut se casser.

Functional Ground

If you use this instrument in a noisy environment, measurement results may be affected by the noise, or interface communication may not operate properly. These problems may be alleviated by connecting the functional ground terminal to ground.



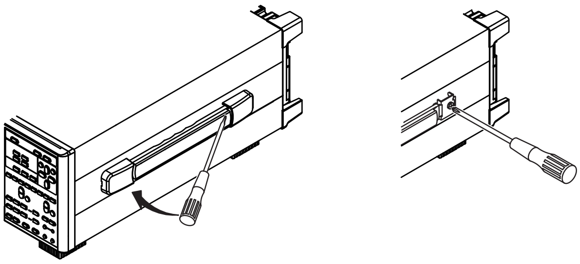
Rack Mounting

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

Item	Model	Notes
Rack mount kit	751542-E4	For EIA
Rack mount kit	751542-J4	For JIS

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.

1. Remove the handles from both sides of the instrument.



2. Remove the four feet from the bottom of the instrument.
3. Remove the two plastic rivets and the four seals covering the rack mount attachment holes on each side of the instrument near the front.
4. Place seals over the feet and handle attachment holes.
5. Attach the rack mount kit to the instrument.
6. Mount the instrument on a rack.

Note

- Rack mount in the following manner to prevent internal heating.
    - Allow at least 20 mm of space around the inlet and vent holes.
    - Insert shelves to prevent hot air from peripheral devices from hitting this instrument.
- Make sure to provide adequate support from the bottom of the instrument. The support should not block the inlet and vent holes.

2.3 Installing Input Elements

WARNING

- To prevent electric shock and damage to the instrument, be sure to turn the power off before you install or remove input elements.
- Check that the input cable is not connected to the input terminals before installing or removing input elements.
- To prevent electric shock and to satisfy the specifications, make sure to put the accessory cover panel on the slots that are not being used. Using the instrument without the cover panel allows the dust to enter the instrument and may cause malfunction due to the rise in temperature inside the instrument.
- If an input element happens to come out of the slot while it is in use, it may cause electric shock or cause damage to the instrument as well as the input element. Make sure to screw input elements in place at the two locations (top and bottom).
  Torque for tightening the screws: 0.6 N•m
- There are protrusions in the slot. Do not put your hand in the slot. If you put your hand in the slot, the protrusions may cut your hand.

Precautions to Be Taken When Using the Elements

- Do not apply an input voltage exceeding the maximum input voltage, maximum isolation voltage, withstand voltage, or allowable surge voltage.
- To avoid electric shock, be sure to ground the instrument.
- To prevent the possibility of electric shock, be sure to fasten the element screws. Failing to do so is extremely dangerous because the electrical and mechanical protection functions will not be activated.
- Avoid continuous connection under an environment in which the surge voltage may occur.

French

AVERTISSEMENT

- Pour éviter tout risque de choc électrique et d'endommagement de l'instrument, veillez à mettre l'instrument hors tension avant d'installer ou de retirer des éléments d'entrée.
- Avant d'installer ou de retirer des éléments d'entrée, vérifiez que le câble d'entrée n'est pas connecté aux bornes d'entrée.
- Afin d'éviter tout risque de choc électrique et de respecter les spécifications, assurez-vous de mettre le cache de recouvrement sur les slots non utilisés. L'utilisation de l'instrument sans le cache laisse entrer la poussière dans l'instrument, ce qui peut causer un dysfonctionnement dû à une élévation de la température à l'intérieur de l'instrument.
- Si un élément d'entrée sort du slot en cours d'utilisation, il peut provoquer un choc électrique ou endommager l'instrument, ainsi que l'élément d'entrée. Assurez-vous de visser les éléments d'entrée dans les deux emplacements (haut et bas).
  Couple de serrage des vis : 0.6 N•m
- Les sots présentent des rebords en saillie. Ne pas insérer les doigts dans les slots, car les saillies pourraient vous blesser.

Précautions à prendre lors de l'utilisation des éléments

- N'appliquez pas de tension d'entrée dépassant la tension d'entrée maximum, la tension d'isolation maximum, la tension de maintient ou la surtension autorisée.
- Pour éviter tout risque de choc électrique, l'instrument doit impérativement être relié à la terre.
- Afin d'éviter toute possibilité de choc électrique, assurez-vous de fixer les vis des éléments. Le non-respect de cette consigne est extrêmement dangereux car les fonctions de protection électrique et mécanique ne seront pas activées.
- Évitez un branchement continu dans un environnement pouvant être soumis à une surtension.

Input Element Types

The following two types are available.

30A High Accuracy Element	760901
5A High Accuracy Element	760902

Notes in Installing and Removing Input Elements

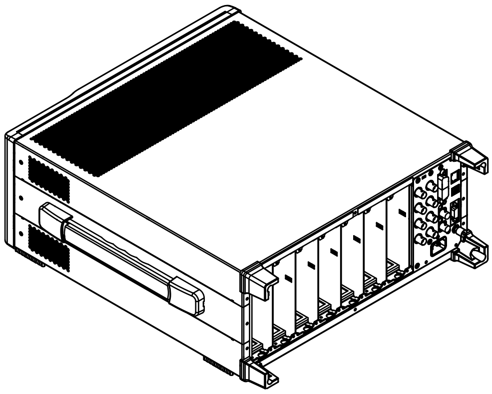
- A wiring unit is configured with adjacent input elements. It is not possible to configure a wiring unit using input elements that are separated apart.
- If you replace one installed input element with another, the settings other than those indicated below will be initialized when the power is turned on.
  - Date and time settings
  - Communication settings
  - Menu and message language settings

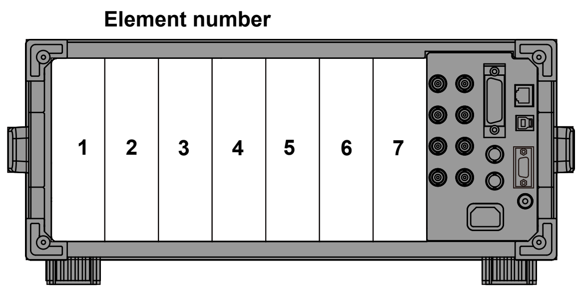
  If you want to keep the settings, specify a save destination and save them before replacing the input element.

Installing Elements

1. Make sure that the instrument's power switch is turned off.
2. Check the element numbers indicated above the input element installation slots on the rear panel of this instrument. Then install the input elements in the appropriate slots.

   While holding the handles on the top and bottom of an input element, press hard until it clicks in place. If there is a cover panel on the slot you want to install an element in, remove the cover panel, first.
3. Fix the elements securely in place by fastening the supplied screws at the top and bottom locations of the input elements. (Screw tightening torque: 0.6 N•m)
4. Turn on the instrument's power switch.
5. In the overview screen, check that the names of the elements you installed are displayed correctly at the appropriate slots. If they are not correct, remove the elements according to the steps in "Removing Elements" provided later, and reinstall the elements according to steps 1 to 3 shown above. For instructions on how to display the overview screen, see section 14.7, "Viewing System Information (Overview)" in the User's Manual.





Note

Be sure to attach the supplied cover panels to unused slots.

Installation Positions of Input Elements

Install input elements in order from the smallest numbered slot. Do not skip slots.

Removing Elements

1. Make sure that the instrument's power switch is turned off.
2. Loosen the two screws that are fastened to the input element you want to remove.
3. Hold the two handles at the top and bottom of the input element, and pull it out.

Safety Precautions for Laser Products

The following input elements use laser light sources internally. The 760901 30A high accuracy element and 760902 5A high accuracy element are class 1 laser products as defined by IEC 60825-1: Safety of Laser Products—Part1: Equipment Classification, and Requirements. In addition, these instruments comply with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

- **760901 30A High Accuracy Element**
- **760902 5A High Accuracy Element**

  The following information is printed on the side.

Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No.50, dated June 24, 2007
2-9-32 Nakacho, Musashino-shi,
Tokyo 180-8750, Japan

WT5000

The following information is printed on the top.

Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No.50, dated June 24, 2007
2-9-32 Nakacho, Musashino-shi,
Tokyo 180-8750, Japan

Laser Specifications

- Laser Class: Class 1
- Maximum Output: 0 mW (This instrument doesn't radiate the laser beam to outside.)
- Wavelength: 850 ± 10 nm

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 warnings and requirements.

2.4 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 of the power cord to use.
- Connect the power cord after checking that the power switch of the instrument is turned off.
- To prevent electric shock or fire, use the power cord for the instrument.
- 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 there is no AC outlet that is compatible with the power cord that you will be using and you cannot ground the instrument, do not use the instrument.

French

AVERTISSEMENT

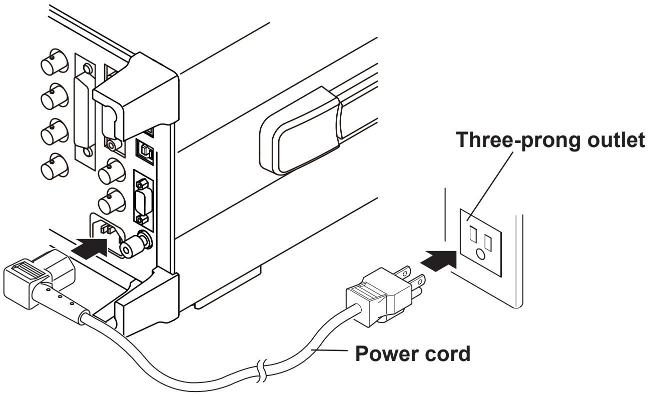
- Assurez-vous que la tension d’alimentation correspond à la tension d’alimentation nominale de l’appareil et qu’elle ne dépasse pas la plage de tension maximale du cordon d’alimentation à utiliser.
- Brancher le cordon d’alimentation après avoir vérifié que l’interrupteur de l’instrument est sur OFF.
- Pour éviter tout risque de choc électrique, utiliser exclusivement le cordon d’alimentation prévu pour cet instrument.
- Relier l’instrument à la terre pour éviter tout risque de choc électrique. Brancher le cordon d’alimentation sur une prise de courant à trois plots reliée à la terre.
- Toujours utiliser une rallonge avec broche de mise à la terre, à défaut de quoi l’instrument ne serait pas relié à la terre.
- Si une sortie CA conforme au câble d’alimentation fourni n’est pas disponible et que vous ne pouvez pas relier l’instrument à la terre, ne l’utilisez pas.

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	Specifications
Rated supply voltage	100 VAC to 120 VAC, 220 VAC to 240 VAC
Permitted supply voltage range	90 VAC to 132 VAC, 198 VAC to 264 VAC
Rated supply frequency	50/60 Hz
Permitted supply frequency range	48 Hz to 63 Hz
Maximum power consumption	560 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. Check that the voltage supplied to the instrument is less than or equal to the maximum rated voltage of the power cord that you will be using before use.



2.5 Turning the Power Switch On and Off

Before Turning On the Power, Check That:

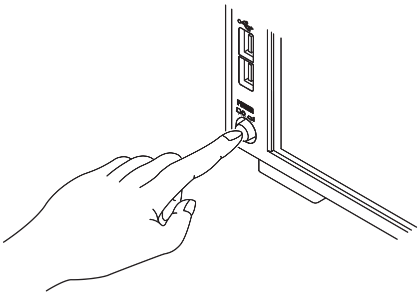
- The instrument is installed properly. → section 2.2, “Installing the Instrument”
- The power cord is connected properly. → section 2.3, “Connecting the Power Supply”

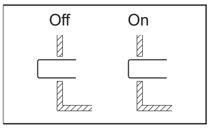
Power Switch Location

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

Turning On and Off the Power Switch

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

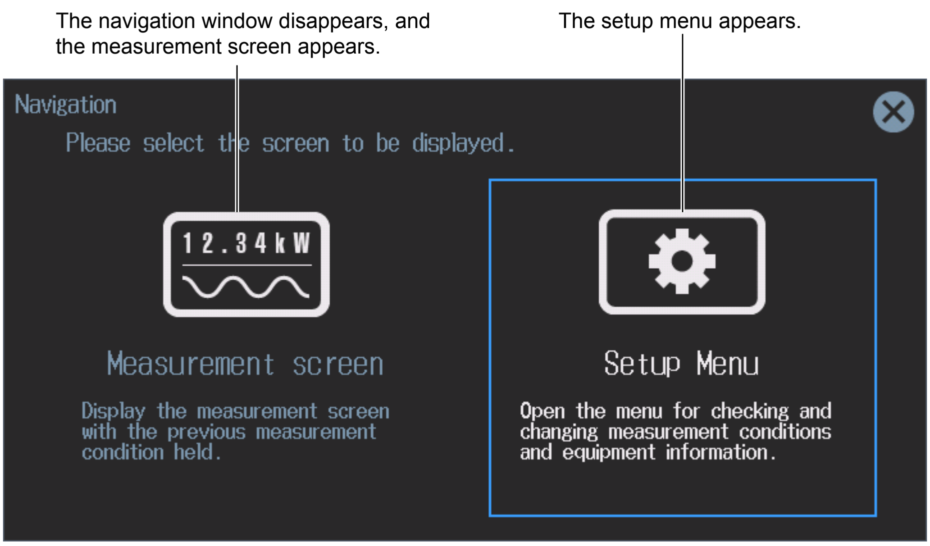
When the power switch is turned on, a self-test starts automatically. When the self-test completes successfully, the screen that was displayed immediately before the power was turned off appears. A navigation window also appears.

Before using the instrument, make sure that the self-test completes successfully.

Note

- After turning the power switch off, wait at least 10 seconds before you turn it on again.
- It may take a few seconds for the startup screen to appear.

Navigation window



When the Power-on Operation Does Not Finish Normally

Turn off the power switch, and check the following items.

- 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”
- Initialize the settings to their factory defaults by turning on the power switch while holding down the ESC key.

If the instrument still does not work properly after checking these items, contact your nearest YOKOGAWA dealer for repairs.

To Make Accurate Measurements

- After turning on the power switch, wait at least 30 minutes to allow the instrument to warm up.
- After warm-up, execute zero-level compensation. → see the user’s manual

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 battery. When the battery voltage falls below a specified value, you will no longer be able to store setup parameters, and a message (error 901) will appear on the screen when you turn on the power. If this message appears frequently, you need to replace the battery soon. You cannot replace batteries by yourself. Contact your nearest YOKOGAWA dealer to have the battery replaced.

CAUTION

Turning off the power switch abruptly or unplugging the power cord while the instrument is saving data may corrupt the media on which data is being saved. Also, the data being saved is not guaranteed. Always turn the power switch off after data has been saved.

French

ATTENTION

Une mise hors tension abrupte ou le débranchement du cordon d'alimentation tandis que l'instrument enregistre des données peuvent compromettre les supports sur lesquels les données sont enregistrées. De plus, l'enregistrement des données n'est pas garanti. Mettez toujours l'instrument hors tension après l'enregistrement des données.

2.6 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 safety terminal adapters, the conductive parts (bare wires) do not protrude from the adapters. Also, make sure to fasten the safety terminal adapter 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 connectors to the external current sensor input terminals, connect only those that have safety terminals that cover their conductive parts. Using a connector with bare conductive parts can be dangerous if the voltage is 42 V or higher.
- 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 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 a 30A High Accuracy Element (760901) and applying a current exceeding 10 A from a current transformer (CT) to this instrument, provide protection.
- When using a 5A High Accuracy Element (760902) and applying a current exceeding 0.7 A from a current transformer (CT) to this instrument, provide protection.
- When using an external current sensor, make sure to use a sensor that comes in a case. The conductive parts and the case should be insulated, and the sensor should have enough 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.
- 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.
- 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 (1 s or less)

Voltage input

Peak value of 2.5 kV or rms value of 1.5 kV, whichever is less.

Current input

Direct input

30A High Accuracy Element (760901)

Peak value of 150 A or rms value of 55 A, whichever is less.

5A High Accuracy Element (760902)

Peak value of 10 A or rms value of 7 A, whichever is less.

External current sensor input

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

Continuous maximum allowable input

Voltage input

Peak value of 1.6 kV or rms value of 1.5 kV, whichever is less.

Current input

Direct input

30A High Accuracy Element (760901)

Peak value of 90 A or rms value of 33 A, whichever is less.

5A High Accuracy Element (760902)

Peak value of 10 A or rms value of 7 A, whichever is less.

External current sensor input

Peak value less than or equal to 2.5 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 mm^2 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.

French

AVERTISSEMENT

- Relier l’instrument à la terre avant de brancher les câbles de mesure. Le cordon d’alimentation à utiliser est un cordon d’alimentation à trois broches. Brancher le cordon d’alimentation sur une prise de courant à trois plots mise à la terre.
- Mettre le circuit à mesurer hors tension avant de brancher et de débrancher les câbles. Il est dangereux de brancher ou de débrancher les câbles de mesure lorsque le circuit est sous tension.
- Ne pas brancher un circuit de courant sur une borne d’entrée de tension ou un circuit de tension sur une borne d’entrée de courant.
- Retirez les caches d'isolation des câbles de mesure pour qu'ils soient raccordés aux adaptateurs de bornes de sécurité, les parties conductrices (fils nus) ne dépassant pas des adaptateurs. De plus, assurez-vous de fixer correctement les vis des adaptateurs de bornes de sécurité de façon à éviter la désolidarisation des câbles.
- Lors de la connexion des câbles de mesure sur les bornes d’entrée de tension, ne brancher que des câbles de mesure dotés de bornes de sécurité capables de couvrir leurs éléments conducteurs. L’utilisation d’une borne dotée d’éléments conducteurs nus (comme une fiche banane) serait dangereuse si la borne venait à se détacher.
- Lors de la connexion de câbles sur les bornes d’entrée du capteur de courant, ne brancher que des câbles dotés de bornes de sécurité capables de couvrir leurs éléments conducteurs. L’utilisation d’un connecteur doté d’éléments conducteurs peut être dangereuse si la tension est de 42 V ou plus.
- Lorsque la tension du circuit à mesurer est appliquée aux bornes d’entrée de courant, ne pas toucher les bornes d’entrée de capteur de courant externe, car elles sont connectées électroniquement à l’intérieur de l’instrument, ce qui présente un danger.
- Lors du branchement d’un câble de mesure d’un capteur de courant externe sur un connecteur d’entrée de capteur de courant externe, retirer les câbles branchés sur les bornes d’entrée de courant. De plus, lorsque la tension du circuit à mesurer est appliquée aux bornes d’entrée de capteur de courant externe, ne pas toucher les bornes d’entrée de courant, car elles sont connectées électroniquement à l’intérieur de l’instrument, ce qui présente un danger.
- En cas d’utilisation d’un transformateur externe de tension ou de courant, vérifier que la rigidité diélectrique est suffisante pour la tension (U) à mesurer (2U + 1000 V recommandé). De plus, il convient d’éviter que le côté secondaire du transformateur de courant devienne un circuit ouvert pendant que le courant est appliqué. Si cela se produisait, la haute tension se déplacerait du côté secondaire du transformateur de courant, le rendant extrêmement dangereux.
- Il faut fournir une protection en cas d'utilisation d'un élément de haute précision de 30 A (760901) et si le courant appliqué sur cet instrument en provenance d'un transformateur de courant (CT) dépasse 10 A.
- Il faut fournir une protection en cas d'utilisation d'un élément de haute précision de 5 A (760902) et si le courant appliqué sur cet instrument en provenance d'un transformateur de courant (CT) dépasse 0,7 A.

- Lors de l'utilisation d'un capteur de courant externe, toujours utiliser un capteur rangé dans un étui. Les éléments conducteurs et l'étui doivent être isolés, et le capteur doit avoir une rigidité diélectrique suffisante pour la tension du circuit à mesurer. L'utilisation d'un capteur nu est dangereuse car le risque de le toucher accidentellement est très élevé.
- Lors de l'utilisation d'un capteur de courant de type shunt en guise de capteur de courant externe, mettre le circuit à mesurer hors tension avant de brancher le capteur. Il est dangereux de brancher ou de débrancher le capteur lorsque le circuit est sous tension.
- Lors de l'utilisation d'un capteur de courant par serrage en guise de capteur de courant externe, tenir compte de la tension du circuit à mesurer, des spécifications et des consignes de manipulation du capteur par serrage, puis vérifier l'absence de dangers, tels le choc électrique.
- Pour des raisons de sécurité, lors de l'utilisation de l'instrument après son installation sur un rack, prévoir un commutateur pour mettre le circuit mesuré hors tension depuis l'avant du rack.
- Pour garantir la sécurité, avant d'appliquer la tension ou le courant depuis le circuit à mesurer, vérifier ce qui suit :
    - Le cordon d'alimentation fourni avec l'instrument est utilisé pour la connexion à l'alimentation et la mise à la terre de l'instrument.
    - L'instrument est sous tension.
- Lorsque l'instrument est sous tension, ne pas appliquer de signal sur les bornes d'entrée de tension ou de courant dépassant les valeurs suivantes. Lorsque l'instrument est hors tension, éteindre également le circuit à mesurer. Pour de plus amples informations sur d'autres bornes d'entrée, se reporter aux spécifications au chapitre 6.

Entrée instantanée maximale admissible (1 s ou moins)

Entrée de tension

Valeur crête de 2.5 kV ou valeur efficace de 1,5 kV, selon la valeur la plus basse.

Entrée de courant

Entrée directe

Élément de haute précision de 30 A (760901)

Valeur crête de 150 A ou valeur efficace de 55 A, selon la valeur la plus basse.

Élément de haute précision de 5 A (760902)

Valeur crête de 10 A ou valeur efficace de 7 A, selon la valeur la plus basse.

Entrée de capteur externe

Valeur crête inférieure ou égale à 10 fois la plage.

Entrée continue maximale admissible

Entrée de tension

Valeur crête de 1.6 kV ou valeur efficace de 1,5 kV, selon la valeur la plus basse.

Entrée de courant

Entrée directe

Élément de haute précision de 30 A (760901)

Valeur crête de 90 A ou valeur efficace de 33 A, selon la valeur la plus basse.

Élément de haute précision de 5 A (760902)

Valeur crête de 10 A ou valeur efficace de 7 A, selon la valeur la plus basse.

Entrée de capteur externe

Valeur crête inférieure ou égale à 2.5 fois la plage.

ATTENTION

- Utiliser des câbles de mesure dont la rigidité diélectrique et la capacité de courant conviennent pour la tension ou le courant à mesurer.
  Exemple : Lors de la réalisation de mesures sur un courant de 20 A, utiliser des fils en cuivre à section transversale conductrice de 4 mm^2.
- Le branchement d'un câble de mesure sur ce produit peut entraîner une interférence radio que l'utilisateur sera tenu de rectifier.

Note

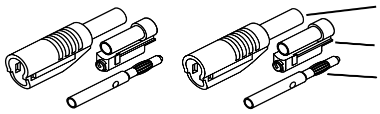
- If you are measuring large currents or voltages or currents that contain high frequency components, take special care in dealing with mutual interference and noise when you wire the cables.
- Keep measurement cables as short as possible to minimize the loss between the circuit under measurement and 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 a three-phase three-wire system with a three-voltage three-current method (3P3W; 3V3A).

2.7 Assembling the Adapters for the Voltage Input Terminals

Voltage Input Terminals of the 760901 and 760902

When connecting a measurement cable to a voltage input terminal of this instrument, use the included B9317WB(black)/B9317WC(red) Safety Terminal Adapter Set or the 758923 Safety Terminal Adapter Set (sold separately). The assembly procedure for the 758931 (sold separately) is the same as that for the B9317WB/B9317WC.

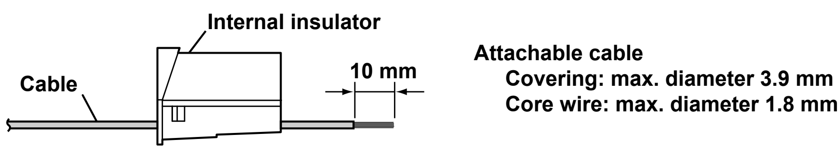
B9317WB(black)/B9317WC(red) Safety Terminal Adapter Set



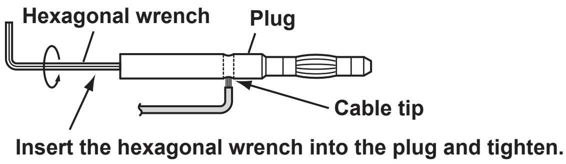
When assembling an adapter, check the wiring method in sections 2.9 to 2.11, and connect an appropriate cable.

Assembling the Safety Terminal Adapter

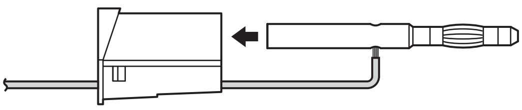
1. Remove approximately 10 mm of the covering from the end of the cable and pass the cable through the internal insulator.



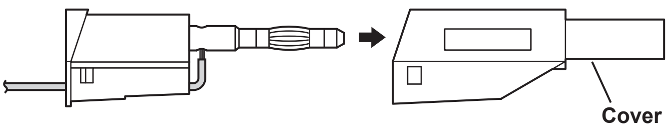
2. Insert the tip of the cable into the plug. Fasten the cable in place using the supplied hexagonal wrench (B9317WD).



3. Insert the plug into the internal insulator.



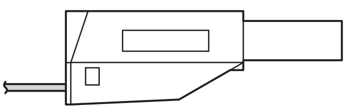
4. Attach the external cover. Make sure that the cover does not come off.



Note

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

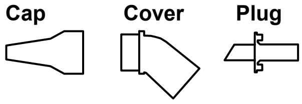
Below is an illustration of the adapter after it has been assembled.



Current Input Terminal of the 760901 (30 A Element)

When connecting a measurement cable to the 30 A current input terminal of this instrument, use the included A1650JZ(black)/A1651JZ(red) High Current Safety Terminal Adapter Set.
The assembly procedure for the 761951 (sold separately) is the same as that for the A1650JZ/A1651JZ.

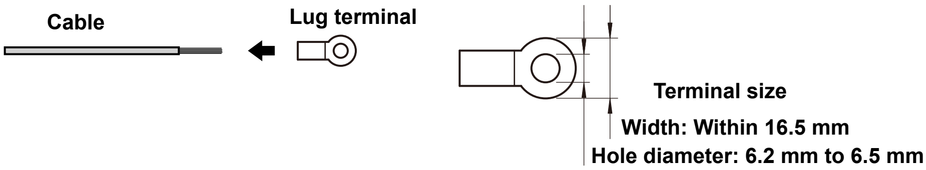
A1650JZ(black)/A1651JZ(red) High Current Safety Terminal Adapter Set



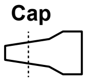
When assembling an adapter, check the wiring method in sections 2.10 to 2.12, and connect an appropriate cable.

Assembling the Safety Terminal Adapter

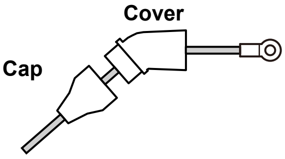
1. Connect a lug terminal appropriate for the cable thickness.



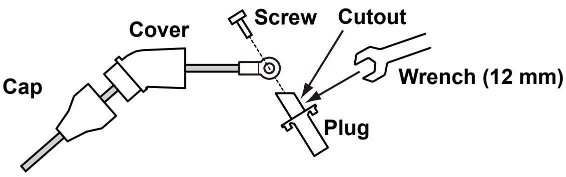
2. Cut the cap according to the cable thickness.



3. Run the cable through the cap and cover.



4. Pinch the cut-out area of the plug with a wrench, and fix the lug terminal to the plug with a screw.

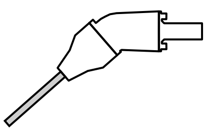


5. Assemble the plug, cover, and cap together.

Note

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

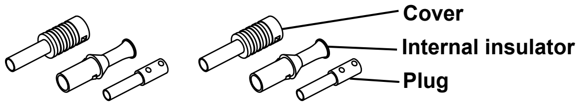
Below is an illustration of the adapter after it has been assembled.



Current Input Terminal of the 760902 (5 A Element)

When connecting a measurement cable to the 5 A current input terminal of this instrument, use the included B8213YA(red)/B8213YB(black) Safety Terminal Adapter Set.
The assembly procedure for the 761953 (sold separately) is the same as that for the B8213YA/B8213YB.

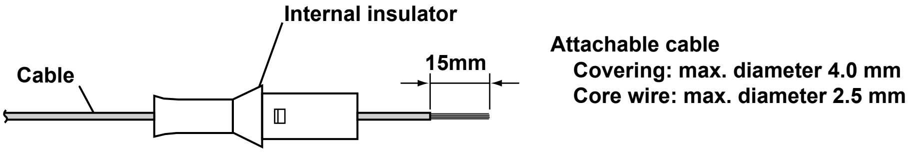
B8213YA(red)/B8213YB(black) Safety Terminal Adapter Set



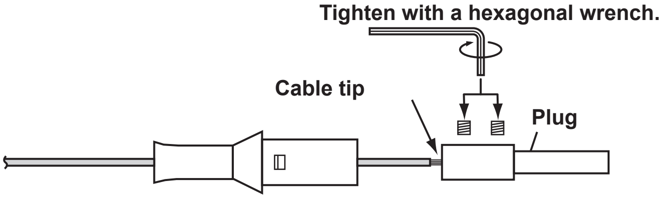
When assembling an adapter, check the wiring method in sections 2.10 to 2.12, and connect an appropriate cable.

Assembling the Safety Terminal Adapter

1. Remove approximately 15 mm of the covering from the end of the cable and pass the cable through the internal insulator.

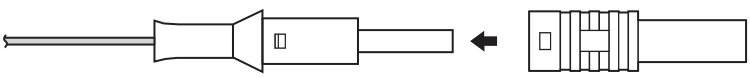


2. Insert the tip of the cable into the plug. Fasten the cable in place using the supplied hexagonal wrench (B9317WD).



3. Insert the plug into the internal insulator.

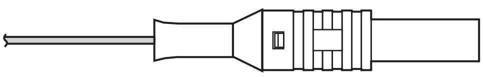
4. Attach the external cover. Make sure that the cover does not come off.



Note

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

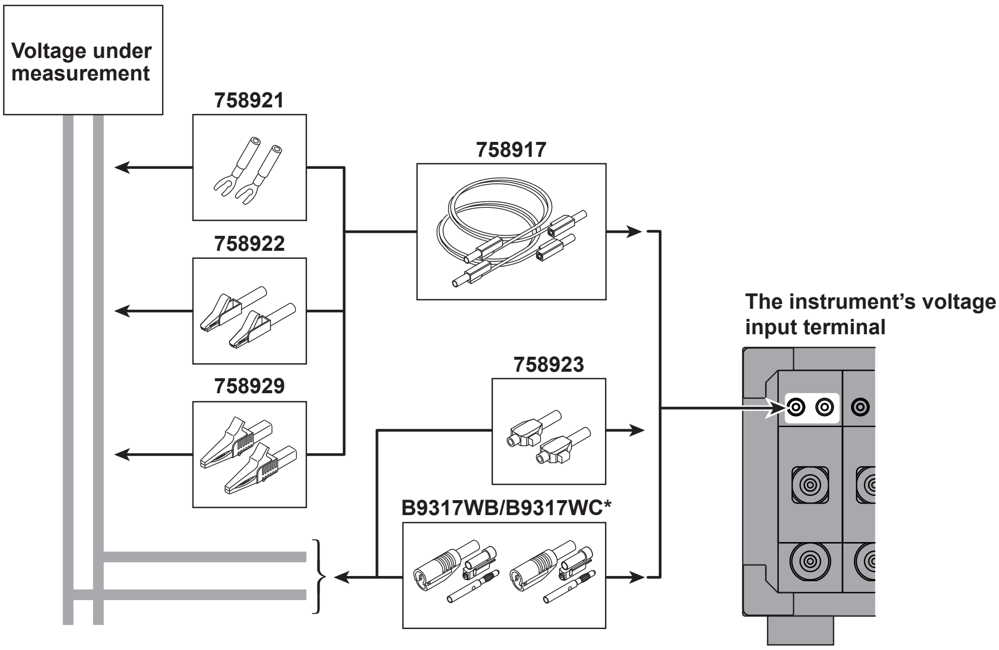
Below is an illustration of the adapter after it has been assembled.



Explanation

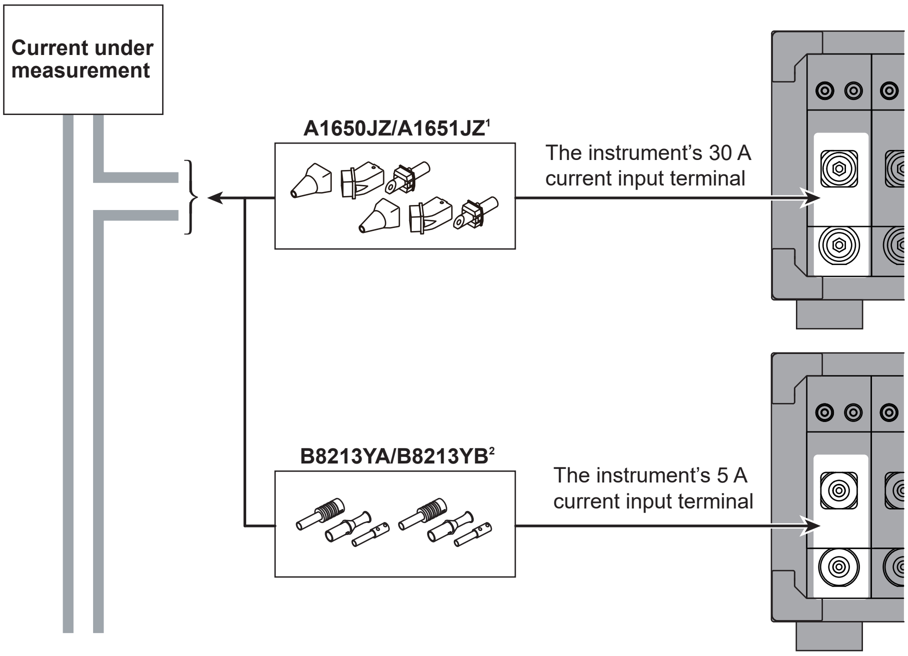
Wire the adapters that come with this instrument or the adapters and various sensors that are sold separately as shown below:

Wiring When Measuring Voltage



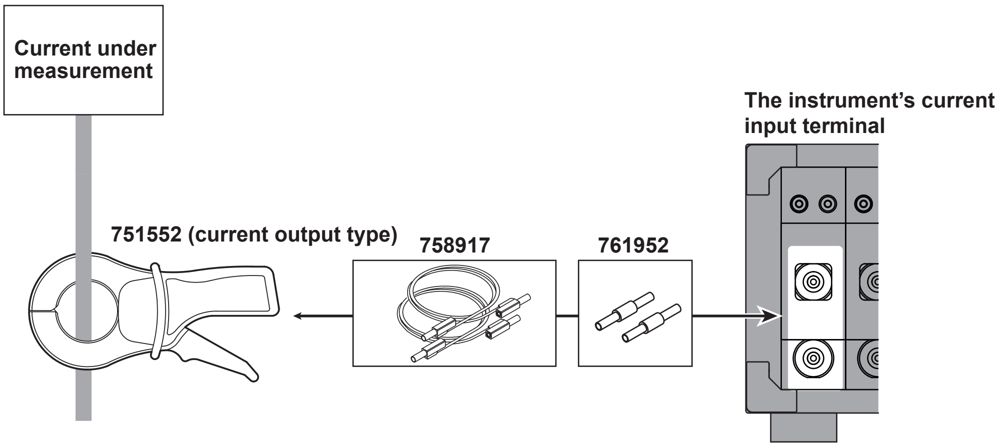
* Optional accessory model: 758931

Wiring When Measuring Current



1 Optional accessory model: 761951
2 Optional accessory model: 761953

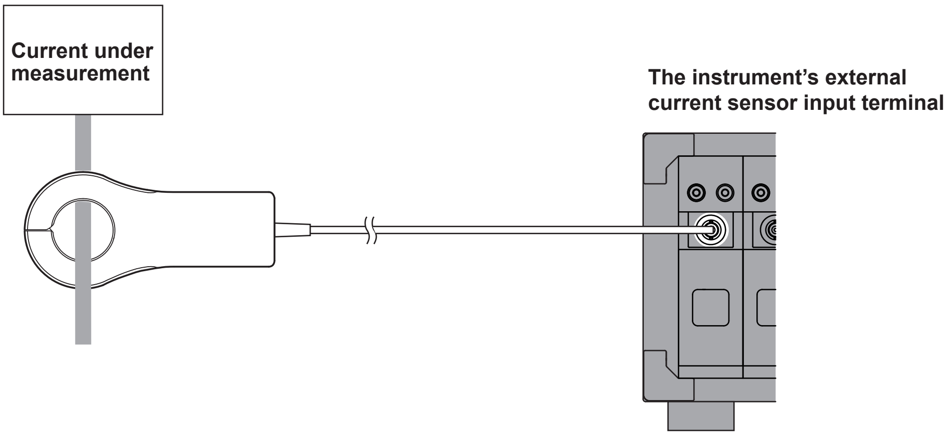
Use the 751552 clamp-on probes (sold separately) as shown below.



Connecting a clamp-on probe

*** The current input terminal and external current sensor input terminal cannot be wired (used) simultaneously.**

Use the current sensor that outputs voltage as shown below.



* The current input terminal and external current sensor input terminal on the same element cannot be wired (used) simultaneously.

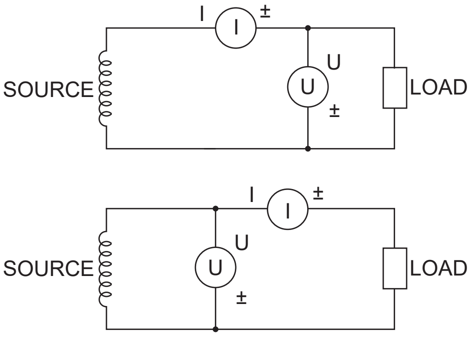
2.8 Wiring for Accurately Measuring a Single-phase Device

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.

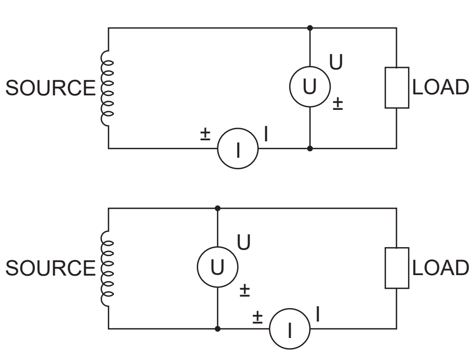
Effects of Stray Capacitance

When measuring a single-phase device, the effects of stray capacitance on measurement accuracy can be minimized 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**

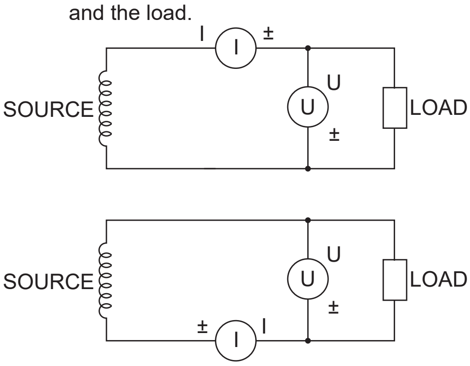


- **Not easily affected**

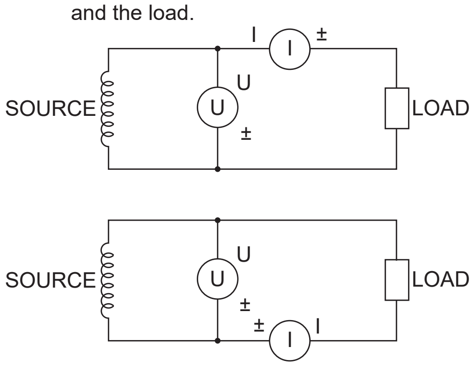


Effects of the Measured Voltage and Current Amplitudes

- **When the measured current is relatively large**
  Connect the voltage measurement terminal between the current measurement terminal and the load.



- **When the measured current is relatively small**
  Connect the current measurement terminal between the voltage measurement 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 3, “How to Make Accurate Measurements.”

2.9 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 its corresponding section (indicated in the table).

Voltage Measurement Methods

<table>
<tr><th colspan="2"></th><th>Voltage at 1000 V or less</th><th>Voltage exceeding 1000 V</th></tr>
<tr><td rowspan="2">Voltage wiring</td><td>Direct input</td><td>→ section 2.10</td><td>Direct input is not possible.</td></tr>
<tr><td>VT (voltage transformer)</td><td colspan="2">→ section 2.12</td></tr>
</table>

Current Measurement Methods

<table>
<tr><th colspan="2"></th><th colspan="2">Voltage at 1000 V or less</th><th rowspan="3">Voltage exceeding 1000 V</th></tr>
<tr><td rowspan="2">Input element</td><td>30 A(760901)</td><td>Current at 30 A or less</td><td>Current exceeding 30 A</td></tr>
<tr><td>5 A(760902)</td><td>Current at 5 A or less</td><td>Current exceeding 5 A</td></tr>
<tr><td rowspan="5">Current wiring</td><td>Direct input</td><td>→ section 2.10*</td><td colspan="2">Direct input is not possible.</td></tr>
<tr><td>Shunt-type current sensor</td><td colspan="2">→ section 2.11</td><td>Shunt-type current sensors cannot be used.</td></tr>
<tr><td>Clamp-type current sensor (voltage output type)</td><td colspan="3">→ section 2.11</td></tr>
<tr><td>Clamp-type current sensor (current output type)</td><td colspan="3">→ section 2.12</td></tr>
<tr><td>CT (current transformer)</td><td colspan="3">→ section 2.12</td></tr>
</table>

* Voltage: 1000 V or less (maximum allowable voltage that can be measured)
(rated voltage of EN61010-2-030)

Notes when Replacing Other Power Meters with the Instrument

In three-phase three-wire systems (3P3W) and three-phase three-wire systems that use a three-voltage three-current method (3P3W; 3V3A), the wiring system of the instrument may be different from that of another product (another digital power meter) depending on whether the reference voltage is set to S phase or T phase when measuring the line voltage (see appendix 2). To make accurate measurements, see the referenced sections in the selection guide above and check the wiring method of the corresponding three-phase three-wire system.

WT5000
WT3000E, WT3000
WT1800E, WT1800
WT1600, WT500
PX8000, PZ4000

The three-phase three-wire systems are different.

WT2000, WT1000
WT330E, WT330
WT230, WT130
etc.

You can change from another digital power meter to this instrument without making changes to the three-phase three-wire systems.

When you change from another digital power meter to this instrument, you have to make changes to the three-phase three-wire systems.

For example, if you replace the WT2000 (used in a three-phase three-wire system) with this instrument and leave the wiring unchanged, the measured power of each element will be different between the WT2000 and this instrument. Refer to this manual and re-wire the system correctly.

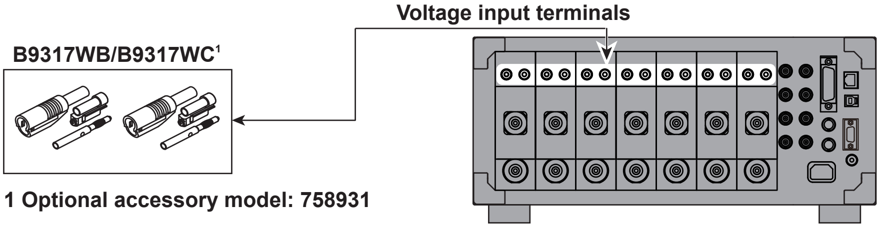
2.10 Wiring the Circuit under Measurement for Direct Input

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

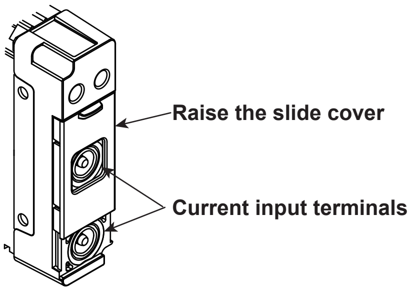
- The terminals are safety banana jacks (female) that are 4 mm in diameter.
- Only insert a safety terminal whose conductive parts are not exposed into a voltage input terminal.
- If you are using the included B9317WB/B9317WC[1] Safety Terminal Adapter Set, see section 2.7.



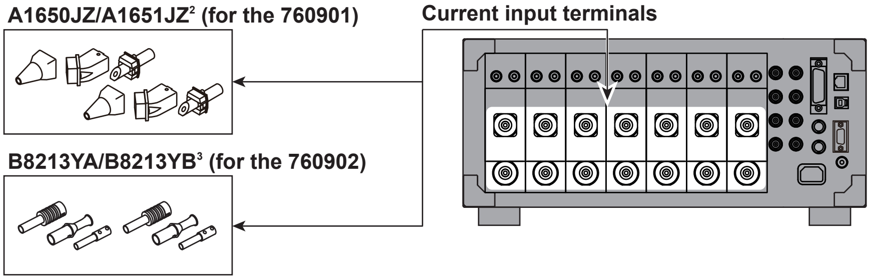
1 Optional accessory model: 758931

Current Input Terminals

- The terminals on the 760901 30A High Accuracy Element are safety banana jacks (male) that are 6 mm in diameter.
- The terminals on the 760902 5A High Accuracy Element are safety banana jacks (male) that are 4 mm in diameter.
- Slide the input element’s slide cover up, and insert a safety terminal whose conductive parts are not exposed into a current input terminal. When you move the slide cover, be careful not to get your hand caught between the slide cover and the element.



- If you are using the included A1650JZ/A1651JZ[2] High Current Safety Terminal Adapter Set (for the 760901) or the B8213YA/B8213YB[3] Current Safety Terminal Adapter Set (for the 760902), see section 2.7.



