
**User's
Manual**

**WT1501, WT1502, WT1503,
WT1504
Precision Power Analyzer
Getting Started Guide**

Thank you for purchasing the WT1501, WT1502, WT1503, or WT1504 Precision Power Analyzer. This instrument is capable of measuring parameters such as voltage, current, and power with high precision.

This getting started guide primarily explains the handling precautions and basic operations of this instrument. To ensure correct use, please read this manual thoroughly before operation.

Keep this manual in a safe place for quick reference in the event that a question arises. The manuals for this instrument are listed on page i. Please read all manuals.

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

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

Notes

- The contents of this manual are subject to change without prior notice as a result of improvements to the product's performance and functionality. Refer to our website to view our latest manuals.
- 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.
- For details on Terms and Conditions of Open Source Software (OSS), see appendix 14 in the User's Manual.

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- Other company and product names are registered trademarks or trademarks of their respective holders.

Updating the firmware

It is recommended to update the firmware to the latest version to improve the features and usability of this instrument.

Download the latest firmware from the YOKOGAWA website, or contact your nearest YOKOGAWA dealer for details.

Revisions

1st Edition: July 2026

Manuals

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
WT1501, WT1502, WT1503, WT1504 Precision Power Analyzer Getting Started Guide	IM WT1501-02EN	This document. Explains the handling precautions and basic operations of this instrument.
WT1501, WT1502, WT1503, WT1504 Precision Power Analyzer Request to Download Manuals	IM WT1501-73Z2	Describes the manuals provided on the website.
China RoHS Information	IM CROHS12-92Z1	Document for China
Safety Instruction Manual	IM 00C01C01-01Z1	Safety manual (European languages)

Manuals provided on the website

Download the following manuals from the YOKOGAWA website.

Manual Title	Manual No.	Description
WT1501, WT1502, WT1503, WT1504 Precision Power Analyzer User's Manual	IM WT1501-01EN	Explains the instrument's features and setup procedures, excluding the communication interface features.
WT1501, WT1502, WT1503, WT1504 Precision Power Analyzer Communication Interface User's Manual	IM WT1501-17EN	Explains the functions of this instrument's communication interface, how to configure it, and the commands used to control this instrument from a PC through the interface.

For details on downloading manuals, see Request to Download Manuals (IM WT1501-73Z2). 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.

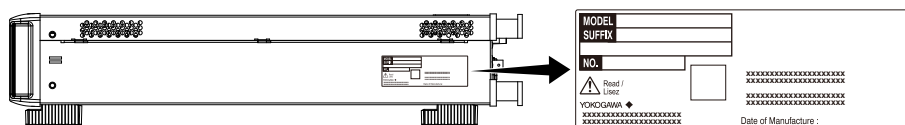
Refer to the "Optional Accessories (Sold Separately)" about the accessory's manual number.

Checking the Contents of the Package

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

WT1501, WT1502, WT1503, WT1504

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 ¹	Description
WT1501		1-Input Element Model
WT1502		2-Input Element Model
WT1503		3-Input Element Model
WT1504		4-Input Element Model
	-10	Standard model
Input element 1	-WB0	None WB Element
WB element	-WB1	WB element x 1
	-WB2	WB element x 2
	-WB3	WB element x 3
	-WB4	WB element x 4
Input element 2	-HV0	None HV Element
HV element	-HV1	HV element x 1
	-HV2	HV element x 2
	-HV3	HV element x 3
	-HV4	HV element x 4
Installation	-BN	Benchtop (with legs, with side handles, without rack mount brackets)
	-RE	EIA-compliant Rackmount (without legs, without side handles, with rack mount brackets)
	-RJ	JIS-compliant Rackmount (without legs, without side handles, with rack mount brackets)
Language ²	-HJ	English/Japanese Menu
(External monitor output and Web server)	-HE	English/Japanese Menu
	-HC	Chinese/English Menu
	-HG	German/English Menu

Checking the Contents of the Package

Power cord ³	-D	UL/CSA standard and PSE compliant, rated voltage: 125 V
	-F	VDE/Korean standard, rated voltage: 250 V
	-H	Chinese standard, rated voltage: 250 V
	-N	Brazilian standard, rated voltage: 250 V
	-Q	British standard, rated voltage: 250 V
	-R	Australian standard, rated voltage: 250 V
	-T	Taiwanese standard, rated voltage: 125 V
	-B	Indian standard, rated voltage: 250 V
	-U	IEC Plug Type B, rated voltage: 250 V
Options	-Y	No power cord included. ⁴
	/M1	32 GB Built-in Memory
	/EM1	Motor Evaluation for Encoder 1 ⁵
	/RM1	Motor Evaluation for Resolver 1 ⁵
	/EM2	Motor Evaluation for Encoder 2 ⁵
	/RM2	Motor Evaluation for Resolver 2 ⁵
	/EM1RM1	Motor Evaluation Function for Encoder/Resolver ⁵
	/SY1	Multi-unit Synchronization function
	/CN1	CAN/CAN FD Interface

- 1 For products whose suffix code contains "Z," an exclusive manual may be included. Please read it along with the standard manual.
- 2 The LCD is English only. You can set the external monitor output and web server language.
- 3 Make sure that the attached power cord meets the designated standards of the country and area that you are using it in.
- 4 Prepare a power cord that complies with the standard specified by the country or region that the instrument will be used in.
- 5 The /EM1, /RM1, /EM2, /EM1RM1, and /RM2 options cannot be installed on the same instrument.

No. (instrument number)

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

The following accessories are attached to the product. Ensure they are properly attached and undamaged.

