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**User's  
Manual**

**WT1801E, WT1802E, WT1803E,  
WT1804E, WT1805E, WT1806E  
Precision Power Analyzer  
Getting Started Guide**

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# 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/>**

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Thank you for purchasing the WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, or WT1806E Precision Power Analyzer. This instrument is an instrument 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 beginning operation. Keep this manual in a safe place for quick reference in the event that a question arises.

## List of Manuals

The following manuals, including this one, are provided as manuals for this instrument.

Please read all manuals.

Manual Title	Manual No.	Description
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer Features Guide	IM WT1801E-01EN	The supplied CD contains the PDF file of this manual. This manual explains all the features of this instrument other than the communication interface features.
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer User's Manual	IM WT1801E-02EN	The supplied CD contains the PDF file of this manual. The manual explains how to operate this instrument.
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer Getting Started Guide	IM WT1801E-03EN	This manual. This guide explains the handling precautions and basic operations of this instrument.
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer Communication Interface User's Manual	IM WT1801E-17EN	The supplied CD contains the PDF file of this manual. This manual explains the communication interface features of this instrument and how to use them.
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer	IM WT1801E-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 functionality. The figures given in this manual may differ from those that actually appear on your screen.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your nearest YOKOGAWA dealer.
- Copying or reproducing all or any part of the contents of this manual without the permission of YOKOGAWA is strictly prohibited.
- The TCP/IP software of this product and the documents concerning it have been developed/created by YOKOGAWA based on the BSD Networking Software, Release 1 that has been licensed from the Regents of the University of California.

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## Revisions

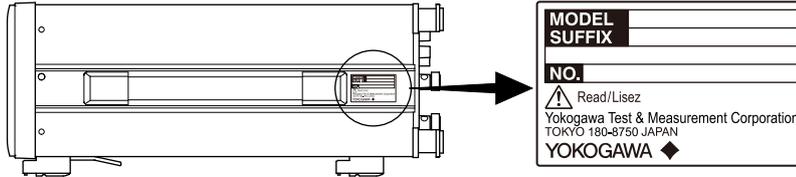
- 1st Edition: September 2016
- 2nd Edition: June 2017
- 3rd Edition: October 2017
- 4th Edition: June 2018
- 5th Edition: September 2019

# Checking the Package Contents

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

## WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E

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/Item	Suffix Code	Description
WT1801E		1-Input Element Model
WT1802E		2-Input Elements Model
WT1803E		3-Input Elements Model
WT1804E		4-Input Elements Model
WT1805E		5-Input Elements Model
WT1806E		6-Input Elements Model
Element configuration	-5A0	None 5A Input Element
	-5A1	5Ax1 Input Element
	-5A2	5Ax2 Input Elements
	-5A3	5Ax3 Input Elements
	-5A4	5Ax4 Input Elements
	-5A5	5Ax5 Input Elements
	-5A6	5Ax6 Input Elements
	-50A0	None 50A Input Element
	-50A1	50Ax1 Input Element
	-50A2	50Ax2 Input Elements
	-50A3	50Ax3 Input Elements
	-50A4	50Ax4 Input Elements
	-50A5	50Ax5 Input Elements
-50A6	50Ax6 Input Elements	
Language	-HE	English/Japanese menu
	-HC	Chinese/English menu
	-HG	German/English menu
	-HR	Russian/English menu
Power cord <sup>1</sup>	-D	UL/CSA standard power cord (part no.: A1006WD) [Maximum rated voltage: 125 V]
	-F	VDE standard power cord (part no.: A1009WD) [Maximum rated voltage: 250 V]
	-H	GB standard power cord (part no.: A1064WD) [Maximum rated voltage: 250 V]
	-N	NBR standard power cord (Part No.: A1088WD) [Maximum rated voltage: 250 V]
	-Q	BS standard power cord (part no.: A1054WD) [Maximum rated voltage: 250 V]
	-R	AS standard power cord (part no.: A1024WD) [Maximum rated voltage: 250 V]
	-T	Taiwanese standard power cord (part No.: A1100WD) [Maximum rated voltage: 125 V]
	-B	Indian standard power cord (part no.: A1101WD) [Maximum rated voltage: 250 V]
	-U	IEC Plug Type B power cord (part no.: A1102WD) [Maximum rated voltage: 250 V]
	-Y	No power cord included <sup>7</sup>

## Checking the Package Contents

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Model/Item	Suffix Code	Description
Options	/EX1	External current sensor input for the WT1801E
	/EX2	External current sensor input for the WT1802E
	/EX3	External current sensor input for the WT1803E
	/EX4	External current sensor input for the WT1804E
	/EX5	External current sensor input for the WT1805E
	/EX6	External current sensor input for the WT1806E
	/B5	Built-in printer <sup>2</sup>
	/G5	Harmonic measurement <sup>3</sup>
	/G6	Simultaneous dual harmonic measurement <sup>3</sup>
	/V1	RGB output
	/DA	20-channel D/A output <sup>4</sup>
	/MTR	Motor evaluation function <sup>5</sup>
	/AUX	2-channel auxiliary input <sup>5</sup>
	/PD <sup>6</sup>	Current sensor power
/PD2	Current sensor power	
/US	US package	

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- 1 Make sure that the attached power cord meets the designated standards of the country and area that you are using it in.
- 2 Includes two rolls of paper (B9316FX)
- 3 The /G5 and /G6 options cannot be installed on the same instrument.
- 4 One 36-pin connector (A1005JD) is installed in the instrument.
- 5 The /MTR and /AUX options cannot be installed on the same instrument.
- 6 End of sale : June 2017
- 7 Prepare a power cord that complies with the standard specified by the country or region that the instrument will be used in.

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

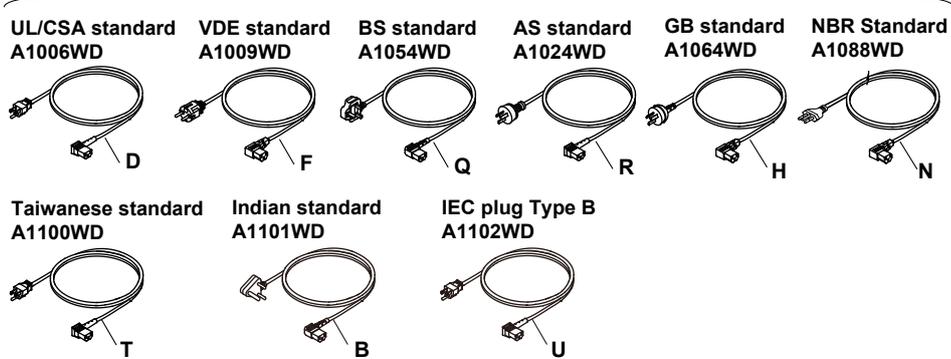
### **No. (Instrument number)**

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

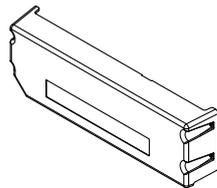
## Accessories

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

**Power cord (one of the following power cords is supplied according to the instrument's suffix codes)<sup>4</sup>**



**Current input protection cover B8211BX**



**Rubber stoppers A9088ZM**



**Safety terminal adapter set<sup>1</sup> 758931**



**Printer roll paper<sup>2</sup> B9316FX**



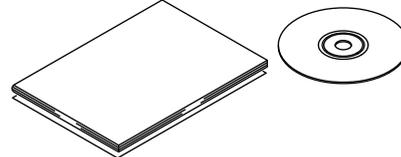
**36-pin connector<sup>3</sup> A1005JD**



**Manuals<sup>5</sup>**

• Printed manuals

• Manual CD



Standard accessories are not covered by warranty.

- 1 Same number of sets as the number of installed input elements  
 WT1801E: One set with one hexagonal socket wrench  
 WT1802E: Two sets with one hexagonal socket wrench  
 WT1803E: Three sets with one hexagonal socket wrench  
 WT1804E: Four sets with one hexagonal socket wrench  
 WT1805E: Five sets with one hexagonal socket wrench  
 WT1806E: Six sets with one hexagonal socket wrench  
 For instructions on how to assemble the 758931, see section 2.6.
- 2 Included with models that have a built-in printer (/B5)
- 3 Included with models that have 20-channel D/A output and remote control (/DA)
- 4 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.
- 5 Manuals

Name	Model/Part No.	Quantity	Note
Printed manuals	IM WT1801E-03EN	1	Getting Started Guide (this guide)
	IM WT1801E-92Z1	1	Document for China
	PIM 113-01Z2	1	List of worldwide contacts
Manual CD	B8211ZX	1	For details, see the next page.

## How to Use the CD (User's Manuals)

The CD contains PDF files of the following manuals. The CD also contains Japanese manuals.

- WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer  
Features Guide  
IM WT1801E-01EN
- WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer  
User's Manual  
IM WT1801E-02EN
- WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer  
Communication Interface User's Manual  
IM WT1801E-17EN

To view the PDF data, you need Adobe Acrobat Reader or a software application that can open PDF data.

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### WARNING

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.

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French

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### AVERTISSEMENT

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.

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## Optional Accessories (Sold separately)

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

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

Name	Model/ Part No.	Min. Q'ty	Notes
Measurement lead	758917	1	Two leads in one set. Used with the 758922 or 758929 adapter (sold separately). Cable length: 0.75 m. Rated voltage: 1000 V.*1
Safety terminal adapter set	758923	1	Two pieces in one set. Rated voltage 600 V.*1
	758931	1	Two pieces in one set. Rated voltage 1000 V.*1
Alligator clip adapter set	758922	1	Two pieces in one set. For use with measurement lead 758917. Rated voltage: 300 V.*1
	758929	1	Two pieces in one set. For use with measurement lead 758917. Rated voltage: 1000 V.*1
Fork terminal adapter set	758921	1	Two pieces in one set. For use with measurement lead 758917. Rated voltage: 1000 V.*1 Rated current: 25 A.
BNC cable	366924	1	42 V or less. Total length: 1 m.
	366925	1	42 V or less. Total length: 2 m.
Safety BNC cable	701902	1	Rated voltage: 1000 V.*1 Cable length: 1 m
	701903	1	Rated voltage: 1000 V.*1 Cable length: 2 m
External sensor cable	B9284LK	1	For connecting to the external current sensor input terminal of this instrument. Cable length: 0.5 m.
Conversion adapter	758924	1	BNC-4 mm socket adapter. Rated voltage: 500 V.*1
Shunt resistor box (5 Ω)	A1323EZ	1	Current rating: 580 mA Usage is limited to 5 minutes for 580 mA to 667 mA input.
Shunt resistor box (10 Ω)	A1324EZ	1	Current rating: 300 mA
Shunt resistor box (20 Ω)	A1325EZ	1	Current rating: 200 mA
Current sensor cable*2	A1559WL	1	Cable length: 3 m
Current sensor cable*2	A1560WL	1	Cable length: 5 m
Direct current input cable*3	A1589WL	1	Cable length: 3 m, Current rating: 667 mA
Direct current input cable*3	A1628WL	1	Cable length: 5 m

Accessories (sold separately) are not covered by warranty.

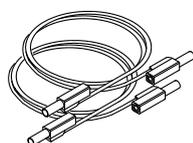
These optional accessories are sold individually.

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

\*2 Used with the shunt resistor box (A1323EZ, A1324EZ, or A1325EZ).

\*3 Used with the fork terminal adapter set (758921).

**Measurement leads  
758917**



**Safety terminal  
adapter set  
758923**



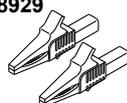
**Safety terminal  
adapter set  
758931**



**Alligator clip  
adapter set  
758922**



**Alligator clip  
adapter set  
758929**



**Fork terminal  
adapter set  
758921**



**BNC cable  
(1 m) 366924**



**BNC cable  
(2 m) 366925**



**Safety BNC cable  
(1 m) 701902**



**Safety BNC cable  
(2 m) 701903**



**Conversion  
adapter  
758924**



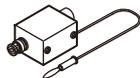
**External sensor cable  
B9284LK**



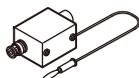
## Checking the Package Contents

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**Shunt resistor box  
(5  $\Omega$ )  
A1323EZ**



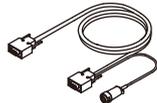
**Shunt resistor box  
(10  $\Omega$ )  
A1324EZ**



**Shunt resistor box  
(20  $\Omega$ )  
A1325EZ**



**Current sensor cable  
(3 m)  
A1559WL**



**Current sensor cable  
(5 m)  
A1560WL**



**Direct current input cable  
(3 m)  
A1589WL**



**Direct current input cable  
(5 m)  
A1628WL**



## Consumables (Sold separately)

The following consumables are available for purchase separately.

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

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<b>Name</b>	<b>Part No.</b>	<b>Min. Q'ty</b>	<b>Notes</b>
Printer roll paper	B9316FX	10	Heat-sensitive paper. One roll is one unit. Length: 10 m.

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# 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.



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, dangerr



Protective earth ground or protective earth ground terminal



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



Alternating current



Direct current



Both direct and alternating current



On (power)



Off (power)



On (power) state



Off (power) state

## French



À manipuler délicatement. Toujours se reporter aux manuels d'utilisation et d'entretien. Ce symbole a été apposé aux endroits dangereux de l'instrument pour lesquels des consignes spéciales d'utilisation ou de manipulation ont été émises. Le même symbole apparaît à l'endroit correspondant du manuel pour identifier les consignes qui s'y rapportent.



Choc électrique, danger



Protection à la terre ou borne de protection à la terre



Borne de terre ou borne de terre fonctionnelle (ne pas utiliser cette borne comme prise de terre)



Courant alternatif



Courant direct

## Safety Precautions

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 Courant direct et alternatif

 Marche (alimentation)

 Arrêt (alimentation)

 Marche

 Arrêt

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

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**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, be sure to 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 gasses or vapors. Doing so is extremely dangerous.

**Fuse**

To have the instrument's fuse replaced, contact your nearest YOKOGAWA dealer.

**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.
- The cables are connected firmly to the current input terminals.
- There are no problems with the current input terminals and the crimping terminals, such as the presence of foreign substances.

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

- There are no problems with the input terminals and the crimping terminals, such as the presence of foreign substances.
- The input terminals are not abnormally hot.
- The cables are connected firmly to the input terminals.

The terminal connections may become loose over time. If this happens, heat may be generated due to changes in contact resistance. If you are going to take measurements using the same setup for a long time, periodically check that the cables are firmly connected to the terminals. (Be sure to turn both the power meter and the item under measurement off before you check the connections.)

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

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

**Accessories**

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

Do not use faulty accessories.

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**CAUTION**

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**Operating Environment Limitations**

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

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### 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, celle-ci 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.

#### **Fusible**

Pour remplacer le fusible de l'instrument, contactez le concessionnaire YOKOGAWA le plus proche.

#### **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 pouvoir 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.
- Les câbles sont correctement raccordés aux bornes d'entrée de courant.
- Il n'y a aucun problème avec les bornes d'entrée de courant et les bornes de sertissage, comme par exemple une présence de corps étrangers.

Pendant la mesure (ne jamais toucher les bornes et les câbles branchés lorsque l'appareil à mesurer est sous tension), vérifier que :

- Il n'y a aucun problème avec les bornes d'entrée et les bornes de sertissage, comme par exemple une présence de corps étrangers.
- Les bornes d'entrée ne chauffent pas anormalement.
- Les câbles sont correctement connectés aux bornes d'entrée.  
Les connexions des bornes peuvent se desserrer au fil du temps. Le cas échéant, une génération de chaleur peut se produire en raison de modifications au niveau de la résistance de contact. Si des mesures doivent être réalisées en utilisant la même configuration pendant une durée prolongée, vérifier périodiquement que les câbles sont correctement connectés aux bornes. (Veiller à mettre hors tension le mesureur de puissance et le dispositif mesuré est réalisée avant de vérifier les raccordements.)

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.

## Safety Precautions

---

### **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.

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## **ATTENTION**

### **Limitations relatives à l'environnement opérationnel**

Ce produit est classé dans classe A (pour utilisation dans des 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 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  
<https://tmi.yokogawa.com/support/service-warranty-quality/product-compliance/>

## Disposal

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

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# Symbols and Notation Used in This Manual

## Prefixes k and K

Prefixes k and K used before units are distinguished as follows:

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

## Displayed Characters

Bold characters in procedural explanations are used to indicate panel keys and soft keys that are used in the procedure and menu items that appear on the screen.

## Notes and Cautions

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 cause damage to the instrument or user's data, and precautions that can be taken to prevent such occurrences.

French

### **AVERTISSEMENT**

Attire l'attention sur des gestes ou des conditions susceptibles de provoquer des blessures graves (voire mortelles), et sur les précautions de sécurité pouvant prévenir de tels accidents.

### **ATTENTION**

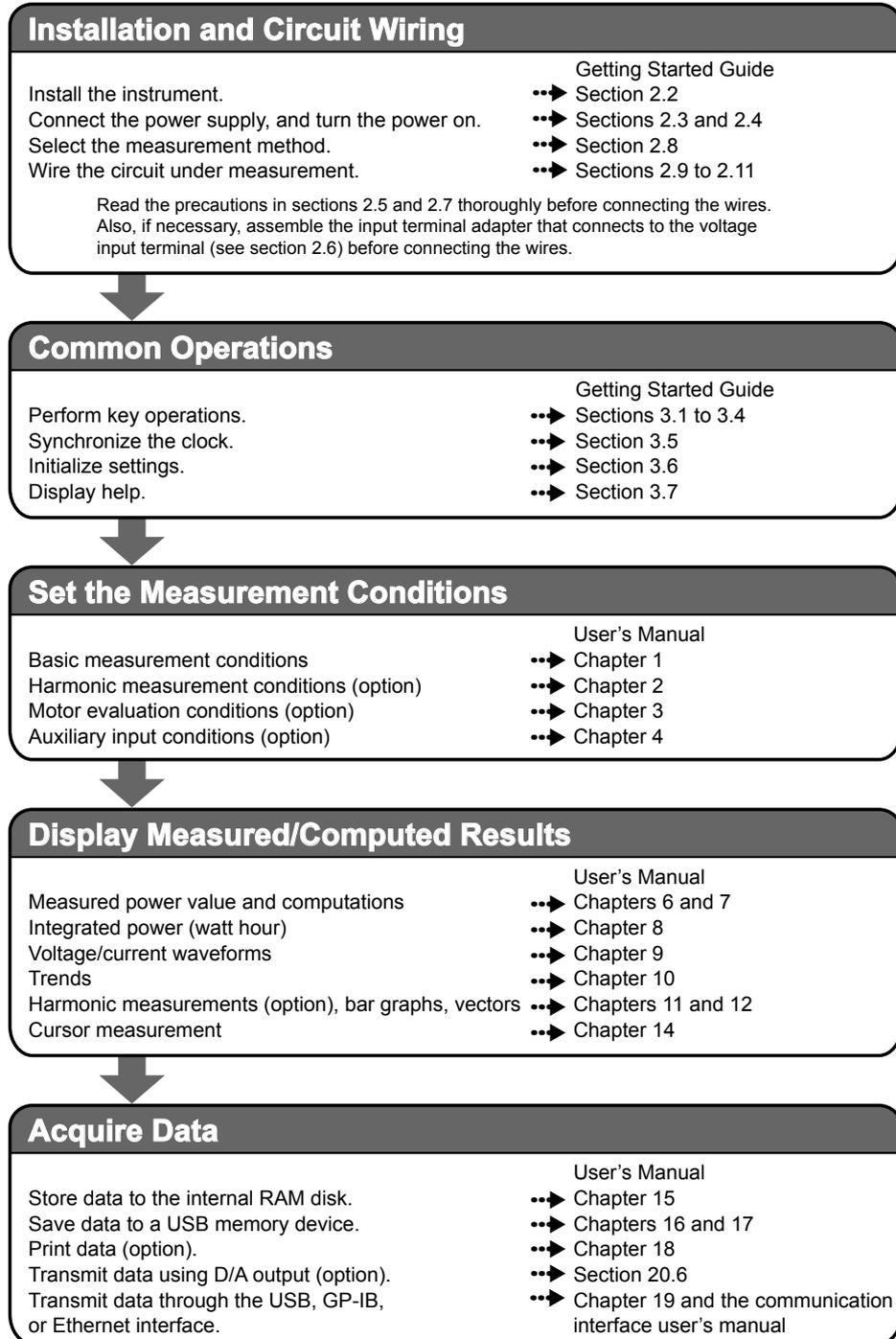
Attire l'attention sur des gestes ou des conditions susceptibles de provoquer des blessures légères ou d'endommager l'instrument ou les données de l'utilisateur, et sur les précautions de sécurité susceptibles de prévenir de tels accidents.

### **Note**

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

# Workflow

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



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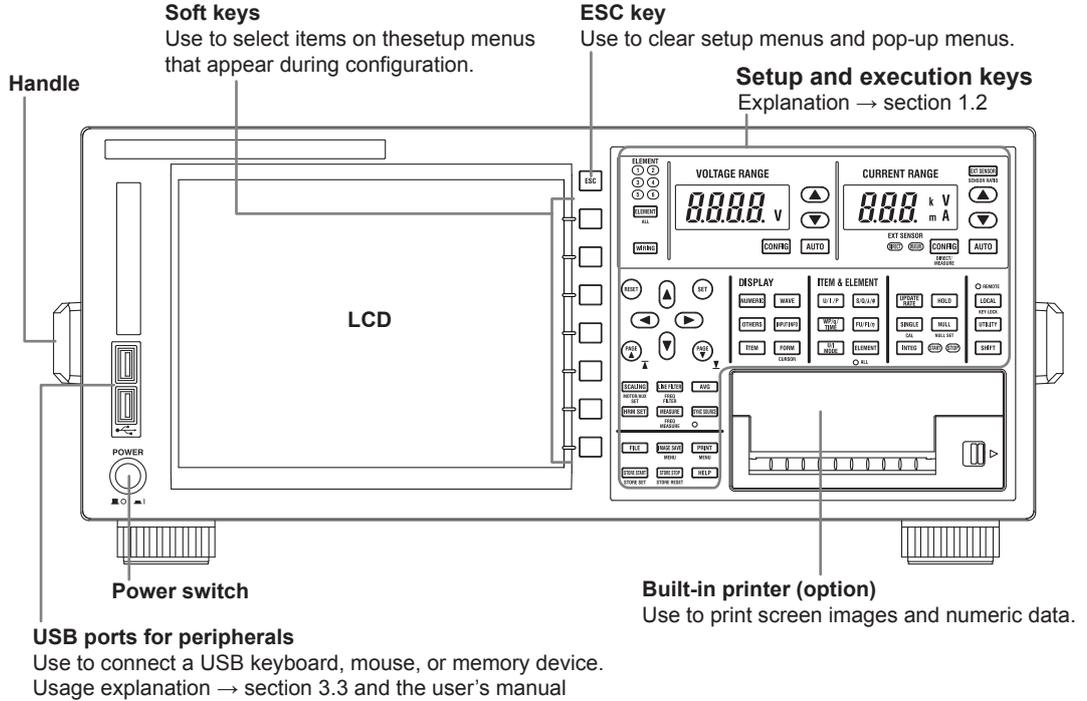
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# 1.1 Front Panel, Rear Panel, and Top Panel

## Front Panel



### Models with the Current Sensor Power (/PD, /PD2) Option

**Sensor status indicator**

Displays the CT connection status and the detection of overcurrent of each channel  
Explanation → Section 2.11

**Fan stop indicator**

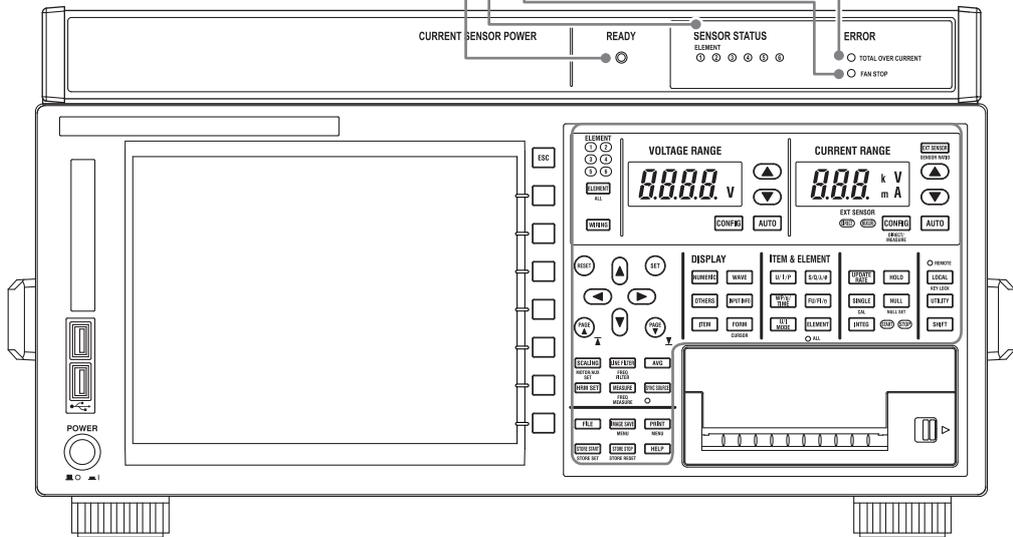
Displays the detection of fan stop  
Explanation → Section 2.11

**Ready indicator**

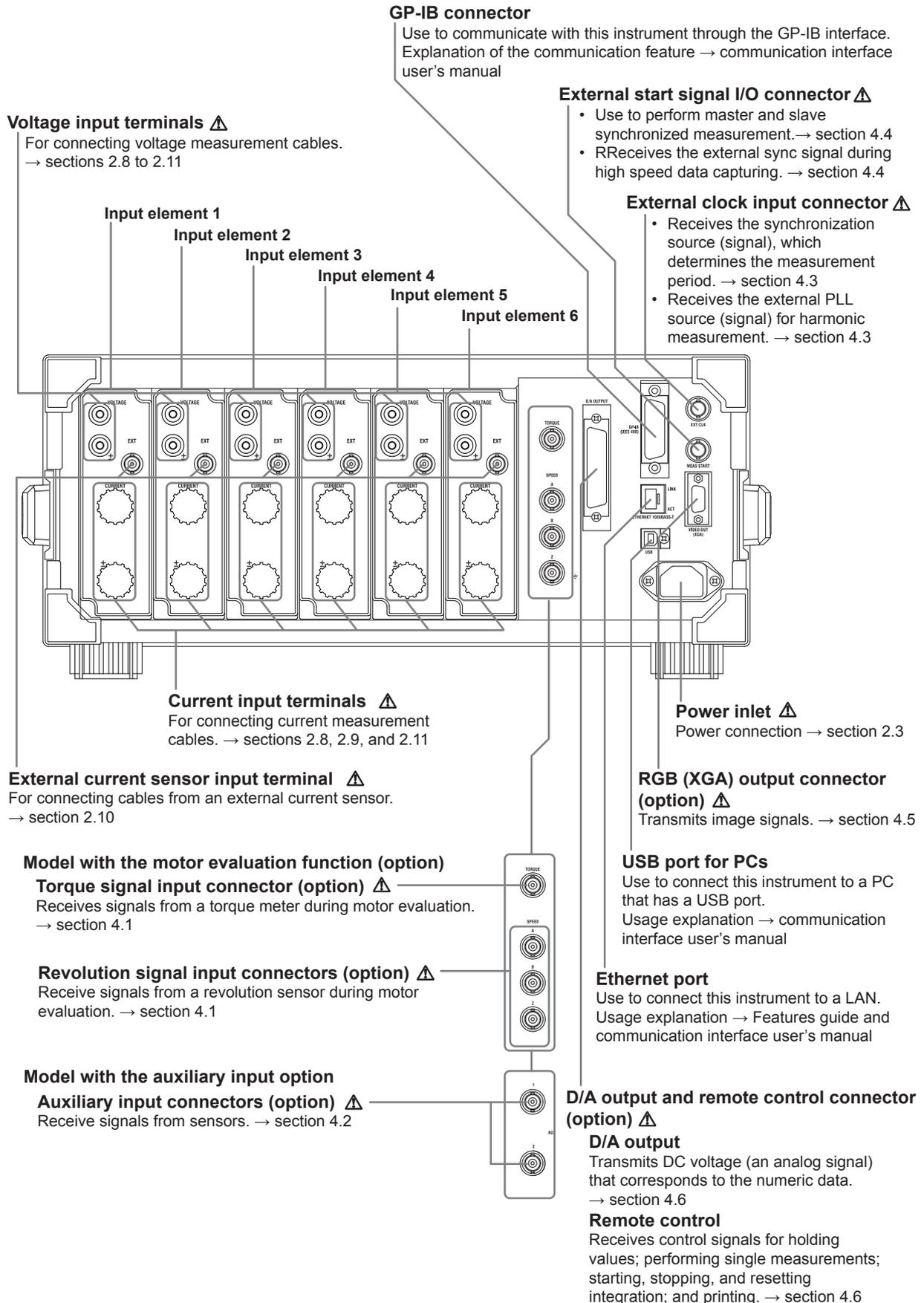
Displays the status of the current sensor power supply.  
Explanation → Section 2.11

**Total overcurrent detection indicator**

Displays the detection of overcurrent in the total current of each channel  
Explanation → Section 2.11



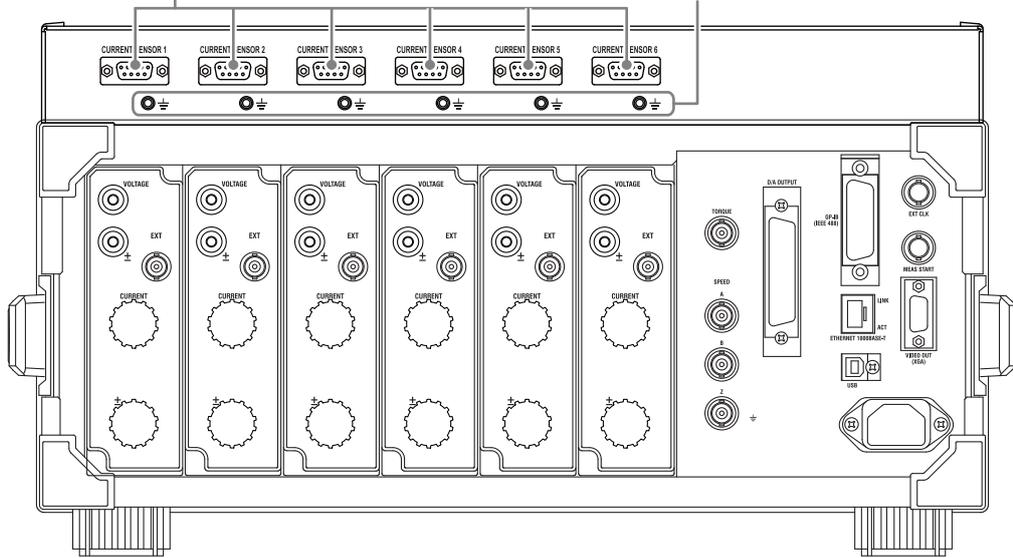
## Rear Panel



**Models with the Current Sensor Power (/PD, /PD2) Option**

**Sensor power supply terminal  $\Delta$**   
 Explanation → Section 2.11

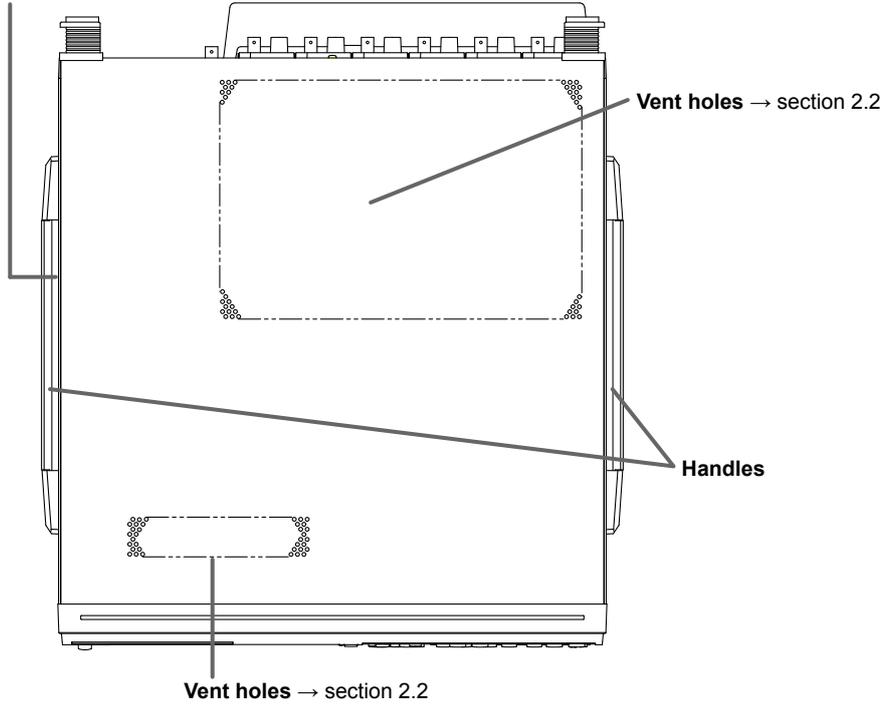
**Shunt resistor box ground terminal**  
 Connect the shunt resistor box ground terminal. → Section 2.11



## Top Panel

**Inlet holes** → section 2.2

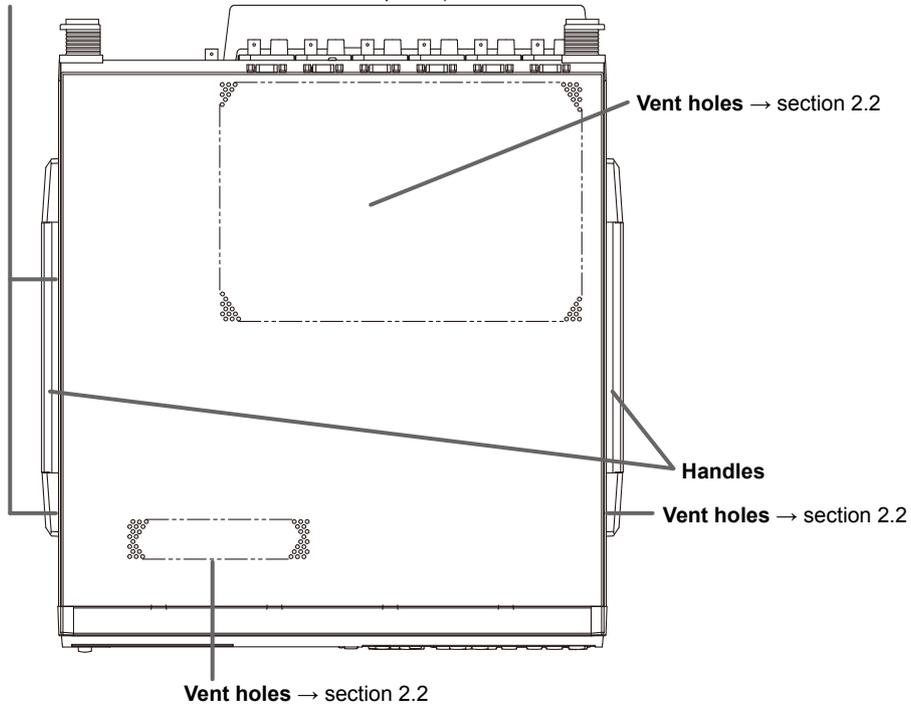
(There are also inlet holes on the bottom panel.)



### Models with the Current Sensor Power (/PD, /PD2) Option

**Inlet holes** → section 2.2

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



## 1.2 Keys

### Measurement Conditions

#### WIRING Key

Press this key to display the menu for selecting the wiring system, setting the efficiency equation, selecting the independent input element configuration, setting the delta computation, and configuring all elements.

#### ELEMENT Key

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

#### SHIFT+ELEMENT (ALL) Key Combination

Press this key combination to collectively set the voltage range, current range, or external current sensor range (option) of all the input elements that satisfy the following conditions.

- The input elements are the same type (5 A or 50 A input elements).
- The valid measurement range settings are the same.

Press ELEMENT again to configure settings for individual elements.

#### ▲ and ▼ Keys

Use these keys to select the voltage range, current range, or external current sensor range (option). 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 illuminates. 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.

#### EXT SENSOR Key

Press EXT SENSOR to illuminate the EXT SENSOR key. While this instrument is in this state, press the current range's ▲ and ▼ keys to select the external current sensor range that is used when this instrument measures the output from the current sensor. Press EXT SENSOR again to turn off the EXT SENSOR key and enable the selecting of the current range for direct input.

#### SHIFT+EXT SENSOR (SENSOR RATIO) Key Combination

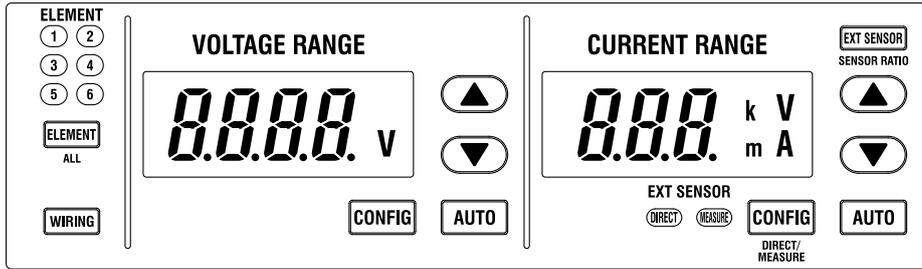
Press this key combination to display a menu for setting the external current sensor conversion ratio for each input element. These conversion ratios are used to convert current sensor output to current.

#### CONFIG Key

Press this key to display a menu for setting the valid measurement ranges for the voltage range, current range, or external current sensor range (option). You can also set the measurement range to switch to when a peak over-range occurs.

#### SHIFT+CONFIG (DIRECT/MEASURE) Key Combination

Press this key combination to display a menu for setting the display format of the external current sensor range.



### SCALING Key

Press this key to display the menu for turning the scaling feature on and off, setting the VT ratio, setting the CT ratio, setting the power coefficient, and configuring all elements.

### LINE FILTER Key

Press this key to display a menu for setting the filters to apply to the circuit under measurement for each input element.

### SHIFT+LINE FILTER (FREQ FILTER) Key Combination

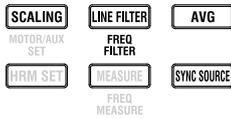
Press this key combination to display a menu for setting the filters to apply to the circuit under frequency measurement for each input element.

### AVG Key

Press this key to display a menu for configuring the measured value averaging feature.

### SYNC SOURCE Key

Press this key to display a menu for setting the synchronization source for each wiring unit. The synchronization source defines the period (measurement period) over which sampled data, which is used to produce numeric data (measured values such as voltage, current, and power), is acquired.



## UPDATE RATE Key

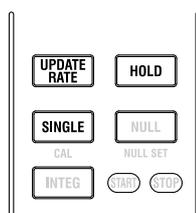
Press this key to display a menu for selecting the period (data update interval) at which sampled data, which is used to produce numeric data (measured values such as voltage, current, and power), is acquired.

## HOLD Key

Press HOLD to illuminate the HOLD key, stop data measurement and display operations per data update interval, and hold the numeric data display. Press HOLD again to turn the HOLD key off and enable the updating of the numeric data display.

## SINGLE Key

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



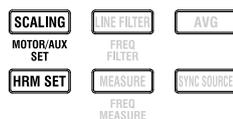
## Harmonic Measurement (Option), Motor Evaluation (Option), and Auxiliary Input (Option)

### HRM SET Key

- Press this key on models with the harmonic measurement option to display a menu for setting the PLL source, the measured harmonic orders, and the distortion factor equation.
- Press this key on models with the simultaneous dual harmonic measurement option to display a menu for configuring the input element groups and setting the PLL source, the measured harmonic orders, and the distortion factor equation for each group.

### SHIFT+SCALING (MOTOR/AUX SET) Key Combination

- Press this key combination on models with the motor evaluation function (option) to display a menu for configuring the motor evaluation function.
- Press this key combination on models with the auxiliary input option to display a menu for configuring the auxiliary input feature.



## Displaying the Measured Results

### NUMERIC Key

Press this key to display numeric data.

- When you are displaying numeric data, you can press ITEM, which is described later in this section, to display a menu for changing the displayed items.
- When you are displaying numeric data, you can press FORM, which is described later in this section, to display a menu for changing the display format.

### WAVE Key

Press this key to display waveforms.

- When you are displaying waveforms, you can press ITEM, which is described later in this section, to display a menu for selecting and zooming in on the displayed waveforms.
- When you are displaying waveforms, you can press FORM, which is described later in this section, to display a menu for configuring settings such as the time axis of the displayed waveforms, the triggers for displaying waveforms on the screen, the number of divisions of the waveform screen, and the mapping of waveforms to parts of the divided screen.

### OTHERS Key

Press this key to display a menu for selecting the trend, bar graph,<sup>1</sup> vector,<sup>1</sup> split displays and high speed data capturing.

- 1 On models with the harmonic measurement option or simultaneous dual harmonic measurement option

### INPUT INFO Key

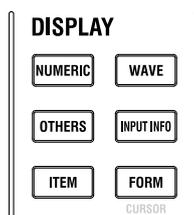
Press this key to display the list of conditions for measuring voltage or current signals, such as the wiring system, wiring unit, measurement range, input filter, scaling, and synchronization source, for each input element. A list of the measurement range and valid measurement range settings are also displayed.

### ITEM Key

Press this key to display a menu for setting the displayed items in the display that has been selected using NUMERIC, WAVE, or OTHERS.

### FORM Key

Press this key to display a menu for selecting the display format for the display that has been selected using NUMERIC, WAVE, or OTHERS.



## U/I/P Key, S/Q/ $\Lambda$ / $\Phi$ Key, WP/q/TIME Key, and FU/FI/ $\eta$ Key

Each time you press U/I/P, the measurement function of the selected display item switches between measurement functions in the following order: U, I, P, the measurement function that was selected before you pressed U/I/P, and then back to U. The numeric data for the selected measurement function is displayed.

- The above behavior takes place when numeric data is being displayed but a menu is not being displayed.
- Only the measurement function changes.
- When you press S/Q/ $\Lambda$ / $\Phi$ , WP/q/TIME, or FU/FI/ $\eta$ , the measurement function changes in the same manner as was explained above for the U/I/P key.

## U/I MODE Key

Each time you press U/I MODE, the measurement function U or I of the selected display item switches between modes in the following order: rms, mean, dc, rmean, ac, and then back to rms. The numeric data for the selected measurement function is displayed. The above behavior takes place when numeric data is being displayed but a menu is not being displayed.

## ELEMENT Key

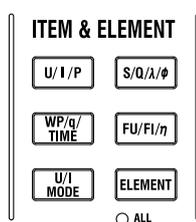
On the instrument that has six input elements installed, each time you press ELEMENT, the input element or wiring unit of the selected display item switches between input elements and wiring units in the following order: 1, 2, 3, 4, 5, 6,  $\Sigma A$ ,  $\Sigma B$ ,  $\Sigma C$ , and then back to 1. The numeric data for the selected input element or wiring unit is displayed.

- The above behavior takes place when numeric data is being displayed but a menu is not being displayed.
- Only the input element or wiring unit changes.
- The displayed input elements and wiring units vary depending on the number of input elements that are installed in this instrument and the selected wiring system.

## SHIFT+ELEMENT (ALL) Key Combination

On the instrument that has six input elements installed, pressing SHIFT+ELEMENT (ALL) illuminates the ALL indicator. With this instrument in this state, each time you press ELEMENT, the input elements or wiring units of the displayed page switch between input elements and wiring units in the following order: 1, 2, 3, 4, 5, 6,  $\Sigma A$ ,  $\Sigma B$ ,  $\Sigma C$ , and then back to 1. The numeric data for the selected input element or wiring unit is displayed. Press SHIFT+ELEMENT (ALL) again to turn the ALL indicator off and disable the feature for changing all the input elements or wiring units on the page.

- The above behavior takes place when numeric data is being displayed but a menu is not being displayed.
- Only the input elements or wiring units change.
- The displayed input elements and wiring units vary depending on the number of input elements that are installed in this instrument and the selected wiring system.



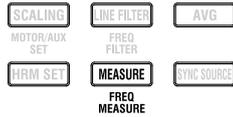
## Computation

### MEASURE Key

Press this key to display a menu for configuring settings for user-defined functions, MAX hold, user-defined events, apparent and reactive power equations, corrected power equations, for selecting the phase difference display format and the sampling frequency, and for configuring settings for master and slave synchronized measurement.

### SHIFT+MEASURE (FREQ MEASURE) Key Combination

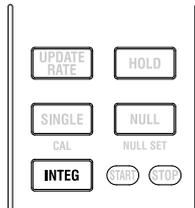
This instrument can measure the frequencies of the voltages or currents of all elements, so the setup menu is not displayed even if you press SHIFT+MEASURE (FREQ MEASURE).



## Integrated Power (Watt hour)

### INTEG Key

Press this key to display a menu for turning independent integration on and off; starting, stopping, and resetting integration; and setting the integration mode, the integration timer, the scheduled integration, the integration auto calibration, the watt-hour integration methods for each polarity, the current mode for current integration, and the rated time of integrated D/A output (option).

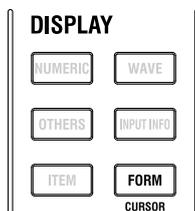


## Cursor Measurement

### SHIFT+FORM (CURSOR) Key Combination

Press this key combination when you are displaying waveforms, trends, or bar graphs\* to display a menu for measuring values such as waveform and graph values using cursors.

\* On models with the harmonic measurement option or simultaneous dual harmonic measurement option



## Storing Data, Saving and Loading Data, Printing on the Built-In Printer (Option)

### STORE START Key

Press this key to start the storage operation.

### STORE STOP Key

Press this key to stop the storage operation.

### SHIFT+STORE STOP (STORE RESET) Key Combination

Press this key combination to reset the storage operation.

### SHIFT+STORE START (STORE SET) Key Operation

Press this key combination to display a menu for setting storage control, stored items, and save conditions.

### FILE Key

Press this key to display a menu for performing operations such as saving and loading setup parameters, saving measured data, deleting and copying folders (directories) and files, renaming folders and files, and making folders.

### IMAGE SAVE Key

Press this key to save the screen image data.

### SHIFT+IMAGE SAVE (MENU) Key Combination

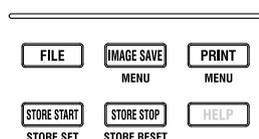
Press this key combination to display a menu for setting screen image data save options such as the file name, data format, color mode, and comments.

### PRINT Key

Press this key to print the screen image or the list of numeric data.

### SHIFT+PRINT MENU Key Combination

Press this key combination to display a menu for performing print-related tasks such as setting the print format, the comment, and auto-printing, and feeding paper.



## Other Functions

### SHIFT+SINGLE (CAL) Key Combination

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

### NULL Key

Press NULL to enable the NULL feature. The NULL indicator illuminates. Press NULL again to disable the NULL feature. The NULL indicator turns off.

### SHIFT+NULL (NULL SET) Key Combination

Press this key combination to display a menu for setting the NULL feature.

### UTILITY Key

Press this key to display a menu for displaying system information (input element information, installed options, and firmware version); initializing settings; configuring communication settings, system settings, network settings, D/A output settings; and performing self-tests.

### LOCAL Key

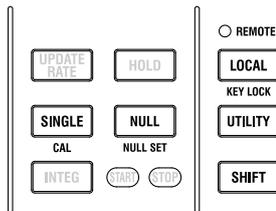
Press this key to switch from remote mode (in which the REMOTE indicator is illuminated) to local mode (in which front panel key operations are valid). This key is disabled when this instrument is in local lockout mode.

### SHIFT+LOCAL (KEY LOCK) Key Combination

Press this key combination to lock the keys on the front panel. The LOCAL (KEY LOCK) key illuminates. Press the key combination again to unlock the keys.

### SHIFT Key

Press this key once to illuminate it and access the features that are written in purple below each key. Press the key again to disable the shifted state.



### RESET Key

Press this key to reset the entered value to its default value.

### SET Key

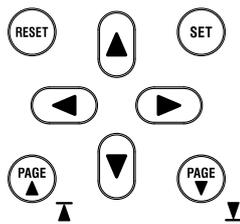
Press this key to display menus that you select using the cursor keys and to confirm items and values in the selected window. When the menu is turned off on the numeric data display, press this key to open a menu for changing displayed items.

### Cursor Keys (▲▼◀▶)

Press the ▶◀ keys to move the cursor between numeric digits. Press the ▲▼ keys to increment or decrement the value of a digit. You can also use the ▲▼ keys to select setup items.

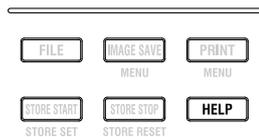
### PAGE▼ and PAGE▲ Keys

When measured items span over multiple pages on the numeric data display, press these keys to switch between pages. Press SHIFT+PAGE▲ to move to the first page and SHIFT+PAGE▼ to move to the last page.