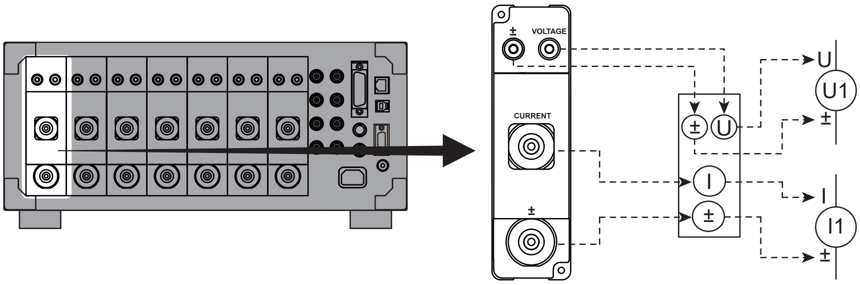
2 Optional accessory model: 761951
3 Optional accessory model: 761953

Note

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.

Connecting to This Instrument

In the figures that follow, the input elements of this instrument, voltage input terminals, and current input terminals are shown simplified as follows.



Input element

The voltage input terminals and current input terminals are labeled as U and I, respectively.

The wiring examples shown below are examples of the following wiring systems in which the specified input elements have been wired. To wire other input elements, substitute the numbers in the figures with the appropriate element numbers.

- Single-phase two-wire systems (1P2W): Input element 1
- Single-phase three-wire system (1P3W) and three-phase three-wire system (3P3W): Input elements 1 and 2
- Three-phase three-wire system that uses a three-voltage three-current method (3P3W; 3V3A) and three-phase four-wire system (3P4W): Input elements 1 to 3

CAUTION

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

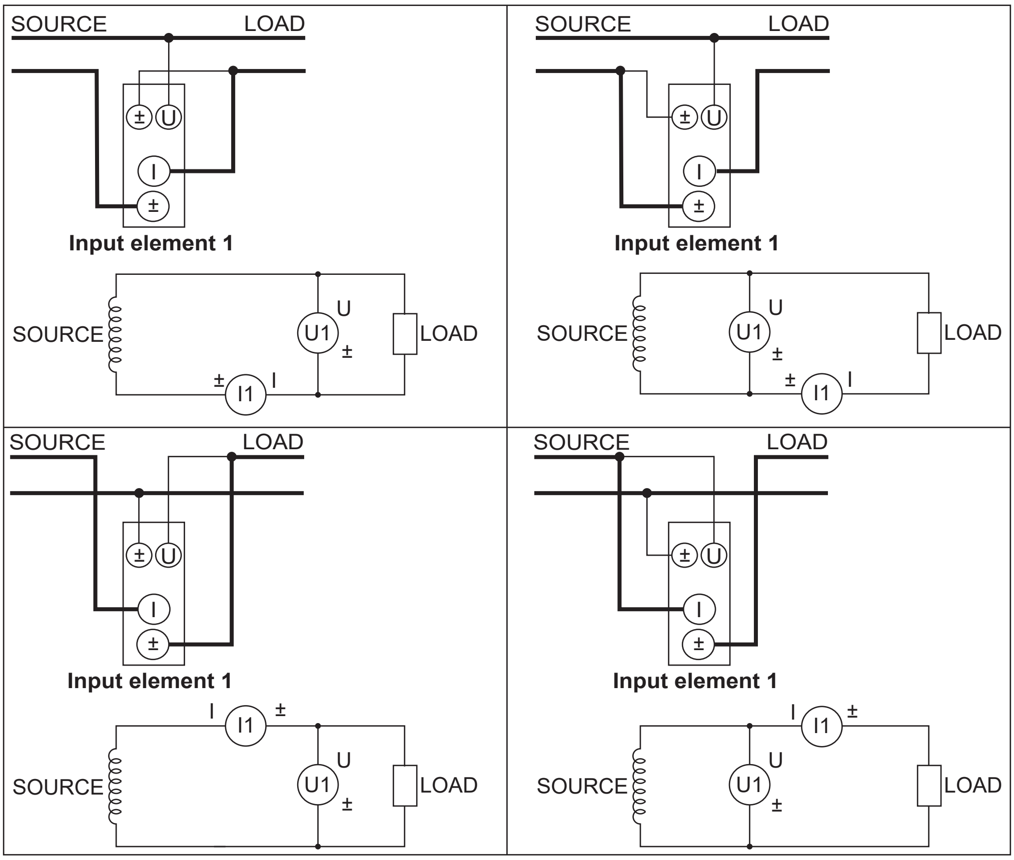
French

ATTENTION

Les lignes épaisses sur les schémas de câblage illustrent l’acheminement du courant. Utiliser des fils qui conviennent aux niveaux de courant.

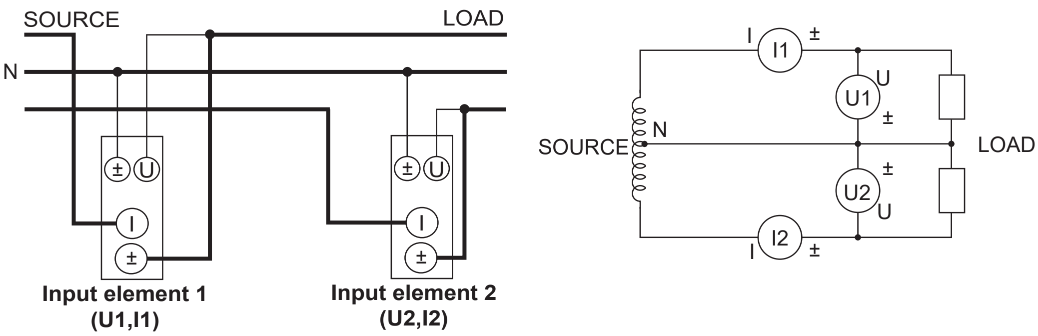
Wiring Examples of Single-Phase Two-Wire Systems (1P2W)

If seven input elements are available, seven single-phase two-wire systems can be wired. For information about deciding which of the wiring systems shown below you should select, see section 2.8.



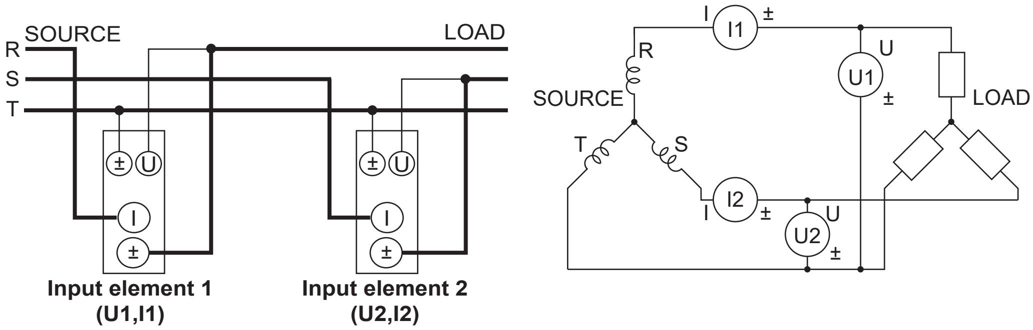
Wiring Example of a Single-Phase Three-Wire System (1P3W)

If six or more input elements are available, three single-phase three-wire systems can be wired.



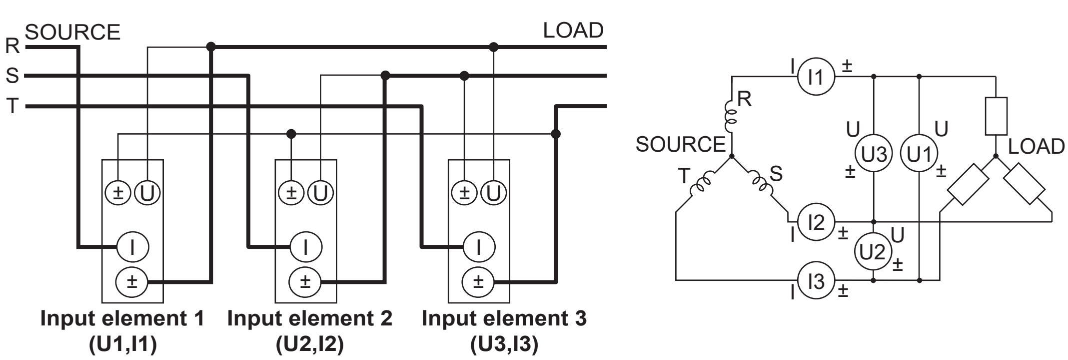
Wiring Example of a three-phase three-wire system (3P3W)

If six or more input elements are available, three three-phase three-wire systems can be wired.



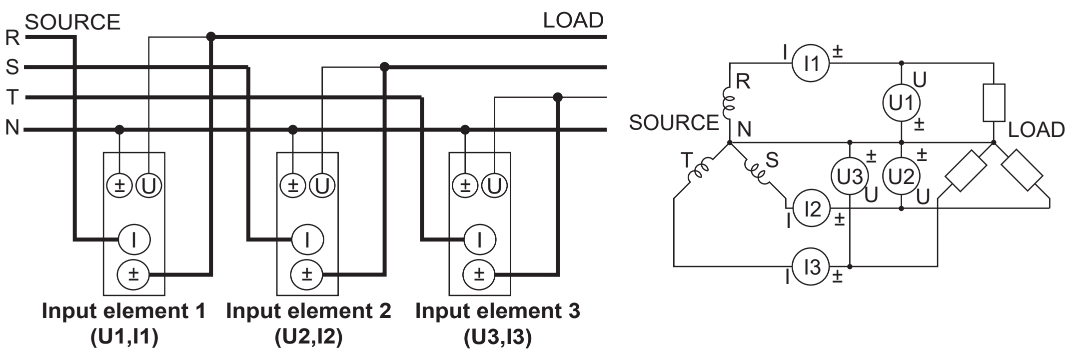
Wiring Example of a Three-Phase Three-Wire System That Uses a Three-Voltage Three-Current Method (3P3W; 3V3A)

If six or more input elements are available, two three-phase three-wire systems that use a three-voltage three-current method can be wired.



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

If six or more input elements are available, two three-phase four-wire systems can be wired.



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 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.

- 30A High Accuracy Element (760901): When the maximum current exceeds 30 Arms
- 5A High Accuracy Element (760902): When the maximum current exceeds 5 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 2.12.

Connecting to the Input Terminals

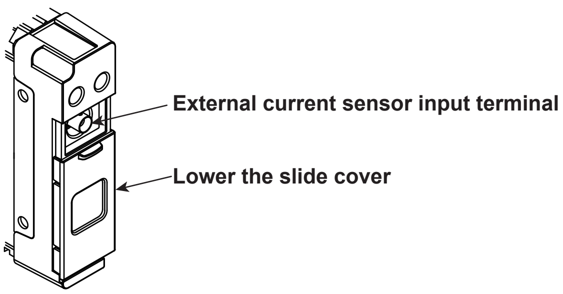
Voltage Input Terminals

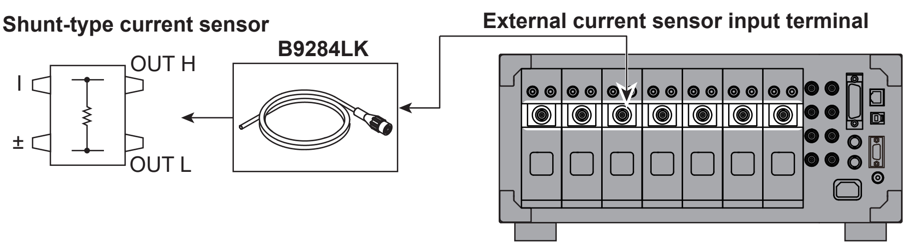
- The terminals are safety banana jacks (female) that are 4 mm in diameter.
- Only insert a safety terminal whose conductive parts are not exposed into a voltage input terminal.
- If you are using the included B9317WB/B9317WC[1] Safety Terminal Adapter Set, see section 2.7.

1 Optional accessory model: 758931

External Current Sensor Input Terminal

- The terminal is an isolated BNC.
- Slide the input element's slide cover down, and connect an external current sensor cable with a BNC (B9284LK, sold separately) to an external current sensor input terminal. When you move the slide cover, be careful not to get your hand caught between the slide cover and the element.





Note

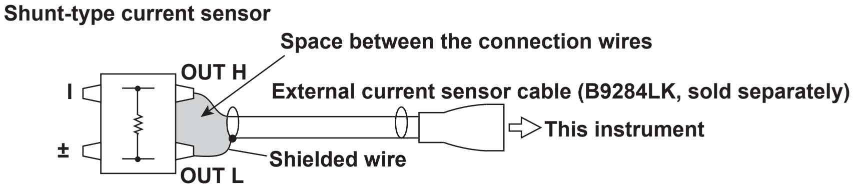
- When connecting a measurement cable from an external current sensor to an external current sensor input terminal, remove the cables connected to the current input terminals.
- Make sure that you have the polarities correct when you make connections. If the polarity is reversed, the polarity of the 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 a three-phase three-wire system that uses a three-voltage three-current method (3P3W; 3V3A).

Using Shunt-type Current Sensors and Clamp-on Probes

Connecting an External Current Sensor Cable

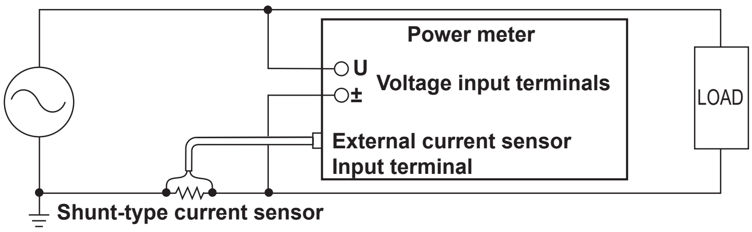
To minimize error when using shunt-type current sensors, follow the guidelines below when connecting the external current sensor cable.

- 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.



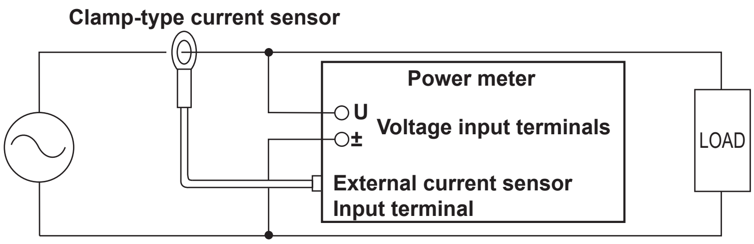
Position on the (Grounded) Circuit under Measurement That You Should Connect the Shunt-type Current Sensor To

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 mm^2) 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.



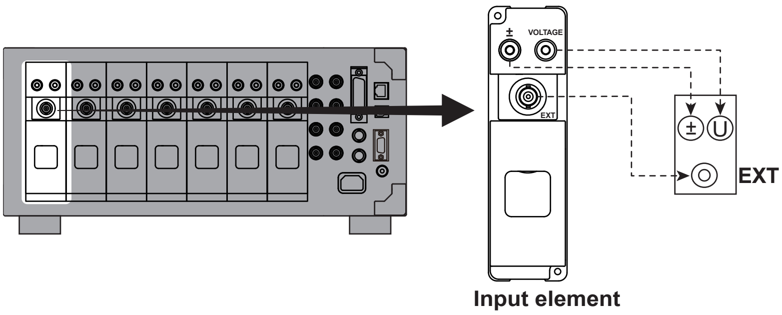
Ungrounded Measurement Circuits

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.

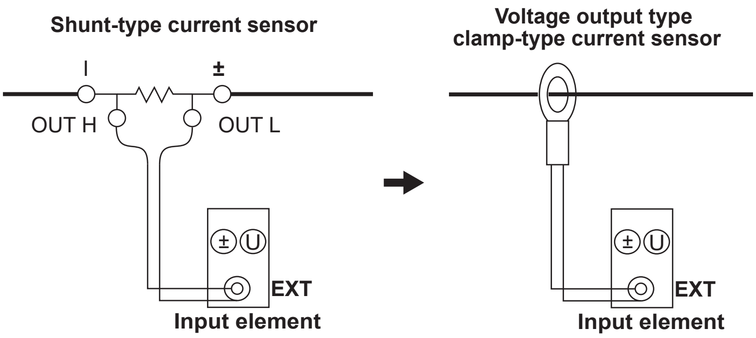


Connecting to This Instrument

In the figures on the following pages, the input elements of this instrument, voltage input terminals, and external current sensor input terminals are shown simplified as follows.



The following wiring examples are for connecting shunt-type current sensors. When connecting a clamp-type current sensor that outputs voltage, substitute shunt-type current sensors with clamp-type current sensors.



The wiring examples shown below are examples of the following wiring systems in which the specified input elements have been wired. To wire other input elements, substitute the numbers in the figures with the appropriate element numbers.

- Single-phase two-wire systems (1P2W): Input element 1
- Single-phase three-wire system (1P3W) and three-phase three-wire system (3P3W): Input elements 1 and 2
- Three-phase three-wire system that uses a three-voltage three-current method (3P3W; 3V3A) and three-phase four-wire system (3P4W): Input elements 1 to 3

CAUTION

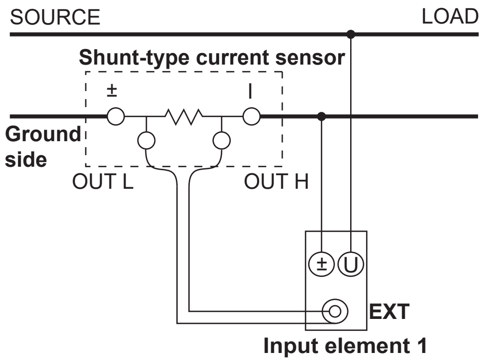
The thick lines on the wiring diagrams are the parts where the current flows. Use wires that are suitable for the current levels.

French

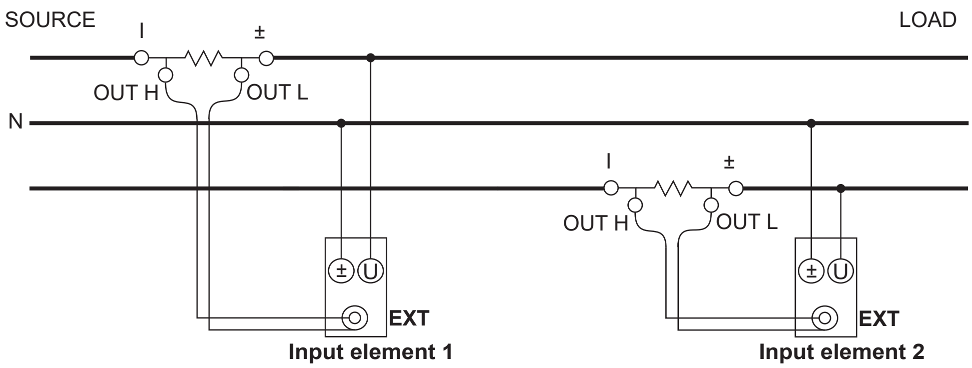
ATTENTION

Les lignes épaisses sur les schémas de câblage illustrent l'acheminement du courant. Utiliser des fils qui conviennent aux niveaux de courant.

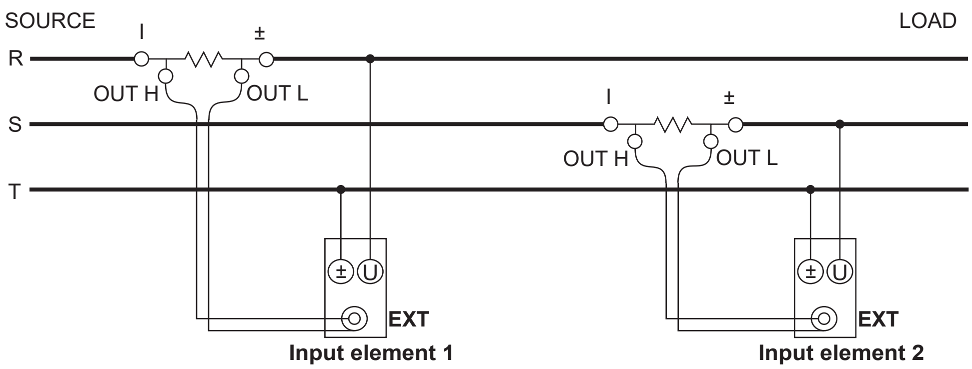
Wiring Example of a Single-Phase, Two-Wire System (1P2W) with a Shunt-Type Current Sensor



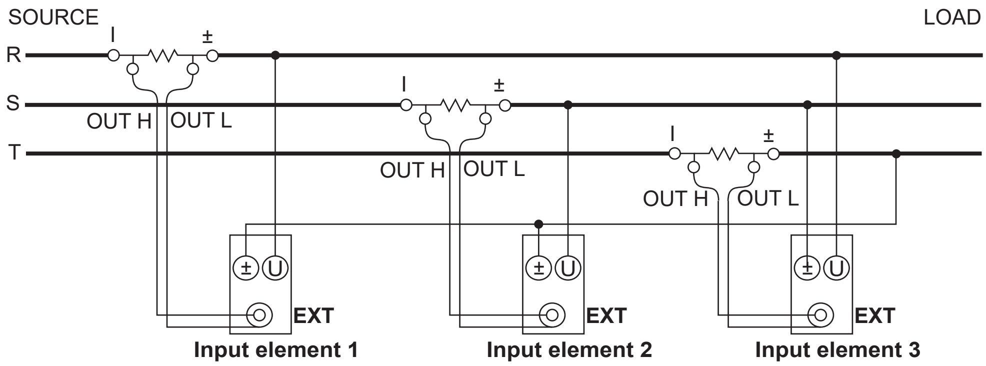
Wiring Example of a Single-Phase Three-Wire System (1P3W) with Shunt-Type Current Sensors



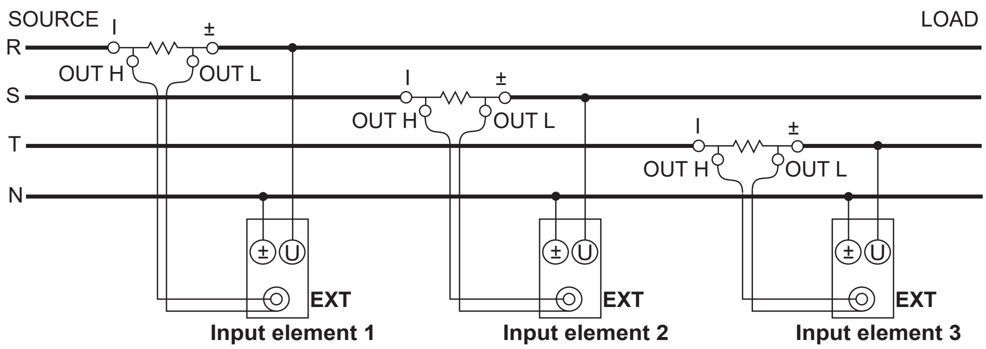
Wiring Example of a Three-Phase Three-Wire System (3P3W) with Shunt-Type Current Sensors



Wiring Example of a Three-Phase Three-Wire System That Uses a Three-Voltage Three-Current Method (3P3W; 3V3A) with Shunt-Type Current Sensors



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



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 Wiring the Circuit under Measurement When Using Voltage and Current Transformers

This section explains how to wire measurement cables from external voltage transformers[1] or current transformers[2] to the voltage or current input terminals of 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 1000 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 range of the input elements, 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.

- 30A High Accuracy Element (760901): When the maximum current exceeds 30 Arms
- 5A High Accuracy Element (760902): When the maximum current exceeds 5 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 B9317WB/B9317WC[1] Safety Terminal Adapter Set, see section 2.7.
  1 Optional accessory model: 758931

Current Input Terminals

- The terminals on the 760901 30A High Accuracy Element are safety banana jacks (male) that are 6 mm in diameter.
- The terminals on the 760902 5A High Accuracy Element are safety banana jacks (male) that are 4 mm in diameter.
- Slide the input element's slide cover up, and insert a safety terminal whose conductive parts are not exposed into a current input terminal. When you move the slide cover, be careful not to get your hand caught between the slide cover and the element.
- If you are using the included A1650JZ/A1651JZ[2] High Current Safety Terminal Adapter Set (for the 760901) or the B8213YA/B8213YB[3] Safety Terminal Adapter Set (for the 760902), see section 2.7.
  2 Optional accessory model: 761951
  3 Optional accessory model: 761953

WARNING

Do not connect a current transformer without protection.

French

AVERTISSEMENT

Ne pas brancher de transformateur de courant sans protection.

Note

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.

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.

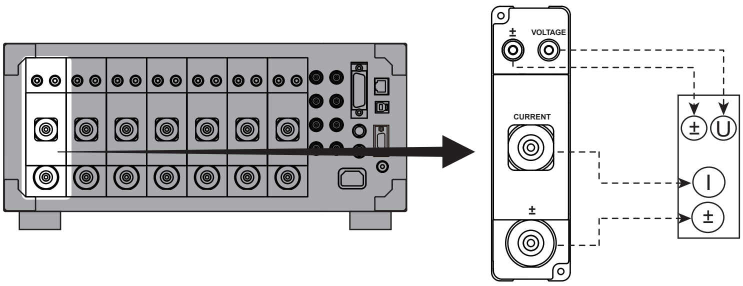
Also, follow the VT or CT handling precautions in the manual that comes with the VT or CT that you are using.

Note

- The thick lines on the wiring diagrams are the parts where the current flows. Use wires that are suitable for the current levels.
- 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 a three-phase three-wire system that uses a three-voltage three-current method (3P3W; 3V3A).

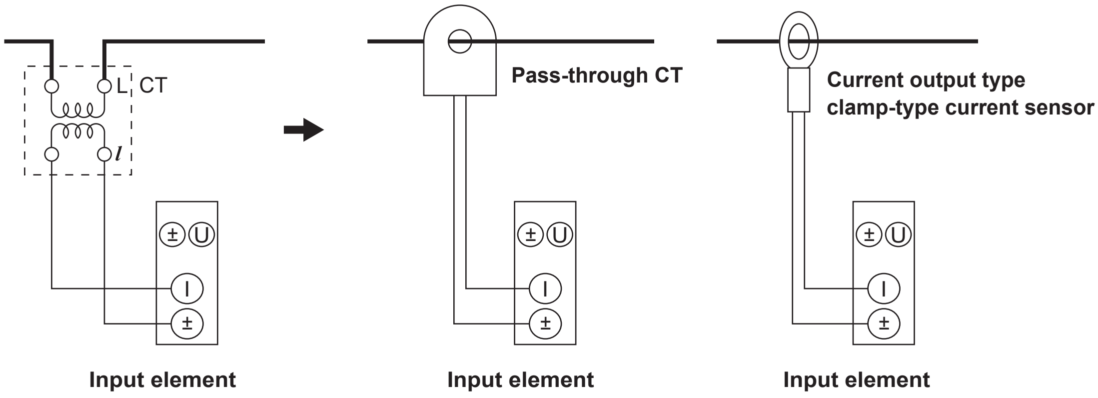
Connecting to This Instrument

In the wiring examples that follow, the input elements of this instrument, voltage input terminals, and current input terminals are shown simplified as follows.



Input element

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.



Note

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

The wiring examples shown below are examples of the following wiring systems in which the specified input elements have been wired.
To wire other input elements, substitute the numbers in the figures with the appropriate element numbers.

- Single-phase two-wire systems (1P2W): Input element 1
- Single-phase three-wire system (1P3W) and three-phase three-wire system (3P3W): Input elements 1 and 2
- Three-phase three-wire system that uses a three-voltage three-current method (3P3W; 3V3A) and three-phase four-wire system (3P4W): Input elements 1 to 3

CAUTION

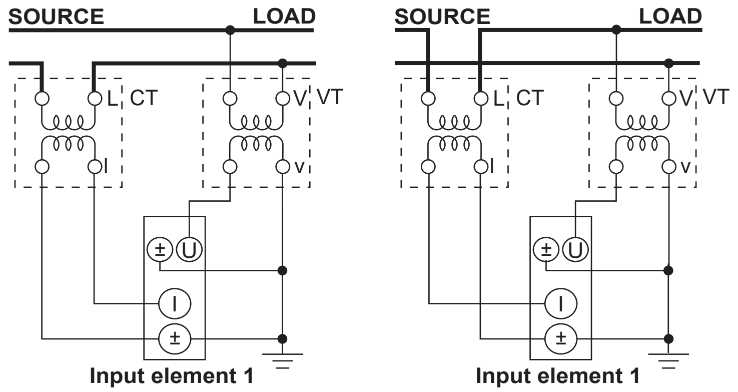
The thick lines on the wiring diagrams are the parts where the current flows. Use wires that are suitable for the current levels.

French

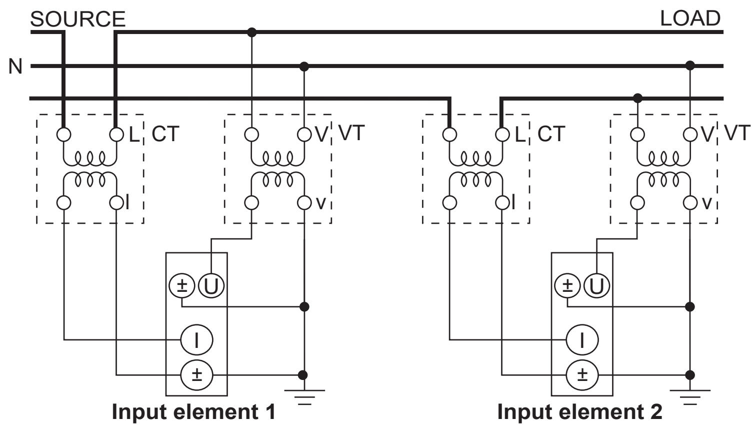
ATTENTION

Les lignes épaisses sur les schémas de câblage illustrent l'acheminement du courant. Utiliser des fils qui conviennent aux niveaux de courant.

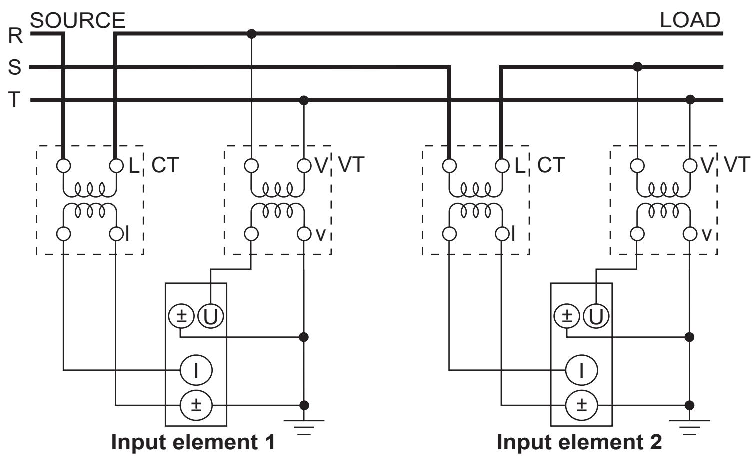
Wiring Example of Single-Phase Two-Wire Systems (1P2W) with a VT and CT



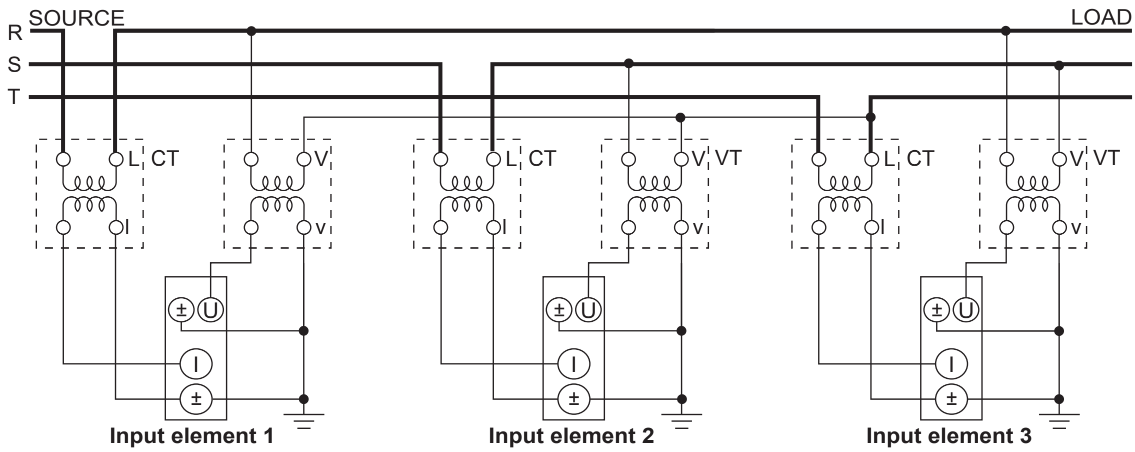
Wiring Example of a Single-Phase Three-Wire System (1P3W) with VTs and CTs



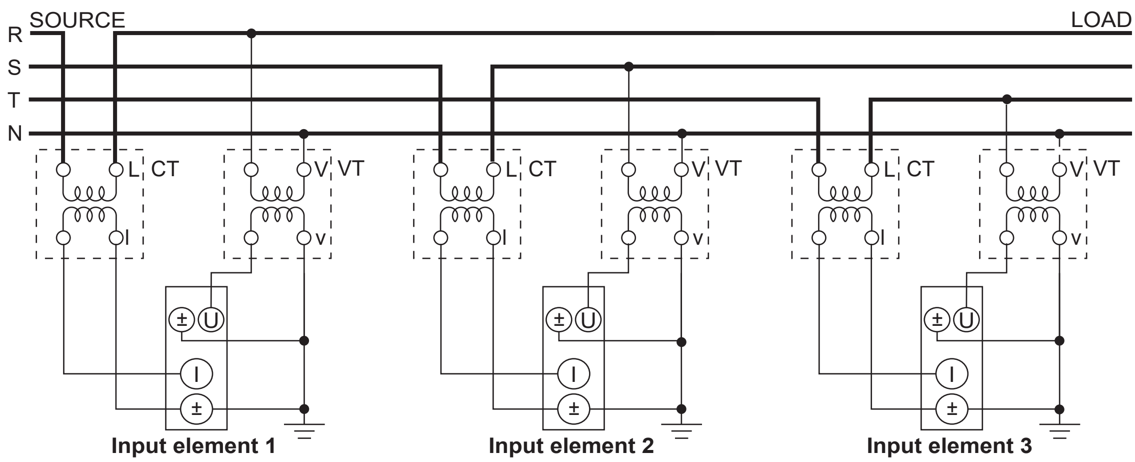
Wiring Example of a three-phase three-wire system (3P3W) with VTs and CTs



Wiring Example of a Three-Phase Three-Wire System That Uses a Three-Voltage Three-Current Method (3P3W; 3V3A) with VTs and CTs



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



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."

3.1 Touch Panel Operations

Touch Panel Operations

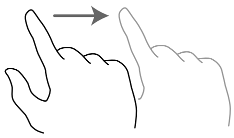
The basic touch panel operations are described below.

Tap

Tap refers to the act of gently hitting the screen with your finger.
This is used to select an item on a setup menu, close a setup menu, and so on.

Drag, Swipe, and Slide

Press your finger against the screen and move your finger across the screen.
Drag refers to the act of selecting and moving items.
Swipe refers to the act of moving a relatively wide display range, such as scrolling the setting screen.
Slide is also a term sometimes used depending on the movement operation.



Key Operation and Functions

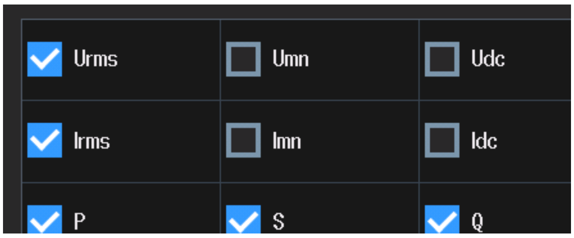
For the key operation and functions, see section 1.2.

3.2 Setup Menu Operation and Function

When you tap an item on a setup menu or select an item using the arrow keys and SET key, any of the following responses will result.

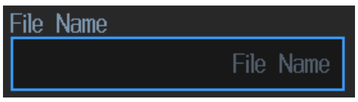
- Available options are displayed.
  Example: Voltage range
  

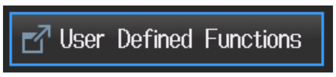
- The value toggles between on and off.
  Example: Voltage auto range
  

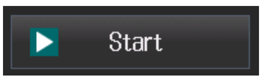
- The value (check box) toggles between selected and unselected.
  Example: Saved items
  

- The selected setting changes.
  Example: Integration resume operation at power failure recovery
  

- You can change the value.
  Example: Cutoff frequency of a line filter
  

- You can change the text using the keyboard.
  Example: Save file name
  

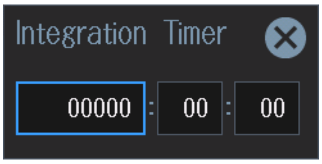
- A related setup menu is displayed.
  Example: User-defined computation
  

- The function is executed.
  Example: Starts integration
  

How to Clear Setup Menus

You can clear the setup menu from the screen by:

- Pressing ESC.
- Tap  in the upper right of the menu.



3.3 Entering Values and Strings

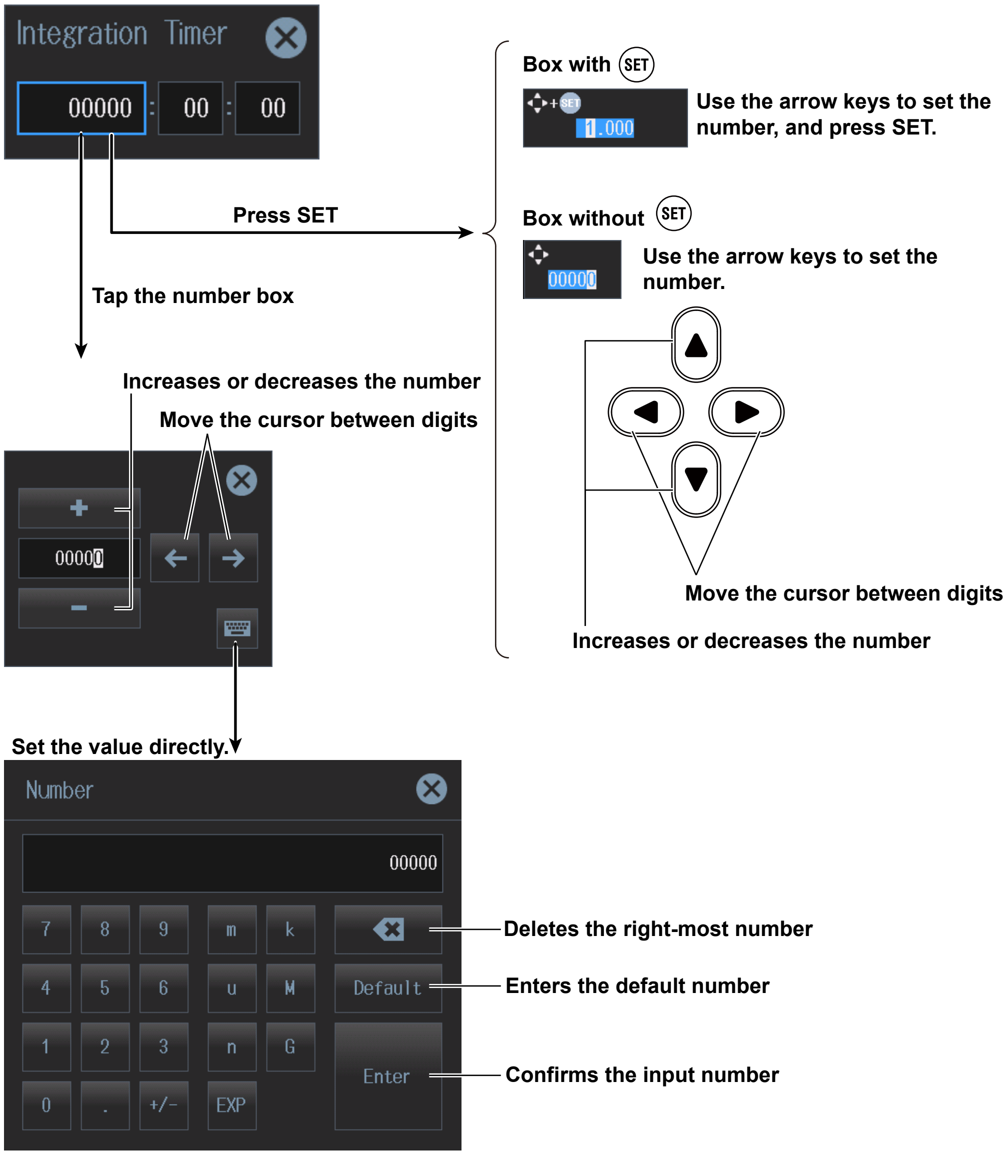
Entering Values

Using the Touch Panel

Tap the keys on the screen to change the value.

Using the Cursor Keys

Press the arrow keys and SET key to change the value.

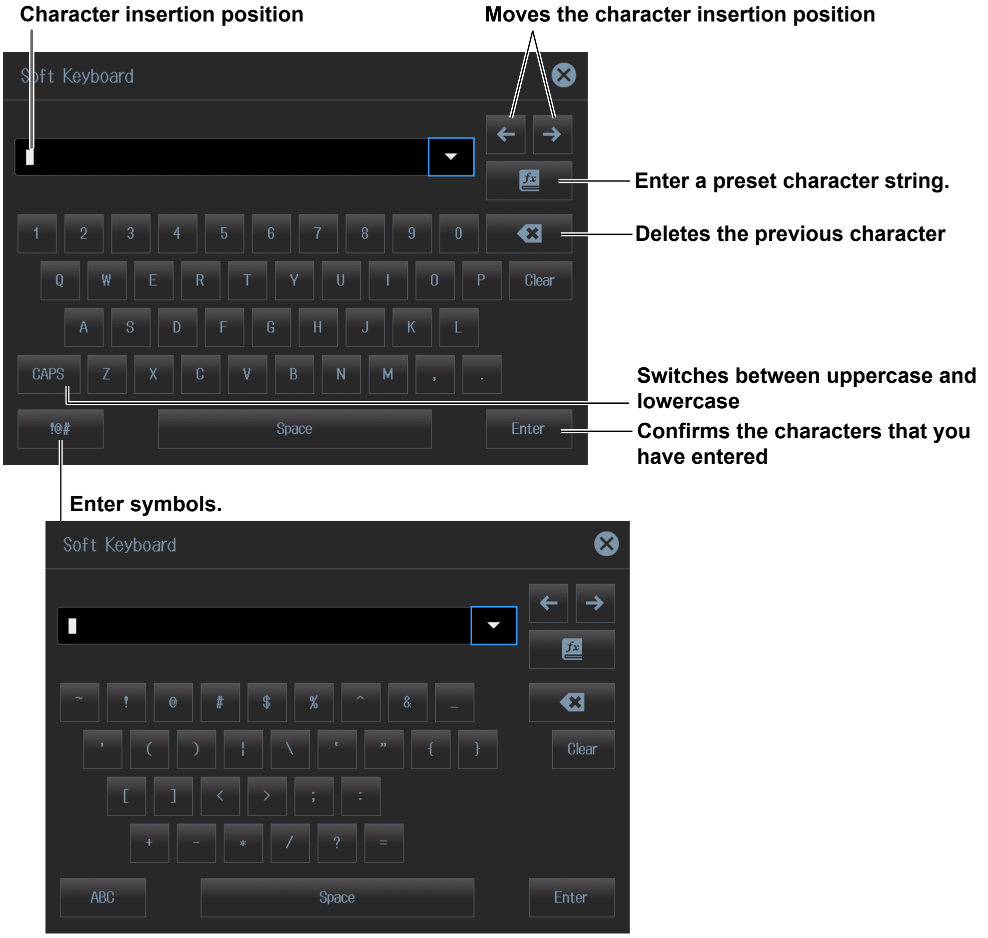


Entering Character Strings

Use the keyboard that appears on the screen to enter character strings such as file names and comments. Tap the keyboard, or use the cursor keys and the SET key to operate the keyboard and enter a character string.

How to Operate the Keyboard

1. With the keyboard displayed, select the character you want to enter.
2. Repeat step 1 to enter all of the characters in the string.
3. Tap **ENTER**, or move the cursor to ENTER, and press **SET**. The character string is confirmed, and the keyboard disappears.



Preset Character Strings

The following operands and equations, which are used with user-defined functions, are included as preset character strings.

ABS(	LOG10(	COS(	CF	TIF(	EAU(	MN(	PC(
SQR(	EXP(	TAN(	ITIME(	HVF(	EAI(	RMN(	
SQRT(	NEG(	PPK(	THD(	HCF(	PLLFRQ(	DC(	
LOG(	SIN(	MPK(	THF(	KFACT(	RMS(	AC(	

Note

- @ cannot be entered consecutively.
- File names are not case-sensitive. Comments are case-sensitive. The following file names cannot be used due to MS-DOS limitations:
  AUX, CON, PRN, NUL, CLOCK, COM1 to COM9, and LPT1 to LPT9
- For details on file name limitations, see the features guide, IM WT5000-01EN.

3.4 Using USB Keyboards and Mouse Devices

Connecting a USB Keyboard

You can connect a USB keyboard and use it to enter file names, comments, and other items.

Compatible Keyboards

You can use the following keyboards that conform to USB Human Interface Devices (HID) Class Ver. 1.1.

- When the USB keyboard language is English: 104-key keyboards
- When the USB keyboard language is Japanese: 109-key keyboards

Note

- Do not connect incompatible keyboards.
- The operation of USB keyboards that have USB hubs or mouse connectors is not guaranteed.
- For USB keyboards that have been tested for compatibility, contact your nearest YOKOGAWA dealer.