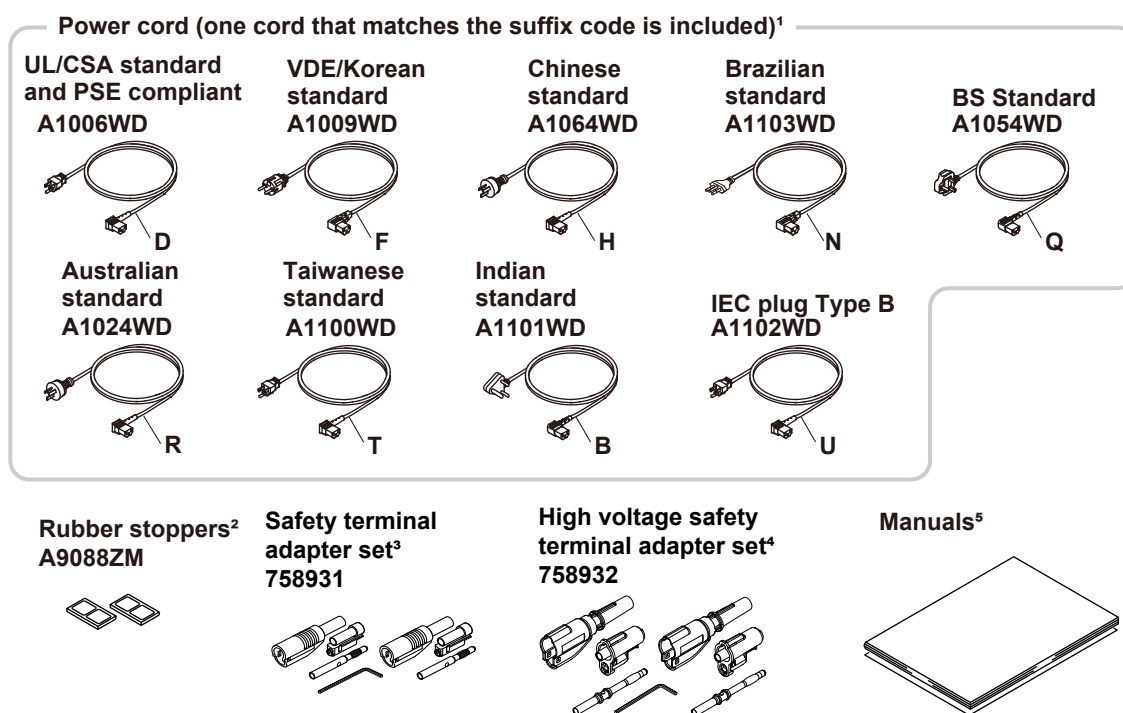
Name	Model or Part No.	Quantity	Specifications and Notes
Bottom legs ¹	A9158ZM	1 set	One set includes four legs.
Handle ¹	A9110ZM, A9160ZM, 1 B8215BK		
EIA rackmount bracket ²	751543-E2	1	
JIS rackmount bracket ³	751543-J2	1	

For the shapes of the base feet, handles, and rack mount brackets, see section 1.1.

- 1: -BN
- 2: -RE
- 3: -RJ

Accessories

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



Standard accessories are not covered by warranty.

- 1 Make sure that the attached power cord meets the designated standards of the country and area that you are using it in. If the suffix code is -Y, a power cord is not included.
- 2 Supplied only with -BN.
- 3 The same number as the WB elements
- 4 The same number as the HV elements
- 5 Manuals

Model or Part No.	Quantity	Notes
IM WT1501-02EN	1	Getting Started Guide (this guide)
IM WT1501-73Z2	1	Request to Download Manuals
IMCROHS11-92Z1	1	Document for China (China RoHS)
IM 00C01C01-01Z1	1	Safety manual (European languages)
PIM 113-01Z2	1	List of worldwide contacts

Optional accessories (sold separately)

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

- Use the following accessories within the ranges indicated in the specifications of each accessory. When using several accessories together, use them within the specification range of the accessory with the lowest rating.
- If you use accessories other than those below, YOKOGAWA assumes no responsibility or liability for the specifications of this instrument or any damage caused by the use of this instrument.
- Accessories (sold separately) are not covered by this instrument's warranty.
- Each product is sold in units of 1 piece.
- The maximum rated voltage to ground is an rms value.

Group 1

Compliance with EN standards is achieved by using the following in combination with the instrument.

Name	Model or Part No.	Maximum Rated Voltage to Ground Measurement Category	Notes	Manual No.
Measurement lead set	758917	1000 V CAT II	Two pieces in one set Used with the 758922, 758929, or 758921 adapter (sold separately). Cable length: 0.75 m	—
	758923	600 V CAT II	Two pieces in one set	—
Safety terminal adapter set	758931	1000 V CAT II	Two pieces in one set Hexagonal wrench (B9317WD) included	IM 758931-01E
	758922	300 V CAT II	Two pieces in one set For the 758917 measurement lead	—
Alligator clip adapter set	758929	1000 V CAT II	Two pieces in one set For the 758917 measurement lead	—
	366924	—	42 V or less. Total length: 1 m.	—
BNC cable	366925	—	42 V or less. Total length: 2 m.	—
	701902	1000 V CAT II	Cable length: 1 m	—
Safety BNC cable	701903	1000 V CAT II	Cable length: 2 m	—
Safety terminal adapter set	761952	1000 V CAT II, Two pieces in one set 1000 V CAT III, 600 V CAT IV		IM 761952-01EN
Current sensor element cable	761954	—	Cable length: 3 m	—
Current sensor element cable	761955	—	Cable length: 5 m	—
Current sensor element cable	761956	—	Cable length: 10 m	—
Optical transceiver module	720941	—	Compatible with 1000BASE-SX and 2.125 Gbps Fibre Channel	IM 720941-01EN
Optical fiber cord	720942	—	Multi-mode fiber (LCLC/3 m)	IM 720942-01EN
Current sensor cable	761964	—	Circular 20-pin connector - D-sub 9 pin, Total length: Approx. 3 m	—
Current sensor cable	761965	—	Circular 20-pin connector - D-sub 9 pin, Total length: Approx. 5 m	—
Adapter cable	761966	—	Circular 20-pin connector - D-sub 9 pin, D-Sub conversion, cable length: 25 cm	—