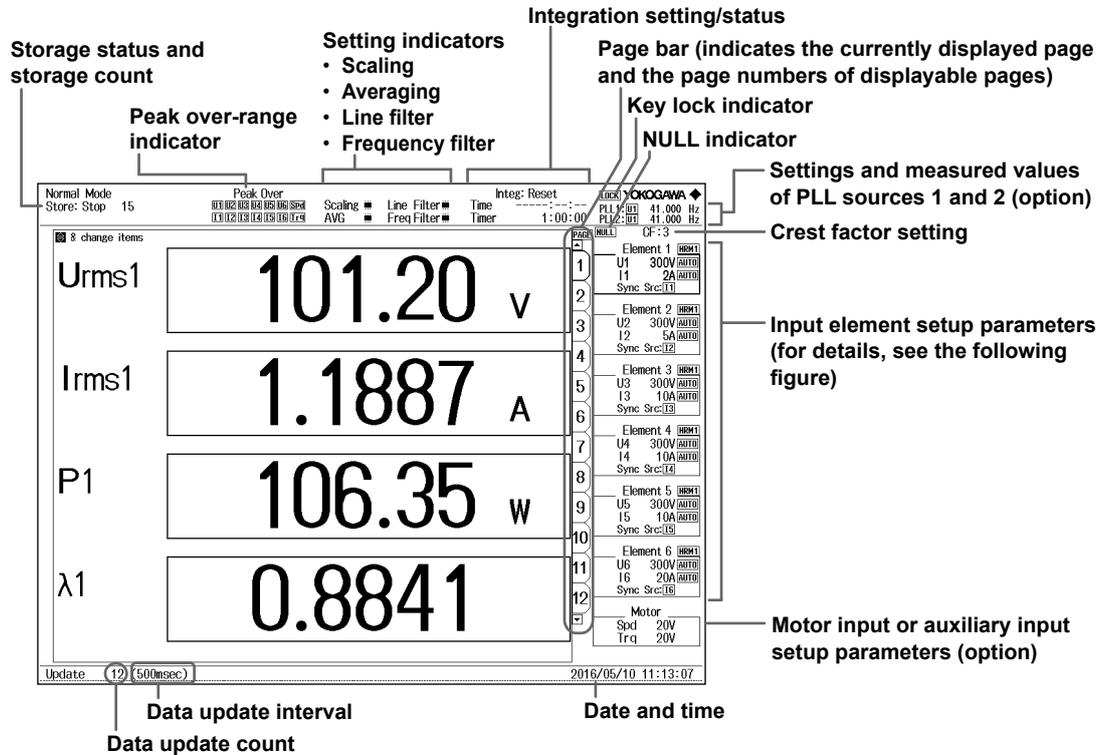
### HELP Key

Press this key to display and hide the help window, which explains various features.

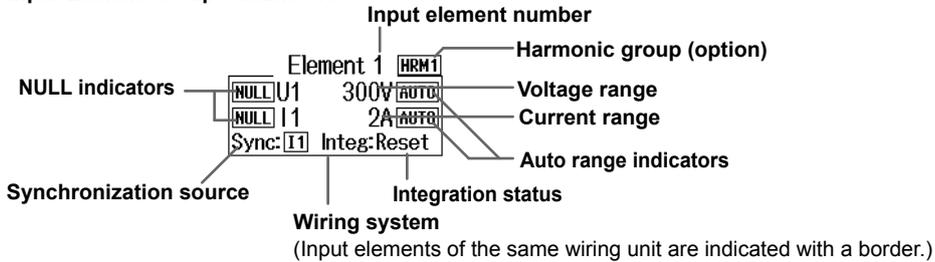


# 1.3 Screen Display

## Display Example When Measuring Power (Numeric display)



### Input Element Setup Parameters



### Non-Numeric Displays

- OL--** **Overload**  
Displayed if the measured value exceeds 140% of the measurement range when the crest factor is set to CF3 or CF6.  
Displayed if the measured value exceeds 280% of the measurement range when the crest factor is set to CF6A.
- OF--** **Overflow**  
Displayed if the measured or computed result cannot be displayed using the specified decimal place or unit.
- **No data**  
Displayed if a measurement function is not selected or if there is no numeric data.

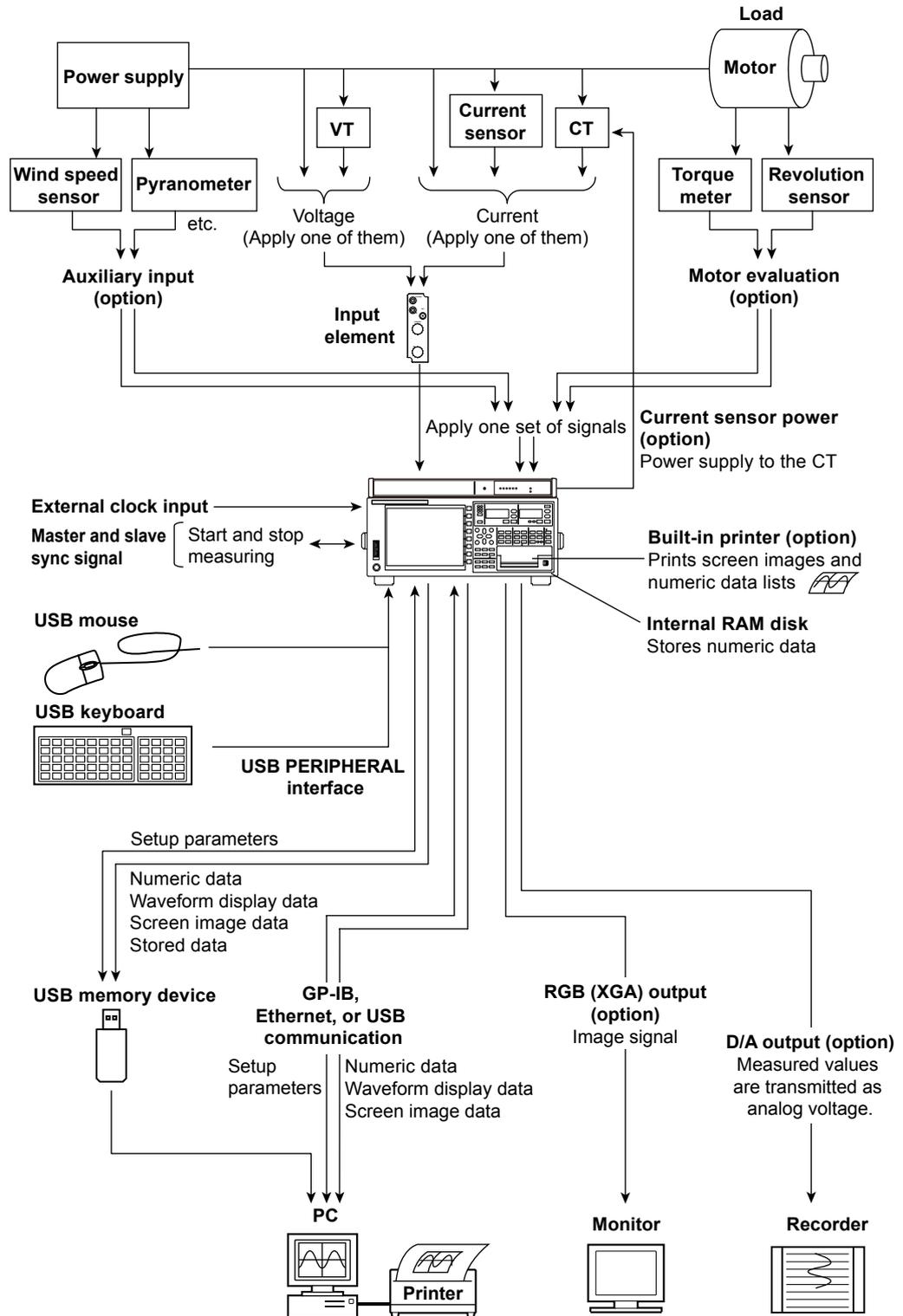
### Error

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

#### Note

The LCD of this instrument may have a few defective pixels. For details, see section 6.2, "Display."

# 1.4 System Configuration



## 2.1 Handling Precautions

### Safety Precautions

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

#### 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 unplugging the power cord from the outlet, never pull by the cord itself. Be sure to hold and pull by 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 cause the instrument to malfunction.

#### 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 it is very easy to damage the LCD, do not allow any sharp objects near it. Also, the LCD should not be exposed to vibration or mechanical shock.

#### During Extended Periods of Non-Use

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

## 2.1 Handling Precautions

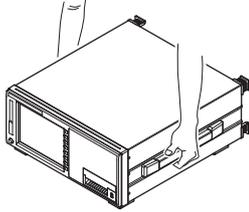
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### When Carrying the Instrument

First, turn off the circuit under measurement and remove the measurement cables. Then, turn off the instrument and remove the power cord and any attached cables.

We recommend that two persons carry this instrument. If one person is to carry this instrument, use both hands to firmly hold the handles as indicated in the following figure.

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



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#### 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

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#### 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.
- 

### When Cleaning the Instrument

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

## 2.2 Installing the Instrument

### 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 pouvoir 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 and Level Location

Install the instrument on a stable surface that is level in all directions. If you install the instrument on an unstable or tilted surface, the quality of recordings made by its printer and 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 and when opening and closing the cover of the built-in printer, allow extra space for operation.

### Ambient Temperature and Humidity

Ambient temperature: 5°C to 40°C

Ambient humidity: 20% RH to 80% RH (when the printer is not being used)

35% RH to 80% RH (when the printer is being used)

In either case, there must be no condensation.

### Do Not Install the Instrument in the Following Kinds of Places

- Outdoors
- In direct sunlight, or near sources of heat
- Where the instrument is exposed to water or other liquids
- In an environment with excessive amounts of soot, steam, dust, or corrosive gases
- Near strong magnetic fields
- Near high voltage equipment or power lines
- In a place that is subject to large levels of mechanical vibration
- On an unstable surface

### Note

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- For the most accurate measurements, use the instrument in the following kind of environment.  
Ambient temperature:  $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$  Ambient humidity: 30% RH to 75% RH (no condensation)  
When using the instrument in a place where the ambient temperature is  $5^{\circ}\text{C}$  to  $18^{\circ}\text{C}$  or  $28^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ , 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 form when the instrument is moved from a low temperature/humidity environment to a high temperature/humidity environment, or when there is a sudden change in temperature. 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:  $-25$  to  $60^{\circ}\text{C}$  (no condensation)
- Ambient humidity: 20 to 80% RH (no condensation)

When storing the instrument, avoid the following places.

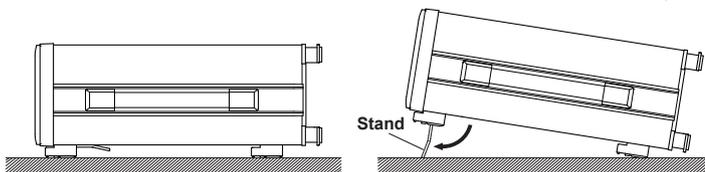
- Where the level of mechanical vibration is high
- In direct sunlight
- Where there are corrosive or explosive gasses
- Where an excessive amount of soot, dust, salt, or iron is present
- Near a strong source of heat or moisture
- Where water, oil, or chemicals may splash onto the instrument

We recommend that the instrument be stored in an environment where the temperature is between  $5^{\circ}\text{C}$  and  $40^{\circ}\text{C}$ .

### Installation Position

#### 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.

## 2.2 Installing the Instrument

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### Rack Mounting

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

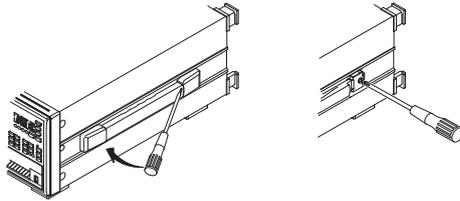
Name	Model	Notes
Rack mount kit	751535-E4	For EIA
Rack mount kit	751535-J4	For JIS

On models with the /PD, or /PD2 option, use the following rack mount kit.

Name	Model	Notes
Rack mount kit	751535-E5	For EIA
Rack mount kit	751535-J5	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

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

## 2.3 Connecting the Power Supply

### Before Connecting the Power Supply

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



#### WARNING

- Make sure that the power supply voltage matches the instrument's rated supply voltage and that it does not exceed the maximum voltage range 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

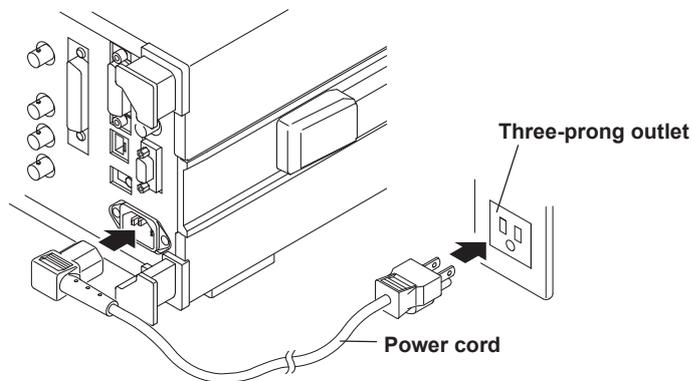
- Assurez-vous que la tension d'alimentation correspond à la tension d'alimentation nominale de l'appareil et qu'elle ne dépasse pas la plage de tension maximale du cordon d'alimentation à utiliser.
- Brancher le cordon d'alimentation après avoir vérifié que l'interrupteur de l'instrument est sur OFF.
- 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. Confirm 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 conditions below. Use a three-prong power outlet with a protective earth terminal.

Item	Specifications
Rated supply voltage	100 VAC to 240 VAC
Permitted supply voltage range	90 VAC to 264 VAC
Rated supply frequency	50/60 Hz
Permitted supply frequency range	48 Hz to 63 Hz
Maximum power consumption	150 VA (when the printer is being used) 450 VA (with the /PD, or /PD2 option and when the built-in printer is being used).

\* The instrument can use a 100 V or a 200 V power supply. The maximum voltage rating 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.



## 2.4 Turning the Power Switch On and Off

### Before Turning On the Power, Check That:

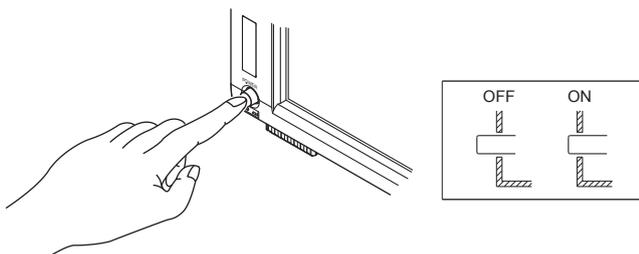
- The instrument is installed properly. → section 2.2, “Installing the Instrument”
- The power cord is connected properly. → section 2.3, “Connecting the Power Supply”

### Power Switch Location

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

### Turning the Power Switch On and Off

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



### Operations Performed When the Power Is Turned On

When the power 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. Before using the instrument, check that the self-test completes successfully.

#### 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. → Page 2-6
- Initialize the settings to their factory defaults by turning on the power switch while holding down the RESET key.

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

#### Note

- After turning the power off, wait at least 10 seconds before you turn it on again.
- If the instrument does not operate as described above when the power is turned on, turn the power off, and then check that:
  - The power cord is securely connected.
  - The correct voltage is coming to the power outlet. → see section 2.3, “Connecting the Power Supply”
  - After checking the above, try turning on the power while holding down RESET to initialize the settings (reset them to their factory defaults). For details about initializing the settings, see section 3.6, “Initializing Settings.”
- If the instrument still does not work properly, contact your nearest YOKOGAWA dealer for repairs.
- It may take a few seconds for the startup screen to appear.

### To Make Accurate Measurements

- After turning on the power, wait at least 30 minutes to allow the instrument to warm up.
- After the instrument warms 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 lithium battery. When the lithium 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. Do not try to replace the battery yourself. Contact your nearest YOKOGAWA dealer to have the battery replaced.

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#### **CAUTION**

Abruptly turning off the power switch or unplugging the power cord while data is being saved or the internal printer is printing may corrupt the media on which data is being saved or damage the built-in printer. Also, the data being saved is not guaranteed. Always turn the power switch off after data has been saved.

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French

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#### **ATTENTION**

Mettre brutalement l'instrument hors tension ou débrancher le cordon d'alimentation pendant l'enregistrement de données ou le fonctionnement de l'imprimante interne peut corrompre le support d'enregistrement des données ou endommager l'imprimante intégrée. Les données en cours d'enregistrement pourront également être perdues. Toujours mettre l'instrument hors tension après que les données ont été enregistrées.

---

## 2.5 Precautions When Wiring the Circuit under Measurement

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



### WARNING

- Ground the instrument before connecting measurement cables. The power cord to use is a three-prong type power cord. Insert the power cord into a grounded three-prong outlet.
- Turn the circuit under measurement off before connecting and disconnecting cables to it. Connecting or removing measurement cables while the power is on is dangerous.
- Do not wire a current circuit to the voltage input terminal or a voltage circuit to the current input terminal.
- Strip the insulation covers of measurement cables so that when they are wired to the input terminals, the conductive parts (bare wires) do not protrude from the terminals. Also, make sure to fasten the input terminal screws securely so that cables do not come loose.
- When connecting measurement cables to the voltage input terminals, only connect measurement cables that have safety terminals that cover their conductive parts. Using a terminal with bare conductive parts (such as a banana plug) can be dangerous if the terminal comes loose.
- When connecting cables to the external current sensor input terminals, only connect cables that have safety terminals that cover their conductive parts. Using a connector with bare conductive parts can be dangerous if the 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 50 A input element and applying a current exceeding 10 A from a current transformer (CT) to this instrument, provide protection.
- When using a 5 A input element 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.
- For safety reasons, after you connect the measurement cables, use the included screws to attach the current input protection cover (screw tightening torque:  $0.6 \text{ N}\cdot\text{m}$ ). Make sure that the conductive parts do not protrude from the protection cover.

## 2.5 Precautions When Wiring the Circuit under Measurement

---

- To make the protective features effective, before applying the voltage or current from the circuit under measurement, check that:
  - The power cord for the instrument is being used to connect to the power supply, and the instrument is grounded.
  - The instrument is turned on.
  - The current input protection cover provided with the instrument is attached.
- When the instrument is turned on, do not apply a signal that exceeds the following values to the voltage or current input terminals. When the instrument is turned off, turn the circuit under measurement off. For information about other input terminals, see the specifications in chapter 6.

### Instantaneous maximum allowable input (within 20 ms)

---

#### Voltage input

Peak value of 4 kV or rms value of 2 kV, whichever is less.

---

#### Current input

##### Direct input

5 A input elements

Peak value of 30 A or rms value of 15 A, whichever is less.

50 A input elements

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

##### External current sensor input

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

---

### Instantaneous maximum allowable input (1 s or less)

---

#### Voltage input

Peak value of 3 kV or rms value of 1.5 kV, whichever is less.

---

#### Current input

##### Direct input

5 A input elements

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

50 A input elements

Peak value of 150 A or rms value of 55 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 2 kV or rms value of 1.1 kV, whichever is less.

---

#### Current input

##### Direct input

5 A input elements

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

50 A input elements

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

##### External current sensor input

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

---

---



### **CAUTION**

- Use measurement cables with dielectric strengths and current capacities that are appropriate for the voltage or current being measured.  
Example: When making measurements on a current of 20 A, use copper wires that have a conductive cross-sectional area of 4 mm<sup>2</sup> 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.
- Retirer les caches d'isolation des câbles de mesure de façon que les éléments conducteurs (fils nus) ne dépassent pas des bornes lorsque les câbles sont branchés sur les bornes d'entrée. Veiller également à serrer correctement les vis des bornes d'entrée 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 d'entrée de 50 A 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 d'entrée de 5 A 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 des raisons de sécurité, après connexion des câbles de mesure, utiliser les vis fournies pour fixer le cache de protection d'entrée de courant (couple de serrage des vis : 0,6 N•m). Veiller à ce que les éléments conducteurs ne dépassent pas du cache de protection.

## 2.5 Precautions When Wiring the Circuit under Measurement

- 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 de l'instrument est utilisé pour la connexion à l'alimentation, et l'instrument est bien relié à la terre.
  - L'instrument est sous tension.
  - Le cache de protection d'entrée de courant fourni avec l'instrument est fixé.
- 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 (dans une fourchette de 20 ms)

---

#### Entrée de tension

Valeur crête de 4 kV ou valeur efficace de 2 kV, selon la valeur la plus basse.

---

#### Entrée de courant

##### Entrée directe

Élément d'entrée 5 A

Valeur crête de 30 A ou valeur efficace de 15 A, selon la valeur la plus basse.

Élément d'entrée 50 A

Valeur crête de 450 A ou valeur efficace de 300 A, selon la valeur la plus basse.

##### Entrée de capteur externe

Valeur crête inférieure ou égale à 10 fois la plage.

---



---

### Entrée instantanée maximale admissible (1 s ou moins)

---

#### Entrée de tension

Valeur crête de 3 kV ou valeur efficace de 1,5 kV, selon la valeur la plus basse.

---

#### Entrée de courant

##### Entrée directe

Élément d'entrée 5 A

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

Élément d'entrée 50 A

Valeur crête de 150 A ou valeur efficace de 55 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 2 kV ou valeur efficace de 1,1 kV, selon la valeur la plus basse.

---

#### Entrée de courant

##### Entrée directe

Élément d'entrée 5 A

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

Élément d'entrée 50 A

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

##### Entrée de capteur externe

Valeur crête inférieure ou égale à 5 fois la plage.

---

## 2.5 Precautions When Wiring the Circuit under Measurement

---



### **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<sup>2</sup>.
  - 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-voltage, three-current method with a three-phase, three-wire system (3P3W; 3V3A).
-

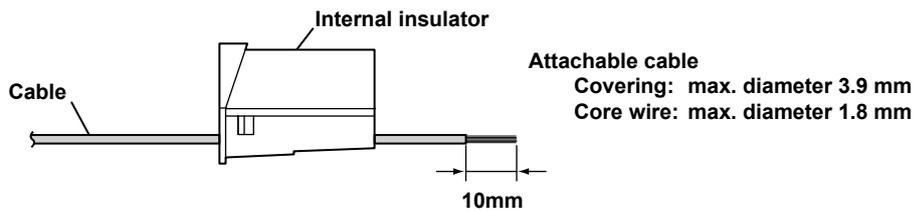
## 2.6 Assembling the Adapters for the Voltage Input Terminals

### Assembling the 758931 Safety Terminal Adapter

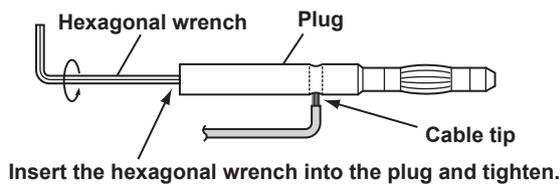
When connecting a measurement cable to a voltage input terminal of this instrument, use the included 758931 Safety Terminal Adapter or the 758923 Safety Terminal Adapter (sold separately). When using the 758931 Safety Terminal Adapter, assemble it according to the following procedure.

### Assembling the Safety Terminal Adapter

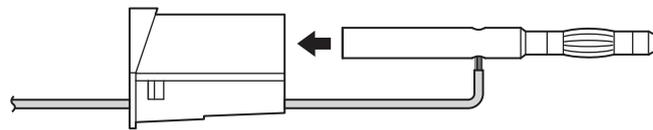
1. Remove approximately 10 mm of the covering from the end of the cable and pass the cable through the internal insulator.



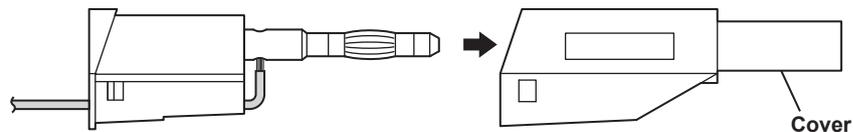
2. Insert the tip of the cable into the plug. Fasten the cable in place using the hexagonal wrench.



3. Insert the plug into the internal insulator.



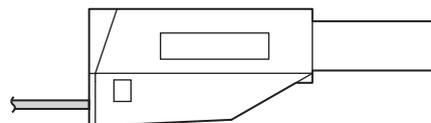
4. Attach the external cover. Make sure that the cover does not come off.



#### Note

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

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

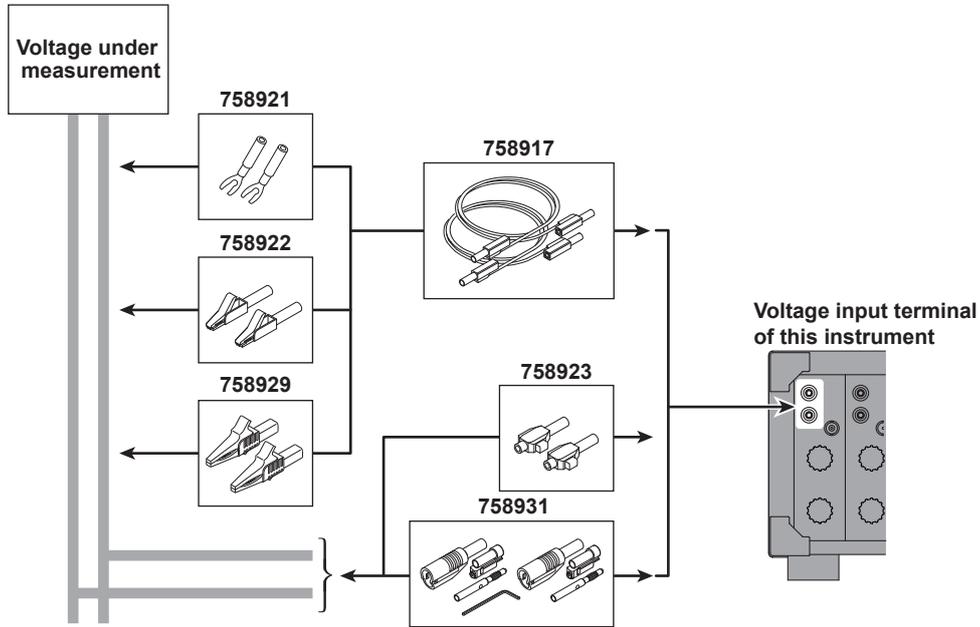


## 2.6 Assembling the Adapters for the Voltage Input Terminals

### Explanation

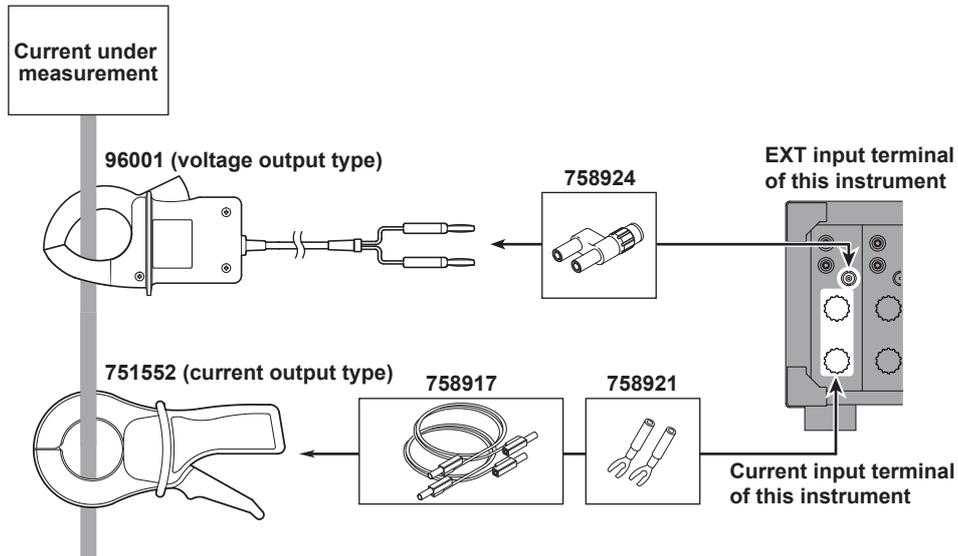
Wire the adapters that come with this instrument or the adapters and various sensors that are sold separately as shown below:

### Wiring When Measuring Voltage



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

### Wiring When Measuring Current



Connecting a clamp-on probe

\* The current input terminal and EXT input terminal cannot be wired (used) simultaneously.

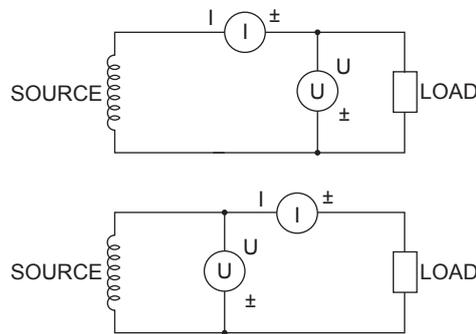
## 2.7 Wiring for Accurate Measurements

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.

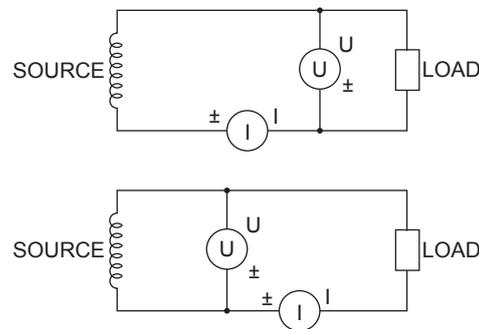
### Effects of Stray Capacitance

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



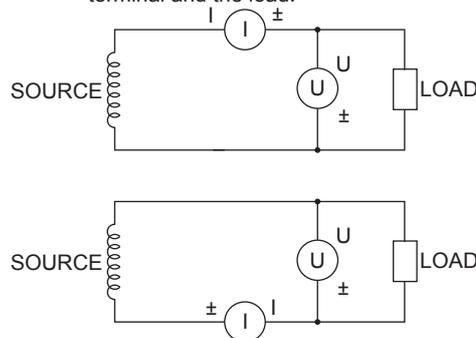
- Not easily affected



### Effects of the Measured Voltage and Current Amplitudes

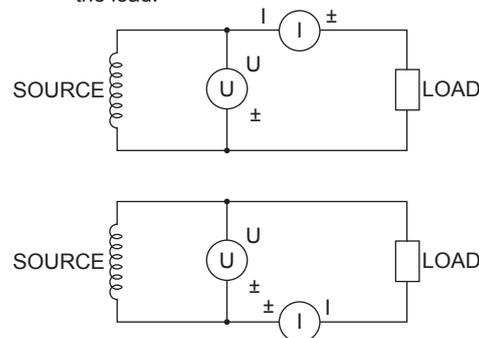
- When the measured current is relatively large

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."

## 2.8 Guide for Selecting the Method Used to Measure the Power

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

### Voltage Measurement Methods

		When the Voltage Is 1000 V or Less	When the Voltage Exceeds 1000 V
Voltage wiring	Direct input	→ Section 2.9	Direct input is not possible.
	VT (voltage transformer)	→ Section 2.11	

### Current Measurement Methods

		When the Voltage Is 1000 V or Less		When the Voltage Exceeds 1000 V	
Input element		When the Current Is 50 A or Less	When the Current Exceeds 50 A		
Current wiring	50 A	When the Current Is 5 A or Less	When the Current Exceeds 5 A	When the Voltage Exceeds 1000 V	
	5 A				
	Direct input	→ Section 2.9*	Direct input is not possible.		
	Shunt-type current sensor	→ Section 2.10**			Shunt-type current sensors cannot be used.
	Clamp-type current sensor (voltage output type)	→ Section 2.10			
Clamp-type current sensor (current output type)	→ Section 2.11				
CT (current transformer)	→ Section 2.11				

\* With /EX1 to /EX6 option

Voltage: 1000 V or less (maximum allowable voltage that can be measured)

600 V or less (rating voltage of EN61010-2-030)

Do not touch the inside of the external current sensor input BNC.

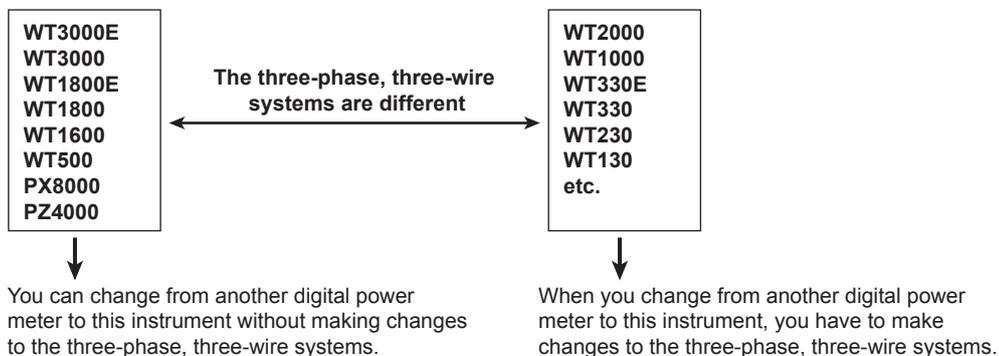
Without /EX1 to /EX6 option

Voltage: 1000 V or less

\*\* The voltage is less than or equal to 600 V.

### Notes when Replacing Other Power Meters with this 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 this instrument may be different from that of another product (another digital power meter) depending on whether the reference voltage used to measure the line voltage (see appendix 2 for details) is based on single-phase or three-phase power. 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.



For example, if you replace the WT1000 (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 WT1000 and this instrument. Refer to this manual and re-wire the system correctly.

## 2.9 Wiring the Circuit under Measurement for Direct Input

This section explains how to wire the measurement cable directly from the circuit under measurement to the voltage or current input terminal.

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

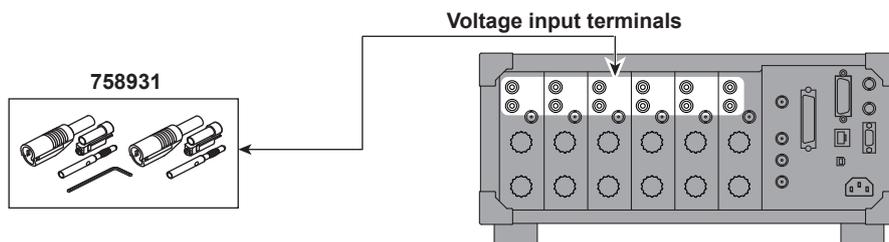
### Connecting to the Input Terminal

#### Voltage Input Terminal

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

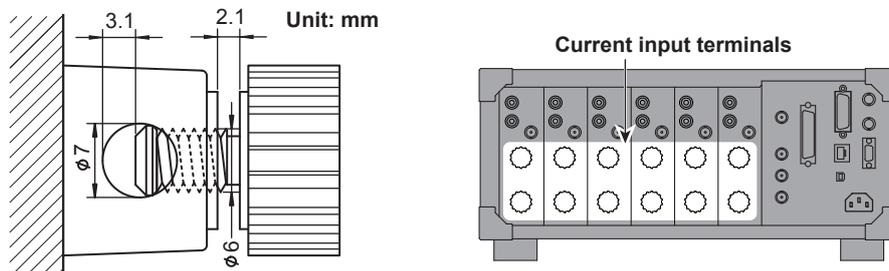
Only insert a safety terminal whose conductive parts are not exposed into a voltage input terminal.

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



#### Current Input Terminal

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



### WARNING

- When the voltage of the circuit under measurement is being applied to the current input terminals, do not touch the external current sensor input 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.

## 2.9 Wiring the Circuit under Measurement for Direct Input

---



### **CAUTION**

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

French



### **AVERTISSEMENT**

- 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.
- 

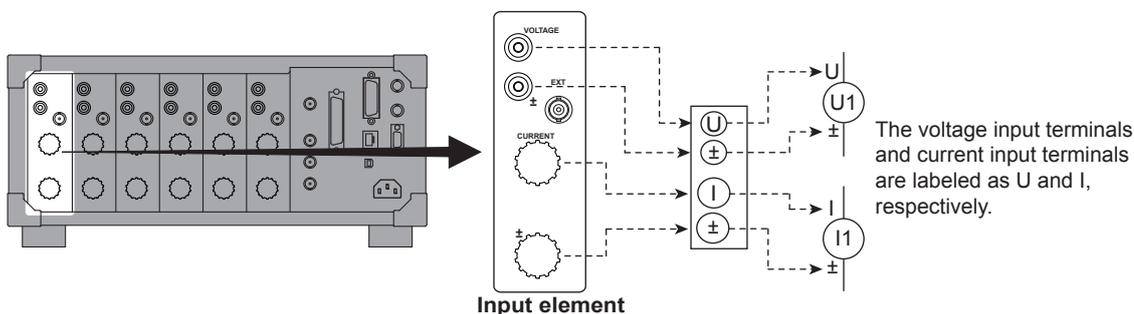


### **ATTENTION**

- Lors de cette opération, s'assurer de l'absence de corps étranger au niveau des contacts entre la borne d'entrée de courant et les cosses à sertir.
  - Vérifier périodiquement si le bouton de la borne d'entrée de courant est desserré, et si des corps étrangers sont présents au niveau des contacts entre la borne d'entrée de courant et les cosses à sertir.
-

## Connecting to this instrument

In the following figures, the input elements of this instrument, voltage input terminals, and current input terminals are simplified as shown in the following figure.



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

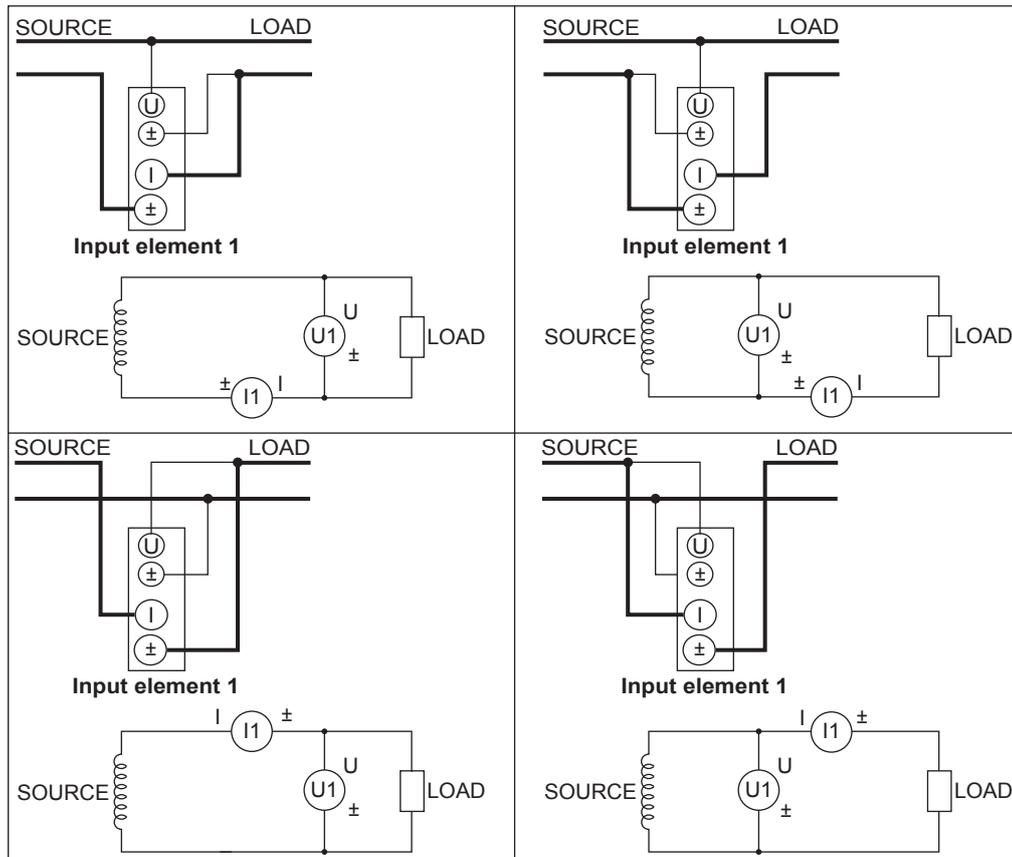


### ATTENTION

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

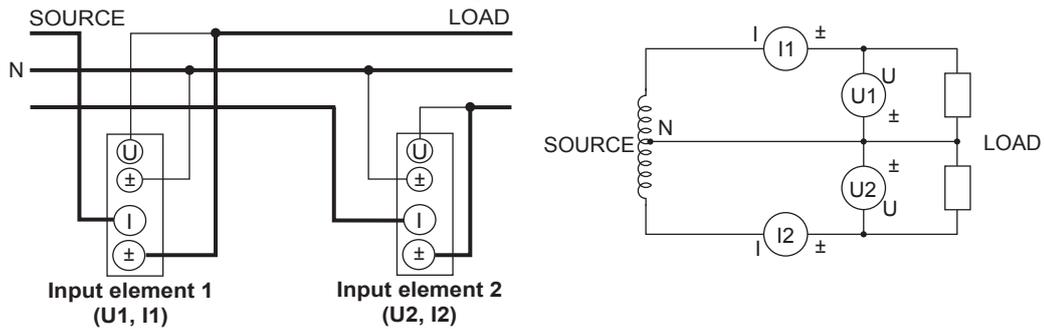
### Wiring Examples of Single-Phase, Two-Wire Systems (1P2W)

If six input elements are available, six single-phase, two-wire systems can be wired. For information about deciding which of the wiring systems shown below you should select, see section 2.7.



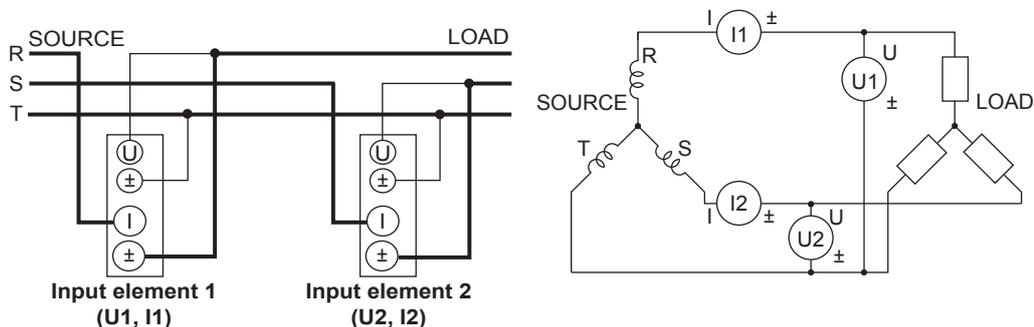
### Wiring Example of a Single-Phase, Three-Wire System (1P3W)

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



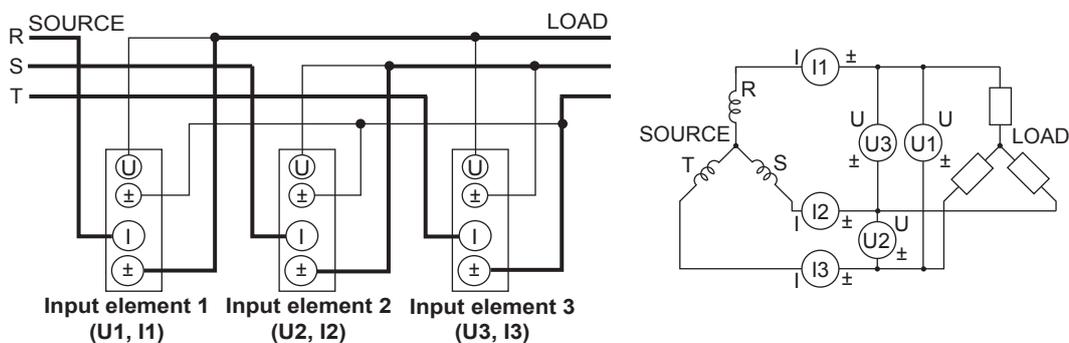
## Wiring Example of a Three-Phase, Three-Wire System (3P3W)

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



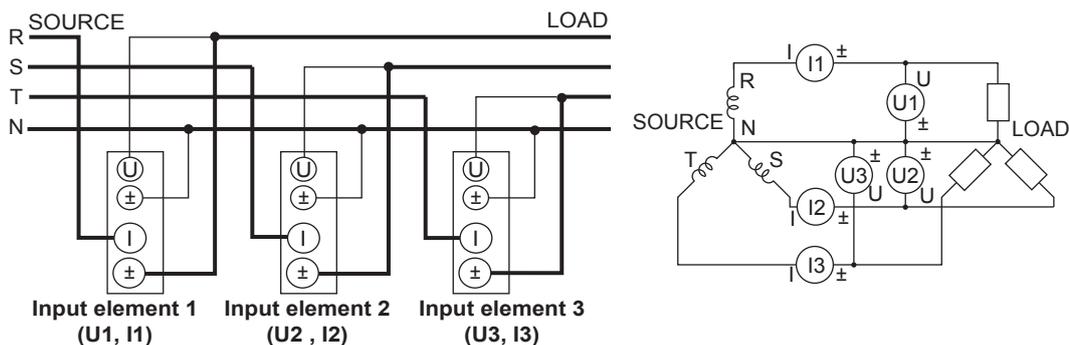
## Wiring Example of a Three-Phase, Three-Wire System That Uses a Three-Voltage, Three-Current Method (3P3W; 3V3A)

If six 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 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."

## 2.10 Wiring the Circuit under Measurement When Using Current Sensors

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

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

- 5 A input elements: When the maximum current exceeds 5 Arms
- 50 A input elements: When the maximum current exceeds 50 Arms

### Current Sensor Output Type

#### Voltage Output

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

#### Current Output

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

### Connecting to the Input Terminal

#### Voltage Input Terminals

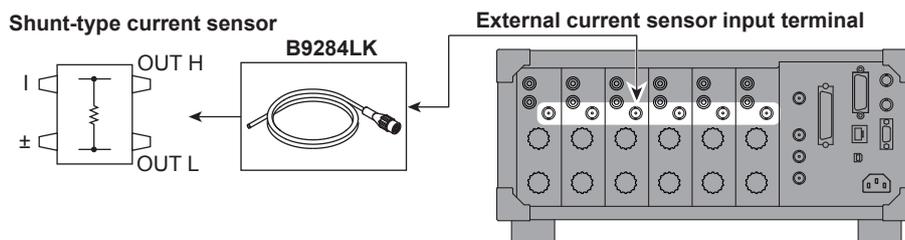
The terminals are safety banana jacks (female) that are 4 mm in diameter.

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

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

#### External Current Sensor Input Terminal

- The terminal is an isolated BNC.
- Connect an external current sensor cable with a BNC (B9284LK, sold separately) to an external current sensor input terminal.



### WARNING

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

French



## AVERTISSEMENT

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. Parce que la borne d'entrée de capteur de courant externe et la borne d'entrée de courant sont connectées en interne, la connexion des deux bornes simultanément, non seulement entraîne des erreurs de mesure, mais peut également endommager l'instrument. 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.

### Note

- Make sure that you have the polarities correct when you make connections. If the polarity is reversed, the polarity of the measurement current will be reversed, and you will not be able to make correct measurements. Be especially careful when connecting clamp-type current sensors to the circuit under measurement, because it is easy to reverse the connection.
- Note that the frequency and phase characteristics of the current sensor affect the measured data.
- To measure the apparent power and power factor more accurately on an unbalanced three-phase circuit, we recommend that you use a three-phase, three-wire system that uses a three-voltage, three-current method (3P3W; 3V3A).

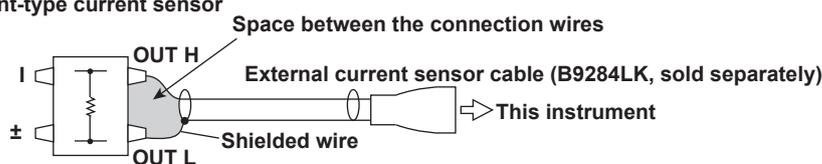
## Notes about Using Shunt-type Current Sensors and Clamp-on Probes

### Connecting an External Current Sensor Cable

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

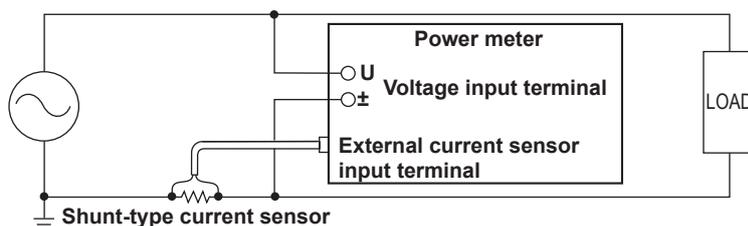
- Connect the shielded wire of the external current sensor cable to the L side of the shunt output terminal (OUT).
- Minimize the area of the space between the wires connecting the current sensor to the external current sensor cable. This reduces the effects of the lines of magnetic force (which are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

#### Shunt-type current sensor



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

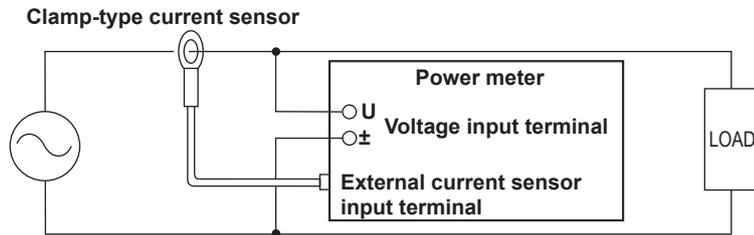
Connect the shunt-type current sensor to the power earth ground as shown in the figure below. If you have to connect the sensor to the non-earth side, use a wire that is thicker than AWG18 (with a conductive cross-sectional area of approximately  $1 \text{ mm}^2$ ) between the sensor and the instrument to reduce the effects of common mode voltage. Take safety and error reduction into consideration when constructing external current sensor cables.