USB Ports for Peripherals

Connect a USB keyboard to one of the USB ports for peripherals on the front panel of the instrument.

Connection Procedure

Connect a USB keyboard directly to the instrument using a USB cable. You can connect or remove the USB cable regardless of whether the instrument's power switch is on or off (hot-plugging is supported). Connect the type A connector of the USB cable to the instrument, and connect the type B connector to the keyboard. When the power switch is turned on, the keyboard is detected and enabled approximately 6 seconds after it is connected.

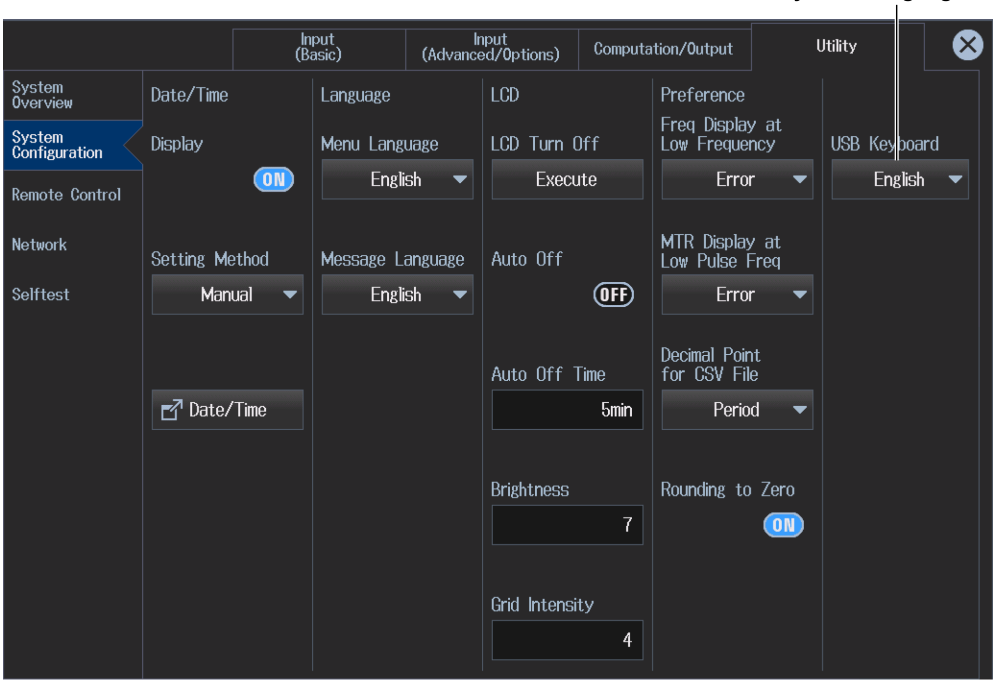
Note

- Only connect compatible USB keyboards, mouse devices, or memory devices to the USB ports for peripherals.
- Do not connect multiple keyboards. You can connect one keyboard and one mouse.
- Do not connect and disconnect multiple USB devices repetitively. Wait for at least 10 seconds after you connect or remove one USB device before you connect or remove another USB device.
- Do not remove USB cables during the time from when this instrument is turned on until key operation becomes available (approximately 20 seconds).

Setting the USB Keyboard Language

1. Tap the menu icon (Setup) under **Setup**, or press **MENU** under **SETUP**.
2. Tap the **Utility** tab.
3. Tap **System Configuration**.

Set the USB keyboard language.



Entering File Names, Comments, and Other Items

When a keyboard is displayed on the screen, you can enter file names, comments, and other items using the USB keyboard.

Entering Values from a USB Keyboard

You can use the USB keyboard to enter values for settings shown on the menu screen of this instrument.

- ↑ key or “8” on the numeric keypad: The value increases.
- ↓ key or “2” on the numeric keypad: The value decreases.
- → key or “6” on the numeric keypad: The digit cursor moves to the next digit on the right.
- ← key or “4” on the numeric keypad: The digit cursor moves to the next digit on the left.

Using a USB Mouse

You can connect a USB mouse and use it to perform the same operations that you can perform with the keys of this instrument. Also, by clicking a menu item, you can perform the same operation that you can perform by pressing the menu item's soft key or selecting the menu item and pressing the SET key.

Compatible USB Mouse Devices

You can use mouse devices (with wheels) that are compliant with USB HID Class Version 1.1.

Note

- For USB mouse devices that have been tested for compatibility, contact your nearest YOKOGAWA dealer.
- Some settings cannot be configured by a mouse without a wheel.

USB Ports for Peripherals

Connect a USB mouse to one of the USB ports for peripherals on the front panel of the instrument.

Connection Procedure

To connect a USB mouse to this instrument, use one of the USB ports for peripherals. You can connect or disconnect the USB mouse at any time regardless of whether the instrument is on or off (hot-plugging is supported). When the power switch is on, the mouse is detected approximately 6 seconds after it is connected, and the mouse pointer ( ) appears.

Note

- Only connect compatible USB keyboards, mouse devices, or memory devices to the USB ports for peripherals.
- Even though there are two USB ports for peripherals, do not connect two mouse devices to the instrument.

Operating the Instrument Using a USB Mouse

Left Button

Move the pointer to an item such as a menu icon, button, or toggle box you want to select on the screen, and click the left button. This is equivalent to tapping the item.

Right Button

The right button is invalid. Clicking the right button produces no effect.

Mouse Wheel

- **Selecting an option**

  Rotate the mouse wheel to scroll the options.

- **Specifying Values**

  In a box for setting a value, the value can be set in the following manner.
  - Rotate the mouse wheel backward to decrease the value.
  - Rotate the mouse wheel forward to increase the value.

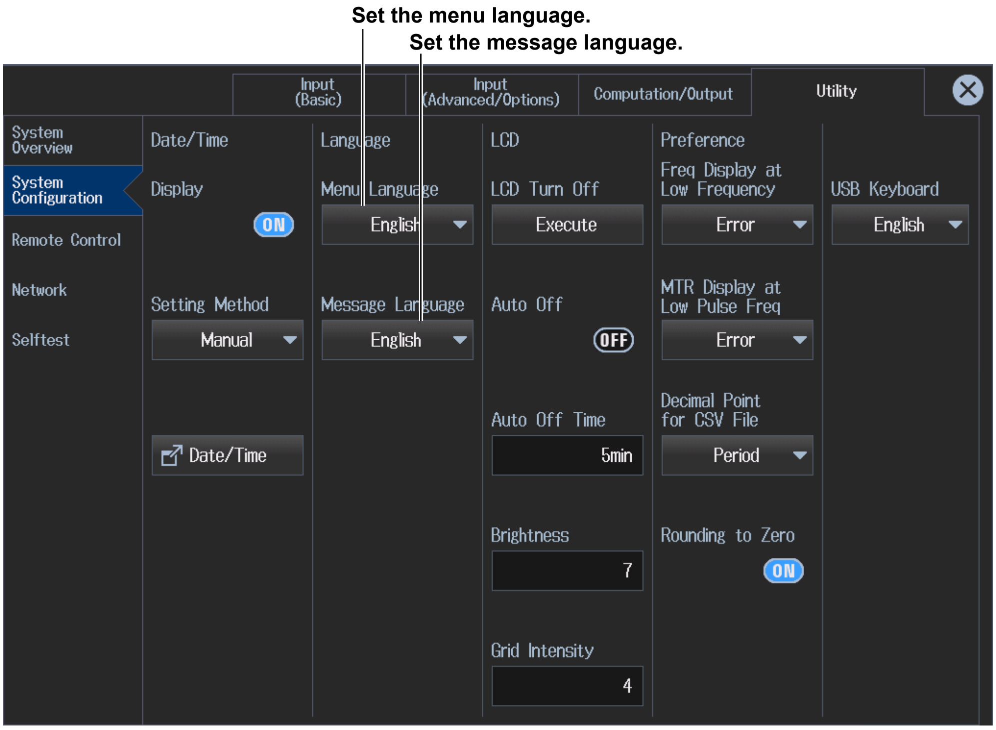
- **Selecting a File, Folder, or Media Drive from the File List Window**

  Rotate the mouse wheel to scroll through the file list.

3.5 Setting the Menu and Message Languages

This section explains how to set the language that is used to display the menus and messages on the screen. The factory default setting is ENG (English).

1. Tap the menu icon under **Setup**, or press **MENU** under **SETUP**.
2. Tap the **Utility** tab.
3. Tap **System Configuration**.



Setting the Menu Language (Menu Language)

You can choose to display menus in any of the following languages.

- English
- Japanese

Setting the Message Language (Message Language)

Error messages appear when errors occur. You can choose to display these messages in any of the following languages. The error codes for error messages are the same for all languages. For details on error messages, see the user's manual, IM WT5000-02EN.

- English
- Japanese

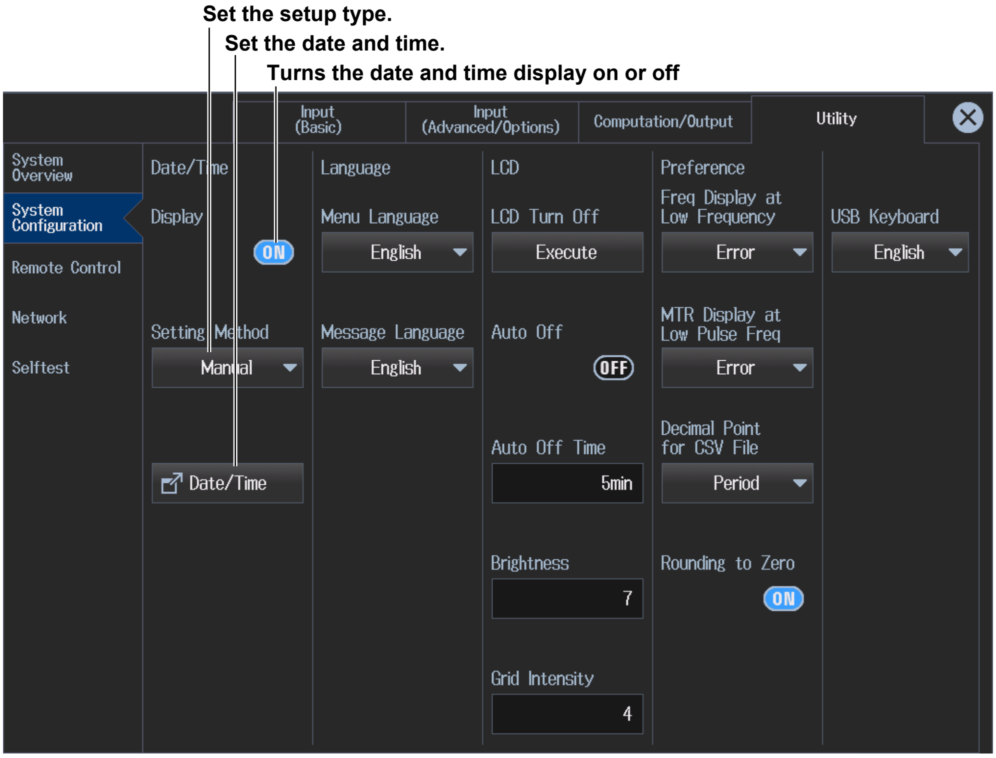
Note

- Even if you set the menu or message language to a language other than English, some terms will be displayed in English.
- You can set different languages for the menu language and message language.

3.6 Synchronizing the Clock

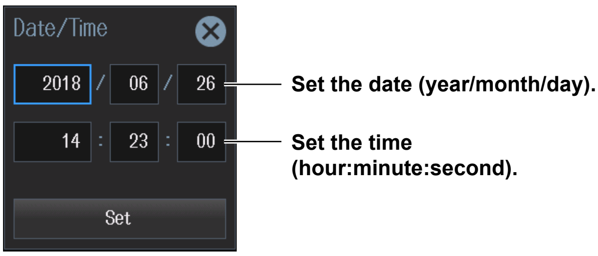
This section explains how to set the instrument’s clock, which is used to generate timestamps for measured data and files. The instrument is factory shipped with a set date and time. You must set the clock before you start measurements.

1. Tap the menu icon under **Setup**, or press **MENU** under **SETUP**.
2. Tap the **Utility** tab.
3. Tap **System Configuration**.



Setting the Setting Method (Setting Method)

- If you select Manual, tap Date/Time, and set the date and time.



- If you select SNTP, the instrument uses an SNTP server to set its date and time. This setting is valid when Ethernet communications have been established. For information on SNTP, see the user's manual. If you select SNTP, set the time difference from Greenwich Mean Time (Time Difference from GMT), and then tap Adjust.

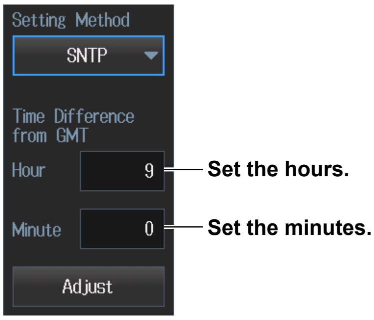
Time Difference from Greenwich Mean Time (Time Difference From GMT)

This setting is valid when the method for setting the date and time is set to SNTP.

Set the time difference between the region where you are using the instrument and Greenwich Mean Time to a value within the following range.

–12 hours 00 minutes to 13 hours 00 minutes

For example, Japan standard time is ahead of GMT by 9 hours. In this case, set Hour to 9 and Minute to 0.



Checking the Standard Time

Using one of the methods below, check the standard time of the region where you are using the instrument.

- Check the Date, Time, Language, and Regional Options on your PC.
- Check the website at the following URL: http://www.worldtimeserver.com/

Note

- This instrument does not support Daylight Saving Time. To set the Daylight Savings Time, reset the time difference from Greenwich Mean Time.
- Date and time settings are backed up using an internal battery. They are retained even if the power is turned off.
- This instrument has leap-year information.
- The Time Difference from GMT setting is shared with the same setting found in the SNTP settings in the Ethernet communication (Network) settings. If you change this setting in the date and time settings, the Time Difference from GMT in the Ethernet communication (Network) settings also changes.

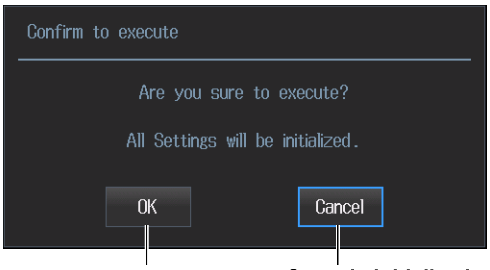
3.7 Initializing the Settings

You can reset the instrument settings to their factory default values. This feature is useful when you want to cancel all the settings that you have entered or when you want to redo measurement from scratch. For information about the initial settings, see appendix 8, "List of Initial Settings and Numeric Data Display Order."

1. Tap the menu icon (Setup) under **Setup**, or press **MENU** under **SETUP**.

Initializes the settings

2. Tap the **Initialize Settings** tab.



Executes initialization **Cancels initialization**

Settings That Cannot Be Reset to Their Factory Default Values

- Date and time settings
- Communication settings
- Menu and message language settings
- Environment settings

  Frequency display at low frequency

  MTR display at low pulse frequency

  Decimal point and separator used when saving to ASCII format (.csv)

To Reset All Settings to Their Factory Default Values

While holding down the ESC key, turn the power switch on. All settings are reset to their factory default values except the date and time settings (the display on/off setting will be reset) and the setup data stored in internal memory.

Note

Only initialize the instrument if you are sure that it is okay for all of the settings to be returned to their default values. You cannot undo an initialization. We recommend that you save the setup parameters before you initialize the instrument.

3.8 Displaying Help

Displaying Help

Tap ⓘ in the upper right of the screen. A help document appears.
The table of contents and index appear in the left frame, and text appears in the right frame.

Switching between Frames

To switch to the frame that you want to control, use the left and right cursor keys.

Moving Cursors and Scrolling

To scroll through the screen or to move the cursor in the table of contents or index, use the up and down cursor keys.

Moving to the Link Destination

To move to a description that relates to blue text or to move from the table of contents or index to the corresponding description, move the cursor to the appropriate blue text or item, and press SET.

Displaying Panel Key Descriptions

With help displayed, press a panel key to display an explanation of it.

Hiding Help

Tap ⓘ in the upper right of the screen, or press ESC. The help closes.

4.1 Motor/Auxiliary Inputs (ChA to H, option)

CAUTION

Signals that do not meet the specifications may damage this instrument, because of factors such as excessive voltage. Signals that do not meet the specifications may damage the instrument because of factors such as excessive voltage.

French

ATTENTION

N’appliquer que des signaux correspondant aux spécifications suivantes. Les autres signaux pourraient endommager l’instrument en raison de divers facteurs, notamment la tension excessive.

Motor/Auxiliary Inputs (ChA to H)

- /MTR1 option: ChA to D
- /MTR2 option: ChE to H

You can apply the following types of signals.

- Torque meter output signal—a DC voltage (analog) signal or pulse signal that is proportional to the motor’s torque
- Revolution sensor output signal—a DC voltage (analog) signal or pulse signal that is proportional to the motor’s rotating speed
  (Apply the signal using a safety BNC cable (sold separately).)
- Sensor output DC voltage signal (an analog signal)
  (Apply the signal using a safety BNC cable (sold separately).)

Apply any of the above signals by following the specifications below.

DC Voltage (Analog input)

Item	Specifications
Connector type	Isolated BNC
Input range	1 V, 2 V, 5 V, 10 V, 20 V
Effective input range	0% to ±110% of the measurement range
Input resistance	Approx. 1 MΩ
Maximum allowable input	±22 V
Maximum isolation voltage	±42 Vpeak or less

Pulse Input

Item	Specifications
Connector type	Isolated BNC
Frequency range	2 Hz to 2 MHz
Amplitude input range	±12 Vpeak
Detection level	H level: approx. 2 V or higher; L level: approx. 0.8 V or less
Pulse width	250 ns or more
Input resistance	Approx. 1 MΩ
Maximum isolation voltage	±42 Vpeak or less

Apply input signals to the terminals shown in the following table according to the motor configuration.*

* See the User's Manual.

Motor evaluation function 1 (/MTR1)

Input terminal	Motor configuration			
	Single Motor (Speed:Pulse)	Single Motor (Speed:Analog)	Double Motor	Auxiliary
ChA	Torque signal	Torque signal	Torque signal 1	External signal 1
ChB	A phase of the rotary encoder	Not use	Speed signal 1	External signal 3
ChC	B phase of the rotary encoder	Speed signal	Torque signal 2	External signal 2
ChD	Z phase of the rotary encoder	Not use	Speed signal 2	External signal 4

Motor evaluation function 2 (/MTR2)

Input terminal	Motor configuration			
	Single Motor (Speed:Pulse)	Single Motor (Speed:Analog)	Double Motor	Auxiliary
ChE	Torque signal	Torque signal	Torque signal 3	External signal 5
ChF	A phase of the rotary encoder	Not use	Speed signal 3	External signal 7
ChG	B phase of the rotary encoder	Speed signal	Torque signal 4	External signal 6
ChH	Z phase of the rotary encoder	Not use	Speed signal 4	External signal 8

Terminal Used for Pulse Input

- If you do not need to detect the revolution direction of a revolution signal (SPEED), apply pulse input to the ChB terminal.
- If you need to detect the revolution direction, apply the A and B phases of a rotary encoder to the ChB and ChC terminals, respectively.
- If you need to measure the electrical angle, apply the Z phase of a rotary encoder to the ChD terminal.

4.2 External Clock Input (EXT CLK IN)

CAUTION

Signals that do not meet the specifications may damage this instrument, because of factors such as excessive voltage. Signals that do not meet the specifications may damage this instrument, because of factors such as excessive voltage.

French

ATTENTION

N’appliquer que des signaux correspondant aux spécifications suivantes. Les autres signaux pourraient endommager l’instrument en raison de divers facteurs, notamment la tension excessive.

External Clock Signal Input Connector

Apply a clock signal that meets the following specifications to the external clock input connector (EXT CLK) on the rear panel.

Common

Item	Specifications
Connector type	BNC
Input level	TTL (0 V to 5 V)

To Apply a Synchronization Source That Determines the Measurement Period

Item	Specifications
Frequency range	Same as the measurement ranges listed under “Frequency Measurement” in section 6.5, “Features”
Input waveform	50% duty ratio rectangular wave

To Apply a PLL Source during Harmonic Measurement

Item	Specifications
Frequency range	0.1 Hz to 300 kHz
Input waveform	50% duty ratio rectangular wave

To Apply a Trigger Source for Displaying Waveforms

Item	Specifications
Input logic	Negative logic, falling edge
Minimum pulse width	1 μs
Trigger delay	Within 2 μs+12 μs

4.3 External Start Signal I/O (MEAS START)

CAUTION

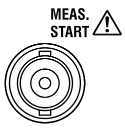
- When the instrument is set to master, do not apply external voltage to the external start signal input/output connector (MEAS. START). If you do, the instrument may malfunction.
- If you have set this instrument as a slave unit or set External Sync to ON in high speed data capturing mode, only apply signals to the external start signal I/O connector that meet the following specifications. Signals that do not meet the specifications may damage this instrument, because of factors such as excessive voltage.

French

ATTENTION

- Lorsque l'instrument est réglé sur maître, ne pas appliquer de tension externe au connecteur d'entrée/de sortie du signal externe de démarrage (MEAS. START). Le cas échéant, un dysfonctionnement de l'instrument est possible.
- Si vous avez réglé cet instrument comme une unité esclave, appliquez uniquement des signaux conformes aux spécifications suivantes sur le connecteur E/S de signal de démarrage externe. Les signaux qui ne sont pas conformes aux spécifications, comme ceux dont la tension est excessive, risquent d'endommager cet instrument.

External Start Signal I/O Connector



Applying Master/Slave Sync Signals for Normal Measurement

Connect the external start signal I/O connectors on the rear panels of the master and slave instruments using a BNC cable (sold separately).

Item	Specifications	Notes
Connector type	BNC	Same for both master and slave
I/O level	TTL(0 V to 5 V)	Same for both master and slave
Output logic	Negative logic, falling edge	Applies to the master
Output hold time	Low level, 500 ns or more	Applies to the master
Input logic	Negative logic, falling edge	Applies to slaves
Minimum pulse width	Low level, 500 ns or more	Applies to slaves
Measurement start output signal delay	Within 1 μs	Applies to the master
Measurement start delay	Within 2 μs	Applies to slaves

Note

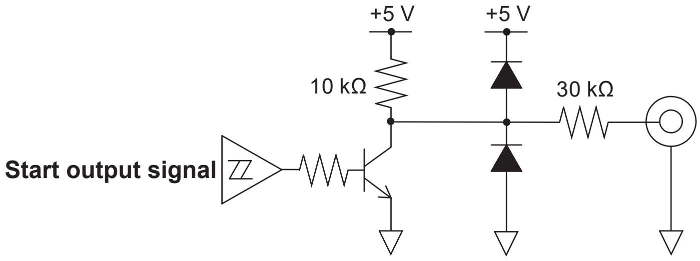
The measurement of the master and slave units cannot be synchronized under the following conditions:

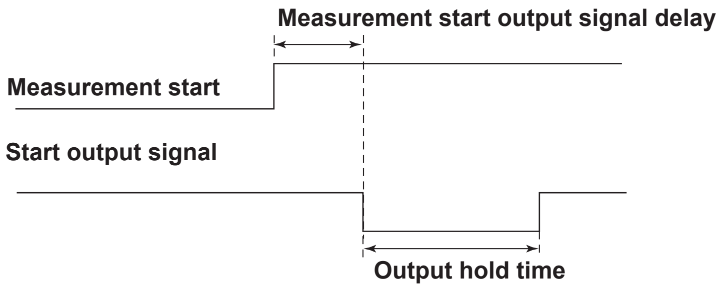
- When the data update interval differs between the master and slave.
- In real-time integration mode or real-time storage mode.

Follow the procedure below to hold values during synchronized measurement.

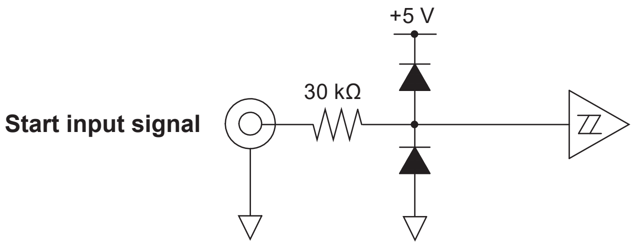
- To hold values: Hold the values on the master first.
- To stop holding values: Stop holding values on the slaves first.

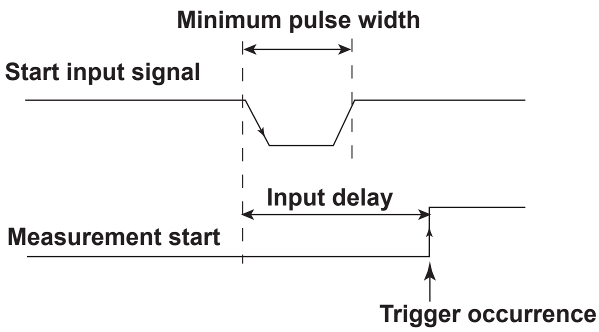
External Start Signal Output Circuit and Timing Chart





External Start Signal Input Circuit and Timing Chart





4.4 VIDEO Output (VIDEO OUT (WXGA))

CAUTION

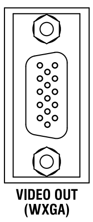
- Connect the cable after turning OFF this instrument and the monitor.
- Do not short the VIDEO OUT terminal or apply external voltage to it. If you do, the instrument may malfunction.

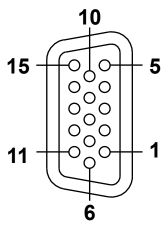
French

ATTENTION

- Connecter le câble après avoir mis cet instrument et le moniteur hors tension.
- Ne pas court-circuiter la borne VIDEO OUT ni y appliquer de tension externe. Le cas échéant, un dysfonctionnement de l’instrument est possible.

VIDEO Output Terminal





D-Sub 15-pin receptacle

You can use RGB output to display the screen of this instrument on a monitor. Any multisync monitor that supports WXGA can be connected.

Item	Specifications
Connector type	D-sub 15-pin
Output format	Analog RGB output
Output resolution	WXGA output, 1280 × 800 dots, approx. 60 Hz Vsync

Pin No.	Signal	Specifications
1	Red	0.7 V_{P-P}
2	Green	0.7 V_{P-P}
3	Blue	0.7 V_{P-P}
4	—	
5	—	
6	GND	
7	GND	
8	GND	
9	—	
10	GND	
11	—	
12	—	
13	Horizontal sync signal	Approx. 36.4 kHz, TTL positive logic
14	Vertical sync signal	Approx. 60 Hz, TTL positive logic
15	—	

Connecting to a Monitor

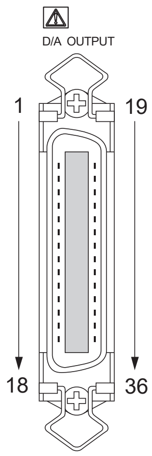
1. Turn off this instrument and the monitor.
2. Connect this instrument and the monitor using an analog RGB cable.
3. Turn on this instrument and the monitor.

4.5 D/A Output and Remote Control (D/A OUTPUT; option)

If you select the /DA option, 20-channel D/A output and remote control features are installed in this instrument.

Connector Pinout

The connector's pinout is explained in the table below.



Pin No.	Signal	Pin No.	Signal
1	D/A CH1	19	D/A CH2
2	D/A CH3	20	D/A CH4
3	D/A CH5	21	D/A CH6
4	D/A CH7	22	D/A CH8
5	D/A CH9	23	D/A CH10
6	D/A CH11	24	D/A CH12
7	D/A CH13	25	D/A CH14
8	D/A CH15	26	D/A CH16
9	D/A CH17	27	D/A CH18
10	D/A CH19	28	D/A CH20
11	D/A COM	29	D/A COM
12	D/A COM	30	D/A COM
13	D/A COM	31	D/A COM
14	Not Connected	32	EXT RESET
15	EXT STOP	33	EXT START
16	EXT SINGLE	34	EXT HOLD
17	INTEG BUSY	35	EXT COM
18	EXT COM	36	EXT COM

Note

The D/A COM and EXT COM signals are connected internally.

D/A Output (D/A OUTPUT)

You can generate numeric data as ±5 V FS DC voltage signals from the rear panel D/A output connector. You can set up to 20 items (channels).

CAUTION

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

French

ATTENTION

- Ne pas court-circuiter la borne de sortie D/A et ne pas y appliquer de tension externe. Le cas échéant, un dysfonctionnement de l’instrument est possible.
- Lors de la connexion de la sortie D/A à un autre dispositif, veiller à connecter les broches de signal correctes. Cela pourrait endommager cet instrument ou l’instrument connecté.

Item	Specifications
D/A conversion resolution	16 bits
Output voltage	Each rated value ±5 V FS (maximum of approx. ±7.5 V)
Update interval	Same as the data update interval of this instrument 50 ms or more Synchronizes to the trigger when the measurement mode is trigger
Number of outputs	20 channels The output items can be set for each channel.
Maximum isolation voltage	±42 Vpeak or less
Relationship between output items and D/A output voltage	See the features guide.

Remote Control

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

CAUTION

Do not apply voltage outside the range of 0 V to 5 V to the remote control input pins. Also, do not short the output pins or apply external voltage to them. If you do, the instrument may malfunction.

French

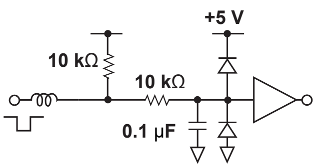
ATTENTION

Ne pas appliquer de tension hors de la plage 0 V à 5 V aux broches d'entrée de la télécommande. Ne pas court-circuiter non plus les broches de sortie, ni y appliquer de tension externe. Le cas échéant, un dysfonctionnement de l'instrument est possible.

Item	Specifications
Input signal	$\overline{\text{EXT START}}$, $\overline{\text{EXT STOP}}$, $\overline{\text{EXT RESET}}$, $\overline{\text{EXT HOLD}}$, $\overline{\text{EXT SINGLE}}$
Output signal	$\overline{\text{INTEG BUSY}}$
Input level	0 V to 5 V

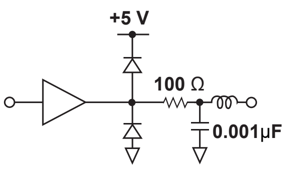
Remote Control I/O Circuit

Input circuit



L level: 0 V to 1 V
H level: 4 V to 5 V

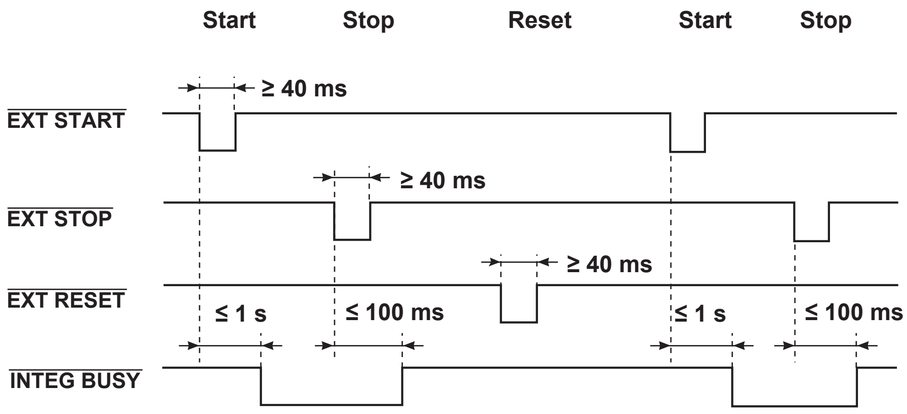
Output circuit



L level: 0 V to 1.5 V (8 mA)
H level: 2.8 V to 5 V (–8 mA)

Controlling Integration Remotely

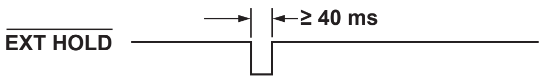
Apply signals according to the following timing chart.



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

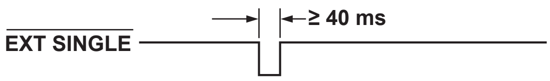
Holding the Updating of Displayed Data (The same functionality as pressing HOLD)

Apply an EXT HOLD signal as shown in the following figure.



Updating Held Display Data (The same functionality as pressing SINGLE)

While the display is being held, you can update it by applying an EXT SINGLE signal.



Note

If the width of the low pulse of the EXT SINGLE signal does not meet the conditions shown in the above figure, the signal may not be detected by this instrument.

4

External Signal I/O

5.1 Troubleshooting

Faults and Corrective Actions

- If a message appears on the screen, see the appendix in the User's Manual, IM WT5000-02EN.
- 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		Reference Section
Nothing appears on the screen when the power is turned on.		
	Securely connect the power cord to the instrument and to the power outlet.	2.4
	Set the supply voltage to within the permitted range.	2.4
	Check the screen settings.	20.4[1]
	The built-in power supply fuse may have blown. Servicing is required.	5.2
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, 2.6
	Check the measurement cable wiring.	2.9 to 2.12
	Check the wiring system.	2.9 to 2.12, 1.1[1]
	Confirm that the line filter is off.	1.13[1]
	Check the measurement period settings.	1.12[1]
	Check the FAQ at the following URL. http://tmi.yokogawa.com/	—
	Turn the power off and then on again.	2.5
Keys do not work.		
	Check the REMOTE indicator. If the REMOTE indicator is illuminated, press LOCAL to turn it off.	—
	Confirm that keys are not locked.	20.10[1]
	Perform a key test. If the test fails, servicing is necessary.	20.7[1]
Triggering does not work.		
	Check the trigger conditions.	9.1[1]
	Confirm that the trigger source is being applied.	9.1[1]
Unable to make harmonic measurements.		
	Check the PLL source settings.	2.1[1]
	Confirm that the input signal that you have selected as the PLL source meets the specifications.	2.1[1]
Unable to recognize a storage device.		
	Check the storage device format. If necessary, format the storage device.	—
	The storage device may be damaged.	—
Unable to save data to the selected storage device.		
	Check the free space on the storage device. Remove files or use a different storage device as necessary.	—
	If necessary, format the storage device.	—
Unable to configure or control the instrument through the communication interface.		
	Confirm that the GP-IB address and the IP address settings meet the specifications.	—[2]
	Confirm that the interface meets the electrical and mechanical specifications.	—[2]

1 See the User's Manual, IM WT5000-02EN.
2 See the Communication Interface User's Manual, IM WT5000-17EN.

5.2 Power Supply Fuse

Because the power supply fuse used by this instrument is inside the case, you cannot replace it yourself. If you believe that the power supply fuse inside the case has blown, contact your nearest YOKOGAWA dealer.

5.3 Recommended Part Replacement

The life and replacement period for expendable items varies depending on the conditions of use. Refer to the table below as a general guideline.
For part replacement and purchase, contact your nearest YOKOGAWA dealer.

Parts with Limited Service Life

Part Name	Service Life
LCD backlight	Under normal conditions of use, approximately 100000 hours

Consumable Parts

We recommend replacing them at the following intervals.

Part Name	Recommended Replacement Interval
Cooling fan	3 year
Backup battery	3 years

5.4 Disposing of YOKOGAWA Products

When disposing of this instrument, follow the laws and ordinances of the country or region where the product will be disposed of.

6.1 Signal Input Section

Power Measurement

Item	Specifications
Element	Plug-in input unit
Number of elements	7
Installable input elements	Elements exclusive to the WT5000
Input element mixing	Allowed
Empty element	Allowed However, element 1 to the element before the first empty element can be used. Elements installed after the empty element number cannot be used.
Hot swapping	Not allowed

Motor Evaluation Function (Option)

Item	Specifications		
Input connector type	Isolated BNC		
Input type	Unbalanced, functional isolation		
Input resistance	Input resistance: 1 MΩ ± 1%, input capacitance: approx. 47 pF		
Continuous maximum allowable input	±22 V		
Maximum rated voltage to earth	±42 Vpeak		
Input channels	MTR1:	ChA (Torque1/Aux1):	Analog/Pulse input
		ChB (Speed1/Aux3):	Pulse input
		ChC (B/Torque2/Aux2):	Analog/Pulse input
		ChD (Z/Speed2/Aux4):	Pulse input
	MTR2:	ChE (Torque3/Aux5):	Analog/Pulse input
		ChF (Speed3/Aux7):	Pulse input
		ChG (B/Torque4/Aux6):	Analog/Pulse input
		ChH (Z/Speed4/Aux8):	Pulse input
Input type	Analog input	Range	1/2/5/10/20 V
		Range setting	Fixed/Auto Auto range Range increase: When the measured value exceeds 110% of the range When the peak value exceeds approximately 150% Range decrease: When the measured value is 30% of the range or less and the peak value is less than 125% of the next lower range
		Input range	±110%
		Bandwidth	20 kHz (-3dB)
		Sample rate	Approx. 200 kS/s
		Resolution	16 bit
		Accuracy * Analog input accuracy guarantee conditions	Accuracy at 6 months ±(0.03% of reading + 0.03% of range) For the accuracy at 1 year, multiply the reading of the accuracy at 6 months by 1.5.
		Temperature coefficient	±0.03% of range/°C
		Line filter	Low-pass filter Filter response: Butterworth fc:100 Hz, 500 Hz, 1 kHz
	Pulse input	Range	10 V
		Input range	±12 Vpeak
		Detection level	H level: approx. 2 V or higher L level: approx. 0.8 V or less
		Pulse width	250 ns or more However, 50% duty ratio for detecting forward rotation

6

Specifications

Item	Specifications	
	Frequency measurement range	2 Hz to 2 MHz
	Rotation direction detection	2 Hz to 1 MHz When the pulse noise filter is in use: 10 kHz: 2 Hz to 3 kHz 100 kHz: 2 Hz to 30 kHz 1 MHz: 2 Hz to 300 kHz
	Accuracy	±(0.03 + f/10000) % of reading ±1 mHz The unit of f is kHz. However, the waveform display data accuracy is ±(0.03 + f/500) % of reading ±1 mHz The unit of f is kHz.
	Pulse noise filter	Low-pass filter fc:10 kHz, 100 kHz, 1 MHz
	Z pulse delay correction	Corrects the time setting delay
Peak over-range detection	150% of the range or more	

* Analog input accuracy guarantee conditions:
Humidity: 30% RH to 75% RH
Voltage to ground: 0 V
In a wired condition after warm-up time has passed and after zero-level compensation.
For 5°C to 18°C and 28°C to 40°C, add the temperature coefficient.

6.2 Measurement Output Section

D/A Output (/DA20 option)

Item	Specifications
Output connector type	Micro ribbon connector (Amphenol 57LE connector), 36-pin
Output source	The set measurement function Normal measurement: Voltage, current, power: U/I rms, mn, dc, rmn, ac P/S/Q/λ/Φ/Pc and Σ Peak value : U/I/P, ±pk Frequency: fU/fI/f2U/f2I/fPLLx Integration: ITime/WPx/qx/WS/WQ Efficiency User-defined function User-defined event Harmonic measurement: Voltage, current, power harmonics: U/I/P/S/Q/λ/ and Σ UI, inter-harmonic, inter-element phase difference: Φxx Load circuit constant: Z/Rs/Xs/Rp/Xp Relative harmonic content, strain: U/I/P Telephone harmonic factor: U/I Telephone influence factor: U/I K-factor Delta computation: U/I/P and ΣU, P Motor evaluation function: Speed, Torque, SyncSp, Slip, Pm, EaMxU, EaMxI, Auxx * 0 V to +5 V when the phase angle display setting is 360° * The % output measurement function is +5 V at 100%. * Rated integrated value is range rating × set integration time * Approx. 7.5 V for setting function errors. However, U/I –pk is approx. –7.5 V. * x consists of characters and numbers.
D/A resolution	16 bit
Output type	Voltage output, functional isolation
Output voltage	Rating: ±5 V, maximum output voltage: approx. ±7.5 V
Range mode	Fixed ±5 V FS Manual Maximum range value: 9.999T, minimum range value: -9.999T
Number of channels	20
Accuracy	±(output source measurement accuracy + 0.1% of FS), accuracy at 1 year
Output resistance	Approx. 100 Ω
Minimum load	100 kΩ
Temperature coefficient	±0.05% of FS/°C
Maximum ratedvoltage to earth	±42 Vpeak or less
Output update interval	Same as the data update interval Synchronizes to the trigger when the measurement mode is trigger
Remote control	See auxiliary I/O

6.3 Display

Item	Specifications
Display	10.1-inch color TFT LCD with a capacitive touch panel
Resolution of the entire screen*	1280 × 800 dots (H × V)
Language	Japanese/English
Display update rate	Same as the data update interval However, 1) When the data update interval is 50 ms, 100 ms, or 200 ms and only numeric display is in use, the display is updated every 200 ms to 500 ms (depends on the number of displayed parameters). 2) When the data update interval is 50 ms, 100 ms, 200 ms, or 500 ms and parameters other than those of numeric display are shown, the display is updated every 1 s. 3) When the measurement mode is normal measurement trigger mode, measurement is executed over the time interval specified by the data update interval from when a trigger is detected. The amount of time shown below is required for the instrument to compute the measured data, process it for displaying, and so on, and become ready for the next trigger. • When the data update interval is 50 ms to 500 ms: Approx. 1 s • When the data update interval is 1 s to 20 s: Data update interval + 500 ms In this case, storage, communication output, and D/A output operate in sync with the triggers. If the measurement mode display is set to normal measurement mode, storage, communication output, and D/A output operate in sync with the data update interval.
LCD adjustment	Turning off the LCD: Manual (default) Off: Panel key operation On: Key operation and panel touch Auto-off on Off: When the panel and keys are not accessed for a given period On: Key operation and panel touch Auto-off time: 1 min to 60 min Brightness adjustment: 10 levels Grid intensity: 8 levels Color: Waveform, trend, and vector display colors are fixed Background color: Gray
Measurement display	Number of displayed digits: If the value is less than or equal to 60000: Six digits. If the value is greater than 60000: Five digits. Display format: All, 4, 8, 16, Matrix, Hrm List Single, Hrm List Dual No-data display symbol: --- Error display symbol: Error For errors that occur when the frequency measurement or motor or AUX pulse measurement is less than the lower limit, Error or zero can be selected.
Waveform display	Peak-to-peak compressed data Waveform display item: Voltage, current: elements 1 to 7 Torque, speed: motor 1 and 2 (/MTR1), motor 3 and 4 (/MTR2) Auxiliary Input: Aux 1 to 4 (/MTR1), Aux 5 to 8 (/MTR2) Screen division: Single, Dual, Triad, Quad, Hexa Vertical axis: Auto, Manual (set the zoom and position) Time axis: Time/div: 0.01 ms to 2 s, 1-2-5 steps Trigger Trigger type: Edge Trigger mode: Select auto or normal. Trigger source: Select voltage, current, or Ext Clk (external clock). Trigger slope: Select rising, falling, or rising and falling. Fixed to rising when the trigger source is Ext Clk (external clock) Trigger level: When the trigger source is a voltage or current applied to an input element Set to a value that is within the range defined by the middle of the screen ± 100% (to the top and bottom edges of the screen). Resolution: 0.1% Trigger delay: Within 2 μs When the trigger source is Ext Clk (external clock) TTL level Time axis zoom feature: None Amplitude zoom feature: Can be set between 0.1x to 100x Display interpolation: Off, two-point linear interpolation Grid: Selectable (frame, grid, X-Y)

Item	Specifications	
Trend display	Time series graph of a measurement function's data updates	
	Display items:	Up to 16 items, most recent measured values
	Screen division	Single, Dual, Triad, Quad
	Vertical axis:	Auto or Manual (set the upper and lower limits)
	Time axis:	Time/div, 3 s to 1 day
Bar graph display	Displays a bar graph of the amplitude and phase of each harmonic	
	Graph division:	Single, Dual, Triad
	Vertical scale:	Log, Linear
	Range setting:	Auto or Manual (set the upper and lower limits)
	Display range:	Starting harmonic: 0 to 490, ending harmonic: 10 to 500
Vector display	Displays the phase difference between the fundamental voltage signal and fundamental current signal as a vector.	
	Divisions:	2
	Screen zoom feature:	0.1 to 100x
	Numeric display:	Allowed
Other measurement screen display items	Setup menu Measurement mode, time, data update interval, data update count, peak over-range information, integration settings/status, storage status, crest factor, averaging, element settings/status, option settings/status	

* Relative to the total number of pixels, 0.002% of the LCD screen may be defective.

6.4 Control area

Item	Specifications
Control devices	Power switch, control keys, capacitive touch panel
Key operation features	Features controlled directly with keys Direct control items: Setup menu display, display format change, range change, storage, data save, integration start/stop/reset, remote clear, key lock, touch lock Panel menus can be controlled using the arrow keys and SET key.
Touch panel	Controls all features Touch lock: Stops the touch panel operation feature

6.5 Wiring Systems

Item	Specifications
Method	Single-phase two-wire (1P2W) Single-phase three-wire (1P3W) Three-phase three-wire (3P3W, 3V3A) Three-phase four-wire (3P4W)

6.6 Measuring Mode

Normal measurement

Item	Specifications
Measurement method	Select sync source period average or digital filter average.
Fixed-period data	Update interval: 50 ms/100 ms/200 ms/500 ms/1 s/2 s/5 s/10 s/20 s Display screen: Single, split screen and the measurement display of the trend Numeric, waveform (free run), trend, bar, vector Measurement function: Normal, harmonic
Trigger update	Display screen: Single, split screen and the measurement display of the trend Numeric, waveform (triggered), trend, bar, vector Measurement function: Normal, harmonic However, the integration feature is not available.