Name	Model or Part No.	Maximum Rated Voltage to Ground Measurement Category	Notes	Manual No.
Conversion adapter	761962	—	Circular 20-pin connector - BNC/ power connector length: 25 cm	—
Conversion adapter	761963	—	Circular 20-pin connector - BNC conversion, cable length: 25 cm	—
Fork terminal adapter set	758921	1000 V CAT II	Two pieces in one set For the 758917 measurement lead Rated current: 25 A	—
BNC Conversion Adapter	758924	1000 V CAT II	BNC-4 mm socket adapter	—
1.5 mm hex wrench	B9317WD	—	—	—
Rack mount kit	751543	—	—	IM 751543-J2 01EN IM 751543-E2 01EN
High voltage safety terminal adapter set	758932	2500 V DC measurement category Other, 1500 V CAT II, 1000 V CAT III	2500 V DC measurement adapter, red/black	IM 758932- 01EN
AC/DC current sensor	CT2000A ¹	1000 Vrms CAT III	DC: 0 to 2000 A AC: 3000 Apeak	IM CT2000A- 01EN
AC/DC current sensor	CT1000A ¹	1000 V CAT III	DC: 0 to 1000 A AC: 1000 Arms, 1500 Apeak	IM CT1000A- 01EN
AC/DC current sensor	CT1000 ¹	1000 Vrms CAT III	DC: 0 to 1000 A AC: 1000 Apeak	IM CT1000- 01EN
AC/DC current sensor	CT200 ¹	1000 Vrms CAT III	DC: 0 to 200 A AC: 200 Apeak	IM CT1000- 01EN
AC/DC current sensor	CT60 ¹	1000 Vrms CAT III	DC: 0 to 60 A AC: 60 Apeak	IM CT1000- 01EN
AC/DC Split Core Current Sensor	CT1000S ¹	CAT O	DC: 0 to 1000 A AC: 1000 Arms	IM CT1000S- 01EN
Clamp-on probe	720930 ¹	300 Vrms CAT III	AC: 0 to 50 Arms	IM 720930- 01EN
Clamp-on probe	720931 ¹	600 Vrms CAT III	AC: 0 to 200 Arms (300 Apeak)	IM 720930- 01EN

¹ The accessories by themselves comply with EN standards.

Conventions 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

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

Provides precautions to avoid the risk of fatal or serious injury to the user if the product is mishandled.

CAUTION

Provides precautions to avoid the risk of minor injury to the user or damage to property if the product is mishandled.

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

Provides important information for handling this instrument.

Safety Precautions

This product is designed to be used by a person with specialized knowledge.

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

The general safety precautions described herein must be observed during all phases of operation.

If the instrument is used in a manner not specified in this manual, the protection provided by the instrument may be impaired. YOKOGAWA assumes no liability for the customer's failure to comply with these requirements.

This manual is part of the product and contains important information. Store this manual in a safe place close to the instrument so that you can refer to it immediately. Keep this manual until you dispose of the instrument.

The following symbols are used on this instrument.

	Warning: handle with care. Refer to the user's manual or service manual. This symbol appears on dangerous locations on the instrument which require special instructions for proper handling or use. The same symbol appears in the corresponding place in the manual to identify those instructions.		
	Electric shock, danger		Protective earth ground or protective ground terminal
	Ground or the functional ground terminal (do not use as the protective ground terminal)		Alternating current
	Direct current		Both direct and alternating current
	Power on		Power off
	Power-on state		Power-off state

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

WARNING

Use the instrument only for its intended purpose

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

Check the physical appearance

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

Use the correct power supply

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

Use the correct power cord and plug

To prevent electric shock and fire, be sure to use the power cord for this 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

To prevent electric shock, make sure to connect the instrument to a protective ground (earth) 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 ground terminal. Doing so may result in electric shock or damage to the instrument.

Do not use when the protection functions are defective

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

Do not operate in an explosive atmosphere

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

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.

External connections

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

Measurement category

- The measurement category of this instrument's HV element is II, III, or Other (O). Do not use for measurements in Measurement Category IV.
- The measurement category of this instrument's WB element is II. Do not use for measurements in Measurement Categories III and IV.

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.

Wiring

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 wire 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 terminal.
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.
- Cables are fastened firmly to the current input terminal.

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

- The input terminals are not abnormally hot.
- 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.

Optional accessories

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

Do not use faulty accessories.

CAUTION

Operating environment limitations

This product is 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.

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'instrument et qu'elle ne dépasse pas la plage de tension du cordon d'alimentation à utiliser.

Utiliser le cordon d'alimentation et la fiche adaptés

Pour éviter tout risque de choc électrique et d'incendie, veillez à utiliser le cordon d'alimentation prévu pour cet instrument. La fiche d'alimentation principale doit être branchée sur une prise munie d'une borne de terre de protection. N'annulez pas cette protection en utilisant une rallonge sans protection de mise à la terre. En outre, n'utilisez pas ce cordon d'alimentation avec d'autres instruments.

Brancher la prise de terre

Avant de mettre l'instrument sous tension, pour éviter tout choc électrique, veillez à raccorder l'instrument à une mise à la terre de protection. 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 faire remplacer le fusible de l'instrument, contactez votre revendeur 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.

Connexions externes

Toujours relier l'instrument à la terre avant de le brancher aux appareils à un circuit de commande externe. Avant de toucher un circuit, mettre l'instrument hors tension et vérifier l'absence de tension.