## 2.10 Wiring the Circuit under Measurement When Using Current Sensors

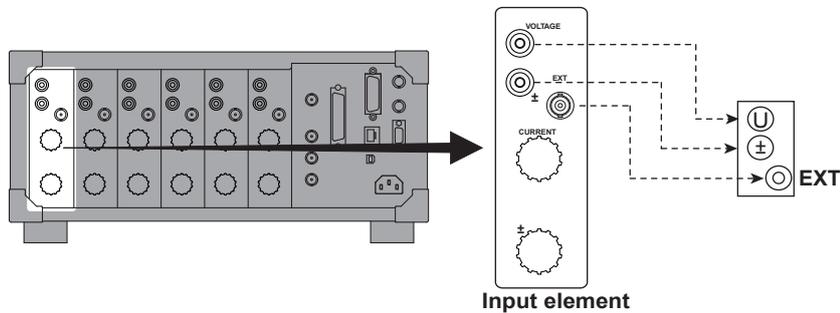
### Ungrounded Measurement Circuits

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

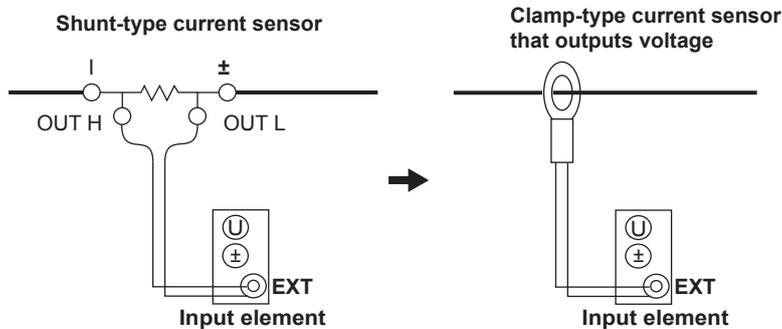


### Connecting to this instrument

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



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 system (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.

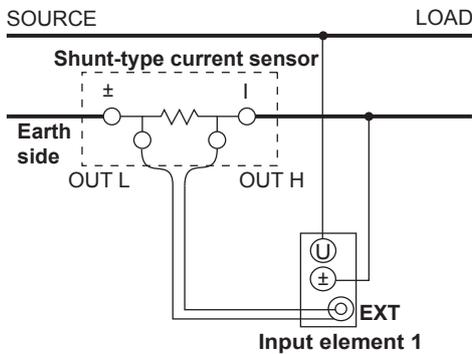
French



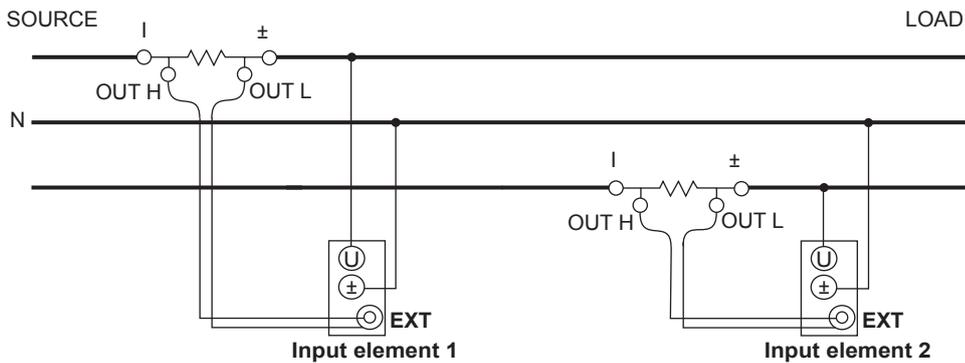
**ATTENTION**

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

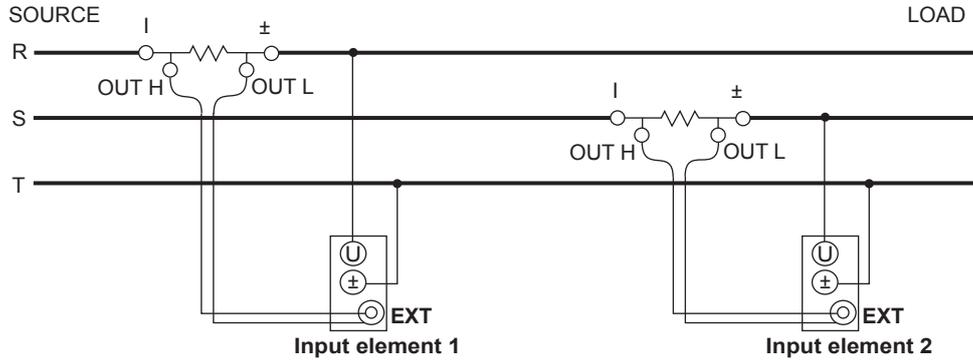
**Wiring Example of a Single-Phase, Two-Wire System (1P2W) with a Shunt-Type Current Sensor**



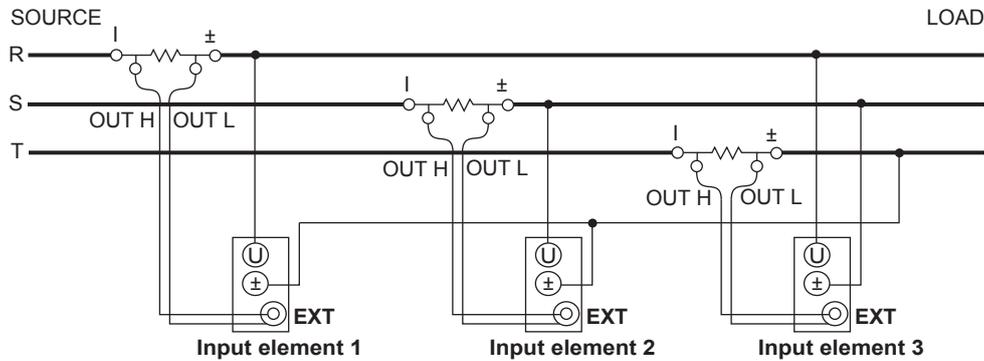
**Wiring Example of a Single-Phase, Three-Wire System (1P3W) with Shunt-Type Current Sensors**



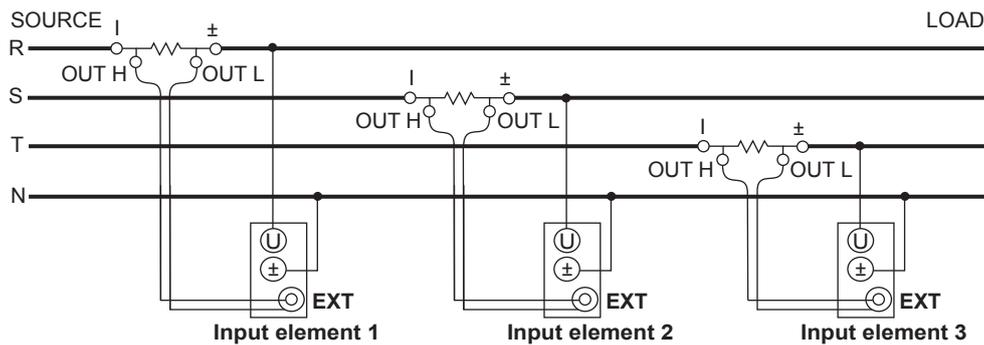
### Wiring Example of a Three-Phase, Three-Wire System (3P3W) with Shunt-Type Current Sensors



### 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."

## 2.11 Wiring the Circuit under Measurement When Using Voltage and Current Transformers

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

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.

- 5 A input elements: When the maximum current exceeds 5 Arms
- 50 A input elements: When the maximum current exceeds 50 Arms

## Connecting to the Input Terminal

### Voltage Input Terminal

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

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

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

### Current Input Terminal

- The screws used on the terminal (binding post) are M6 screws. Wind the wire around the screw, use the Fork Terminal Adapter (758921; sold separately), or pass the crimping terminal through the screw axis, and then tighten firmly with the terminal knob.
- For the dimensions of the terminal parts, see section 2.9.
- For the precautions to follow when you connect the current input terminal and the crimping terminal and after you connect these terminals, see section 2.9.



### WARNING

- Do not connect a current transformer without protection.
- 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.

French



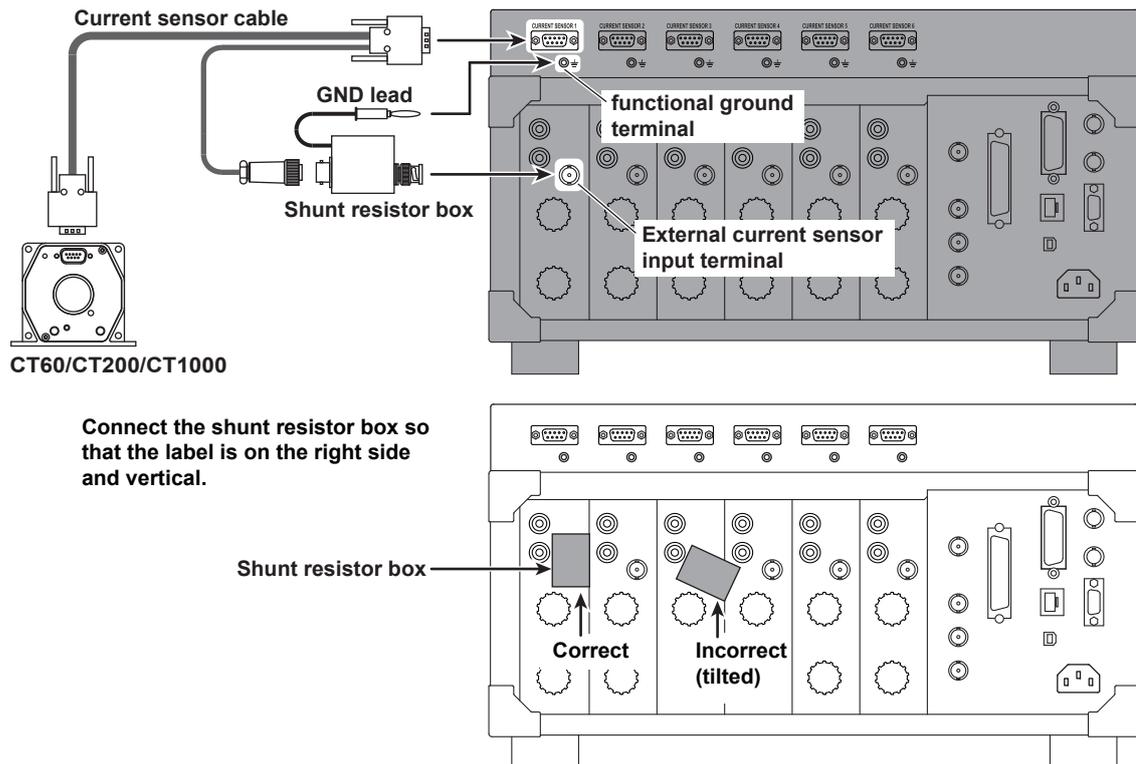
**AVERTISSEMENT**

- Ne pas brancher de transformateur de courant sans protection.
- 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.

**Connecting a CT60/CT200/CT1000/CT2000A to the Current Sensor Power (/PD, or /PD2 Option)**

Models with the current sensor power option can supply power to YOKOGAWA's CT60/CT200/CT1000/CT2000A AC/DC current sensors.

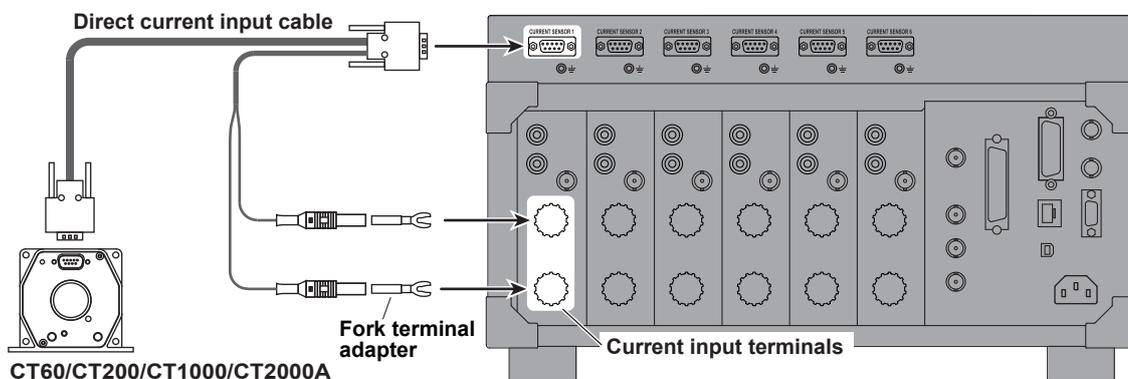
When connecting a CT60/CT200/CT1000 to this instrument, connect the current sensor cable (A1559WL or A1560WL, sold separately) and the shunt resistor box as shown below.



## 2.11 Wiring the Circuit under Measurement When Using Voltage and Current Transformers

When applying the CT60/CT200/CT1000/CT2000A output current to this instrument's direct current input terminals, connect the direct current input cable (sold separately) and the fork terminal adapter as shown below.

Direct current input cable : A1589WL (CT60/CT200/CT1000)  
 A1628WL (CT60/CT200/CT2000A)  
 Fork terminal adapter : 758921



### WARNING

Before connecting the shunt resistor box to the CT with the current sensor cable, be sure to connect the GND lead of the shunt resistor box to the functional ground terminal on the rear panel of this instrument. Not doing so is dangerous as high voltage may appear in the BNC.



### CAUTION

- Before connecting or disconnecting a CT from this instrument, turn this instrument off. Connecting or disconnecting the CT while the power is on can damage this instrument or CT.
- Use the current sensor power terminal (option) on the right side panel of this instrument only as a power supply for the CT60/CT200/CT1000/CT2000A. Connecting other devices may damage this instrument or the connected device.

French



### AVERTISSEMENT

Avant de connecter le boîtier de résistance de shunt au CT à l'aide du câble du capteur de courant, veuillez à raccorder le câble de terre (GND) du boîtier de résistance de shunt à la borne de protection à la terre située sur le panneau arrière de cet instrument. Il est dangereux de ne pas effectuer cette opération, car une tension élevée risque de se manifester au niveau du connecteur BNC.



### ATTENTION

- Avant de connecter ou de déconnecter un CT à/de cet instrument, mettez ce dernier hors tension. Vous risqueriez d'endommager cet instrument si vous connectez ou déconnectez le CT pendant que l'alimentation est sous tension.
- Utilisez uniquement la borne d'alimentation du capteur de courant (en option) sur le panneau droit de cet instrument comme alimentation du CT60/CT200/CT1000/CT2000A. Le branchement d'autres dispositifs risque d'endommager cet instrument ou le dispositif connecté.

## 2.11 Wiring the Circuit under Measurement When Using Voltage and Current Transformers

### Note

Warm up the CT60/CT200/CT1000 for at least 30 minutes without input.

## Specifications of the Current Sensor Power (Optional)

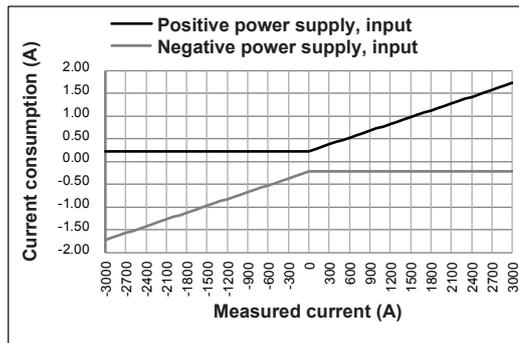
Item	Specifications
Number of channels	6
Connector type	D-sub9 pin (Plug)
Output voltage	±15 V DC
Output current	/PD : 1A/ 1 channel /PD2 : 1.8A/ 1 channel, up to 6A in six channels total.

If you are connecting YOKOGAWA's CT series to the power supply terminal of this instrument's current sensor power option, make sure that the following current is not exceeded.

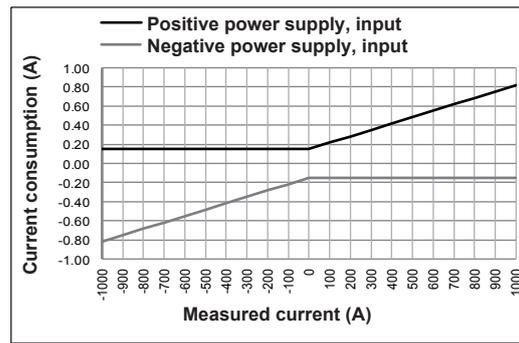
If exceeded, power supply to the CT series will stop due to the activation of the power supply overcurrent protection circuit of this instrument.

- 1 A/1 channel(/PD)
- 1.8 A/1 channel(PD2)
- 6 A for a total of six channels(/PD2)

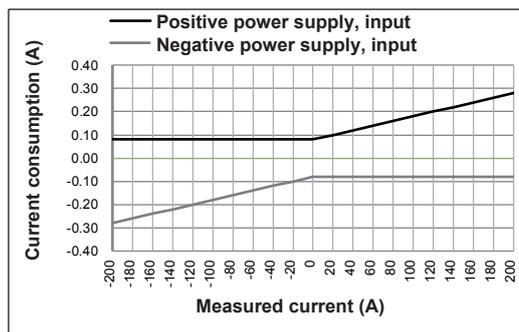
When using the CT series, the number of sensors that can be used is limited by the current generated by the device under measurement(current measured by the CT series). The measured versus consumed current characteristics of CT series that can be connected to the instrument are indicated below.



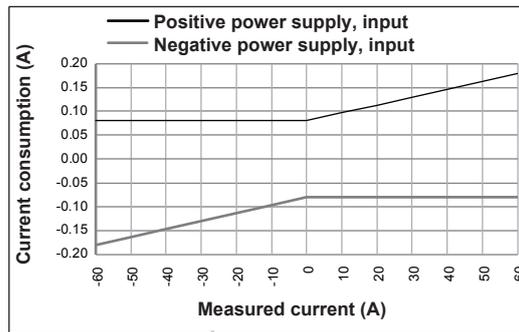
Measured current and current consumption of the CT2000A(example of characteristics)



Measured current and current consumption of the CT1000(example of characteristics)



Measured current and current consumption of the CT200(example of characteristics)



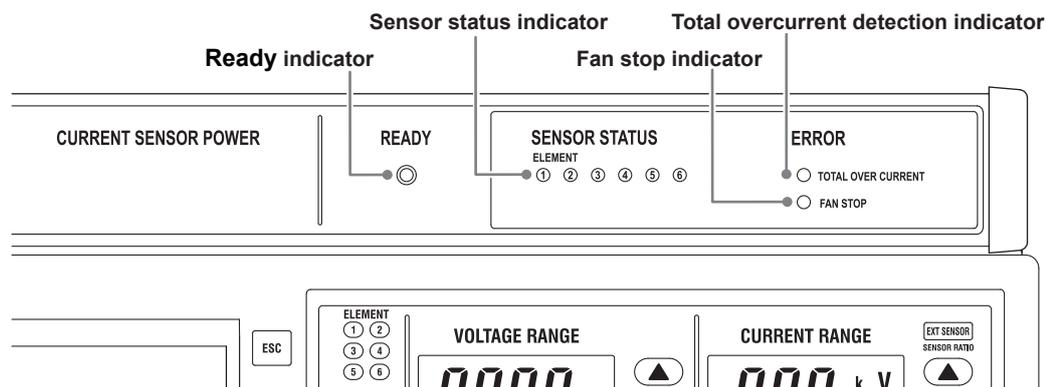
Measured current and current consumption of the CT60(example of characteristics)

Item	CT2000A	CT1000	CT200	CT60
Current Rating	DC: 0 to 2000 A AC: 3000 Apeak	DC: 0 to 1000 A AC: 1000 Apeak	DC: 0 to 200 A AC: 200 Apeak	DC: 0 to 60 A AC: 60 Apeak
Output Current	Primary rated current at 2000 A is 1A	Primary rated current at 1000 A is 666.6mA	Primary rated current at 200 A is 200.0mA	Primary rated current at 60 A is 100.0mA
Current Transformation Ratio	2000 : 1	1500 : 1	1000 : 1	600 : 1

For details of CT specifications, refer to their manuals.

## Current Sensor Power Status Display

The current sensor power supply status is displayed with the following indicators.



### READY indicator

This indicator displays the status of the current sensor power supply (/PD, or PD2 option).

- Off: The current sensor power supply cannot be used. (Repair is necessary.)
- Green: The current sensor power supply can be used.

Even when the READY indicator is illuminated in green, if the sensor status indicator, total overcurrent detection indicator, or fan stop indicator is illuminated in red, power supply to all CTs will be stopped.

### Sensor status indicator

The indicators display the CT connection status and the detection of overcurrent of elements 1 to 6.

- Off: A CT is not connected.
- Green: A CT is connected, and power is supplied to it.  
You can also check the presence of a power supply with the CT's NORMAL OPERATION indicator.
- Red: Overcurrent detected. If overcurrent is detected on any CT, the power supply to all CTs is stopped.\*

### Total overcurrent detection indicator

This indicator displays the detection of overcurrent in the total current of each CT.

- Off: Overcurrent not detected.
- Red: Overcurrent detected. The power supply to all CTs is stopped.\*

### Fan stop indicator

This indicator displays the detection of fan stop.

- Off: Fan stop not detected.
- Red: Fan stop detected. The power supply to all CTs is stopped.\*

\* To resume the power supply, remove the root cause of the overcurrent, and then restart this instrument. If the indicator still lights red after this instrument is restarted, this instrument needs to be repaired.

When the power is turned on or off, the above indicators illuminate for about 1 second in the following manner.

- READY indicator: Green
- Sensor status indicator: Orange
- Total overcurrent detection indicator, fan stop indicator: Red

### Configuration after Connection

Set Sensor Preset and CT Preset according to the instructions in section 1.17, “Displaying the Menu for Configuring All Elements,” in the User’s Manual. If the configuration is not appropriate, measured values will not be read correctly.

### General VT and CT Handling Precautions

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

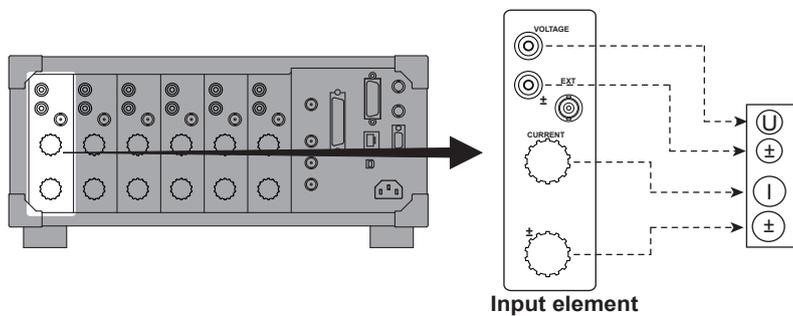
Also, follow the VT or CT handling precautions in the manual for the VT or CT that you are using.

#### Note

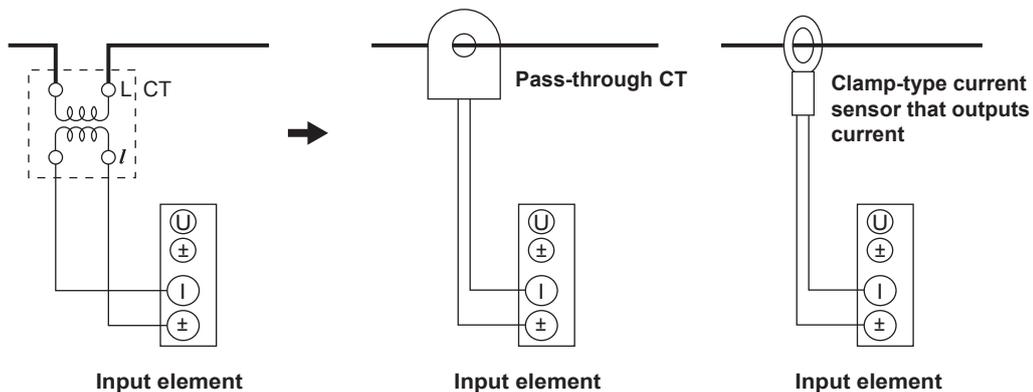
- The thick lines on the wiring diagrams are the parts where the current flows. Use wires that are suitable for the current levels.
- Make sure that you have the polarities correct when you make connections. If the polarity is reversed, the polarity of the measurement current will be reversed, and you 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 simplified as shown in the following figure.



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



## 2.11 Wiring the Circuit under Measurement When Using Voltage and Current Transformers

### Note

Some CTs (including 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.

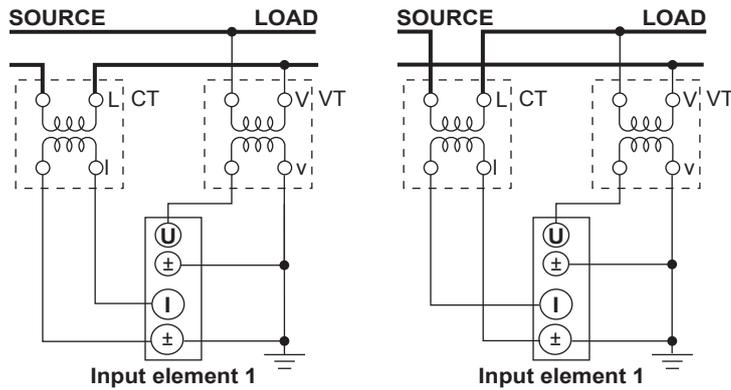
French



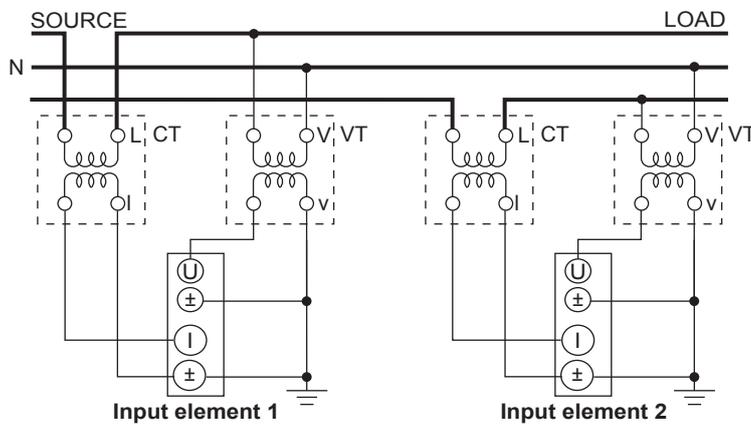
### ATTENTION

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

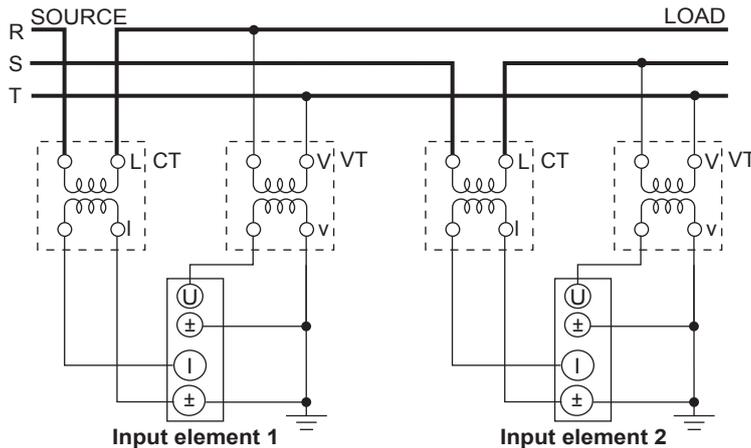
### Wiring Example of Single-Phase, Two-Wire Systems (1P2W) with a VT and CT



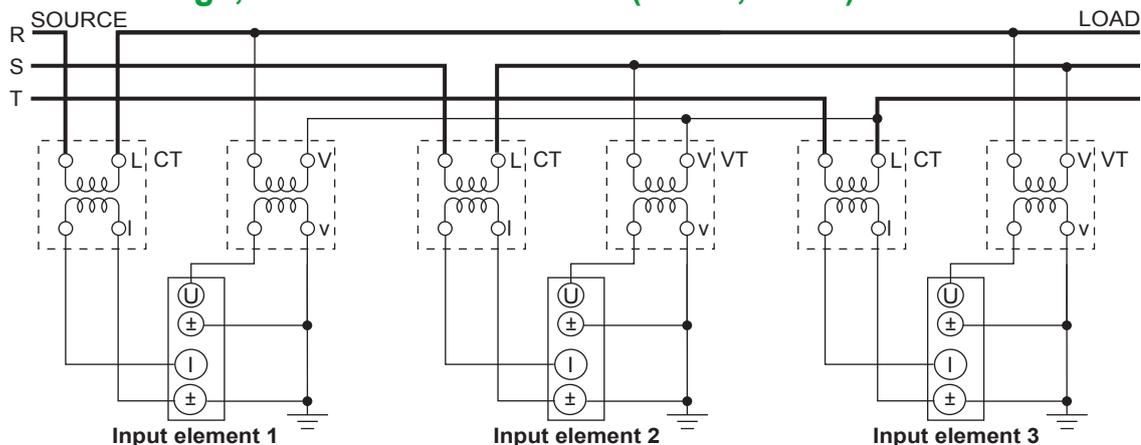
### Wiring Example of a Single-Phase, Three-Wire System (1P3W) with VTs and CTs



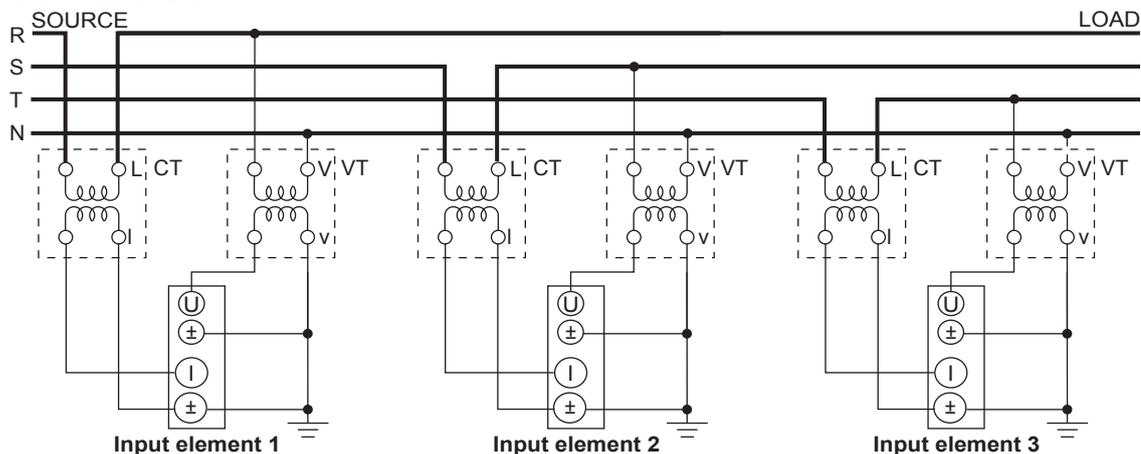
### Wiring Example of a Three-Phase, Three-Wire System (3P3W) with VTs and CTs



### 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."

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## 2.12 Loading Roll Paper into the Built-In Printer (Option)

This section explains how to load roll paper into the optional built-in printer.

### Printer Roll Paper

Only use roll paper specifically made for use with this instrument. When you first use the printer, use the included roll paper. When you need a new supply of roll paper, contact your nearest YOKOGAWA dealer.

Part Number: B9316FX  
Specifications: Heat sensitive paper, 10 m  
Minimum Quantity: 10 rolls

### Handling Roll Paper

The roll paper is made of heat sensitive paper that changes color thermochemically. Please read the following information carefully.

#### Storage Precautions

When in use, the heat-sensitive paper changes color gradually at temperatures of approximately 70°C or higher. The paper can be affected by heat, humidity, light, and chemicals, whether something has been recorded on it or not. As such, please follow the guidelines listed below.

- Store the paper in a cool, dry, and dark place.
- Use the paper as quickly as possible after you break its protective seal.
- If you attach a plastic film that contains plasticizing material, such as vinyl chloride film or cellophane tape, to the paper for a long time, the recorded sections will fade due to the effect of the plasticizing material. Use a holder made of polypropylene to store the roll paper.
- When pasting the record paper to another material, do not use paste that contains organic solvents such as alcohol or ether. Doing so will change the paper's color.
- We recommend that you make copies of the recordings if you intend to store them for a long period of time. Because of the nature of heat-sensitive paper, the recorded sections may fade.

#### Handling Precautions

- Use genuine, YOKOGAWA-supplied roll paper.
- If you touch the roll paper with sweaty hands, there is a chance that you will leave fingerprints on the paper, thereby blurring the recorded sections.
- If you rub something against the surface of the roll paper, the paper may change color due to frictional heat.
- If the roll paper comes into contact with products such as chemicals or oil, there is a chance that the paper will change color or that the recorded sections will disappear.

## Loading the Roll Paper



### WARNING

A roll paper cutter is attached to the printer unit cover. Be careful not to injure your hand or fingers on the cutter.

- Do not insert your finger into the printer unit opening where the roll paper is fed out.
- Do not let your hand or fingers come in contact with the cutter when opening the printer unit cover and loading the roll paper in the holder.

Do not touch the print head and print motor. If you do, you may burn yourself.

French



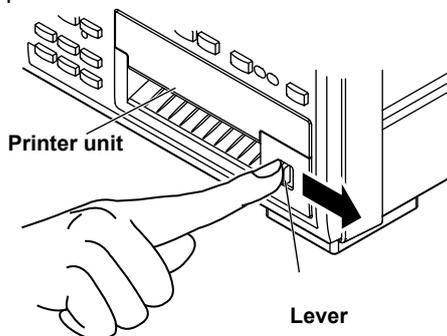
### AVERTISSEMENT

Un dispositif de coupe de papier en rouleau est fixé sur le couvercle de l'imprimante. Prendre garde de se blesser les mains ou les doigts avec le dispositif de coupe.

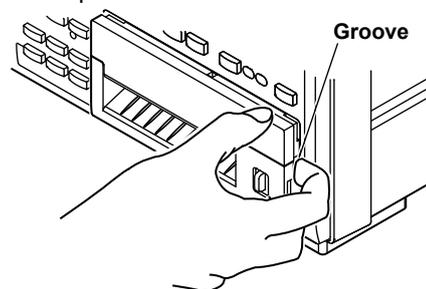
- Ne pas insérer de doigt dans l'ouverture de sortie du papier en rouleau de l'imprimante.
- Ne pas laisser une main ou des doigts entrer en contact avec le dispositif de coupe lors de l'ouverture du couvercle de l'imprimante et de la charge du papier en rouleau dans son logement.

Ne touchez pas la tête d'impression ni le moteur d'impression. Vous pourriez vous brûler.

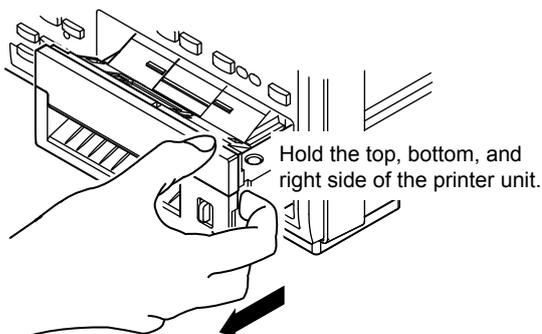
1. Slide the lever to the right to make the printer unit protrude from this instrument.



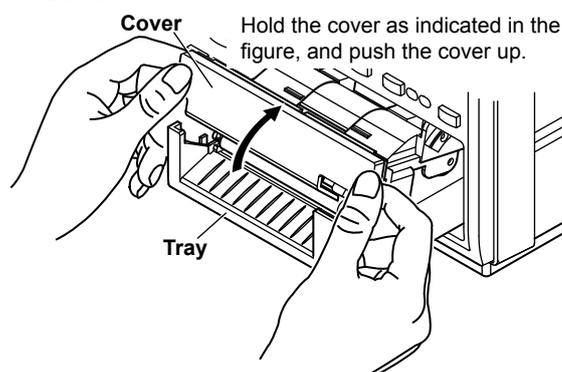
2. Insert your finger into the groove on the right side of the printer unit.



3. Hold the top, bottom, and right side of the printer unit, and then pull it toward you until it stops (pull the unit approximately 5 cm).

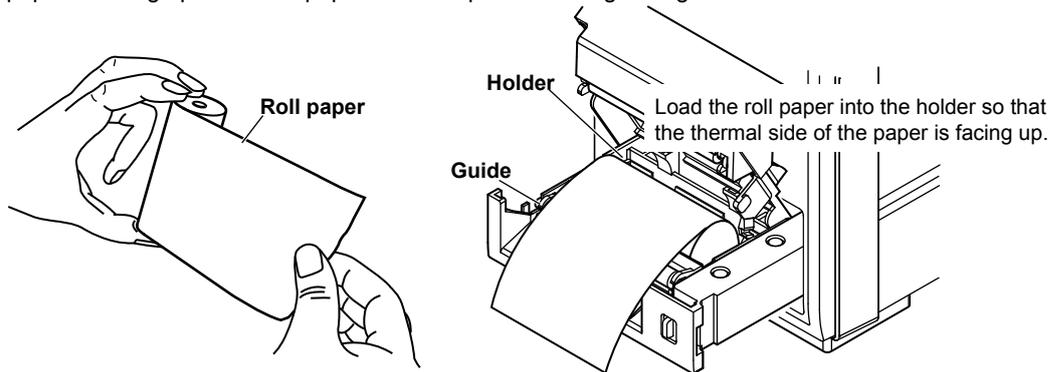


4. Hold the left and right sides of the printer unit's tray with your hands, and push the right and left sides of the front of the cover with your thumbs to raise it.

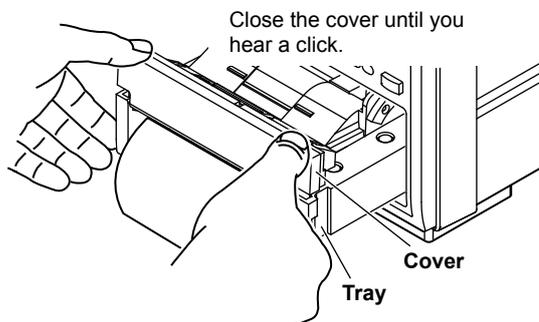
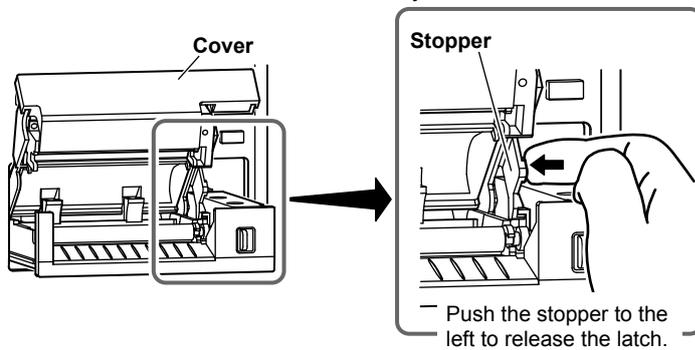


## 2.12 Loading Roll Paper into the Built-In Printer (Option)

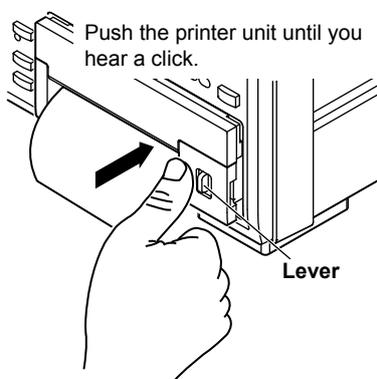
5. Pull approximately 10 cm of the roll paper out, and load the roll paper in the holder so that the thermal side of the paper is facing up. Load the paper so that it passes through the guides.



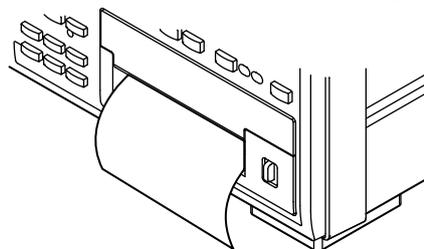
6. Lower the cover while you push the stopper to the left to release the latch. Hold the tray from underneath with both hands, and close the cover until you hear a click.



7. Push the printer unit (push the area to the left of the lever on the front panel) back into this instrument until you hear a click.



This completes the procedure for loading the roll paper.



## Feeding Paper

Press **SHIFT+PRINT** (MENU) to display the following menu.



### Feeds paper

Each time that you press this soft key, this instrument feeds approximately 3 cm of the roll paper.

## Cutting Roll Paper

After you load roll paper and close the cover or after you print measured data, to cut the roll paper, pull the paper up against the top of the cover.

### Note

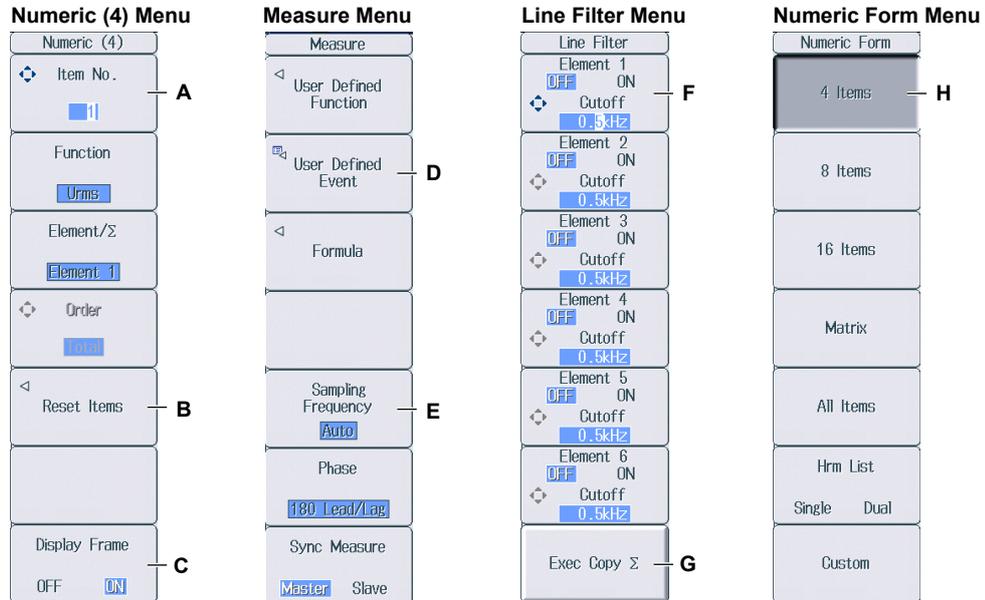
- If you open the printer cover immediately after you cut the roll paper, repeat steps 5 to 7 on pages 2-26 and 2-27.
- After you load roll paper and close the cover, check whether the paper feeds correctly. If the roll paper does not feed straight, repeat steps 1 to 7 on pages 2-26 and 2-27.
- If you load the roll paper backwards, the paper may not feed properly or data may not be printed. This is because the print head doesn't come into contact with the thermal side of the paper. Load the roll paper into the holder in the proper orientation.

## 3.1 Key Operation and Functions

### Key Operation

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

The operation after you press a key varies depending on the key that you press.



A: Press the soft key to use the cursor keys to configure this setting. Use the cursor keys to set the value or select an item.

B: A related setup menu appears when you press the soft key.

C: The selected setting switches each time you press the soft key.

D: A dialog box or the keyboard appears when you press the soft key.

Use the cursor keys and the SET key to configure the settings.

E: Press the soft key to display a selection menu.

Press the soft key that corresponds to the appropriate setting.

F: Press the soft key to use the cursor keys to configure this setting. After you configure the setting, the status of the selected setting switches each time you press the soft key.

G: Press the soft key to execute the specified feature.

H: Press the soft key to apply the value assigned to the key.

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

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

1. Press **SHIFT**. The SHIFT key illuminates to indicate that the keys are shifted.

Now you can select the setup menus written in purple below the keys.

2. Press the key that you want to display the setup menu of.

#### ESC Key Operation

If you press **ESC** when a setup menu or available options are displayed, the screen returns to the menu level above the current one. If you press **ESC** when the highest level menu is displayed, the setup menu disappears.

### 3.1 Key Operation and Functions

#### RESET Key Operation

If you press **RESET** when you are using the cursor keys to set a value or select an item, the setting is reset to its default value (depending on the operating state of this instrument, the setting may not be reset).

#### SET Key Operation

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

- For a soft key menu that has two values that you use the cursor keys to adjust  
Press **SET** to switch the value that the cursor keys adjust.
- For a menu that has the cursor keys + SET mark (◀+⊕) displayed on it  
Press **SET** to confirm the selected item.

#### Cursor Keys Operations

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

- When setting a value  
Up and down **cursor** keys:  
Increases and decreases the value  
Left and right **cursor** keys:  
Changes which digit to set
- When selecting the item to set  
Up and down **cursor** keys:  
Moves the cursor between settings

## How to Enter Values in Setup Dialog Boxes

1. Use the keys to display the appropriate setup dialog box.
2. Use the **cursor** keys to move the cursor to the item that you want to set.
3. Press **SET**. The operation varies as indicated below depending on what you are setting.
  - A selection menu appears.
  - A check box is selected or cleared.
  - An item is selected.
  - A table of settings is selected.

#### Displaying a Selection Menu and Selecting an Item

Select OFF or ON.

Displays the selection menu

After selecting an item with the cursor keys, press SET to confirm it.

#### Setting Items in a Table

After moving the cursor to the table, press SET to select the setting that you want to change.

Use the cursor keys and the SET key to select a table entry.

Display	Function	Element/Z	Order	Scaling	Upper Scale	Lower Scale
✓T1	Urms	Element 1	-	Auto	-	-
✓T2	Irms	Element 1	-	Auto	-	-
✓T3	P	Element 1	-	Auto	-	-
✓T4	S	Element 1	-	Auto	-	-
✓T5	Q	Element 1	-	Auto	-	-
✓T6	λ	Element 1	-	Auto	-	-

#### How to Clear Setup Dialog Boxes

Press **ESC** to clear the setup dialog box from the screen.

## 3.2 Entering Values and Strings

### Entering Values

#### Using the Cursor Keys to Enter Values

Select the appropriate item using the soft keys, and change the value using the cursor keys and the SET key. This manual sometimes describes this operation simply as “using the cursor keys.”

#### Note

Some items that you can set using the cursor keys are reset to their default values when you press the RESET key.

### Entering Character Strings

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

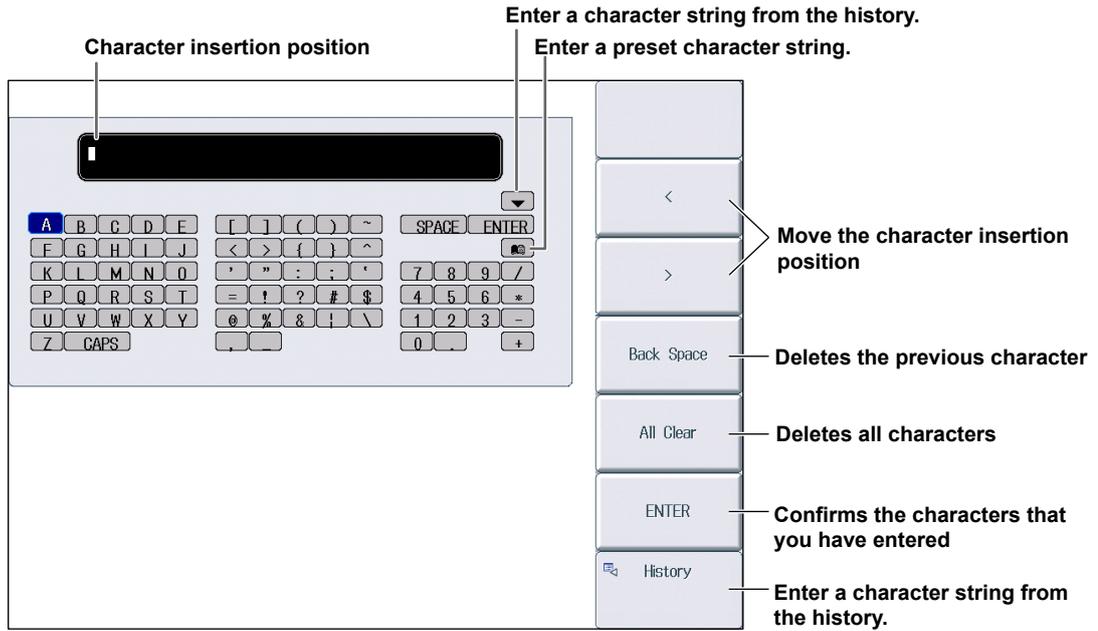
#### How to Operate the Keyboard

- After bringing up the keyboard, use the **cursor** keys to move the cursor to the character that you want to enter.
- Press **SET** to enter the character.
  - If a character string has already been entered, use the arrow soft keys (< and >) to move the cursor to the position you want to insert characters into.
  - To switch between uppercase and lowercase letters, move the cursor to **CAPS** on the keyboard, and then press **SET**.
  - To delete the previous character, press the **Back Space** soft key.
  - To delete all the characters, press the **All Clear** soft key.
- Repeat steps 1 and 2 to enter all the characters in the string.
  - Select  on the keyboard or press the **History** soft key to display a list of character strings that you have entered previously. Use the cursor keys to select a character string, and press **SET** to enter the selected character string.
  - Select  on the keyboard to display a list of preset character strings. The following operands and equations, which are used with user-defined functions, are included as preset character strings.
 

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

Use the **cursor** keys to select a character string, and press **SET** to enter the selected character string.
- Press the **ENTER** soft key, or move the cursor to ENTER on the keyboard, and press **SET** to confirm the character string and clear the keyboard.

### 3.2 Entering Values and Strings



#### Input History: A List of Previously Entered Character Strings



After selecting an item with the cursor keys, press SET to confirm it.

#### 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 WT1801E-01EN.

## 3.3 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.

#### Usable 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

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#### 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 this instrument.