6.7 Features

General Features

Item	Specifications
Crest factor setting	Select crest factor CF3, crest factor CF6, or crest factor C6A.
Element range setting	Can be set for each input element and wiring unit Fixed/auto range setting Fixed range setting Manually set the range of your choice (except only the ranges selected by the valid measurement range selection feature). Range Σ link: ON: Set the range for each wiring unit. OFF: Set the range for each element. Auto range setting Auto range setting feature Range increase When Urms or Irms exceeds 110% of the measurement range (220% for crest factor CF6A). When the peak value of the input signal exceeds approximately 310% (approximately 620% for crest factor CF6 or CF6A) of the range. Range decrease When the measured Urms or Irms value is less than or equal to 30% of the range, Upk and Ipk are less than equal to 300% of the lower range (range to decrease to) (less than equal to 600% for crest factor CF6 or CF6A), and Urms and Irms are less than 105% Changes the range directly to the appropriate range when the range-decrease conditions are met. A feature for changing to the specified range when a peak over-range occurs * The null value is not used for peak over-range detection. Valid measurement range selection feature A feature for selecting the valid measurement range according to the usage conditions Only the selected ranges are used.
Element scaling	A feature that allows direct reading by setting the current sensor conversion ratio, VT ratio, CT ratio, and power coefficient SF • Auto CT ratio configuration is possible by selecting the CT series model name. Source measurement function Set voltage U, current I, power (P, S, Q), maximum voltage (U+pk)/minimum voltage (U-pk), maximum current (I+pk)/minimum current (I-pk), maximum power (P+pk)/minimum power (P-pk), and VT ratio in the following range. Selectable range: 0.0001 to 99999.9999
Averaging	Type: Exponential average, moving average Source: Normal measurement function Urms, Umn, Udc, Urmn, Uac, Irms, Imn, Idc, Irmn, Iac, P, S, Q, fU, fI, f2U, f2I, ΔU1 to ΔPΣ, Torque, Speed, Pm, Aux(/MTR1/MTR2 option) Harmonic measurement function U(k), I(k), P(k), S(k), Q(k) Exponential averaging, attenuation constant: 2 to 64 Moving average, average count: 8 to 64 Data reset: Averaging is reset if a setting of any of the functions below is changed. Averaging type, averaging attenuation constant Range, crest factor, range Σ link, wiring Scale value Line filter, frequency filter Data update interval, averaging method, sync source Zero-level compensation Maximum harmonic order, minimum harmonic order, harmonic window span Waveform observation time
Hold	Measurement hold: Suspends the measurement and display operations and holds the data display of each measurement function. However, measurement is not suspended during integration. Only the display is held. D/A output, communication output, and the like are also held. However, if only the display is held and measurement is continuing during integration, the storage function saves the measured values that are being updated.

Item	Specifications
Single measurement	A single measurement is performed at the specified data update rate while a measurement is being held and the hold state is maintained. If you press SINGLE when the measurement is not being held, measurement is performed again from that point.
Zero-level compensation (Cal)	Measurement element's circuit offset correction feature Manual: Executed under the current settings through a key operation or communication. Auto: Automatically execute when the measurement range is changed or the filter is changed.
Zero-level compensation (Null)	Offset correction feature for all measurement circuits including measurement elements Executed under the current settings through a key operation or communication. Null status: Can be set separately for each function ON: Updates the null value every time a null is executed. HOLD: Holds the null value set once. OFF: Disables null correction. [Upper null limit] Analog input (Elements/Motor/Aux): 0% of range rating Pulse input (Motor/Aux): Speed: 10% of [60/PulseN × 10000 Hz] [rpm] Torque: 10% of the absolute value of Rated Upper [Nm] Rated Upper: The larger of "Nm-Hz coordinates × 2 points" for determining the linear scaling value Aux: 10% of the upper pulse input specification limit 2 MHz [Hz]
Storage	Stores numeric data to internal memory and a USB memory device Save Interval: Data update interval, specified time, or specified interval Synchronization: Manual, real time, integration, event Storage count: 1 to 9999999 Time interval: 50 ms to 99h59m59s File Format: Binary Maximum data file size: 1 GB Saved data conversion: Converts to CSV
Data save	Save numeric data, waveform data, and screen images to the internal memory, a USB memory device, or a network drive
Saving and loading setup parameters	Save setup parameters to the internal memory, a USB memory device, or a network drive Load saved setup parameters.
File operations	Create folder, copy, move, rename, protect, delete
Master and slave synchronized measurement	A feature for synchronizing the measurement start on slave devices to the master device Connector type: BNC: Same for master and slaves I/O level: TTL: Same for master and slaves Output logic: Negative logic, falling edge: Applies to the master Output hold time: Low level, 500 ns or more: Applies to the master Input logic: Negative logic, falling edge: Applies to slaves Minimum pulse width: Low level, 500 ns or more: Applies to slaves Measurement start output signal delay: Applies to the master: Within 1 μs Measurement start delay: Applies to slaves: Within 2 μs Maximum number of connected units: 4 unit Data update interval: 50 ms to 20 s Measuring Mode: Normal measurement
User-Defined Function	A feature for performing computation by combining measurement function symbols Number of computations: 20 Maximum number of operands: 16 Number of characters in an expression: Up to 60 characters Number of unit characters: Up to 8 characters Operators: +, -, ×, ÷, ABS, SQR, SQRT, LOG, LOG10, EXP, NEG, SIN, COS, TAN, ASIN, ACOS, ATAN Parameters: Element, Σ unit, harmonic order
MAX hold	Can be defined using the user-defined function
Efficiency equation	Efficiency computation of up to 4 systems is possible.
User-defined events	Uses measurement functions as trigger conditions Event: Measurement condition Judgment condition: <, <=, =, >, >=, != Number of events: 8

6.7 Features

Item	Specifications
Peak over-range detection	Elements, Motor (/MTR1/MTR2) Displays over-range information on the screen when the allowable range of each element and motor (/MTR1/MTR2) is exceeded.
System configuration	Date and time, message language, menu language
Time setting	Sets the time at startup using the Simple Network Time Protocol (SNMP)
Initialization feature	Returns the settings to their factory default values Settings that are not initialized: date and time, communication settings, menu language, message language, environmental settings* * Environmental settings (Preference): Indication that appears when the frequency or motor pulse frequency is less than the lower limit, decimal point and separator used when saving to ASCII format (.csv) * Starting the instrument with the ESC key held down returns all settings except the date and time to their factory default values.
Help	Displays explanations of features
Self-test	Memory, keyboard

Delta Math Function

Item	Set delta computation.	Symbols and Meanings
Voltage (V)	difference	ΔUE Differential voltage UE between UE+1 determined through computation
	3P3W->3V3A	ΔUE Unmeasured line voltage computed in a three-phase three-wire system
	DELTA->STAR	ΔUE, ΔUE+1, ΔUE+2 Phase voltage computed in a three-phase three-wire (3V3A) system
	STAR->DELTA	ΔUE, ΔUE+1, ΔUE+2 Line voltage calculated in a three-phase four-wire system
Current (A)	difference	ΔI Differential current iE between iE+1 determined through computation
	3P3W->3V3A	ΔI Unmeasured phase current
	DELTA->STAR	ΔI Neutral line current
	STAR->DELTA	ΔI Neutral line current
Power (W)	difference	———
	3P3W->3V3A	———
	DELTA->STAR	ΔPE, ΔPE+1, ΔPE+2 Phase power computed in a three-phase three-wire system
	STAR->DELTA	———

Averaging Function

Method	Computation
Sync source period average	Averaging performed over a specified period Set the calculation period using the set reference signal (sync source) (excluding WP and DCq) Sync source: Ux, Ix, EXT CLK, Z (/MTR1/MTR2 option) The period of UE and IE is detected using a specified trigger value from the waveform sampling data (E is the element number.) Data update interval: 50 ms/100 ms/200 ms/500 ms/1 s/2 s/5 s/10 s/20 s Averaging period: Data update interval or less
Digital filter average	Digital low-pass filter Filter form: FIR

Filter response	Attenuation characteristics (<-100 dB)	Computation rate	Settling time
FAST	100 Hz	10kHz	40 ms
MID	10 Hz	1 kHz	400 ms
SLOW	1 Hz	100 Hz	4 s
VSLOW	0.1 Hz	10 Hz	40 s

Averaging period: Continuous computation
However, the computed value is reset to 0 when a range change, line filter change, zero cal, filter response change, or data update interval change is executed.
Data update interval: 50 ms/100 ms/200 ms/500 ms/1 s/2 s/5 s/10 s/20 s

Filter Function

Item	Specifications	
Line filter	For elements 1 to 7	
	Can be set separately for each element	
	Computation rate	Maximum computation rate: 10 MS/s
	Filter response	Bessel Filter form: IIR Filter type: LPF Filter order: 4 LPF: Cutoff frequency: 100 Hz to 100 kHz, 1 MHz[1] Resolution: 100 Hz Cutoff characteristic: –24 dB/Oct (typical)
	Filter response	Butterworth Filter form: IIR Filter type: LPF Filter order: 4 LPF: Cutoff frequency: 100 Hz to 100 kHz, 1 MHz[1] Resolution: 100 Hz Cutoff characteristic: –24 dB/Oct (typical)
	1 Anti-aliasing filter: element's internal analog filter, Bessel	
	For MOTOR (/MTR1/MTR2 option)	
	Can be used during analog input	
	Computation rate	Maximum computation rate: 200 kS/s
	Filter response	Butterworth Filter form: IIR Filter type: LPF Filter order: 4 LPF: Cutoff frequency: 100 Hz, 500 Hz, 1 kHz Cutoff characteristic: –24 dB/Oct (typical)
	For harmonic measurement	
	Stable measurement is possible through the anti-aliasing filter provided for each sampling frequency.	
	Harmonic analysis in an area different from normal measurement is possible.	
	When the line filter advanced setting is off	According to the element's line filter
	When the line filter advanced setting is on	Filter exclusive to harmonic measurement (independent of the element's line filter)
	Filter response	Bessel Filter form: IIR Filter type: LPF Filter order: 4 LPF: Cutoff frequency: 100 Hz to 100 kHz Resolution: 100 Hz Cutoff characteristic: –24 dB/Oct (typical)
	Filter response	Butterworth Filter form: IIR Filter type: LPF Filter order: 4 LPF: Cutoff frequency: 100 Hz to 100 kHz Resolution: 100 Hz Cutoff characteristic: –24 dB/Oct (typical)
Frequency filter	Elements 1 to 7, for frequency measurement and sync source	
	Can be set separately for each element	
	Computation rate	Maximum computation rate: 10 MS/s The computation rate is selected automatically based on the set frequency 100, 1 k, 10 k, 100 k, 1 M, 5 M, or 10 MHz.

Item	Specifications	
	Filter response	Butterworth Filter form: IIR Filter type: LPF, HPF, (BPF)[1] Filter order: 4 LPF: Cutoff frequency: 100 Hz to 100 kHz Resolution: 100 Hz HPF: When the line filter advanced setting is off: Fixed to 0.1 Hz When the line filter advanced setting is on: Cutoff frequency: 0.1 Hz, 1 Hz, 10 Hz, 100 Hz to 100 kHz Resolution: 100 Hz (fc ≥ 100 Hz) Cutoff characteristic: –24 dB/Oct (typical)
	1 BPF is possible by setting HPF and LPF simultaneously. LPF, BPF, and HPF can be set for the first frequency and for the sync source. Default setting: HPF, 0.1 Hz HPF only for the second frequency. Default setting: Off	

Integration Function

Item	Specifications
Sample rate	5 MS/s
Calculation period	Manual, integration time, real-time control Integration time repetition, real-time control repetition Integration timer range: 0h00m00s to 10000h00m00s Count over: When the maximum integration time (10000 hours) is reached or when an integrated value reaches the maximum or minimum displayable integrated value (±999999 MWh, ±999999 MAh, ±999999 MVAh, ±999999 Mvarh), the integration time and value at that point are held and integration is stopped.
Power failure recovery	Resumes integration if a power failure occurs during integration.
Independent integration	Integration can be executed separately for each element.
External control	With the /DA20 option, start, stop, and reset are possible through external signals.
Auto calibration	Auto offset calibration feature Zero-level compensation is performed at the current range of all elements approximately every hour.

Frequency Measurement Function

Item	Specifications
Measured item	Measures the frequency of the voltage or current applied to all input elements.
Measurement system	A/D data level trigger gate generation Reciprocal method
Display resolution	99999
Minimum frequency resolution	0.0001 Hz
Measurement range	0.1 Hz ≤ f ≤ 2 MHz For the relationship between the data update interval and the measurement range, see the specifications of each element (sections 6.15 and 6.16). * Measurement frequency range is limited by the element. * The display limit is 1.1 times the upper limit of the measurement range (2.2 MHz). Display: Error, 32-bit floating-point value: 0xFFFFFFFE
Accuracy	Depends on the element
Condition	When the input signal level is 30% or more (60% or more when the crest factor is set to CF6 or CF6A) of the measurement range. However, 1) Input condition for 50% of the range or more • Twice the lower frequency limit above or less • Minimum current range 500 mA range (760901)(CF3) 5 mA range (760902)(CF3) • Minimum external sensor range 50 mV range (760901, 760902)(CF3) 2) Frequency filter setup conditions 0.1 Hz to 100 Hz: fc = 100 Hz 100 Hz to 1 kHz: fc = 1 kHz 1kHz to 100 kHz: fc = 100 kHz
Frequency detection signal level setting	Selectable range HPF: ON: Auto HPF: OFF: Rectifier OFF: ±100% of range Rectifier ON: 0% to +100% of range

Harmonic Measurement Feature

Item	Specifications
Measured item	All installed elements
Method	PLL synchronization method
Frequency range	Fundamental frequency: 0.1 Hz to 300 kHz Analysis frequency: 0.1 Hz to 1.5 MHz
PLL source	Select the input element's voltage or current or external clock. Input level: 50% or more of the rated measurement range when the crest factor is CF3. 100% or more of the rated measurement range when the crest factor is CF6 or CF6A. The conditions in which frequency filters are turned on 0.1 Hz ≤ f < 100 Hz: 100 Hz 100 Hz ≤ f < 1 kHz: 1 kHz 1 kHz ≤ f < 10 kHz: 10 kHz 10 kHz ≤ f < 100 kHz: 100 kHz
Number of FFT points	Select 1024 or 8192.
Window function	Rectangular
Anti-Aliasing Filter	Set using a line filter or harmonic filter

When the number of FFT points is 1024

Fundamental frequency	Sample rate	Window width	Upper limit of harmonic analysis	
			U, I, P, Φ, ΦU, ΦI	Other measured values
0.1 Hz to 3 kHz	f × 1024	1 wave	100th	100th
3 kHz to 7.5 kHz	f × 512	2 waves	100th	100th
7.5 kHz to 15 kHz	f × 256	4 waves	50th	50th
15 kHz to 30 kHz	f × 128	8 waves	20th	20th
30 kHz to 75 kHz	f × 64	16 waves	10th	10th
75 kHz to 150 kHz	f × 32	32 waves	5th	5th

When the number of FFT points is 8192 (at 10 MS/s)

Fundamental frequency	Sample rate	Window width	Upper limit of harmonic analysis*	
			U, I, P, Φ, ΦU, ΦI	Other measured values
0.5 Hz to 3 kHz	f × 1024	8 waves	500th harmonic	100th
3 kHz to 7.5 kHz	f × 1024	8 waves	200th	100th
7.5 kHz to 15 kHz	f × 512	16 waves	100th	100th
15 kHz to 30 kHz	f × 256	32 waves	50th	50th
30 kHz to 75 kHz	f × 128	64 waves	20th	20th
75 kHz to 150 kHz	f × 64	128 waves	10th	10th
150 kHz to 300 kHz	f × 32	256 waves	5th	5th

* The maximum measurable order is 100 when the update interval is 50 ms or less.

When the number of FFT points is 8192 (at 5 MS/s)

Fundamental frequency	Sample rate	Window width	Upper limit of harmonic analysis*	
			U, I, P, Φ, ΦU, ΦI	Other measured values
0.5 Hz to 1.2 kHz	f × 1024	8 waves	500th harmonic	100th
1.2 kHz to 3 kHz	f × 1024	8 waves	200th	100th
3 kHz to 7.5 kHz	f × 512	16 waves	100th	100th
7.5 kHz to 15 kHz	f × 256	32 waves	50th	50th
15 kHz to 30 kHz	f × 128	64 waves	20th	20th
30 kHz to 75 kHz	f × 64	128 waves	10th	10th
75 kHz to 150 kHz	f × 32	256 waves	5th	5th

* The maximum measurable order is 100 when the update interval is 50 ms or less.

6.8 Measurement Function Computation

Normal Measurement

For details about how the measurement function values are computed and determined, see appendix 1.

Item	Symbols and Meanings
Voltage (V)	Urms: true rms value, Umn: rectified mean value calibrated to the rms value, Urmn: current rectified mean value, Udc: simple average, Uac: AC component, Ufnd: fundamental component
Current (A)	Irms: true rms value, Imn: rectified mean value calibrated to the rms value, Irmn: current rectified mean value, Idc: simple average, Iac: AC component, Ifnd: fundamental component
Active power (W)	P Pfnd: fundamental component
Apparent power (VA)	S Sfnd: fundamental component
Reactive power (var)	Q Qfnd: fundamental component
Power factor	λ λfnd: fundamental component
Phase difference (°)	Φ Φfnd: fundamental component
Frequency (Hz)	fU (FreqU): voltage frequency, fI (FreqI): current frequency The fU and fI of elements 1 to 7 can be measured simultaneously.
	f2U (Freq2U): voltage frequency, f2I (Freq2I): the current frequency when the second frequency filter is applied
Corrected Power(W)	Pc Applicable standards IEC76-1 (1976), IEC76-1 (2011)
Voltage max. and min. (V)	U+pk: maximum voltage, U-pk: minimum voltage
Current max. and min. (A)	I+pk: maximum current, I-pk: minimum current
Power max. and min. (W)	P+pk: maximum power, P-pk: minimum power
Crest factor (peak-to-rms ratio)	CfU: voltage crest factor, CfI: current crest factor
Integration	ITime: integration time WP: sum of positive and negative watt hours WP+: sum of positive P (consumed watt hours) WP–: sum of negative P (watt hours returned to the power supply) q: sum of positive and negative ampere hours q+: sum of positive I (ampere hours) q–: sum of negative I (ampere hours) WS: volt-ampere hours WQ: var hours By using the current mode setting, you can select to integrate the ampere hours using Irms, Imn, Idc, Iac, or Irmn.
Voltage measurement range	RngU
Current measurement range	RngI

Measurement Functions (Σ Functions) Determined for Each Wiring Unit (ΣA, ΣB, ΣC)

For details about how Σ function values are computed and determined, see appendix 1.

Item	Symbols and Meanings
Voltage (V)	UrmsΣ: true rms value, UmnΣ: rectified mean value calibrated to the rms value, UrmnΣ: current rectified mean value, UdcΣ: simple average, UacΣ: AC component
Current (A)	IrmsΣ: true rms value, ImnΣ: rectified mean value calibrated to the rms value, IrmnΣ: current rectified mean value, IdcΣ: simple average, IacΣ: AC component
Active power (W)	PΣ
Apparent power (VA)	SΣ
Reactive power (var)	QΣ
Corrected Power(W)	PcΣ Applicable standards IEC76-1 (1976), IEC76-1 (2011)
Integration	WPΣ: sum of positive and negative watt hours WP+Σ: sum of positive P (consumed watt hours) WP–Σ: sum of negative P (watt hours returned to the power supply) qΣ: sum of positive and negative ampere hours q+Σ: sum of positive I (ampere hours) q–Σ: sum of negative I (ampere hours) WQΣ: Integration of QΣ WSΣ: Integration of SΣ
Power factor	λΣ
Phase difference (°)	ΦΣ

Harmonic Measurement Computation Feature

Measurement Functions Determined for Each Input Element

Item	Symbols and Meanings	
Voltage (V)	U (k): rms voltage value of harmonic order k[1]	U: total rms voltage[2]
Current (A)	I (k): rms current value of harmonic order k	I: total rms current[2]
Active power (W)	P (k): active power of harmonic order k	P: total active power[2]
Apparent power (VA)	S (k): apparent power of harmonic order k	S: total apparent power[2]
Reactive power (var)	Q (k): reactive power of harmonic order k	Q: total reactive power[2]
Power factor	λ (k): power factor of harmonic order k	λ: total power factor[2]
Phase difference (°)	Φ (k): phase difference between the voltage and current of harmonic order k, Φ: total phase difference ΦU (k): phase difference between harmonic voltage U(k) and the fundamental wave U(1) ΦI (k): phase difference between harmonic current I(k) and the fundamental wave I(1)	
Load circuit impedance (Ω)	Z (k): impedance of the load circuit in relation to harmonic order k	
Load circuit resistance and reactance (Ω)	Rs (k): resistance of the load circuit in relation to harmonic order k when resistor R, inductor L, and capacitor C are connected in series Xs (k): reactance of the load circuit in relation to harmonic order k when resistor R, inductor L, and capacitor C are connected in series Rp (k): resistance of the load circuit in relation to harmonic order k when R, L, and C are connected in parallel Xp (k): reactance of the load circuit in relation to harmonic order k when R, L, and C are connected in parallel	
Fundamental component of voltage (V)	Ufnd: U (1)	
Fundamental component of current (A)	Ifnd: I (1)	
Fundamental active power (W)	Pfnd: P (1)	
Fundamental apparent power (VA)	Sfnd: S (1)	
Fundamental reactive power (var)	Qfnd: Q (1)	
Fundamental power factor	λfnd: λ (1)	
Phase difference between the fundamental voltage and current (°)	Φfnd: Φ (1)	
Harmonic distortion factor (%)	Uhdf (k): ratio of harmonic voltage U(k) to U(1) or U Ihdf (k): ratio of harmonic current I(k) to I(1) or I Phdf (k): ratio of harmonic active power P(k) to P(1) or P	
Total harmonic distortion (%)	Uthd: ratio of the total harmonic voltage to U(1) or U[3] Ithd: ratio of the total harmonic current to I(1) or I[3] Pthd: ratio of the total harmonic active power to P(1) or P[3]	
Telephone harmonic factor [applicable standard: IEC34-1 (1996)]	Uthf: voltage telephone harmonic factor, Ithf: current telephone harmonic factor	
Telephone influence factor [applicable standard: IEEE Std 100 (1996)]	Utif: voltage telephone influence factor, Itif: current telephone influence factor	
Harmonic voltage factor[4]	hvf:harmonic voltage factor	
Harmonic current factor[4]	hcf:harmonic current factor	
K-factor	Ratio of the squared sum weighted harmonic components to the squared sum of the harmonic currents	

1 Harmonic order k is an integer from 0 to the upper limit of harmonic analysis. The 0th order is the DC component. The upper limit is determined automatically according to the PLL source frequency. It can go up to the 500th harmonic order.
2 The total value is determined according to the equation on page 4 of the appendix from the fundamental wave (1st harmonic) and all harmonic components (2nd harmonic to the upper limit of harmonic analysis). The DC component can also be included.
3 Total harmonic values are determined from all harmonic components (the 2nd harmonic to the upper limit of harmonic analysis) according to the equations on page 5 of the appendix.
4 The expression may vary depending on the definitions in the standard. For details, see the corresponding standard.

Measurement Functions (Σ Functions) Determined for Each Wiring Unit (ΣA, ΣB, ΣC)

Item	Symbols and Meanings	
Voltage (V)	UΣ (1): rms voltage of harmonic order 1	UΣ: total rms voltage[1]
Fundamental component of voltage (V)	UfndΣ	
Current (A)	IΣ (1): rms current of harmonic order 1	IΣ: total rms current[1]
Fundamental component of current (A)	IfndΣ	
Active power (W)	PΣ (1): active power of harmonic order 1	PΣ: total active power[1]
Fundamental active power (W)	PfndΣ	
Apparent power (VA)	SΣ (1): apparent power of harmonic order 1	SΣ: total apparent power[1]
Fundamental apparent power (VA)	SfndΣ	
Reactive power (var)	QΣ (1): reactive power of harmonic order 1	QΣ: total reactive power[1]
Fundamental reactive power (var)	QfndΣ	
Power factor	λΣ (1): power factor of harmonic order 1	λΣ: total power factor[1]
Fundamental power factor	λfndΣ	
Phase difference (°)	ΦΣ	

1 The total value is determined according to the equation on page 4 of the appendix from the fundamental wave (1st harmonic) and all harmonic components (2nd harmonic to the upper limit of harmonic analysis). The DC component can also be included.

Measurement Functions that Indicate Fundamental Voltage and Current Phase Differences between Input Elements

These measurement functions indicate the phase differences between the fundamental voltage U(1) of the smallest numbered input element in a wiring unit and the fundamental voltages U(1) or currents I(1) of other input elements. The following table indicates the measurement functions for a wiring unit that combines elements 1, 2, and 3.

Item	Symbols and Meanings
Phase angle U1-U2 (°)	ΦU1-U2: phase angle between U1 (1) and the fundamental voltage of element 2, U2 (1)
Phase angle U1-U3 (°)	ΦU1-U3: phase angle between U1 (1) and the fundamental voltage of element 3, U3 (1)
Phase angle U1-I1 (°)	ΦU1-I1: phase angle between U1 (1) and the fundamental current of element 1, I1 (1)
Phase angle U2-I2 (°)	ΦU2-I2: phase angle between U2 (1) and the fundamental current of element 2, I2 (1)
Phase angle U3-I3 (°)	ΦU3-I3: phase angle between U3 (1) and the fundamental current of element 3, I3 (1)
EAM1U1 to EAM1U7 (°), EAM1I1 to EAM1I7 (°)	Phase angles of the fundamental waves of U1 to I7 with the rising edge of the signal received through the Motor1 (MTR1) Z terminal of the motor evaluation function as the reference.
EAM3U1 to EAM3U7 (°), EAM3I1 to EAM3I7 (°)	Phase angles of the fundamental waves of U1 to I7 with the rising edge of the signal received through the Motor3 (MTR2) Z terminal of the motor evaluation function as the reference.

Motor Evaluation Function (Option)

Item	Symbols and Meanings
Motor rotating speed	Speed
Motor torque	Torque
Synchronous speed	SyncSp
Slip (%)	Slip
Motor output	Pm
Auxiliary input	AUX

Measurement Range

Item	Symbols and Meanings
Voltage measurement range	RngU
Current measurement range	RngI
Speed measurement range	RngSpd
Torque measurement range	RngTrq
Aux measurement range	RngAux

6.9 Auxiliary I/O

External Clock Input Section

Item	Specifications
Input connector type	BNC
Input level	TTL
Sync signal input	Normal measurement: Frequency range: Same as the frequency measurement range Harmonic measurement: Frequency range: 0.1 Hz to 300 kHz * Input waveform: 50% duty ratio rectangular wave
Trigger input	Input logic: Negative logic, falling edge Minimum pulse width: 1 μs Trigger delay: Within (2 μs + 12 μs)

External Monitor

Item	Specifications
Input connector type	D-sub 15 pin (receptacle)
Output format	Analog RGB output
Output resolution	WXGA output, 1280 × 800 dots Approx. 60 Hz Vsync (66 MHz dot clock frequency)

Remote, D/A (Option)

Item	Specifications
Input connector type	Micro ribbon connector (Amphenol 57LE connector), 36-pin
Control signal	Integration RESET: $\overline{\text{EXT RESET}}$ START: $\overline{\text{EXT START}}$ STOP: $\overline{\text{EXT STOP}}$ BUSY: $\overline{\text{INTEG BUSY}}$ Updating Data HOLD: $\overline{\text{EXT HOLD}}$ SINGLE: $\overline{\text{EXT SINGLE}}$
Input	0 to 5 V
Output	0 to 5 V

6.10 Peripheral Device Connection

USB

Item	Specifications
Connector type	Type A connector (receptacle)
Ports	2
Electrical and mechanical	Complies with USB Rev. 2.0
Supported transfer modes	HS (High Speed) mode (480 Mbps), FS (Full Speed) mode (12 Mbps), LS (Low Speed) mode (1.5 Mbps)
Compatible devices	Mass storage devices that comply with USB Mass Storage Class Ver. 1.1 Usable capacity: 8 TB, partition format: MBR/GPT, format type: FAT32/FAT16/exFAT 104 or 109 keyboards that comply with USB HID Class Ver. 1.1 Mouse devices that comply with USB HID Class Ver. 1.1
Power supply	5 V, 500 mA (each port) You cannot connect devices whose maximum current consumptions exceed 100 mA to two different ports on the instrument at the same time.

6.11 Computer Interface

GP-IB Interface

Item	Specifications
Input connector type	24-pin connector
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, and C0
Protocol	Conforms to IEEE St'd 488.2-1992
Code	ISO (ASCII) code
Mode	Addressable mode
Address	0 to 30
Clear remote mode	Press UTILITY (LOCAL) to clear remote mode (except during Local Lockout).

Ethernet interface

Item	Specifications
Connector type	RJ-45 connector
Ports	1
Electrical and mechanical	IEEE802.3 compliant, Auto-MDIX
Transmission system	Ethernet1000Base-T/100BASE-TX/10BASE-T
Communication protocol	TCP/IP
Supported services	FTP server, DHCP, DNS, remote control (VXI-11), SNTP, and FTP client

USB PC Interface

Item	Specifications
Connector type	Type B connector (receptacle)
Ports	1
Electrical and mechanical	Complies with USB 3.0
Supported transfer modes	SS (SuperSpeed) mode (5 Gbps), HS (High Speed) mode (480 Mbps), FS (Full Speed) mode (12 Mbps)
Supported protocols	USBTMC-USB488(USB Test and Measurement Class Ver. 1.0)
PC system requirements	A PC with a USB port, running Windows 7, Windows 8.1, or Windows 10. A separate device driver is required to enable the connection with the PC.

6.12 System Maintenance Processing

Alarm Generation and Operation

Item	Specifications
Fan stop	Fan stop alarm indication Emergency operation stop after about 60 seconds*
Internal temperature error	Temperature error alarm indication Emergency operation stop*

* Emergency operation stop
Stops the power supply for running the instrument
Stops the power supply to elements, motor (/MTR1/MTR2), and D/A output (/DA20)
Generates intermittent beeps, MENU key in the SETUP area blinks in red
Continues the fan operation

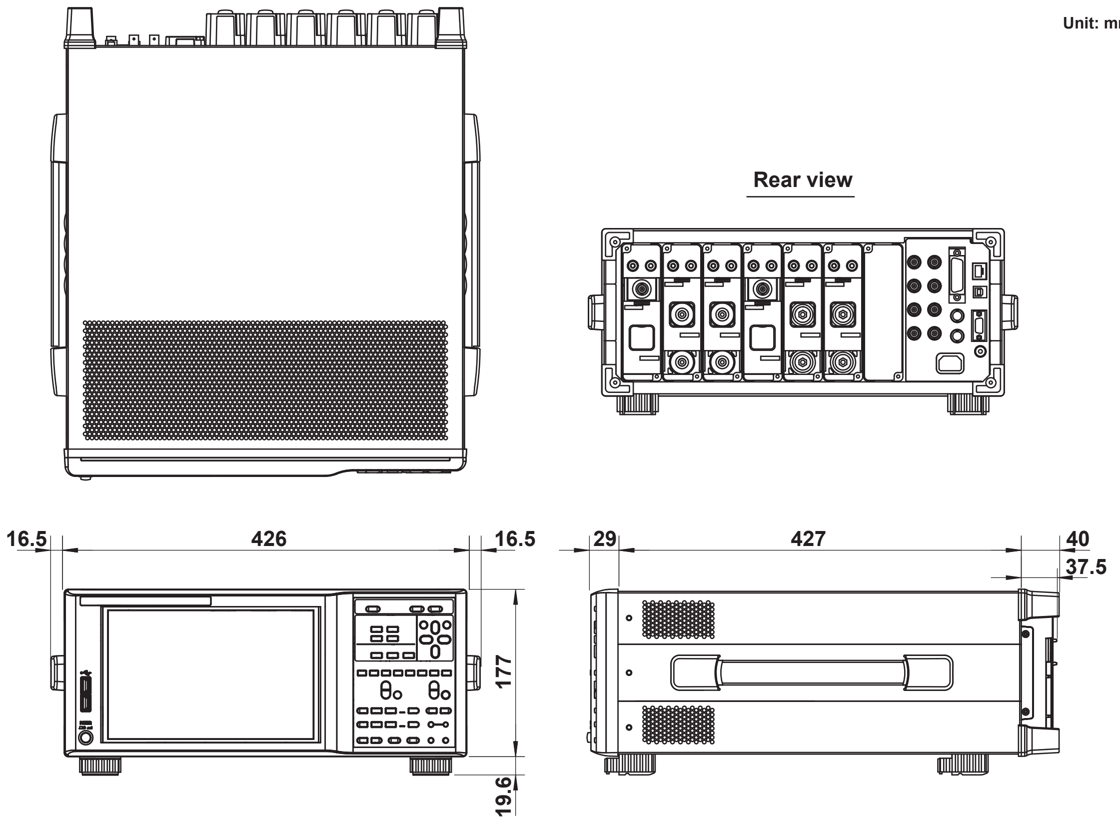
6.13 General Specifications

Item	Specifications	
Warm-up time	Approx. 30 minutes	
Operating environment	Temperature	5°C to 40°C
	Humidity	20% RH to 80% RH (no condensation)
	Operating altitude	2000 m or less
	Installation location	Indoors
Storage environment	Temperature	-25°C to 60°C (no condensation)
	Humidity	20% RH to 80% RH (no condensation)
Rated supply voltage	100 VAC to 120 VAC, 220 VAC to 240 VAC	
Permitted supply voltage range	90 VAC to 132 VAC, 198 VAC to 264 VAC	
Rated supply frequency	50 Hz/60 Hz	
Permitted supply frequency range	48 Hz to 63 Hz	
Maximum power consumption	560 VA	
Power fuse	Built in, not replaceable	
Cooling method	Forced air cooling, air vents on the left, right, and top panels	
Installation orientation	Horizontal, tilted (using the stand)	
External dimensions	177 mm (H) × 426 mm (W) × 496 mm (D) (excluding the handles and protrusions)	
Weight	Approx. 12.5 kg (main unit only with /M1/MTR1/DA20 installed)	
Battery backup	Setup parameters and the internal clock are backed up with a lithium battery.	
Safety standards[1]	Compliant standards EN 61010-1, EN 61010-2-030, EN 61010-031, EN 60825-1 Installation category (overvoltage category) CAT II[2] Measurement category CAT II[3] Pollution degree 2[4]	
Emissions[1]	Compliant standard EN 61326-1 ClassA, EN 61326-2-1, EN 61000-3-2, EN 61000-3-3 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 • EXT CLK, MEAS. START input terminals Use BNC cables.[5] • Motor evaluation function terminals, AUX input terminals Use safety BNC cables.[5] • GP-IB interface connector Use a shielded GP-IB cable.[5] • RGB output connector Use a shielded D-sub 15 pin cable.[5] • USB port (PC) Use a shielded USB cable.[5] • USB port (for peripheral devices) Use a shielded USB cable.[5] • Ethernet connector Use a category 5 or better Ethernet cable (STP).[6]	
Immunity1	Compliant standard EN 61326-1 Table 2 (for use in industrial locations) EN 61326-2-1 Influence in the immunity environment Measurement input: within ±20% of range (When the crest factor is set to 6, within ±40% of range.) External current sensor input : within ±300 mV D/A output: within ±20% of FS; FS = 5 V Cable conditions Same as the cable conditions for emission above.	
Environmental standard[1]	Compliant standard EN 50581 Monitoring and control instruments including industrial monitoring and control instruments	

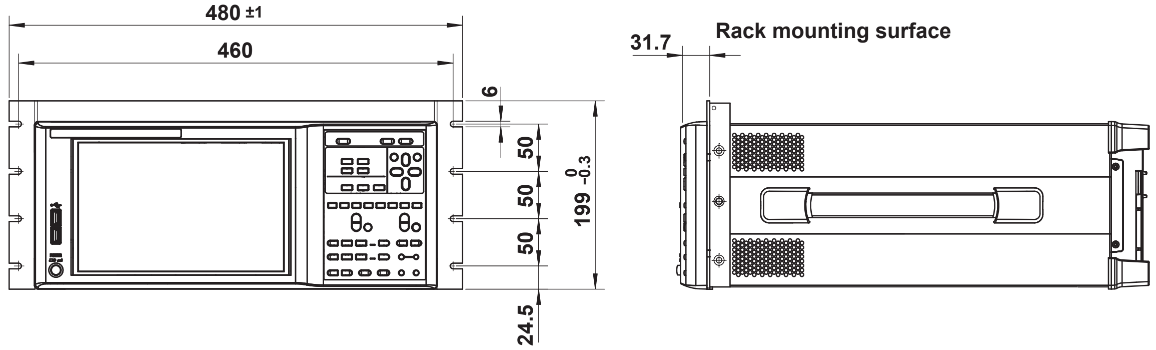
1 Applies to products with CE marks. For information on other products, contact your nearest YOKOGAWA dealer.
2 The overvoltage category (installation category) is a value used to define the transient overvoltage condition and includes the rated impulse withstand voltage. CAT II applies to electrical equipment that is powered through a fixed installation, such as a wall outlet wired to a distribution board.
3 This instrument is a measurement category II product. Do not use it for measurement category III or IV measurements.
Measurement category O applies to measurement of other types of 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 30 m or less.

6.14 External Dimensions

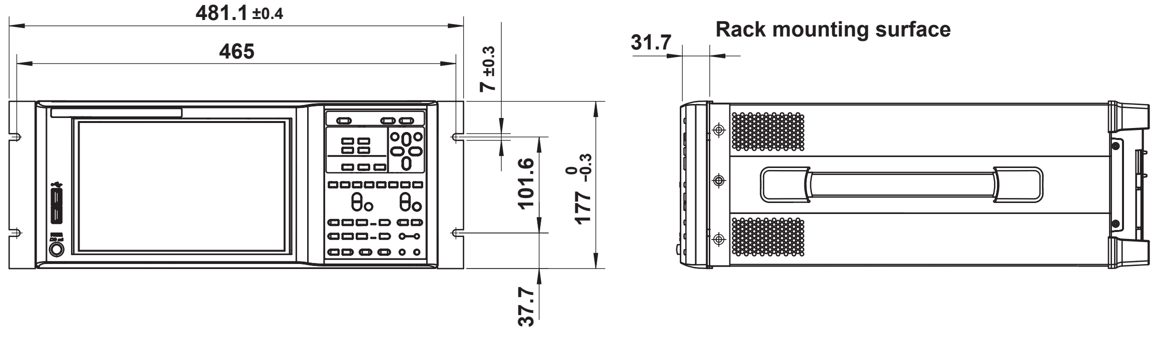
Unit: mm



JIS rack mount dimensions



EIA rack mount dimensions



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

6.15 760901 30A High Accuracy Element Specifications

Item	Specifications
Input terminal type	Voltage Plug-in terminal (safety terminal) Current Direct input: Plug-in terminal (safety terminal) External current sensor input: isolated BNC
Input type	Voltage Floating input through resistive voltage divider Current Floating input through shunt
Measurement range	Voltage 1.5 V/3 V/6 V/10 V/15 V/30 V/60 V/100 V/150 V/300 V/600 V/1000 V (crest factor CF3) 0.75 V/1.5 V/3 V/5 V/7.5 V/15 V/30 V/50 V/75 V/150 V/300 V/500 V (crest factor CF6/CF6A) Current Direct input 500 mA, 1 A, 2 A, 5 A, 10 A, 20 A, 30 A (crest factor CF3) 250 mA, 500 mA, 1 A, 2.5 A, 5 A, 10 A, 15 A (crest factor CF6/CF6A) External current sensor input 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V (crest factor CF3) 25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V, 5 V (crest factor CF6/CF6A)
Input impedance	Voltage Input resistance: 10 MΩ ± 1%, input capacitance: approx. 15 pF Current Direct input: 6.5 mΩ ± 10% + approx. 0.3 μH External current sensor input: input resistance: 1 MΩ ± 1%, input capacitance: approx. 50 pF
Instantaneous maximum allowable input (within 1 s)	Voltage Peak value of 2.5 kV or RMS value of 1.5 kV, whichever is less Current Direct input Peak value of 150 A or rms value of 50 A, whichever is less. External current sensor input Peak value 10 times the range or 25 V, whichever is less
Continuous maximum allowable input	Voltage Peak value of 1.6 kV or RMS value of 1.5 kV, whichever is less If the frequency of the input voltage exceeds 100 kHz, (1200 – f) Vrms or less. f is the frequency of the input voltage in units of kHz. Current Direct input Peak value of 90 A or rms value of 33 A, whichever is less. External current sensor input Peak value 5 times the range or 25 V, whichever is less
Maximum rated voltage to earth (DC to 50/60Hz)	Voltage input terminal 1000 V CAT II Current input terminal 1000 V CAT II External current sensor input connector 1000 V CAT II

Item	Specifications
Influence of voltage to earth	When 1000 Vrms is applied between the input terminal and the WT5000 case with the voltage input terminals shorted, current input terminals open and external current sensor input terminals shorted. 50/60 Hz: ±0.01% of range or less. Reference value for up to 200 kHz Voltage: ±{(maximum rated range)/(rated range) × 0.001 × f% of range} or less Current: Direct input: ±{(maximum rated range)/(rated range) × 0.001 × f% of range} or less External current sensor input: ±{(maximum rated range)/(rated range) × 0.001 × f% of range} or less However, 0.01% or greater. The unit of f is kHz. The maximum range rating in the equation is for a voltage of 1000 V, direct current input of 30 A, and external current sensor input of 10 V.
A/D converter	Simultaneous conversion of voltage and current inputs. Resolution: 18 bits Sample rate: 10 MS/s max.
Measurement frequency bandwidth	DC, 0.1 Hz to 2 MHz
Lower limit of measurement frequency	Sync source period average method Data update interval 50 ms 45 Hz 100 ms 20 Hz 200 ms 10 Hz 500 ms 5 Hz 1 s 2 Hz 2 s 1 Hz 5 s 0.5 Hz 10 s 0.2 Hz 20 s 0.1 Hz Digital filter average method FAST: 100 Hz MID: 10 Hz SLOW: 1 Hz VSLOW: 0.1 Hz
Maximum display	140% of the rated voltage or current range (160% for the 1000 V range) 280% of the voltage and current range rating for CF6A (except 320% for the 500 V range)

Accuracy

Item	Specifications
Accuracy (6 months)	Condition Temperature: 23°C ± 5°C Input waveform: Sine wave λ (power factor): 1 Voltage to ground: 0 V Crest factor: CF3 Line filter: OFF Sync source period average method Frequency filter: Used for signal frequencies at 1 kHz or less Sync source signal level: Same as the frequency measurement conditions Input range: DC 0% to ± 110% of range, AC 1% to 110% of range Defined using rms values for AC After the warm-up time has elapsed. Wired condition after zero-level compensation or measurement range change. The unit of f in the accuracy equations is kHz.

Item	Specifications	
	Voltage	
	DC	±(0.02% of reading + 0.05% of range)
	0.1 Hz ≤ f < 10 Hz	±(0.03% of reading + 0.05% of range)
	10 Hz ≤ f < 45 Hz	±(0.03% of reading + 0.05% of range)
	45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.02% of range)
	66 Hz < f ≤ 1 kHz	±(0.03% of reading + 0.04% of range)
	1 kHz < f ≤ 10 kHz	±(0.1% of reading + 0.05% of range) Add 0.015 × f % of reading (10 V range or less).
	10 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.1% of range)
	50 kHz < f ≤ 100 kHz	±(0.6% of reading + 0.2% of range)
	100 kHz < f ≤ 500 kHz	±{(0.006 × f)% of reading + 0.5% of range}
	500 kHz < f ≤ 1 MHz	±{(0.022 × f - 8)% of reading + 1% of range}
	Frequency bandwith	DC to 10 MHz (Typical)
	Current	
	DC	±(0.02% of reading + 0.05% of range)
	0.1 Hz ≤ f < 10 Hz	±(0.03% of reading + 0.05% of range)
	10 Hz ≤ f < 45 Hz	±(0.03% of reading + 0.05% of range)
	45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.02% of range)
	66 Hz < f ≤ 1 kHz	±(0.03% of reading + 0.04% of range)
	1 kHz < f ≤ 10 kHz	±(0.1% of reading + 0.05% of range)
	10 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.1% of range)
	50 kHz < f ≤ 100 kHz	±(0.6% of reading + 0.2% of range)
	100 kHz < f ≤ 200 kHz	±{(0.00725 × f - 0.125)% of reading + 0.5% of range}
	200 kHz < f ≤ 500 kHz	±{(0.00725 × f - 0.125)% of reading + 0.5% of range}
	500 kHz < f ≤ 1 MHz	±{(0.022 × f - 8)% of reading + 1% of range}
	Frequency bandwidth	Direct input: DC to 5 MHz (typical) External current sensor input: DC to 5 MHz (typical)
	Active power (power factor 1)	
	DC	±(0.02% of reading + 0.05% of range)
	0.1 Hz ≤ f < 10 Hz	±(0.08% of reading + 0.1% of range)
	10 Hz ≤ f < 30 Hz	±(0.08% of reading + 0.1% of range)
	30 Hz ≤ f < 45 Hz	±(0.05% of reading + 0.05% of range)
	45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.02% of range)
	66 Hz < f ≤ 1 kHz	±(0.05% of reading + 0.05% of range)
	1 kHz < f ≤ 10 kHz	±(0.15% of reading + 0.1% of range) Add 0.01 × f % of reading (10 V range or less).
	10 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.2% of range)
	50 kHz < f ≤ 100 kHz	±(0.7% of reading + 0.3% of range)
	100 kHz < f ≤ 200 kHz	±{(0.008 × f)% of reading + 1% of range}
	200 kHz < f ≤ 500 kHz	±{(0.008 × f)% of reading + 1% of range}
	500 kHz < f ≤ 1 MHz	±{(0.048 × f - 20)% of reading + 1% of range}

- For the accuracy at 1 year, multiply the reading of the accuracy at 6 months by 1.5.