Catégorie de mesure

- La catégorie de mesure de l'élément HV de cet instrument est II, III ou Autre (O). N'utilisez pas l'instrument pour des mesures relevant de la catégorie de mesure IV.
- La catégorie de mesure de l'élément WB de cet instrument est II. N'utilisez pas l'instrument pour des mesures relevant des catégories de mesure III et 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.

Câblage

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 de mesure de la tension n'ont pas été malencontreusement branchés sur les bornes d'entrée de courant.
Vérifiez qu'aucun câble de mesure de tension n'a été connecté à la borne d'entrée de courant.
Vérifiez qu'aucun câble de mesure de courant n'a été connecté aux bornes d'entrée de tension.
Si vous mesurez une puissance polyphasée, vérifiez qu'il n'y a pas d'erreurs dans le câblage des phases.
- Les câbles sont solidement fixés à la borne d'entrée de courant.
Vérifiez qu'aucun câble de mesure de tension n'a été connecté au connecteur multifonction.
Vérifiez qu'aucun câble de mesure de courant n'a été connecté aux bornes d'entrée de tension.
Si vous mesurez une puissance polyphasée, vérifiez qu'il n'y a pas d'erreurs dans le câblage des phases.
- Les câbles sont solidement fixés au connecteur multifonction.

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

- Les bornes d'entrée ne chauffent pas anormalement.

Safety Precautions

- Les câbles sont solidement connectés aux bornes d'entrée.
Les connexions des bornes peuvent se desserrer avec le temps. Si cela se produit, de la chaleur peut être générée en raison de variations de la résistance de contact. Si vous devez effectuer des mesures en utilisant la même configuration pendant une longue période, vérifiez périodiquement que les câbles sont solidement connectés aux bornes. (Veillez à éteindre à la fois le wattmètre et l'élément sous mesure avant de vérifier les connexions.)

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.

Accessoires en option

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

Ne pas utiliser d'accessoires défectueux.

ATTENTION

Limitations de l'environnement d'exploitation

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

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.

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

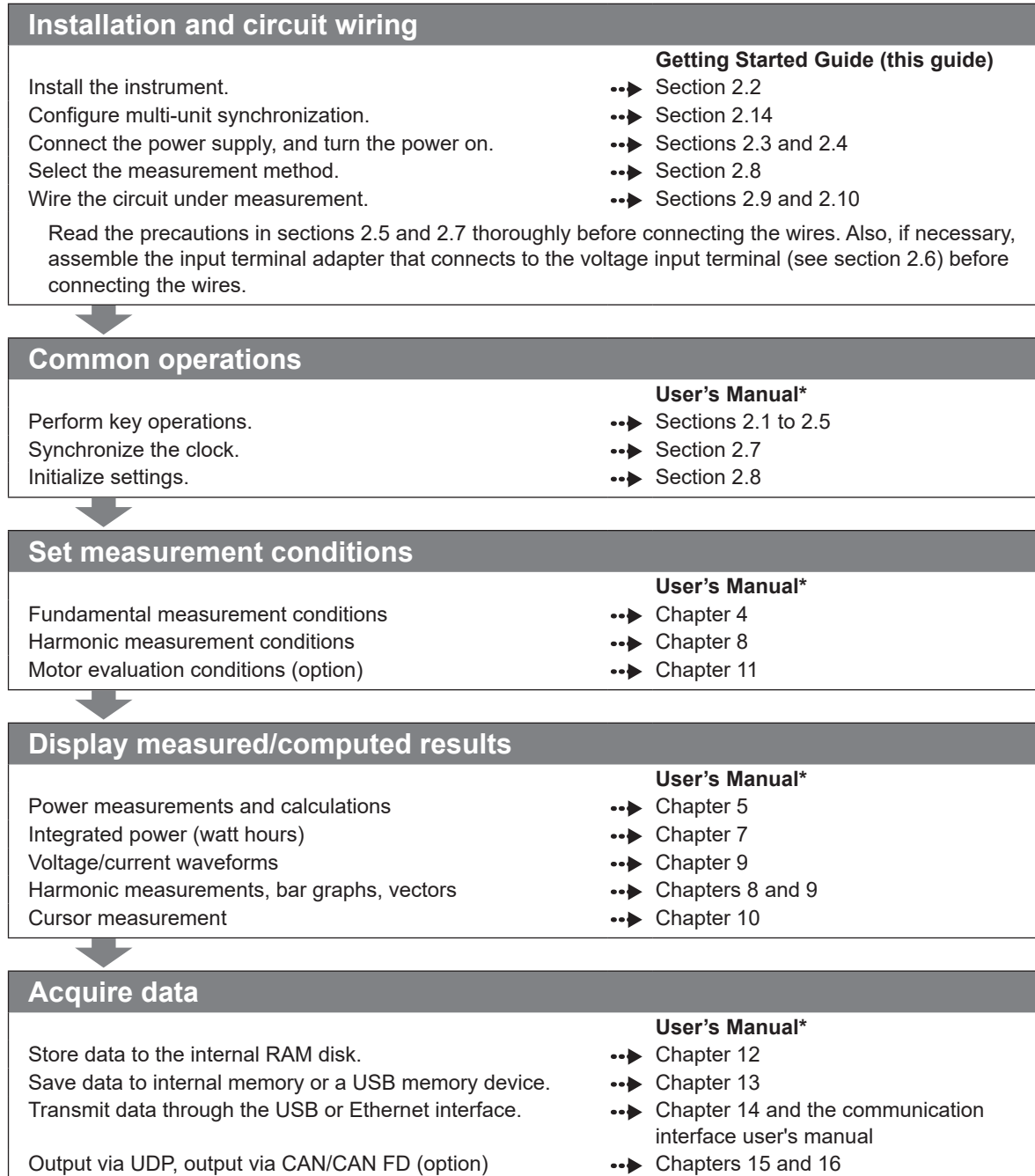
<https://tmi.yokogawa.com/support/service-warranty-quality/product-compliance/>

Disposal

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

Workflow

The following figure 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 following figure, this manual also contains safety precautions for handling and wiring the instrument. Be sure to observe the precautions.