#### Connection Procedure

Connect a USB keyboard directly to this instrument using a USB cable. You can connect or remove the USB cable regardless of whether this instrument is on or off (hot-plugging is supported). Connect the type A connector of the USB cable to this instrument, and connect the type B connector to the keyboard. When the power 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 to this instrument.
  - 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

### UTILITY System Config Menu

Press **UTILITY** and then the **System Config** soft key to display the following menu.



#### 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 in which the  mark is displayed on the menu.

- ↑ 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.

#### Usable 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 this instrument.

### Connection Procedure

To connect a USB mouse to this instrument, use one of the USB ports for peripherals. You can connect or disconnect a USB mouse at any time regardless of whether this instrument is on or off (hot-plugging is supported). When the power 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 this instrument.

### Operating this instrument Using a USB Mouse

- **Operations That Correspond to the Front Panel Keys (Top menu)**

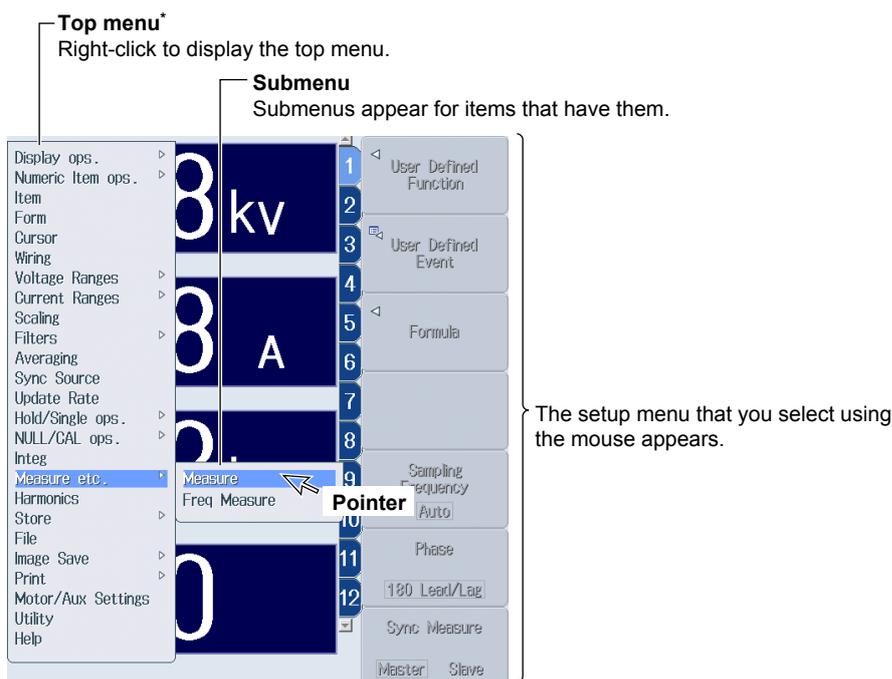
#### Displaying the Top Menu

Right-click on the display. A menu of this instrument front panel keys (the top menu) appears.

#### Selecting an Item from the Top Menu

Click the item that you want to select. A setup menu that corresponds to the item that you selected appears on the right side of the display. The top menu disappears.

To display an item's submenu, click the item. To select an item on a submenu, click it, just as you would to select an item on the top menu.



\* "Ops." is short for "operations."

### Note

- The following keys are not displayed on the top menu:  
ESC, RESET, and SET

### 3.3 Using USB Keyboards and Mouse Devices

- **Setup Menu Operations (Same as soft key operations)**

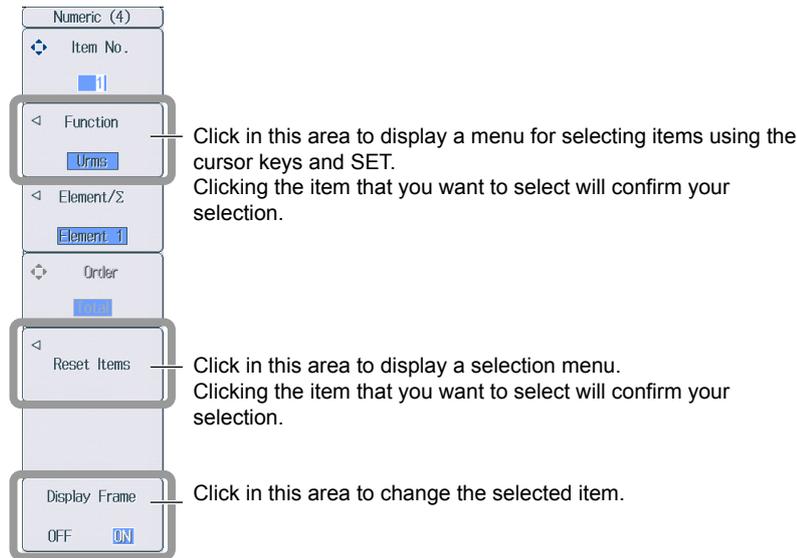
#### Selecting a Setup Menu Item

Click the setup menu item that you want to select.

If a selection menu appears after you select an item, click the selection menu item that you want to choose.

If an item has available options such as ON and OFF, click the item to change its setting.

For menu items that are usually selected using the cursor keys and the SET key, clicking on the item that you want to select will confirm your selection and close the dialog box.



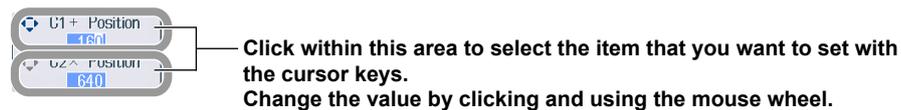
#### Clearing the Menu

To clear the menu, click outside of it.

- **Specifying Values**

The following description explains how to specify values for menu items that have a  icon next to them.

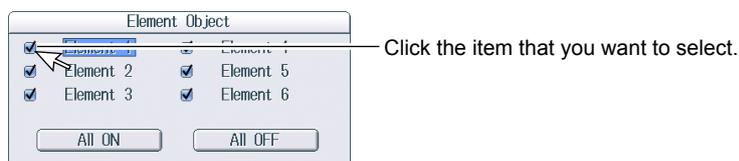
- When a menu item has two  icons, click the top or bottom half of the menu item to select the corresponding setting.
- To decrease a value, rotate the mouse wheel back.
- To increase a value, rotate the mouse wheel forward.
- To increase a value, move the pointer above the value so that the pointer becomes a , and then click above the value.
- To decrease a value, move the pointer below the value so that the pointer becomes a , and then click below the value.
- To move the digit cursor between digits, point to the left or right of the value you want to set so that the pointer becomes a  or a , and then click this area. The digit cursor will move one digit to the left or right each time you click.



- **Selecting Check Boxes in Dialog Boxes**

Click the item that you want to select. A check mark appears next to the item that you selected.

To clear an item's check box, click it again.



**Note**

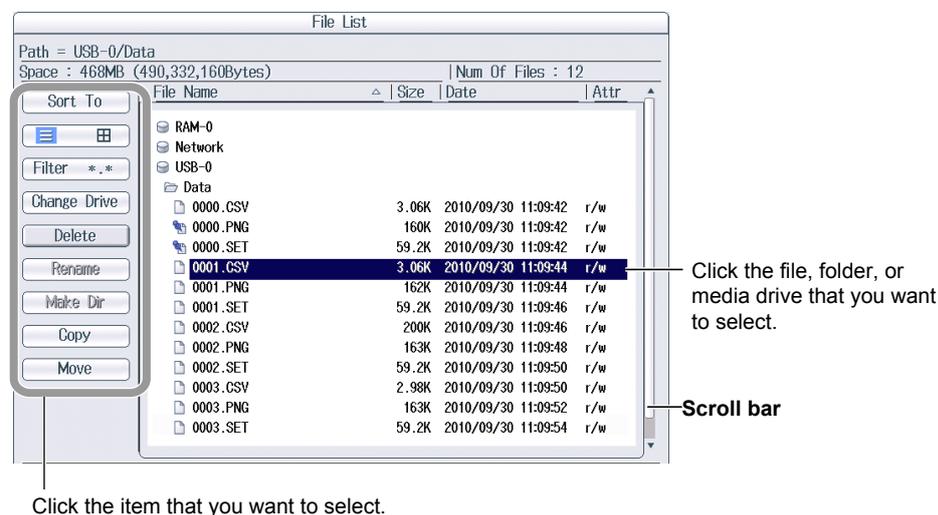
To close a dialog box, click outside of it.

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

Click on a file, folder, or media drive to select it.

Rotate the mouse wheel to scroll through the file list.

To cancel your selection, click outside of the File List window. The File List window will close when you cancel your selection.



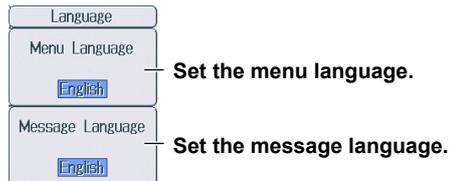
---

## 3.4 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).

### UTILITY System Config Menu

Press **UTILITY**, the **System Config** soft key, and then the **Language** soft key to display the following menu.



### Setting the Menu Language (Menu Language)

You can choose to display menus using one of the following languages.

- English
- Japanese
- Chinese
- German
- Russian

### Setting the Message Language (Message Language)

Error messages appear when errors occur. You can choose to display these messages and the help (see section 3.7) using one of the following languages. The error codes that accompany error messages are the same for all languages. For more information about error messages, see section 5.2.

- English
- Japanese
- Chinese
- German
- Russian

---

#### **Note**

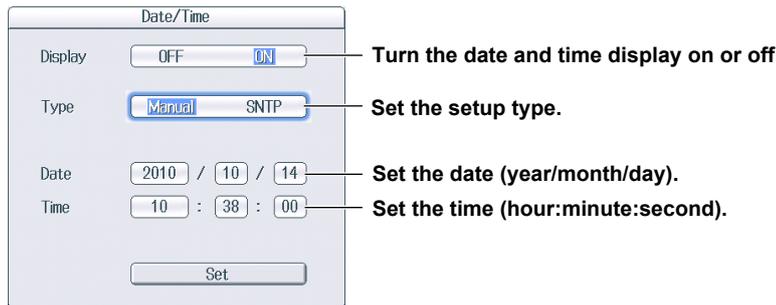
- Even if you set the menu or message language to a language other than English, some terms will be displayed in English.
  - You can specify different menu and message languages. However, you cannot set Japanese and Chinese to the menu language and the message language at the same time. For example, if you specify Japanese as the menu language and Chinese as the message language, the menu language will also be set to Chinese.
-

## 3.5 Synchronizing the Clock

This section explains how to set the clock of this instrument, which is used to generate timestamps for measured data and files. When this instrument is shipped from the factory, it has a set date and time. You must synchronize the clock before you start measurements.

### UTILITY System Config Menu

Press **UTILITY**, the **System Config** soft key, and then the **Date/Time** soft key to display the following screen.



### Setting the Setup Type (Type)

- If you select Manual, set the Date and Time values, and then select Set.
- If you select SNTP, this 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 (the Time Diff. GMT values), and then select Set.

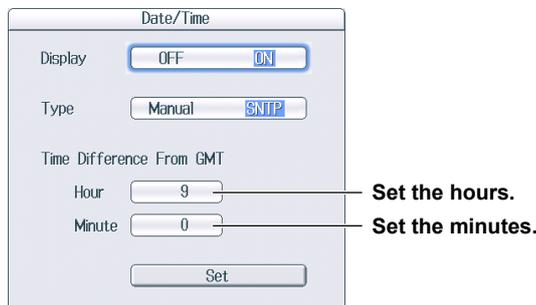
### Setting the Time Difference from Greenwich Mean Time (Time Difference From GMT)

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 this 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 00.



### 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 standard time at the following URL:<http://www.worldtimeserver.com/>

### 3.5 Synchronizing the Clock

---

#### **Note**

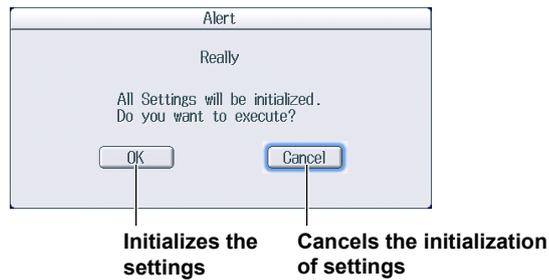
- This instrument does not support Daylight Savings Time. To set the Daylight Savings Time, reset the time difference from Greenwich Mean Time.
  - Date and time settings are backed up using an internal lithium battery. They are retained even if the power is turned off.
  - This instrument has leap-year 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.
-

## 3.6 Initializing Settings

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

### UTILITY System Config Menu

Press **UTILITY**, the **System Config** soft key, and then the **Initialize Settings** soft key to display the following screen.



### Settings That Cannot Be Reset to Their Factory Default Values

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

### To Reset All Settings to Their Factory Default Values

While holding down RESET, turn this instrument on. All settings except the date and time settings (display on/off setting will be reset) and the setup data stored on the internal RAM disk will be reset to their factory default values.

#### Note

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

---

## 3.7 Displaying Help

### Displaying Help

Press HELP to display the help screen.

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.
- Press PAGE ▲ or PAGE ▼ to scroll through the screen by approximately half a page in the specified direction.
- Press SHIFT+PAGE ▲ (▲) to display the first entry.
- Press SHIFT+PAGE ▼ (▼) to display the last entry.

### 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.

### Returning to the Previous Screen

To return to the previous screen, press RESET.

### Hiding Help

Press HELP or ESC to hide the help screen.

## 4.1 Motor Torque Signal and Revolution Signal Input (TORQUE/SPEED; option)



### CAUTION

Only apply signals 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

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.

## Torque Signal Input Connector (TORQUE)



Apply a torque meter output signal—a DC voltage (analog) signal or pulse signal that is proportional to the motor's torque—that meets the following specifications. Use a safety BNC cable (sold separately).

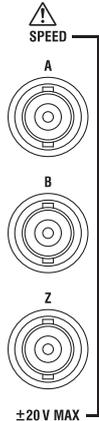
### DC Voltage (Analog input)

Item	Specifications
Connector type	Isolated BNC
Input range	1 V, 2 V, 5 V, 10 V, 20 V
Effective input range	0% to $\pm 110\%$ of the measurement range
Input resistance	Approx. 1 M $\Omega$
Maximum allowable input	$\pm 22$ V
Continuous maximum common-mode voltage	$\pm 42$ V <sub>peak</sub> or less

### Pulse Input

Item	Specifications
Connector type	Isolated BNC
Frequency range	2 Hz to 1 MHz
Amplitude input range	$\pm 12$ V <sub>peak</sub>
Detection level	H level: approx. 2 V or more; L level: approx. 0.8 V or less
Pulse width	500 ns or more
Input resistance	Approx. 1 M $\Omega$
Continuous maximum common-mode voltage	$\pm 42$ V <sub>peak</sub> or less

## Revolution Signal Input Connector (SPEED)



Apply a revolution sensor output signal—a DC voltage (analog) signal or pulse signal that is proportional to the motor’s rotating speed—that meets the following specifications. Use a safety BNC cable (sold separately).

### 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
Continuous maximum common-mode voltage	±42 V <sub>peak</sub> or less

### Pulse Input

Item	Specifications
Connector type	Isolated BNC
Frequency range	2 Hz to 1 MHz
Amplitude input range	±12 V <sub>peak</sub>
Detection level	H level: approx. 2 V or more; L level: approx. 0.8 V or less
Pulse width	500 ns or more
Input resistance	Approx. 1 MΩ
Continuous maximum common-mode voltage	±42 V <sub>peak</sub> or less

### Terminal Used for Analog Input

Apply analog input to terminal A.

### Terminal Used for Pulse Input

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

## 4.2 Auxiliary Input (AUX1/AUX2; option)



### CAUTION

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

French



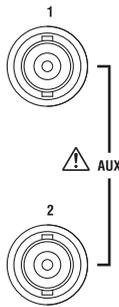
### ATTENTION

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.

4

Auxiliary I/O

## Auxiliary Input Connectors (AUX1/AUX2)



Apply a sensor output DC voltage signal (an analog signal) that meets the following specifications. Use a safety BNC cable (sold separately).

### DC Voltage (Analog input)

Item	Specifications
Connector type	Isolated BNC
Input range	50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V, 20 V
Effective input range	0% to $\pm 110\%$ of the measurement range
Input resistance	Approx. 1 M $\Omega$
Maximum allowable input	$\pm 22$ V
Continuous maximum common-mode voltage	$\pm 42$ V <sub>peak</sub> or less

## 4.3 External Clock Input (EXT CLK IN)



### CAUTION

Only apply signals 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

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	0.5 Hz to 2.6 kHz
Input waveform	50% duty ratio rectangular wave

### To Apply a Trigger Source for Displaying Waveforms

Item	Specifications
Minimum pulse width	1 $\mu$ s
Trigger delay	Within (1 $\mu$ s + 3 sample intervals)

## 4.4 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, such as those with excessive voltage, may damage this instrument.

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 ou External Sync sur ON en mode de collecte de données haute vitesse, 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



### To Apply a Master/Slave Synchronization Signal during 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 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 delay	Within 15 sample intervals	Applies to the master
	Within 1 $\mu$ s + 15 sample intervals	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.

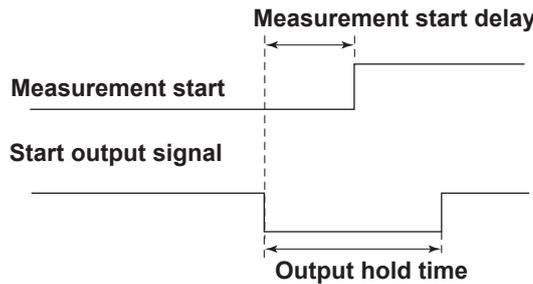
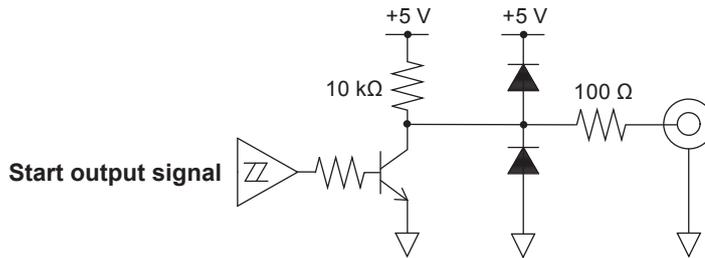
#### 4.4 External Start Signal I/O (MEAS START)

### To Apply a External Synchronization Signal during High Speed Data Capturing

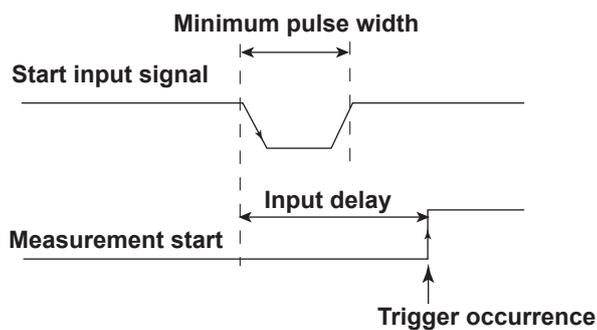
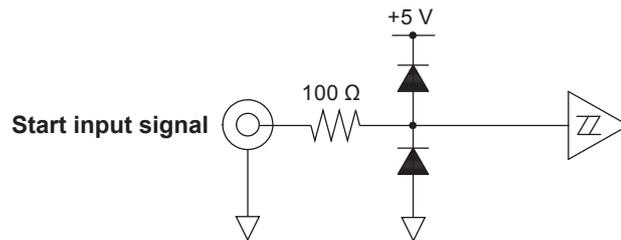
Apply a external synchronization signal that meets the following specifications to the external start signal I/O connector (MEAS START) on the rear panel.

Item	Specifications
Connector type	BNC
Input level	TTL (0 to 5 V)
Input logic	Negative logic, falling edge
Minimum pulse width	Low level, 500 ns or more
Measurement start delay	Within 1 $\mu$ s + 15 sample intervals

### External Start Signal Output Circuit and Timing Chart



### External Start Signal Input Circuit and Timing Chart



## 4.5 RGB Output (RGB OUT (XGA); option)



### 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.

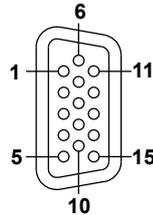
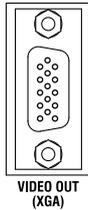
French



### 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.

## RGB 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 XGA can be connected.

Item	Specifications
Connector type	D-sub 15-pin
Output format	Analog RGB output
Output resolution	XGA output, 1024 × 768 dots, approx. 60 Hz Vsync

Pin No.	Signal	Specifications
1	Red	0.7 V <sub>P-P</sub>
2	Green	0.7 V <sub>P-P</sub>
3	Blue	0.7 V <sub>P-P</sub>
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

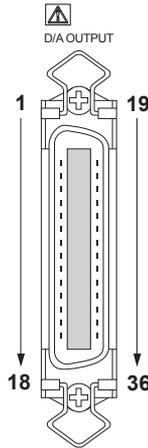
1. Turn off this instrument and the monitor.
2. Connect this instrument and the monitor using an analog RGB cable.
3. Turn on this instrument and the monitor.

## 4.6 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	EXT PRINT	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 a  $\pm 5$  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 $\pm 5$ V FS (maximum of approx. $\pm 7.5$ V)
Update interval	Same as the data update interval of this instrument (if the waveform display is enabled and the trigger mode is set to Auto or Normal, the data update interval depends on the trigger operation)
Number of outputs	20 channels The output items can be set for each channel.
Continuous maximum common-mode voltage	$\pm 42$ V <sub>peak</sub> 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; start, stop, and reset integration; and print.



### CAUTION

Do not apply voltage outside the range of 0 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

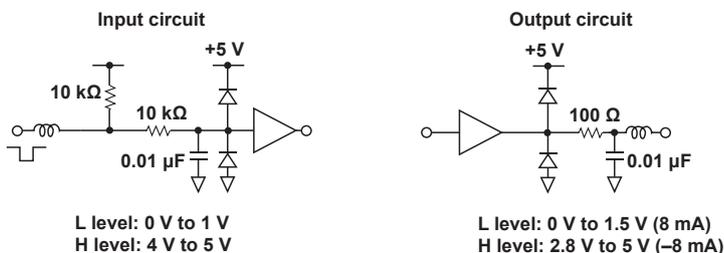


### ATTENTION

Ne pas appliquer de tension hors de la plage 0 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.

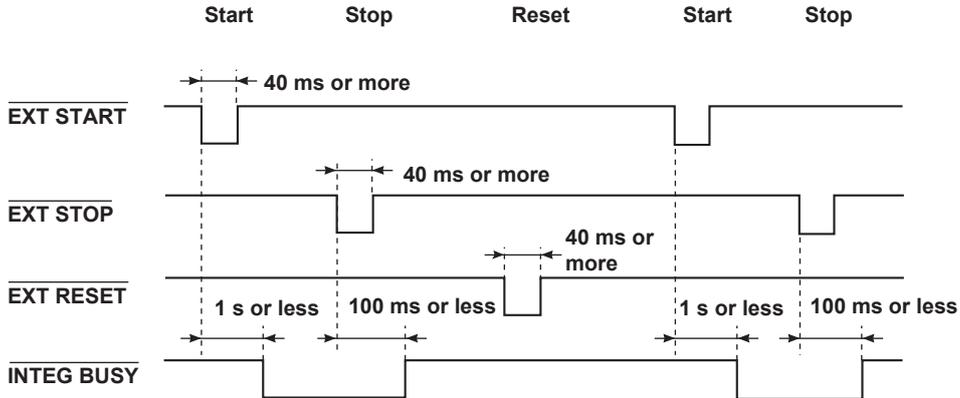
Item	Specifications
Input signal	EXT START, EXT STOP, EXT RESET, EXT HOLD, EXT SINGLE, EXT PRINT
Output signal	INTEG BUSY
Input level	0 V to 5 V

## Remote Control I/O Circuit



### Controlling Integration Remotely

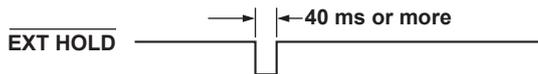
Apply signals according to the following timing chart.



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

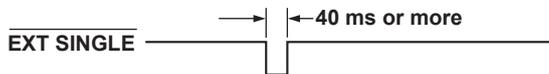
### Holding the Updating of Displayed Data (The same functionality as pressing HOLD)

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.

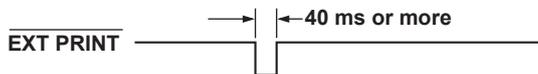


**Note**

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.

### Printing on the Built-In Printer (Option; the same functionality as pressing PRINT)

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



## 5.1 Troubleshooting

### Dealing with Problems

- If a message appears on the screen, see the appendix in the user's manual, IM WT1801E-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 you turn on the power.	
Securely connect the power cord to the instrument and to the power outlet.	2.3
Set the supply voltage to within the permitted range.	2.3
Check the screen settings.	20.4 <sup>1</sup>
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 noise is not affecting the measurement.	2.1, 2.5
Check the measurement cable wiring.	2.8-2.11
Check the wiring system.	2.8-2.11, 1.1 <sup>1</sup>
Confirm that the line filter is off.	1.13 <sup>1</sup>
Check the measurement period settings.	1.12 <sup>1</sup>
Check the FAQ at the following URL. <a href="http://tmi.yokogawa.com/">http://tmi.yokogawa.com/</a>	—
Turn the power off and then on again.	2.4
Keys do not work.	
Check the REMOTE indicator. If the REMOTE indicator is illuminated, press LOCAL to turn it off.	—
Confirm that keys are not locked.	20.10 <sup>1</sup>
Perform a key test. If the test fails, servicing is necessary.	20.7 <sup>1</sup>
Triggering does not work.	
Check the trigger conditions.	9.1 <sup>1</sup>
Confirm that the trigger source is being applied.	9.1 <sup>1</sup>
Unable to make harmonic measurements.	
Check the PLL source settings.	2.1 <sup>1</sup>
Confirm that the input signal that you have selected as the PLL source meets the specifications.	2.1 <sup>1</sup>
Cannot print to the built-in printer.	
The printer head may be damaged or worn out. Servicing is required.	—
Unable to recognize a storage medium.	
Check the storage medium format. If necessary, format the storage medium.	—
The storage medium may be damaged.	—
Unable to save data to the selected storage medium.	
If necessary, format the storage medium.	—
Check the free space on the storage medium. Remove files or use a different storage medium as necessary.	—
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.	— <sup>2</sup>
Confirm that the interface meets the electrical and mechanical specifications.	— <sup>2</sup>

1 See the user's manual, IM WT1801E-02EN.

2 See the communication interface user's manual, IM WT1801E-17EN.

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## 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 Replacement Parts

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
Built-in printer	Under normal conditions of use, the period it takes to use 200 rolls of printer paper (part number: B9316FX)

### Consumable Parts

We recommend replacing them at the following intervals.

Part Name	Recommended Replacement Interval
Cooling fan	3 years
Backup battery (lithium)	3 years

## 6.1 Input

Item	Specifications
Input terminal type	Voltage Plug-in terminal (safety terminal) Current <ul style="list-style-type: none"> <li>• Direct input: large binding post</li> <li>• External current sensor input: isolated type BNC connector</li> </ul>
Input format	Voltage Floating input through resistive voltage divider Current Floating input through shunt
Measurement range	Voltage Crest factor CF3: 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 CF6/CF6A: 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 Current <ul style="list-style-type: none"> <li>• Direct input               <ul style="list-style-type: none"> <li>50 A input elements                   <ul style="list-style-type: none"> <li>Crest factor CF3: 1 A, 2 A, 5 A, 10 A, 20 A, 50 A</li> <li>Crest factor CF6/CF6A: 500 mA, 1 A, 2.5 A, 5 A, 10 A, 25 A</li> </ul> </li> <li>5 A input elements                   <ul style="list-style-type: none"> <li>Crest factor CF3: 10 mA, 20 mA, 50 mA, 100 mA, 200 mA, 500 mA, 1 A, 2 A, 5 A</li> <li>Crest factor CF6/CF6A: 5 mA, 10 mA, 25 mA, 50 mA, 100 mA, 250 mA, 500 mA, 1 A, 2.5 A</li> </ul> </li> </ul> </li> <li>• External current sensor input               <ul style="list-style-type: none"> <li>Crest factor CF3: 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V</li> <li>Crest factor CF6/CF6A: 25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V, 5 V</li> </ul> </li> </ul>
Input impedance	Voltage Input resistance: Approx. 2 M $\Omega$ ; input capacitance: Approx. 10 pF Current <ul style="list-style-type: none"> <li>• Direct input               <ul style="list-style-type: none"> <li>50 A input element: approx. 2 m<math>\Omega</math> + approx. 0.07 <math>\mu</math>H</li> <li>5 A input element: approx. 100 m<math>\Omega</math> + approx. 0.07 <math>\mu</math>H</li> </ul> </li> <li>• External current sensor input: approx. 1 M<math>\Omega</math></li> </ul>
Instantaneous maximum allowable input (within 20 ms)	Voltage Peak value of 4 kV or rms value of 2 kV, whichever is less. Current <ul style="list-style-type: none"> <li>• Direct input (50 A input element): peak value of 450 A or rms value of 300 A, whichever is less</li> <li>• Direct input (5 A input element): peak value of 30 A or rms value of 15 A, whichever is less</li> <li>• External current sensor input: peak value less than or equal to 10 times the range</li> </ul>
Instantaneous maximum allowable input (within 1 s)	Voltage Peak value of 3 kV or rms value of 1.5 kV, whichever is less Current <ul style="list-style-type: none"> <li>• Direct input (50 A input element): peak value of 150 A or rms value of 55 A, whichever is less</li> <li>• Direct input (5 A input element): peak value of 10 A or rms value of 7 A, whichever is less</li> <li>• External current sensor input: peak value less than or equal to 10 times the range</li> </ul>
Continuous maximum allowable input	Voltage Peak value of 2 kV or rms value of 1.1 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 <ul style="list-style-type: none"> <li>• Direct input (50 A input element): peak value of 150 A or rms value of 55 A, whichever is less</li> <li>• Direct input (5 A input element): peak value of 10 A or rms value of 7 A, whichever is less</li> <li>• External current sensor input: peak value less than or equal to 5 times the range</li> </ul>
Continuous maximum common-mode voltage (50/60 Hz)	Voltage input terminals: 1000 Vrms Current input terminals <ul style="list-style-type: none"> <li>with /EX1 to /EX6 option*: 1000 Vrms (maximum allowable voltage that can be measured) 600 Vrms (rating voltage of EN 61010-2-030)</li> <li>without /EX1 to /EX6 option: 1000 Vrms</li> </ul> External current sensor input connector: 600 Vrms

## 6.1 Input

Item	Specifications
Influence of common-mode voltage	When 1000 Vrms is applied between the input terminal and case with the voltage input terminals shorted, the current input terminals open, and the external current sensor input terminals shorted. <ul style="list-style-type: none"> <li>• 50/60 Hz: <math>\pm 0.01\%</math> of range or less.</li> <li>• Reference value for up to 100 kHz: <math>\pm \{(\text{maximum rated range})/(\text{rated range}) \times 0.001 \times f\%</math> of range) or less For external current sensor input, add <math>\text{maximum rated range}/\text{rated range} \times \{0.0125 \times \log(f \times 1000) - 0.021\}\%</math> of range to the value above. 0.01% or greater. The unit of f is kHz. The maximum rated range in the equation is 1000 V, 50 A, 5 A, or 10 V.</li> </ul>
Line filter	Select from OFF, 100 Hz to 100 kHz (in steps of 100 Hz), 300 kHz, and 1 MHz.
Frequency filter	Select from OFF, 100 Hz, and 1 kHz.
Frequency filter under condition of AUTO update interval	Select from OFF, 100Hz, 200Hz, 400Hz, 800Hz, 1.6kHz, 3.2kHz, 6.4kHz, 12.8kHz, 25.6kHz
A/D converter	Converts voltage and current inputs simultaneously Resolution: 16 bits Conversion rate (sampling interval): approx. 500 ns. For the values when displaying harmonics, see the sections on harmonic measurement.
Range switching	The range can be set for each input element.
Auto range feature	Range increase <ul style="list-style-type: none"> <li>• When Urms or Irms exceeds 110% (approximately 220% when the crest factor is set to CF6A) of the measurement range.</li> <li>• When the peak value of the input signal exceeds approximately 330% (approximately 660% when the crest factor is set to CF6/CF6A) of the range.</li> </ul> Range decrease The range is decreased when all the following conditions are met. <ul style="list-style-type: none"> <li>• The measured Urms or Irms value is less than or equal to 30% of the range.</li> <li>• The measured Upk or Ipk value is less than or equal to 300% (approximately 600% when the crest factor is set to CF6/CF6A) of the lower range.</li> <li>• The measured Urms or Irms value is less than or equal to 105% of the lower range (the range to decrease to).</li> </ul>
Rated voltage to ground	Voltage input terminals: 1000 V Current input terminals with /EX1 to /EX6 option*: 1000 V (maximum allowable voltage that can be measured) 600 V (rating voltage of EN 61010-2-030) without /EX1 to /EX6 option: 1000 V External current sensor input connector: 600 V

\* Do not touch the inside of the external current sensor input BNC.

## 6.2 Display

Item	Specifications
Display	8.4-inch color TFT LCD
Resolution of the entire screen*	1024 × 768 dots (H × V)
Display update interval	Same as the data update interval. However, <ol style="list-style-type: none"> <li>1) When only the numeric display is in use and the data update interval is 50 ms, 100 ms, or 200 ms, the display update interval is a value in the range of 200 ms to 500 ms (the rate varies depending on the number of displayed items).</li> <li>2) When a display other than the numeric display (including the Custom display) is in use and the data update interval is 50 ms, 100 ms, 200 ms, or 500 ms, the display update rate is 1 s.</li> <li>3) If the measurement mode display is set to Normal Mode (Trg), measurement takes place from when a trigger is detected over the data update interval. The following amount of time is required for this instrument to compute the measured data, process it for displaying, and so on, and become ready for the next trigger. <ul style="list-style-type: none"> <li>• When the data update interval is 50 ms to 500 ms: Approx. 1 s</li> <li>• When the data update interval is 1 s to 5 s: Data update interval + 500 ms</li> </ul> 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 Mode, storage, communication output, and D/A output operate in sync with the data update interval.</li> <li>4) In the case of numerical value indication, the display update interval when the data update interval is Auto is more than 200ms. In addition, the cases except the numerical value indication and the Custom screen is more than 1s.</li> </ol>

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

## 6.3 Displayed Items

### Numeric Display

#### Measurement Functions Determined for Each Input Element

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, Udc: simple average, Urmn: rectified mean value, Uac: AC component
Current (A)	Irms: true rms value, Imn: rectified mean value calibrated to the rms value, Idc: simple average, Irmn: rectified mean value, Iac: AC component
Active power (W)	P
Apparent power (VA)	S
Reactive power (var)	Q
Power factor	$\lambda$
Phase difference (°)	$\Phi$
Frequency (Hz)	fU (FreqU): voltage frequency, fI (FreqI): current frequency Simultaneously measure all fU and fI of element 1 to 6.
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
Corrected power (W)	Pc Applicable standards IEC76-1 (1976), IEC76-1 (1993)
Integration	Time: 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, Irmn, or Iac.

\* This item is not calculated when data update interval is set to Auto.

### 6.3 Displayed Items

#### Measurement Functions ( $\Sigma$ Functions) Determined for Each Wiring Unit ( $\Sigma A$ , $\Sigma B$ , and $\Sigma C$ )

For details about how  $\Sigma$  function values are computed and determined, see appendix 1.

Item	Symbols and Meanings
Voltage (V)	Urms $\Sigma$ : true rms value, Umn $\Sigma$ : rectified mean value calibrated to the rms value, Udc $\Sigma$ : simple average, Urmn $\Sigma$ : rectified mean value, Uac $\Sigma$ : AC component
Current (A)	Irms $\Sigma$ : true rms value, Imn $\Sigma$ : rectified mean value calibrated to the rms value, Idc $\Sigma$ : simple average, Irmn $\Sigma$ : rectified mean value, Iac $\Sigma$ : AC component
Active power (W)	P $\Sigma$
Apparent power (VA)	S $\Sigma$
Reactive power (var)	Q $\Sigma$
Power factor	$\lambda$ $\Sigma$
Phase difference (°)	$\Phi$ $\Sigma$
Corrected power(W)	Pc $\Sigma$ Applicable standards IEC76-1 (1976), IEC76-1 (1993)
Integration	WP $\Sigma$ : sum of positive and negative watt hours WP+ $\Sigma$ : sum of positive P (consumed watt hours) WP- $\Sigma$ : sum of negative P (watt hours returned to the power supply) q $\Sigma$ : sum of positive and negative ampere hours q+ $\Sigma$ : sum of positive I (ampere hours) q- $\Sigma$ : sum of negative I (ampere hours) WS $\Sigma$ : integrated value of S $\Sigma$ * WQ $\Sigma$ : integrated value of Q $\Sigma$ *

\* This item is not calculated when data update interval is set to Auto.

## Harmonic Measurement (Option)

### Measurement Functions Determined for Each Input Element

Item	Symbols and Meanings
Voltage (V)	$U(k)$ : rms voltage value of harmonic order $k$ <sup>1</sup> $U$ : total rms voltage <sup>2</sup>
Current (A)	$I(k)$ : rms current value of harmonic order $k$ $I$ : total rms current <sup>2</sup>
Active power (W)	$P(k)$ : active power of harmonic order $k$ $P$ : total active power <sup>2</sup>
Apparent power (VA)	$S(k)$ : apparent power of harmonic order $k$ $S$ : total apparent power <sup>2</sup>
Reactive power (var)	$Q(k)$ : reactive power of harmonic order $k$ $Q$ : total reactive power <sup>2</sup>
Power factor	$\lambda(k)$ : power factor of harmonic order $k$ $\lambda$ : total power factor <sup>2</sup>
Phase difference (°)	$\Phi(k)$ : phase difference between the voltage and current of harmonic order $k$ , $\Phi$ : total phase difference $\Phi U(k)$ : phase difference between harmonic voltage $U(k)$ and the fundamental wave $U(1)$ $\Phi I(k)$ : phase difference between harmonic current $I(k)$ and the fundamental wave $I(1)$
Load circuit impedance ( $\Omega$ )	$Z(k)$ : impedance of the load circuit in relation to harmonic order $k$
Load circuit resistance and reactance ( $\Omega$ )	$R_s(k)$ : resistance of the load circuit in relation to harmonic order $k$ when resistor $R$ , inductor $L$ , and capacitor $C$ are connected in series $X_s(k)$ : reactance of the load circuit in relation to harmonic order $k$ when resistor $R$ , inductor $L$ , and capacitor $C$ are connected in series $R_p(k)$ : resistance of the load circuit in relation to harmonic order $k$ when $R$ , $L$ , and $C$ are connected in parallel $X_p(k)$ : reactance of the load circuit in relation to harmonic order $k$ when $R$ , $L$ , and $C$ are connected in parallel
Harmonic distortion factor (%)	$U_{hdf}(k)$ : ratio of harmonic voltage $U(k)$ to $U(1)$ or $U$ $I_{hdf}(k)$ : ratio of harmonic current $I(k)$ to $I(1)$ or $I$ $P_{hdf}(k)$ : ratio of harmonic active power $P(k)$ to $P(1)$ or $P$
Total harmonic distortion (%)	$U_{thd}$ : ratio of the total harmonic voltage to $U(1)$ or $U^3$ $I_{thd}$ : ratio of the total harmonic current to $I(1)$ or $I^3$ $P_{thd}$ : ratio of the total harmonic active power to $P(1)$ or $P^3$
Telephone harmonic factor (applicable standard: IEC34-1 (1996))	$U_{thf}$ : voltage telephone harmonic factor, $I_{thf}$ : current telephone harmonic factor
Telephone influence factor (applicable standard: IEEE Std 100 (1996))	$U_{tif}$ : voltage telephone influence factor, $I_{tif}$ : current telephone influence factor
Harmonic voltage factor <sup>4</sup>	$hvf$ : harmonic voltage factor
Harmonic current factor <sup>4</sup>	$hcf$ : harmonic current factor
K-factor	Ratio of the sum of squares whose harmonic components are weighted to the sum of squares of the electric current harmonics

- 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 App-4 from the fundamental wave (1st order) and all harmonic components (2nd order 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 order to the upper limit of harmonic analysis) according to the equations on App-5.
- 4 The expression may vary depending on the definitions in the standard. For details, see the corresponding standard.

### 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 $U1-U2$ (°)	$\Phi U1-U2$ : phase angle between the fundamental voltage of element 1, which is expressed as $U1(1)$ , and the fundamental voltage of element 2, which is expressed as $U2(1)$
Phase angle $U1-U3$ (°)	$\Phi U1-U3$ : phase angle between $U1(1)$ and the fundamental voltage of element 3, $U3(1)$
Phase angle $U1-I1$ (°)	$\Phi U1-I1$ : phase angle between $U1(1)$ and the fundamental current of element 1, $I1(1)$
Phase angle $U2-I2$ (°)	$\Phi U2-I2$ : phase angle between $U2(1)$ and the fundamental current of element 2, $I2(1)$
Phase angle $U3-I3$ (°)	$\Phi U3-I3$ : phase angle between $U3(1)$ and the fundamental current of element 3, $I3(1)$
$EaU1$ to $EaU6$ (°), $EaI1$ to $EaI6$ (°)	Phase angle of the fundamental waves of $U1$ to $I6$ based on the fall of the Z terminal input in the motor evaluation function.

### 6.3 Displayed Items

#### Measurement Functions ( $\Sigma$ Functions) Determined for Each Wiring Unit ( $\Sigma A$ , $\Sigma B$ , and $\Sigma C$ )

Item	Symbols and Meanings	
Voltage (V)	$U\Sigma(1)$ : rms voltage of harmonic order 1	$U\Sigma$ : total rms voltage*
Current (A)	$I\Sigma(1)$ : rms current of harmonic order 1	$I\Sigma$ : total rms current*
Active power (W)	$P\Sigma(1)$ : active power of harmonic order 1	$P\Sigma$ : total active power*
Apparent power (VA)	$S\Sigma(1)$ : apparent power of harmonic order 1	$S\Sigma$ : total apparent power*
Reactive power (var)	$Q\Sigma(1)$ : reactive power of harmonic order 1	$Q\Sigma$ : total reactive power*
Power factor	$\lambda\Sigma(1)$ : power factor of harmonic order 1	$\lambda\Sigma$ : total power factor*

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

### Delta Computation

Item	Delta Computation Setting	Symbols and Meanings
Voltage (V)	difference	$\Delta U1$ : differential voltage between u1 and u2 determined through computation
	3P3W->3V3A	$\Delta U1$ : unmeasured line voltage computed in a three-phase, three-wire system
	DELTA->STAR	$\Delta U1, \Delta U2, \Delta U3$ : phase voltage computed in a three-phase, three-wire (3V3A) system $\Delta U\Sigma = (\Delta U1 + \Delta U2 + \Delta U3)/3$
	STAR->DELTA	$\Delta U1, \Delta U2, \Delta U3$ : line voltage computed in a three-phase, four-wire system $\Delta U\Sigma = (\Delta U1 + \Delta U2 + \Delta U3)/3$
Current (A)	difference	$\Delta I$ : differential current between i1 and i2 determined through computation
	3P3W->3V3A	$\Delta I$ : unmeasured phase current
	DELTA->STAR	$\Delta I$ : neutral line current
	STAR->DELTA	$\Delta I$ : neutral line current
Power (W)	difference	—
	3P3W->3V3A	—
	DELTA->STAR	$\Delta P1, \Delta P2, \Delta P3$ : phase power computed in a three-phase, three-wire (3V3A) system $\Delta P\Sigma = \Delta P1 + \Delta P2 + \Delta P3$
	STAR->DELTA	—

### Waveforms

Item	Specifications
Waveform display items	Voltage, current, torque, speed, AUX1, and AUX2 for elements 1 to 6

### Bar Graphs and Vectors (Option)

Item	Specifications
Bar graph display	Displays a bar graph of the amplitude of each harmonic
Vector display	Displays the phase difference between the fundamental voltage signal and fundamental current signal as a vector.

### Trends

Item	Specifications
Number of measurement channels	Up to 16 items
Trend display	Displays a line graph of measurement function numeric data trends

## 6.4 Accuracy

### Voltage and Current

Item	Specifications
Accuracy (at 6 months)	<p>Conditions            Temperature: 23°C ± 5°C. Humidity: 30%RH to 75%RH. Input waveform: Sine wave. <math>\lambda</math> (power factor): 1. Common-mode voltage: 0 V. Crest factor: CF3. Line filter: Off. Frequency filter: Set to 1 kHz. 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.</p>
Voltage {Frequency bandwidth 5MHz (-3dB, TYP.)}	
Frequency	Accuracy ±(reading error + measurement range error)
DC	±(0.05% 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	±(0.03% of reading + 0.05% of range) * Add 0.02% of reading for the 1000 V range.
66 Hz < f ≤ 1 kHz	±(0.1% of reading + 0.1% of range)
1 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 bandwidth	5 MHz (-3 dB, typical)
Current {Frequency bandwidth 5MHz (-3dB, TYP.) External current sensor input of 5A input element or 50A input element}	
Frequency	Accuracy ±(reading error + measurement range error)
DC	±(0.05% 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) + (2 μA*)}
45 Hz ≤ f ≤ 66 Hz	±{(0.03% of reading + 0.05% of range) + (2 μA*)} * Not added under the external current sensor input setting
66 Hz < f ≤ 1 kHz	±(0.1% of reading + 0.1% of range) Direct input of a 50 A input element ±(0.2% of reading + 0.1% of range)
1 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.1% of range) 50 mV, 100 mV, or 200 mV range of an external current sensor's input ±(0.5% of reading + 0.1% of range) Direct input of a 50 A input element ±{(0.1 × f + 0.2)% of reading + 0.1% of range}
50 kHz < f ≤ 100 kHz	±(0.6% of reading + 0.2% of range) Direct input of a 50 A input element ±{(0.1 × f + 0.2)% of reading + 0.1% of range}
100 kHz < f ≤ 200 kHz	±{(0.006 × f)% of reading + 0.5% of range} Direct input of a 50 A input element ±{(0.05 × f + 5)% of reading + 0.5% of range}
200 kHz < f ≤ 500 kHz	±{(0.006 × f)% of reading + 0.5% of range} Direct input of a 50 A input element Accuracy is not defined.
500 kHz < f ≤ 1 MHz	±{(0.022 × f - 8)% of reading + 1% of range} Direct input of a 50 A input element Accuracy is not defined.

## 6.4 Accuracy

### Power

Item	Specifications
Accuracy (at 6 months)	Conditions: Same as the conditions for the voltage and current accuracies
	Frequency Accuracy
	$\pm(\text{reading error} + \text{measurement range error})$
	DC $\pm(0.05\% \text{ of reading} + 0.05\% \text{ of range})$
	$0.1 \text{ Hz} \leq f < 10 \text{ Hz}$ $\pm(0.08\% \text{ of reading} + 0.1\% \text{ of range})$
	$10 \text{ Hz} \leq f < 45 \text{ Hz}$ $\pm(0.08\% \text{ of reading} + 0.1\% \text{ of range}) + (2 \mu\text{A} \times U^*)$
	$45 \text{ Hz} \leq f \leq 66 \text{ Hz}$ $\pm(0.05\% \text{ of reading} + 0.05\% \text{ of range}) + (2 \mu\text{A} \times U^*)$
	* Not added under the external current sensor input setting
	$66 \text{ Hz} < f \leq 1 \text{ kHz}$ $\pm(0.2\% \text{ of reading} + 0.1\% \text{ of range})$
	$1 \text{ kHz} < f \leq 50 \text{ kHz}$ $\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$ 50 mV, 100 mV, or 200 mV range of an external current sensor's input $\pm(0.5\% \text{ of reading} + 0.2\% \text{ of range})$ Direct input of a 50 A input element $\pm\{(0.1 \times f + 0.2)\% \text{ of reading} + 0.2\% \text{ of range}\}$
	$50 \text{ kHz} < f \leq 100 \text{ kHz}$ $\pm(0.7\% \text{ of reading} + 0.3\% \text{ of range})$ Direct input of a 50 A input element $\pm\{(0.3 \times f - 9.5)\% \text{ of reading} + 0.3\% \text{ of range}\}$
	$100 \text{ kHz} < f \leq 200 \text{ kHz}$ $\pm\{(0.008 \times f)\% \text{ of reading} + 1\% \text{ of range}\}$ Direct input of a 50 A input element $\pm\{(0.09 \times f + 11)\% \text{ of reading} + 1\% \text{ of range}\}$
	$200 \text{ kHz} < f \leq 500 \text{ kHz}$ $\pm\{(0.008 \times f)\% \text{ of reading} + 1\% \text{ of range}\}$ Direct input of a 50 A input element Accuracy is not defined.
	$500 \text{ kHz} < f \leq 1 \text{ MHz}$ $\pm\{0.048 \times f - 20\}\% \text{ of reading} + 2\% \text{ of range}\}$ Direct input of a 50 A input element Accuracy is not defined.