- For the direct current input range, add the following values to the accuracies listed above:
  DC current accuracy: 0.1 mA
  DC power accuracy: (0.1 mA/rated value of the direct current input range) × 100% of range

- For the accuracies of waveform data functions Upk and Ipk:
  Add the following values (reference values) to the accuracies listed above.
  The effective input range is within ±300% (±600% when the crest factor is set to CF6 or CF6A) of the range.
  Voltage input: {√(1.5/range) + 0.5}% of range
  Direct current input range
  {√(1/range) + 0.5}% of range + 10 mA
  External current sensor input range
  {√(0.01/range) + 0.5}% of range (50 mV to 200 mV)
  {√(0.1/range) + 0.5}% of range (500 mV to 10 V)

- Influence of temperature changes after zero-level compensation or range change
  Add the following values to the accuracies listed above.
  - DC voltage accuracy: ±0.02% of range/°C (1.5 V to 10 V range)
    ±0.005% of range/°C (15 V to 1000 V range)
  - Direct current input DC accuracy: ±0.1 mA/°C
  - External current sensor input DC accuracy: ±50 µV/°C (50 mV to 200 mV)
    ±200 µV/°C (0.5 V to 10 V)

  For the DC power accuracy, add the voltage influence × I and the current influence × U.
  U is the voltage reading (V).
  I is the current reading (A).

- Influence of self-generated heat caused by current input
  Add the following values to the current accuracy:
  For the power accuracy, add the voltage and the current influence.
  - AC input signal
    Current, active power, apparent power: $0.00002 \times I^2$% of reading
  - DC input signal
    Current: $0.00002 \times I^2$% of reading + $3 \times I^2$ mA
    Power: $0.00002 \times I^2$ % of reading + $3 \times I^2$ mA × U
    U is the voltage reading (V).
    I is the current reading (A).

  Even if the current input decreases, the influence from self-generated heat continues until the temperature of the shunt resistor decreases.

- Guaranteed accuracy ranges for frequency, voltage, and current
  All accuracy figures for 0.1 Hz to 10 Hz are reference values.
  The voltage and power accuracy figures for 30 kHz to 100 kHz when the voltage exceeds 750 V are reference values.
  The current and power accuracy figures for DC, 10 Hz to 45 Hz, and 400 Hz to 100 kHz when the current exceeds 20 A are reference values.

- Influence of data update interval
  Add the following value for signal sync period average
  50ms: 0.03% of reading
  100ms: 0.02% of reading

- Accuracy when the crest factor is set to CF6 or CF6A:
  The same as the accuracy when the crest factor is CF3 after doubling the range.

Item	Specifications
Power factor (λ) influence	When λ = 0 Apparent power reading × 0.02% in the range of 45 Hz to 66 Hz. For other frequency ranges, see below. However, note that these figures are reference values. Apparent power reading × (0.02 + 0.05 × f)% When 0 < λ < 1 (Power reading) × [(power reading error %) + (power range error %) × (power range/indicated apparent power value) + {tan φ × (influence when λ = 0)%}], where φ is the phase angle between the voltage and current. The unit of f in the accuracy equations is kHz.
Temperature coefficient	±0.01% of reading/°C (5°C to 18°C or 28°C to 40°C)
Influence of humidity	Add to the voltage and active power accuracies: ±0.00022 × |HUM - 50| × f % of reading: f ≤ 40 kHz ±0.0087 × |HUM - 50| % of reading: f > 40 kHz Reference: Add to the power factor error. When λ = 0 Apparent power reading × 0.00002 ×|HUM - 50| × f% When 0 < λ < 1 (Power reading) × {(power reading error %) + (power range error %) × (power range/indicated apparent power value) + [tan φ × (influence when λ = 0)%]}, HUM: Relative humidity [%RH] The unit of f in the accuracy equations is kHz.
Effective input range	Udc, Idc: 0% to ±130% of the measurement range (excluding the 1000 V range)* Udc 1000 V range: 0% to ±150%* Urms, Irms: 1% to 130% of the measurement range* Umn, Imn: 10% to 130% of the measurement range* Urmn, Irmn: 10% to 130% of the measurement range* Power DC measurement: 0% to ±130%* AC measurement: 1% to 130%* of the voltage and current ranges; up to ±130%* of the power range * The accuracy for 110% to 130% of the measurement range (excluding the 1000 V range) is range error × 1.5. If the input voltage exceeds 600 V, add 0.02% of reading. However, the signal level for the signal sync period average must meet the input signal level for frequency measurement. When the crest factor is set to CF6 or CF6A, double the lower limit.
Accuracy of apparent power S	Voltage accuracy + current accuracy
Accuracy of reactive power Q	Accuracy of apparent power + ($\sqrt{(1.0002 - \lambda^2)} - \sqrt{(1 - \lambda^2)}$) × 100% of range
Accuracy of power factor λ	±[(λ – λ/1.0002) + |cosφ – cos{φ + $\sin^{-1}$((influence from the power factor when λ = 0)%/100)}|] ±1 digit The voltage and current must be within their rated ranges.
Accuracy of phase difference Φ	±[|φ – {$\cos^{-1}$(λ/1.0002)}| + $\sin^{-1}${(influence from the power factor when λ = 0)%/100}] deg ±1 digit The voltage and current must be within their rated ranges.
Lead and lag detection	Phase difference: ±(5° to 175°) Frequency: 20 Hz to 10 kHz Condition: Sine wave At least 50% of the measurement range (at least 100% for CF6 and CF6A)
Line filter	Bessel, 5th order LPF, fc: 1 MHz Voltage, current Up to 100 kHz: Add (20 × f/fc)% of reading Power Up to 100 kHz: Add (40 × f/fc)% of reading For LPFs less than or equal to 100 kHz, see “Line filter” in section 6.7.

6.15 760901 30A High Accuracy Element Specifications

Item	Specifications
Frequency measurement	Frequency measurement range Data update interval — Measurement range 50 ms — 45 Hz ≤ f ≤ 2 MHz 100 ms — 20 Hz ≤ f ≤ 2 MHz 200 ms — 10 Hz ≤ f ≤ 2 MHz 500 ms — 5 Hz ≤ f ≤ 2 MHz 1 s — 2 Hz ≤ f ≤ 2 MHz 2 s — 1 Hz ≤ f ≤ 2 MHz 5 s — 0.5 Hz ≤ f ≤ 2 MHz 10 s — 0.2 Hz ≤ f ≤ 2 MHz 20 s — 0.1 Hz ≤ f ≤ 2 MHz Accuracy: ±0.06% of reading ± 0.1 mHz Conditions: Input signal level: CF3: At least 30% of the measurement range CF6/6A: At least 60% of the measurement range However, at least 50% of the range if the signal is less than or equal to twice the lower measurement frequency Frequency filter 0.1 Hz ≤ f < 100 Hz: 100 Hz 100 Hz ≤ f < 1 kHz: 1 kHz 1 kHz ≤ f < 100 kHz: 100 kHz

Item	Specifications
Harmonic measurement	PLL source input level

50% or more of the rated measurement range when the crest factor is CF3.
100% or more of the rated measurement range when the crest factor is CF6 or CF6A.

Accuracy
Add the following accuracy values to the normal measurement accuracy values.

• When line filters are turned off

Frequency	Voltage, current
0.1 Hz ≤ f < 10 Hz	±(0.01% of reading + 0.03% of range)
10 Hz ≤ f < 45 Hz	±(0.01% of reading + 0.03% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.03% of range)
66 Hz < f ≤ 440 Hz	±(0.01% of reading + 0.03% of range)
440Hz < f ≤ 1 kHz	±(0.01% of reading + 0.03% of range)
1 kHz < f ≤ 10 kHz	±(0.01% of reading + 0.03% of range)
10 kHz < f ≤ 50 kHz	±(0.05% of reading + 0.1% of range)
50 kHz < f ≤ 100 kHz	±(0.1% of reading + 0.2% of range)
100 kHz < f ≤ 500 kHz	±(0.1% of reading + 0.5% of range)
500 kHz < f ≤ 1.5 MHz	±(0.5% of reading + 2% of range)

Frequency	Power
0.1 Hz ≤ f < 10 Hz	±(0.02% of reading + 0.06% of range)
10 Hz ≤ f < 45 Hz	±(0.02% of reading + 0.06% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.02% of reading + 0.06% of range)
66 Hz < f ≤ 440 Hz	±(0.02% of reading + 0.06% of range)
440 Hz < f ≤ 1 kHz	±(0.02% of reading + 0.06% of range)
1 kHz < f ≤ 10 kHz	±(0.02% of reading + 0.06% of range)
10 kHz < f ≤ 50 kHz	±(0.1% of reading + 0.2% of range)
50 kHz < f ≤ 100 kHz	±(0.2% of reading + 0.4% of range)
100 kHz < f ≤ 500 kHz	±(0.2% of reading + 1% of range)
500 kHz < f ≤ 1.5 MHz	±(1% of reading + 4% of range)

• When line filters are turned on
  Add the line filter influence to the accuracy values when the line filters are turned off.
• When the crest factor is set to CF3
• When λ (the power factor) is 1
• Power figures that exceed 10 kHz are reference values.
• For the voltage range, add 25 mV to the voltage accuracy and (25 mV/current range rating) × 100% of range to the power accuracy.
• For the direct current input range, add 20 mA to the current accuracy and (20 mA/current range rating) × 100% of range to the power accuracy.
• For the external current sensor range, add 2 mV to the current accuracy and (2 mV/rated value of the external current sensor range)×100% of range to the power accuracy.
• When the number of FFT points is 1024, add ±0.2% to the voltage and current range errors and ±0.4% to the power range error.
• Add (n/500)% of reading to the n^{th} component of the voltage and current, and add (n/250)% of reading to the n^{th} component of the power.
• The accuracy when the crest factor is CF6 or CF6A is the same as the accuracy when the crest factor is CF3 after doubling the measurement range.
• The guaranteed accuracy ranges for frequency, voltage, and current, are the same as the guaranteed ranges for normal measurement.
• The neighboring harmonic orders may be affected by the side lobes from the input harmonic order.

When FFT points is set to 8192

When the frequency of the PLL source is 2 Hz or greater, for n^{th} order component input, add {[n/(m + 1)]/50}% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the voltage and current, and add {[n/(m + 1)]/25}% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the power.

When the frequency of the PLL source is less than 2 Hz, for n^{th} order component input, add {[n/(m + 1)]/20}% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the voltage and current, and add {[n/(m + 1)]/10}% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the power.

Item	Specifications
	When FFT points is set to 1024 When the frequency of the PLL source is 75 Hz or greater, for n^{th} order component input, add ({n/(m + 1)}/50)% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the voltage and current, and add ({n/(m + 1)}/25)% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the power. When the frequency of the PLL source is less than 75 Hz, for n^{th} order component input, add ({n/(m + 1)}/5)% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the voltage and current, and add (2{n/(m + 1)}/5)% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the power.

Dimensions

Item	Specifications
Dimensions	Approx. 145 mm (H) × 42 mm (W) × 297 mm (D) * The depth includes the slide cover (293 mm if slide cover is excluded).
Weight	Approx. 900 g
Connection	50-pin B to B connector

For general specifications, see section 6.13.

6.16 760902 5A High Accuracy Element Specifications

Item	Specifications
Input terminal type	Voltage Plug-in terminal (safety terminal) Current Direct input: Plug-in terminal (safety terminal) External current sensor input: isolated BNC
Input type	Voltage Floating input through resistive voltage divider Current Floating input through shunt
Measurement range	Voltage 1.5 V/3 V/6 V/10 V/15 V/30 V/60 V/100 V/150 V/300 V/600 V/1000 V (crest factor CF3) 0.75 V/1.5 V/3 V/5 V/7.5 V/15 V/30 V/50 V/75 V/150 V/300 V/500 V (crest factor CF6/CF6A) Current Direct input 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, 200 mA, 500 mA, 1 A, 2 A, 5 A (crest factor CF3) 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, 100 mA, 250 mA, 500 mA, 1 A, 2.5 A (crest factor CF6/CF6A) External current sensor input 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V (crest factor CF3) 25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V, 5 V (crest factor CF6/CF6A)
Input impedance	Voltage Input resistance: 10 MΩ ± 1%, input capacitance: approx. 15 pF Current Direct input: 0.5 Ω ± 10% + approx. 0.3 μH (200 mA range or less) 0.11 Ω ± 10% + approx. 0.3 μH (500 mA range or more) External current sensor input: input resistance: 1 MΩ ± 1%, input capacitance: approx. 50 pF
Instantaneous maximum allowable input (within 1 s)	Voltage Peak value of 2.5 kV or RMS value of 1.5 kV, whichever is less Current Direct input Peak value of 30 A or rms value of 15 A, whichever is less. External current sensor input Peak value 10 times the range or 25 V, whichever is less
Continuous maximum allowable input	Voltage Peak value of 1.6 kV or RMS value of 1.5 kV, whichever is less If the frequency of the input voltage exceeds 100 kHz, (1200 – f) Vrms or less. f is the frequency of the input voltage in units of kHz. Current Direct input Peak value of 10 A or rms value of 7 A, whichever is less. External current sensor input Peak value 5 times the range or 25 V, whichever is less
Maximum rated voltage to earth (DC to 50/60Hz)	Voltage input terminal 1000 V CAT II Current input terminal 1000 V CAT II External current sensor input connector 1000 V CAT II

Item	Specifications
Influence of voltage to earth	When 1000 Vrms is applied between the input terminal and the WT5000 case with the voltage input terminals shorted, current input terminals open and external current sensor input terminals shorted. 50/60 Hz: ±0.01% of range or less. ±0.01% of range + 0.5 μA or less Reference value for up to 200 kHz Voltage: ±{(maximum rated range)/(rated range) × 0.001 × f% of range} or less Current: Direct input: ±{(maximum rated range)/(rated range) × 0.001 × f% of range} or less External current sensor input: ±{(maximum rated range)/(rated range) × 0.001 × f% of range} or less However, 0.01% or greater. The unit of f is kHz. The maximum range rating in the equation is for a voltage of 1000 V, direct current input of 5 A, and external current sensor input of 10 V.
A/D converter	Simultaneous conversion of voltage and current inputs. Resolution: 18 bits Sample rate: 10 MS/s max.
Measurement frequency bandwidth	DC, 0.1 Hz to 2 MHz
Lower limit of measurement frequency	Sync source period average method Data update interval 50 ms 45 Hz 100 ms 20 Hz 200 ms 10 Hz 500 ms 5 Hz 1 s 2 Hz 2 s 1 Hz 5 s 0.5 Hz 10 s 0.2 Hz 20 s 0.1 Hz Digital filter average method FAST: 100 Hz MID: 10 Hz SLOW: 1 Hz VSLOW: 0.1 Hz
Maximum display	140% of the rated voltage or current range (160% for the 1000 V range) 280% of the voltage and current range rating for CF6A (except 320%) the 500 V range)

Accuracy

Item	Specifications
Accuracy (6 months)	Condition Temperature: 23°C ± 5°C Input waveform: Sine wave λ (power factor): 1 Voltage to ground: 0 V Crest factor: CF3 Line filter: OFF Sync source period average method Frequency filter: Used for signal frequencies at 1 kHz or less Sync source signal level: Same as the frequency measurement conditions Input range: DC 0% to ± 110% of range, AC 1% to 110% of range Defined using rms values for AC After the warm-up time has elapsed. Wired condition after zero-level compensation or measurement range change. The unit of f in the accuracy equations is kHz.

Item	Specifications	
	Voltage	
	DC	±(0.02% of reading + 0.05% of range)
	0.1 Hz ≤ f < 10 Hz	±(0.03% of reading + 0.05% of range)
	10 Hz ≤ f < 45 Hz	±(0.03% of reading + 0.05% of range)
	45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.02% of range)
	66 Hz < f ≤ 1 kHz	±(0.03% of reading + 0.04% of range)
	1 kHz < f ≤ 10 kHz	±(0.1% of reading + 0.05% of range) Add 0.015 × f % of reading (10 V range or less).
	10 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.1% of range)
	50 kHz < f ≤ 100 kHz	±(0.6% of reading + 0.2% of range)
	100 kHz < f ≤ 500 kHz	±{(0.006 × f)% of reading + 0.5% of range}
	500 kHz < f ≤ 1 MHz	±{(0.022 × f-8)% of reading + 1% of range}
	Frequency bandwith	DC to 10 MHz (Typical)
	Current	
	DC	±(0.02% of reading + 0.05% of range)
	0.1 Hz ≤ f < 10 Hz	±(0.03% of reading + 0.05% of range)
	10 Hz ≤ f < 45 Hz	±(0.03% of reading + 0.05% of range)
	45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.02% of range) ±0.5 μA* * Direct input only
	66 Hz < f ≤ 1 kHz	±(0.03% of reading + 0.04% of range)
	1 kHz < f ≤ 10 kHz	±(0.1% of reading + 0.05% of range)
	10 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.1% of range)
	50 kHz < f ≤ 100 kHz	±(0.6% of reading + 0.2% of range)
	100 kHz < f ≤ 200 kHz	±{(0.00725 × f -0.125)% of reading + 0.5% of range}
	200 kHz < f ≤ 500 kHz	±{(0.00725 × f- 0.125)% of reading + 0.5% of range}
	500 kHz < f ≤ 1 MHz	±{(0.022 × f - 8)% of reading + 1% of range}
	Frequency bandwidth	Direct input: DC to 5 MHz (typical) External current sensor input: DC to 5 MHz (typical)
	Active power (power factor 1)	
	DC	±(0.02% of reading + 0.05% of range)
	0.1 Hz ≤ f < 10 Hz	±(0.08% of reading + 0.1% of range)
	10 Hz ≤ f < 30 Hz	±(0.08% of reading + 0.1% of range)
	30 Hz ≤ f < 45 Hz	±(0.05% of reading + 0.05% of range)
	45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.02% of range)
	66 Hz < f ≤ 1 kHz	±(0.05% of reading + 0.05% of range)
	1 kHz < f ≤ 10 kHz	±(0.15% of reading + 0.1% of range) Add 0.01 × f % of reading (10 V range or less).
	10 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.2% of range)
	50 kHz < f ≤ 100 kHz	±(0.7% of reading + 0.3% of range)
	100 kHz < f ≤ 200 kHz	±{(0.008 × f)% of reading + 1% of range}
	200 kHz < f ≤ 500 kHz	±{(0.008 × f)% of reading + 1% of range}
	500 kHz < f ≤ 1 MHz	±{(0.048 × f - 20)% of reading + 1% of range}

- For the accuracy at 1 year, multiply the reading of the accuracy at 6 months by 1.5.

- For the direct current input range, add the following values to the accuracies listed above:
  DC current accuracy: 1 μA
  DC power accuracy: (1 μA/rated value of the direct input range) × 100% of range

- For the accuracies of waveform data functions Upk and Ipk:
  Add the following values (reference values) to the accuracies listed above.
  The effective input range is within ±300% (±600% when the crest factor is set to CF6 or CF6A) of the range.
  Voltage input: {√(1.5/range) + 0.5}% of range
  Direct current input range
  {√(0.01/range) + 0.5}% of range + 100 μA (200 mA range or less)
  {√(0.1/range) + 0.5}% of range + 100 μA (500 mA range or more
  External current sensor input range
  {√(0.01/range) + 0.5}% of range (50 mV to 200 mV)
  {√(0.1/range) + 0.5}% of range (500 mV to 10 V)

- Influence of temperature changes after zero-level compensation or range change
  Add the following values to the accuracies listed above.
  - DC voltage accuracy: ±0.02% of range/°C (1.5 V to 10 V range)
    ±0.005% of range/°C (15 V to 1000 V range)
  - Direct current input DC accuracy: ±1 μA/°C
  - External current sensor input DC accuracy: ±50 μV/°C (50 mV to 200 mV)
    ±200 μV/°C (0.5 V to 10 V)

  For the DC power accuracy, add the voltage influence × I and the current influence × U.
  U is the voltage reading (V).
  I is the current reading (A).

- Influence of self-generated heat caused by current input
  Add the following values to the current accuracy:
  For the power accuracy, add the voltage and the current influence.
  - AC input signal
    Current, active power, apparent power: 0.004 × I^2% of reading
  - DC input signal
    Current: 0.004 × I^2% of reading + 6 × I^2 μA
    Power: 0.004 × I^2 % of reading + 6 × I^2 μA × U
    U is the voltage reading (V).
    I is the current reading (A).

  Even if the current input decreases, the influence from self-generated heat continues until the temperature of the shunt resistor decreases.

- Guaranteed accuracy ranges for frequency, voltage, and current
  All accuracy figures for 0.1 Hz to 10 Hz are reference values.
  The voltage and power accuracy figures for 30 kHz to 100 kHz when the voltage exceeds 750 V are reference values.

- Influence of data update interval
  Add the following value for signal sync period average
  50ms: 0.03% of reading
  100ms: 0.02% of reading

- Accuracy when the crest factor is set to CF6 or CF6A:
  The same as the accuracy when the crest factor is CF3 after doubling the range.

Item	Specifications
Power factor (λ) influence	When λ = 0 Apparent power reading × 0.02% in the range of 45 Hz to 66 Hz. For other frequency ranges, see below. However, note that these figures are reference values. Apparent power reading × (0.02 + 0.05 × f)% When 0 < λ < 1 (Power reading) × [(power reading error %) + (power range error %) × (power range/indicated apparent power value) + {tan φ × (influence when λ = 0)%}], where φ is the phase angle between the voltage and current. The unit of f in the accuracy equations is kHz.
Temperature coefficient	±0.01% of reading/°C (5°C to 18°C or 28°C to 40°C)
Influence of humidity	Add to the voltage and active power accuracies: ±0.00022 × |HUM - 50| × f % of reading: f ≤ 40 kHz ±0.0087 × |HUM - 50| % of reading: f > 40 kHz Reference: Add to the power factor error. When λ = 0 Apparent power reading × 0.00002 ×|HUM - 50| × f% When 0 < λ < 1 (Power reading) × {(power reading error %) + (power range error %) × (power range/ indicated apparent power value) + [tan φ × (influence when λ = 0)%]}, HUM: Relative humidity [%RH] The unit of f in the accuracy equations is kHz.
Effective input range	Udc, Idc: 0% to ±130% of the measurement range (excluding the 1000 V range)* Udc 1000 V range: 0% to ±150%* Urms, Irms: 1% to 130% of the measurement range* Umn, Imn: 10% to 130% of the measurement range* Urmn, Irmn: 10% to 130% of the measurement range* Power DC measurement: 0% to ±130%* AC measurement: 1% to 130%* of the voltage and current ranges; up to ±130%* of the power range * The accuracy for 110% to 130% of the measurement range (excluding the 1000 V range) is range error × 1.5. If the input voltage exceeds 600 V, add 0.02% of reading. However, the signal level for the signal sync period average must meet the input signal level for frequency measurement. When the crest factor is set to CF6 or CF6A, double the lower limit.
Accuracy of apparent power S	Voltage accuracy + current accuracy
Accuracy of reactive power Q	Accuracy of apparent power + ($\sqrt{(1.0002 - \lambda^2)} - \sqrt{(1 - \lambda^2)}$) × 100% of range
Accuracy of power factor λ	$\pm[(\lambda - \lambda/1.0002) + \|\cos\varphi - \cos\{\varphi + \sin^{-1}((\text{influence from the power factor when } \lambda = 0)\%/100)\}\|]$ ±1 digit The voltage and current must be within their rated ranges.
Accuracy of phase difference Φ	$\pm[\|\varphi - \{\cos^{-1}(\lambda/1.0002)\}\| + \sin^{-1}\{(\text{influence from the power factor when } \lambda = 0)\%/100\}]$ deg ±1 digit The voltage and current must be within their rated ranges.
Lead and lag detection	Phase difference: ±(5° to 175°) Frequency: 20 Hz to 10 kHz Condition: Sine wave At least 50% of the measurement range (at least 100% for CF6 and CF6A)
Line filter	Bessel, 5th order LPF, fc: 1 MHz Voltage, current Up to 100 kHz: Add (20 × f/fc)% of reading Power Up to 100 kHz: Add (40 × f/fc)% of reading For LPFs less than or equal to 100 kHz, see “Line filter” in section 6.7.

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Item	Specifications
Frequency measurement	Frequency measurement range Data update interval — Measurement range 50 ms — 45 Hz ≤ f ≤ 2 MHz 100 ms — 20 Hz ≤ f ≤ 2 MHz 200 ms — 10 Hz ≤ f ≤ 2 MHz 500 ms — 5 Hz ≤ f ≤ 2 MHz 1 s — 2 Hz ≤ f ≤ 2 MHz 2 s — 1 Hz ≤ f ≤ 2 MHz 5 s — 0.5 Hz ≤ f ≤ 2 MHz 10 s — 0.2 Hz ≤ f ≤ 2 MHz 20 s — 0.1 Hz ≤ f ≤ 2 MHz Accuracy: ±0.06% of reading ± 0.1 mHz Conditions: Input signal level: CF3: At least 30% of the measurement range CF6/6A: At least 60% of the measurement range However, at least 50% of the range if the signal is less than or equal to twice the lower measurement frequency Frequency filter 0.1 Hz ≤ f < 100 Hz: 100 Hz 100 Hz ≤ f < 1 kHz: 1 kHz 1 kHz ≤ f < 100 kHz: 100 kHz

Item	Specifications
Harmonic measurement	PLL source input level 50% or more of the rated measurement range when the crest factor is CF3. 100% or more of the rated measurement range when the crest factor is CF6 or CF6A.

Accuracy

Add the following accuracy values to the normal measurement accuracy values.

• When line filters are turned off

Frequency	Voltage, current
0.1 Hz ≤ f < 10 Hz	±(0.01% of reading + 0.03% of range)
10 Hz ≤ f < 45 Hz	±(0.01% of reading + 0.03% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.03% of range)
66 Hz < f ≤ 440 Hz	±(0.01% of reading + 0.03% of range)
440 Hz < f ≤ 1 kHz	±(0.01% of reading + 0.03% of range)
1 kHz < f ≤ 10 kHz	±(0.01% of reading + 0.03% of range)
10 kHz < f ≤ 50 kHz	±(0.05% of reading + 0.1% of range)
50 kHz < f ≤ 100 kHz	±(0.1% of reading + 0.2% of range)
100 kHz < f ≤ 500 kHz	±(0.1% of reading + 0.5% of range)
500 kHz < f ≤ 1.5 MHz	±(0.5% of reading + 2% of range)

Frequency	Power
0.1 Hz ≤ f < 10 Hz	±(0.02% of reading + 0.06% of range)
10 Hz ≤ f < 45 Hz	±(0.02% of reading + 0.06% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.02% of reading + 0.06% of range)
66 Hz < f ≤ 440 Hz	±(0.02% of reading + 0.06% of range)
440 Hz < f ≤ 1 kHz	±(0.02% of reading + 0.06% of range)
1 kHz < f ≤ 10 kHz	±(0.02% of reading + 0.06% of range)
10 kHz < f ≤ 50 kHz	±(0.1% of reading + 0.2% of range)
50 kHz < f ≤ 100 kHz	±(0.2% of reading +0.4% of range)
100 kHz < f ≤ 500 kHz	±(0.2% of reading + 1% of range)
500 kHz < f ≤ 1.5 MHz	±(1% of reading + 4% of range)

• When line filters are turned on
  Add the line filter influence to the accuracy values when the line filters are turned off.
• When the crest factor is set to CF3
• When λ (the power factor) is 1
• Power figures that exceed 10 kHz are reference values.
• For the voltage range, add 25 mV to the voltage accuracy and (25 mV/current range rating) × 100% of range to the power accuracy.
• For the direct current input range, add 200 µA to the current accuracy and (200 µA/current range rating) × 100% of range to the power accuracy.
• For the external current sensor range, add 2 mV to the current accuracy and (2 mV/rated value of the external current sensor range)×100% of range to the power accuracy.
• When the number of FFT points is 1024, add ±0.2% to the voltage and current range errors and ±0.4% to the power range error.
• Add (n/500)% of reading to the n^{th} component of the voltage and current, and add (n/250)% of reading to the n^{th} component of the power.
• The accuracy when the crest factor is CF6 or CF6A is the same as the accuracy when the crest factor is CF3 after doubling the measurement range.
• The guaranteed accuracy ranges for frequency, voltage, and current, are the same as the guaranteed ranges for normal measurement.
• The neighboring harmonic orders may be affected by the side lobes from the input harmonic order.

When FFT points is set to 8192

When the frequency of the PLL source is 2 Hz or greater, for n^{th} order component input, add {[n/(m + 1)]/50}% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the voltage and current, and add {[n/(m + 1)]/25}% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the power.

When the frequency of the PLL source is less than 2 Hz, for n^{th} order component input, add {[n/(m + 1)]/20}% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the voltage and current, and add {[n/(m + 1)]/10}% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the power.

Item	Specifications
	When FFT points is set to 1024 When the frequency of the PLL source is 75 Hz or greater, for n^{th} order component input, add ({n/(m + 1)}/50)% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the voltage and current, and add ({n/(m + 1)}/25)% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the power. When the frequency of the PLL source is less than 75 Hz, for n^{th} order component input, add ({n/(m + 1)}/5)% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the voltage and current, and add (2{n/(m + 1)}/5)% of (the n^{th} order reading) to the n + m^{th} order and n – m^{th} order of the power.

Dimensions

Item	Specifications
Dimensions	Approx. 145 mm (H) × 42 mm (W) × 297 mm (D) * The depth includes the slide cover (293 mm if slide cover is excluded).
Weight	Approx. 720 g
Connection	50-pin B to B connector

For general specifications, see section 6.13.

Appendix 1 Symbols and Determination of Measurement Functions

Measurement Functions Used in Normal Measurement

(Table 1/4)

Measurement Function		Formula For information about the symbols in the equations, see the notes provided 3 pages later.					
Voltage U [V]	True rms value: Urms Rectified mean value calibrated to the rms value: Umn Simple average: Udc Rectified mean value: Urmn AC component: Uac Fundamental component: Ufnd	Urms	Umn	Udc	Urmn	Uac	Ufnd*
		$\sqrt{AVG[u(n)^2]}$	$\frac{\pi}{2\sqrt{2}}AVG[\lvert u(n)\rvert]$	AVG[u(n)]	$AVG[\lvert u(n)\rvert]$	$\sqrt{RMS^2\text{-}DC^2}$	U(1)
Current I [A]	True rms value: Irms Rectified mean value calibrated to the rms value: Imn Simple average: Idc Rectified mean value: Irmn AC component: Iac Fundamental component: Ifnd	Irms	Imn	Idc	Irmn	Iac	Ifnd*
		$\sqrt{AVG[i(n)^2]}$	$\frac{\pi}{2\sqrt{2}}AVG[\lvert i(n)\rvert]$	AVG[i(n)]	$AVG[\lvert i(n)\rvert]$	$\sqrt{RMS^2\text{-}DC^2}$	I(1)
Active power P [W]		$AVG[u(n)\cdot i(n)]$					
Fundamental active power Pfnd[W]		P(1)*					
Apparent power S [VA]	TYPE1, TYPE2	Select from Urms • Irms, Umn • Imn, Udc • Idc, Umn • Irms, Urmn • Irmn.					
	TYPE3	$\sqrt{P^2 + Q^2}$					
Fundamental apparent power Sfnd[VA]		S(1)*					
Reactive power Q [var]	TYPE1, TYPE2	$s\cdot\sqrt{S^2 - P^2}$ s is -1 for a lead phase and 1 for a lag phase					
	TYPE3	$\sum_{k=min}^{max} Q(k)$ Q (k) = Ur (k) • Ij (k) – Uj (k) • Ir (k) Ur(k) and Ir(k) are the real number components of U(k) and I(k). Uj(k) and Ij(k) are the imaginary components of U(k) and I(k). This is valid only when harmonics are being measured correctly.					
Fundamental reactive power Qfnd[var]		Q(1)*					
Power factor λ		$\frac{P}{S}$					
Fundamental power factor λfnd		λ(1)*					
Phase difference Φ [°]		$\cos^{-1}\left(\frac{P}{S}\right)$ The phase angle can be switched between lead (D)/lag (G) display and 360° display.					
Fundamental phase difference Φfnd[°]		Φ(1)*					
Voltage frequency: fU (FreqU) [Hz] Current frequency: fI (FreqI) [Hz]		The voltage frequency (fU) and current frequency (fI) are measured by detecting the cross points. The fU and fI of all elements can be measured simultaneously.					
Voltage frequency: f2U(Freq2U) [Hz] Current frequency: f2I (Freq2I) [Hz]		Frequency when the second frequency filter of voltage frequency (fU) and current frequency (fI) is connected					

* This is valid only when harmonics are being measured correctly.

(Table 2/4)

Measurement Function		Formula For information about the symbols in the equations, see the notes provided 2 pages later.
Corrected Power Pc [W]		TYPE1: IEC76-1 (1976), IEEE C57.12.90-2010 $\dfrac{P}{P1 + P2\left(\dfrac{Urms}{Umn}\right)^2}$ P1, P2: coefficients defined in the applicable standards TYPE2:IEC76-1(2011) $P\left(1 + \dfrac{Umn - Urms}{Umn}\right)$
Maximum voltage: U + pk [V]		The maximum u(n) for every data update
Minimum voltage: U – pk [V]		The minimum u(n) for every data update
Maximum current: I + pk [A]		The maximum i(n) for every data update
Minimum current: I - pk [A]		The minimum i(n) for every data update
Maximum power: P + pk [W]		The maximum u(n) • i(n) for every data update
Minimum power: P – pk [W]		The minimum u(n) • i(n) for every data update
Voltage crest factor: CfU Current crest factor: CfI		Voltage crest factor CfU = $\dfrac{Upk}{Urms}$ Upk = |U + pk| or |U – pk| whichever is larger Current crest factor CfI = $\dfrac{Ipk}{Irms}$ Ipk = |I + pk| or |I – pk| whichever is larger
Integration	Integration time [h:m:s] ITime	Time from integration start to integration stop
Integration	Watt hours [Wh] WP WP+ WP–	When the watt-hour integration method for each polarity is Charge/Discharge $\left[\dfrac{1}{N}\sum_{n=1}^{N}\{u(n)\cdot i(n)\}\right]\cdot ITime$ N is the integration time sampling count. The unit of ITime is hours. WP is the sum of positive and negative watt hours. WP+ is the sum of the above equations for all iterations where u(n) • i(n) is positive. WP– is the sum of the above equations for all iterations where u(n) • i(n) is negative.
		When the watt-hour integration method for each polarity is Sold/Bought $\left[\dfrac{1}{N}\sum_{n=1}^{N}\{u(n)\cdot i(n)\}\right]\cdot ITime$ N is the integration time sampling count. The unit of ITime is hours. WP is the sum of positive and negative watt hours. WP+ is the sum of the positive power values at each data update interval. WP- is the sum of the negative power values at each data update interval.
Integration	Ampere hours [Ah] q q+ q– rms, mean, r-mean, ac	$\dfrac{1}{N}\sum_{n=1}^{N} I(n)\cdot ITime$ I(n) is the n^{th} measured current value. N is the number of data updates. The unit of ITime is hours.
	dc	$\dfrac{1}{N}\sum_{n=1}^{N} i(n)\cdot ITime$ i(n) is the n^{th} sampled data of the current signal. N is the number of data samples. The unit of ITime is hours. q is the sum of i(n)'s positive and negative ampere hours. q+ is the sum of the above equations for all iterations where i(n) is positive. q– is the sum of the above equations for all iterations where i(n) is negative.
Integration	Apparent energy WS[VAh]	$\dfrac{1}{N}\sum_{n=1}^{N} S(n)\cdot ITime$ S(n) is the n^{th} measured apparent power value. N is the number of data updates. The unit of ITime is hours.
Integration	Reactive energy WQ[varh]	$\dfrac{1}{N}\sum_{n=1}^{N} \lvert Q(n)\rvert\cdot ITime$ Q(n) is the n^{th} measured reactive power value. N is the number of data updates. The unit of ITime is hours.

(Table 3/4)

Measurement Function	Formula For information about the symbols in the equations, see the notes provided 2 pages later.
Voltage measurement range RngU [V]	Present voltage range
Current measurement range RngI [A]	Present current range

(Table 4/4)

Measurement Function			Formula For information about the symbols in the equations, see the notes provided 1 pages later.			
Σ functions	Wiring system		Single-phase three-wire 1P3W	Three-phase three-wire 3P3W	Three-phase three-wire with three-voltage three-current method 3P3W(3V3A)	Three-phase four-wire 3P4W
	UΣ [V]		(U1 + U2) / 2		(U1 + U2 + U3) / 3	
	IΣ [A]		(I1 + I2) / 2		(I1 + I2 + I3) / 3	
	PΣ [W]		P1 + P2			P1 + P2 + P3
	SΣ [VA]	TYPE1, TYPE2	S1 + S2	$\frac{\sqrt{3}}{2}$(S1 + S2)	$\frac{\sqrt{3}}{3}$(S1 + S2 + S3)	S1 + S2 + S3
		TYPE3	$\sqrt{P\Sigma^2 + Q\Sigma^2}$			
	QΣ [var]	TYPE1	Q1 + Q2			Q1 + Q2 + Q3
		TYPE2	$\sqrt{S\Sigma^2 - P\Sigma^2}$			
		TYPE3	Q1 + Q2			Q1 + Q2 + Q3
	PcΣ [W]		Pc1 + Pc2			Pc1 + Pc2 + Pc3
	WPΣ [Wh]	WPΣ	WP1 + WP2			WP1 + WP2 + WP3
		WP+Σ	When the watt-hour integration method for each polarity is Charge/Discharge WP+1 + WP+2			WP+1 + WP+2 + WP+3
			When the watt-hour integration method for each polarity is Sold/Bought WP+Σ is the sum of the positive active power WPΣ values at each data update interval.			
		WP–Σ	When the watt-hour integration method for each polarity is Charge/Discharge WP–1 + WP–2			WP–1 + WP–2 + WP–3
			When the watt-hour integration method for each polarity is Sold/Bought WP-Σ is the sum of the negative active power WPΣ values at each data update interval.			
	qΣ [Ah]	qΣ	q1 + q2			q1 + q2 + q3
		q+Σ	q+1 + q+2			q+1 + q+2 + q+3
		q–Σ	q–1 + q–2			q–1 + q–2 + q–3
	WQΣ [varh]		$\frac{1}{N}\sum_{n=1}^{N}\left\lvert Q\Sigma(n)\right\rvert \cdot \mathrm{ITime}$ QΣ(n) is the n^{th} reactive power Σ function. N is the number of data updates. The unit of ITime is hours.			
	WSΣ [VAh]		$\frac{1}{N}\sum_{n=1}^{N} S\Sigma(n) \cdot \mathrm{ITime}$ SΣ(n) is the n^{th} apparent power Σ function. N is the number of data updates. The unit of ITime is hours.			
	λΣ		$\frac{P\Sigma}{S\Sigma}$			
	ΦΣ [°]		$\cos^{-1}\left(\frac{P\Sigma}{S\Sigma}\right)$			

Note

- u(n) denotes instantaneous voltage.
- i(n) denotes instantaneous current.
- n denotes the n^{th} measurement period. The measurement period is determined by the sync source setting.
- AVG[ ] denotes the simple average of the item in brackets determined over the data measurement interval. The data measurement interval is determined by the sync source setting.
- PΣ denotes the active power of wiring unit Σ. Input elements are assigned to wiring unit Σ differently depending on the number of input elements that are installed in the instrument and the selected wiring system pattern.
- The numbers 1, 2, and 3 used in the equations for UrmsΣ, UmnΣ, UrmnΣ, UdcΣ, UacΣ, IrmsΣ, ImnΣ, IrmnΣ, IdcΣ, IacΣ, PΣ, SΣ, QΣ, PcΣ, WPΣ, and qΣ indicate the case when input elements 1, 2, and 3 are set to the wiring system shown in the table.

On this instrument, S, Q, λ, and Φ are derived through the computation of the measured values of voltage, current, and active power. (However, when Type 3 is selected, Q is calculated directly from the sampled data.) Therefore, for distorted signal input, the value obtained on the instrument may differ from that obtained on other instruments that use a different method.

- For Q [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 QΣ may be negative, because it is calculated from the Q of each element with the signs included.

Measurement Functions Used in Harmonic Measurement

(Table 1/6)

Measurement Function	Formula: Numbers and Characters in the Parentheses: dc (when k = 0)	1 (when k = 1)	k (when k = 1 to max)	Total value (Total) (No parentheses)
Voltage U( ) [V]	$U(dc) = U_r(0)$	$U(k) = \sqrt{U_r(k)^2 + U_j(k)^2}$		$U = \sqrt{\sum_{k=min}^{max} U(k)^2}$
Current I( ) [A]	$I(dc) = I_r(0)$	$I(k) = \sqrt{I_r(k)^2 + I_j(k)^2}$		$I = \sqrt{\sum_{k=min}^{max} I(k)^2}$
Active power P( ) [W]	$P(dc) = U_r(0) \cdot I_r(0)$	$P(k) = U_r(k) \cdot I_r(k) + U_j(k) \cdot I_j(k)$		$P = \sum_{k=min}^{max} P(k)$
Apparent power S( ) [VA] (TYPE3)*	$S(dc) = P(dc)$	$S(k) = \sqrt{P(k)^2 + Q(k)^2}$		$S = \sqrt{P^2 + Q^2}$
Reactive power Q( ) [var] (TYPE3)*	$Q(dc) = 0$	$Q(k) = U_r(k) \cdot I_j(k) - U_j(k) \cdot I_r(k)$		$Q = \sum_{k=min}^{max} Q(k)$
Power factor λ ( )	$\lambda(dc) = \frac{P(dc)}{S(dc)}$	$\lambda(k) = \frac{P(k)}{S(k)}$		$\lambda = \frac{P}{S}$
Phase difference Φ ( ) [°]	—	$\Phi(k) = \tan^{-1}\left\{\frac{Q(k)}{P(k)}\right\}$		$\Phi = \tan^{-1}\left(\frac{Q}{P}\right)$
Phase difference with U(1) ΦU( ) [°]	—	—	—	ΦU(k) = The phase difference between U(k) and U(1)
Phase difference with I(1) ΦI( ) [°]	—	—	—	ΦI(k) = The phase difference between I(k) and I(1)
Impedance of the load circuit Z( ) [Ω]	$Z(dc) = \left\lvert\frac{U(dc)}{I(dc)}\right\rvert$	$Z(k) = \left\lvert\frac{U(k)}{I(k)}\right\rvert$		—
Series resistance of the load circuit Rs( ) [Ω]	$Rs(dc) = \frac{P(dc)}{I(dc)^2}$	$Rs(k) = \frac{P(k)}{I(k)^2}$		—
Series reactance of the load circuit Xs( ) [Ω]	$Xs(dc) = 0$	$Xs(k) = \frac{Q(k)}{I(k)^2}$		—
Parallel resistance of the load circuit Rp( ) [Ω] (= 1/G)	$Rp(dc) = \frac{U(dc)^2}{P(dc)}$	$Rp(k) = \frac{U(k)^2}{P(k)}$		—
Parallel reactance of the load circuit Xp( ) [Ω] (= 1/B)	Xp(dc) = Error	$Xp(k) = \frac{U(k)^2}{Q(k)}$		—

(Continued on next page)

* For details on the types of S and Q expressions, see "Apparent Power, Reactive Power, and Corrected Power Equations (Formula)" in chapter 8, "Computation," of the Features Guide, IM WT5000-01EN.

Note

- k denotes a harmonic order, r denotes the real part, and j denotes the imaginary part.
- U(k), Ur(k), Uj(k), I(k), Ir(k), and Ij(k) are expressed using rms values.
- The minimum harmonic order is denoted by min. min can be set to either 0 (the dc component) or 1 (the fundamental component).
- The upper limit of harmonic analysis is denoted by max. max is either an automatically determined value or the specified maximum measured harmonic order, whichever is smaller.