*1 IM WT1501-01EN

*2 IM WT1501-17EN

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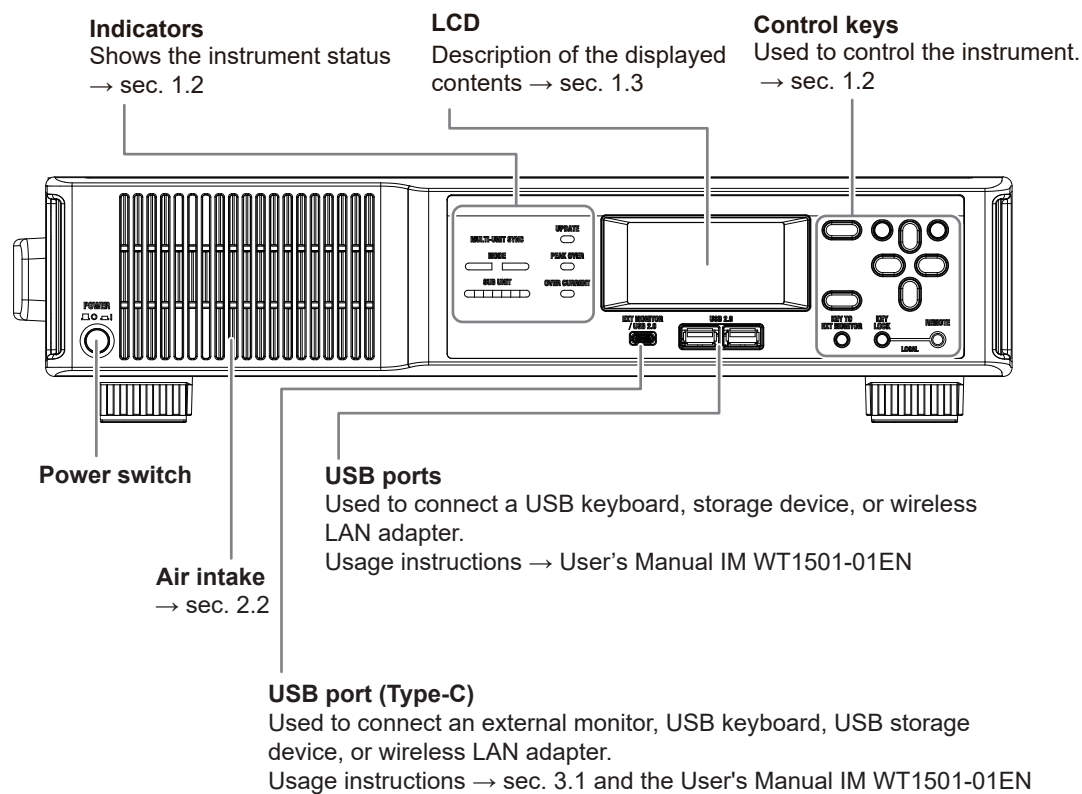
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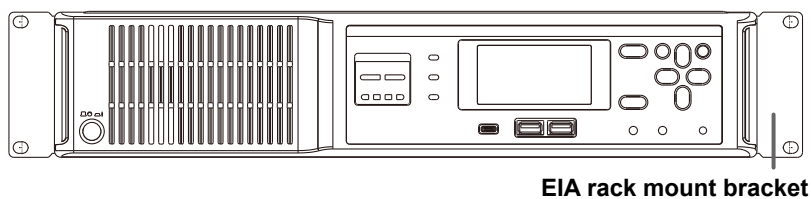
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1.1 Front Panel, Rear Panel, and Top Panel

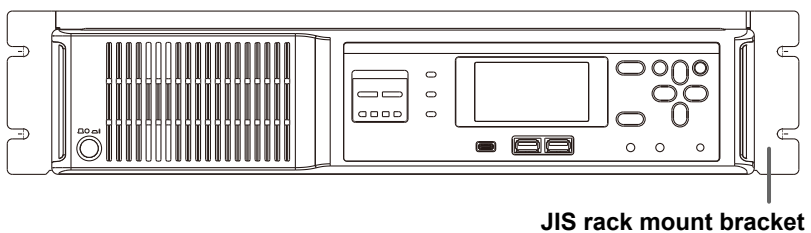
Front panel (Benchtop model (-BN))