- For the external current sensor range, add the following values to the accuracies listed above:
  - DC current accuracy: 50  $\mu\text{V}$
  - DC power accuracy:  $(50 \mu\text{V}/\text{rated value of the external current sensor range}) \times 100\%$  of range
- For the direct current input range, add the following values to the accuracies listed above:
  - 50 A input elements:
    - DC current accuracy: 1.5 mA
    - DC power accuracy:  $(1 \text{ mA}/\text{rated value of the direct current input range}) \times 100\%$  of range
  - 5 A input elements:
    - DC current accuracy: 15  $\mu\text{A}$
    - DC power accuracy:  $(10 \mu\text{A}/\text{rated value of the direct current input range}) \times 100\%$  of range
- For the accuracies of waveform display data functions  $U_{pk}$  and  $I_{pk}$ :
  - Add the following values (reference values) to the accuracies listed above. The effective input range is within  $\pm 300\%$  ( $\pm 600\%$  when the crest factor is set to CF6/CF6A) of the range.
    - Voltage input:  $\{1.5 \times \sqrt{(15/\text{range})} + 0.5\}\%$  of range
    - Direct current input range:
      - 50 A input element:  $3 \times \sqrt{(1/\text{range})}\%$  of range + 10 mA
      - 5 A input element:  $\{10 \times \sqrt{(0.01/\text{range})} + 0.5\}\%$  of range
    - External current sensor input range:
      - 50 mV to 200 mV range:  $\{10 \times \sqrt{(0.01/\text{range})} + 0.5\}\%$  of range
      - 500 mV to 10 V range:  $\{10 \times \sqrt{(0.05/\text{range})} + 0.5\}\%$  of range
  - 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/ $^{\circ}\text{C}$
      - Direct current input DC accuracy
        - 50 A input element: 1 mA/ $^{\circ}\text{C}$
        - 5 A input element: 10  $\mu\text{A}/^{\circ}\text{C}$
      - External current sensor input DC accuracy: 50  $\mu\text{V}/^{\circ}\text{C}$
      - DC power accuracy: the product of the voltage influence and the current influence
  - Influence of self-generated heat caused by voltage input
    - Add the following values to the voltage and power accuracies:
      - AC input signal:  $0.0000001 \times U^2\%$  of reading
      - DC input signal:  $0.0000001 \times U^2\%$  of reading +  $0.0000001 \times U^2\%$  of range
      - U is the voltage reading (V).
    - Even if the voltage input decreases, the influence from self-generated heat continues until the temperature of the input resistor decreases.
  - Influence of self-generated heat caused by current input
    - Add the following values to the current and power accuracies of 50 A input elements.
      - AC input signal:  $0.00006 \times I^2\%$  of reading
      - DC input signal:  $0.00006 \times I^2\%$  of reading +  $0.004 \times I^2 \text{ mA}$

Add the following values to the current and power accuracies of 5 A input elements.

AC input signal:  $0.006 \times I^2\%$  of reading

DC input signal:  $0.006 \times I^2\%$  of reading +  $0.004 \times 1\%$  of reading

I is the current reading (A). Even if the current input decreases, the influence from self-generated heat continues until the shunt resistor temperature 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.

- The accuracy when the crest factor is CF6/CF6A is the same as that when the crest factor is CF3 after doubling the measurement range.

Item	Specifications																						
Power factor ( $\lambda$ ) influence	<p>When <math>\lambda = 0</math></p> <p>Apparent power reading <math>\times 0.07\%</math> in the range of 45 Hz to 66 Hz. For other frequency ranges, see below. Be aware that these figures are reference values.</p> <p>5 A input element and external current sensor input: apparent power reading <math>\times (0.07 + 0.05 \times f)\%</math> 50 A input element and direct input: apparent power reading <math>\times (0.07 + 0.3 \times f)\%</math></p> <p>When <math>0 &lt; \lambda &lt; 1</math></p> <p>(Power reading) <math>\times</math> [(power reading error %) + (power range error %) <math>\times</math> (power range/indicated apparent power value) + {<math>\tan \Phi \times</math> (influence when <math>\lambda = 0</math>)%}], where <math>\Phi</math> is the phase angle between the voltage and current.</p>																						
Line filter influence	<p>When the cutoff frequency (<math>f_c</math>) is 100 Hz to 100 kHz</p> <p>Voltage and current Up to approx. <math>(f_c/2)</math> Hz: Add <math>2 \times [1 - \sqrt{1/(1 + (f/f_c)^4)}] \times 100 + (20 \times f/300k)\%</math> of reading Applies to frequencies less than or equal to 30 kHz</p> <p>Power Up to approx. <math>(f_c/2)</math> Hz: Add <math>4 \times [1 - \sqrt{1/(1 + (f/f_c)^4)}] \times 100 + (40 \times f/300k)\%</math> of reading Applies to frequencies less than or equal to 30 kHz</p> <p>When the cutoff frequency (<math>f_c</math>) is 300 kHz to 1 MHz</p> <p>Voltage and current Up to approx. <math>(f_c/10)</math> Hz: Add <math>(20 \times f/f_c)\%</math> of reading.</p> <p>Power Up to approx. <math>(f_c/10)</math> Hz: Add <math>(40 \times f/f_c)\%</math> of reading.</p>																						
Lead and lag detection (Phase angle $\Phi$ 's D (lead) and G (lag))	<p>The lead and lag of the voltage and current inputs can be detected correctly for the following:</p> <ul style="list-style-type: none"> <li>• Sine waves</li> <li>• When the measured value is 50% or more (100% or more when the crest factor is CF6/CF6A) of the measurement range</li> <li>• Frequency: 20 Hz to 10 kHz</li> <li>• Phase difference: <math>\pm(5^\circ</math> to <math>175^\circ)</math></li> </ul>																						
Symbol s in the reactive power $Q\Sigma$ computation	s is the sign for the lead and lag of each element. It is negative when the voltage leads the current.																						
Temperature coefficient	Add $\pm 0.03\%$ of reading/ $^\circ\text{C}$ within the range of $5^\circ\text{C}$ to $18^\circ\text{C}$ or $28^\circ\text{C}$ to $40^\circ\text{C}$ .																						
Effective input range	<p>Udc, Idc: 0% to <math>\pm 110\%</math> of the measurement range</p> <p>Urms, Irms: 1% to <math>\pm 110\%</math> of the measurement range</p> <p>Umn, Imn: 10% to 110% of the measurement range</p> <p>Urmn, Irmn: 10% to 110% of the measurement range</p> <p>Power:</p> <p>DC measurement: 0% to <math>\pm 110\%</math></p> <p>AC measurement: 1% to 110% of the voltage and current ranges; up to <math>\pm 110\%</math> of the power range</p> <p>However, the synchronization source level must meet the frequency measurement input signal level. When the crest factor is set to CF6/CF6A, the upper and lower limits are multiplied by 2.</p>																						
Maximum display	<p>140% of the rated voltage or current range</p> <p>When crest factor is set to CF6A, 280% of the voltage and current range rating</p>																						
Minimum display	<p>Depending on the measurement range, the following are the minimum values that are displayed:</p> <ul style="list-style-type: none"> <li>• Urms, Uac, Irms, and Iac: 0.3% (0.6% when the crest factor is set to 6)</li> <li>• Umn, Urmn, Imn, and Irmn: 2% (4% when the crest factor is set to 6)</li> </ul> <p>When input level is lower than above, the display shows zero if zero-surplus setting is ON, otherwise measured value will be shown. Current integration value q also depends on the current value.</p>																						
Lower limit of measurement frequency	<table border="1"> <thead> <tr> <th>Data update interval</th> <th>50 ms</th> <th>100 ms</th> <th>200 ms</th> <th>500 ms</th> <th>1 s</th> <th>2 s</th> <th>5 s</th> <th>10 s</th> <th>20 s</th> <th>Auto</th> </tr> </thead> <tbody> <tr> <td>Lower limit of measurement frequency</td> <td>45 Hz</td> <td>25 Hz</td> <td>12.5 Hz</td> <td>5 Hz</td> <td>2.5 Hz</td> <td>1.25 Hz</td> <td>0.5 Hz</td> <td>0.2 Hz</td> <td>0.1 Hz</td> <td>0.1 Hz</td> </tr> </tbody> </table>	Data update interval	50 ms	100 ms	200 ms	500 ms	1 s	2 s	5 s	10 s	20 s	Auto	Lower limit of measurement frequency	45 Hz	25 Hz	12.5 Hz	5 Hz	2.5 Hz	1.25 Hz	0.5 Hz	0.2 Hz	0.1 Hz	0.1 Hz
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Lower limit of measurement frequency	45 Hz	25 Hz	12.5 Hz	5 Hz	2.5 Hz	1.25 Hz	0.5 Hz	0.2 Hz	0.1 Hz	0.1 Hz													
Accuracy of apparent power S	Voltage accuracy + current accuracy																						
Accuracy of reactive power Q	Accuracy of apparent power + $(\sqrt{(1.0004 - \lambda^2)} - \sqrt{1 - \lambda^2}) \times 100\%$ of range																						
Accuracy of power factor $\lambda$	$\pm[(\lambda - \lambda/1.0002) +  \cos \Phi - \cos\{\Phi + \sin^{-1}((\text{influence from the power factor when } \lambda = 0)\%/100)\} ] \pm 1$ digit. The voltage and current must be within their rated ranges.																						
Accuracy of phase angle $\Phi$	$\pm[\Phi - \{\cos^{-1}(\lambda/1.0002)\}] + \sin^{-1}\{(\text{influence from the power factor when } \lambda = 0)\%/100\}$ deg $\pm 1$ digit. The voltage and current must be within their rated ranges.																						
Accuracy at 1 year	1.5 times the reading errors for the accuracy at 6 months																						

## 6.5 Features

### Measurement Features and Measurement Conditions

Item	Specifications
Crest factor	300 for the minimum effective input CF3:3 (relative to the the rated values of the measurement range) CF6/CF6A:6 (relative to the the rated values of the measurement range)
Measurement period	Period used to determine and compute measurement functions. <ul style="list-style-type: none"> <li>• Except for watt hours (Wp) and DC ampere hours (q), the measurement period is set using the reference signal (synchronization source). Timing of Data update is diferrent (minimum time resolution is 50ms) among elements with diferrent reference signals (synch sources) when the Data update interval is set to Auto. Timeout period can be selected from 1s, 5s, 10s or 20s. And full period of timeout becomes actual measurement period when synchronization source signal does not come any cycles during the timeout period.</li> <li>• When displaying harmonics: The measurement period is the first 1024 or 8192 points from the beginning of the data update interval at the harmonic sampling frequency.</li> <li>• Measurement period detection method: When the Data update interval is set to other than Auto, a nalog signal zero cross detection method When the Data update interval is set to Auto, sampling data level detection method. Data level can be set arbitrarily.</li> </ul>
Wiring system	(1) 1P2W, single-phase, two-wire; (2) 1P3W, single-phase, three-wire; (3) 3P3W, three-phase, three-wire; (4) 3P4W, three-phase, four-wire; and (5) 3P3W(3V3A), three-phase, three wire system that uses a three-voltage, three-current method The selectable wiring systems vary depending on the number of input elements that are installed.
Scaling	Set the current sensor conversion ratio, VT ratio, CT ratio, and power coefficient in the range of 0.0001 to 99999.9999 when applying the external current sensor, VT, or CT output to the instrument. <ul style="list-style-type: none"> <li>• CT ratio can be set automatically by selecting a model name of CT series.</li> <li>• Current sensor conversion ratio can be set automatically by selecting a model name of dedicated shunt resistor.</li> </ul>
Averaging	<ul style="list-style-type: none"> <li>• Using one of the following methods, perform averaging on the normal measurement items: voltage U, current I, power P, apparent power S, or reactive power Q. Power factor <math>\lambda</math> and phase difference angle <math>\Phi</math> are determined from the averaged P and S values.</li> <li>• Select either exponential averages or moving averages. <ul style="list-style-type: none"> <li>• Exponential average Select the attenuation constant from a value between 2 and 64.</li> <li>• Moving average Select the average count from a value between 8 and 64.</li> </ul> </li> <li>• Harmonic measurement Only exponential averaging is valid.</li> </ul>
Data update interval	Select from 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s, 20 s, and Auto. Period detection method is different depending on update interval. <ul style="list-style-type: none"> <li>• 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s, and 20 s: Analog signal zero cross detection method</li> <li>• Auto: Sampling deta level detection method</li> </ul>
Response time	Data update interval $\times$ 2 or less (only during numeric display) When Data update interval is set to Auto, response time is signal cycle period plus 50 ms.
Hold	Holds the data display
Single	Executes a single measurement while measurements are held * When the Data update interval is set to Auto, single measurement can't excutes.
Zero-level compensation/ Null	Performs zero-level compensation. Null compensation range: $\pm 10\%$ of range You can configure the null setting individually for each of the following input signals: <ul style="list-style-type: none"> <li>• Each input element's voltage and current</li> <li>• Rotating speed and torque</li> <li>• AUX1 and AUX2</li> </ul>

## Frequency Measurement

Item	Specifications																						
DUT	The frequencies of the voltage and current being input to all input elements can be measured.																						
Measurement method	Reciprocal method																						
Measurement range	<table border="1"> <thead> <tr> <th>Data Update interval</th> <th>Measurement Range</th> </tr> </thead> <tbody> <tr> <td>50 ms</td> <td>45 Hz ≤ f ≤ 1 MHz</td> </tr> <tr> <td>100 ms</td> <td>25 Hz ≤ f ≤ 1 MHz</td> </tr> <tr> <td>200 ms</td> <td>12.5 Hz ≤ f ≤ 500 kHz</td> </tr> <tr> <td>500 ms</td> <td>5 Hz ≤ f ≤ 200 kHz</td> </tr> <tr> <td>1 s</td> <td>2.5 Hz ≤ f ≤ 100 kHz</td> </tr> <tr> <td>2 s</td> <td>1.25 Hz ≤ f ≤ 50 kHz</td> </tr> <tr> <td>5 s</td> <td>0.5 Hz ≤ f ≤ 20 kHz</td> </tr> <tr> <td>10 s</td> <td>0.25 Hz ≤ f ≤ 10 kHz</td> </tr> <tr> <td>20 s</td> <td>0.15 Hz ≤ f ≤ 5 kHz</td> </tr> <tr> <td>Auto</td> <td>0.1 Hz ≤ f ≤ 500 kHz</td> </tr> </tbody> </table>	Data Update interval	Measurement Range	50 ms	45 Hz ≤ f ≤ 1 MHz	100 ms	25 Hz ≤ f ≤ 1 MHz	200 ms	12.5 Hz ≤ f ≤ 500 kHz	500 ms	5 Hz ≤ f ≤ 200 kHz	1 s	2.5 Hz ≤ f ≤ 100 kHz	2 s	1.25 Hz ≤ f ≤ 50 kHz	5 s	0.5 Hz ≤ f ≤ 20 kHz	10 s	0.25 Hz ≤ f ≤ 10 kHz	20 s	0.15 Hz ≤ f ≤ 5 kHz	Auto	0.1 Hz ≤ f ≤ 500 kHz
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20 s	0.15 Hz ≤ f ≤ 5 kHz																						
Auto	0.1 Hz ≤ f ≤ 500 kHz																						
Accuracy	<p>±0.06% of reading ± 0.1 mHz, when the input signal level is 30% or more (60% or more when the crest factor is set to CF6/CF6A) of the measurement range.</p> <p>The equation above holds true given that:</p> <ul style="list-style-type: none"> <li>The input signal is less than or equal to two times the frequency lower limit written above. <ul style="list-style-type: none"> <li>The input signal is less than or equal to two times the frequency lower limit written above .</li> <li>The range is 10 mA for the 5 A element.</li> <li>The range is 1 A for the 50 A element.</li> </ul> </li> <li>When the Data update interval is set to other than Auto, the 100 Hz frequency filter is ON at 0.15 Hz to 100 Hz, and the 1 kHz frequency filter is ON at 100 Hz to 1 kHz.</li> <li>When the Data update interval is set to Auto, 100 Hz cutoff frequency filter is set to ON for 0.1 Hz to 100 Hz, and 1.6 kHz cutoff frequency filter is set to ON for 100 Hz to 1 kHz.</li> </ul>																						
Number of Displayed Digits (Display Resolution)	5 (99999)																						
Minimum frequency resolution	0.0001 Hz																						
Frequency measurement filter	<ul style="list-style-type: none"> <li>When the Data update interval is set to other than Auto: Select from OFF, 100 Hz, or 1 kHz.</li> <li>When the Data update interval is set to Auto: Select from OFF, 100 Hz, 200 Hz, 400 Hz, 800 Hz, 1.6kHz, 3.2 kHz, 6.4 kHz, 12.8 kHz, or 25.6 kHz.</li> </ul>																						

## Integration

Item	Specifications
Mode	Manual, normal, continuous, real-time normal, and real-time continuous * When Data update interval is set to Auto, integration will be executed in Manual mode or Normal mode. Other Integration modes, Standard, Continuous, Real Time Control Standard and Real Time Control Continuous are not supported.
Integration timer	Integration can be stopped automatically by a timer that can be set to: 0000h00m00s to 10000h00m00s
Count overflow	<p>When the maximum integration time (10000 hours) is reached or when an integrated value reaches the maximum or minimum displayable integrated value,* the integration time and value at that point are held and integration is stopped.</p> <p>* WP: ±999999 MWh q: ±999999 MAh WS: ±999999 MVAh WQ: ±999999 Mvarh</p>
Integration resume action at power failure recovery	<p>When the integration resume function at power failure recovery is set, the integration operation can be resumed if a power failure occurs and recovers while integration is in progress.</p> <p>* When Data update interval is set to Auto, this feature is not supported. Integration state will always change to "Error" after the recovery, disabling continue of integration.</p>
Auto range	<p>Voltage and current: Auto range is available (When the Data update interval is set to other than Auto). Motor input signal, auxiliary input signal: Not available When Element Independent is ON : Not available When S,Q Formula is Type3 : Not available</p>
Accuracy	±(normal measurement accuracy + 0.02% of reading)
Timer accuracy	±0.02% of reading

## 6.6 Harmonic Measurement (Option)

Item	Specifications
DUT	All installed elements
Method	PLL synchronization method (no external sampling clock)
Frequency range	When the Data update interval is set to other than Auto, or when the Data update interval is set to Auto and FFT data length is set to 8192, Fundamental frequency of the PLL source is in the range of 0.5 Hz to 2.6 kHz. When the Data update interval is set to Auto and FFT data length is set to 1024, Fundamental frequency of the PLL source is in the range of 0.1 Hz to 2.6 kHz.
PLL source	<ul style="list-style-type: none"> <li>Select the voltage or current of each input element or an external clock.</li> <li>On models with the /G6 option, when the data update interval is not Auto, you can select two PLL sources and perform dual harmonic measurement. On models with the /G5 option, you can select one PLL source.</li> <li>Input level <ul style="list-style-type: none"> <li>With voltage input, 15 V range or higher</li> <li>With direct current input, 50 mA range or higher</li> <li>With external current sensor input, 200 mV range or higher</li> <li>50% or more of the rated measurement range when the crest factor is CF3.</li> <li>100% or more of the rated measurement range when the crest factor is CF6/CF6A.</li> <li>20 Hz to 1 kHz for 1 A and 2 A ranges of 50 A elements.</li> </ul> </li> <li>The conditions in which frequency filters are turned on are the same as those for frequency measurements.</li> </ul>
FFT data length	1024 when the data update interval is 50 ms, 100 ms, or 200 ms. 8192 when the data update interval is 500 ms, 1 s, 2 s, 5 s, 10 s, or 20 s. Select from 1024 or 8192 when the Data update interval is set to Auto
Window function	Rectangular
Anti-aliasing filter	Set using the line filter
Sample rates, window widths, and upper limits of harmonic analysis	

Number of FFT points: 1024 (when the data update interval is 50 ms, 100 ms, or 200 ms)

Fundamental Frequency	Sample Rate	Window Width	Upper Limit of Harmonic Analysis	
			U, I, P, $\Phi$ , $\Phi$ U, $\Phi$ I	Other Measured Values
15 Hz to 600 Hz	$f \times 1024$	1	500	100
600 Hz to 1200 Hz	$f \times 512$	2	255	100
1200 Hz to 2600 Hz	$f \times 256$	4	100	100

However, when the data update rate is 50 ms, the maximum harmonic order that can be measured is 100.

Number of FFT points: 8192 (when the data update interval is 500 ms, 1 s, 2 s, 5 s, 10 s, or 20 s)

Fundamental Frequency	Sample Rate	Window Width	Upper Limit of Harmonic Analysis	
			U, I, P, $\Phi$ , $\Phi$ U, $\Phi$ I	Other Measured Values
0.5 Hz to 1.5 Hz	$f \times 8192$	1	500	100
1.5 Hz to 5 Hz	$f \times 4096$	2	500	100
5 Hz to 10 Hz	$f \times 2048$	4	500	100
10 Hz to 600 Hz	$f \times 1024$	8	500	100
600 Hz to 1200 Hz	$f \times 512$	16	255	100
1200 Hz to 2600 Hz	$f \times 256$	32	100	100

Number of FFT points: 1024 (when the data update interval is Auto)

Fundamental Frequency	Sample Rate	Window Width	Upper Limit of Harmonic Analysis	
			U, I, P, $\Phi$ , $\Phi$ U, $\Phi$ I	Other Measured Values
0.1 Hz to 75 Hz	$f \times 1024$	1	100	100
75 Hz to 600 Hz	$f \times 1024$	1	100	100
600 Hz to 1200 Hz	$f \times 512$	2	100	100
1200 Hz to 2600 Hz	$f \times 256$	4	100	100

Number of FFT points: 8192 (when the data update interval is Auto)

Fundamental Frequency	Sample Rate	Window Width	Upper Limit of Harmonic Analysis	
			U, I, P, $\Phi$ , $\Phi$ U, $\Phi$ I	Other Measured Values
0.5 Hz to 75 Hz	$f \times 1024$	8	500	100
75 Hz to 600 Hz	$f \times 1024$	8	500	100
600 Hz to 1200 Hz	$f \times 512$	16	255	100
1200 Hz to 2600 Hz	$f \times 256$	32	100	100

Item	Specifications																																																																								
Accuracy	<p>Add the following accuracy values to the normal measurement accuracy values.</p> <ul style="list-style-type: none"> <li>When the line filter is set to OFF and Update interval is set to other than Auto</li> </ul> <table border="1"> <thead> <tr> <th>Frequency</th> <th>Voltage</th> <th>Current</th> <th>Power</th> </tr> </thead> <tbody> <tr> <td>0.5 Hz ≤ f &lt; 10 Hz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>10 Hz ≤ f &lt; 45 Hz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>45 Hz ≤ f ≤ 66 Hz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>66 Hz &lt; f ≤ 440 Hz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>440 Hz &lt; f ≤ 1 kHz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>1 kHz &lt; f ≤ 10 kHz</td> <td>0.5% of reading + 0.25% of range</td> <td>0.5% of reading + 0.25% of range</td> <td>1% of reading + 0.5% of range</td> </tr> <tr> <td>10 kHz &lt; f ≤ 100 kHz</td> <td>0.5% of range</td> <td>0.5% of range</td> <td>1% of range</td> </tr> <tr> <td>100 kHz &lt; f ≤ 260 kHz</td> <td>1% of range</td> <td>1% of range</td> <td>2% of range</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>When the line filter is set to OFF and update interval is set to Auto</li> </ul> <table border="1"> <thead> <tr> <th>Frequency</th> <th>Voltage</th> <th>Current</th> <th>Power</th> </tr> </thead> <tbody> <tr> <td>0.5 Hz ≤ f &lt; 10 Hz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>10 Hz ≤ f &lt; 45 Hz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>45 Hz ≤ f ≤ 66 Hz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>66 Hz &lt; f ≤ 440 Hz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>440 Hz &lt; f ≤ 1 kHz</td> <td>0.05% of reading + 0.25% of range</td> <td>0.05% of reading + 0.25% of range</td> <td>0.1% of reading + 0.5% of range</td> </tr> <tr> <td>1 kHz &lt; f ≤ 10 kHz</td> <td>0.5% of reading + 0.25% of range</td> <td>0.5% of reading + 0.25% of range</td> <td>1% of reading + 0.5% of range</td> </tr> <tr> <td>10 kHz &lt; f ≤ 100 kHz</td> <td>0.5% of range</td> <td>0.5% of range</td> <td>1% of range</td> </tr> <tr> <td>100 kHz &lt; f ≤ 260 kHz</td> <td>1% of range</td> <td>1% of range</td> <td>2% of range</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>When line filters are turned on</li> </ul> <p>Add the line filter accuracy values to the accuracy values when the line filters are turned off.</p>	Frequency	Voltage	Current	Power	0.5 Hz ≤ f < 10 Hz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	10 Hz ≤ f < 45 Hz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	45 Hz ≤ f ≤ 66 Hz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	66 Hz < f ≤ 440 Hz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	440 Hz < f ≤ 1 kHz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	1 kHz < f ≤ 10 kHz	0.5% of reading + 0.25% of range	0.5% of reading + 0.25% of range	1% of reading + 0.5% of range	10 kHz < f ≤ 100 kHz	0.5% of range	0.5% of range	1% of range	100 kHz < f ≤ 260 kHz	1% of range	1% of range	2% of range	Frequency	Voltage	Current	Power	0.5 Hz ≤ f < 10 Hz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	10 Hz ≤ f < 45 Hz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	45 Hz ≤ f ≤ 66 Hz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	66 Hz < f ≤ 440 Hz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	440 Hz < f ≤ 1 kHz	0.05% of reading + 0.25% of range	0.05% of reading + 0.25% of range	0.1% of reading + 0.5% of range	1 kHz < f ≤ 10 kHz	0.5% of reading + 0.25% of range	0.5% of reading + 0.25% of range	1% of reading + 0.5% of range	10 kHz < f ≤ 100 kHz	0.5% of range	0.5% of range	1% of range	100 kHz < f ≤ 260 kHz	1% of range	1% of range	2% of range
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The items listed below apply to the tables in this section.

- The crest factor is set to CF3.
- $\lambda$  (the power factor) is 1.
- Power figures that exceed 2.6 kHz are reference values.
- Add the following values when a voltage range is being used:
  - Voltage accuracy: 25 mV
  - Power accuracy: (25 mV/rated voltage range) × 100% of range
- Add the following values when direct current input is being used:
  - 5 A elements:
    - Current accuracy: 50  $\mu$ A
    - Power accuracy: (50  $\mu$ A/rated current range) × 100% of range
  - 50 A elements:
    - Current accuracy: 4 mA
    - Power accuracy: (4 mA/rated current range) × 100% of range
- Add the following values when an external current sensor range is being used:
  - Current accuracy: 2 mV
  - Power accuracy: (2 mV/rated external current sensor range) × 100% of range
- Add (n/500)% of reading to the n<sup>th</sup> component of the voltage and current. Add (n/250)% of reading to the n<sup>th</sup> component of the power.
- The accuracy when the crest factor is CF6/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.

## 6.6 Harmonic Measurement (Option)

- When the Data update interval is set to other than AUTO, or when the Data update interval is set to AUTO and FFT data length is set to 8192
  - For  $n^{\text{th}}$  order component input when the PLL source frequency is 2Hz or more, add  $(\{n/(m + 1)\}/50)\%$  of (the  $n^{\text{th}}$  order reading) to the  $(n + m)^{\text{th}}$  order and  $(n - m)^{\text{th}}$  order of the voltage and current, and add  $(\{n/(m + 1)\}/25)\%$  of (the  $n^{\text{th}}$  order reading) to the  $(n + m)^{\text{th}}$  order and  $(n - m)^{\text{th}}$  order of the power.
  - For  $n^{\text{th}}$  order component input when the PLL source frequency is less than 2Hz, add  $(\{n/(m + 1)\}/20)\%$  of (the  $n^{\text{th}}$  order reading) to the  $(n + m)^{\text{th}}$  order and  $(n - m)^{\text{th}}$  order of the voltage and current, and add  $(\{n/(m + 1)\}/10)\%$  of (the  $n^{\text{th}}$  order reading) to the  $(n + m)^{\text{th}}$  order and  $(n - m)^{\text{th}}$  order of the power.
- When the Data update interval is set to AUTO and FFT data length is set to 1024
  - For  $n^{\text{th}}$  order component input when the PLL source frequency is 75Hz or more, add  $(\{n/(m + 1)\}/50)\%$  of (the  $n^{\text{th}}$  order reading) to the  $(n + m)^{\text{th}}$  order and  $(n - m)^{\text{th}}$  order of the voltage and current, and add  $(\{n/(m + 1)\}/25)\%$  of (the  $n^{\text{th}}$  order reading) to the  $(n + m)^{\text{th}}$  order and  $(n - m)^{\text{th}}$  order of the power.
  - For  $n^{\text{th}}$  order component input when the PLL source frequency is less than 75Hz, add  $(\{n/(m + 1)\}/10)\%$  of (the  $n^{\text{th}}$  order reading) to the  $(n + m)^{\text{th}}$  order and  $(n - m)^{\text{th}}$  order of the voltage and current, and add  $(\{n/(m + 1)\}/5)\%$  of (the  $n^{\text{th}}$  order reading) to the  $(n + m)^{\text{th}}$  order and  $(n - m)^{\text{th}}$  order of the power.

## 6.7 Motor Evaluation Function (Option)

Item	Specifications
Input terminal	TORQUE, SPEED (A, B, Z)
Input resistance	Approx. 1 M $\Omega$
Input connector type	Isolated BNC

### Analog Input

(SPEED is being applied to terminal A.)

Item	Specifications
Range	1 V, 2 V, 5 V, 10 V, 20 V
Input range	$\pm 110\%$
Line filter	Off, 100 kHz, 1 kHz
Continuous maximum allowable input	$\pm 22$ V
Maximum common-mode voltage	$\pm 42$ V <sub>peak</sub>
Sampling interval	Approx. 200 kS/s
Resolution	16 bits
Accuracy	$\pm(0.03\%$ of reading + 0.03% of range)
Temperature coefficient	$\pm 0.03\%$ of range/ $^{\circ}$ C

### Pulse Input

(If you do not need to detect the direction, apply SPEED to terminal A. If you need to detect the direction, apply phase A and phase B of a rotary encoder to terminals A and B, respectively. If you are measuring the electrical angle, apply phase Z of a rotary encoder to terminal Z.)

Item	Specifications
Input range	$\pm 12$ V <sub>peak</sub>
Frequency measurement range	2 Hz to 1 MHz
Maximum common-mode voltage	$\pm 42$ V <sub>peak</sub>
Accuracy	$\pm(0.03 + f/10000)\%$ of reading $\pm 1$ mHz      The unit of f is kHz. Accuracy of the waveform display data $\pm(0.03+f/500) \%$ of reading $\pm 1$ mHz      The unit of f is kHz.
Z terminal input fall time and electrical angle measurement start time	500 ns or less
Detection level	H level: approx. 2 V or more L level: approx. 0.8 V or less
Pulse width	500 ns or more

To measure electrical angles, you need the harmonic measurement option (/G5 or /G6).

## 6.8 Auxiliary Input (Option)

Item	Specifications
Input terminal	AUX1, AUX2
Input format	Analog
Input resistance	Approx. 1 M $\Omega$
Input connector type	Isolated BNC
Range	50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V, 20 V
Input range	$\pm 110\%$
Line filter	Off, 100 Hz, 1 kHz
Continuous maximum allowable input	$\pm 22$ V
Maximum common-mode voltage	$\pm 42$ V <sub>peak</sub>
Sampling interval	Approx. 200 kS/s
Resolution	16 bits
Accuracy	$\pm(0.03\%$ of reading + $0.03\%$ of range) • Add 20 $\mu\text{V}/^\circ\text{C}$ for temperature changes after zero-level compensation or range change.
Temperature coefficient	$\pm 0.03\%$ of range/ $^\circ\text{C}$

## 6.9 D/A Output and Remote Control (Option)

### D/A Output

Item	Specifications
D/A conversion resolution	16 bits
Output voltage	Each rated value $\pm 5$ V FS (maximum of approx. $\pm 7.5$ V)
Update interval	Same as the data update interval of this instrument (if the waveform display is enabled and the trigger mode is set to Auto or Normal, the data update interval depends on the trigger operation) * When Data update interval is set to Auto, update interval is 50 ms.
Number of outputs	20 channels (the output items can be set for each channel)
Accuracy	$\pm$ (each measurement function's accuracy + 0.1% of FS); FS = 5 V
Minimum load	100 k $\Omega$
Temperature coefficient	$\pm 0.05\%$ of FS/ $^\circ\text{C}$
Continuous maximum common-mode voltage	$\pm 42$ V <sub>peak</sub> or less

### Remote Control

Item	Specifications
Signal	EXT START, EXT STOP, EXT RESET, INTEG BUSY, EXT HOLD, EXT SINGLE, EXT PRINT
Input level	0 V to 5 V

## 6.10 High Speed Data Capturing

Item	Specifications
Data capturing interval	<ul style="list-style-type: none"><li>• 5 ms when External Sync is set to OFF</li><li>• 1 ms to 100 ms when External Sync is set to ON; synchronized with the external signal applied to the MEAS START terminal</li></ul>
Display update interval	1 s (the last data acquired in a 1 s interval is displayed)
Measurement functions	<ul style="list-style-type: none"><li>• Voltage, current, and power (all elements, <math>\Sigma</math>) Select rms, mean, dc, or r-mean.</li><li>• Torque, speed, and motor output (option) or AUX1 and AUX2 (option)</li></ul>
Wiring systems	<ul style="list-style-type: none"><li>• 1P2W, single-phase, two-wire system (DC signal)</li><li>• 3P4W, three-phase, four-wire system</li><li>• 3P3W(3V3A), three-phase, three wire system</li></ul>
Line filter	Always on Cutoff frequency: 100 Hz to 100 kHz (in steps of 100 Hz) or 300 kHz
Peak over Status	The indicator lights if a peak over-range occurs even once from start to stop.
Data output destination	<ul style="list-style-type: none"><li>• Storage medium: Internal RAM disk or USB memory</li><li>• Communication interface: GP-IB, Ethernet, or USB-PC Interface</li></ul> The captured data for each second is output together.
Data capture start	Data capturing starts after Start in the HS Settings menu is pressed or this instrument receives a communication command, and the trigger conditions are met.
HS filter	Off, 1 Hz to 1000 Hz (in steps of 1 Hz)

## 6.11 Computations and Event Feature

Item	Specifications
User-defined functions	Used to compute equations that are created by combining measurement function symbols and operators (up to 20 equations can be created).
Efficiency equation	Up to four efficiencies can be displayed by setting the items to measure with the efficiency equation.
User-defined events	Event: Set conditions for measured values. Auto printing, storage, and D/A output can be performed as the result of an event occurring.

## 6.12 Display

### Numeric Display

Item	Specifications
Number of Displayed Digits (Display Resolution)	If the value is less than or equal to 60000: Five digits. If the value is greater than 60000: Four digits.
Number of displayed items	Select from 4, 8, 16, Matrix, ALL, Hrm List Single, Hrm List Dual, and Custom.

### Waveform Display

Item	Specifications
Display format	Peak-to-peak compressed data If the time axis setting is set so that there are not enough sampled data, the missing data values are filled using the previous data value.
Time axis	0.05 ms to 2 s/div range when the data update interval is not Auto. But it must be less than 1/10 of the data update interval. 0.05 ms to 5 ms/div range when the data update interval is Auto.
Trigger	<ul style="list-style-type: none"> <li>• Trigger type Edge</li> <li>• Trigger mode Select from off, auto, and normal. Triggering is automatically switched off during integration. Triggering is automatically switched off when the data update interval is Auto.</li> <li>• Trigger source Can be set to an external clock signal or to a voltage or current applied to an input element.</li> <li>• Trigger slope Select from rising, falling, and rising and falling.</li> <li>• Trigger level <ul style="list-style-type: none"> <li>• When the trigger source is set to the voltage or current applied to an input element, the trigger level can be set to a value that is within the range defined by the middle of the screen <math>\pm</math> 100% (to the top and bottom edges of the screen). Resolution: 0.1%</li> <li>• When the trigger source is Ext Clk (external clock): TTL level</li> </ul> </li> </ul>
Time axis zoom feature	None

## 6.13 Data Storage Feature

Item	Specifications
Storage	Numeric data is stored to the internal memory or to an external USB storage medium.
Maximum file size	1 GB
Storage interval	50 ms (when waveforms are turned off) to 99 hours 59 minutes 59 seconds (if the waveform display is enabled and the trigger mode is set to Auto or Normal, the data update interval depends on the trigger operation)

## 6.14 File Feature

Item	Specifications
Saving	Setup parameters, waveform display data, numeric data, and screen image data can be saved to a storage medium.
Loading	Saved setup parameters can be loaded from the storage medium.

## 6.15 Auxiliary I/O Section

### External Start Signal I/O Section

#### To Apply the Master/Slave Synchronization Signal during Normal Measurement

Item	Specifications
Connector type	BNC (Same for both master and slave)
I/O level	TTL (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 delay	Within 15 sample intervals (Applies to the master) Within 1 $\mu$ s + 15 sample intervals (Applies to slaves)

#### To Apply the External Synchronization Signal during High Speed Data Capturing

Item	Specifications
Connector type	BNC
Input level	TTL
Input logic	Negative logic, falling edge
Minimum pulse width	Low level, 500 ns or more
Measurement start delay	Within 1 $\mu$ s + 15 sample intervals

### External Clock Input Section

#### Common

Item	Specifications
Connector type	BNC
Input level	TTL

#### To Apply the Synchronization Source during Normal Measurement as Ext Clk

Item	Specifications
Frequency range	Same as the measurement ranges listed under "Frequency Measurement"
Input waveform	50% duty ratio rectangular wave

#### To Apply the PLL Source during Harmonic Measurement as Ext Clk

Item	Specifications
Frequency range	Harmonic measurement option (/G5 or /G6): 0.5 Hz to 2.6 kHz
Input waveform	50% duty ratio rectangular wave

#### To Apply Triggers

Item	Specifications
Minimum pulse width	1 $\mu$ s
Trigger delay	Within (1 $\mu$ s + 15 sample intervals)

### RGB Output Section (Option)

Item	Specifications
Connector type	D-sub 15 pin (receptacle)
Output format	Analog RGB output

## 6.16 Computer Interface

### GP-IB Interface

Item	Specifications
Usable devices	National Instruments Corporation <ul style="list-style-type: none"><li>• PCI-GPIB or PCI-GPIB+</li><li>• PCIe-GPIB or PCIe-GPIB+</li><li>• PCMCIA-GPIB or PCMCIA-GPIB+</li><li>• GPIB-USB-HS</li><li>• GPIB-USB-HS+</li></ul> Use driver NI-488.2M Ver. 1.60 or later.
Electrical and mechanical specifications	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	Complies with IEEE St'd 488.2-1992
Code	ISO (ASCII)
Mode	Addressable mode
Address	0 to 30
Clearing remote mode	Press LOCAL to clear remote mode (except during Local Lockout).

### Ethernet Interface

Item	Specifications
Ports	1
Connector type	RJ-45 connector
Electrical and mechanical specifications	Complies with IEEE802.3
Transmission system	Ethernet 1000Base-T, 100BASE-TX, 10BASE-T
Communication protocol	TCP/IP
Supported services	FTP server, DHCP, DNS, remote control (VXI-11), SNMP, FTP client, Modbus/TCP server, and Web server

### USB PC Interface

Item	Specifications
Number of ports	1
Connector	Type B connector (receptacle)
Electrical and mechanical specifications	Complies with USB Rev. 2.0
Supported transfer modes	HS (High Speed; 480 Mbps) and FS (Full Speed; 12 Mbps)
Supported protocols	USBTMC-USB488 (USB Test and Measurement Class Ver. 1.0)
PC system requirements	A PC with a USB port, running the English or Japanese version of Windows XP, Windows Vista, Windows 7, Windows 8, Windows 8.1, or Windows 10

## 6.17 USB for Peripherals

Item	Specifications
Number of ports	2
Connector type	USB type A (receptacle)
Electrical and mechanical specifications	Complies with USB Rev. 2.0
Supported transfer modes	HS (High Speed; 480 Mbps), FS (Full Speed; 12 Mbps), LS (Low Speed; 1.5 Mbps)
Compatible devices	Mass storage devices that comply with USB Mass Storage Class Ver. 1.1 Available space: 2 TB, Partition format: MBR, format type: FAT32/FAT16 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 (for each port) You cannot connect devices whose maximum current consumptions exceed 100 mA to two different ports on this instrument at the same time.

## 6.18 Built-in Printer (Option)

Item	Specifications
Print system	Thermal line dot system
Dot density	8 dots/mm
Sheet width	80 mm
Valid recording width	72 mm
Auto print	Set the interval at which you want to print measured values automatically. You can set the start and stop times.

## 6.19 Current Sensor Power (option)

Item	Specifications
Number of channel	6
Connector type	D-sub9 pin (Plug)
Output voltage	$\pm 15$ VDC
Output current	/PD : 1 A/1 channel /PD2 : 1.8A/ 1 channel, up to 6A in six channel total

## 6.20 Safety Terminal Adapter

Item	Specifications
Maximum allowable current	36 A
Dielectric strength	1000 V CATIII
Contact resistance	10 m $\Omega$ or less
Contact section	Nickel plating on brass or bronze
Insulator	Polyamide
Core wire	Maximum diameter 1.8 mm
Insulation	Maximum diameter 3.9 mm

## 6.21 General Specifications

Item	Specifications
Warm-up time	Approx. 30 minutes
Operating environment	Temperature: 5°C to 40°C Humidity: 20%RH to 80%RH (No condensation)
Elevation	2000 m or less
Installation location	Indoors
Storage environment	Temperature: -25°C to 60°C Humidity: 20%RH to 80%RH (No condensation)
Rated supply voltage	100 VAC to 240 VAC
Permitted supply voltage range	90 VAC to 264 VAC
Rated supply frequency	50/60 Hz
Permitted supply voltage frequency range	48 Hz to 63 Hz
Maximum power consumption	150 VA (when using a built-in printer) 450VA (when using a built-in printer and current sensor power)
External dimensions (See section 6.22.)	Approx. 426 (W) × 177 (H) × 459 (D) mm (When the printer cover is not attached; excluding the handle and other protruding parts.) Approx. 426 (W) × 221 (H) × 459 (D) mm (When the printer cover is not attached; excluding the handle and other protruding parts;/ PD, /PD2 option is mounted.)
Weight	Approx. 15 kg (the weight of the main unit with six input elements and options except /PD, /PD2 are mounted) Approx. 17 kg (the weight of the main unit with six input elements and options are mounted)
Battery backup	Setup parameters and the internal clock are backed up with a lithium battery.
Safety standards <sup>1</sup>	Compliant standard: EN 61010-1, EN 61010-2-030 The overvoltage category (installation category) is CAT II. <sup>2</sup> The measurement category is CAT II. <sup>3</sup> Pollution degree 2 <sup>4</sup>
Emissions <sup>1</sup>	Compliant standards EN 61326-1 Class A, 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 environments) product. Operation of this product in a residential area may cause radio interference in which case the user is required to correct the interference. Cable conditions <ul style="list-style-type: none"> <li>• EXT CLK and MEAS. START input terminals Use BNC cables.<sup>5</sup></li> <li>• Motor evaluation function terminals and AUX input terminals Use safety BNC cables.<sup>5</sup></li> <li>• GP-IB interface connector Use a shielded GP-IB cable.<sup>5</sup></li> <li>• RGB output connector Use a shielded D-sub 15 pin cable.<sup>5</sup></li> <li>• USB port (PC) Use a shielded USB cable.<sup>5</sup></li> <li>• USB port (for peripheral devices) Use a USB keyboard that has a shielded cable.<sup>5</sup></li> <li>• Ethernet connector Use a category 5 or better Ethernet cable (STP).<sup>6</sup></li> <li>• Current sensor cable Use dedicated cables.</li> </ul>
Immunity <sup>1</sup>	Compliant standard EN 61326-1 Table 2 (for use in industrial locations) Influence in the immunity environment Measurement input: within ±20% of range (When the crest factor is set to CF6/CF6A, within ±40% of range.) External current sensor input: within ±300 mV D/A output: within ±20% of FS; FS = 5 V Cable conditions The same as the cable conditions listed above for emissions.

## 6.21 General Specifications

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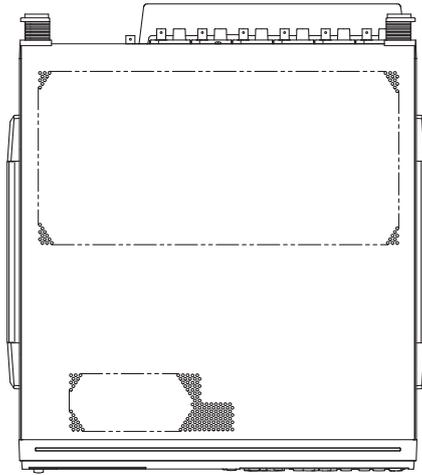
Item	Specifications
Environmental standard <sup>1</sup>	Compliant standard EN 50581 Monitoring and control instruments including industrial monitoring and control instruments.

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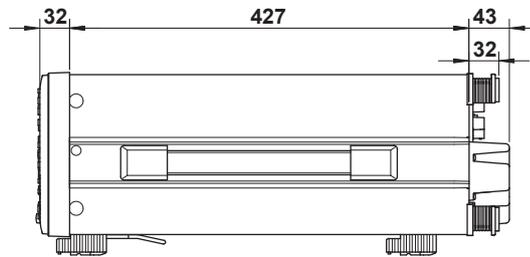
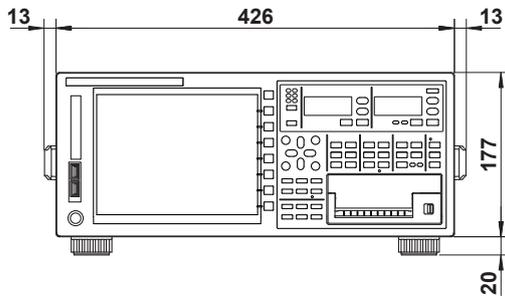
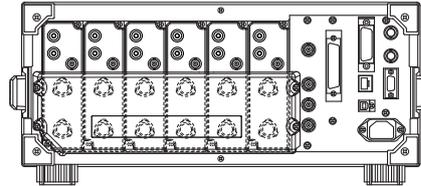
- 1 Applies to products with CE marks. For information on other products, contact your nearest YOKOGAWA dealer.
- 2 The overvoltage category (installation category) is a value used to define the transient overvoltage condition and includes the rated impulse withstand voltage. CAT II applies to electrical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

## 6.22 External Dimensions

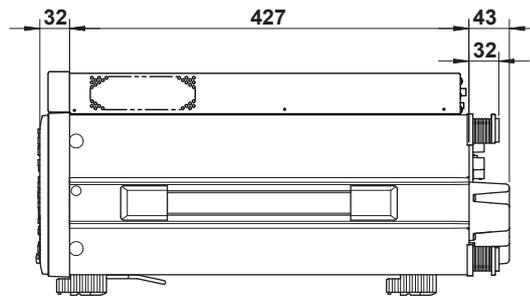
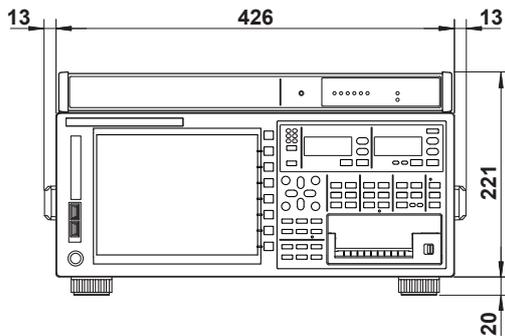
Unit: mm



Rear view



Models with the Current Sensor Power (/PD, or /PD2) Option

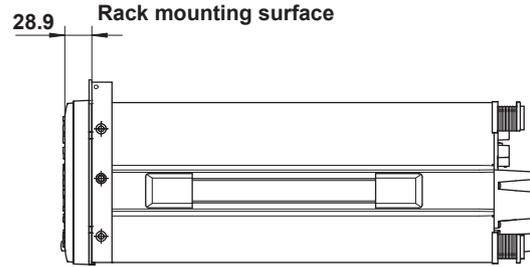
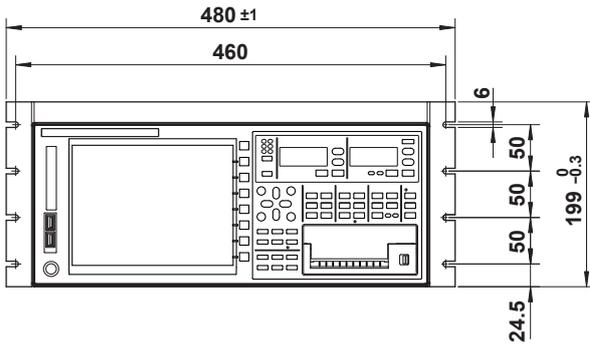


Unless otherwise specified, tolerances are  $\pm 3\%$   
(however, tolerances are  $\pm 0.3$  mm when below 10 mm).