(Table 2/6)

Measurement Function	Formula	
	The numbers and characters in the parentheses are dc (when k = 0) or k (when k = 1 to max).	
	When the Denominator of the Distortion Factor Equation Is the Total Value (Total)	When the Denominator of the Distortion Factor Equation Is the Fundamental Wave (Fundamental)
Harmonic voltage distortion factor Uhdf( ) [%]	$\frac{U(k)}{U(Total)^{*2}} \cdot 100$	$\frac{U(k)}{U(1)} \cdot 100$
Harmonic current distortion factor Ihdf( ) [%]	$\frac{I(k)}{I(Total)^{*2}} \cdot 100$	$\frac{I(k)}{I(1)} \cdot 100$
Harmonic active power distortion factor Phdf( ) [%]	$\frac{P(k)}{P(Total)^{*2}} \cdot 100$	$\frac{P(k)}{P(1)} \cdot 100$
Total harmonic distortion of voltage Uthd [%]	$\frac{\sqrt{\sum_{k=2}^{max} U(k)^2}}{U(Total)^{*2}} \cdot 100$	$\frac{\sqrt{\sum_{k=2}^{max} U(k)^2}}{U(1)} \cdot 100$
Total harmonic distortion of current Ithd [%]	$\frac{\sqrt{\sum_{k=2}^{max} I(k)^2}}{I(Total)^{*2}} \cdot 100$	$\frac{\sqrt{\sum_{k=2}^{max} I(k)^2}}{I(1)} \cdot 100$
Total harmonic active power distortion Pthd [%]	$\left\lvert \frac{\sum_{k=2}^{max} P(k)}{P(Total)^{*2}} \right\rvert \cdot 100$	$\left\lvert \frac{\sum_{k=2}^{max} P(k)}{P(1)} \right\rvert \cdot 100$
Voltage telephone harmonic factor Uthf [%] Current telephone harmonic factor Ithf [%]	$Uthf = \frac{1}{U(Total)^{*2}} \sqrt{\sum_{k=1}^{max} \{\lambda(k) \cdot U(k)\}^2} \cdot 100$ $Ithf = \frac{1}{I(Total)^{*2}} \sqrt{\sum_{k=1}^{max} \{\lambda(k) \cdot I(k)\}^2} \cdot 100$ λ(k): coefficient defined in the applicable standard (IEC34-1 (1996))	
Voltage telephone influence factor Utif Current telephone influence factor Itif	$Utif = \frac{1}{U(Total)^{*2}} \sqrt{\sum_{k=1}^{max} \{T(k) \cdot U(k)\}^2}$ $Itif = \frac{1}{I(Total)^{*2}} \sqrt{\sum_{k=1}^{max} \{T(k) \cdot I(k)\}^2}$ T(k): coefficient defined in the applicable standard (IEEE Std 100 (1992))	
Harmonic voltage factor hvf [%]*1 Harmonic current factor hcf [%]*1	$hvf = \frac{1}{U(Total)^{*2}} \sqrt{\sum_{k=2}^{max} \frac{U(k)^2}{k}} \cdot 100$ $hcf = \frac{1}{I(Total)^{*2}} \sqrt{\sum_{k=2}^{max} \frac{I(k)^2}{k}} \cdot 100$	
K-factor	$K\text{-}factor = \frac{\sum_{k=1}^{max} \{I(k)^2 \cdot k^2\}}{\sum_{k=1}^{max} I(k)^2}$	

(Continued on next page)

*1 The expression varies depending on the definitions in the standard. For more details, see the standard (IEC34-1: 1996).

*2 $U(Total) = \sqrt{\sum_{k=min}^{max} U(k)^2}$, $I(Total) = \sqrt{\sum_{k=min}^{max} I(k)^2}$, $P(Total) = \sum_{k=min}^{max} P(k)$

Note

- k denotes a harmonic order, r denotes the real part, and j denotes the imaginary part.
- The minimum harmonic order is denoted by min.
- The upper limit of harmonic analysis is denoted by max. max is either an automatically determined value or the specified maximum measured harmonic order, whichever is smaller.

(Table 3/6)

Measurement Function	Formula
Frequency of PLL source 1 FreqPLL1[Hz]	Frequency of the PLL source of harmonic group 1 (PLL source 1)
Frequency of PLL source 2 FreqPLL2[Hz]	Frequency of the PLL source of harmonic group 2 (PLL source 2)

(Table 4/6)

<table>
<tr><th colspan="2">Measurement Function</th><th colspan="4">Formula</th></tr>
<tr><td rowspan="14">Σ functions</td><td>Wiring system</td><td>Single-phase three-wire 1P3W</td><td>Three-phase three-wire 3P3W</td><td>Three-phase three-wire with three-voltage three-current method 3P3W(3V3A)</td><td>Three-phase four-wire 3P4W</td></tr>
<tr><td>UΣ[1] [V]</td><td colspan="2">(U1 + U2) / 2</td><td colspan="2">(U1 + U2 + U3) / 3</td></tr>
<tr><td>UfndΣ[2] [V]</td><td colspan="2">(Ufnd1 + Ufnd2) / 2</td><td colspan="2">(Ufnd1 + Ufnd2 + Ufnd3) / 3</td></tr>
<tr><td>IΣ[1] [A]</td><td colspan="2">(I1 + I2) / 2</td><td colspan="2">(I1 + I2 + I3) / 3</td></tr>
<tr><td>IfndΣ[2] [A]</td><td colspan="2">(Ifnd1 + Ifnd2) / 2</td><td colspan="2">(Ifnd1 + fndI2 + Ifnd3) / 3</td></tr>
<tr><td>PΣ[1] [W]</td><td colspan="3">P1 + P2</td><td>P1 + P2 + P3</td></tr>
<tr><td>PfndΣ[2] [W]</td><td colspan="3">Pfnd1 + Pfnd2</td><td>Pfnd1 + Pfnd2 + Pfnd3</td></tr>
<tr><td>SΣ[1] [VA] (TYPE3)[3]</td><td colspan="4">$\sqrt{P\Sigma^2 + Q\Sigma^2}$</td></tr>
<tr><td>SfndΣ[2] [VA] (TYPE3)[3]</td><td colspan="4">$\sqrt{Pfnd\Sigma^2 + Qfnd\Sigma^2}$</td></tr>
<tr><td>QΣ[1] [var] (TYPE3)[3]</td><td colspan="3">Q1 + Q2</td><td>Q1 + Q2 + Q3</td></tr>
<tr><td>QfndΣ[2] [var] (TYPE3)[3]</td><td colspan="3">Qfnd1 + Qfnd2</td><td>Qfnd1 + Qfnd2 + Qfnd3</td></tr>
<tr><td>λΣ[1]</td><td colspan="4">$\frac{P\Sigma}{S\Sigma}$</td></tr>
<tr><td>λfndΣ[2]</td><td colspan="4">$\frac{Pfnd\Sigma}{Sfnd\Sigma}$</td></tr>
<tr><td>ΦΣ[2] [°]</td><td colspan="4">$\cos^{-1}\left(\frac{P\Sigma}{S\Sigma}\right)$</td></tr>
</table>

1 Only the total value and the fundamental wave (1st harmonic) are computed.
2 Only the fundamental wave (1st harmonic) is computed.
3 For details on the types of SΣ and QΣ expressions, see “Apparent Power, Reactive Power, and Corrected Power Equations (Formula)” in chapter 8, “Computation,” of the Features Guide, IM WT5000-01EN.

Note

The numbers 1, 2, and 3 used in the equations for UΣ, IΣ, PΣ, SΣ, and QΣ, indicate the case when input elements 1, 2, and 3 are set to the wiring system shown in the table.

(Table 5/6)

Measurement Function	Formula
ΦU1-U2(°)	**Phase angle between U1(1) and the fundamental voltage of element 2, U2(1)**
ΦU1-U3(°)	**Phase angle between U1(1) and the fundamental voltage of element 3, U3(1)**
ΦU1-I1(°)	**Phase angle between U1(1) and the fundamental current of element 1, I1(1)**
ΦU2-I2(°)	**Phase angle between U2(1) and the fundamental current of element 2, I2(1)**
ΦU3-I3(°)	**Phase angle between U3(1) and the fundamental current of element 3, I3(1)**

Note

The numbers 1, 2, and 3 used in the equations indicate the case when input elements 1, 2, and 3 are set to the wiring system shown in the table.

(Table 6/6)

Measurement Function	Formula
EaM1U1 to EaM1U7 (°) **EaM1I1 to EaM1I7 (°)**	**Phase angles of the fundamental waves of U1 to I7 with the falling edge of the signal received through the Motor1 (MTR1) Z terminal of the motor evaluation function as the reference.** $EaM1U^* = \tan^{-1}\frac{U_r(1)}{U_j(1)} - B$ Ur(1): real part of the fundamental voltage Uj(1): imaginary part of the fundamental voltage B: offset $EaM1I^* = \tan^{-1}\frac{I_r(1)}{I_j(1)} - B$ Ir(1): real part of the fundamental current Ij(1): imaginary part of the fundamental current B: offset
EaM3U1 to EaM3U7 (°) **EaM3I1 to EaM3I7 (°)**	**Phase angles of the fundamental waves of U1 to I7 with the falling edge of the signal received through the Motor3 (MTR2) Z terminal of the motor evaluation function as the reference.** $EaM1U^* = \tan^{-1}\frac{U_r(1)}{U_j(1)} - B$ Ur(1): real part of the fundamental voltage Uj(1): imaginary part of the fundamental voltage B: offset $EaM1I^* = \tan^{-1}\frac{I_r(1)}{I_j(1)} - B$ Ir(1): real part of the fundamental current Ij(1): imaginary part of the fundamental current B: offset

Delta Math Measurement Functions

Computed results are determined by substituting all of the sampled data in the table into the equations for voltage U and current I.* The sync source used in delta computation is the same source as the source of the first input element (the input element with the smallest number) in the wiring unit that is subject to delta computation.

Measurement Function	Delta Computation Type	Symbols and Meanings The computation mode for ΔU1 to ΔU3, ΔUΣ, and ΔI can be set to rms, mean, dc, r-mean, or ac.		Substituted Sampled Data u (t), i (t)
Voltage [V]	Difference	Computed differential voltage	ΔU1[Udiff]	u1—u2
	3P3W→3V3A	Unmeasured line voltage computed in a three-phase three-wire system	ΔU1[Urs]	u1—u2
	Delta→Star	Phase voltage computed in a three-phase three-wire (3V3A) system	ΔU1[Ur]	$u1-\frac{(u1+u2)}{3}$
			ΔU2[Us]	$u2-\frac{(u1+u2)}{3}$
			ΔU3[Ut]	$-\frac{(u1+u2)}{3}$
		Wiring unit voltage $\Delta U\Sigma=\frac{(\Delta U1+\Delta U2+\Delta U3)}{3}$	ΔUΣ[UΣ]	—
	Star→Delta	Line voltage calculated in a three-phase four-wire system	ΔU1[Urs]	u1—u2
			ΔU2[Ust]	u2—u3
			ΔU3[Utr]	u3—u1
		Wiring unit voltage $\Delta U\Sigma=\frac{(\Delta U1+\Delta U2+\Delta U3)}{3}$	ΔUΣ[UΣ]	—
Current [A]	Difference	Computed differential current	ΔI[Idiff]	i1—i2
	3P3W→3V3A	Unmeasured phase current	ΔI[It]	—i1—i2
	Delta→Star	Neutral line current	ΔI[In]	i1 + i2 + i3
	Star→Delta	Neutral line current	ΔI[In]	i1 + i2 + i3
Power [W]	Difference	—	—	—
	3P3W→3V3A	—	—	—
	Delta→Star	Phase power computed in a three-phase three-wire (3V3A) system	ΔP1[Pr]	$\left\{u1-\frac{(u1+u2)}{3}\right\}\cdot i1$
			ΔP2[Ps]	$\left\{u2-\frac{(u1+u2)}{3}\right\}\cdot i2$
			ΔP3[Pt]	$\left\{-\frac{(u1+u2)}{3}\right\}\cdot i3$
		Wiring unit power ΔPΣ=ΔP1 + ΔP2 + ΔP3	ΔPΣ[PΣ]	—
	Star→Delta	—	—	—

For the 3P3W→3V3A computation, it is assumed that i1 + i2 + i3 = 0.
For the Delta→Star computation, it is assumed that the center of the delta connection is computed as the center of the star connection.

* The equations for voltage U and current I listed in "Symbols and Determination of Measurement Functions"

Note

- u1, u2, and u3 represent the sampled voltage data of elements 1, 2, and 3, respectively. i1, i2, and i3 represent the sampled current data of elements 1, 2, and 3, respectively.
- The numbers (1, 2, and 3) that are attached to delta computation measurement function symbols have no relation to the element numbers.
- For details on the rms, mean, dc, rmean, and ac equations of delta computation mode, see page 1 of the appendix.
- We recommend that you set the measurement range and scaling (conversion ratios and coefficients) of the elements that are undergoing delta computation as closely as possible. Using different measurement ranges or scaling causes the measurement resolutions of the sampled data to be different. This results in errors.

Measurement Functions Used in the Motor Evaluation Function (Option)

Measurement Function	Methods of Determination and Equation
Rotating speed	When the input signal from the revolution sensor is DC voltage (an analog signal): **S(AX + B – NULL)** S: scaling factor A: slope of the input signal X: input voltage from the revolution sensor B: offset NULL: null value
	When the input signal from the revolution sensor is the number of pulses: $S\left(\frac{X}{N} - NULL\right)$ S: scaling factor X: number of input pulses from the revolution sensor per minute N: number of pulses per revolution NULL: null value
Torque Torque	When the input signal from the torque meter is DC voltage (an analog signal): **S(AX + B – NULL)** S: scaling factor A: slope of the input signal X: input voltage from the torque meter B: offset NULL: null value
	When the input signal from the torque meter is a pulse signal: **S(AX + B – NULL)** S: scaling factor A: torque pulse coefficient X: pulse frequency B: torque pulse offset NULL: null value The instrument computes the torque pulse coefficient and torque pulse offset from torque values (the unit is N•m) at the upper and lower frequency limits. Normally use a scaling factor of 1. If you are using a unit other than N•m, set the unit conversion ratio.
Synchronous speed SyncSp	$\frac{120 \cdot \text{the frequency of the frequency measurement source (Hz)}}{\text{Number of motor poles}}$ • The unit of synchronous speed is fixed to min^{-1} or rpm. • Normally use the voltage or current supplied by the motor as the frequency measurement source. If you use any other signals, the synchronous speed may not be computed correctly.
Slip Slip [%]	$\frac{SyncSp - Speed}{SyncSp} \cdot 100$
Motor Output Pm	$\frac{2\pi \cdot Speed \cdot Torque}{60} \cdot \text{Scaling coefficient}$ **When the unit of speed is min – 1 or rpm, the unit of torque is N•m, and the scaling factor is 1, the unit of motor output Pm is W.**

Use the efficiency equation and the user-defined functions to set the motor efficiency and total efficiency.

Measurement Functions for Auxiliary Input (Option)

Measurement Function	Methods of Determination and Equation
AUX1 to 8	When the input signal is DC voltage (an analog signal): **S(AX + B – NULL)** S: scaling factor A: slope of the external signal X: average value of the external signal's input voltage B: offset NULL: null value
	When the input signal is a pulse signal: **S(AX + B – NULL)** S: scaling factor A: pulse coefficient X: pulse frequency B: offset NULL: null value

Measuring Range

Measurement Function	Description
RngU [V]	Voltage measurement range
RngI [A]	Current measurement range
RngSpd [V]	Speed measurement range
RngTrq [V]	Torque measurement range
RngAux [V]	Aux measurement range

Appendix 2 Power Basics (Power, harmonics, and AC RLC circuits)

This section explains the basics of power, harmonics, and AC RLC circuits.

Power

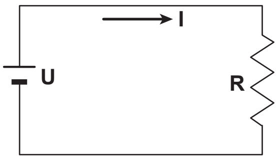
Electrical energy can be converted into other forms of energy and used. For example, it can be converted into the heat in an electric heater, the torque in a motor, or the light in a fluorescent or mercury lamp. In these kinds of examples, the work that electricity performs in a given period of time (or the electrical energy expended) is referred to as electric power. The unit of electric power is watts (W). 1 watt is equivalent to 1 joule of work performed in 1 second.

DC Power

The DC power P (in watts) is determined by multiplying the applied voltage U (in volts) by the current I (in amps).

P = UI [W]

In the example below, the amount of electrical energy determined by the equation above is retrieved from the power supply and consumed by resistance R (in ohms) every second.

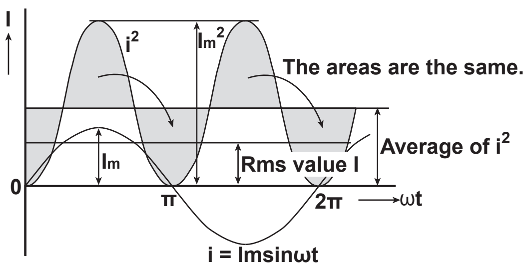


Alternating Current

Normally, the power supplied by power companies is alternating current with sinusoidal waveforms. The magnitude of alternating current can be expressed using values such as instantaneous, maximum, rms, and mean values. Normally, it is expressed using rms values.

The instantaneous value i of a sinusoidal alternating current is expressed by Imsinωt (where Im is the amplitude of the current, ω is the angular velocity defined as ω = 2πf, and f is the frequency of the sinusoidal alternating current). The thermal action of this alternating current is proportional to i^2, and varies as shown in the figure below.*

* Thermal action is the phenomenon in which electric energy is converted to heat energy when a current flows through a resistance.



The rms value (effective value) is the DC value that generates the same thermal action as the alternating current. With I as the DC value that produces the same thermal action as the alternating current:

$$I = \sqrt{\text{The mean of } i^2 \text{ over one period}} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} i^2\, d\omega t} = \frac{Im}{\sqrt{2}}$$

Because this value corresponds to the root mean square of the instantaneous values over 1 period, the effective value is normally denoted using the abbreviation "rms."

To determine the mean value, the average is taken over 1 period of absolute values, because simply taking the average over 1 period of the sine wave results in a value of zero. With Imn as the mean value of the instantaneous current i (which is equal to Imsinωt):

$$I_{mn} = \text{The mean of } |i| \text{ over one period} = \frac{1}{2\pi}\int_0^{2\pi} |i|\,d\omega t = \frac{2}{\pi} I_m$$

These relationships also apply to sinusoidal voltages.

The maximum value, rms value, and mean value of a sinusoidal alternating current are related as shown below. The crest factor and form factor are used to define the tendency of an AC waveform.

$$\text{Crest factor} = \frac{\text{Maximum value}}{\text{Rms value}}$$

$$\text{Form factor} = \frac{\text{Rms value}}{\text{Mean value}}$$

Phasor Display of Alternating Current

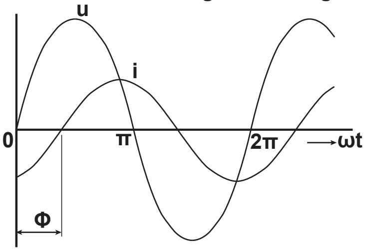
In general, instantaneous voltage and current values are expressed using the equations listed below.

Voltage: u = Umsinωt

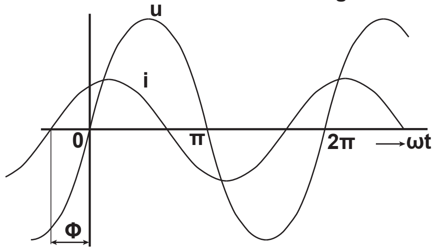
Current: i = Imsin (ωt – Φ)

The time offset between the voltage and current is called the phase difference, and Φ is the phase angle. The time offset is mainly caused by the load that the power is supplied to. In general, the phase difference is zero when the load is purely resistive. The current lags the voltage when the load is inductive (is coiled). The current leads the voltage when the load is capacitive.

When the current lags the voltage



When the current leads the voltage



A phasor display is used to clearly convey the magnitude and phase relationships between the voltage and current.

In phasor display, the voltage and current are expressed using the following equations.

Voltage: Ue^{j0}

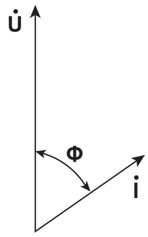
Current: $Ie^{-j\Phi}$

(Euler's formula $e^{j\Phi} = \cos\Phi + j\sin\Phi$ j: complex number)

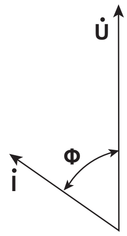
In this manual, phasor magnitudes U and I represent rms values.

A positive phase angle is represented by a counterclockwise angle with respect to the vertical axis.

When the current lags the voltage



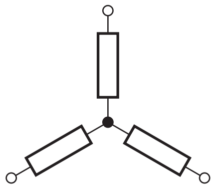
When the current leads the voltage



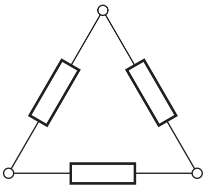
Three-Phase AC Wiring

Generally three-phase AC power lines are connected in star wiring configurations or delta wiring configurations.

Star wiring

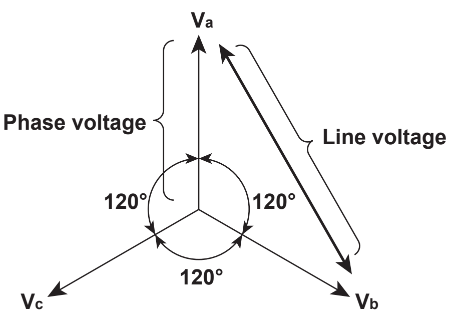


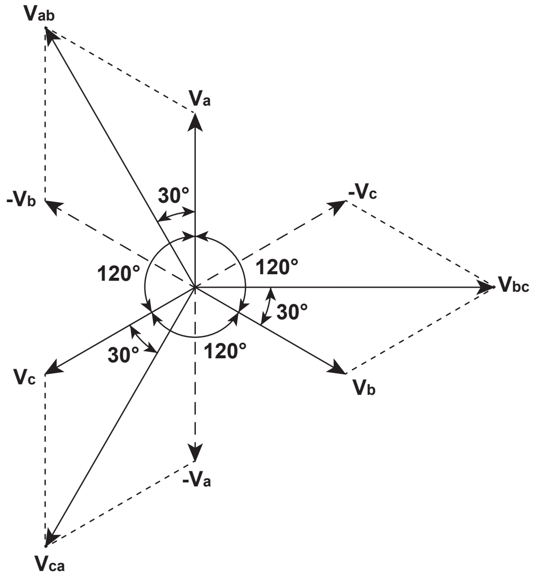
Delta wiring



Phasor Display of Three-Phase Alternating Current

In typical three-phase AC power, the voltage of each phase is offset by 120°. The figure on the left below illustrates this relationship in a phasor diagram. The voltage of each phase is called the phase voltage, and the voltage between each phase is called the line voltage.

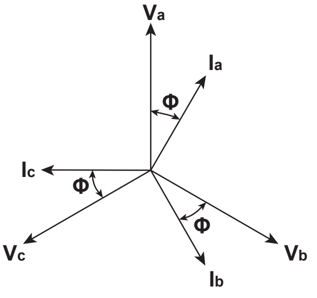




If a power supply or load is connected in a delta wiring configuration and no neutral line is present, the phase voltage cannot be measured. In this case, the line voltage is measured. Sometimes the line voltage is also measured when measuring three-phase AC power using two single-phase wattmeters (the two-wattmeter method).

If the magnitude of each phase voltage is equal and each phase is offset by 120°, the magnitude of the line voltage is $\sqrt{3}$ times the magnitude of the phase voltage, and the line voltage phase is offset by 30° (the figure on the right above).

Below is a phasor diagram of the relationship between the phase voltages and line currents of a three-phase AC voltage when the current lags the voltage by Φ°.



AC Power

AC power cannot be determined as easily as DC power, because of the phase difference between the voltage and current caused by load.

Instantaneous Power

If the instantaneous voltage u = Umsinωt and the instantaneous current i = Imsin(ωt – Φ), the instantaneous AC power p is as follows:

$p = u \times i = U_m \sin\omega t \times I_m \sin(\omega t - \Phi) = UI\cos\Phi - UI\cos(2\omega t - \Phi)$

U and I represent the rms voltage and rms current, respectively.

p is the sum of the time-independent term, UIcosΦ, and the AC component term of the voltage or current at twice the frequency, –UIcos(2ωt – Φ).

Active Power P

The true power that a device consumes is called active power P (or effective power). It is the mean of the instantaneous power values described above over 1 period.

P=UIcosΦ [W]

Active power is the power that a device consumes.

Apparent Power S

In alternating electrical current, not all of the power calculated by the product of voltage and current, UI, is consumed. The product of U and I is called the apparent power. It is expressed as S.

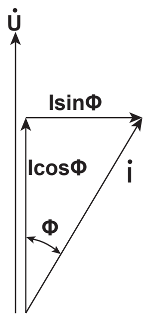
S = UI [VA]

The unit of apparent power is the volt-ampere (VA). The apparent power is used to express the electrical capacity of a device that runs on AC electricity.

Reactive Power Q

Of the apparent power, the power that is not consumed by the device and goes back and forth between the power supply and the load is called reactive power Q. If current I lags voltage U by Φ, current I can be broken down into a component in the same direction as voltage U, IcosΦ, and a perpendicular component, IsinΦ. Active power P, which is equal to UIcosΦ, is the product of voltage U and the current component IcosΦ. Reactive power is the product of voltage U and the current component IsinΦ, and its unit is the var.

Q = UIsinΦ [var]



Power Factor λ

cosΦ in the active power equation indicates the portion of the apparent power that becomes active power and is called the power factor λ.

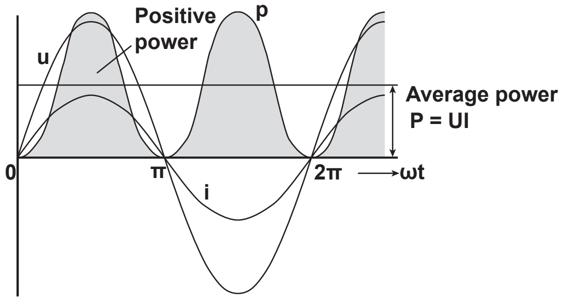
The relationship between S, the apparent power, P, the active power, and Q, the reactive power is as follows:

$S^2 = P^2 + Q^2$

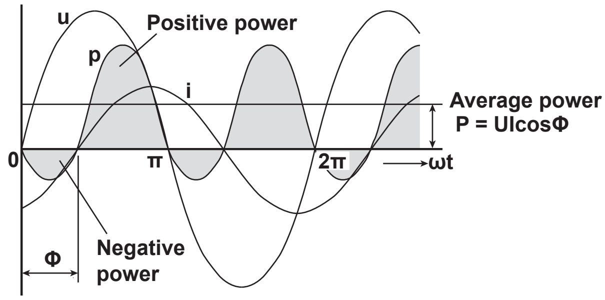
Influence of Phase Difference Φ

Even if the voltage and current are the same, the active power varies depending on the phase difference Φ. The section above the horizontal axis in the figure below represents positive power (power supplied to the load), and the section below the horizontal axis represents negative power (power fed back from the load). The difference between the positive and negative powers is the active power consumed by the load. As the phase difference between the voltage and current increases, the negative power increases. At $\Phi = \pi/2$, the positive and negative powers are equal, and the load consumes no power.

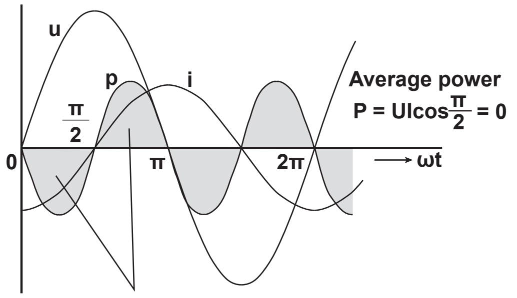
When the phase difference between voltage and current is 0



When the phase difference between voltage and current is Φ



When phase difference between voltage and current is $\frac{\pi}{2}$



The positive and negative powers are the same.

Harmonics

Harmonics refer to all sine waves whose frequency is an integer multiple of the fundamental wave (normally a 50 Hz or 60 Hz sinusoidal power line signal) except for the fundamental wave itself. The input currents that flow through the power rectification circuits, phase control circuits, and other circuits used in various kinds of electrical equipment generate harmonic currents and voltages in power lines. When the fundamental wave and harmonic waves are combined, waveforms become distorted, and interference sometimes occurs in equipment connected to the power line.

Terminology

The terminology related to harmonics is described below.

- Fundamental wave (fundamental component)
  The sine wave with the longest period among the different sine waves contained in a periodic complex wave. Or the sine wave that has the fundamental frequency within the components of the complex wave.
- Fundamental frequency
  The frequency corresponding to the longest period in a periodic complex wave. The frequency of the fundamental wave.
- Distorted wave
  A wave that differs from the fundamental wave.
- Higher harmonic
  A sine wave with a frequency that is an integer multiple (twice or more) of the fundamental frequency.
- Harmonic component
  A waveform component with a frequency that is an integer multiple (twice or more) of the fundamental frequency.
- Harmonic distortion factor
  The ratio of the rms value of the specified nth order harmonic contained in the distorted wave to the rms value of the fundamental wave (or all signals).
- Harmonic order
  The integer ratio of the harmonic frequency with respect to the fundamental frequency.
- Total harmonic distortion
  The ratio of the rms value of all harmonics to the rms value of the fundamental wave (or all signals).

Interference Caused by Harmonics

Some of the effects of harmonics on electrical devices and equipment are explained in the list below.

- Synchronization capacitors and series reactors
  Harmonic current reduces circuit impedance. This causes excessive current flow, which can result in vibration, humming, overheat, or burnout.
- Cable
  Harmonic current flow through the neutral line of a three-phase four-wire system will cause the neutral line to overheat.
- Voltage transformers
  Harmonics cause magnetostrictive noise in the iron core and increase iron and copper loss.
- Circuit breakers and fuses
  Excessive harmonic current can cause erroneous operation and blow fuses.
- Communication cables
  The electromagnetic induction caused by harmonics creates noise voltage.
- Control devices
  Harmonic distortion of control signals can lead to erroneous operation.
- Audio visual devices
  Harmonics can cause degradation of performance and service life, noise-related video flickering, and damaged parts.

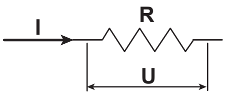
AC RLC Circuits

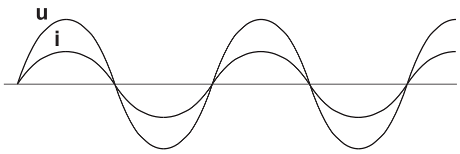
Resistance

The current i when an AC voltage whose instantaneous value $u = U_m \sin\omega t$ is applied to load resistance R [Ω] is expressed by the equation below. I_m denotes the amplitude of the current.

$$i = \frac{U_m}{R}\sin\omega t = I_m \sin\omega t$$

Expressed using rms values, the equation is I = U/R.
There is no phase difference between the current flowing through a resistive circuit and the voltage.



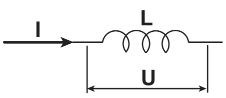


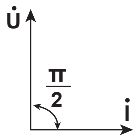
Inductance

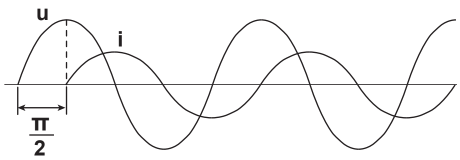
The current i when an AC voltage whose instantaneous value $u = U_m \sin\omega t$ is applied to a coil load of inductance L [H] is expressed by the equation below.

$$i = \frac{U_m}{X_L}\sin\left(\omega t - \frac{\pi}{2}\right) = I_m \sin\left(\omega t - \frac{\pi}{2}\right)$$

Expressed using rms values, the equation is $I = U/X_L$. X_L is called inductive reactance and is defined as $X_L = \omega L$. The unit of inductive reactance is Ω.
Inductance works to counter current changes (increase or decrease), and causes the current to lag the voltage.





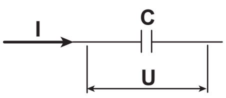


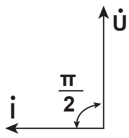
Capacitance

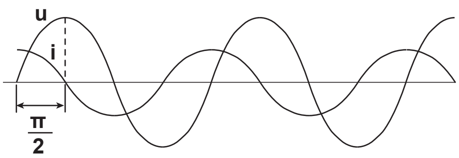
The current i when an AC voltage whose instantaneous value $u = U_m \sin\omega t$ is applied to capacitance C [F] is expressed by the equation below.

$$i = \frac{U_m}{X_C}\sin\left(\omega t + \frac{\pi}{2}\right) = I_m \sin\left(\omega t + \frac{\pi}{2}\right)$$

Expressed using rms values, the equation is $I = U/X_C$. X_C is called capacitive reactance and is defined as $X_C = 1/\omega C$. The unit of capacitive reactance is Ω.
When the polarity of the voltage changes, the largest charging current with the same polarity as the voltage flows through the capacitor. When the voltage decreases, discharge current with the opposite polarity of the voltage flows. Thus, the current phase leads the voltage.







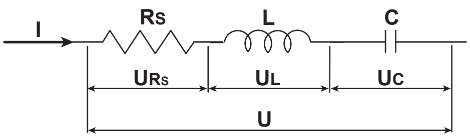
Series RLC Circuits

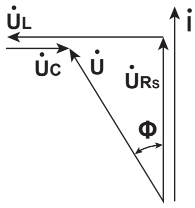
The equations below express the voltage relationships when resistance R_S [Ω], inductance L [H], and capacitance C [F] are connected in series.

$$U = \sqrt{(U_{Rs})^2 + (U_L - U_C)^2} = \sqrt{(IR_S)^2 + (IX_L - IX_C)^2}$$

$$= I\sqrt{(R_S)^2 + (X_L - X_C)^2} = I\sqrt{R_S^2 + X_S^2}$$

$$I = \frac{U}{\sqrt{R_S^2 + X_S^2}}, \quad \Phi = \tan^{-1}\frac{X_S}{R_S}$$





The relationship between resistance R_S, reactance X_S, and impedance Z is expressed by the equations below.

$$X_S = X_L - X_C$$

$$Z = \sqrt{R_S^2 + X_S^2}$$

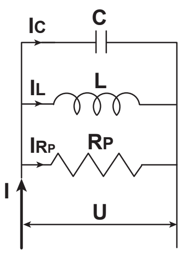
Parallel RLC Circuits

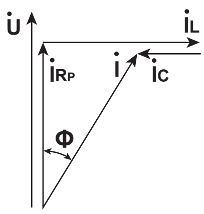
The equations below express the current relationships when resistance R_P [Ω], inductance L [H], and capacitance C [F] are connected in parallel.

$$I = \sqrt{(I_{RP})^2 + (I_L - I_C)^2} = \sqrt{\left(\frac{U}{R_P}\right)^2 + \left(\frac{U}{X_L} - \frac{U}{X_C}\right)^2}$$

$$= U\sqrt{\left(\frac{1}{R_P}\right)^2 + \left(\frac{1}{X_L} - \frac{1}{X_C}\right)^2} = U\sqrt{\left(\frac{1}{R_P}\right)^2 + \left(\frac{1}{X_P}\right)^2}$$

$$U = \frac{IR_PX_P}{\sqrt{R_P^2 + X_P^2}}, \quad \Phi = \tan^{-1}\frac{R_P}{X_P}$$





The relationship between resistance R_P, reactance X_P, and impedance Z is expressed by the equations below.

$$X_P = \frac{X_LX_C}{X_C - X_L}$$

$$Z = \frac{R_PX_P}{\sqrt{R_P^2 + X_P^2}}$$

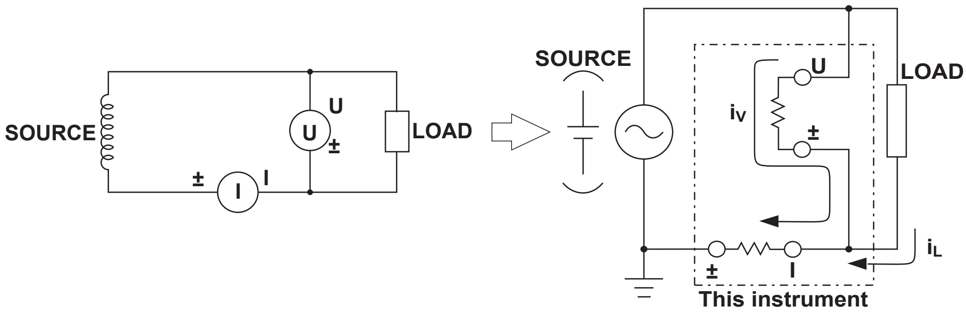
Appendix 3 How to Make Accurate Measurements

Effects of Power Loss

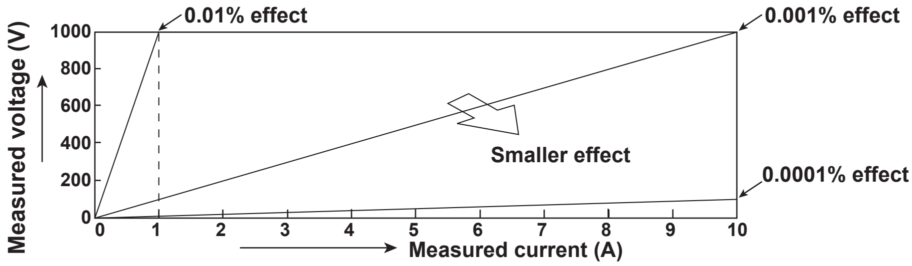
By wiring a circuit to match the load, you can minimize the effects of power loss on measurement accuracy. We will discuss the wiring of the DC power supply (SOURCE) and a load resistance (LOAD) below.

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 instrument is approximately 10 MΩ. For 1000 V input i_V is approximately 0.1 mA (1000 V/10 MΩ). If the load current i_L is 1 A or more (the load resistance is 200 Ω 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 1 A, i_V = 0.01 mA (100 V/10 MΩ), so the effect of i_V on the measurement accuracy is 0.001% (0.01 mA/1 A).

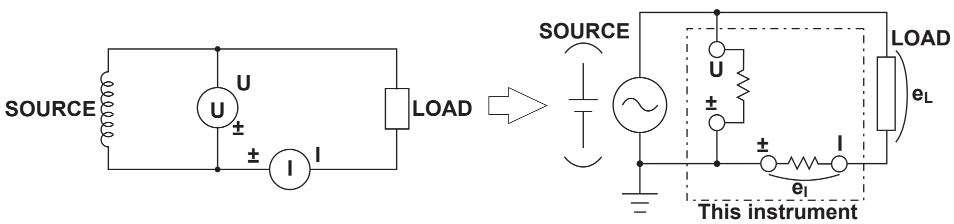


As a reference, the relationships between the voltages and currents that produce effects of 0.01%, 0.001%, and 0.0001% are shown in the figure below.



When the Measured Current Is Relatively Small

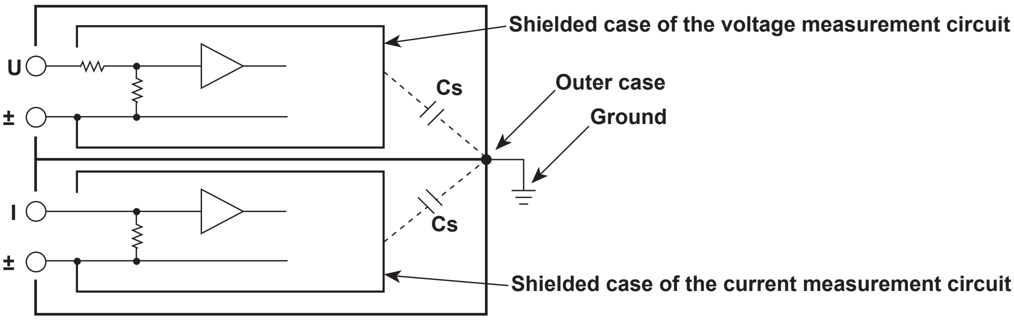
Connect the current measurement circuit between the voltage measurement circuit and the load. In this case, the voltage measurement circuit measures the sum of e_L and e_I. e_L is the load voltage, and e_I is the voltage drop across the current measurement circuit. Only e_I reduces measurement accuracy. The input resistance of the current measurement circuit of the instrument is approximately 0.6 Ω for the 5 A input terminals and approximately 5.5 mΩ for the 30 A input terminals. If the load resistance is 1 kΩ, the effect on the measurement accuracy is approximately 0.06% (0.6 Ω/1 kΩ) for the 5 A input terminals and approximately 0.00055% (5.5 mΩ/1 kΩ) for the 30 A input terminals.



Effects of Stray Capacitance

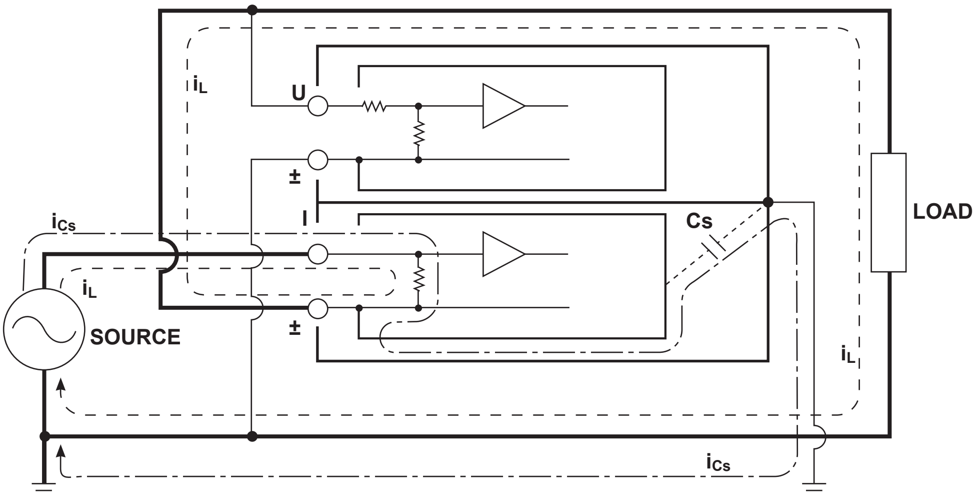
The effects of stray capacitance on measurement accuracy can be minimized by connecting the instrument's current input terminal to the side of the power supply (SOURCE) that is closest to its earth potential.

The internal structure of the instrument 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 Cs. Cs is approximately 40 pF. The current generated by stray capacitance Cs 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 Cs 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.

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



Because the instrument measures high frequencies, the effects of i_{Cs} cannot be ignored.
If you connect the instrument's current input terminal to the side of the power supply (SOURCE) that is close to its earth potential, the instrument's 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.

Appendix 4 Power Range

The following tables show the ranges of the active power (unit: W) when the voltage ranges and current ranges of the elements making up a wiring unit are the same. The same ranges are set for apparent power (unit: VA) and reactive power (unit: var). Just read the unit as VA or var. The number of displayed digits (display resolution) is six for numbers up to 600000 and five digits for larger numbers.