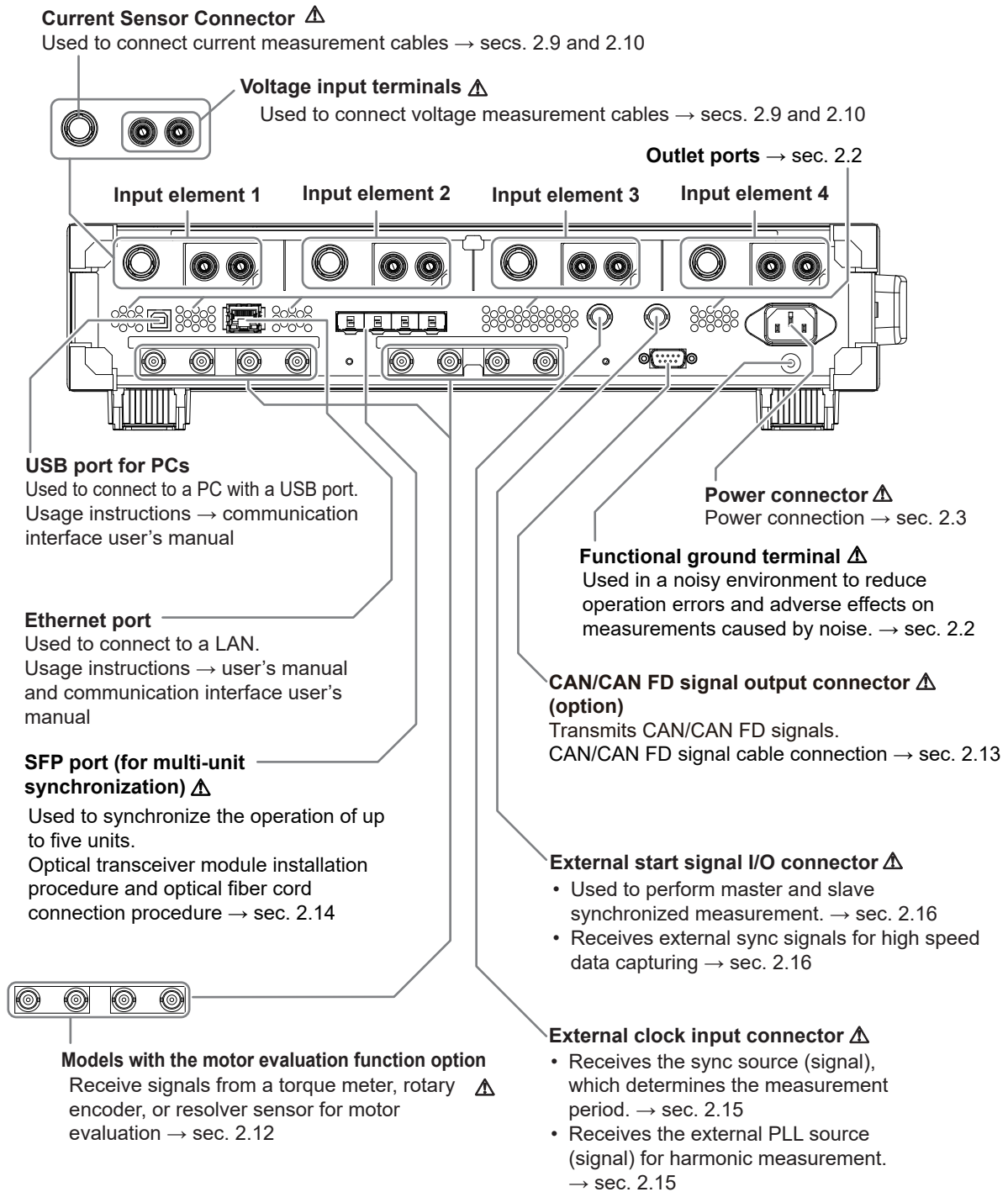
Rackmount model (-RE)



Rackmount model (-RJ)

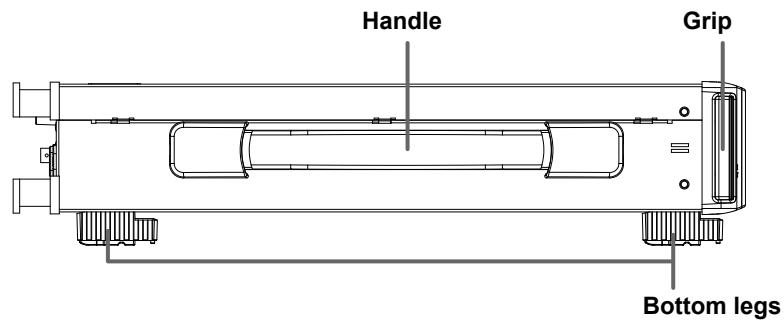


Rear panel (Benchtop model (-BN))

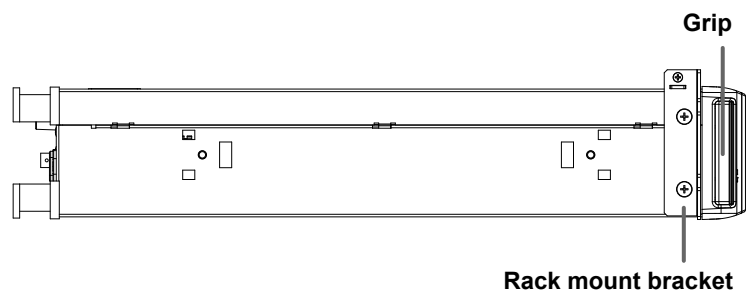


Left side panel

Benchtop model (-BN)

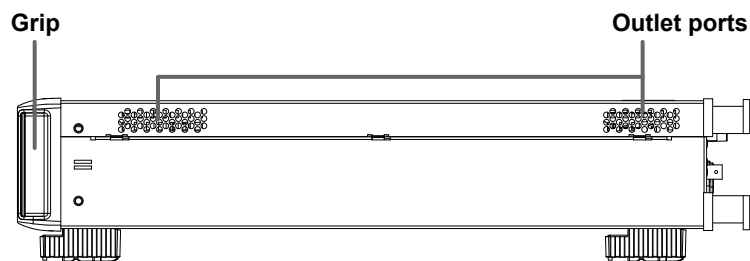


Rackmount model (-RE, -RJ)

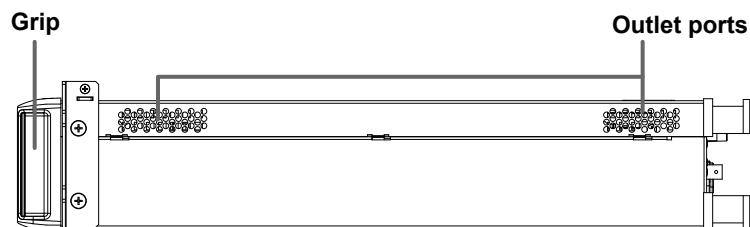


Right side panel

Benchtop model (-BN)