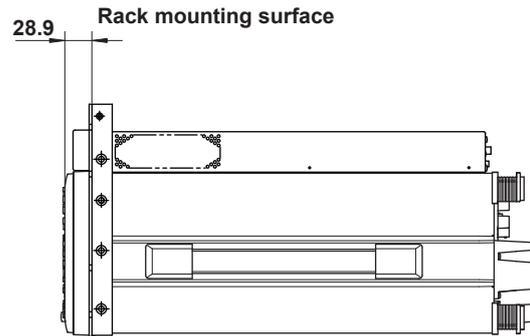
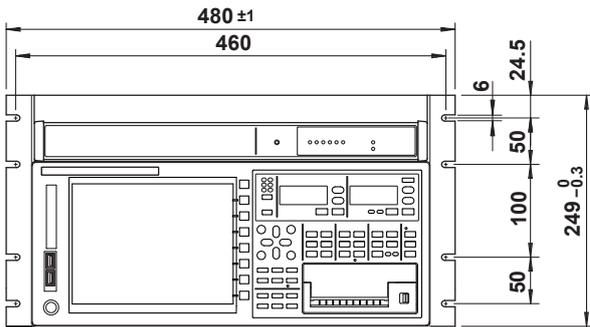
## 6.22 External Dimensions

### JIS rack mount dimensions

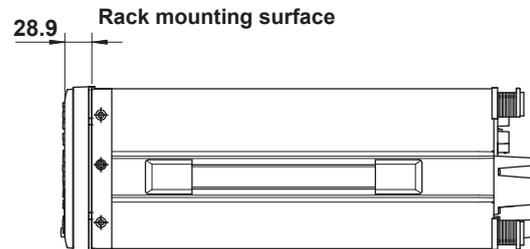
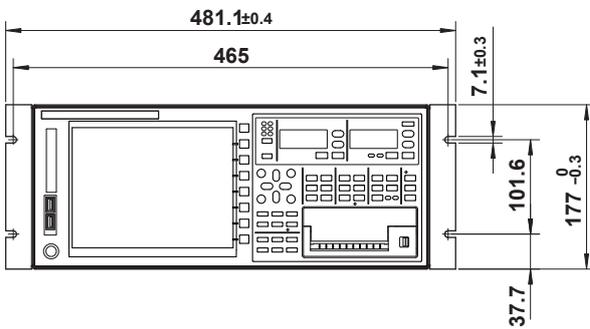
Unit : mm



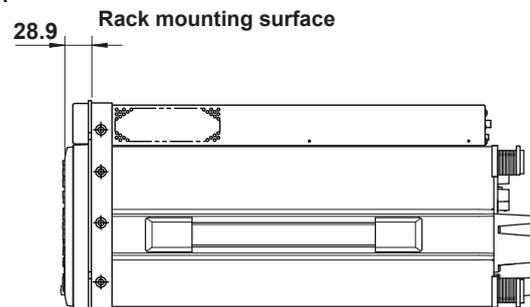
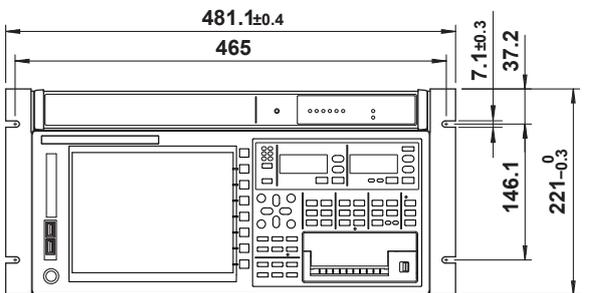
### Models with the Current Sensor Power (/PD, or /PD2) Option



### EIA rack mount dimensions



### Models with the Current Sensor Power (/PD, or /PD2) Option



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

# Appendix 1 Symbols and Determination of Measurement Functions

## Measurement Functions Used in Normal Measurement

(Table 1/3)

Measurement Function	Formula				
	For information about the symbols in the equations, see the notes at the end of page App-3.				
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	Urms	Umn	Udc	Urmn	Uac
	$\sqrt{\text{AVG}[u(n)^2]}$	$\frac{\pi}{2\sqrt{2}} \text{AVG}[ u(n) ]$	$\text{AVG}[u(n)]$	$\text{AVG}[ u(n) ]$	$\sqrt{\text{RMS}^2\text{-DC}^2}$
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	Irms	Imn	Idc	Irmn	Iac
	$\sqrt{\text{AVG}[i(n)^2]}$	$\frac{\pi}{2\sqrt{2}} \text{AVG}[ i(n) ]$	$\text{AVG}[i(n)]$	$\text{AVG}[ i(n) ]$	$\sqrt{\text{RMS}^2\text{-DC}^2}$
Active power P [W]	$\text{AVG}[u(n) \cdot i(n)]$				
Apparent power S [VA] TYPE1, TYPE2 TYPE3	Select from Urms • Irms, Umn • Imn, Udc • Idc, Umn • Irms, and Urmn • Irmn.				
	$\sqrt{P^2 + Q^2}$				
Reactive power Q [var] TYPE1, TYPE2 TYPE3	$s \cdot \sqrt{S^2 - P^2}$ s is -1 for a lead phase and 1 for a lag phase <sup>1</sup>				
	$\sum_{k=\min}^{\max} Q(k)$ <p>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)                      Valid only when harmonics are being measured correctly.</p>				
Power factor λ	$\frac{P}{S}$				
Phase difference Φ [°]	$\cos^{-1}\left(\frac{P}{S}\right)$ <p>The lead (D) and lag (G) display conditions vary depending on the S and Q expressions.                      • If the S and Q expressions are TYPE1 or TYPE2, lead is displayed as D and lag as G.<sup>2</sup>                      • If the S and Q expressions are TYPE3, negative reactive power Q is displayed as D and positive as G.                      The phase angle can be switched between lead (D)/lag (G) display and 360° display.</p>				
Voltage frequency: fU (FreqU) [Hz] Current frequency: fI (FreqI) [Hz]	The voltage frequency (fU) and current frequency (fI) are measured by detecting the zero-crossing points. The fU and fI of all elements can be measured simultaneously.				
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 = $\frac{Upk}{Urms}$ Upk =  U + pk  or  U – pk  whichever is larger		Current crest factor CfI = $\frac{Ipk}{Irms}$ Ipk =  I + pk  or  I – pk  whichever is larger		
Corrected Power Pc [W]	IEC76-1(1976), IEEE C57.12.90-1993		IEC76-1(1993)		
	$\frac{P}{P1 + P2 \left(\frac{Urms}{Umn}\right)^2}$ P1, P2: coefficients defined in the applicable standards		$P \left(1 + \frac{Umn - Urms}{Umn}\right)$		

- 1 If the data update interval is Auto, for elements with the synchronization source rectifier set to ON, s is fixed to 1.
- 2 If the data update interval is Auto, for elements with the synchronization source rectifier set to ON, the display is fixed to G (When 360° display format is in use, the phase is displayed in the range of 0 to 180°).

(Table 2/3)

Measurement Function		Formula				
		For information about the symbols in the equations, see the notes at the end of page App-3.				
Integration	Integration time [h:m:s]      Time	Time from integration start to integration stop				
	Watt hours [Wh]      WP WP+ WP-	When the watt-hour integration method for each polarity is Charge/Discharge <sup>1</sup> $\left[ \frac{1}{N} \sum_{n=1}^N \{u(n) \cdot i(n)\} \right] \cdot \text{Time}$ N is the integration time sampling count. The unit of Time 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 <sup>1</sup> $\left[ \frac{1}{N} \sum_{n=1}^N \{u(n) \cdot i(n)\} \right] \cdot \text{Time}$ N is the integration time sampling count. The unit of Time 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.				
	Ampere hours [Ah]      q q+ q-	rms, mean, r-mean, ac	$\frac{1}{N} \sum_{n=1}^N I(n) \cdot \text{Time}$ I(n) is the nth measured current value. N is the number of data updates. The unit of time is hours.			
		dc	$\frac{1}{N} \sum_{n=1}^N i(n) \cdot \text{Time}$ i(n) is the nth sampled data of the current signal. N is the number of data samples. The unit of time 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.			
	Volt-ampere hours WS[VAh]		$\frac{1}{N} \sum_{n=1}^N S(n) \cdot \text{Time}$ S(n) is the nth measured apparent power value. N is the number of data updates. The unit of time is hours.			
	Var hours WQ <sup>2</sup> [varh]		$\frac{1}{N} \sum_{n=1}^N  Q(n)  \cdot \text{Time}$ Q(n) is the nth measured reactive power value. N is the number of data updates. The unit of time is hours.			
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 <sup>3</sup>	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	

- 1 WP TYPE (watt-hour integration method for each polarity): Charge/Discharge will only be calculated when data update interval is set to Auto.
- 2 WS and WQ are not computed when the data update interval is Auto.
- 3 If the data update interval is Auto, QΣ that includes elements with the synchronization source rectifier set to ON is calculated with TYPE2.

(Table 3/3)

Measurement Function		Formula For information about the symbols in the equations see the notes.				
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	
	WPΣ [Wh]	WPΣ	WP1 + WP2			WP1 + WP2 + WP3
		WP+Σ	When the watt-hour integration method for each polarity is Charge/Discharge <sup>1</sup> WP+1 + WP+2			WP+1 + WP+2 + WP+3
			When the watt-hour integration method for each polarity is Sold/Bought <sup>1</sup> 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 <sup>1</sup> WP-1 + WP-2			WP-1 + WP-2 + WP-3
			When the watt-hour integration method for each polarity is Sold/Bought <sup>1</sup> 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
	WSΣ <sup>2</sup> [VAh]	$\frac{1}{N} \sum_{n=1}^N S\Sigma(n) \cdot \text{Time}$ SΣ(n) is the nth apparent power Σ function. N is the number of data updates. The unit of time is hours.				
WQΣ <sup>2</sup> [varh]	$\frac{1}{N} \sum_{n=1}^N  Q\Sigma(n)  \cdot \text{Time}$ QΣ(n) is the nth reactive power Σ function. N is the number of data updates. The unit of time is hours.					
λΣ	$\frac{P\Sigma}{S\Sigma}$					
ΦΣ [°]	$\cos^{-1}\left(\frac{P\Sigma}{S\Sigma}\right)$					

- 1 WP TYPE (watt-hour integration method for each polarity): Charge/Discharge will only be calculated when data update interval is set to Auto.
- 2 WSΣ and WQΣ are not computed when the data update interval is Auto.

**Note**

- u(n) denotes the instantaneous voltage.
- i(n) denotes the instantaneous current.
- n denotes the n<sup>th</sup> measurement period. The measurement period is determined by the synchronization 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 synchronization 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 this 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.
- Equation Type 3 for SΣ and QΣ can only be selected on models with the harmonic measurement option.
- 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 this 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 (Option)

(Table 1/4)

Measurement Function	Formula			Total Value (Total) (No parentheses)
	Numbers and Characters in the Parentheses			
	dc (when k = 0)	1 (when k = 1)	k (when k = 1 to max)	
Voltage U ( ) [V]	$U(\text{dc}) = U_r(0)$	$U(k) = \sqrt{U_r(k)^2 + U_j(k)^2}$		$U = \sqrt{\sum_{k=\text{min}}^{\text{max}} U(k)^2}$
Current I ( ) [A]	$I(\text{dc}) = I_r(0)$	$I(k) = \sqrt{I_r(k)^2 + I_j(k)^2}$		$I = \sqrt{\sum_{k=\text{min}}^{\text{max}} I(k)^2}$
Active power P ( ) [W]	$P(\text{dc}) = U_r(0) \cdot I_r(0)$	$P(k) = U_r(k) \cdot I_r(k) + U_j(k) \cdot I_j(k)$		$P = \sum_{k=\text{min}}^{\text{max}} P(k)$
Apparent power S ( ) [VA] (TYPE3) <sup>*1</sup>	$S(\text{dc}) = P(\text{dc})$	$S(k) = \sqrt{P(k)^2 + Q(k)^2}$		$S = \sqrt{P^2 + Q^2}$
Reactive power Q ( ) [var] (TYPE3) <sup>*1</sup>	$Q(\text{dc}) = 0$	$Q(k) = U_r(k) \cdot I_j(k) - U_j(k) \cdot I_r(k)$		$Q = \sum_{k=\text{min}}^{\text{max}} Q(k)$
Power factor λ ( )	$\lambda(\text{dc}) = \frac{P(\text{dc})}{S(\text{dc})}$	$\lambda(k) = \frac{P(k)}{S(k)}$		$\lambda = \frac{P}{S}$
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(\text{dc}) = \left  \frac{U(\text{dc})}{I(\text{dc})} \right $	$Z(k) = \left  \frac{U(k)}{I(k)} \right $		—
Series resistance of the load circuit Rs ( ) [Ω]	$R_s(\text{dc}) = \frac{P(\text{dc})}{I(\text{dc})^2}$	$R_s(k) = \frac{P(k)}{I(k)^2}$		—
Series reactance of the load circuit Xs ( ) [Ω]	$X_s(\text{dc}) = \frac{Q(\text{dc})}{I(\text{dc})^2}$	$X_s(k) = \frac{Q(k)}{I(k)^2}$		—
Parallel resistance of the load circuit Rp ( ) [Ω] (= 1/G)	$R_p(\text{dc}) = \frac{U(\text{dc})^2}{P(\text{dc})}$	$R_p(k) = \frac{U(k)^2}{P(k)}$		—
Parallel reactance of the load circuit Xp ( ) [Ω] (= 1/B)	$X_p(\text{dc}) = \frac{U(\text{dc})^2}{Q(\text{dc})}$	$X_p(k) = \frac{U(k)^2}{Q(k)}$		—
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 <sup>*2</sup> [Hz]	Frequency of the PLL source of harmonic group 2 (PLL source 2)			

(Continued on next page)

\*1 For details about the S and Q formula type settings, see “8 Computation”, “Apparent Power, Reactive Power, and Corrected Power Equations (Formula).” in the features guide, IM WT1801E-01EN.

\*2 When the data update interval is Auto, fPLL2 is not measured.

### 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 2/4)

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 U <sub>hdf</sub> ( ) [%]	$\frac{U(k)}{U(\text{Total})^2} \cdot 100$	$\frac{U(k)}{U(1)} \cdot 100$
Harmonic current distortion factor I <sub>hdf</sub> ( ) [%]	$\frac{I(k)}{I(\text{Total})^2} \cdot 100$	$\frac{I(k)}{I(1)} \cdot 100$
Harmonic active power distortion factor P <sub>hdf</sub> ( ) [%]	$\frac{P(k)}{P(\text{Total})^2} \cdot 100$	$\frac{P(k)}{P(1)} \cdot 100$
Total harmonic voltage distortion U <sub>thd</sub> [%]	$\frac{\sqrt{\sum_{k=2}^{\max} U(k)^2}}{U(\text{Total})^2} \cdot 100$	$\frac{\sqrt{\sum_{k=2}^{\max} U(k)^2}}{U(1)} \cdot 100$
Total harmonic current distortion I <sub>thd</sub> [%]	$\frac{\sqrt{\sum_{k=2}^{\max} I(k)^2}}{I(\text{Total})^2} \cdot 100$	$\frac{\sqrt{\sum_{k=2}^{\max} I(k)^2}}{I(1)} \cdot 100$
Total harmonic active power distortion P <sub>thd</sub> [%]	$\frac{\left  \sum_{k=2}^{\max} P(k) \right }{P(\text{Total})^2} \cdot 100$	$\frac{\left  \sum_{k=2}^{\max} P(k) \right }{P(1)} \cdot 100$
Voltage telephone harmonic factor U <sub>thf</sub> [%] Current telephone harmonic factor I <sub>thf</sub> [%]	$U_{thf} = \frac{1}{U(\text{Total})^2} \sqrt{\sum_{k=1}^{\max} \{\lambda(k) \cdot U(k)\}^2} \cdot 100 \quad I_{thf} = \frac{1}{I(\text{Total})^2} \sqrt{\sum_{k=1}^{\max} \{\lambda(k) \cdot I(k)\}^2} \cdot 100$ <p style="text-align: center;">λ(k): coefficient defined in the applicable standard (IEC34-1 (1996))</p>	
Voltage telephone influence factor U <sub>tif</sub> Current telephone influence factor I <sub>tif</sub>	$U_{tif} = \frac{1}{U(\text{Total})^2} \sqrt{\sum_{k=1}^{\max} \{T(k) \cdot U(k)\}^2} \quad I_{tif} = \frac{1}{I(\text{Total})^2} \sqrt{\sum_{k=1}^{\max} \{T(k) \cdot I(k)\}^2}$ <p style="text-align: center;">T(k): coefficient defined in the applicable standard (IEEE Std 100 (1992))</p>	
Harmonic voltage factor hvf [%] <sup>*1</sup> Harmonic current factor hcf [%] <sup>*1</sup>	$hvf = \frac{1}{U(\text{Total})^2} \sqrt{\sum_{k=2}^{\max} \frac{U(k)^2}{k}} \cdot 100 \quad hcf = \frac{1}{I(\text{Total})^2} \sqrt{\sum_{k=2}^{\max} \frac{I(k)^2}{k}} \cdot 100$	
K-factor	$K\text{-factor} = \frac{\sum_{k=1}^{\max} \{I(k)^2 \cdot k^2\}}{\sum_{k=1}^{\max} I(k)^2}$	

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

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

**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.

Appendix 1 Symbols and Determination of Measurement Functions

(Table 3/4)

Measurement Function		Formula			
Σ Function	Wiring system	Single-Phase, Three-Wire (1P3W)	Three-Phase, Three-Wire (3P3W)	Three-Voltage, Three-Current Method (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] (TYPE3)*	$\sqrt{P\Sigma^2 + Q\Sigma^2}$			
	QΣ [var] (TYPE3)*	Q1 + Q2			Q1 + Q2 + Q3
	λΣ	$\frac{P\Sigma}{S\Sigma}$			

\* For details about the SΣ and QΣ formula type settings, see “8 Computation”, “Apparent Power, Reactive Power, and Corrected Power Equations (Formula)” in the features guide, IM WT1801E-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.
- Only the total value and the fundamental wave (1<sup>st</sup> harmonic) are computed for Σ.

(Table 4/4)

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)
EaU1(°)	Electrical angle: Phase angle of U1 to I6 with the falling edge of the signal received through the Z terminal of the motor evaluation function (option) as the reference.
EaU2(°)	
EaU3(°)	
EaU4(°)	
EaU5(°)	
EaU6(°)	
EaI1(°)	
EaI2(°)	
EaI3(°)	
EaI4(°)	
EaI5(°)	
EaI6(°)	

**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.

## Measurement Functions Used in Delta Computation

Computed results are determined by substituting all of the sampled data in the table into the equations for voltage U and current I.\* The synchronization 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	Symbol and Meaning The computation mode for $\Delta U1$ to $\Delta U3$ , $\Delta U\Sigma$ , and $\Delta I$ can be set to rms, mean, dc, r-mean, or ac.	Substituted Sampled Data $u(t), i(t)$
Voltage [V]	Difference	Computed differential voltage	$\Delta U1[U_{diff}]$ $u1 - u2$
	3P3W→3V3A	Unmeasured line voltage computed in a three-phase, three-wire system	$\Delta U1[U_{rs}]$ $u1 - u2$
	Delta→Star	Phase voltage computed in a three-phase, three-wire (3V3A) system	$\Delta U1[U_r]$ $u1 - \frac{(u1 + u2)}{3}$
			$\Delta U2[U_s]$ $u2 - \frac{(u1 + u2)}{3}$
			$\Delta U3[U_t]$ $-\frac{(u1 + u2)}{3}$
		Wiring unit voltage $\Delta U\Sigma = \frac{(\Delta U1 + \Delta U2 + \Delta U3)}{3}$	$\Delta U\Sigma[U_\Sigma]$ —
	Star→Delta	Line voltage computed in a three-phase, four-wire system	$\Delta U1[U_{rs}]$ $u1 - u2$
			$\Delta U2[U_{st}]$ $u2 - u3$
			$\Delta U3[U_{tr}]$ $u3 - u1$
			Wiring unit voltage $\Delta U\Sigma = \frac{(\Delta U1 + \Delta U2 + \Delta U3)}{3}$
Current [A]	Difference	Computed differential current	$\Delta I[I_{diff}]$ $i1 - i2$
	3P3W→3V3A	Unmeasured phase current	$\Delta I[I_t]$ $-i1 - i2$
	Delta→Star	Neutral line current	$\Delta I[I_n]$ $i1 + i2 + i3$
	Star→Delta	Neutral line current	$\Delta I[I_n]$ $i1 + i2 + i3$
Power [W]	Difference	—	—
	3P3W→3V3A	—	—
	Delta→Star	Phase power computed in a three-phase, three-wire (3V3A) system	$\Delta P1[P_r]$ $\left\{u1 - \frac{(u1 + u2)}{3}\right\} \cdot i1$
			$\Delta P2[P_s]$ $\left\{u2 - \frac{(u1 + u2)}{3}\right\} \cdot i2$
			$\Delta P3[P_t]$ $\left\{-\frac{(u1 + u2)}{3}\right\} \cdot i3$
		Wiring unit power $\Delta P\Sigma = \Delta P1 + \Delta P2 + \Delta P3$	$\Delta P\Sigma[P_\Sigma]$ —
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 App-1.
- 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 Computation and Determination
<b>Rotating speed</b>	<p>When the input signal from the revolution sensor is DC voltage (an analog signal):</p> <p><b><math>S(A \cdot X + B) - \text{NULL}</math></b>                      S: scaling factor                      A: slope of the input signal                      X: input voltage from the revolution sensor                      B: offset                      NULL: null value</p> <p>When the input signal from the revolution sensor is the number of pulses:</p> <p><b><math>S \frac{X}{N} - \text{NULL}</math></b>                      S: scaling factor                      X: number of input pulses from the revolution sensor per minute                      N: number of pulses per revolution                      NULL: null value</p>
<b>Torque</b>	<p>When the input signal from the torque meter is DC voltage (an analog signal):</p> <p><b><math>S(A \cdot X + B) - \text{NULL}</math></b>                      S: scaling factor                      A: slope of the input signal                      X: input voltage from the torque meter                      B: offset                      NULL: null value</p> <p>When the input signal from the torque meter is a pulse signal:</p> <p><b><math>S(A \cdot X + B) - \text{NULL}</math></b>                      S: scaling factor                      A: torque pulse coefficient                      X: pulse frequency                      B: torque pulse offset                      NULL: null value</p> <p>This 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.</p>
<b>Synchronous speed SyncSp</b>	<p style="text-align: center;"><b><u><math>120 \cdot \text{the frequency of the frequency measurement source (Hz)}</math></u></b></p> <p style="text-align: center;"><b>Number of motor poles</b></p> <ul style="list-style-type: none"> <li>• The unit of synchronous speed is fixed to min – 1 or rpm.</li> <li>• 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.</li> </ul>
<b>Slip Slip [%]</b>	<p><b><math>\frac{\text{SyncSp} - \text{Speed}}{\text{SyncSp}} \cdot 100</math></b></p>
<b>Monitor output Pm</b>	<p style="text-align: center;"><b><math>\frac{2\pi \cdot \text{Speed} \cdot \text{Torque}}{60} \cdot \text{Scaling factor}</math></b></p> <p>When the unit of <b>speed</b> is min – 1 or rpm, the unit of <b>torque</b> is N·m, and the scaling factor is 1, the unit of motor output <b>Pm</b> is W.</p>

Measurement Function	Methods of Computation and Determination	
Electrical angle [°]	EaU	$\tan^{-1} \frac{U_r(1)}{U_j(1)} - B$ Ur(1): real part of the fundamental voltage Uj(1): imaginary part of the fundamental voltage B: offset
	Eal	$\tan^{-1} \frac{I_r(1)}{I_j(1)} - B$ Ir(1): real part of the fundamental current Ij(1): imaginary part of the fundamental current B: offset

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 Computation and Determination
AUX1	<b>S(Ax + B) – NULL</b> S: scaling factor A: slope of the external signal X: average value of the external signal's input voltage (AVG[AUX_input1(n)]) B: offset NULL: null value
AUX2	<b>S(Ax + B) – NULL</b> S: scaling factor A: slope of the external signal X: average value of the external signal's input voltage (AVG[AUX_input2(n)]) B: offset NULL: null value

**Note**

- AUX\_input1(n) and AUX\_input2(n) denote the instantaneous auxiliary input.
- n denotes the n<sup>th</sup> measurement period. The measurement period is determined by the synchronization 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 synchronization source setting.

### Measurement Functions for High Speed Data Capturing

Measurement Function	Methods of Computation and Determination	
U[V] <sup>-1</sup>	rms	True rms value $\sqrt{\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter}[u(n)^2]}$
	mean	Rectified mean value calibrated to the rms value $\frac{\pi}{2\sqrt{2}} \times \frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter}[ u(n) ]$
	rmean	Rectified mean value $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter}[ u(n) ]$
	dc	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter}[u(n)]$

(Continued on next page)

Appendix 1 Symbols and Determination of Measurement Functions

Measurement Function		Methods of Computation and Determination
I[A] <sup>*1</sup>	rms	True rms value $\frac{1}{N} \sqrt{\sum_{n=0}^{N-1} \text{HSFilter} [i(n)^2]}$
	mean	Rectified mean value calibrated to the rms value $\frac{\pi}{2\sqrt{2}} \times \frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [ i(n) ]$
	rmean	Rectified mean value $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [ i(n) ]$
	dc	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [i(n)]$
P[W] <sup>*1</sup>		Active power $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [u(n) \times i(n)]$
ΣU[V] Three-phase, four-wire 3P4W	rms	True rms value $\sqrt{\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[u_1(n)^2 + u_2(n)^2 + u_3(n)^2]/3\}}$
	mean <sup>*1</sup>	Rectified mean value calibrated to the rms value $\frac{\pi}{2\sqrt{2}} \times \frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[ u_1(n)  +  u_2(n)  +  u_3(n) ]/3\}$
	rmean <sup>*1</sup>	Rectified mean value $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[ u_1(n)  +  u_2(n)  +  u_3(n) ]/3\}$
	dc	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[u_1(n) + u_2(n) + u_3(n)]/3\}$
ΣU[V] Three-phase, three-wire with three-voltage, three-current method. 3P3W(3V3A)	rms	True rms value $\sqrt{\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[u_1(n)^2 + u_2(n)^2 + u_3(n)^2]/3\}}$
	mean <sup>*1</sup>	Rectified mean value calibrated to the rms value $\frac{\pi}{2\sqrt{2}} \times \frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[ u_1(n)  +  u_2(n)  +  u_3(n) ]/3\}$
	rmean <sup>*1</sup>	Rectified mean value $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[ u_1(n)  +  u_2(n)  +  u_3(n) ]/3\}$
	dc <sup>*2</sup>	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[u_1(n) + u_2(n) + u_3(n)]/3\}$
ΣI[A] Three-phase, four-wire 3P4W	rms	True rms value $\sqrt{\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[i_1(n)^2 + i_2(n)^2 + i_3(n)^2]/3\}}$
	mean <sup>*1</sup>	Rectified mean value calibrated to the rms value $\frac{\pi}{2\sqrt{2}} \times \frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[ i_1(n)  +  i_2(n)  +  i_3(n) ]/3\}$
	rmean <sup>*1</sup>	Rectified mean value $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[ i_1(n)  +  i_2(n)  +  i_3(n) ]/3\}$
	dc	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} \{[i_1(n) + i_2(n) + i_3(n)]/3\}$

(Continued on next page)

Measurement Function	Methods of Computation and Determination	
<b>ΣI[A]</b> Three-phase, three-wire with three-voltage, three-current method. 3P3W(3V3A)	rms	True rms value $\sqrt{\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [\{i_1(n)^2+i_2(n)^2+i_3(n)^2\}/3]}$
	mean*1	Rectified mean value calibrated to the rms value $\frac{\pi}{2\sqrt{2}} \times \frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [\{ i_1(n) + i_2(n) + i_3(n) \}/3]$
	rmean*1	Rectified mean value $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [\{ i_1(n) + i_2(n) + i_3(n) \}/3]$
	dc*1	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [\{i_1(n)+i_2(n)+i_3(n)\}/3]$
<b>ΣP[W]</b> Three-phase, four-wire 3P4W	Active power $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [u_1(n) \times i_1(n) + u_2(n) \times i_2(n) + u_3(n) \times i_3(n)]$	
<b>ΣP[W]</b> Three-phase, three-wire with three-voltage, three-current method. 3P3W(3V3A)	Active power $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [u_1(n) \times i_1(n) + u_2(n) \times i_2(n)]$	
Torque	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [\text{torque}(n)]$	
Speed	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [\text{speed}(n)]$	
Pm	See page App-8, “Monitor output Pm”.	
AUX1	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [\text{aux1}(n)]$	
AUX2	Simple average $\frac{1}{N} \sum_{n=0}^{N-1} \text{HSFilter} [\text{aux2}(n)]$	

- \*1 It is necessary to set the cutoff frequency of the HS filter to match the frequency of the circuit under measurement.
- \*2 This value does not have physical meaning when three-phase AC wiring is used.

**Note**

- In the above equations, u(n) and i(n) denote the nth instantaneous voltage value and the nth instantaneous current value, respectively.
- n indicates the nth item within the data capturing interval. N indicates the number of sampled data items within the data capturing interval. HSFilter indicates that the items enclosed in the brackets that follow have passed through an HS Filter low-pass filter.
- The HS filter is a second order Butterworth filter.
- When the HS filter is enabled, the characteristics of the second order Butterworth filter result in the attenuation (averaging) of the amplitude of the AC components. The response also becomes slower.
- The 16-bit data (instantaneous voltage and current values) from the A/D converter is converted to single-precision floating point data before it undergoes computation.

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

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

### Power

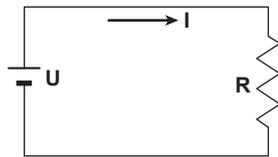
Electrical energy can be converted into other forms of energy and used. For example, it can be converted into the heat in an electric heater, the torque in a motor, or the light in a fluorescent or mercury lamp. In these kinds of examples, the work that electricity performs in a given period of time (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).

$$P = UI \text{ [W]}$$

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.

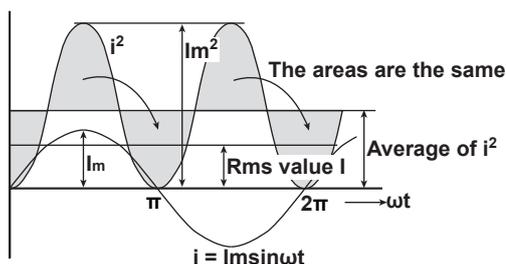


### Alternating Current

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  $I_m \sin \omega t$  (where  $I_m$  is the maximum value of the current,  $\omega$  is the angular velocity defined as  $\omega = 2\pi f$ , 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:

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

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  $I_{mn}$  as the mean value of the instantaneous current  $i$  (which is equal to  $I_m \sin \omega t$ ):

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

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.

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

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

### Vector Display of Alternating Current

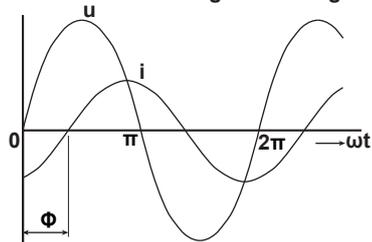
In general, instantaneous voltage and current values are expressed using the equations listed below.

$$\text{Voltage: } u = U_m \sin \omega t$$

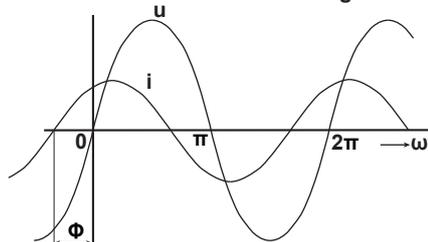
$$\text{Current: } i = I_m \sin(\omega t - \Phi)$$

The time offset between the voltage and current is called the phase difference, and  $\Phi$  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



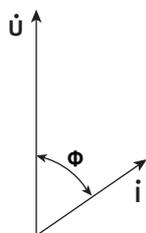
When the current leads the voltage



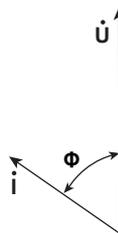
A vector display is used to clearly convey the magnitude and phase relationships between the voltage and current. A positive phase angle is represented by a counterclockwise angle with respect to the vertical axis.

Normally, a dot is placed above the symbol representing a quantity to explicitly indicate that it is a vector. The magnitude of a vector represents the rms value.

When the current lags the voltage



When the current leads the voltage



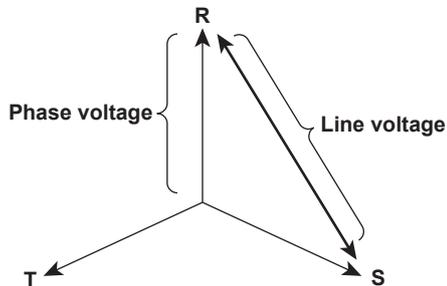
### Three-Phase AC Wiring

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



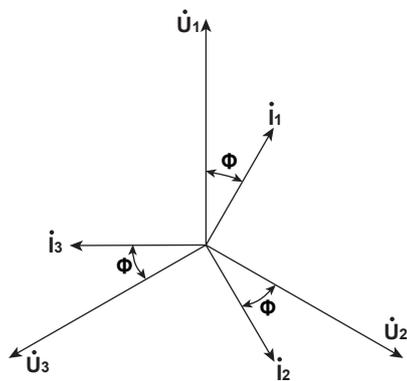
### Vector Display of Three-Phase Alternating Current

In typical three-phase AC power, the voltage of each phase is offset by  $120^\circ$ . The figure below expresses this offset using vectors. 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  $120^\circ$ , the magnitude of the line voltage is  $\sqrt{3}$  times the magnitude of the phase voltage, and the line voltage phase is offset by  $30^\circ$ .

Below is a vector representation of the relationship between the phase voltages and line currents of a three-phase AC voltage when the current lags the voltage by  $\Phi^\circ$ .



## 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.

If the instantaneous voltage  $u = U_m \sin \omega t$  and the instantaneous current  $i = I_m \sin(\omega t - \Phi)$ , 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.

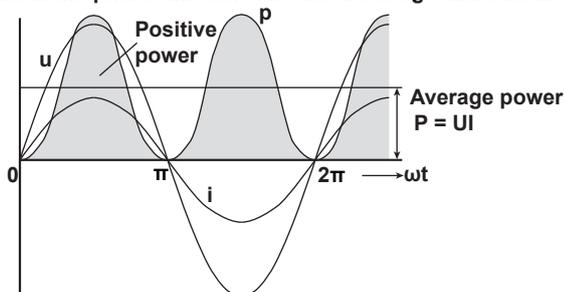
$p$  is the sum of the time-independent term,  $UI \cos \Phi$ , and the AC component term of the voltage or current at twice the frequency,  $-UI \cos(2\omega t - \Phi)$ .

AC power refers to the mean power over 1 period. When the mean over 1 period is taken, AC power  $P$  is as follows:

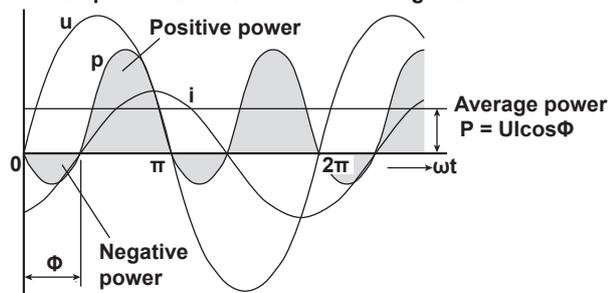
$$P = UI \cos \Phi \text{ [W]}$$

Even if the voltage and current are the same, the power varies depending on the phase difference  $\Phi$ . 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 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.

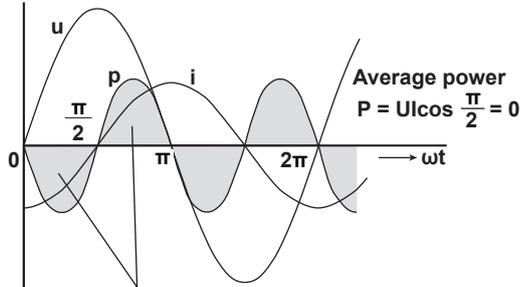
When the phase difference between voltage and current is 0



When the phase difference between voltage and current is  $\Phi$



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



The positive and negative powers are the same

### Active Power and the Power Factor

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  $S$ . 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.

The true power that a device consumes is called active power (or effective power). It is expressed as  $P$ . This power corresponds to the AC power discussed in the previous section.

$$S = UI \text{ [VA]}$$

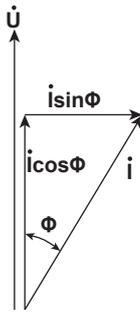
$$P = UI\cos\Phi \text{ [W]}$$

$\cos\Phi$  is called the power factor and is expressed as  $\lambda$ . It indicates the portion of the apparent power that becomes true power.

### Reactive Power

If current  $I$  lags voltage  $U$  by  $\Phi$ , current  $I$  can be broken down into a component in the same direction as voltage  $U$ ,  $I\cos\Phi$ , and a perpendicular component,  $I\sin\Phi$ . Active power  $P$ , which is equal to  $UI\cos\Phi$ , is the product of voltage  $U$  and the current component  $I\cos\Phi$ . The product of voltage  $U$  and the current component  $I\sin\Phi$  is called the reactive power. It is expressed as  $Q$ . The unit of reactive power is the var.

$$Q = UI\sin\Phi \text{ [var]}$$



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

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

## 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  $n^{\text{th}}$  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.
- **Cables**  
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.
- **Breakers and fuses**  
Excessive harmonic current can cause erroneous operation and blow fuses.
- **Communication lines**  
The electromagnetic induction caused by harmonics creates noise voltage.
- **Controllers**  
Harmonic distortion of control signals can lead to erroneous operation.
- **Audio visual equipment**  
Harmonics can cause degradation of performance and service life, noise-related video flickering, and damaged parts.

## AC RLC Circuits

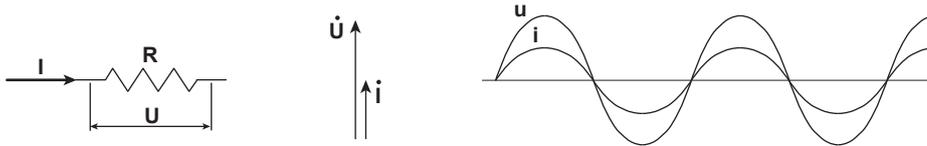
### Resistance

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



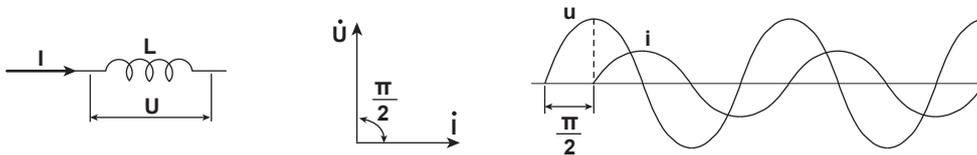
### Inductance

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  $\Omega$ .

Inductance works to counter current changes (increase or decrease), and causes the current to lag the voltage.



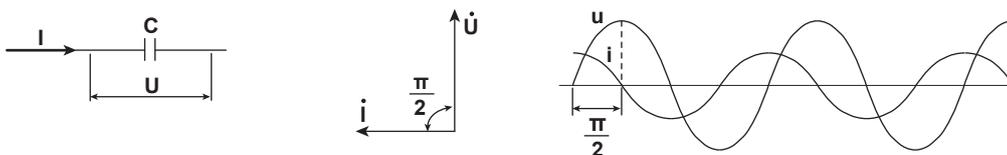
### Capacitance

The current  $i$  when an AC voltage whose instantaneous value  $u = U_m \sin \omega t$  is applied to a capacitive load  $C [F]$  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  $\Omega$ .

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.



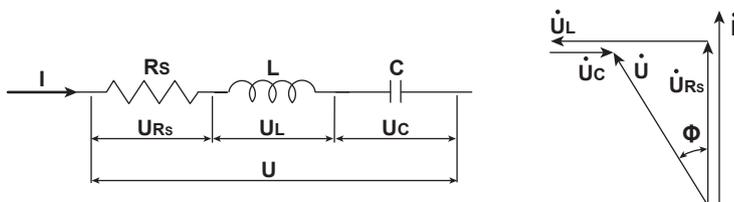
### Series RLC Circuits

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

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

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

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



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

$$X_S = X_L - X_C$$

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

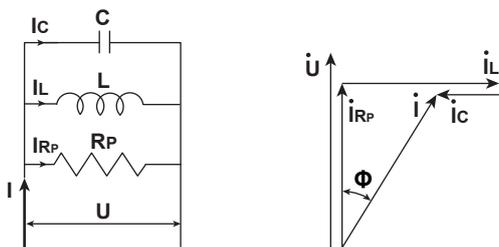
### Parallel RLC Circuits

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

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

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

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



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

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

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

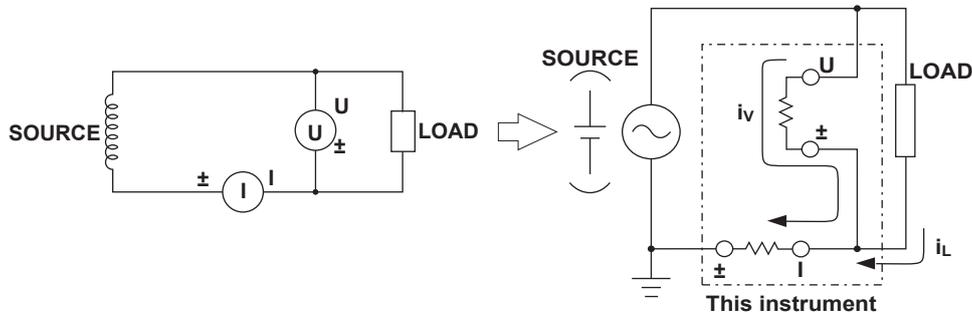
# Appendix 3 How to Make Accurate Measurements

## Effects of Power Loss

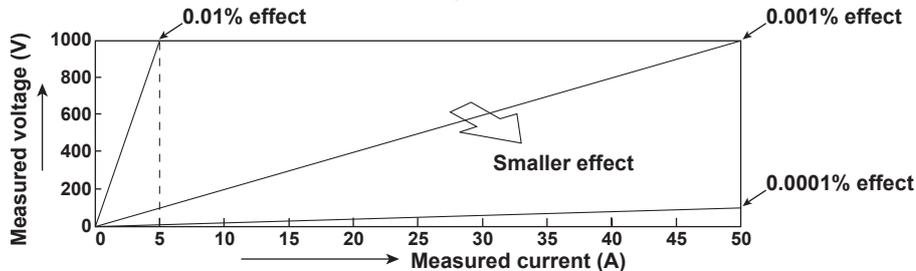
By wiring a circuit to match the load, you can minimize the effects of power loss on measurement accuracy. We will discuss the wiring of the DC power supply (SOURCE) and a load resistance (LOAD) below.

### 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 this instrument is approximately 2 M $\Omega$ . If the input voltage is 1000 V,  $i_V$  is approximately 0.5 mA (1000 V/2 M $\Omega$ ). If the load current  $i_L$  is 5 A or more (load resistance is 200  $\Omega$  or less), the effect of  $i_V$  on the measurement accuracy is 0.01% or less. If the input voltage is 100 V and the current is 5 A,  $i_V = 0.05$  mA (100 V/2 M $\Omega$ ), so the effect of  $i_V$  on the measurement accuracy is 0.001% (0.05 mA/5 A).

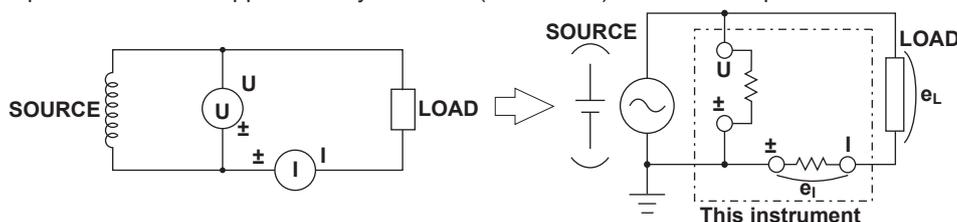


As a reference, the relationships between the voltages and currents that produce effects of 0.01%, 0.001%, and 0.0001% are shown in the figure below.



### 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 this instrument is approximately 100 m $\Omega$  for the 5 A input terminals and approximately 2 m $\Omega$  for the 50 A input terminals. If the load resistance is 1 k $\Omega$ , the effect of  $e_I$  on the measurement accuracy is approximately 0.01% (100 m $\Omega$ /1 k $\Omega$ ) for the 5 A input terminals and approximately 0.0002% (2 m $\Omega$ /1 k $\Omega$ ) for the 50 A input terminals.



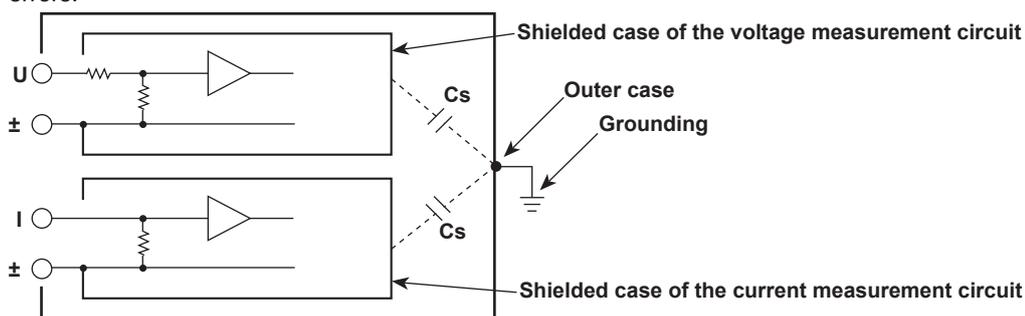
## Effects of Stray Capacitance

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

The internal structure of this 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  $C_s$ .  $C_s$  is approximately 40 pF. The current generated by stray capacitance  $C_s$  causes errors.

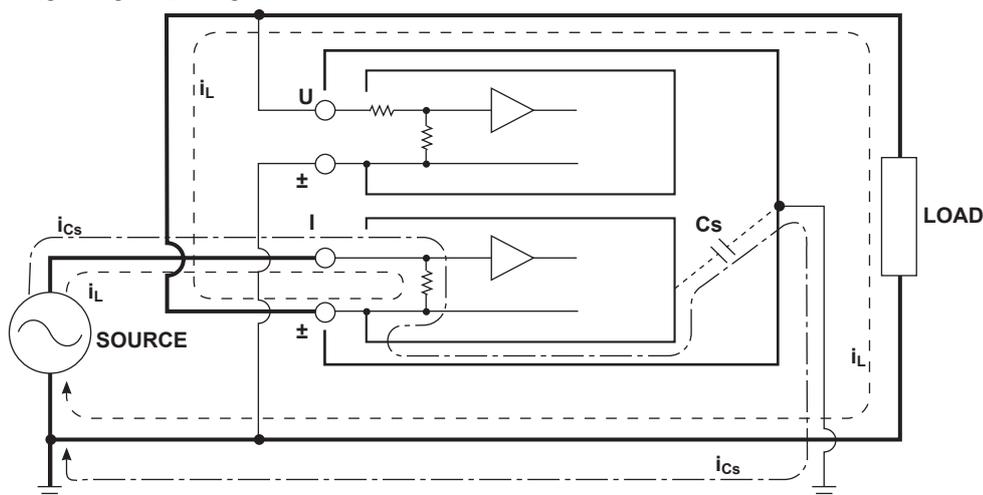


As an example, we will consider the case when the outer case and one side of the power supply are grounded.

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

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

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



Because this instrument measures high frequencies, the effects of  $i_{Cs}$  cannot be ignored.

If you connect the current input terminal of this instrument to the side of the power supply (SOURCE) that is close to its earth potential, the current measurement circuit positive and negative terminals of this instrument 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 table below shows actual voltage and current range combinations and the power ranges that result from them. The values are for when the voltage and current ranges of each element are the same. The table shows the active power range (unit: W). The same ranges are set for apparent power (unit: VA) and reactive power (unit: var). Just read the unit as VA or var. The number of displayed digits (display resolution) is as follows:

- If the value is less than or equal to 60000: Five digits.
- If the value is greater than 60000: Four digits.