When the Crest Factor Is Set to CF3

Active Power Range of Each Element

Current Range	Voltage Range [V]					
[A]	1.50000	3.00000	6.00000	10.0000	15.0000	30.0000
5.00000m	7.5000 mW	15.0000 mW	30.0000 mW	50.0000 mW	75.000 mW	150.000 mW
10.0000m	15.0000 mW	30.0000 mW	60.0000 mW	100.000 mW	150.000 mW	300.000 mW
20.0000m	30.0000 mW	60.0000 mW	120.000 mW	200.000 mW	300.000 mW	600.000 mW
50.0000m	75.000 mW	150.000 mW	300.000 mW	500.000 mW	0.75000 W	1.50000 W
100.000m	150.000 mW	300.000 mW	600.000 mW	1.00000 W	1.50000 W	3.00000 W
200.000m	300.000 mW	600.000 mW	1.20000 W	2.00000 W	3.00000 W	6.00000 W
500.000m	0.75000 W	1.50000 W	3.00000 W	5.00000 W	7.5000 W	15.0000 W
1.00000	1.50000 W	3.00000 W	6.00000 W	10.0000 W	15.0000 W	30.0000 W
2.00000	3.00000 W	6.00000 W	12.0000 W	20.0000 W	30.0000 W	60.0000 W
5.00000	7.5000 W	15.0000 W	30.0000 W	50.0000 W	75.000 W	150.000 W
10.0000	15.0000 W	30.0000 W	60.0000 W	100.000 W	150.000 W	300.000 W
20.0000	30.0000 W	60.0000 W	120.000 W	200.000 W	300.000 W	600.000 W
30.0000	45.0000 W	90.000 W	180.000 W	300.000 W	450.000 W	0.90000 kW

Current Range	Voltage Range [V]					
[A]	60.0000	100.000	150.000	300.000	600.000	1000.00
5.00000m	300.000 mW	500.000 mW	750.00 mW	1.50000 W	3.00000 W	5.00000 W
10.0000m	600.000 mW	1.00000 W	1.50000 W	3.00000 W	6.00000 W	10.0000 W
20.0000m	1.20000 W	2.00000 W	3.00000 W	6.00000 W	12.0000 W	20.0000 W
50.0000m	3.00000 W	5.00000 W	7.5000 W	15.0000 W	30.0000 W	50.0000 W
100.000m	6.00000 W	10.0000 W	15.0000 W	30.0000 W	60.0000 W	100.000 W
200.000m	12.0000 W	20.0000 W	30.0000 W	60.0000 W	120.000 W	200.000 W
500.000m	30.0000 W	50.0000 W	75.000 W	150.000 W	300.000 W	500.000 W
1.00000	60.0000 W	100.000 W	150.000 W	300.000 W	600.000 W	1.00000 kW
2.00000	120.000 W	200.000 W	300.000 W	600.000 W	1.20000 kW	2.00000 kW
5.00000	300.000 W	500.000 W	0.75000 kW	1.50000 kW	3.00000 kW	5.00000 kW
10.0000	600.000 W	1.00000 kW	1.50000 kW	3.00000 kW	6.00000 kW	10.0000 kW
20.0000	1.20000 kW	2.00000 kW	3.00000 kW	6.00000 kW	12.0000 kW	20.0000 kW
30.0000	1.80000 kW	3.00000 kW	4.50000 kW	9.0000 kW	18.0000 kW	30.0000 kW

Active Power Range of a Wiring Unit with a 1P3W or 3P3W System, or a 3P3W System That Uses a 3V3A Method

Current Range	Voltage Range [V]					
[A]	1.50000	3.00000	6.00000	10.0000	15.0000	30.0000
5.00000m	15.0000 mW	30.0000 mW	60.0000 mW	100.0000 mW	150.000 mW	300.000 mW
10.0000m	30.0000 mW	60.0000 mW	120.0000 mW	200.000 mW	300.000 mW	600.000 mW
20.0000m	60.0000 mW	120.0000 mW	240.000 mW	400.000 mW	600.000 mW	1200.000 mW
50.0000m	150.000 mW	300.000 mW	600.000 mW	1000.000 mW	1.50000 W	3.00000 W
100.000m	300.000 mW	600.000 mW	1200.000 mW	2.00000 W	3.00000 W	6.00000 W
200.000m	600.000 mW	1200.000 mW	2.40000 W	4.00000 W	6.00000 W	12.00000 W
500.000m	1.50000 W	3.00000 W	6.00000 W	10.00000 W	15.0000 W	30.0000 W
1.00000	3.00000 W	6.00000 W	12.00000 W	20.0000 W	30.0000 W	60.0000 W
2.00000	6.00000 W	12.00000 W	24.0000 W	40.0000 W	60.0000 W	120.0000 W
5.00000	15.0000 W	30.0000 W	60.0000 W	100.0000 W	150.000 W	300.000 W
10.0000	30.0000 W	60.0000 W	120.0000 W	200.000 W	300.000 W	600.000 W
20.0000	60.0000 W	120.0000 W	240.000 W	400.000 W	600.000 W	1200.000 W
30.0000	90.0000 W	180.000 W	360.000 W	600.000 W	900.000 W	1.80000 kW

Current Range [A]	Voltage Range [V]					
	60.0000	100.000	150.000	300.000	600.000	1000.00
5.00000m	600.000 mW	1000.000 mW	1.50000 W	3.00000 W	6.00000 W	10.00000 W
10.0000m	1200.000 mW	2.00000 W	3.00000 W	6.00000 W	12.00000 W	20.0000 W
20.0000m	2.40000 W	4.00000 W	6.00000 W	12.00000 W	24.0000 W	40.0000 W
50.0000m	6.00000 W	10.00000 W	15.0000 W	30.0000 W	60.0000 W	100.0000 W
100.000m	12.00000 W	20.0000 W	30.0000 W	60.0000 W	120.0000 W	200.000 W
200.000m	24.0000 W	40.0000 W	60.0000 W	120.0000 W	240.000 W	400.000 W
500.000m	60.0000 W	100.0000 W	150.000 W	300.000 W	600.000 W	1000.000 W
1.00000	120.0000 W	200.000 W	300.000 W	600.000 W	1200.000 W	2.00000 kW
2.00000	240.000 W	400.000 W	600.000 W	1200.000 W	2.40000 kW	4.00000 kW
5.00000	600.000 W	1000.000 W	1.50000 kW	3.00000 kW	6.00000 kW	10.00000 kW
10.0000	1200.000 W	2.00000 kW	3.00000 kW	6.00000 kW	12.00000 kW	20.0000 kW
20.0000	2.40000 kW	4.00000 kW	6.00000 kW	12.00000 kW	24.0000 kW	40.0000 kW
30.0000	3.60000 kW	6.00000 kW	9.00000 kW	18.0000 kW	36.0000 kW	60.0000 kW

Active Power Range of a Wiring Unit with a 3P4W Wiring System

Current Range [A]	Voltage Range [V]					
	1.50000	3.00000	6.00000	10.0000	15.0000	30.0000
5.00000m	22.5000 mW	45.0000 mW	90.0000 mW	150.0000 mW	225.000 mW	450.000 mW
10.0000m	45.0000 mW	90.0000 mW	180.0000 mW	300.000 mW	450.000 mW	900.000 mW
20.0000m	90.0000 mW	180.0000 mW	360.000 mW	600.000 mW	900.000 mW	1800.000 mW
50.0000m	225.000 mW	450.000 mW	900.000 mW	1500.000 mW	2.25000 W	4.50000 W
100.000m	450.000 mW	900.000 mW	1800.000 mW	3.00000 W	4.50000 W	9.00000 W
200.000m	900.000 mW	1800.000 mW	3.60000 W	6.00000 W	9.00000 W	18.00000 W
500.000m	2.25000 W	4.50000 W	9.00000 W	15.00000 W	22.5000 W	45.0000 W
1.00000	4.50000 W	9.00000 W	18.00000 W	30.0000 W	45.0000 W	90.0000 W
2.00000	9.00000 W	18.00000 W	36.0000 W	60.0000 W	90.0000 W	180.0000 W
5.00000	22.5000 W	45.0000 W	90.0000 W	150.0000 W	225.000 W	450.000 W
10.0000	45.0000 W	90.0000 W	180.0000 W	300.000 W	450.000 W	900.000 W
20.0000	90.0000 W	180.0000 W	360.000 W	600.000 W	900.000 W	1800.000 W
30.0000	135.0000 W	270.000 W	540.000 W	900.000 W	1350.000 W	2.70000 kW

Current Range [A]	Voltage Range [V]					
	60.0000	100.000	150.000	300.000	600.000	1000.00
5.00000m	900.000 mW	1500.000 mW	2.25000 W	4.50000 W	9.00000 W	15.00000 W
10.0000m	1800.000 mW	3.00000 W	4.50000 W	9.00000 W	18.00000 W	30.0000 W
20.0000m	3.60000 W	6.00000 W	9.00000 W	18.00000 W	36.0000 W	60.0000 W
50.0000m	9.00000 W	15.00000 W	22.5000 W	45.0000 W	90.0000 W	150.0000 W
100.000m	18.00000 W	30.0000 W	45.0000 W	90.0000 W	180.0000 W	300.000 W
200.000m	36.0000 W	60.0000 W	90.0000 W	180.0000 W	360.000 W	600.000 W
500.000m	90.0000 W	150.0000 W	225.000 W	450.000 W	900.000 W	1500.000 W
1.00000	180.0000 W	300.000 W	450.000 W	900.000 W	1800.000 W	3.00000 kW
2.00000	360.000 W	600.000 W	900.000 W	1800.000 W	3.60000 kW	6.00000 kW
5.00000	900.000 W	1500.000 W	2.25000 kW	4.50000 kW	9.00000 kW	15.00000 kW
10.0000	1800.000 W	3.00000 kW	4.50000 kW	9.00000 kW	18.00000 kW	30.0000 kW
20.0000	3.60000 kW	6.00000 kW	9.00000 kW	18.00000 kW	36.0000 kW	60.0000 kW
30.0000	5.40000 kW	9.00000 kW	13.50000 kW	27.0000 kW	54.0000 kW	90.00000 kW

When the Crest Factor Is Set to CF6 or CF6A

Active Power Range of Each Element

Current Range [A]	Voltage Range [V]					
	0.75000	1.50000	3.00000	5.00000	7.5000	15.0000
2.50000m	1.87500 mW	3.75000 mW	7.5000 mW	12.5000 mW	18.7500 mW	37.5000 mW
5.00000m	3.75000 mW	7.5000 mW	15.0000 mW	2.50000 mW	37.5000 mW	75.000 mW
10.0000m	7.5000 mW	15.0000 mW	30.0000 mW	50.0000 mW	75.000 mW	150.000 mW
25.0000m	18.7500 mW	37.5000 mW	75.000 mW	125.000 mW	187.500 mW	375.000 mW
50.0000m	37.5000 mW	75.000 mW	150.000 mW	250.000 mW	375.000 mW	0.75000 W
100.000m	75.000 mW	150.000 mW	300.000 mW	500.000 mW	0.75000 W	1.50000 W
250.000m	187.500 mW	375.000 mW	0.75000 W	1.25000 W	1.87500 W	3.75000 W
500.000m	375.000 mW	0.75000 W	1.50000 W	2.50000 W	3.75000 W	7.5000 W
1.00000	0.75000 W	1.50000 W	3.00000 W	5.00000 W	7.5000 W	15.0000 W
2.50000	1.87500 W	3.75000 W	7.5000 W	12.5000 W	18.7500 W	37.5000 W
5.00000	3.75000 W	7.5000 W	15.0000 W	25.0000 W	37.5000 W	75.000 W
10.0000	7.5000 W	15.0000 W	30.0000 W	50.0000 W	75.000 W	150.000 W
15.0000	11.2500 W	22.5000 W	45.0000 W	75.000 W	112.500 W	225.000 W

Current Range [A]	Voltage Range [V]					
	30.0000	50.0000	75.000	150.000	300.000	500.000
2.50000m	75.000 mW	125.000 mW	187.500 mW	375.000 mW	0.75000 W	1.25000 W
5.00000m	150.000 mW	250.000 mW	375.000 mW	0.75000 W	1.50000 W	2.50000 W
10.0000m	300.000 mW	500.000 mW	0.75000 W	1.50000 W	3.00000 W	5.00000 W
25.0000m	0.75000 W	1.25000 W	1.87500 W	3.75000 W	7.5000 W	12.5000 W
50.0000m	1.50000 W	2.50000 W	3.75000 W	7.5000 W	15.0000 W	25.0000 W
100.000m	3.00000 W	5.00000 W	7.5000 W	15.0000 W	30.0000 W	50.0000 W
250.000m	7.5000 W	12.5000 W	18.7500 W	37.5000 W	75.000 W	125.000 W
500.000m	15.0000 W	25.0000 W	37.5000 W	75.000 W	150.000 W	250.000 W
1.00000	30.0000 W	50.0000 W	75.000 W	150.000 W	300.000 W	500.000 W
2.50000	75.000 W	125.000 W	187.500 W	375.000 W	0.75000 kW	1.25000 kW
5.00000	150.000 W	250.000 W	375.000 W	0.75000 kW	1.50000 kW	2.50000 kW
10.0000	300.000 W	500.000 W	0.75000 kW	1.50000 kW	3.00000 kW	5.00000 kW
15.0000	450.000 W	0.75000 kW	1.12500 kW	2.25000 kW	4.50000 kW	7.5000 kW

Active Power Range of a Wiring Unit with a 1P3W or 3P3W System, or a 3P3W System That Uses a 3V3A Method

Current Range [A]	Voltage Range [V]					
	0.75000	1.50000	3.00000	5.00000	7.5000	15.0000
2.50000m	3.75000 mW	7.50000 mW	15.0000 mW	25.0000 mW	37.5000 mW	75.0000 mW
5.00000m	7.50000 mW	15.0000 mW	30.0000 mW	50.0000 mW	75.0000 mW	150.000 mW
10.0000m	15.0000 mW	30.0000 mW	60.0000 mW	100.0000 mW	150.000 mW	300.000 mW
25.0000m	37.5000 mW	75.0000 mW	150.000 mW	250.000 mW	375.000 mW	750.000 mW
50.0000m	75.0000 mW	150.000 mW	300.000 mW	500.000 mW	750.000 mW	1.50000 W
100.000m	150.000 mW	300.000 mW	600.000 mW	1000.000 mW	1.50000 W	3.00000 W
250.000m	375.000 mW	750.000 mW	1.50000 W	2.50000 W	3.75000 W	7.50000 W
500.000m	750.000 mW	1.50000 W	3.00000 W	5.00000 W	7.50000 W	15.0000 W
1.00000	1.50000 W	3.00000 W	6.00000 W	10.00000 W	15.0000 W	30.0000 W
2.50000	3.75000 W	7.50000 W	15.0000 W	25.0000 W	37.5000 W	75.0000 W
5.00000	7.50000 W	15.0000 W	30.0000 W	50.0000 W	75.0000 W	150.000 W
10.0000	15.0000 W	30.0000 W	60.0000 W	100.0000 W	150.000 W	300.000 W
15.0000	22.5000 W	45.0000 W	90.0000 W	150.000 W	225.000 W	450.000 W

Current Range [A]	Voltage Range [V] 30.0000	50.0000	75.000	150.000	300.000	500.000
2.50000m	150.000 mW	250.000 mW	375.000 mW	750.000 mW	1.50000 W	2.50000 W
5.00000m	300.000 mW	500.000 mW	750.000 mW	1.50000 W	3.00000 W	5.00000 W
10.0000m	600.000 mW	1000.000 mW	1.50000 W	3.00000 W	6.00000 W	10.00000 W
25.0000m	1.50000 W	2.50000 W	3.75000 W	7.50000 W	15.0000 W	25.0000 W
50.0000m	3.00000 W	5.00000 W	7.50000 W	15.0000 W	30.0000 W	50.0000 W
100.000m	6.00000 W	10.00000 W	15.0000 W	30.0000 W	60.0000 W	100.0000 W
250.000m	15.0000 W	25.0000 W	37.5000 W	75.0000 W	150.000 W	250.000 W
500.000m	30.0000 W	50.0000 W	75.0000 W	150.000 W	300.000 W	500.000 W
1.00000	60.0000 W	100.0000 W	150.000 W	300.000 W	600.000 W	1000.000 W
2.50000	150.000 W	250.000 W	375.000 W	750.000 W	1.50000 kW	2.50000 kW
5.00000	300.000 W	500.000 W	750.000 W	1.50000 kW	3.00000 kW	5.00000 kW
10.0000	600.000 W	1000.000 W	1.50000 kW	3.00000 kW	6.00000 kW	10.00000 kW
15.0000	900.000 W	1.50000 kW	2.25000 kW	4.50000 kW	9.00000 kW	15.0000 kW

Active Power Range of a Wiring Unit with a 3P4W Wiring System

Current Range [A]	Voltage Range [V] 0.75000	1.50000	3.00000	5.00000	7.5000	15.0000
2.50000m	5.62500 mW	11.25000 mW	22.5000 mW	37.5000 mW	56.2500 mW	112.5000 mW
5.00000m	11.25000 mW	22.5000 mW	45.0000 mW	75.0000 mW	112.5000 mW	225.000 mW
10.0000m	22.5000 mW	45.0000 mW	90.0000 mW	150.0000 mW	225.000 mW	450.000 mW
25.0000m	56.2500 mW	112.5000 mW	225.000 mW	375.000 mW	562.500 mW	1125.000 mW
50.0000m	112.5000 mW	225.000 mW	450.000 mW	750.000 mW	1125.000 mW	2.25000 W
100.000m	225.000 mW	450.000 mW	900.000 mW	1500.000 mW	2.25000 W	4.50000 W
250.000m	562.500 mW	1125.000 mW	2.25000 W	3.75000 W	5.62500 W	11.25000 W
500.000m	1125.000 mW	2.25000 W	4.50000 W	7.50000 W	11.25000 W	22.5000 W
1.00000	2.25000 W	4.50000 W	9.00000 W	15.00000 W	22.5000 W	45.0000 W
2.50000	5.62500 W	11.25000 W	22.5000 W	37.5000 W	56.2500 W	112.5000 W
5.00000	11.25000 W	22.5000 W	45.0000 W	75.0000 W	112.5000 W	225.000 W
10.0000	22.5000 W	45.0000 W	90.0000 W	150.0000 W	225.000 W	450.000 W
15.0000	33.7500 W	67.500 W	135.000 W	225.000 W	337.500 W	675.000 W

Current Range [A]	Voltage Range [V] 30.0000	50.0000	75.000	150.000	300.000	500.000
2.50000m	225.000 mW	375.000 mW	562.500 mW	1125.000 mW	2.25000 W	3.75000 W
5.00000m	450.000 mW	750.000 mW	1125.000 mW	2.25000 W	4.50000 W	7.50000 W
10.0000m	900.000 mW	1500.000 mW	2.25000 W	4.50000 W	9.00000 W	15.00000 W
25.0000m	2.25000 W	3.75000 W	5.62500 W	11.25000 W	22.5000 W	37.5000 W
50.0000m	4.50000 W	7.50000 W	11.25000 W	22.5000 W	45.0000 W	75.0000 W
100.000m	9.00000 W	15.00000 W	22.5000 W	45.0000 W	90.0000 W	150.0000 W
250.000m	22.5000 W	37.5000 W	56.2500 W	112.5000 W	225.000 W	375.000 W
500.000m	45.0000 W	75.0000 W	112.5000 W	225.000 W	450.000 W	750.000 W
1.00000	90.0000 W	150.0000 W	225.000 W	450.000 W	900.000 W	1500.000 W
2.50000	225.000 W	375.000 W	562.500 W	1125.000 W	2.25000 kW	3.75000 kW
5.00000	450.000 W	750.000 W	1125.000 W	2.25000 kW	4.50000 kW	7.50000 kW
10.0000	900.000 W	1500.000 W	2.25000 kW	4.50000 kW	9.00000 kW	15.00000 kW
15.0000	1350.000 W	2.25000 kW	3.37500 kW	6.75000 kW	13.50000 kW	22.5000 kW

Appendix 5 Setting the Measurement Period

To make correct measurements on the instrument, you must set its measurement period properly.

There are two cases for setting the measurement period depending on the computing method (Measurement Method).

- When Measurement Method is set to Sync Source Period Average
  Setting the measurement period is necessary
- When Measurement Method is set to Digital Filter Average
  Setting the measurement period is not necessary.

These two cases are detailed below.

When Measurement Method Is Set to Sync Source Period Average

The instrument detects the period of the input signal selected using the measurement period setting. The measurement period is an integer multiple of this detected period. The instrument determines the measured values by averaging the data sampled in the measurement period. The input signal used to determine the measurement period is called the sync source.
The measurement period is automatically determined inside the instrument when you specify the sync source.
This computing method is called the sync source period average method. This method is effective for cases when the data update interval is short or for efficiently measuring low frequency signals.

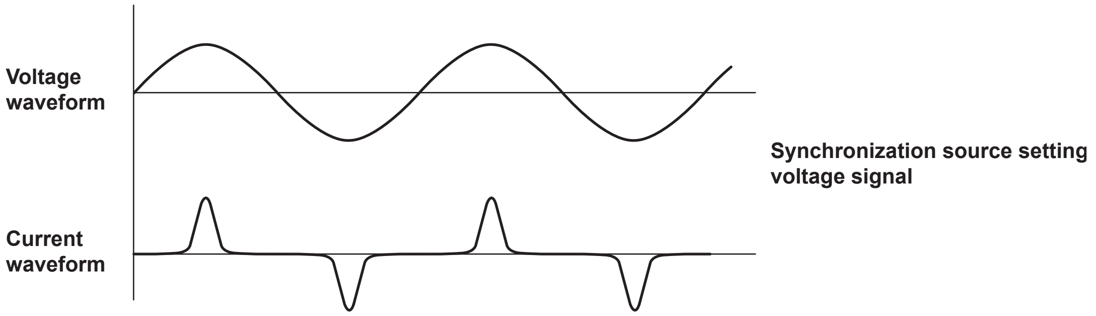
You can select the sync source signal from the options listed below.
U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6, U7, I7, Ext Clk (external clock), Z Phase 1 (Ch D), Z Phase 3 (Ch H), None

* The available options vary depending on the installed elements.

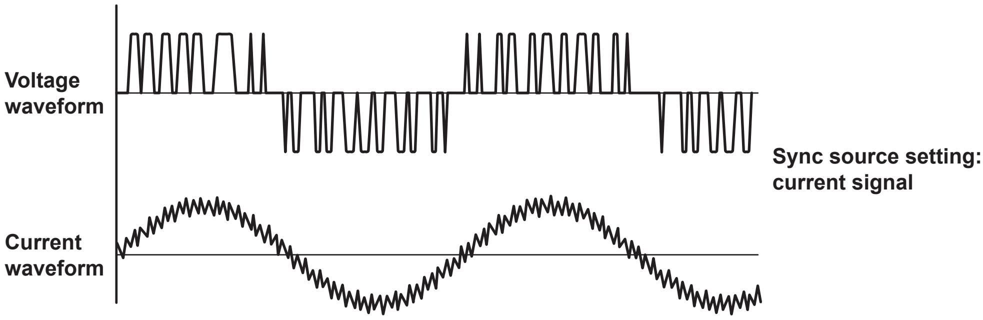
For example, if the sync source for input element 1 is set to I1, an integer multiple of the period of I1 becomes the measurement period. By averaging the sampled data in this measurement period, the instrument computes the measured values for input element 1, such as U1, I1, and P1.

Deciding Whether to Use Voltage or Current Input as the Sync Source

Select input signals with stable input levels and frequencies (with little distortion) as sync sources. Correct measured values can only be obtained if the period of the sync source signal is detected accurately. On the instrument, display the frequency of the input signal that you have selected as the sync source, and confirm that the frequency is being measured correctly. The most suitable sync source is the input signal that is the most stable and that provides accurate measured results.
For example, if a switching power supply is being measured and the voltage waveform distortion is smaller than the current waveform distortion, set the sync source to the voltage signal.

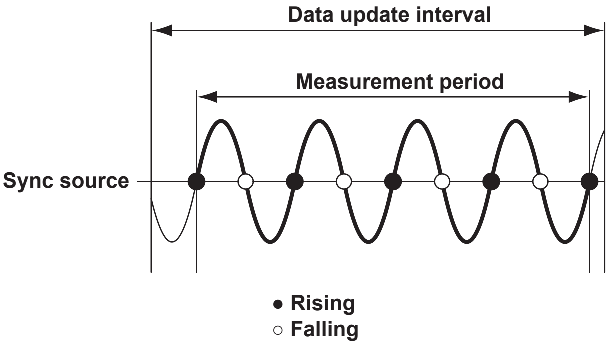


As another example, if an inverter is being measured and the current waveform distortion is smaller than the voltage waveform distortion, set the sync source to the current signal.



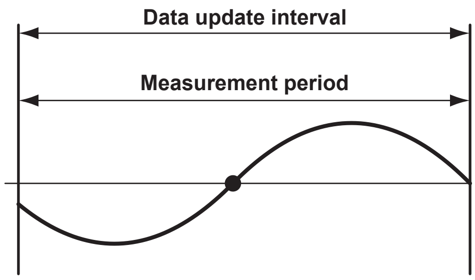
Period Detection

- The rising (or falling) cross point is the time when the sync source passes through the specified level (the center of the amplitude) on a rising (or falling) slope. The measurement period on the instrument is between the first rising (or falling) cross point and the last rising (or falling) cross point in the data update interval.
- The instrument determines whether to define the measurement period using the rising or falling cross point automatically by choosing the method that will result in the longest measurement period.



When the Period of the Sync Source Cannot Be Detected

If the total number of rising and falling zero crossings on the input signal that has been set as the sync source is less than two within the data update interval, the period cannot be detected. Also, the period cannot be detected if the AC amplitude is small. For information on the detection levels of the frequency measurement circuit, see “Conditions” under “Frequency Measurement Function” in section 6.7, “Features.” In this situation, the entire data update interval is used to average the sampled data.



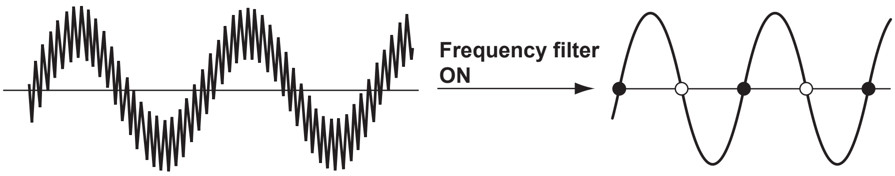
Because of the reasons described above, the measured voltage and current values may be unstable. If this happens, lower the data update interval so that more periods of the input signal fit within the data update interval.

App

Appendix

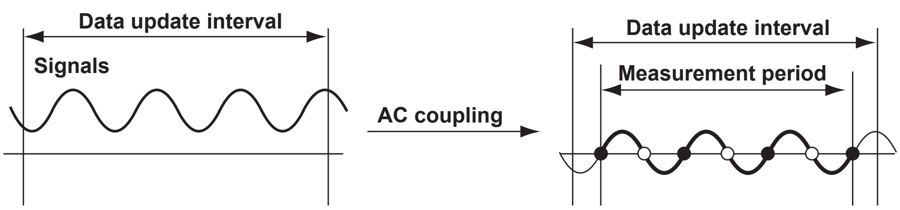
When the Waveform of the Sync Source Is Distorted

Change the sync source to a signal that allows for more stable detection of the period (switch from voltage to current or from current to voltage). Also, turn on the frequency filter.
The instrument reduces the effects of noise by using hysteresis when it detects cross points. If the synchronization source is distorted or harmonics and noise are superposed on the signal to a level exceeding this hysteresis, harmonic components will cause cross point detection to occur frequently, and the cross point of the fundamental frequency will not be detected stably. Consequently, the measured voltage and current may be unstable. When high frequency components are superposed on the current waveform such as in the aforementioned inverter example, turn the frequency filter on to stably detect cross points. Use of the filter is appropriate if it makes the measured frequency accurate and more stable. In this way, the frequency filter also functions as a filter for detecting the cross points of the sync source.



When Measuring a Signal That Has No Cross Points Because of a DC Offset Superposed on the AC Signal

The measured values may be unstable if the period of the AC signal cannot be detected accurately. Change the sync source to a signal that allows for more stable detection of the period (switch from voltage to current or from current to voltage).
The AC coupling (high-pass filter) of the frequency detection circuit is turned on and off using Sync Source/Freq Measurement under Input (Advanced/Options). If you turn on the AC coupling (high-pass filter), even with AC signals in which there are no cross points because of an offset, the period can be detected if the AC amplitude is greater than or equal to the detection level of the frequency measurement circuit (see “Conditions” under “Frequency Measurement Function” in section 6.7, “Features”).
With this feature, the measurement period is set to an integer multiple of the period of the AC signal.

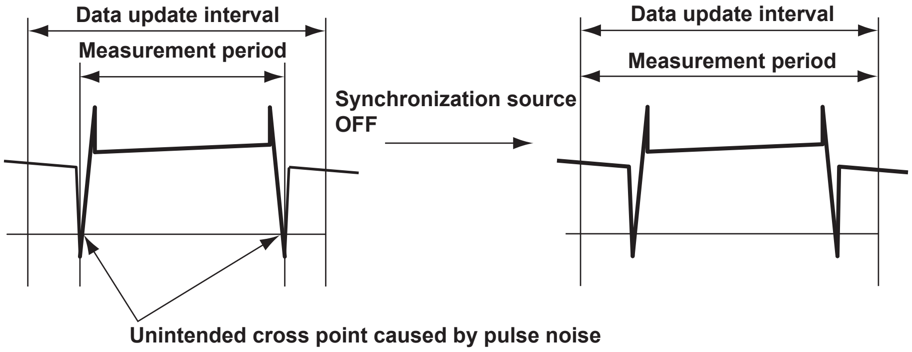


When Measuring a DC Signal

When there are ripples in the DC signal, if the level of the ripples is greater than or equal to the detection level of the frequency measurement circuit (see the conditions listed under “Accuracy” under “Frequency Measurement” in section 6.7, “Features”) and the period can be detected accurately and stably, a more accurate DC measurement is possible. If a large AC signal is superposed on a DC signal, you can achieve a more stable measurement by detecting the AC signal period and averaging it.

In addition, if a small fluctuating pulse noise riding on the DC signal crosses the specified level, that point is detected as a cross point. As a result, sampled data is averaged over an unintended period, and measured values such as voltage and current may be unstable. You can prevent these kinds of erroneous detections by setting the sync source to None.

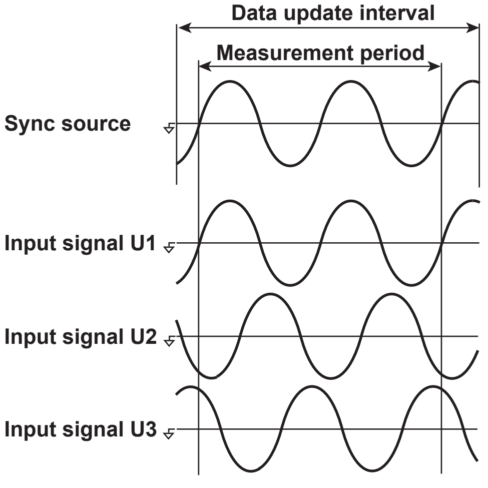
All of the sampled data in the data update interval is used to determine measured values.



Set the sync source according to the signal under measurement and the measurement objective.

Setting the Synchronization Period When Measuring a Three-Phase Device

If a three-phase device is measured with input elements 1 and 2 using a three-phase three-wire system, set the sync source of input elements 1 and 2 to the same signal. For example, set the sync source of input elements 1 and 2 to U1 or I1. The measurement periods of input elements 1 and 2 will match, and it will be possible to measure the Σ voltage, Σ current, and Σ power of a three-phase device more accurately.
Likewise, if a three-phase device is measured with input elements 1, 2, and 3 using a three-phase four-wire system, set the sync source of input elements 1, 2, and 3 to the same signal.
To facilitate this sort of configuration, the synchronization source setting on the instrument is linked to the Σ wiring unit of the wiring system (when independent input element configuration is turned off).
If independent input element configuration is turned on, the synchronization source of each input element in the Σ wiring unit can be set independently.



Synchronization Source Setup Example	
Input element 1	U1 (or I1)
Input element 2	
Input element 3	

Setting the Synchronization Period When Measuring the Efficiency of a Power Transformer

(1) Power Transformer with Single-Phase Input and Single-Phase Output

If you are using input elements 1 and 2 to measure a device that converts single-phase AC power to single-phase DC power, set the sync source of input elements 1 and 2 to the voltage (or current) on the AC power end. In the example shown in the figure below, set the sync source of input elements 1 and 2 to U1 (or I1).

The measurement periods of input element 1 (input end) and input element 2 (output end) will match, and it will be possible to measure the power conversion efficiency at the input and output ends of the power transformer more accurately.

Synchronization Source Setup Example	
Input element 1	U1 (or I1)
Input element 2	

Likewise, if you are using input elements 1 (DC end) and 2 (AC end) to measure a device that converts single-phase DC power to single-phase AC power, set the sync source of input elements 1 and 2 to the voltage (or current) on the AC power end (input element 2). In the example shown in the figure below, set the sync source of input elements 1 and 2 to U2 (or I2).

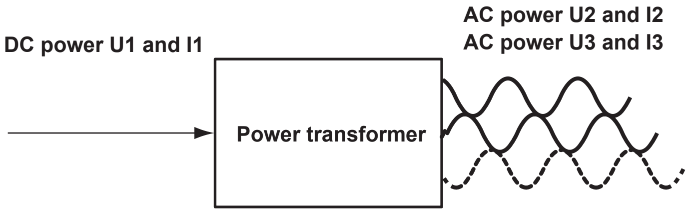
Synchronization Source Setup Example	
Input element 1	U2 (or I2)
Input element 2	

(2) Power Transformer with Single-Phase DC Input and Three-Phase AC Output

If you are using the connections shown on the next page to measure a device that converts single-phase DC power to three-phase AC power, set the sync source of all input elements to the same signal: the voltage or current of element 2 or 3 on the AC power end.

In this example, set the sync source of input elements 1, 2, and 3 to U2 (or I2, U3, or I3). The measurement periods of the input signal and all output signals will match, and it will be possible to measure the power conversion efficiency of the power transformer more accurately.

- Single-phase DC power: Connect to input element 1.
- Three-phase AC power: Connect to input elements 2 and 3 using a three-phase three-wire system.



Synchronization Source Setup Example	
Input element 1	U2 (or I2, U3, or I3)
Input element 2	
Input element 3	

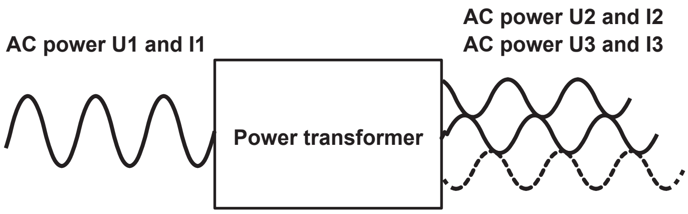
(3) Power Transformer with Single-Phase AC Input and Three-Phase AC Output

If you are using the connections shown in the figure below to measure a device that converts single-phase AC power to three-phase AC power, set the sync source of input elements on the input end to the same signal and do the same for input elements on the output end.

In this example, set the sync source of input element 1 to U1 (or I1), and set the sync source of input elements 2 and 3 to U2 (or I2, U3, or I3).

In this case, AC signals of different frequencies are measured. If the sync source of all input elements is set to the same signal, the measurement period of either the input signal or the output signal will not be an integer multiple of the signal.

- Single-phase AC power: Connect to input element 1.
- Three-phase AC power: Connect to input elements 2 and 3 using a three-phase three-wire system.



Synchronization Source Setup Example	
Input element 1	U1 (or I1)
Input element 2	U2 (or I2, U3, or I3)
Input element 3	

Note

- The measurement period for determining the numeric data of the peak voltage or peak current is the entire span of the data update interval, regardless of the measurement period settings discussed above. Therefore, the measurement period for the measurement functions that are determined using the maximum voltage or current value (U+pk, U-pk, I+pk, I-pk, CfU, and CfI) is also the entire span of the data update interval.
- For details on the measurement period for measurement functions related to harmonic measurement, see the features guide.

When Measurement Method Is Set to Digital Filter Average

Measured values are determined by applying a digital filter on all sampled data and computing the averages, regardless of the data update interval. This computing method is called the digital filter method. With this method, the measurement period is not affected by the input signal period or the sync source settings. As such, there is no need to detect the input signal period. In addition, the measurement period is always the same on all input elements. If aligning the measurement period between the input and output is difficult as shown in the earlier example in “(3) Power Transformer with Single-Phase AC Input and Three-Phase AC Output,” we recommend using this method. This method, in principle, is free of period detection errors and the like and provides highly stable measurements.

Appendix 6 User-Defined Function Operands

The following is a list of operands that can be used in user-defined functions.

Measurement Functions Used in Normal Measurement

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
		Example	E1 to E7	SA to SC
Urms	URMS( )	URMS(E1)	Yes	Yes
Umn	UMN( )	UMN(E1)	Yes	Yes
Udc	UDC( )	UDC(E1)	Yes	Yes
Urmn	URMN( )	URMN(E1)	Yes	Yes
Uac	UAC( )	UAC(E1)	Yes	Yes
Ufnd	UFND( )	UFND(E1)	Yes	Yes
Irms	IRMS( )	IRMS(E1)	Yes	Yes
Imn	IMN( )	IMN(E1)	Yes	Yes
Idc	IDC( )	IDC(E1)	Yes	Yes
Irmn	IRMN( )	IRMN(E1)	Yes	Yes
Iac	IAC( )	IAC(E1)	Yes	Yes
Ifnd	IFND( )	IFND(E1)	Yes	Yes
P	P( )	P(E1)	Yes	Yes
S	S( )	S(E1)	Yes	Yes
Q	Q( )	Q(E1)	Yes	Yes
λ	LAMBDA( )	LAMBDA(E1)	Yes	Yes
Φ	PHI( )	PHI(E1)	Yes	Yes
Pfnd	PFND( )	PFND(E1)	Yes	Yes
Sfnd	SFND( )	SFND(E1)	Yes	Yes
Qfnd	QFND( )	QFND(E1)	Yes	Yes
λfnd	LAMBDAFND( )	LAMBDAFND(E1)	Yes	Yes
Φfnd	PHIFND( )	PHIFND(E1)	Yes	No
fU	FU( )	FU(E1)	Yes	No
fI	FI( )	FI(E1)	Yes	No
f2U	F2U( )	F2U(E1)	Yes	No
f2I	F2I( )	F2I(E1)	Yes	No
U+pk	UPPK( )	UPPK(E1)	Yes	No
U-pk	UMPK( )	UMPK(E1)	Yes	No
I+pk	IPPK( )	IPPK(E1)	Yes	No
I-pk	IMPK( )	IMPK(E1)	Yes	No
P+pk	PPPK( )	PPPK(E1)	Yes	No
P-pk	PMPK( )	PMPK(E1)	Yes	No
CfU	CFU( )	CFU(E1)	Yes	No
CfI	CFI( )	CFI(E1)	Yes	No
Pc	PC( )	PC(E1)	Yes	Yes

Integrated Power (Watt hour)

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
		Example	E1 to E7	SA to SC
Wp	WH( )	WH(E1)	Yes	Yes
Wp+	WHP( )	WHP(E1)	Yes	Yes
Wp-	WHM( )	WHM(E1)	Yes	Yes
q	AH( )	AH(E1)	Yes	Yes
q+	AHP( )	AHP(E1)	Yes	Yes
q-	AHM( )	AHM(E1)	Yes	Yes
WS	SH( )	SH(E1)	Yes	Yes
WQ	QH( )	QH(E1)	Yes	Yes
ITime	ITIME( )	ITIME(E1)	Yes	No

Efficiency

Measurement Function	User-Defined Function		Parameter in ( )
		Example	
η1	ETA1( )	ETA1( )	None or space*
η2	ETA2( )	ETA2( )	None or space*
η3	ETA3( )	ETA3( )	None or space*
η4	ETA4( )	ETA4( )	None or space*

* You cannot omit the parentheses.

User-Defined Function

Measurement Function	User-Defined Function		Parameter in ( )
		Example	
F1	F1( )	F1( )	None or space*
F2	F2( )	F2( )	None or space*
F3	F3( )	F3( )	None or space*
F4	F4( )	F4( )	None or space*
F5	F5( )	F5( )	None or space*
F6	F6( )	F6( )	None or space*
F7	F7( )	F7( )	None or space*
F8	F8( )	F8( )	None or space*
F9	F9( )	F9( )	None or space*
F10	F10( )	F10( )	None or space*
F11	F11( )	F11( )	None or space*
F12	F12( )	F12( )	None or space*
F13	F13( )	F13( )	None or space*
F14	F14( )	F14( )	None or space*
F15	F15( )	F15( )	None or space*
F16	F16( )	F16( )	None or space*
F17	F17( )	F17( )	None or space*
F18	F18( )	F18( )	None or space*
F19	F19( )	F19( )	None or space*
F20	F20( )	F20( )	None or space*

* You cannot omit the parentheses.

MAX Hold

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
		Example	E1 to E7	SA to SC
Rms voltage	MAXURMS( )	MAXURMS(E1)	Yes	Yes
Voltage mean	MAXUMN( )	MAXUMN(E1)	Yes	Yes
Voltage simple average	MAXUDC( )	MAXUDC(E1)	Yes	Yes
Voltage rectified mean value	MAXURMN( )	MAXURMN(E1)	Yes	Yes
Voltage AC component	MAXUAC( )	MAXUAC(E1)	Yes	Yes
Rms current	MAXIRMS( )	MAXIRMS(E1)	Yes	Yes
Current mean	MAXIMN( )	MAXIMN(E1)	Yes	Yes
Current simple average	MAXIDC( )	MAXIDC(E1)	Yes	Yes
Current rectified mean value	MAXIRMN( )	MAXIRMN(E1)	Yes	Yes
Current AC component	MAXIAC( )	MAXIAC(E1)	Yes	Yes
Active power	MAXP( )	MAXP(E1)	Yes	Yes
Apparent power	MAXS( )	MAXS(E1)	Yes	Yes
Reactive power	MAXQ( )	MAXQ(E1)	Yes	Yes
Positive peak voltage	MAXUPPK( )	MAXUPPK(E1)	Yes	No
Negative peak voltage	MINUMPK( )	MINUMPK(E1)	Yes	No
Positive peak current	MAXIPPK( )	MAXIPPK(E1)	Yes	No
Negative peak current	MINIMPK( )	MINIMPK(E1)	Yes	No
Positive peak power	MAXPPPK( )	MAXPPPK(E1)	Yes	No
Negative peak power	MINPMPK( )	MINPMPK(E1)	Yes	No

Motor Evaluation Option

Measurement Function	User-Defined Function		Parameter in ( )
			Motor
		Example	M1 to M4
Speed	SPEED( )	SPEED(M1)	Yes
Torque	TORQUE( )	TORQUE(M1)	Yes
Pm	PM( )	PM(M1)	Yes
Slip	SLIP( )	SLIP(M1)	Yes
SyncSp	SYNC( )	SYNC(M1)	Yes

Auxiliary Input Option

Measurement Function	User-Defined Function		Parameter in ( )
		Example	
Aux1	AUX1( )	AUX1( )	None or space*
Aux2	AUX2( )	AUX2( )	None or space*
Aux3	AUX3( )	AUX3( )	None or space*
Aux4	AUX4( )	AUX4( )	None or space*
Aux5	AUX5( )	AUX5( )	None or space*
Aux6	AUX6( )	AUX6( )	None or space*
Aux7	AUX7( )	AUX7( )	None or space*
Aux8	AUX8( )	AUX8( )	None or space*

* You cannot omit the parentheses.

Delta Computation

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
		Example	E1 to E7	SA to SC
ΔU1( )	DELTAU1( )	DELTAU1(SA)	No	Yes
ΔU2( )	DELTAU2( )	DELTAU2(SA)	No	Yes
ΔU3( )	DELTAU3( )	DELTAU3(SA)	No	Yes
ΔUΣ( )	DELTAUSIG( )	DELTAUSIG(SA)	No	Yes
ΔI( )	DELTAI( )	DELTAI(SA)	No	Yes
ΔP1( )	DELTAP1( )	DELTAP1(SA)	No	Yes
ΔP2( )	DELTAP2( )	DELTAP2(SA)	No	Yes
ΔP3( )	DELTAP3( )	DELTAP3(SA)	No	Yes
ΔPΣ( )	DELTAPSIG( )	DELTAPSIG(SA)	No	Yes
ΔU1rms( )	DELTAU1RMS( )	DELTAU1RMS(SA)	No	Yes
ΔU2rms( )	DELTAU2RMS( )	DELTAU2RMS(SA)	No	Yes
ΔU3rms( )	DELTAU3RMS( )	DELTAU3RMS(SA)	No	Yes
ΔUΣrms( )	DELTAUSIGRMS( )	DELTAUSIGRMS(SA)	No	Yes
ΔU1mean( )	DELTAU1MN( )	DELTAU1MN(SA)	No	Yes
ΔU2mean( )	DELTAU2MN( )	DELTAU2MN(SA)	No	Yes
ΔU3mean( )	DELTAU3MN( )	DELTAU3MN(SA)	No	Yes
ΔUΣmean( )	DELTAUSIGMN( )	DELTAUSIGMN(SA)	No	Yes
ΔU1rmean( )	DELTAU1RMN( )	DELTAU1RMN(SA)	No	Yes
ΔU2rmean( )	DELTAU2RMN( )	DELTAU2RMN(SA)	No	Yes
ΔU3rmean( )	DELTAU3RMN( )	DELTAU3RMN(SA)	No	Yes
ΔUΣrmean( )	DELTAUSIGRMN( )	DELTAUSIGRMN(SA)	No	Yes
ΔU1dc( )	DELTAU1DC( )	DELTAU1DC(SA)	No	Yes
ΔU2dc( )	DELTAU2DC( )	DELTAU2DC(SA)	No	Yes
ΔU3dc( )	DELTAU3DC( )	DELTAU3DC(SA)	No	Yes
ΔUΣdc( )	DELTAUSIGDC( )	DELTAUSIGDC(SA)	No	Yes
ΔU1ac( )	DELTAU1AC( )	DELTAU1AC(SA)	No	Yes
ΔU2ac( )	DELTAU2AC( )	DELTAU2AC(SA)	No	Yes
ΔU3ac( )	DELTAU3AC( )	DELTAU3AC(SA)	No	Yes
ΔUΣac( )	DELTAUSIGAC( )	DELTAUSIGAC(SA)	No	Yes
ΔIrms( )	DELTAIrms( )	DELTAIRMS(SA)	No	Yes
ΔImean( )	DELTAIMN( )	DELTAIMN(SA)	No	Yes
ΔIrmean( )	DELTAIRMN( )	DELTAIRMN(SA)	No	Yes
ΔIdc( )	DELTAIDC( )	DELTAIDC(SA)	No	Yes
ΔIac( )	DELTAIAC( )	DELTAIAC(SA)	No	Yes

Harmonic Measurement:

Measurement Function	User-Defined Function	Example	Left Parameter in (,) or Parameter in ( ): Element E1 to E7	Left Parameter in (,) or Parameter in ( ): Wiring Unit SA to SC	Right Parameter in (,): Harmonics: Total Value ORT	Right Parameter in (,): Harmonics: DC OR0	Right Parameter in (,): Harmonics: Fundamental Wave OR1	Right Parameter in (,): Harmonics: Harmonics OR2 to OR100(500)
U_k	UK(,)	UK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR500
I_k	IK(,)	IK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR500
P_k	PK(,)	PK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR500
S_k	SK(,)	SK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR100
Q_k	QK(,)	QK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR100
λ_k	LAMBDAK(,)	LAMBDAK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR100
Φ_k	PHIK(,)	PHIK(E1,OR3)	Yes	No	Yes	No	Yes	Up to OR500
ΦU	UPHI(,)	UPHI(E1,OR3)	Yes	No	No	No	No	Up to OR500
ΦI	IPHI(,)	IPHI(E1,OR3)	Yes	No	No	No	No	Up to OR500
Z	ZK(,)	ZK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Rs	RSK(,)	RSK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Xs	XSK(,)	XSK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Rp	RPK(,)	RPK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Xp	XPK(,)	XPK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Uhdf	UHDF(,)	UHDF(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR500
Ihdf	IHDF(,)	IHDF(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR500
Phdf	PHDF(,)	PHDF(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR500
Uthd	UTHD( )	UTHD(E1)	Yes	No				
Ithd	ITHD( )	ITHD(E1)	Yes	No				
Pthd	PTHD( )	PTHD(E1)	Yes	No				
Uthf	UTHF( )	UTHF(E1)	Yes	No				
Ithf	ITHF( )	ITHF(E1)	Yes	No				
Utif	UTIF( )	UTIF(E1)	Yes	No				
Itif	ITIF( )	ITIF(E1)	Yes	No				
hvf	HVF( )	HVF(E1)	Yes	No				
hcf	HCF( )	HCF(E1)	Yes	No				
K-factor	KFACT( )	KFACT(E1)	Yes	No				
EaM1U*	EAM1U( )	EAM1U(E1)	Yes	No				
EaM1I*	EAM1I( )	EAM1I(E1)	Yes	No				
EaM3U*	EAM3U( )	EAM3U(E1)	Yes	No				
EaM3I*	EAM3I( )	EAM3I(E1)	Yes	No				
FreqPLL1	PLLFRQ1( )	PLLFRQ1( )	No	No				
FreqPLL2	PLLFRQ2( )	PLLFRQ2( )	No	No				
ΦU1-U2	PHIU1U2( )	PHIU1U2(SA)	No	Yes				
ΦU1-U3	PHIU1U3( )	PHIU1U3(SA)	No	Yes				
ΦU1-I1	PHIU1I1( )	PHIU1I1(SA)	Yes	Yes				
ΦU2-I2	PHIU2I2( )	PHIU2I2(SA)	No	Yes				
ΦU3-I3	PHIU3I3( )	PHIU3I3(SA)	No	Yes				

* Available on models with the motor evaluation function (option)

Measuring Range

Measurement Function	User-Defined Function	Example	Parameter in ( )
RngU	RNGU( )	RNGU(E1)	E1 to E7 (element)
RngI	RNGI( )	RNGI(E1)	E1 to E7 (element)
RngSpd[1]	RNGSPD( )	RNGSPD(M1)	M1 to M4 (motor)
RngTrq[1]	RNGTRQ( )	RNGTRQ(M1)	M1 to M4 (motor)
RngAux[1]	RNGAUX1( ) ~RNGAUX8( )	RNGAUX1( ) ~RNGAUX8( )	None or space[2]

1 Available on models with the motor evaluation function (option)

2 You cannot omit the parentheses.

Appendix 7 USB Keyboard Key Assignments

104 Keyboard (US)

Key	When the Ctrl Key Is Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the instrument		Other
			+Shift on the USB Keyboard	
a	SETUP LOAD menu	a	A	
b	STORE REC	b	B	
c	Execute CAL	c	C	
d	Execute HOLD	d	D	
e	STORE END	e	E	
f	DATA SAVE menu	f	F	
g	INTEGRATION menu	g	G	
h	SETUP SAVE menu	h	H	
i		i	I	
j	Execute NULL	j	J	
k	STORE PAUSE	k	K	
l	NUMERIC UPPER	l	L	
m	NUMERIC LOWER	m	M	
n	NUMERIC FULL	n	N	
o	CUSTOM	o	O	
p	INTEGRATION STOP	p	P	
q	INTEGRATION START	q	Q	
r	INTEGRATION RESET	r	R	
s	SETUP menu	s	S	
t	STORE menu	t	T	
u	GRAPH UPPER	u	U	
v	GRAPH LOWER	v	V	
w	GRAPH FULL	w	W	
x	TOUCH LOCK	x	X	
y	KEY LOCK	y	Y	
z	Execute SINGLE	z	Z	
1		1	!	
2		2	@	
3		3	#	
4		4	$	
5		5	%	
6		6	^	
7		7	&	
8		8	*	
9		9	(	
0		0	)	
Enter	Execute SET	Enter	Same as left	Execute SET
Esc	Execute ESC	Escape	Same as left	Execute ESC
Back Space		Back Space	Same as left	
Tab				
Space Bar		Space	Same as left	
`		`	to	
-		-	=	
=		=	+	
[		[	{	
]		]	}	
\		\	|	
;		;	:	
'		'	"	
,		,	<	
.	UTILITY menu	.	>	
/	Execute Help	/	?	
Caps Lock				

: No feature is assigned to the key.