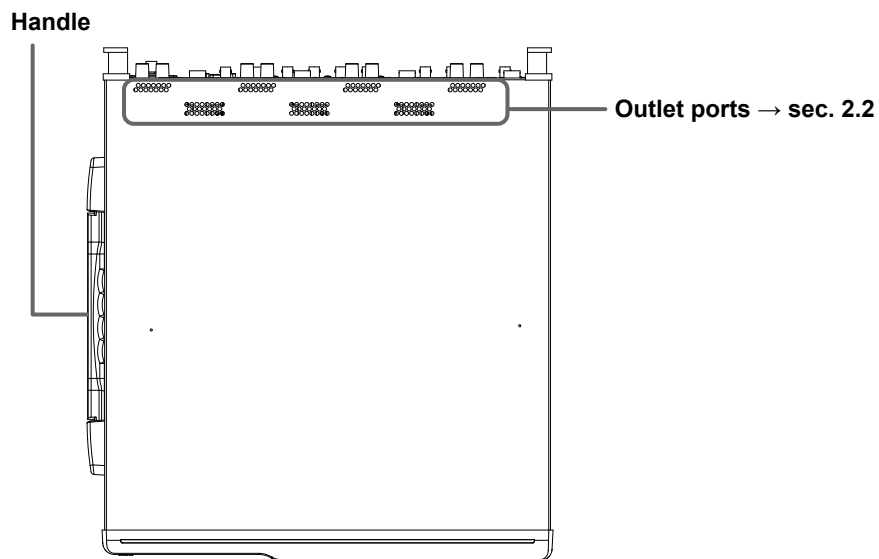


Rackmount model (-RE, -RJ)

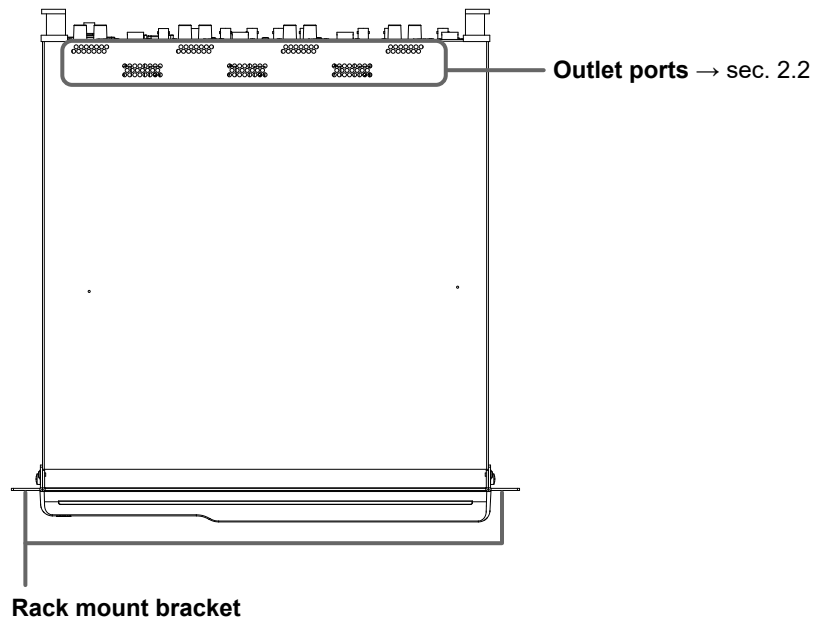


Top panel

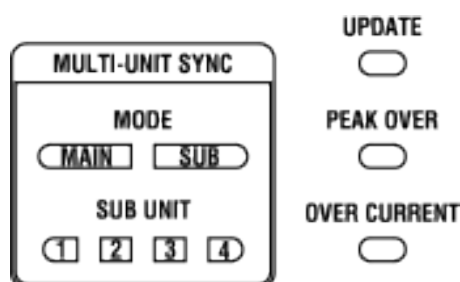
Benchtop model (-BN)



Rackmount model (-RE, -RJ)



1.2 Keys and LED Indicators



MAIN/SUB LED

Indicate the status of multi-unit synchronization mode.

- MAIN on or blinking: The multi-unit synchronization mode is set to Main Unit.
- SUB blinking: The multi-unit synchronization mode is set to Sub unit.
- Both MAIN and SUB off: The multi-unit synchronization mode is off.

Depending on the synchronous operation status, the LED light or blink green as follows:

On: Synchronous operation is in progress (Operating).

Blinking: Synchronous operation is off (OFF) or in standby mode (Standby).

SUB UNIT LED

When the multi-unit synchronization mode is set to Main Unit, these LED indicate the connection status with sub units.

When the multi-unit synchronization mode is set to Sub unit, one of these LED is used to indicate the sub unit number assigned to the instrument and the connection status with the main unit.

- Off: Not used
- Lit green: Connected properly
- Blinking green: Connecting
- Blinking red: Connection error

UPDATE LED

Blinks green while data is being updated.

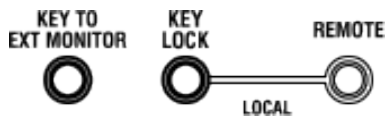
PEAK OVER LED

Lights red when a peak over-range occurs on any installed input elements.

OVER CURRENT LED

Displays overcurrent detection of the current sensors for elements 1 to 4.

When an overcurrent to the current sensor or probe is detected on one or more elements, the LED blinks red, and the power supply to the current sensor of the affected element is stopped. To resume the power supply, resolve the cause of the overcurrent, and then restart the instrument. If the LED still blinks red even after restarting the instrument, repair is required.



KEY TO EXT MONITOR key and LED

Switches control of the arrow, ESC, SET, and MENU keys between the instrument and the external monitor or web server.

When KEY TO EXT MONITOR is lit, you can operate the external monitor screen with a USB keyboard.