### When the Crest Factor Is Set to 3 Active Power Range of Each Element

Current Range	Voltage Range [V]					
	1.5000	3.0000	6.0000	10.000	15.000	30.000
[A]						
10.000m	15.000 mW	30.000 mW	60.000 mW	100.00 mW	150.00 mW	300.00 mW
20.000m	30.000 mW	60.000 mW	120.00 mW	200.00 mW	300.00 mW	600.00 mW
50.000m	75.00 mW	150.00 mW	300.00 mW	500.00 mW	0.7500 W	1.5000 W
100.00m	150.00 mW	300.00 mW	600.00 mW	1.0000 W	1.5000 W	3.0000 W
200.00m	300.00 mW	600.00 mW	1.2000 W	2.0000 W	3.0000 W	6.0000 W
500.00m	0.7500 W	1.5000 W	3.0000 W	5.0000 W	7.5000 W	15.000 W
1.0000	1.5000 W	3.0000 W	6.0000 W	10.000 W	15.000 W	30.000 W
2.0000	3.0000 W	6.0000 W	12.000 W	20.000 W	30.000 W	60.000 W
5.0000	7.5000 W	15.000 W	30.000 W	50.000 W	75.000 W	150.00 W
10.000	15.000 W	30.000 W	60.000 W	100.00 W	150.00 W	300.00 W
20.000	30.000 W	60.000 W	120.00 W	200.00 W	300.00 W	600.00 W
50.000	75.00 W	150.00 W	300.00 W	500.00 W	0.7500 kW	1.5000 kW

Current Range	Voltage Range [V]					
	60.000	100.00	150.00	300.00	600.00	1000.0
[A]						
10.000m	600.00 mW	1.0000 W	1.5000 W	3.0000 W	6.0000 W	10.000 W
20.000m	1.2000 W	2.0000 W	3.0000 W	6.0000 W	12.000 W	20.000 W
50.000m	3.0000 W	5.0000 W	7.5000 W	15.000 W	30.000 W	50.000 W
100.00m	6.0000 W	10.000 W	15.000 W	30.000 W	60.000 W	100.00 W
200.00m	12.000 W	20.000 W	30.000 W	60.000 W	120.00 W	200.00 W
500.00m	30.000 W	50.000 W	75.000 W	150.00 W	300.00 W	500.00 W
1.0000	60.000 W	100.00 W	150.00 W	300.00 W	600.00 W	1.0000 kW
2.0000	120.00 W	200.00 W	300.00 W	600.00 W	1.2000 kW	2.0000 kW
5.0000	300.00 W	500.00 W	0.7500 kW	1.5000 kW	3.0000 kW	5.0000 kW
10.000	600.00 W	1.0000 kW	1.5000 kW	3.0000 kW	6.0000 kW	10.000 kW
20.000	1.2000 kW	2.0000 kW	3.0000 kW	6.0000 kW	12.000 kW	20.000 kW
50.000	3.0000 kW	5.0000 kW	7.5000 kW	15.000 kW	30.000 kW	50.000 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]					
	1.5000	3.0000	6.0000	10.000	15.000	30.000
[A]						
10.000m	30.000 mW	60.000 mW	120.000 mW	200.00 mW	300.00 mW	600.00 mW
20.000m	60.000 mW	120.000 mW	240.00 mW	400.00 mW	600.00 mW	1200.00 mW
50.000m	150.00 mW	300.00 mW	600.00 mW	1000.00 mW	1.5000 W	3.0000 W
100.00m	300.00 mW	600.00 mW	1200.00 mW	2.0000 W	3.0000 W	6.0000 W
200.00m	600.00 mW	1200.00 mW	2.4000 W	4.0000 W	6.0000 W	12.0000 W
500.00m	1.5000 W	3.0000 W	6.0000 W	10.0000 W	15.000 W	30.000 W
1.0000	3.0000 W	6.0000 W	12.0000 W	20.000 W	30.000 W	60.000 W
2.0000	6.0000 W	12.0000 W	24.000 W	40.000 W	60.000 W	120.000 W
5.0000	15.000 W	30.000 W	60.000 W	100.000 W	150.00 W	300.00 W
10.000	30.000 W	60.000 W	120.000 W	200.00 W	300.00 W	600.00 W
20.000	60.000 W	120.000 W	240.00 W	400.00 W	600.00 W	1200.00 W
50.000	150.00 W	300.00 W	600.00 W	1000.00 W	1.5000 kW	3.0000 kW

Current Range	Voltage Range [V]					
	60.000	100.00	150.00	300.00	600.00	1000.0
[A]						
10.000m	1200.00 mW	2.0000 W	3.0000 W	6.0000 W	12.0000 W	20.000 W
20.000m	2.4000 W	4.0000 W	6.0000 W	12.0000 W	24.000 W	40.000 W
50.000m	6.0000 W	10.0000 W	15.000 W	30.000 W	60.000 W	100.000 W
100.00m	12.0000 W	20.000 W	30.000 W	60.000 W	120.000 W	200.00 W
200.00m	24.000 W	40.000 W	60.000 W	120.000 W	240.00 W	400.00 W
500.00m	60.000 W	100.000 W	150.00 W	300.00 W	600.00 W	1000.00 W
1.0000	120.000 W	200.00 W	300.00 W	600.00 W	1200.00 W	2.0000 kW
2.0000	240.00 W	400.00 W	600.00 W	1200.00 W	2.4000 kW	4.0000 kW
5.0000	600.00 W	1000.00 W	1.5000 kW	3.0000 kW	6.0000 kW	10.0000 kW
10.000	1200.00 W	2.0000 kW	3.0000 kW	6.0000 kW	12.0000 kW	20.000 kW
20.000	2.4000 kW	4.0000 kW	6.0000 kW	12.0000 kW	24.000 kW	40.000 kW
50.000	6.0000 kW	10.0000 kW	15.000 kW	30.000 kW	60.000 kW	100.000 kW

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

Current Range	Voltage Range [V]					
	1.5000	3.0000	6.0000	10.000	15.000	30.000
[A]						
10.000m	45.000 mW	90.000 mW	180.000 mW	300.00 mW	450.00 mW	900.00 mW
20.000m	90.000 mW	180.000 mW	360.00 mW	600.00 mW	900.00 mW	1800.00 mW
50.000m	225.00 mW	450.00 mW	900.00 mW	1500.00 mW	2.2500 W	4.5000 W
100.00m	450.00 mW	900.00 mW	1800.00 mW	3.0000 W	4.5000 W	9.0000 W
200.00m	900.00 mW	1800.00 mW	3.6000 W	6.0000 W	9.0000 W	18.0000 W
500.00m	2.2500 W	4.5000 W	9.0000 W	15.0000 W	22.500 W	45.000 W
1.0000	4.5000 W	9.0000 W	18.0000 W	30.000 W	45.000 W	90.000 W
2.0000	9.0000 W	18.0000 W	36.000 W	60.000 W	90.000 W	180.000 W
5.0000	22.500 W	45.000 W	90.000 W	150.000 W	225.00 W	450.00 W
10.000	45.000 W	90.000 W	180.000 W	300.00 W	450.00 W	900.00 W
20.000	90.000 W	180.000 W	360.00 W	600.00 W	900.00 W	1800.00 W
50.000	225.00 W	450.00 W	900.00 W	1500.00 W	2.2500 kW	4.5000 kW

Current Range	Voltage Range [V]					
	60.000	100.00	150.00	300.00	600.00	1000.0
[A]						
10.000m	1800.00 mW	3.0000 W	4.5000 W	9.0000 W	18.0000 W	30.000 W
20.000m	3.6000 W	6.0000 W	9.0000 W	18.0000 W	36.000 W	60.000 W
50.000m	9.0000 W	15.0000 W	22.500 W	45.000 W	90.000 W	150.000 W
100.00m	18.0000 W	30.000 W	45.000 W	90.000 W	180.000 W	300.00 W
200.00m	36.000 W	60.000 W	90.000 W	180.000 W	360.00 W	600.00 W
500.00m	90.000 W	150.000 W	225.00 W	450.00 W	900.00 W	1500.00 W
1.0000	180.000 W	300.00 W	450.00 W	900.00 W	1800.00 W	3.0000 kW
2.0000	360.00 W	600.00 W	900.00 W	1800.00 W	3.6000 kW	6.0000 kW
5.0000	900.00 W	1500.00 W	2.2500 kW	4.5000 kW	9.0000 kW	15.0000 kW
10.000	1800.00 W	3.0000 kW	4.5000 kW	9.0000 kW	18.0000 kW	30.000 kW
20.000	3.6000 kW	6.0000 kW	9.0000 kW	18.0000 kW	36.000 kW	60.000 kW
50.000	9.0000 kW	15.0000 kW	22.500 kW	45.000 kW	90.000 kW	150.000 kW

## When the Crest Factor Is Set to 6 or 6A Active Power Range of Each Element

Current Range	Voltage Range [V]					
	0.7500	1.5000	3.0000	5.0000	7.500	15.000
[A]						
5.0000m	3.7500 mW	7.500 mW	15.000 mW	2.5000 mW	37.500 mW	75.00 mW
10.000m	7.500 mW	15.000 mW	30.000 mW	50.000 mW	75.00 mW	150.00 mW
25.000m	18.750 mW	37.500 mW	75.00 mW	125.00 mW	187.50 mW	375.00 mW
50.000m	37.500 mW	75.00 mW	150.00 mW	250.00 mW	375.00 mW	0.7500 W
100.00m	75.00 mW	150.00 mW	300.00 mW	500.00 mW	0.7500 W	1.5000 W
250.00m	187.50 mW	375.00 mW	0.7500 W	1.2500 W	1.8750 W	3.7500 W
500.00m	375.00 mW	0.7500 W	1.5000 W	2.5000 W	3.7500 W	7.500 W
1.0000	0.7500 W	1.5000 W	3.0000 W	5.0000 W	7.500 W	15.000 W
2.5000	1.8750 W	3.7500 W	7.500 W	12.500 W	18.750 W	37.500 W
5.0000	3.7500 W	7.500 W	15.000 W	25.000 W	37.500 W	75.00 W
10.000	7.500 W	15.000 W	30.000 W	50.000 W	75.00 W	150.00 W
25.000	18.750 W	37.500 W	75.00 W	125.00 W	187.50 W	375.00 W

Current Range	Voltage Range [V]					
	30.000	50.000	75.00	150.00	300.00	500.00
[A]						
5.0000m	150.00 mW	250.00 mW	375.00 mW	0.7500 W	1.5000 W	2.5000 W
10.000m	300.00 mW	500.00 mW	0.7500 W	1.5000 W	3.0000 W	5.0000 W
25.000m	0.7500 W	1.2500 W	1.8750 W	3.7500 W	7.500 W	12.500 W
50.000m	1.5000 W	2.5000 W	3.7500 W	7.500 W	15.000 W	25.000 W
100.00m	3.0000 W	5.0000 W	7.500 W	15.000 W	30.000 W	50.000 W
250.00m	7.500 W	12.500 W	18.750 W	37.500 W	75.00 W	125.00 W
500.00m	15.000 W	25.000 W	37.500 W	75.00 W	150.00 W	250.00 W
1.0000	30.000 W	50.000 W	75.00 W	150.00 W	300.00 W	500.00 W
2.5000	75.00 W	125.00 W	187.50 W	375.00 W	0.7500 kW	1.2500 kW
5.0000	150.00 W	250.00 W	375.00 W	0.7500 kW	1.5000 kW	2.5000 kW
10.000	300.00 W	500.00 W	0.7500 kW	1.5000 kW	3.0000 kW	5.0000 kW
25.000	0.7500 kW	1.2500 kW	1.8750 kW	3.7500 kW	7.500 kW	12.500 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]					
	0.7500	1.5000	3.0000	5.0000	7.500	15.000
[A]						
5.0000m	7.5000 mW	15.000 mW	30.000 mW	50.000 mW	75.000 mW	150.00 mW
10.000m	15.000 mW	30.000 mW	60.000 mW	100.000 mW	150.00 mW	300.00 mW
25.000m	37.500 mW	75.000 mW	150.00 mW	250.00 mW	375.00 mW	750.00 mW
50.000m	75.000 mW	150.00 mW	300.00 mW	500.00 mW	750.00 mW	1.5000 W
100.00m	150.00 mW	300.00 mW	600.00 mW	1000.00 mW	1.5000 W	3.0000 W
250.00m	375.00 mW	750.00 mW	1.5000 W	2.5000 W	3.7500 W	7.5000 W
500.00m	750.00 mW	1.5000 W	3.0000 W	5.0000 W	7.5000 W	15.000 W
1.0000	1.5000 W	3.0000 W	6.0000 W	10.0000 W	15.000 W	30.000 W
2.5000	3.7500 W	7.5000 W	15.000 W	25.000 W	37.500 W	75.000 W
5.0000	7.5000 W	15.000 W	30.000 W	50.000 W	75.000 W	150.00 W
10.000	15.000 W	30.000 W	60.000 W	100.000 W	150.00 W	300.00 W
25.000	37.500 W	75.000 W	150.00 W	250.00 W	375.00 W	750.00 W

Current Range	Voltage Range [V]					
	30.000	50.000	75.00	150.00	300.00	500.00
[A]						
5.0000m	300.00 mW	500.00 mW	750.00 mW	1.5000 W	3.0000 W	5.0000 W
10.000m	600.00 mW	1000.00 mW	1.5000 W	3.0000 W	6.0000 W	10.0000 W
25.000m	1.5000 W	2.5000 W	3.7500 W	7.5000 W	15.000 W	25.000 W
50.000m	3.0000 W	5.0000 W	7.5000 W	15.000 W	30.000 W	50.000 W
100.00m	6.0000 W	10.0000 W	15.000 W	30.000 W	60.000 W	100.000 W
250.00m	15.000 W	25.000 W	37.500 W	75.000 W	150.00 W	250.00 W
500.00m	30.000 W	50.000 W	75.000 W	150.00 W	300.00 W	500.00 W
1.0000	60.000 W	100.000 W	150.00 W	300.00 W	600.00 W	1000.00 W
2.5000	150.00 W	250.00 W	375.00 W	750.00 W	1.5000 kW	2.5000 kW
5.0000	300.00 W	500.00 W	750.00 W	1.5000 kW	3.0000 kW	5.0000 kW
10.000	600.00 W	1000.00 W	1.5000 kW	3.0000 kW	6.0000 kW	10.0000 kW
25.000	1.5000 kW	2.5000 kW	3.7500 kW	7.5000 kW	15.000 kW	25.000 kW

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

Current Range	Voltage Range [V]					
	0.7500	1.5000	3.0000	5.0000	7.500	15.000
[A]						
5.0000m	11.2500 mW	22.500 mW	45.000 mW	75.000 mW	112.500 mW	225.00 mW
10.000m	22.500 mW	45.000 mW	90.000 mW	150.000 mW	225.00 mW	450.00 mW
25.000m	56.250 mW	112.500 mW	225.00 mW	375.00 mW	562.50 mW	1125.00 mW
50.000m	112.500 mW	225.00 mW	450.00 mW	750.00 mW	1125.00 mW	2.2500 W
100.00m	225.00 mW	450.00 mW	900.00 mW	1500.00 mW	2.2500 W	4.5000 W
250.00m	562.50 mW	1125.00 mW	2.2500 W	3.7500 W	5.6250 W	11.2500 W
500.00m	1125.00 mW	2.2500 W	4.5000 W	7.5000 W	11.2500 W	22.500 W
1.0000	2.2500 W	4.5000 W	9.0000 W	15.0000 W	22.500 W	45.000 W
2.5000	5.6250 W	11.2500 W	22.500 W	37.500 W	56.250 W	112.500 W
5.0000	11.2500 W	22.500 W	45.000 W	75.000 W	112.500 W	225.00 W
10.000	22.500 W	45.000 W	90.000 W	150.000 W	225.00 W	450.00 W
25.000	56.250 W	112.500 W	225.00 W	375.00 W	562.50 W	1125.00 W

Current Range	Voltage Range [V]					
	30.000	50.000	75.00	150.00	300.00	500.00
[A]						
5.0000m	450.00 mW	750.00 mW	1125.00 mW	2.2500 W	4.5000 W	7.5000 W
10.000m	900.00 mW	1500.00 mW	2.2500 W	4.5000 W	9.0000 W	15.0000 W
25.000m	2.2500 W	3.7500 W	5.6250 W	11.2500 W	22.500 W	37.500 W
50.000m	4.5000 W	7.5000 W	11.2500 W	22.500 W	45.000 W	75.000 W
100.00m	9.0000 W	15.0000 W	22.500 W	45.000 W	90.000 W	150.000 W
250.00m	22.500 W	37.500 W	56.250 W	112.500 W	225.00 W	375.00 W
500.00m	45.000 W	75.000 W	112.500 W	225.00 W	450.00 W	750.00 W
1.0000	90.000 W	150.000 W	225.00 W	450.00 W	900.00 W	1500.00 W
2.5000	225.00 W	375.00 W	562.50 W	1125.00 W	2.2500 kW	3.7500 kW
5.0000	450.00 W	750.00 W	1125.00 W	2.2500 kW	4.5000 kW	7.5000 kW
10.000	900.00 W	1500.00 W	2.2500 kW	4.5000 kW	9.0000 kW	15.0000 kW
25.000	2.2500 kW	3.7500 kW	5.6250 kW	11.2500 kW	22.500 kW	37.500 kW

## Appendix 5 Setting the Measurement Period

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

This instrument uses its frequency measurement circuit (see appendix 11) to detect the period of the input signal that is selected using the measurement period setting. The measurement period is an integer multiple of this detected period. This 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 synchronization source.

The measurement period is automatically determined inside this instrument when you specify the synchronization source.

You can select the synchronization source signal from the options listed below.

U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6, Ext Clk (external clock), and None

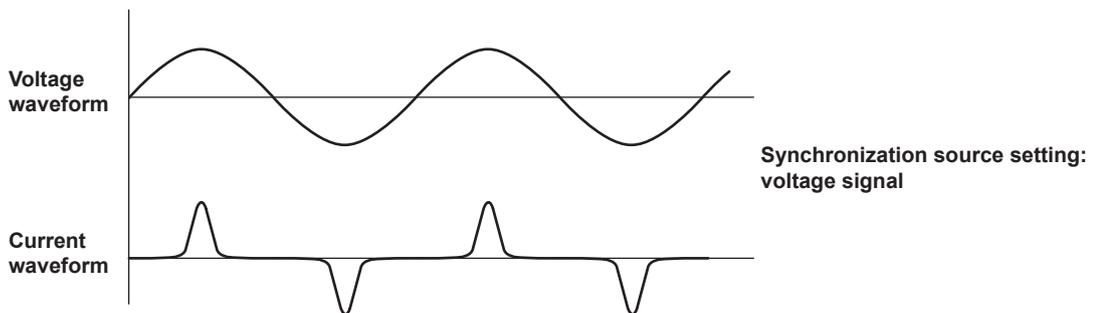
\* The available options vary depending on the installed elements.

For example, if the synchronization 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, this instrument computes the measured values for input element 1, such as U1, I1, and P1.

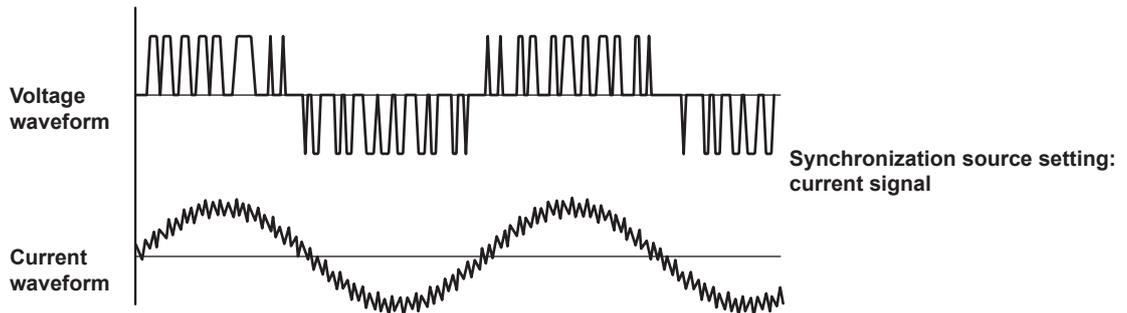
### Deciding Whether to Use Voltage or Current Input as the Synchronization Source

Select input signals with stable input levels and frequencies (with little distortion) as synchronization sources. Correct measured values can only be obtained if the period of the synchronization source signal is detected accurately. On this instrument, display the frequency of the input signal that you have selected as the synchronization source, and confirm that the frequency is being measured correctly. The most suitable synchronization 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 synchronization source to the voltage signal.

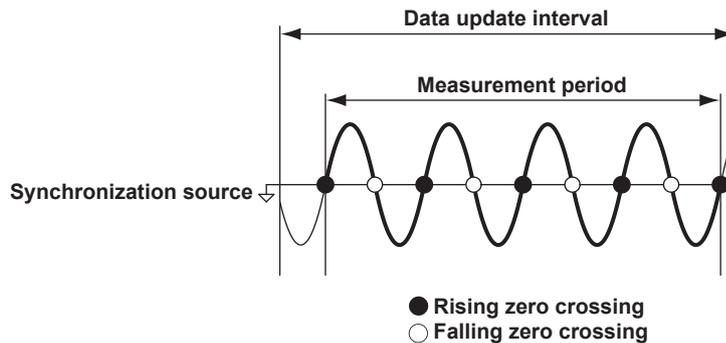


As another example, if an inverter is being measured and the current waveform distortion is smaller than the voltage waveform distortion, set the synchronization source to the current signal.



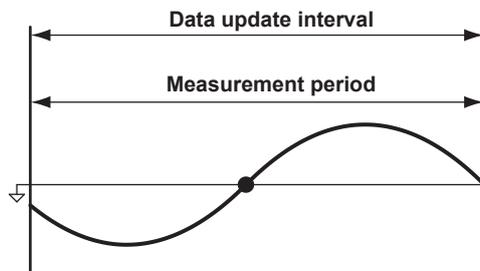
### Zero Crossing

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



### When the Period of the Synchronization Source Cannot Be Detected

If the total number of rising and falling zero crossings on the input signal that has been set as the synchronization 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 about the detectable frequency levels, see the conditions listed under “Accuracy” under “Frequency Measurement” in section 6.5, “Features.”) If the period cannot be detected, the entire data update interval becomes the measurement period, and the sampled data of the entire period is averaged.

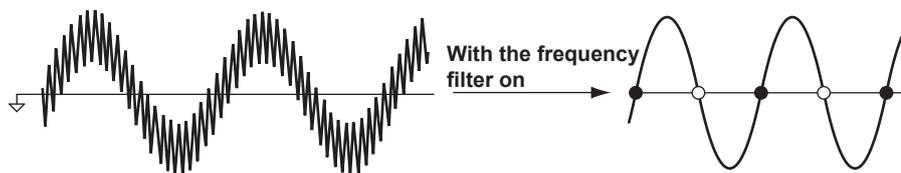


Because of the reasons described above, the measured voltage and current values may be unstable. If this happens, lower the data update rate so that more periods of the input signal fit within the data update interval.

### When the Waveform of the Synchronization Source Is Distorted

Change the synchronization 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.

This instrument reduces the effects of noise by using hysteresis when it detects zero crossings. 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 zero crossing detection to occur frequently, and the zero crossing 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 zero crossings. Use of the filter is appropriate if it makes the measured frequency accurate and more stable. Because the frequency filter can be used to facilitate the detection of the synchronization source's zero crossings, it is sometimes called the synchronization source filter or the zero-crossing filter.

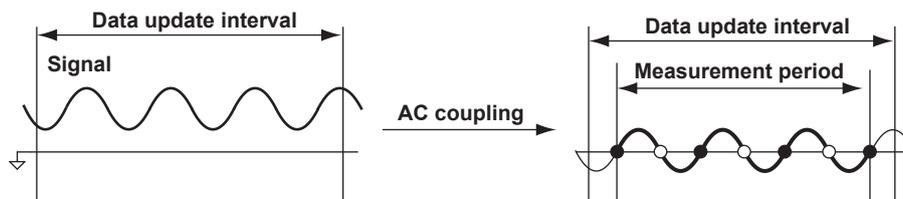


### When Measuring a Signal That Has No Zero Crossings Because of a DC Offset Superposed on the AC Signal

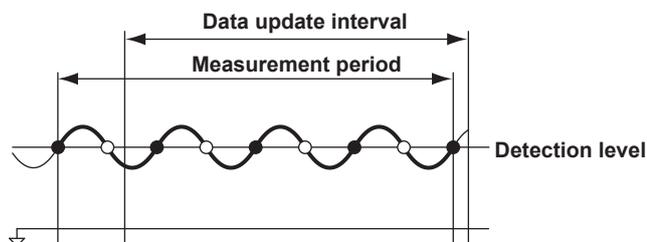
The measured values may be unstable if the period of the AC signal cannot be detected accurately. Change the synchronization source to a signal that allows for more stable detection of the period (switch from voltage to current or from current to voltage).

- When the data update interval is not Auto, the frequency detection circuit is AC coupled. Even with AC signals in which there are no zero crossings 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 the conditions listed under "Accuracy" under "Frequency Measurement" in section 6.5, "Features").

With this feature, the measurement period is set to an integer multiple of the period of the AC signal.



- When the data update interval is Auto, you can detect the period by setting the detection level to the center of the current amplitude.

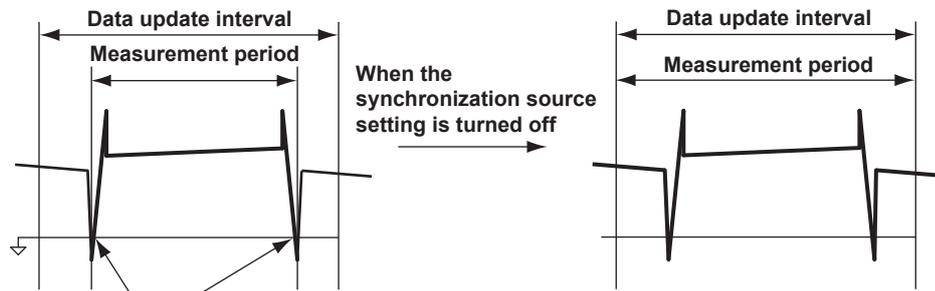


### When Measuring a DC Signal

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 6.5, “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.

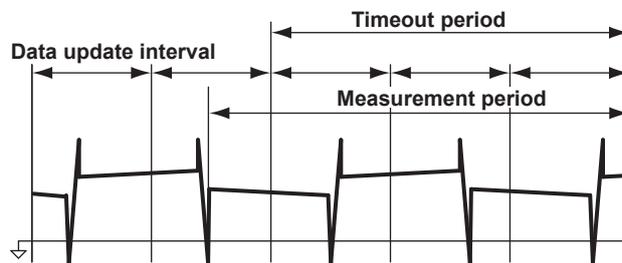
In addition, if a small fluctuating pulse noise riding on the DC signal crosses level zero, that point is detected as a zero crossing. As a result, sampled data is averaged over an unintended period, and measured values such as voltage and current may be unstable. You can prevent these kinds of erroneous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

- When the data update interval is not Auto, all of the sampled data in the data update interval is used to determine measured values.



Unintended zero crossing caused by pulse noise

- When the data update interval is Auto, all the sampled data within the timeout period is used to determine measured values.



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

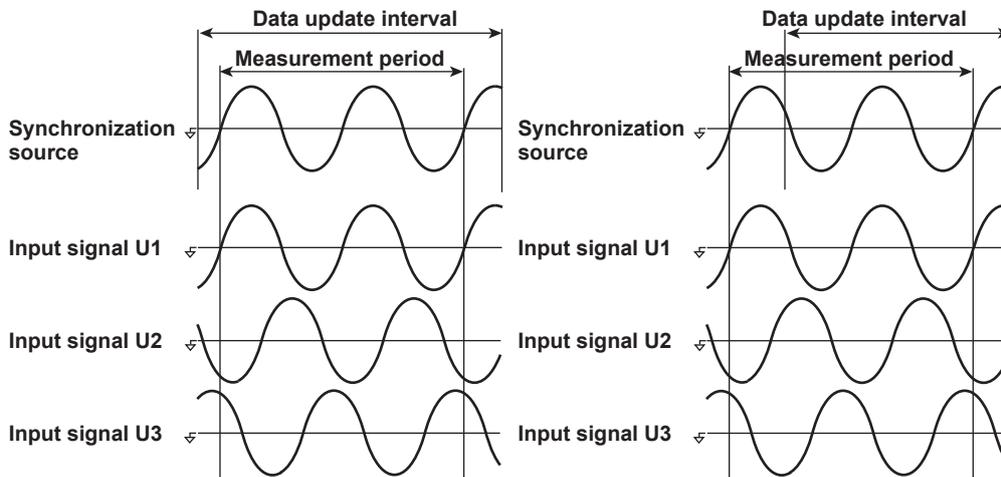
### Setting the Synchronization Period When Measuring a Three-Phase Device

If a three-phase device is measured with input elements 1 and 2 using a three-phase, three-wire system, set the synchronization source of input elements 1 and 2 to the same signal. For example, set the synchronization 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  $\Sigma$  voltage,  $\Sigma$  current, and  $\Sigma$  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 synchronization source of input elements 1, 2, and 3 to the same signal. To facilitate this sort of configuration, the synchronization source setting on this instrument is linked to the  $\Sigma$  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  $\Sigma$  wiring unit can be set independently.

When the data update interval is not Auto

When the data update interval is Auto



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

- **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 synchronization 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 synchronization 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 synchronization 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 synchronization source of input elements 1 and 2 to U2 (or I2).

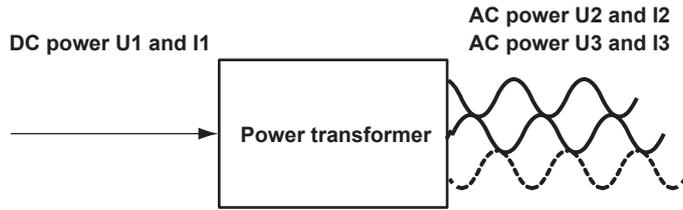


Synchronization Source Setup Example	
Input element 1	U2 (or I2)
Input element 2	

- **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 synchronization 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 synchronization 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	

• **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 synchronization 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 synchronization source of input element 1 to U1 (or I1), and set the synchronization 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 synchronization 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**

- When the data update interval is not Auto, 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.
- When the data update interval is not Auto, the measurement period for determining the numeric data of the peak voltage or peak current is the measurement period settings discussed above.
- For details on the measurement period for measurement functions related to harmonic measurement, see the features guide.

## 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 E1 to E6	Wiring Unit E7 to E9
		Example		
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
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
P	P( )	P(E1)	Yes	Yes
S	S( )	S(E1)	Yes	Yes
Q	Q( )	Q(E1)	Yes	Yes
$\lambda$	LAMBDA( )	LAMBDA(E1)	Yes	Yes
$\Phi$	PHI( )	PHI(E1)	Yes	Yes
fU	FU( )	FU(E1)	Yes	No
fI	FI( )	FI(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 E1 to E6	Wiring Unit E7 to E9
		Example		
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
Time	TI( )	TI(E1)	Yes	No

## Efficiency

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
		Example	E1 to E6	E7 to E9
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 Functions

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
		Example	E1 to E6	E7 to E9
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.

## User-Defined Events

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
		Example	E1 to E6	E7 to E9
Ev1	EV1( )	EV1( )	None or space*	
Ev2	EV2( )	EV2( )	None or space*	
Ev3	EV3( )	EV3( )	None or space*	
Ev4	EV4( )	EV4( )	None or space*	
Ev5	EV5( )	EV5( )	None or space*	
Ev6	EV6( )	EV6( )	None or space*	
Ev7	EV7( )	EV7( )	None or space*	
Ev8	EV8( )	EV8( )	None or space*	

\* You cannot omit the parentheses.

## MAX Hold

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
	Example	E1 to E6	E7 to E9	
Rms voltage	URMSMAX( )	URMSMAX(E1)	Yes	Yes
Voltage mean	UMEANMAX( )	UMEANMAX(E1)	Yes	Yes
Voltage simple average	UDCMAX( )	UDCMAX(E1)	Yes	Yes
Voltage rectified mean value	URMEANMAX( )	URMEANMAX(E1 )	Yes	Yes
Voltage AC component	UACMAX( )	UACMAX(E1)	Yes	Yes
Rms current	IRMSMAX( )	IRMSMAX(E1)	Yes	Yes
Current mean	IMEANMAX( )	IMEANMAX(E1)	Yes	Yes
Current simple average	IDCMAX( )	IDCMAX(E1)	Yes	Yes
Current rectified mean value	IRMEANMAX( )	IRMEANMAX(E1)	Yes	Yes
Current AC component	IACMAX( )	IACMAX(E1)	Yes	Yes
Active power	PMAX( )	PMAX(E1)	Yes	Yes
Apparent power	SMAX( )	SMAX(E1)	Yes	Yes
Reactive power	QMAX( )	QMAX(E1)	Yes	Yes
Positive peak voltage	UPPEAKMAX( )	UPPEAKMAX(E1)	Yes	No
Negative peak voltage	UMPEAKMAX( )	UMPEAKMAX(E1)	Yes	No
Positive peak current	IPPEAKMAX( )	IPPEAKMAX(E1)	Yes	No
Negative peak current	IMPEAKMAX( )	IMPEAKMAX(E1)	Yes	No
Positive peak power	PPPEAKMAX( )	PPPEAKMAX(E1)	Yes	No
Negative peak power	PMPEAKMAX( )	PMPEAKMAX(E1)	Yes	No

## Motor Evaluation Option

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
	Example	E1 to E6	E7 to E9	
Speed	SPEED( )	SPEED( )	None or space*	
Torque	TORQUE( )	TORQUE( )	None or space*	
Pm	PM( )	PM( )	None or space*	
Slip	SLIP( )	SLIP( )	None or space*	
SyncSp	SYNC( )	SYNC( )	None or space*	

\* You cannot omit the parentheses.

## Auxiliary Input Option

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
	Example	E1 to E6	E7 to E9	
Aux1	AUX1( )	AUX1( )	None or space*	
Aux2	AUX2( )	AUX2( )	None or space*	

\* You cannot omit the parentheses.

## Delta Computation

Measurement Function	User-Defined Function		Parameter in ( )	
			Element	Wiring Unit
		Example	E1 to E6	E7 to E9
$\Delta U1( )$	DELTAU1( )	DELTAU1(E7)	No	Yes
$\Delta U2( )$	DELTAU2( )	DELTAU2(E7)	No	Yes
$\Delta U3( )$	DELTAU3( )	DELTAU3(E7)	No	Yes
$\Delta U\Sigma( )$	DELTAUSIG( )	DELTAUSIG(E7)	No	Yes
$\Delta I( )$	DELTAI( )	DELTAI(E7)	No	Yes
$\Delta P1( )$	DELTA P1( )	DELTA P1(E7)	No	Yes
$\Delta P2( )$	DELTA P2( )	DELTA P2(E7)	No	Yes
$\Delta P3( )$	DELTA P3( )	DELTA P3(E7)	No	Yes
$\Delta P\Sigma( )$	DELTA P SIG( )	DELTA P SIG(E7)	No	Yes
$\Delta U1rms( )$	DELTAU1RMS( )	DELTAU1RMS(E7)	No	Yes
$\Delta U2rms( )$	DELTAU2RMS( )	DELTAU2RMS(E7)	No	Yes
$\Delta U3rms( )$	DELTAU3RMS( )	DELTAU3RMS(E7)	No	Yes
$\Delta U\Sigma rms( )$	DELTAUSIGRMS( )	DELTAUSIGRMS(E7)	No	Yes
$\Delta U1mean( )$	DELTAU1MN( )	DELTAU1MN(E7)	No	Yes
$\Delta U2mean( )$	DELTAU2MN( )	DELTAU2MN(E7)	No	Yes
$\Delta U3mean( )$	DELTAU3MN( )	DELTAU3MN(E7)	No	Yes
$\Delta U\Sigma mean( )$	DELTAUSIGMN( )	DELTAUSIGMN(E7)	No	Yes
$\Delta U1rmean( )$	DELTAU1RMN( )	DELTAU1RMN(E7)	No	Yes
$\Delta U2rmean( )$	DELTAU2RMN( )	DELTAU2RMN(E7)	No	Yes
$\Delta U3rmean( )$	DELTAU3RMN( )	DELTAU3RMN(E7)	No	Yes
$\Delta U\Sigma rmean( )$	DELTAUSIGRMN( )	DELTAUSIGRMN(E7)	No	Yes
$\Delta U1dc( )$	DELTAU1DC( )	DELTAU1DC(E7)	No	Yes
$\Delta U2dc( )$	DELTAU2DC( )	DELTAU2DC(E7)	No	Yes
$\Delta U3dc( )$	DELTAU3DC( )	DELTAU3DC(E7)	No	Yes
$\Delta U\Sigma dc( )$	DELTAUSIGDC( )	DELTAUSIGDC(E7)	No	Yes
$\Delta U1ac( )$	DELTAU1AC( )	DELTAU1AC(E7)	No	Yes
$\Delta U2ac( )$	DELTAU2AC( )	DELTAU2AC(E7)	No	Yes
$\Delta U3ac( )$	DELTAU3AC( )	DELTAU3AC(E7)	No	Yes
$\Delta U\Sigma ac( )$	DELTAUSIGAC( )	DELTAUSIGAC(E7)	No	Yes
$\Delta Irms( )$	DELTAI rms( )	DELTAI RMS(E7)	No	Yes
$\Delta I mean( )$	DELTAI MN( )	DELTAI MN(E7)	No	Yes
$\Delta I rmean( )$	DELTAI RMN( )	DELTAI RMN(E7)	No	Yes
$\Delta Idc( )$	DELTAI DC( )	DELTAI DC(E7)	No	Yes
$\Delta I ac( )$	DELTAI AC( )	DELTAI AC(E7)	No	Yes

## Harmonic Measurement Option or Simultaneous Dual Harmonic Measurement Option

Measurement Function	User-Defined Function		Left Parameter in ( , ) or Parameter in ( )		Right Parameter in ( , )			
			Element	Wiring Unit	Harmonic Order			
					Total Value	DC	Fundamental Wave	Harmonics
Example	E1 to E6	E7 to E9	ORT	OR0	OR1	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 OR500
Q_k	QK( , )	QK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR500
λ_k	LAMBDAK( , )	LAMBDAK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR500
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	(This area is shaded gray and contains a diagonal line from the bottom-left to the top-right.)			
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				
EaU <sup>+</sup>	EAU( )	EAU(E1)	Yes	No				
EaI <sup>+</sup>	EAI( )	EAI(E1)	Yes	No				
FreqPLL1	PLLFRQ1( )	PLLFRQ1( )	No	No				
FreqPLL2	PLLFRQ2( )	PLLFRQ2( )	No	No				
ΦU1-U2	PHIU1U2( )	PHIU1U2(E7)	No	Yes				
ΦU1-U3	PHIU1U3( )	PHIU1U3(E7)	No	Yes				
ΦU1-I1	PHIU1I1( )	PHIU1I1(E7)	Yes	Yes				
ΦU2-I2	PHIU2I2( )	PHIU2I2(E7)	No	Yes				
ΦU3-I3	PHIU3I3( )	PHIU3I3(E7)	No	Yes				

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

# 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 This Instrument		Other	
		When the Shift of This Instrument Is On		+Shift on the USB Keyboard		When the Shift of This Instrument Is On
a	AVG menu		a	A		
b	Execute STORE START	STORE SET menu	b	B		
c	SCALING menu	MOTOR/AUX SET menu	c	C		
d	Execute HOLD		d	D		
e	Execute ELEMENT	Execute ELEMENT ALL	e	E		
f	FILE menu	Same as left	f	F		
g	INTEG menu		g	G		
h	HRM SET menu		h	H		
i	Execute IMAGE SAVE	IMAGE SAVE menu	i	I		
j	Execute NULL	NULL SET menu	j	J		
k	Execute STORE STOP	Execute STORE RESET	k	K		
l	LINE FILTER menu	FREQ FILTER menu	l	L		
m	MEASURE menu	FREQ MEASURE menu	m	M		
n	Execute NUMERIC		n	N		
o	OTHERS menu		o	O		
p	Execute PRINT	PRINT menu	p	P		
q	FORM menu	CURSOR menu	q	Q		
r	Execute RESET	Same as left	r	R		
s	SHIFT on	SHIFT off	s	S		
t	ITEM menu		t	T		
u	UPDATE RATE menu		u	U		
v	WIRING menu		v	V		
w	Execute WAVE		w	W		
x	Execute EXT-SENSOR	SENSOR RATIO menu	x	X		
y	SYNC SOURCE menu		y	Y		
z	Execute SINGLE	Execute CAL	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	Same as left	Enter	Same as left	Execute SET	Same as left
Esc	Execute ESC	Same as left	Escape	Same as left	Execute ESC	Same as left
Back Space			Back Space	Same as left		
Tab						
Space Bar			Space	Same as left		
`			`	~		
-			-	=		
=			=	+		
[			[	{		
]			]	}		
\			\			
;			;	:		
'			'	"		
,			,	<		
.	UTILITY menu		.	>		
/	Execute HELP	Same as left	/	?		
Caps Lock			Caps Lock	Same as left		

 : No feature is assigned to the key.

## 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 This Instrument		Other	
		When the Shift of This Instrument Is On		+Shift on the USB Keyboard		When the Shift of This Instrument Is On
F1	Execute U RANGE UP		Select soft key 1	Same as left	Select soft key 1	Same as left
F2	Execute U RANGE DOWN		Select soft key 2	Same as left	Select soft key 2	Same as left
F3	Execute U CONFIG		Select soft key 3	Same as left	Select soft key 3	Same as left
F4	Execute U AUTO		Select soft key 4	Same as left	Select soft key 4	Same as left
F5	Execute I RANGE UP		Select soft key 5	Same as left	Select soft key 5	Same as left
F6	Execute I RANGE DOWN		Select soft key 6	Same as left	Select soft key 6	Same as left
F7	Execute I CONFIG	Execute DIRECT/MEASURE	Select soft key 7	Same as left	Select soft key 7	Same as left
F8	Execute I AUTO					
F9	Execute U,I,P					
F10	Execute S,Q,λ,Φ					
F11	Execute WP,q,TIME		μ	Same as left		
F12	Execute FU,F,I,η		Ω	Same as left		
Print Screen	Execute PRINT	PRINT menu				
Scroll Lock	Execute IMAGE SAVE	IMAGE SAVE menu				
Pause						
Insert	Execute INPUT INFO					
Home	Execute U/I MODE					
Page Up	Execute PAGE UP	Execute PAGE TOP			Execute PAGE UP	Execute PAGE TOP
Delete						
End	ELEMENT	ALL				
Page Down	Execute PAGE DOWN	Execute PAGE END			Execute PAGE DOWN	Execute PAGE END
→	Move cursor to the right	Same as left	Move cursor to the right	Same as left	Move cursor to the right	Same as left
←	Move cursor to the left	Same as left	Move cursor to the left	Same as left	Move cursor to the left	Same as left
↓	Move cursor down	Same as left			Move cursor down	Same as left
↑	Move cursor up	Same as left			Move cursor up	Same as left

Numeric Keypad	When the Ctrl Key Is Held Down on the USB Keyboard		When the Soft Keyboard Is Displayed on This Instrument		Other	
		When the Shift of This Instrument Is On		+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	Same as left	Enter	Same as left		Execute SET
1			1			
2	Move cursor down	Same as left	2			Move cursor down
3	Execute PAGE DOWN	Execute PAGE END	3			Execute PAGE DOWN
4	Move cursor to the left	Same as left	4	Move cursor to the left		Move cursor to the left
5			5			
6	Move cursor to the right	Same as left	6	Move cursor to the right		Move cursor to the right
7			7			
8	Move cursor up	Same as left	8			Move cursor up
9	Execute PAGE UP	Execute PAGE TOP	9			Execute PAGE UP
0			0			
.			.			

: No feature is assigned to the key.

## 109 Keyboard (Japanese)

Key	When the Ctrl Key Is Held Down on the USB Keyboard		When the Soft Keyboard Is Displayed on This Instrument		Other	
		When the Shift of This Instrument Is On		+Shift on the USB Keyboard		When the Shift of This Instrument Is On
a	AVG menu		a	A		
b	Execute STORE START	STORE SET menu	b	B		
c	SCALING menu	MOTOR/AUX SET menu	c	C		
d	Execute HOLD		d	D		
e	Execute ELEMENT	Execute ELEMENT ALL	e	E		
f	FILE menu	Same as left	f	F		
g	INTEG menu		g	G		
h	HRM SET menu		h	H		
i	Execute IMAGE SAVE	IMAGE SAVE menu	i	I		
j	Execute NULL	NULL SET menu	j	J		
k	Execute STORE STOP	Execute STORE RESET	k	K		
l	LINE FILTER menu	FREQ FILTER menu	l	L		
m	MEASURE menu	FREQ MEASURE menu	m	M		
n	Execute NUMERIC		n	N		
o	OTHERS menu		o	O		
p	Execute PRINT	PRINT menu	p	P		
q	FORM menu	CURSOR menu	q	Q		
r	Execute RESET	Same as left	r	R		
s	SHIFT on	SHIFT off	s	S		
t	ITEM menu		t	T		
u	UPDATE RATE menu		u	U		
v	WIRING menu		v	V		
w	Execute WAVE		w	W		
x	Execute EXT-SENSOR	SENSOR RATIO menu	x	X		
y	SYNC SOURCE menu		y	Y		
z	Execute SINGLE	Execute CAL	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	Same as left	Enter	Same as left	Execute SET	Same as left
Esc	Execute ESC	Same as left	Escape	Same as left	Execute ESC	Same as left
BS			Back Space	Same as left		
Tab						
Space			Space	Same as left		
-			-	=		
^			^	~		
\			\			
@			@	`		
[			[	{		
;			;	+		
:			:	*		
]			]	}		
,			,	<		
.	UTILITY menu		.	>		
/	Execute HELP	Same as left	/	?		
\			\	_		
Caps Lock			Caps Lock	Same as left		

 : No feature is assigned to the key.

## 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 This Instrument		Other	
		When the Shift of This Instrument Is On		+Shift on the USB Keyboard		When the Shift of This Instrument Is On
F1	Execute U RANGE UP		Select soft key 1	Same as left	Select soft key 1	Same as left
F2	Execute U RANGE DOWN		Select soft key 2	Same as left	Select soft key 2	Same as left
F3	Execute U CONFIG		Select soft key 3	Same as left	Select soft key 3	Same as left
F4	Execute U AUTO		Select soft key 4	Same as left	Select soft key 4	Same as left
F5	Execute I RANGE UP		Select soft key 5	Same as left	Select soft key 5	Same as left
F6	Execute I RANGE DOWN		Select soft key 6	Same as left	Select soft key 6	Same as left
F7	Execute I CONFIG	Execute DIRECT/MEASURE	Select soft key 7	Same as left	Select soft key 7	Same as left
F8	Execute I AUTO					
F9	Execute U,I,P					
F10	Execute S,Q,λ,Φ					
F11	Execute WP,q,TIME		μ	Same as left		
F12	Execute FU,FI,η		Ω	Same as left		
Print Screen	Execute PRINT	PRINT menu				
Scroll Lock	Execute IMAGE SAVE	IMAGE SAVE menu				
Pause						
Insert	Execute INPUT INFO					
Home	Execute U/I MODE					
Page Up	Execute PAGE UP	Execute PAGE TOP			Execute PAGE UP	Execute PAGE TOP
Delete						
End	ELEMENT	ALL				
Page Down	Execute PAGE DOWN	Execute PAGE END			Execute PAGE DOWN	Execute PAGE END
→	Move cursor to the right	Same as left	Move cursor to the right	Same as left	Move cursor to the right	Same as left
←	Move cursor to the left	Same as left	Move cursor to the left	Same as left	Move cursor to the left	Same as left
↓	Move cursor down	Same as left			Move cursor down	Same as left
↑	Move cursor up	Same as left			Move cursor up	Same as left

Numeric Keypad	When the Ctrl Key Is Held Down on the USB Keyboard		When the Soft Keyboard Is Displayed on this instrument		Other	
		When the Shift of This Instrument Is On		+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	Same as left	Enter	Same as left		Execute SET
1			1			
2	Move cursor down	Same as left	2			Move cursor down
3	Execute PAGE DOWN	Execute PAGE END	3			Execute PAGE DOWN
4	Move cursor to the left	Same as left	4	Move cursor to the left		Move cursor to the left
5			5			
6	Move cursor to the right	Same as left	6	Move cursor to the right		Move cursor to the right
7			7			
8	Move cursor up	Same as left	8			Move cursor up
9	Execute PAGE UP	Execute PAGE TOP	9			Execute PAGE UP
0			0			
.			.			

: No feature is assigned to the key.