App

Appendix

Appendix 7 USB Keyboard Key Assignments

Key	When the Ctrl Key Is Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the instrument		Other
			+Shift on the USB Keyboard	
F1	Execute VOLTAGE RANGE UP			ELEMENTS 1
F2	Execute VOLTAGE RANGE DOWN	Move cursor to the left	Same as left	ELEMENTS 2
F3		Move cursor to the right	Same as left	ELEMENTS 3
F4	Execute VOLTAGE RANGE AUTO	Back Space	Same as left	ELEMENTS 4
F5	Execute CURRENT RANGE UP	All Clear	Same as left	ELEMENTS 5
F6	Execute CURRENT RANGE DOWN	Enter	Same as left	ELEMENTS 6
F7		History	Same as left	ELEMENTS 7
F8	Execute CURRENT RANGE AUTO			OPTIONS
F9				
F10				
F11		μ	Same as left	
F12		Ω	Same as left	
Print Screen	Execute DATA SAVE EXEC			
Scroll Lock				
Pause				
Insert				
Home				
Page Up	Execute Page Up*			Execute Page Up*
Delete				
End				
Page Down	Execute Page Down*			Execute Page Down*
→	Move cursor to the right	Move cursor to the right	Same as left	Move cursor to the right
←	Move cursor to the left	Move cursor to the left	Same as left	Move cursor to the left
↓	Move cursor down			Move cursor down
↑	Move cursor up			Move cursor up

Numeric keypad	When the Ctrl Key Is Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the instrument		Other	
			+Shift on the USB Keyboard		+Shift on the USB Keyboard
Num Lock					
/		/	Same as left		
*		*	Same as left		
-		-	Same as left		
+		+	Same as left		
Enter	Execute SET	Enter	Same as left		Execute SET
1		1			
2	Move cursor down	2			Move cursor down
3	Execute Page Down*	3			Execute Page Down*
4	Move cursor to the left	4	Move cursor to the left		Move cursor to the left
5		5			
6	Move cursor to the right	6	Move cursor to the right		Move cursor to the right
7		7			
8	Move cursor up	8			Move cursor up
9	Execute Page Up*	9			Execute Page Up*
0		0			
.		.			

: No feature is assigned to the key.

* Full screen display or the top half of the split display
- Numeric data display: Page up/down
- Graph display: Display page (Group) up/down

109 Keyboard (Japanese)

Key	When the Ctrl Key Is Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the instrument	+Shift on the USB Keyboard	Other
a	SETUP LOAD menu	a	A	
b	STORE REC	b	B	
c	Execute CAL	c	C	
d	Execute HOLD	d	D	
e	STORE END	e	E	
f	DATA SAVE menu	f	F	
g	INTEGRATION menu	g	G	
h	SETUP SAVE menu	h	H	
i		i	I	
j	Execute NULL	j	J	
k	STORE PAUSE	k	K	
l	NUMERIC UPPER	l	L	
m	NUMERIC LOWER	m	M	
n	NUMERIC FULL	n	N	
o	CUSTOM	o	O	
p	INTEGRATION STOP	p	P	
q	INTEGRATION START	q	Q	
r	INTEGRATION RESET	r	R	
s	SETUP menu	s	S	
t	STORE menu	t	T	
u	GRAPH UPPER	u	U	
v	GRAPH LOWER	v	V	
w	GRAPH FULL	w	W	
x	TOUCH LOCK	x	X	
y	KEY LOCK	y	Y	
z	Execute SINGLE	z	Z	
1		1	!	
2		2	"	
3		3	#	
4		4	$	
5		5	%	
6		6	&	
7		7	'	
8		8	(	
9		9	)	
0		0		
Enter	Execute SET	Enter	Same as left	Execute SET
Esc	Execute ESC	Escape	Same as left	Execute ESC
BS		Back Space	Same as left	
Tab				
Space		Space	Same as left	
-		-	=	
^		^	to	
\		\	|	
@		@	`	
[		[	{	
;		;	+	
:		:	*	
]		]	}	
,		,	<	
.	UTILITY menu	.	>	
/	Execute Help	/	?	
\		\	_	
Caps Lock				

: No feature is assigned to the key.

Key	When the Ctrl Key Is Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the instrument		Other
			+Shift on the USB Keyboard	
F1	Execute VOLTAGE RANGE UP			ELEMENTS 1
F2	Execute VOLTAGE RANGE DOWN	Move cursor to the left	Same as left	ELEMENTS 2
F3		Move cursor to the right	Same as left	ELEMENTS 3
F4	Execute VOLTAGE RANGE AUTO	Back Space	Same as left	ELEMENTS 4
F5	Execute CURRENT RANGE UP	All Clear	Same as left	ELEMENTS 5
F6	Execute CURRENT RANGE DOWN	Enter	Same as left	ELEMENTS 6
F7		History	Same as left	ELEMENTS 7
F8	Execute CURRENT RANGE AUTO			OPTIONS
F9				
F10				
F11		µ	Same as left	
F12		Ω	Same as left	
Print Screen	Execute DATA SAVE EXEC			
Scroll Lock				
Pause				
Insert				
Home				
Page Up	Execute Page Up*			Execute Page Up*
Delete				
End				
Page Down	Execute Page Down*			Execute Page Down*
→	Move cursor to the right	Move cursor to the right	Same as left	Move cursor to the right
←	Move cursor to the left	Move cursor to the left	Same as left	Move cursor to the left
↓	Move cursor down			Move cursor down
↑	Move cursor up			Move cursor up

Numeric keypad	When the Ctrl Key Is Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the instrument		Other	
			+Shift on the USB Keyboard		+Shift on the USB Keyboard
Num Lock					
/		/	Same as left		
*		*	Same as left		
-		-	Same as left		
+		+	Same as left		
Enter	Execute SET	Enter	Same as left		Execute SET
1		1			
2	Move cursor down	2			Move cursor down
3	Execute Page Down*	3			Execute Page Down*
4	Move cursor to the left	4	Move cursor to the left		Move cursor to the left
5		5			
6	Move cursor to the right	6	Move cursor to the right		Move cursor to the right
7		7			
8	Move cursor up	8			Move cursor up
9	Execute Page Up*	9			Execute Page Up*
0		0			
.		.			

: No feature is assigned to the key.

* Full screen display or the top half of the split display
- Numeric data display: Page up/down
- Graph display: Display page (Group) up/down

Appendix 8 List of Initial Settings and Numeric Data Display Order

Factory Default Settings (Example for a model with seven input elements installed)

The default settings vary depending on the number of installed input elements and what options are installed.

Measurement Mode

Item	Setting
Measurement Mode	Normal

Input (Basic)

Item	Setting
Wiring	1P2W
Voltage	1000V
Auto	OFF
Current	760901:30A 760902:5A
Auto	OFF
Ext Sensor	OFF
Sensor Preset	Others
Sensor Ratio	10.0000
Scaling	OFF
VT Scaling	1.0000
CT Preset	Others
CT Scaling	1.0000
SF Scaling	1.0000
Line Filter	OFF
Cutoff	0.5kHz
Freq Filter	OFF
Cutoff	0.1kHz
Sync Source	Element1: I1, Element2: I2, Element3: I3, Element4: I4, Element5: I5, Element6: I6, Element7: I7

Input (Advanced/Options)

Range

Item	Setting
Crest Factor	CF3
Range Σ Link	ON
Ext Sensor Range Display Format	Direct
Valid Measurement Range	All measurement ranges: Checking available
Peak Over Jump	OFF

Line Filter

Item	Setting
Line Filter Advanced Settings	OFF
Line Filter Type	Butterworth
Line Filter	OFF
Cutoff	0.5 kHz

Freq Filter/Rectifier/Level

Item	Setting
Sync Source/ Freq Measurement	
Freq Filter Advanced Settings	OFF
HPF	
Freq Filter (0.1Hz)	ON
LPF	
Freq Filter	OFF
Cutoff	0.1 kHz
Freq2 Measurement	
HPF	
Freq Filter (Freq2)	OFF
Cutoff	0.1 Hz
Level	
Voltage Level (Freq2)	0.0%
Current Level (Freq2)	0.0%

Null

Item	Setting
Null	OFF
Target Element	All
On Items	U1 to U7, I1 to I7, Speed1 and 2[1], Torque1 and 2[1], Speed3 and 4[2], Torque3 and 4[2], Aux1 to Aux4[1], Aux5 to Aux8[2]

1 Available on models with the motor evaluation function 1 (option)

2 Available on models with the motor evaluation function 2 (option)

Motor/Aux

Item	Setting		
MTR Configuration	Single Motor(Speed: Pulse)		
Ch Settings			
	Torque	Speed	Pm
Scaling	1.0000	1.0000	1.0000
Unit	Nm	rpm	W
Sense Type	Analog	Pulse	
Analog Auto Range	OFF	—	
Analog Range	20V	—	
Linear Scale A	1.000	—	
Linear Scale B	0.000	—	
Calculation		—	
Point1X	1.000V	—	
Point1Y	1.000Nm	—	
Point2X	-1.000V	—	
Point2Y	-1.000Nm	—	
Line Filter	OFF	—	
Pulse Noise Filter	—	OFF	
Sync Source	None	None	
Pulse Range Upper	—	10000.0000	
Pulse Range Lower	—	0.0000	
Rated Upper	—		
Rated Freq (Upper)	—		
Rated Lower	—		
Rated Freq (Lower)	—		
Pulse N(Speed)		60	
Sync Speed			
Pole	2		
Source	I1		
Electrical Angle Measurement	OFF		
Harmonics Trigger	Hrm1, Hrm2: Z Phase1(ChD)		
Electrical Angle Correction	0.00		
Auto Enter Correction Target	U1		

App

Appendix

Computation/Output

Efficiency

Item	Setting
η1	PΣB/PΣA
η2	PΣA/PΣB
η3	OFF/OFF
η4	OFF/OFF
Udef1	P1+None+None+None
Udef2	P1+None+None+None

Δ Measure

Item	Setting
ΔMeasure Type	-
ΔMeasure Mode	rms

Update Rate/Averaging

Item	Setting
Update Rate	
Update Mode	Constant
Update Rate	500ms
Measurement Method	Sync Source Period Average
Trigger	
Mode	Auto
Source	U1
Slope	Rise
Level	0.0%
Averaging	
Averaging	OFF
Averaging Type	Exp.
Averaging Count	2

Harmonics

Item	Setting
Element Settings	Element1 to Element7: Hrm1
PLL Source	U1
Min Order	1
Max Order	100
Thd Formula	1/Total
FFT Points	1024

Measure

Item	Setting				
User Defined Functions	ON/OFF	Name	Expression		Unit
Function1	OFF	Avg-W	WH(E1)/(ITIME(E1)/3600)		W
Function2	OFF	P-loss	P(E1)-P(E2)		W
Function3	OFF	U-ripple	(UPPK(E1)-UMPK(E1))/2/UDC(E1)*100		%
Function4	OFF	I-ripple	(IPPK(E1)-IMPK(E1))/2/IDC(E1)*100		%
Function5	OFF	D-UrmsR	DELTAU1RMS(SA)		V
Function6	OFF	D-UrmsS	DELTAU2RMS(SA)		V
Function7	OFF	D-UrmsT	DELTAU3RMS(SA)		V
Function8	OFF	D-UmnR	DELTAU1MN(SA)		V
Function9	OFF	D-UmnS	DELTAU2MN(SA)		V
Function10	OFF	D-UmnT	DELTAU3MN(SA)		V
Function11	OFF	PhiU3-U2	360-PHIU1U3(SA)+PHIU1U2(SA)		deg
Function12	OFF	PhiI1-I2	PHIU1I2(SA)-PHIU1I1(SA)		deg
Function13	OFF	PhiI2-I3	PHIU3I3(SA)-PHIU2I2(SA)-F11()		deg
Function14	OFF	PhiI3-I1	(360-PHIU3I3(SA))+PHIU1I1(SA)+(360-PHIU1U3(SA))		deg
Function15	OFF	Pp-p	PPPK(E1)-PMPK(E1)		W
Function16	OFF	F16	DELTAU1RMN(SA)		V
Function17	OFF	F17	DELTAU2RMN(SA)		V
Function18	OFF	F18	DELTAU3RMN(SA)		V
Function19	OFF	F19	DELTAU1DC(SA)		V
Function20	OFF	F20	DELTAU2DC(SA)		V
Max Hold	OFF				
User Defined Events	ON/OFF	Name	TRUE	FALSE	Expression
Event No.1	OFF	Ev1	True	False	URMS(E1) > 0.00000E+00
Event No.2	OFF	Ev2	True	False	IRMS(E1) > 0.00000E+00
Event No.3	OFF	Ev3	True	False	EV1() & EV2()
Event No.4	OFF	Ev4	True	False	No Expression
Event No.5	OFF	Ev5	True	False	No Expression
Event No.6	OFF	Ev6	True	False	No Expression
Event No.7	OFF	Ev7	True	False	No Expression
Event No.8	OFF	Ev8	True	False	No Expression
S Formula	Urms*Irms				
S,Q Formula	Type 1				
Pc Formula	Type 1 P1=0.5000, P2=0.5000				
Phase	180 degrees				
Sync Measure	Master				

Display

Item	Setting
Display	Numeric+Graph(Wave)
Numeric	All Items
Page	Page 1
Item (Numeric)	
Order(k)	1
Display All Elements	ON
Graph	Wave
Wave	
Group	Group 1
Item (Wave)	
Group	1
Display On	U1 to I7, Speed1 and 2[1], Torque1 and 2[1], Speed3 and 4[2], Torque3 and 4[2]
Vertical Zoom	×1
Vertical Position	0.000%
Form (Wave)	
Format	Single
Time/div	5ms
Advanced	
Interpolate	Line
Graticule	Grid(▦)
Scale Value	ON
Wave Label	OFF
Cursor (Wave Cursor)	
Cursor	OFF
C1+ Trace	U1
C1+ Position	200
C2x Trace	I1
C2x Position	800
Cursor Path	Max
Linkage	OFF
Trend	
Group	Group 1
Item (Trend)	
Group	1
Display On	T1 to T8
Function	T1: Urms, T2: Irms, T3: P, T4: S, T5: Q, T6: λ, T7: Φ, T8: FreqU, T9 to T16: Urms
Element	Element1
Order	-
Scaling	Auto
Upper Scale	100.0
Lower Scale	-100.0
Form (Trend)	
Trend Format	Single
Time/div	3s
Advanced	Same as those listed under Form (Wave)
Cursor (Trend Cursor)	
Cursor	OFF
C1+ Trace	T1
C1+ Position	200
C2x Trace	T2
C2x Position	1800
Linkage	OFF

1 Available on models with the motor evaluation function 1 (option)
2 Available on models with the motor evaluation function 2 (option)

Item	Setting		
Bar			
Group	Group 1		
Item (Bar)			
Bar Item No.	1	2	3
Function	U	I	P
Element	Element1	Element1	Element1
Scale Mode	Fixed	Fixed	Fixed
Form (Bar)			
Format	Single		
Start Order	1		
End Order	100		
Cursor (Bar Cursor)			
Cursor	OFF		
C1+ Order	1		
C2x Order	15		
Linkage	OFF		
Vector			
Group	Group 1		
Item (Vector)			
Vector Item No	1	2	
Object	ΣA	Element1	
U Mag	1.000	1.000	
I Mag	1.000	1.000	
Form (Vector)			
Format	Single		
Numeric	On		

Store

Item	Setting
Store Mode	Manual
Store Count	100
Interval	00:00:00
Stored Items	Selected Items
Select Stored Items	Element1
	Urms, Irms, P, S, Q, λ, Φ, FreqU, FreqI
Auto Naming	Numbering
Auto CSV Conversion	ON

Data Save

Item	Setting
Saved Objects	Numeric
Saved Numeric Items	Selected Items
Select Saved Numeric Items	Element1
	Urms, Irms, P, S, Q, λ, Φ, FreqU, FreqI
Image File Format	PNG
Image Color	Color
Auto Naming	Numbering

Integration

Item	Setting
Integration Mode	Normal
Integration Timer	0:00:00
Independent Control	OFF
Auto Cal	OFF
WP±Type	
Setting	Each
Element1 to 7	Charge/Discharge
q mode	
Setting	Each
Element1 to 7	dc
Resume Action	Error

D/A Output (Available on models with the D/A output option)

Item	Setting			
Ch.	Function	Element/Σ	Order	Range Mode
1	Urms	Element 1	-	Fixed
2	Irms	Element 1	-	Fixed
3	P	Element 1	-	Fixed
4	S	Element 1	-	Fixed
5	Q	Element 1	-	Fixed
6	λ	Element 1	-	Fixed
7	Φ	Element 1	-	Fixed
8	fU	Element 1	-	Fixed
9	fI	Element 1	-	Fixed
10 to 20	Urms	Element 1	-	Fixed
Integration Rated Time	00001:00:00			

Utility

System Configuration

Item	Setting
Date/Time	
Display[1, 2]	ON
Setting Method[1, 2]	Manual
Language	
Menu Language[1]	English
Message Language[1]	English
LCD	
Auto OFF[1, 2]	OFF
Auto OFF Time[1, 2]	5min
Brightness	7
Grid Intensity	4
Preference	
Freq Display at Low Frequency[1, 2]	Error
Motor Display at Low Pulse Freq[1, 2]	Error
Decimal Point for CSV File[1, 2]	Period
Rounding to Zero	ON
USB Keyboard[1, 2]	English

1 This item is not affected when the instrument is initialized (by pressing Setup and then Initialize Settings).
2 This item is not loaded when a setup parameter file is loaded (by pressing Setup and then Load Setup).

Remote Control

Item	Setting
Network(VXI-11)	
Time Out[1, 2]	Infinite
GP-IB	
Address[1, 2]	1
Command Type	WT5000

1 This item is not affected when the instrument is initialized (by pressing Setup and then Initialize Settings).
2 This item is not loaded when a setup parameter file is loaded (by pressing Setup and then Load Setup).

Network

Item	Setting
TCP/IP	
DHCP[1, 2]	ON
DNS[1, 2]	Auto
FTP Server	
User Name[1, 2]	anonymous
Time Out(sec)[1, 2]	900
Net Drive	
Login Name[1, 2]	anonymous
FTP Passive[1, 2]	OFF
Time Out(sec)[1, 2]	15
SNTP	
Time Out[1, 2]	3sec
Adjust at Power On[1, 2]	OFF
Time Difference from GMT[1, 2]	Hour: 9, Minute: 0

1 This item is not affected when the instrument is initialized (by pressing Setup and then Initialize Settings).
2 This item is not loaded when a setup parameter file is loaded (by pressing Setup and then Load Setup).

App

Appendix

Selftest

Item	Setting
Test Item	Memory

Other

Item	Setting
Hold	OFF
KEY LOCK[1, 2]	OFF
TOUCH LOCK[1, 2]	OFF

1 This item is not affected when the instrument is initialized (by pressing Setup and then Initialize Settings).

2 This item is not loaded when a setup parameter file is loaded (by pressing Setup and then Load Setup).

Numeric Data Display Order (Example for a model with seven input elements installed)

If you reset the order of the numeric data using the Element Origin setting, the data of each measurement function is displayed in the order indicated in the table below.

All Items Display

Page											
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Urms	Urms	Irms	ITime	F1	Ev1	Speed[1]	ΔU1	U(k)	Uhdf(k)	Uthd	ΦUi-Uj
rmsI	Umn	Imn	Wp	F2	Ev2	Torque[1]	ΔU2	I(k)	Ihdf(k)	Ithd	ΦUi-Uk
P	Udc	Idc	WP+	F3	Ev3	SyncSp[1]	ΔU3	P(k)	Phdf(k)	Pthd	ΦUi-Ii
S	Urmn	Irmn	WP-	F4	Ev4	Slip[1]	ΔUΣ	S(k)	Z(k)	Uthf	ΦUj-Ij
Q	Uac	Iac	q	F5	Ev5	Pm[1]	ΔI	Q(k)	Rs(k)	Ithf	ΦUk-Ik
λ	Ufnd	Ifnd	q+	F6	Ev6	EaM1U[1]	ΔP1	λ(k)	Xs(k)	Utif	
Φ	U+pk	I+pk	q-	F7	Ev7	EaM1I[1]	ΔP2	Φ(k)	Rp(k)	Itif	
fU	U-pk	I-pk	WS	F8	Ev8	EaM3U[2]	ΔP3	ΦU(k)	Xp(k)	hvf	
fI	CfU	CfI	WQ	F9	η1	EaM3[2]	ΔPΣ	ΦI(k)	K-factor	hcf	
	Pc[*3]			F10	η2						
	P+pk[*3]			F11	η3						
	P-pk[3]			F12	η4						
				F13							
				F14							
				F15							
				F16							
				F17							
				F18							
				F19							
				F20							

4 Items Display

Page											
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Urms1	Urms2	Urms3	Urms4	Urms5	Urms6	Urms7	UrmsΣA	UrmsΣB	WP1	WP5	η1
Irms1	Irms2	Irms3	Irms4	Irms5	Irms6	Irms7	IrmsΣA	IrmsΣB	WP2	WP6	η2
P1	P2	P3	P4	P5	P6	P7	PΣA	PΣB	WP3	WP7	η3
λ1	λ2	λ3	λ4	λ5	λ6	λ7	λΣA	λΣB	WP4	WPΣA	η4

8 Items Display

Page											
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Urms1	Urms2	Urms3	Urms4	Urms5	Urms6	Urms7	UrmsΣA	UrmsΣB	WP1	WP5	P1
Irms1	Irms2	Irms3	Irms4	Irms5	Irms6	Irms7	IrmsΣA	IrmsΣB	q1	q5	P2
P1	P2	P3	P4	P5	P6	P7	PΣA	PΣB	WP2	WP6	P3
S1	S2	S3	S4	S5	S6	S7	SΣA	SΣB	q2	q6	P4
Q1	Q2	Q3	Q4	Q5	Q6	Q7	QΣA	QΣB	WP3	WP7	η1
λ1	λ2	λ3	λ4	λ5	λ6	λ7	λΣA	λΣB	q3	q7	η2
Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	ΦΣA	ΦΣB	WP4	WPΣA	η3
fU1	fU2	fU3	fU4	fU5	fU6	fU7	—	—	q4	qΣA	η4

App

Appendix

16 Items Display

Page											
1	2	3	4	5	6	7	8	9	10	11	12
Urms1	Urms2	Urms3	Urms4	Urms5	Urms6	Urms7	UrmsΣA	P1	P5	P1	F1
Irms1	Irms2	Irms3	Irms4	Irms5	Irms6	Irms7	IrmsΣA	WP1	WP5	P2	F2
P1	P2	P3	P4	P5	P6	P7	PΣA	Irms1	Irms5	P3	F3
S1	S2	S3	S4	S5	S6	S7	SΣA	q1	q5	P4	F4
Q1	Q2	Q3	Q4	Q5	Q6	Q7	QΣA	P2	P6	P5	F5
λ1	λ2	λ3	λ4	λ5	λ6	λ7	λΣA	WP2	WP6	P6	F6
Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	ΦΣA	Irms2	Irms6	P7	F7
Pc1	Pc2	Pc3	Pc4	Pc5	Pc6	Pc7	PcΣA	q2	q6	PΣA	F8
fU1	fU2	fU3	fU4	fU5	fU6	fU7	UrmsΣB	P3	P7	η1	F9
fI1	fI2	fI3	fI4	fI5	fI6	fI7	IrmsΣB	WP3	WP7	η2	F10
U+pk1	U+pk2	U+pk3	U+pk4	U+pk5	U+pk6	U+pk7	PΣB	Irms3	Irms7	η3	F11
U-pk1	U-pk2	U-pk3	U-pk4	U-pk5	U-pk6	U-pk7	SΣB	q3	q7	η4	F12
I+pk1	I+pk2	I+pk3	I+pk4	I+pk5	I+pk6	I+pk7	QΣB	P4	PΣA	—	F13
I-pk1	I-pk2	I-pk3	I-pk4	I-pk5	I-pk6	I-pk7	λΣB	WP4	WPΣA	—	F14
CfU1	CfU2	CfU3	CfU4	CfU5	CfU6	CfU7	ΦΣB	Irms4	IrmsΣA	—	F15
CfI1	CfI2	CfI3	CfI4	CfI5	CfI6	CfI7	PcΣB	q4	qΣA	—	F16

Matrix Display

Page								
1	2	3	4	5	6	7	8	9
Urms	Urms	Irms	ITime	—	—	—	—	—
Irms	Umn	Imn	WP	—	—	—	—	—
P	Udc	Idc	WP+	—	—	—	—	—
S	Urmn	Irmn	WP-	—	—	—	—	—
Q	Uac	Iac	q	—	—	—	—	—
λ	U+pk	I+pk	q+	—	—	—	—	—
Φ	U-pk	I-pk	q-	—	—	—	—	—
fU	CfU	CfI	WS	—	—	—	—	—
fI	fU	fI	WQ	—	—	—	—	—

Left Side of the HRM Single List and Dual List Displays (single screen display)

Page										
1	2	3	4	5	6	7	8	9	10	11
Urms1	Urms2	Urms3	Urms4	Urms5	Urms6	Urms7	UrmsΣA	UrmsΣB	UrmsΣC	F1
Irms1	Irms2	Irms3	Irms4	Irms5	Irms6	Irms7	IrmsΣA	IrmsΣB	IrmsΣC	F2
P1	P2	P3	P4	P5	P6	P7	PΣA	PΣB	PΣC	F3
S1	S2	S3	S4	S5	S6	S7	SΣA	SΣB	SΣC	F4
Q1	Q2	Q3	Q4	Q5	Q6	Q7	QΣA	QΣB	QΣC	F5
λ1	λ2	λ3	λ4	λ5	λ6	λ7	λΣA	λΣB	λΣC	F6
Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	ΦUi-Uj	ΦUi-Uj	ΦUi-Uj	F7
Uthd1	Uthd2	Uthd3	Uthd4	Uthd5	Uthd6	Uthd7	ΦUi-Uk	ΦUi-Uk	ΦUi-Uk	F8
Ithd1	Ithd2	Ithd3	Ithd4	Ithd5	Ithd6	Ithd7	ΦUi-Ii	ΦUi-Ii	ΦUi-Ii	F9
Pthd1	Pthd2	Pthd3	Pthd4	Pthd5	Pthd6	Pthd7	ΦUj-Ij	ΦUj-Ij	ΦUj-Ij	F10
Uthf1	Uthf2	Uthf3	Uthf4	Uthf5	Uthf6	Uthf7	ΦUk-Ik	ΦUk-Ik	ΦUk-Ik	F11
Ithf1	Ithf2	Ithf3	Ithf4	Ithf5	Ithf6	Ithf7				F12
Utif1	Utif2	Utif3	Utif4	Utif5	Utif6	Utif7				F13
Itif1	Itif2	Itif3	Itif4	Itif5	Itif6	Itif7				F14
hvf1	hvf2	hvf3	hvf4	hvf5	hvf6	hvf7				F15
hcf1	hcf2	hcf3	hcf4	hcf5	hcf6	hcf7				F16
K-factor1	K-factor2	K-factor3	K-factor4	K-factor	K-factor6	K-factor7				F17
										F18
										F19
										F20

Left Side of the HRM Single List and Dual List Displays (split display)

Page										
1	**3**	**5**	**7**	**9**	**11**	**13**	**15**	**17**	**19**	**21**
Urms1	Urms2	Urms3	Urms4	Urms5	Urms6	Urms7	UrmsΣA	UrmsΣB	UrmsΣC	F1
Irms1	Irms2	Irms3	Irms4	Irms5	Irms6	Irms7	IrmsΣA	IrmsΣB	IrmsΣC	F2
P1	P2	P3	P4	P5	P6	P7	PΣA	PΣB	PΣC	F3
S1	S2	S3	S4	S5	S6	S7	SΣA	SΣB	SΣC	F4
Q1	Q2	Q3	Q4	Q5	Q6	Q7	QΣA	QΣB	QΣC	F5
λ1	λ2	λ3	λ4	λ5	λ6	λ7	λΣA	λΣB	λΣC	F6
Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7				F7
										F8
										F9
										F10

Page										
2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**
Uthd1	Uthd2	Uthd3	Uthd4	Uthd5	Uthd6	Uthd7	ΦUi-Uj	ΦUi-Uj	ΦUi-Uj	F11
Ithd1	Ithd2	Ithd3	Ithd4	Ithd5	Ithd6	Ithd7	ΦUi-Uk	ΦUi-Uk	ΦUi-Uk	F12
Pthd1	Pthd2	Pthd3	Pthd4	Pthd5	Pthd6	Pthd7	ΦUi-Ii	ΦUi-Ii	ΦUi-Ii	F13
Uthf1	Uthf2	Uthf3	Uthf4	Uthf5	Uthf6	Uthf7	ΦUj-Ij	ΦUj-Ij	ΦUj-Ij	F14
Ithf1	Ithf2	Ithf3	Ithf4	Ithf5	Ithf6	Ithf7	ΦUk-Ik	ΦUk-Ik	ΦUk-Ik	F15
Utif1	Utif2	Utif3	Utif4	Utif5	Utif6	Utif7				F16
Itif1	Itif2	Itif3	Itif4	Itif5	Itif6	Itif7				F17
hvf1	hvf2	hvf3	hvf4	hvf5	hvf6	hvf7				F18
hcf1	hcf2	hcf3	hcf4	hcf5	hcf6	hcf7				F19
K-factor1	K-factor2	K-factor3	K-factor4	K-factor	K-factor6	K-factor7				F20

1 Displayed on models with the motor evaluation function 1 (/MTR1 option)
2 Displayed on models with the motor evaluation function 2 (/MTR2 option)
3 Not displayed when the split display is in use.

Appendix 9 Limitations on Modifying Settings and Operations

During integration and storage, there are measurement conditions and computations whose settings you cannot change and features that you cannot execute.

Operation (Changing settings or executing features)		Integration status		Storage State		
		Start/ Ready	Stop/Timeup/ Error	Rec/ Ready	Pause	Cmpl/ Error
Fundamental Measurement Conditions	Measurement Mode	No	No	No	No	No
	Wiring	No	No	No	No	No
	η Formula	No	Yes	No	No	No
	Element Independent	No	No	No	No	No
	ΔMeasure Type	No	No	No	No	No
	ΔMeasure Mode	No	Yes	No	No	No
	Voltage or current range	No	No	Yes	Yes	Yes
	Voltage or current Auto Range	No	No	Yes	Yes	Yes
	Direct Current Input or External Current Sensor	No	No	No	No	No
	Sensor Preset	No	No	No	No	No
	Sensor Ratio	No	No	No	No	No
	CT Preset	No	No	No	No	No
	VT/CT/SF Scaling	No	No	No	No	No
	Valid Measurement Range	No	No	No	No	No
	Crest Factor	No	No	No	No	No
	Sync Source	No	No	No	No	No
	Line Filter Settings	No	No	No	No	No
	Freq Filter Settings	No	No	No	No	No
	Rectifier	No	No	No	No	No
	Level	No	No	No	No	No
	Update Rate	No	No	No	No	No
	Average	No	No	No	No	No
Harmonics	PLL Source	No	No	No	No	No
	Min/Max Order	No	No	No	No	No
	Thd Formula	No	No	No	No	No
	Element Settings	No	No	No	No	No
Motor	Scaling	No	No	No	No	No
	Sense Type	No	No	No	No	No
	Auto Range	No	No	Yes	Yes	Yes
	Range	No	No	Yes	Yes	Yes
	Linear Scale A/B	No	No	No	No	No
	Linear Scale Calculate Execute	No	No	No	No	No
	Line Filter	No	No	No	No	No
	Pulse Noise Filter	No	No	No	No	No
	Motor	No	No	No	No	No
	Pulse Range Upper/Lower	No	No	No	No	No
	Torque Pulse	No	No	No	No	No
	Torque Pulse Rated Freq	No	No	No	No	No
	Pulse N	No	No	No	No	No
	Pole	No	No	No	No	No
	Sync Speed Source	No	No	No	No	No
	Electrical Angle Measurement ON/OFF	No	No	No	No	No
	Electrical Angle Correction	No	No	No	No	No
External signal	Scaling	No	No	No	No	No
	Auto Range	No	No	Yes	Yes	Yes
	Range	No	No	Yes	Yes	Yes
	Linear Scale A/B	No	No	No	No	No
	Linear Scale Calculate Execute	No	No	No	No	No
	Line Filter	No	No	No	No	No
	Pulse Noise Filter	No	No	No	No	No
	Pulse Range Upper/Lower	No	No	No	No	No

Operation (Changing settings or executing features)		Integration status		Storage State		
		Start/ Ready	Stop/Timeup/ Error	Rec/ Ready	Pause	Cmpl/ Error
Computation	User-Defined Function Conditions	No	Yes	No	No	No
	Max Hold ON/OFF	No	No	Yes	Yes	Yes
	User-Defined Event Conditions	No	Yes	No	No	No
	S Formula	No	No	No	No	No
	S, Q Formula	No	No	No	No	No
	Pc Formula	No	No	No	No	No
	Phase	No	No	No	No	No
	Sync Measure	No	No	No	No	No
Hold Single measurement	Hold	Yes	Yes	Yes	Yes	Yes
	Single	Yes	Yes	Yes	Yes	Yes
Integration	Independent Control	No	No	Yes	Yes	Yes
D/A	D/A Rated Time	No	No	Yes	Yes	Yes
Waveform display	Time/Div	No	No	No	No	No
	Trigger Mode	No	No	Yes	Yes	Yes
	Trigger Source	No	No	No	No	No
	Trigger Slope	No	No	No	No	No
	Trigger Level	No	No	No	No	No
Storage	Store CSV Conversion	Yes	Yes	No	No	Yes
	Store Rec	Yes	Yes	No[1]	Yes	No
	Store Pause	Yes	Yes	Yes	Yes	Yes
	Store End	Yes	Yes	Yes	Yes	Yes
File	File Auto Naming	Yes	Yes	No	No	Yes
	File Name	Yes	Yes	No	No	Yes
	Comment	Yes	Yes	No	No	Yes
	Setup File Save	No	No	No	No	No
	Setup File Load	No	No	No	No	No
	Numeric Save	Yes	Yes	No	No	Yes
	Numeric Save Item Settings	Yes	Yes	No	No	Yes
	Wave Save	Yes	Yes	No	No	Yes
	Execute Image Save	Yes	Yes	No	No	Yes
	Change Drive	Yes	Yes	No	No	No
	Change Folder	Yes	Yes	No	No	No
	Delete	No	No	No	No	No
	Rename	No	No	No	No	No
	New Folder	No	No	No	No	No
	Copy	No	No	No	No	No
	Move	No	No	No	No	No
	Execute Image Save	No	Yes	No	No	Yes
Utility	Initialize Settings	Yes	Yes	No	No	No
	Date/Time	No	No	No	No	No
	Setting Method	No	No	No	No	No
	Menu Language	No	No	Yes	Yes	Yes
	Message Language	No	No	Yes	Yes	Yes
	Freq Display at Low Frequency	No	No	No	No	No
	Motor Display at Low Pulse Freq	No	No	No	No	No
	SelfTest	No	No	No	No	No
Other	Manual Cal	No	No	Yes	Yes	Yes
	Null	No	No	No	No	No

Yes: The setting can be changed, or the feature can be performed.

No: The setting cannot be changed, or the feature cannot be performed.

1 You can execute the Rec function of the Store feature.

App

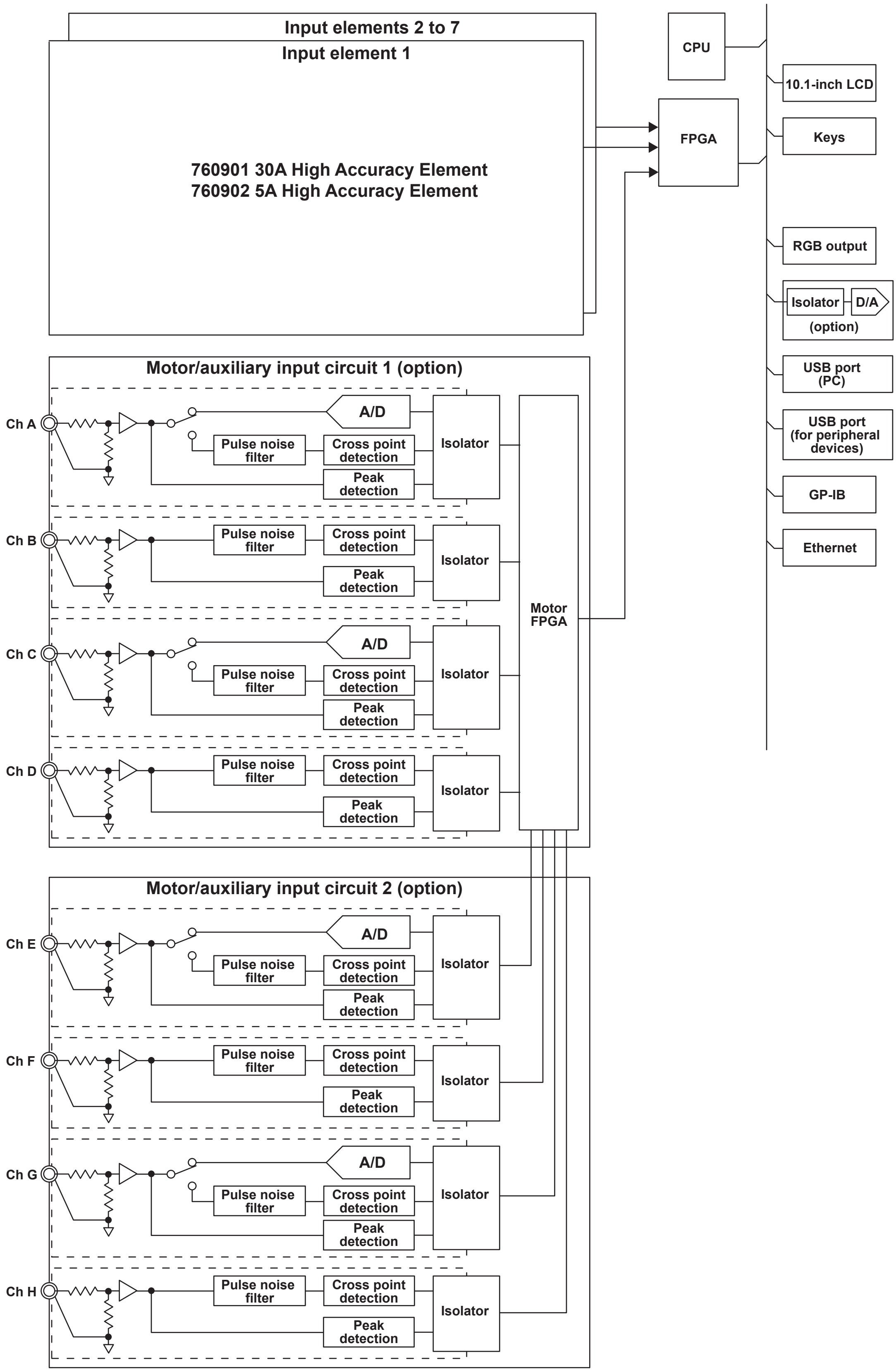
Appendix

Appendix 10 Firmware Version

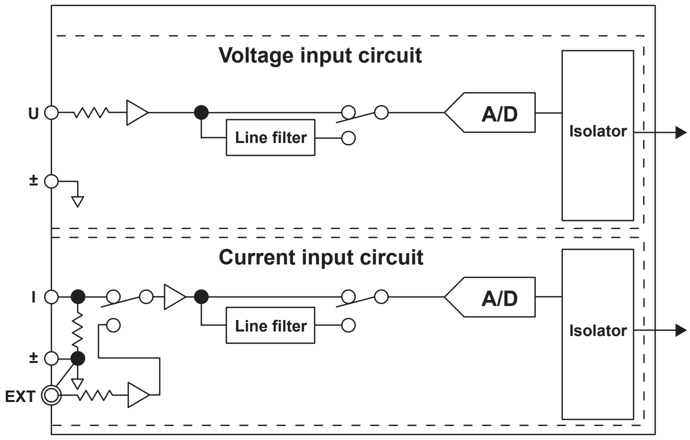
This manual covers firmware versions 1.01 or later of the WT5000.
You can check the firmware version on the overview screen that appears by pressing Setup > Utility Setting > System Overview.

Appendix 11 Block Diagram

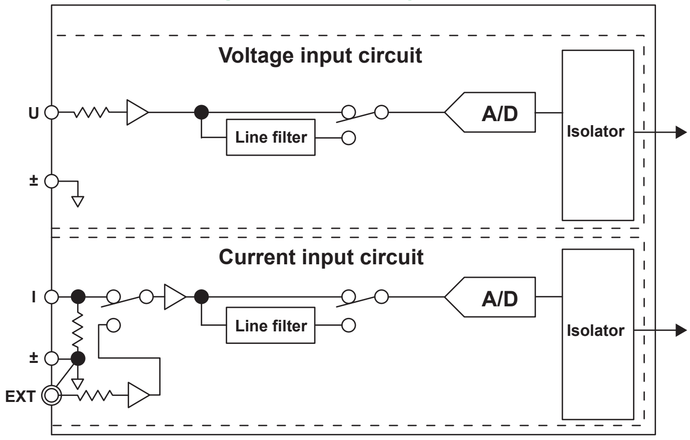
WT5000



760901 30A High Accuracy Element



760902 5A High Accuracy Element



Input Signal Flow and Process

Input elements 1 through 7 consist of a voltage input circuit and a current input circuit. The input circuits are mutually isolated. They are also isolated from the case.

The voltage signal that is applied to the voltage input terminal (U, ±) is normalized using the voltage divider and the operational amplifier (op-amp) of the voltage input circuit. It is then sent to a voltage A/D converter.

The current input circuit is equipped with two types of input terminals, a current input terminal (I, ±) and an external current sensor input terminal (EXT). Only one can be used at any given time. The voltage signal from the current sensor that is received at the external current sensor input terminal is normalized using the voltage divider and the operational amplifier (op-amp). It is then sent to a current A/D converter.

The current signal that is applied to the current input terminal is converted to a voltage signal by a shunt. Then, it is sent to the current A/D converter in the same fashion as the voltage signal from the current sensor.

The voltage signal that is applied to the voltage A/D converter and current A/D converter is converted to digital values at an interval of approximately 100 ns. These digital values are isolated by the isolator and passed to the FPGA. In the FPGA, the measured values are derived based on the digital values. The measured values are then transmitted to the CPU. Various computed values are determined from the measured values. The measured values and computed values are displayed and transmitted (as D/A and communication output) as measurement functions of normal measurement and harmonic measurement.