# Appendix 8 List of Initial Settings and Numeric Data Display Order

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

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

Item	Setting
<b>RANGE</b>	5 A Input Element                      50 A Input Element
U Range	1000V                                      1000V
I Input Terminal	Direct                                      Direct
I Direct input Range	5A    50A
External Sensor Range*	10V                                         10V
<b>SENSOR RATIO*</b>	10.0000mV/A
<b>WIRING</b>	
Wiring Setting	1P2W
η Formula	
η1	PΣB/PΣA
η2	PΣA/PΣB
η3	Off/Off
η4	Off/Off
Udef1	P1+None+None+None
Udef2	P1+None+None+None
Element Independent	Off
ΔMeasure	
ΔMeasure Type	-
ΔMeasure Mode	rms
All Elements Setup	Others
Sensor Preset	Others
CT Preset	
For other items, see RANGE, SENSOR RATIO, SCALING, LINE FILTER, FREQ FILTER, and SYNC SOURCE.	
<b>SCALING</b>	
Scaling	Off
VT Scaling	1.0000
CT Scaling	1.0000
Scaling Factor	1.0000
<b>LINE FILTER</b>	Normal measurement mode: Off (Cutoff 0.5kHz) High speed data capturing mode: On (Cutoff 300kHz)
<b>FREQ FILTER</b>	
Freq Filter	Off
Freq Filter at Update Rate Auto	Off
Cutoff	100Hz
<b>AVG</b>	
Averaging	Off
Averaging Type	Exp.
Exp. Count	2
Lin. Count	8
<b>MEASURE</b>	
User-Defined Function	On/Off    Name    Unit    Expression
Function1	Off    Avg-W    W    WH(E1)/(TI(E1)/3600)
Function2	Off    P-loss    W    P(E1)-P(E2)
Function3	Off    U-ripple    %    (UPPK(E1)-UMPKE1)/2/UDC(E1)*100
Function4	Off    I-ripple    %    (IPPK(E1)-IMPKE1)/2/IDC(E1)*100
Function5	Off    D-UrmsR    V    DELTAU1RMS(E7)
Function6	Off    D-UrmsS    V    DELTAU2RMS(E7)
Function7	Off    D-UrmsT    V    DELTAU3RMS(E7)
Function8	Off    D-UmnR    V    DELTAU1MN(E7)
Function9	Off    D-UmnS    V    DELTAU2MN(E7)
Function10	Off    D-UmnT    V    DELTAU3MN(E7)

\* Available on models with the external current sensor input option

## Appendix 8 List of Initial Settings and Numeric Data Display Order

Item	Setting					
Function11	Off	PhiU3-U2	deg	360-PHIU1U3(E7)+PHIU1U2(E7)		
Function12	Off	Phil1-I2	deg	PHIU1I2(E7)-PHIU1I1(E7)		
Function13	Off	Phil2-I3	deg	PHIU3I3(E7)-PHIU2I2(E7)-F11()		
Function14	Off	Phil3-I1	deg	(360-PHIU3I3(E7))+PHIU1I1(E7)+(360-PHIU1U3(E7))		
Function15	Off	Pp-p	W	PPPK(E1)-PMPK(E1)		
Function16	Off	F16	V	DELTAU1RMN(E7)		
Function17	Off	F17	V	DELTAU2RMN(E7)		
Function18	Off	F18	V	DELTAU3RMN(E7)		
Function19	Off	F19	V	DELTAU1DC(E7)		
Function20	Off	F20	V	DELTAU2DC(E7)		
Max Hold	Off					
User-Defined Event	On/Off	Event Name	True	False	Expression	
Event No.1	Off	Ev1	True	False	URMS(E1) > 0.00000	
Event No.2	Off	Ev2	True	False	IRMS(E1) > 0.00000	
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	
Formula						
S Formula	Urms*Irms					
S,Q Formula	Type1					
Pc Formula	IEC76-1(1976)					
IEC76-1(1976)'s P1 and P2	P1 = 0.5000, P2 = 0.5000					
Sampling Frequency	Auto					
Phase	180 Lead/Lag					
Sync Measure	Master					
<b>SYNC SOURCE</b>						
Element Object	Element1	Element2	Element3	Element4	Element5	Element6
Sync Source	I1	I2	I3	I4	I5	I6
Sync Source Settings						
Voltage Rectifier	Off					
Voltage Level	0.0%					
Current Rectifier	Off					
Current Level	0.0%					
Ext. Sensor Rectifier	Off					
Ext. Sensor Level	0.0%					
<b>HRM SET (Available on models with the harmonic measurement option or the simultaneous dual harmonic measurement option)</b>						
Element Settings*	Element1 to Element6: Hrm1					
Hrm1 PLL Source	U1					
Hrm1 Min Order	1					
Hrm1 Max Order	100					
Hrm1 Thd Formula	1/Total					
Hrm1 FFT Points	1024					
Hrm2 PLL Source*	U1					
Hrm2 Min Order*	1					
Hrm2 Max Order*	100					
Hrm2 Thd Formula*	1/Total					
<b>MOTOR SET (Available on models with the motor evaluation function; option)</b>						
Scaling	Speed	Torque			Pm	
Unit	1.0000	1.0000			1.0000	
Sense Type	rpm	Nm			W	
Analog Auto Range	Analog	Analog				
Analog Range	Off	Off				
Linear Scale A	20V	20V				
Linear Scale B	1.000	1.000				
	0.000	0.000				

\* Available on models with the simultaneous dual harmonic measurement option

## Appendix 8 List of Initial Settings and Numeric Data Display Order

Item	Setting	
Calculation		
Point1X	0.000	0.000
Point1Y	0.000	0.000
Point2X	0.000	0.000
Point2Y	0.000	0.000
Line Filter	Off	
Sync Source	None	
Pulse Range Upper	10000.0000	50.0000
Pulse Range Lower	0.0000	-50.0000
Rated Upper		50.0000
Rated Upper (Rated Freq)		15000Hz
Rated Lower		-50.0000
Rated Lower (Rated Freq)		5000Hz
Pulse N (Speed)	60	
Sync Speed		
Pole	2	
Source	I1	
Electrical Angle Measurement	Off	
Electrical Angle Offset		
Offset Value	0.00	
Auto Enter Target	U1	
<b>AUX SET (Available on models with the auxiliary input option)</b>		
Aux Name	AUX1	AUX2
Scaling	1.0000	1.0000
Unit	kW/m2	kW/m2
Analog Auto Range	Off	Off
Analog Range	20V	20V
Linear Scale A	1.000	1.000
Linear Scale B	0.000	0.000
Calculation		
Point1X	0.000	0.000
Point1Y	0.000	0.000
Point2X	0.000	0.000
Point2Y	0.000	0.000
Line Filter	Off	
<b>UPDATE RATE</b>		
Auto	Off	
Update Rate	500ms	
Time Out at Update Rate Auto	1s	
<b>HOLD</b>		
Hold	Off	
<b>INTEG</b>		
Integrator Status	Reset condition	
Independent Control	Off	
Integ Set		
Mode	Normal	
Integ Timer	00000:00:00	
Integ Start	2016/01/01 00:00:00	
Integ End	2016/01/01 01:00:00	
Auto Cal	Off	
WP±Type		
Setting	Each	
Element1 to Element6	Charge/Discharge	
q mode		
Setting	Each	
Element1 to Element6	dc	
D/A Output Rated Time	00001:00:00	
	(Displayed on models with the D/A output option)	

## Appendix 8 List of Initial Settings and Numeric Data Display Order

Item	Setting		
<b>ITEM (Numeric)</b>			
Item No.	1		
Function	Urms		
Element/ $\Sigma$	Element1		
Order	-		
Display Frame	On		
<b>FORM (Numeric)</b>			
Numeric Form	4 Items		
<b>ITEM (Wave)</b>			
Display On	U1 to I6, Speed, <sup>1</sup> Torque, <sup>1</sup> Aux1, <sup>2</sup> Aux2 <sup>2</sup>		
Vertical Zoom	×1		
Vertical Position	0.000%		
<b>FORM (Wave)</b>			
Format	Single		
Time/div	5ms		
Trigger Settings			
Mode	Off		
Source	U1		
Slope	Rise		
Level	0.0%		
Display Setting			
Interpolate	Line		
Graticule	Grid(■)		
Scale Value	On		
Wave Label	Off		
Wave Mapping			
Mode	Auto		
User Setting	U1: 0, I1: 0, U2: 1, I2: 1, U3: 2, I3: 2, U4: 3, I4: 3, U5: 4, I5: 4, U6: 5, I6: 5, Speed: 0, <sup>1</sup> Torque: 0, <sup>1</sup> Aux1: 0, <sup>2</sup> Aux2: 0 <sup>2</sup>		
<b>ITEM (Trend)</b>			
Display On	T1 to T8		
Function	T1: Urms, T2: Irms, T3: P, T4: S, T5: Q, T6: $\lambda$ , T7: $\Phi$ , T8: FreqU, T9 to T16: Urms		
Element	Element1		
Order	-		
Scaling	Auto		
Upper Scale	1.000E+02		
Lower Scale	-1.000E+02		
<b>FORM (Trend)</b>			
Trend Format	Single		
Time/div	3s		
Display Setting	Same as those listed under FORM (Wave)		
<b>ITEM (Bar; displayed on models with the harmonic measurement option or simultaneous dual harmonic measurement option)</b>			
Bar Item No.	1	2	3
Function	U	I	P
Element	Element1	Element1	Element1
Scale Mode	Fixed	Fixed	Fixed
<b>FORM (Bar; displayed on models with the harmonic measurement option or simultaneous dual harmonic measurement option)</b>			
Format	Single		
Start Order	1		
End Order	100		

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

2 Available on models with the auxiliary input option

## Appendix 8 List of Initial Settings and Numeric Data Display Order

Item	Setting
<b>ITEM (Vector; displayed on models with the harmonic measurement option or simultaneous dual harmonic measurement option)</b>	
Vector Item No	1 2
Object	$\Sigma A$ Element1
U Mag	1.000 1.000
I Mag	1.000 1.000
<b>FORM (Vector; displayed on models with the harmonic measurement option or simultaneous dual harmonic measurement option)</b>	
Format	Single
Numeric	On
<b>FORM (High speed data capturing)</b>	
Capt. Count	Infinite
Control Settings	
U/I Measuring Mode	
Setting	Each
U1 to I6	rms
HS Filter	Off
Cutoff	100Hz
Trigger Settings	Same as those listed under FORM (Wave)
External Sync	Off
Record to File	Off
File Settings	
Auto CSV Conversion	On
Item Settings	U1, I1, P1
Auto Naming	Numbering
<b>ITEM (High speed data capturing)</b>	
Column Num	4
Column No.	1
Element/ $\Sigma$	Element1
Display Peak Over Status	Off
Display Frame	Same as those listed under ITEM (Numeric)
<b>CURSOR (Wave)</b>	
Wave Cursor	Off
Wave C1+ Trace	U1
Wave C2x Trace	I1
Cursor Path	Max
Wave C1+ Position	160
Wave C2x Position	640
Linkage	Off
<b>CURSOR (Trend)</b>	
Trend Cursor	Off
Trend C1+ Trace	T1
Trend C2x Trace	T2
Trend C1+ Position	160
Trend C2x Position	1440
Linkage	Off
<b>CURSOR (Bar; displayed on models with the harmonic measurement option or simultaneous dual harmonic measurement option)</b>	
Bar Cursor	Off
Bar C1+	1 order
Bar C2x	15 order
Linkage	Off

## Appendix 8 List of Initial Settings and Numeric Data Display Order

Item	Setting
<b>STORE START/STOP/RESET</b>	
Store Status	Off
<b>STORE SET</b>	
Control Settings	
Store Mode	Manual
Store Count	100
Interval	00:00:00
Item Settings	
Store Items	Selected Items
Items	Element1 Urms, Irms, P, S, Q, λ, Φ, FreqU, FreqI
File Settings	
Auto CSV Conversion	On
Auto Naming	Numbering
<b>FILE</b>	
Auto Naming	Numbering
<b>IMAGE SAVE</b>	
Format	BMP
Color	Off
Auto Naming	Numbering
<b>PRINT MENU (Available on models with the printer option)</b>	
Format	Screen
Auto Print Settings	
Print Mode	Interval
Print Count	Infinite
Print Interval	00:00:10
Print at Start	On
<b>NULL</b>	
Null	Off
<b>NULL SET</b>	
Target Element	All
Selected Items	U1 to U6, I1 to I6, Speed, <sup>1</sup> Torque, <sup>1</sup> Aux1, <sup>2</sup> Aux2 <sup>2</sup>
<b>KEY LOCK<sup>3</sup></b>	
	Off

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

2 Available on models with the auxiliary input option

3 This setting is initialized when an RST command is received through the communication interface.

## Appendix 8 List of Initial Settings and Numeric Data Display Order

Item	Setting			
<b>UTILITY</b>				
Remote Control				
GP-IB				
Address <sup>1,2</sup>	1			
Network				
Time Out <sup>1,2</sup>	900s			
System Config				
Date/Time				
Display <sup>1,2</sup>	On			
Type <sup>1,2</sup>	Manual			
Language				
Menu Language <sup>1</sup>	ENG			
Message Language <sup>1</sup>	ENG			
LCD				
Auto Off <sup>1,2</sup>	Off			
Auto Off Time <sup>1,2</sup>	5min			
Brightness	7			
Color Settings				
Graph Color	Default			
Grid Intensity	4			
Base Color	Blue			
USB Keyboard <sup>1,2</sup>	English			
Preference				
Resolution <sup>1,2</sup>	5digits			
Freq Display at Frequency Low <sup>1,2</sup>	Error			
Motor Display at Pulse Freq Low <sup>1,2</sup>	Error			
Decimal Point for CSV File <sup>1,2</sup>	Period			
Integration Resume Action	Error			
Menu Font Size <sup>1,2</sup>	Large			
Rounding to Zero	On			
Crest Factor	CF3			
Network				
TCP/IP				
DHCP <sup>1,2</sup>	On			
DNS <sup>1,2</sup>	Auto			
FTP/Web Server				
User Name <sup>1,2</sup>	anonymous			
Time Out (seconds) <sup>1,2</sup>	900			
Net Drive				
Login Name <sup>1,2</sup>	anonymous			
FTP Passive <sup>1,2</sup>	Off			
Time Out (seconds) <sup>1,2</sup>	15			
SNTP				
Time Out (seconds) <sup>1,2</sup>	3			
Adjust at Power On <sup>1,2</sup>	Off			
Time Difference From GMT <sup>1,2</sup>	Hour: 9, Minute: 0			
D/A Output (Available on models with the D/A output option)				
Ch.	Function	Element/ $\Sigma$	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	$\lambda$	Element 1	-	Fixed
7	$\phi$	Element 1	-	Fixed
8	fU	Element 1	-	Fixed
9	fI	Element 1	-	Fixed
10 to 20	None	Element 1	-	Fixed

1 This setting is not affected when this instrument is initialized (when you press UTILITY and then the Initialize Settings soft key).

2 Items that are not loaded when a setup parameter file is loaded (FILE-Load Setup)

**Appendix 8 List of Initial Settings and Numeric Data Display Order**

<b>Item</b>	<b>Setting</b>
Selftest	
Test Item	Memory

## Numeric Data Display Order (Example for a Model with Six 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.

### 4 Items Display

Page											
1	2	3	4	5	6	7	8	9	10	11	12
Urms1	Urms2	Urms3	Urms4	Urms5	Urms6	UrmsΣA	UrmsΣB	WP1	WP5	η1	Speed <sup>1</sup>
Irms1	Irms2	Irms3	Irms4	Irms5	Irms6	IrmsΣA	IrmsΣB	WP2	WP6	η2	Torque <sup>1</sup>
P1	P2	P3	P4	P5	P6	PΣA	PΣB	WP3	WPΣA	η3	Slip <sup>1</sup>
λ1	λ2	λ3	λ4	λ5	λ6	λΣA	λΣB	WP4	WPΣB	η4	Pm <sup>1</sup>

### 8 Items Display

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

### 16 Items Display

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

### Matrix Display

Page								
1	2	3	4	5	6	7	8	9
Urms	Urms	Irms	Time	—	—	—	—	—
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	—	—	—	—	—

All Items Display

Page											
1	2	3	4	5	6	7	8	9 <sup>2</sup>	10 <sup>2</sup>	11 <sup>2</sup>	12 <sup>2</sup>
Urms	Urms	Irms	Time	F1	Ev1	$\eta_1$	$\Delta U_1$	U(k)	Uhdf(k)	Uthd	K-factor
rmsl	Umn	lmn	Wp	F2	Ev2	$\eta_2$	$\Delta U_2$	I(k)	lhdf(k)	lthd	EaU <sup>1</sup>
P	Udc	ldc	WP+	F3	Ev3	$\eta_3$	$\Delta U_3$	P(k)	Phdf(k)	Pthd	Eal <sup>1</sup>
S	Urmn	lrmn	WP-	F4	Ev4	$\eta_4$	$\Delta U_\Sigma$	S(k)	Z(k)	Uthf	$\Phi_{Ui-Uj}$
Q	Uac	lac	q	F5	Ev5	Speed <sup>1,3</sup>	$\Delta I$	Q(k)	Rs(k)	lthf	$\Phi_{Ui-Uk}$
$\lambda$	U+pk	I+pk	q+	F6	Ev6	Torque <sup>1,3</sup>	$\Delta P_1$	$\lambda(k)$	Xs(k)	Utif	$\Phi_{Ui-li}$
$\Phi$	U-pk	I-pk	q-	F7	Ev7	SyncSp <sup>1</sup>	$\Delta P_2$	$\Phi(k)$	Rp(k)	ltif	$\Phi_{Uj-lj}$
fU	CfU	Cfl	WS	F8	Ev8	Slip <sup>1</sup>	$\Delta P_3$	$\Phi U(k)$	Xp(k)	hvf	$\Phi_{Uk-lk}$
fl	Pc		WQ	F9		Pm <sup>1</sup>	$\Delta P_\Sigma$	$\Phi I(k)$		hcf	
	P+pk <sup>4</sup>			F10							
	P-pk <sup>4</sup>			F11							
				F12							
				F13							
				F14							
				F15							
				F16							
				F17							
				F18							
				F19							
				F20							

Left Side of the Single List Screen<sup>2</sup> and Dual List Screen<sup>2y</sup>

Page										
1	2	3	4	5	6	7	8	9	10	11
Urms1	Urms2	Urms3	Urms4	Urms5	Urms6	UrmsΣA	UrmsΣB	UrmsΣC	F1	F17
Irms1	Irms2	Irms3	Irms4	Irms5	Irms6	IrmsΣA	IrmsΣB	IrmsΣC	F2	F18
P1	P2	P3	P4	P5	P6	PΣA	PΣB	PΣC	F3	F19
S1	S2	S3	S4	S5	S6	SΣA	SΣB	SΣC	F4	F20
Q1	Q2	Q3	Q4	Q5	Q6	QΣA	QΣB	QΣC	F5	
$\lambda_1$	$\lambda_2$	$\lambda_3$	$\lambda_4$	$\lambda_5$	$\lambda_6$	$\lambda\Sigma A$	$\lambda\Sigma B$	$\lambda\Sigma C$	F6	
$\Phi_1$	$\Phi_2$	$\Phi_3$	$\Phi_4$	$\Phi_5$	$\Phi_6$	$\Phi_{Ui-Uj}$	$\Phi_{Ui-Uj}$	$\Phi_{Ui-Uj}$	F7	
Uthd1	Uthd2	Uthd3	Uthd4	Uthd5	Uthd6	$\Phi_{Ui-Uk}$	$\Phi_{Ui-Uk}$	$\Phi_{Ui-Uk}$	F8	
lthd1	lthd2	lthd3	lthd4	lthd5	lthd6	$\Phi_{Ui-li}$	$\Phi_{Ui-li}$	$\Phi_{Ui-li}$	F9	
Pthd1	Pthd2	Pthd3	Pthd4	Pthd5	Pthd6	$\Phi_{Uj-lj}$	$\Phi_{Uj-lj}$	$\Phi_{Uj-lj}$	F10	
Uthf1	Uthf2	Uthf3	Uthf4	Uthf5	Uthf6	$\Phi_{Uk-lk}$	$\Phi_{Uk-lk}$	$\Phi_{Uk-lk}$	F11	
lthf1	lthf2	lthf3	lthf4	lthf5	lthf6				F12	
Utif1	Utif2	Utif3	Utif4	Utif5	Utif6				F13	
ltif1	ltif2	ltif3	ltif4	ltif5	ltif6				F14	
hvf1	hvf2	hvf3	hvf4	hvf5	hvf6				F15	
hcf1	hcf2	hcf3	hcf4	hcf5	hcf6				F16	
K-factor1	K-factor2	K-factor3	K-factor4	K-factor	K-factor6					

- 1 Displayed on models with the motor evaluation function (option)
- 2 Displayed on models with the harmonic measurement option or the simultaneous dual harmonic measurement option
- 3 On models with the auxiliary input option, Aux1 is displayed instead of Speed, and Aux2 is displayed instead of Torque.
- 4 Not displayed when the split display is in use.

# Appendix 9 Limitations on Modifying Settings and Operations

During integration, storage, and auto printing, 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			Auto Print
		Start or Ready	Stop, Timeup, or Error	Start or Ready	Stop	Comp or Error	On
Basic Measurement Conditions	Wiring	No	No	No	No	No	No
	$\eta$ Formula	No	Yes	No	No	No	Yes
	Element Independent	No	No	No	No	No	No
	$\Delta$ Measure Type	No	No	No	No	No	Yes
	$\Delta$ Measure Mode	No	Yes	No	No	No	Yes
	Element ALL	No	No	No	No	No	Yes
	Voltage or current range	No	No	Yes	Yes	Yes	Yes
	Voltage or current Auto Range	No	No	Yes	Yes	Yes	Yes
	Direct Current Input or External Current Sensor	No	No	No	No	No	Yes
	Sensor Preset	No	No	No	No	No	Yes
	Sensor Ratio	No	No	No	No	No	Yes
	CT Preset	No	No	No	No	No	Yes
	VT/CT/SF Scaling	No	No	No	No	No	Yes
	Config(V)/Config(A)	No	No	No	No	No	Yes
	Crest Factor	No	No	No	No	No	No
	Sync Source	No	No	No	No	No	Yes
	Sync Source Settings	No	No	No	No	No	Yes
	Line Filter	No	No	No	No	No	Yes
	Freq Filter	No	No	No	No	No	Yes
	Update Rate	No	No	No	No	No	No
Update Rate Auto	No	No	No	No	No	No	
Timeout at Update Rate Auto	No	No	No	No	No	Yes	
Average	No	No	No	No	No	Yes	
Harmonics	PLL Source	No	No	No	No	No	Yes
	Min/Max Order	No	No	No	No	No	Yes
	Thd Formula	No	No	No	No	No	Yes
	Element Settings	No	No	No	No	No	Yes
Motor	Scaling	No	No	No	No	No	Yes
	Sense Type	No	No	No	No	No	Yes
	Auto Range	No	No	Yes	Yes	Yes	Yes
	Range	No	No	Yes	Yes	Yes	Yes
	Linear Scale A/B	No	No	No	No	No	Yes
	Linear Scale Calculate Execute	No	No	No	No	No	Yes
	Line Filter	No	No	No	No	No	Yes
	Motor	No	No	No	No	No	Yes
	Pulse Range Upper/Lower	No	No	No	No	No	Yes
	Torque Pulse	No	No	No	No	No	Yes
	Torque Pulse Rated Freq	No	No	No	No	No	Yes
	Pulse N	No	No	No	No	No	Yes
	Pole	No	No	No	No	No	Yes
	Sync Speed Source	No	No	No	No	No	Yes
Electrical Angle Measurement ON/OFF	No	No	No	No	No	Yes	
Electrical Angle Correction	No	No	No	No	No	Yes	
External Signal	Scaling	No	No	No	No	No	Yes
	Auto Range	No	No	Yes	Yes	Yes	Yes
	Range	No	No	Yes	Yes	Yes	Yes
	Linear Scale A/B	No	No	No	No	No	Yes
	Linear Scale Calculate Execute	No	No	No	No	No	Yes
Line Filter	No	No	No	No	No	Yes	
Computation	User-Defined Function Conditions	No	Yes	No	No	No	Yes
	Max Hold ON/OFF	No	No	Yes	Yes	Yes	Yes
	User-Defined Event Conditions	No	Yes	No	No	No	Yes

## Appendix 9 Limitations on Modifying Settings and Operations

Operation (Changing settings or executing features)		Integration Status		Storage State			Auto Print
		Start or Ready	Stop, Timeup, or Error	Start or Ready	Stop	Comp or Error	On
Computation	S Formula	No	No	No	No	No	Yes
	S, Q Formula	No	No	No	No	No	Yes
	Pc Formula	No	No	No	No	No	Yes
	Sampling Frequency	No	No	No	No	No	Yes
	Phase	No	No	No	No	No	Yes
	Sync Measure	No	No	No	No	No	No
	Freq Measure	No	No	No	No	No	Yes
Integration	Independent Control	No	No	No <sup>1</sup>	No <sup>1</sup>	No <sup>1</sup>	No <sup>1</sup>
	D/A Rated Time	No	No	Yes	Yes	Yes	Yes
Waveform Display	Time/Div	No	No	No	No	No	Yes
	Trigger Mode	No	No	Yes	Yes	Yes	Yes
	Trigger Source	No	No	No	No	No	Yes
	Trigger Slope	No	No	No	No	No	Yes
	Trigger Level	No	No	No	No	No	Yes
Storage	STORE CSV Conversion	Yes	Yes	No	No	Yes	Yes
	STORE START	Yes	Yes	No <sup>2</sup>	Yes	No	No
	STORE STOP	Yes	Yes	Yes	Yes	Yes	No
	STORE RESET	Yes	Yes	Yes	Yes	Yes	No
Files	File Auto Naming	Yes	Yes	No	No	Yes	Yes
	File Name	Yes	Yes	No	No	Yes	Yes
	Comment	Yes	Yes	No	No	Yes	Yes
	Setup File Save	No	No	No	No	No	Yes
	Setup File Load	No	No	No	No	No	No
	Numeric Save	No	Yes	No	No	Yes	Yes
	Numeric Save Item Settings	Yes	Yes	No	No	Yes	Yes
	Wave Save	No	Yes	No	No	Yes	Yes
	Custom File Save	No	Yes	No	No	Yes	Yes
	Custom File Load	No	No	No	No	No	No
	Change Drive	Yes	Yes	No	No	No	Yes
	Change Directory	Yes	Yes	No	No	No	Yes
	Delete	No	No	No	No	No	Yes
	Rename	No	No	No	No	No	Yes
	Make Directory	No	No	No	No	No	Yes
	Copy	No	No	No	No	No	Yes
	Move	No	No	No	No	No	Yes
Save Images	No	Yes	No	No	Yes	Yes	
Printing	Auto Print ON	Yes	Yes	No	No	No	No
	Auto Print OFF	Yes	Yes	No	No	No	Yes
	Print images	Yes	Yes	No	No	No	Yes
	Print the numeric data list	Yes	Yes	No	No	No	Yes
	Print Abort	Yes	Yes	No	No	No	Yes
	Paper Feed	Yes	Yes	No	No	No	Yes
Utilities	Initialize Settings	Yes	Yes	No	No	No	Yes
	Date/Time	No	No	No	No	No	No
	Date/Time Type	No	No	No	No	No	No
	Menu Language	No	No	Yes	Yes	Yes	Yes
	Message Language	No	No	Yes	Yes	Yes	Yes
	Menu Font Size	No	No	Yes	Yes	Yes	Yes
	Freq Display at Frequency Low	No	No	No	No	No	Yes
	Motor Display at Pulse Freq Low	No	No	No	No	No	Yes
	SelfTest	No	No	No	No	No	No
Other Features	Manual Cal	No	No	Yes	Yes	Yes	Yes
	NULL	No	No	No	No	No	Yes

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 Only in Integ Sync mode

2 Storage can be started in Single Shot mode.

# Appendix 10 Limitations on the Features during High Speed Data Capturing

During high speed data capturing, there are measurement conditions and computations whose settings you cannot change and features that you cannot execute.

Item		Operation	
High Speed Data Capturing	Capture Count	Yes <sup>1, 2</sup>	
	Optimize Count	Yes <sup>1, 2</sup>	
	Control Settings	Voltage/Current Measuring Mode	Yes <sup>1, 2</sup>
		HS Filter	Yes <sup>1, 2</sup>
		Trigger	Yes <sup>1</sup>
		External Sync	Yes <sup>1, 2</sup>
	Record to File	Yes <sup>1, 2</sup>	
	Save Conditions	Yes <sup>2</sup>	
	Start	Yes <sup>1, 2</sup>	
	Stop	Yes	

Item		Operation
Switching the Display	Numeric Data Display	No <sup>1</sup>
	Waveform Display	No <sup>1</sup>
	Trend Display	No <sup>1</sup>
	Bar Graph Display	No <sup>1</sup>
	Vector Display	No <sup>1</sup>
	High Speed Data Capturing	Yes
	Setup Parameter List Display	No
Fundamental Measurement Conditions	Wiring System <sup>3, 4</sup>	Yes <sup>1</sup>
	Efficiency Equation	No
	Independent Input Element Configuration <sup>4</sup>	Yes <sup>1</sup>
	Delta Computation	No
	Selecting All Input Elements <sup>4</sup>	Yes <sup>1</sup>
	Voltage or Current Auto Range	No
	Direct Current Input or External Current Sensor <sup>5</sup>	No
	Measurement Period	No
	Line Filter <sup>6</sup>	Yes <sup>1</sup>
	Frequency Filter	No
	Data Update Interval	No
Averaging	No	
Fundamental measurement conditions other than those listed above	Yes <sup>1</sup>	
Harmonic Measurement	Harmonic Measurement Conditions	No
Motor Evaluation	Input Signal Type <sup>7</sup>	No <sup>1</sup>
	Analog Auto Range	No
	Synchronization Source	No
	Synchronous Speed	No
	Electrical Angle Measurement	No
Auxiliary Input	Analog Auto Range	No
	Synchronization Source	No
Computation	User-Defined Functions	No
	MAX Hold	No
	User-Defined Events	No
	Equation for Apparent Power (S Formula)	No
	Apparent Power and Reactive Power Computation Types (S,Q Formula)	No
	Corrected Power Equation (Pc Formula)	No
	Sampling Frequency <sup>8</sup>	Yes <sup>7</sup>
	Phase Difference Display Format	No
Master/Slave Synchronization Measurement	No	
Integrated Power	Integration Conditions, Integration Execution	No
Data Storage	Storage Conditions, Storage Execution	No
Saving and Loading Data	Saving Setup Data	Yes <sup>1, 2</sup>
	Saving Waveform Display Data	No
	Saving Numeric Data	No

## Appendix 10 Limitations on the Features during High Speed Data Capturing

Item		Operation
Saving Screen Images	Saving a Screen Image	Yes <sup>2</sup>
Printing	Printing <sup>9</sup>	Yes <sup>2</sup>
	Automatic Printing	No
Utility	D/A Output	No
Other Features	NULL Feature <sup>10</sup>	No
	Zero-Level Compensation	Yes <sup>1</sup>

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 This setting or operation is unavailable when high speed data capturing has been started (Start).
- 2 This setting or operation is unavailable when a high speed data capturing file is being recorded to (Rec).
- 3 When the wiring system of a wiring unit has been set to a single-phase, three-wire system (1P3W) or a three-phase, three-wire system (3P3W), the voltage (U $\Sigma$ ), current (I $\Sigma$ ), and power (P $\Sigma$ ) of that wiring unit are not measured and are displayed as "-----" (no data).
- 4 When the NULL feature is enabled and this setting or operation would cause a current input switch between direct input and external current sensor input, this setting or operation is unavailable. Perform this setting or operation in the normal measurement mode.
- 5 When the NULL feature is enabled, you cannot switch between direct input and external current sensor input using the current input setting. Perform this setting in the normal measurement mode.
- 6 The line filter is always on. The line filter setting range is different than the setting range for normal measurement. The line filter setting for high speed data capturing is not the same as the line filter setting for normal measurement. This instrument saves both settings.
- 7 When the NULL feature is enabled, you cannot change the motor input signal type. Perform this setting in the normal measurement mode.
- 8 You cannot select Auto. When the sampling frequency has been set to Auto for normal measurement and you switch to high speed data capturing, this instrument operates under the Clock C setting.
- 9 You can print a screen image. You cannot print numeric data lists.
- 10 During high speed data capturing, the setting for the NULL feature remains the same as the setting specified during normal measurement (ON or OFF). You cannot change the setting for the NULL feature. Perform this setting in the normal measurement mode.

### Note

When the same setting is used for both normal measurement and high speed data capturing, that setting cannot be specified when high speed data capturing has been started (Start).

## Appendix 11 Limitations on the Features during the Data Update Interval is Auto

During the data update interval is Auto, there are measurement conditions and computations whose settings you cannot change and features that you cannot execute.

Item	
Sampling Frequency	Setting sampling frequency to Auto will set the sampling frequency to Clock C.
Single Measurement	This cannot be executed.
Trigger Mode	This is fixed to OFF.
Independent Input Element Configuration and Measurement Period (Synchronization Source)	The synchronization source cannot be set independently even when the independent input element configuration is on.
Independent Integration	When independent integration is on, integration cannot be started.
Integration Mode	This is fixed to "Normal."
Watt hour integration method for each polarity (WP ± Type)	This is fixed to "Charge/Discharge."
Integration auto calibration	This is fixed to OFF.
Auto range during integration	This is set to OFF. Fixed range is selected when integration is started.
Integration Resume Action at Power Failure Recovery	The instrument recovers in an integration error state. Integration cannot be resumed.
Input element group during harmonic measurement	All elements are fixed to group Hrm1.
Storage Mode (Store Mode)	Storage cannot be started in either of the following situations. <ul style="list-style-type: none"> <li>• When the storage mode is integration-synchronized mode</li> <li>• When the storage interval is not 00:00:00</li> </ul>
Automatic Printing (Auto Print )	Auto print cannot be turned on during integration-synchronized mode.
Self-Test	The test item "memory test (Memory)" cannot be executed.

### Measurement Functions

When the data update interval is Auto, the following measurement functions are not measured and displayed as "-----" (no data). When data is stored or output via communication, data is NAN.

- fPLL2: PLL frequency of harmonic setting 2
- WS, WQ: Integrated value of apparent power and reactive power

## Data update status

When the data update interval is set to Auto, storing data also stores the following data update status information.

The data update status information represents when the measured value of the detected measurement period was updated within the data update interval of 50 ms in 16-bit hexadecimal notation.

- When the bit is 1, the measured value is updated.
- When the bit is 0, the measured value is not updated, and the previous measured value is output. However, if averaging is on, measured values are averaged every data update interval of 50 ms.

### UpdateStsPwr\*1

Input element data update status for normal measurement

This bit is set to 1 when the measured value in the newly specified measurement period resulting from a “period detection of the synchronization source” or “timeout” is updated.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
										EL6	EL5	EL4	EL3	EL2	EL1

EL1: input element 1 to EL6: input element 6

### UpdateStsMtr\*1

Motor evaluation input data update status for normal measurement

This bit is set to 1 when the measured value in the newly specified measurement period resulting from a “period detection of the synchronization source” or “timeout” is updated.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
														Trq	Spd

Spd: Speed input, Trq: Torque input

### UpdateStsAux\*1

Auxiliary signal input data update status for normal measurement

This bit is set to 1 when the measured value in the newly specified measurement period resulting from a “period detection of the synchronization source” or “timeout” is updated.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
														AUX2	AUX1

AUX1, AUX2: Auxiliary signal input

### UpdateStsHrm\*1

Input element data update status for harmonic measurement

- This bit is set to 1 when the new measured value resulting from a detection of the number of cycles of the PLL source is updated.
- This bit is also set to 1 when no harmonic measurement data [-----] is updated due to a timeout.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
										EL6	EL5	EL4	EL3	EL2	EL1

EL1: input element 1 to EL6: input element 6

### UpdateStsWave\*2

Data update status of waveform measurement

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Trq	Spd	I6	U6	I5	U5	I4	U4	I3	U3	I2	U2	I1	U1

U1 to 6: Voltage input of input elements 1 to 6

I1 to 6: Current input of input elements 1 to 6

Spd: Speed input, Trq: Torque input

AUX1, AUX2: Auxiliary signal input

\*1 This can be output using the :NUMeric[:NORMal]:VALue? communication function and storage feature.

\*2 This can be output using the :NUMeric[:NORMal]:VALue? communication function.

## Communication Commands and Data Update Status

The aforementioned data update status corresponds to the following communication command functions.

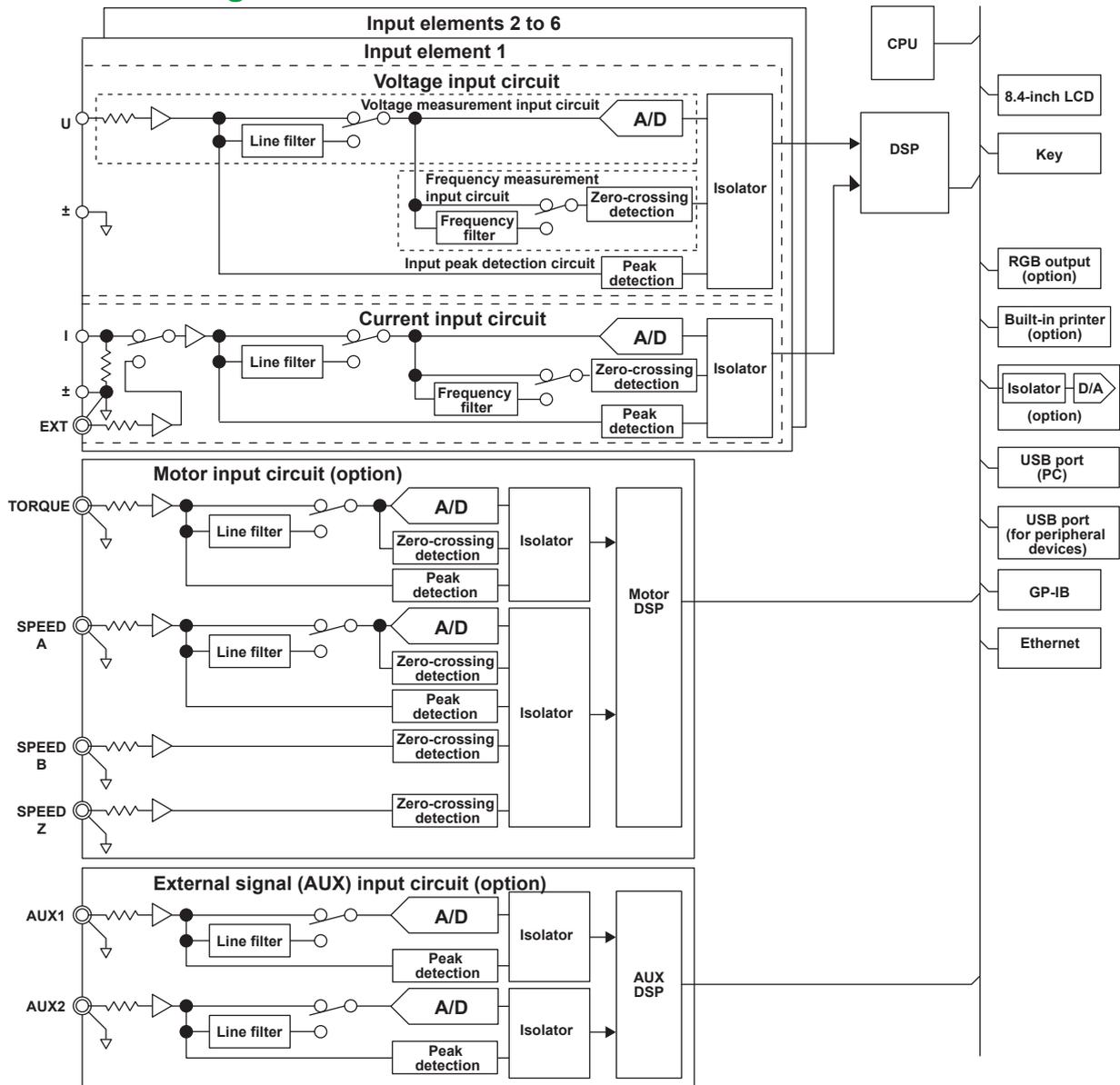
- UpdateStsPwr: UNPower
- UpdateStsMtr : UNMotor
- UpdateStsAux: UNAux
- UpdateStsHrm: UHPower
- UpdateStsWave: UWChannel

If the data update interval is not Auto and any of the functions above is substituted into <Function> in the following communication command, the return value for :NUMeric[:NORMal]:VALue? will be 0x0: “no update.”

:NUMeric[:NORMal]:ITEM<x> {NONE|<Function>[,<Element>][,<Order>]}

# Appendix 12 Block Diagram

## Block Diagram



## Input Signal Flow and Process

Input elements 1 through 6 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,  $\pm$ ) 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,  $\pm$ ) 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.

## Appendix 12 Block Diagram

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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 0.5  $\mu$ s. These digital values are isolated by the isolator and passed to the DSP. In the DSP, 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.

The harmonic measurement functions (option) are derived in the following manner. The voltage signal sent to the A/D converter is converted to digital values at a sampling frequency that is determined by the PLL source signal. The DSP derives the measured value of each harmonic measurement item by performing an FFT on the converted digital values.

Please make the following alterations to the User's Manual IM WT1801E-03EN.

#### ■ Page i “List of Manuals”

Make changes as shown in the dotted line section.

The following manuals, including this one, are provided as manuals for this instrument. Please read all manuals.

#### Manuals Included with the Product

Manual Title	Manual No.	Description
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer Getting Started Guide	IM WT1801E-03EN	This manual. This guide explains the handling precautions and basic operations of this instrument.
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Request to Download Manuals	IM WT1801E-73Z2	Describes the manuals provided on the website.
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer Safety Instruction Manual	IM WT1801E-92Z1 IM 00C01C01-01Z1	Document for China Safety manual (European languages)

#### Manuals Provided on the Website

Download the following manuals from the YOKOGAWA website.

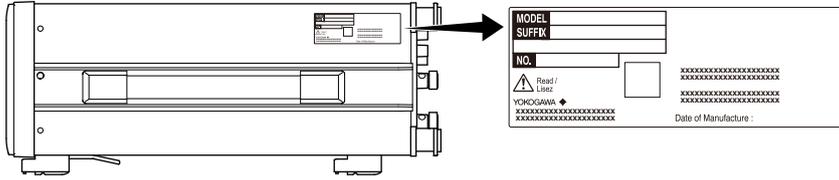
Manual Title	Manual No.	Description
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer Features Guide	IM WT1801E-01EN	This manual explains all the features of this instrument other than the communication interface features.
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer User's Manual	IM WT1801E-02EN	The manual explains how to operate this instrument.
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer Communication Interface User's Manual	IM WT1801E-17EN	This manual explains the communication interface features of this instrument and how to use them.

For details on downloading manuals, see Request to Download Manuals (IM WT1801E-73Z2). To view the PDF data, you need Adobe Acrobat Reader or a software application that can open PDF data.

The “EN”, “Z1”, and “Z2” in the manual numbers are the language codes.

■ Page iii “Checking the Package Contents”

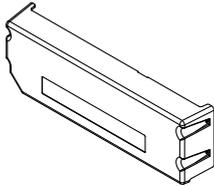
WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E



■ Page v “Accessories”

Add the underlined sections, and delete the dotted line sections. The manual CD is not included with the product.

Current input protection cover  
B8211BX



Rubber stoppers  
A9088ZM



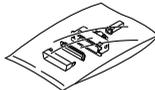
Safety terminal adapter set<sup>1</sup>  
758931



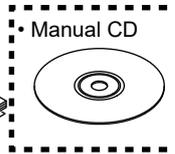
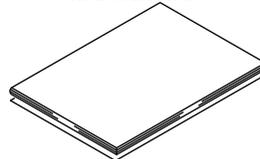
Printer roll paper<sup>2</sup>  
B9316FX



36-pin connector<sup>3</sup>  
A1005JD



Manuals<sup>5</sup>  
• Printed manuals



5 Manuals

Name	Model/Part No.	Quantity	Note
Printed manuals	IM WT1801E-03EN	1	Getting Started Guide (this guide)
	<u>IM WT1801E-73Z2</u>	<u>1</u>	<u>Request to Download Manuals</u>
	IM WT1801E-92Z1	..	.....
	<u>IM 00C01C01-01Z1</u>	<u>1</u>	<u>Safety manual (European languages)</u>
	PIM 113-01Z2	..	.....
<u>Manual CD</u>	<u>B8211ZX</u>	<u>1</u>	<u>For details, see the next page.</u>

■ Page vi “How to Use the CD (User’s Manuals)”

Delete the dotted line section. The manual CD is not included with the product.

**How to Use the CD (User’s Manuals)**

The CD contains PDF files of the following manuals. The CD also contains Japanese manuals.

- WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer Features Guide  
IM WT1801E-01EN
- WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer User’s Manual  
IM WT1801E-02EN
- WT1801E, WT1802E, WT1803E, WT1804E, WT1805E, WT1806E Precision Power Analyzer Communication Interface User’s Manual  
IM WT1801E-17EN

To view the PDF data, you need Adobe Acrobat Reader or a software application that can open PDF data.

**WARNING**

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.

French

**AVERTISSEMENT**

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.

■ Page xvii “Regulations and Sales in Various Countries and Regions”

**Waste Electrical and Electronic Equipment (WEEE)**



(EU WEEE Directive valid only in the EEA\* and UK WEEE Regulation in the UK)

This product complies with the WEEE marking requirement. This marking indicates that you must not discard this electrical/electronic product in domestic household waste. When disposing of products in the EEA or UK, contact your local Yokogawa office in the EEA or UK respectively.

\* EEA: European Economic Area

**Batteries and Waste Batteries**



(EU Battery Directive/Regulation valid only in the EEA and UK Battery Regulation in the UK)

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

Battery type: Lithium battery

When you need to replace batteries, contact your local Yokogawa office in the EEA or UK respectively.

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■ Page xix “Workflow”

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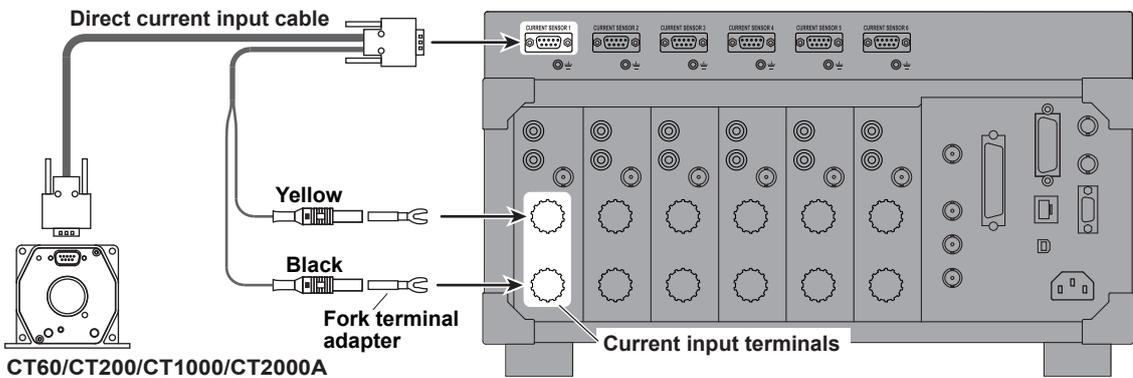


**Acquire Data**

Store data to the internal RAM disk. Save data to a USB memory device. Print data (option). Transmit data using D/A output (option). Transmit data through the USB, GP-IB, or Ethernet interface.	User's Manual ••▶ Chapter 15 ••▶ Chapters 16 and 17 ••▶ Chapter 19 ••▶ Section 21.6 ••▶ Chapter 20 and the communication interface user's manual
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■ Page 2-33 “2.11 Wiring the Circuit under Measurement When Using Voltage and Current Transformers”

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■ Page 6-21 “6.21 General Specifications”

Item	Specifications
.....	.....
Installation location	Indoor use
.....	.....
Safety standards	Compliant standard: EN 61010-1, EN IEC 61010-2-030 The overvoltage category is II. <sup>1</sup> The measurement category is CAT II. <sup>2</sup> Pollution degree 2 <sup>3</sup>
Emissions	..... ..... EMC Regulatory Arrangement in Australia and New Zealand EN 55011 Class A, Group 1 <sup>4</sup> .....
Immunity	..... .....

■ Page 6-22 “6.21 General Specifications”

Item	Specifications
Environmental standards <sup>7</sup>	EU RoHS Directive compliant

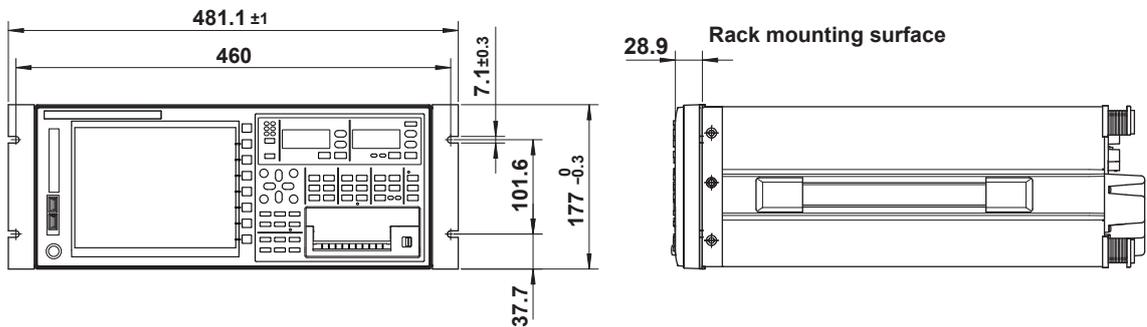
If you obtained this manual separately from the product, the specifications in this manual may differ from those of the product.

- 1 The overvoltage category is a value used to define the transient overvoltage condition and includes the rated impulse withstand voltage. Overvoltage category II applies to electrical equipment that is powered through a fixed installation, such as a wall outlet wired to a distribution board.
- 2 This instrument is measurement category II product. Do not use it for Measurement Categories III, and IV. Measurement category O applies to measurement of other circuits that are not directly connected to a main power supply. 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.
- 3 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).
- 4 Group 1: Equipment that does not intentionally generate or use radio-frequency (RF) energy  
.....  
.....
- 7 For conformity to environmental regulations and/or standards other than EU, contact your nearest YOKOGAWA office (PIM 113-0122).

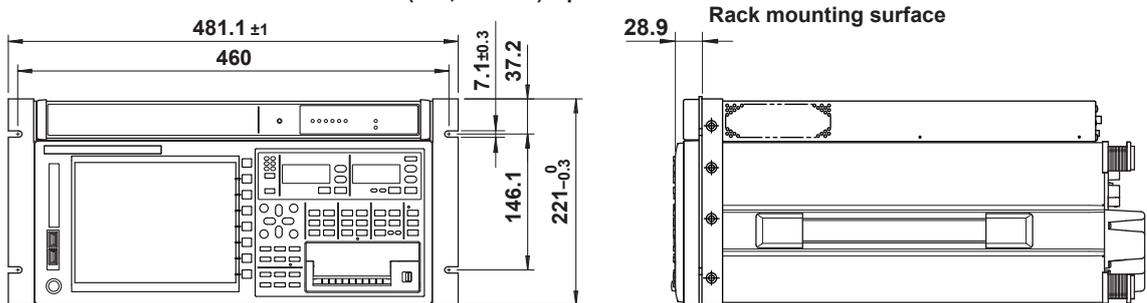
■ Page 6-24 “6.22 External Dimensions”

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EIA rack mount dimensions



Models with the Current Sensor Power (PD, or PD2) Option



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■ Page App-57 “Appendix 11 Limitations on the Features during the Data Update Interval is Auto”

**Data update status**

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UpdateStsWave<sup>2</sup>

Data update status of waveform measurement

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Trq AUX2	Spd AUX1	I6	U6	I5	U5	I4	U4	I3	U3	I2	U2	I1	U1

.....  
 .....