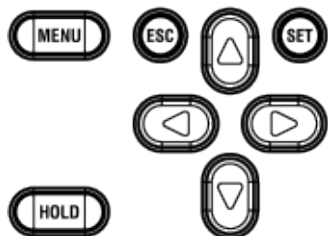
KEY LOCK/LOCAL key

Key lock: Press this key to lock the keys on the front panel. The KEY LOCK (LOCAL) key lights. Press the key again to unlock the keys.

Remote release: Press this key to switch this instrument from remote mode (REMOTE LED lit) to local mode (front panel key operation enabled). This key is disabled when the instrument is in local lockout mode.

REMOTE LED

Lights green when the instrument is in remote mode.



MENU key

Press this key to display the menu screen on the instrument's LCD display.

The MENU key lights red when the instrument automatically shuts down after detecting a fan stop or an internal temperature error.

ESC key

Use this key to cancel the settings and to return to the menu level above the current one.

SET key

Confirms a selected menu item or settings.

Arrow keys (▲ ▼ ► ◀ keys)

Press the ► and ◀ keys to change screens. Press the ▲ and ▼ keys to select menu items or scroll the screen. When entering numeric values, use the ► ◀ keys to move the digit (cursor) left or right and the ▲ ▼ keys to increase or decrease the value to be entered.

HOLD key

When you press HOLD, the HOLD key lights. Data measurement and display operations per data update interval stop, and the numeric data display is held. When you press HOLD again, the HOLD key turns off. Updating of the numeric data display resumes.

1.3 Display Screen

Display screen

The following seven types of screens can be displayed from the menu screen on the instrument's LCD display.

- Numeric display by element (Numeric Element)
- Numeric display by measurement function (Numeric Function)
- Numeric display for motor function (Numeric Motor)
- 4-value display (Numeric 4 Items)
- Peak over-range display (Peak Over Status)
- Sensor status display (SensorPowerStatus)
- Utility (Utility)

When you start the instrument, the menu screen appears.

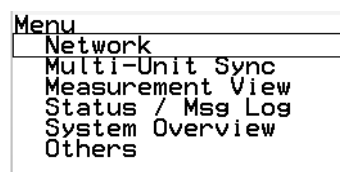
Pressing MENU switches the display screen.

Menu

The menu screen appears when you start the instrument or press MENU.

Use the arrow keys (▲▼) to select a screen, and press SET to move to the selected screen.

Press ESC to return to the menu screen.



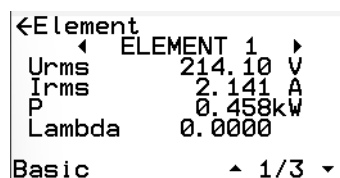
Numeric display by element (Numeric Element)

Displays the measured values for each element.

Use the arrow keys (▲▼) to select the measurement functions to be displayed from three pages.

Use the arrow keys (►◄) to select the element to be displayed.

For details, see chapter 5 in IM WT1501-01EN.



Numeric display by measurement function (Numeric Function)

Displays RMS voltage (Urms), RMS current (Irms), active power (P), and power factor (λ) measurements for all elements and wiring units.

Use the arrow keys ($\blacktriangle$ $\blacktriangledown$) to select the measurement functions to be displayed from four pages.

For details, see chapter 5 in IM WT1501-01EN.

<Function	
Elem1	292.11 V
Elem2	293.11 V
Elem3	294.11 V
Elem4	295.11 V
ΣA	-----
ΣB	-----
Urms	▲ 1/4 ▼

Numeric display for motor function (Numeric Motor)

Displays measured rotating speed (Speed), torque (Torque), synchronous speed (SyncSP), slip (Slip), motor output (Pm), and auxiliary inputs (AUX1 to 8) for each motor.

Use the arrow keys ($\blacktriangleright$ $\blacktriangleleft$) to select the motor input to be displayed.

For details, see chapter 11 in IM WT1501-01EN.

<Motor	
	Motor 1
Speed	60.000 rpm
Torque	0.2000 Nm
SyncSP	1.1914Mrpm
Slip	99.995 %
PM	0.0013kW

4-value display (Numeric 4 Items)

Displays 48 items configured for 4-value display across 12 pages.

Use the arrow keys ($\blacktriangle$ $\blacktriangledown$) to select the measurement function and the element or wiring unit to be displayed.

For details, see chapter 5 in IM WT1501-01EN.

<4 Items	
Urms1	134.10 V
Irms1	1.341 A
P1	0.180kW
Lambda1	0.0000
▲1/12▼	

Peak over-range display (Peak Over Status)

Displays peak over-range status for voltage (U) and current (I) of each element, and for rotating speed (Speed) and torque (Torque) of each motor. Input signals in a peak over-range condition are indicated by icons with white text on a black background.

Example: Display when U1, I1, U3, I3, Ch A, Ch B, CH E, and CH F are in a peak over-range condition.

<Peak Over Status	
U1	U3
I1	I3
ChA	ChE
ChB	ChF

Sensor status display (SensorPowerStatus)

Displays the overcurrent status (Over Current) and the power supply status (CT Power Status) of each current sensor. Icons with white text on a black background are displayed for the following elements:

- Elements for which the power supply has been shut down due to an overcurrent condition
- Elements receiving power

Example: Display when power is supplied to elements 1 through 4, and the power supply to elements 1 and 3 has been shut down due to an overcurrent condition

```

←Sensor Power Status
OverCurrent
  I1      I3
CT Power Status
  I2      I4
  
```

Utility (Utility)

Displays the following setup menus. Use the arrow keys (▲▼) to move the cursor to an item, and press SET to open the detailed setup menu. For the details on each setting, see the relevant section in IM WT1501-01EN.

- Ethernet Communication Settings (Network) → chapter 14
- Message Log (Message Log) → sec. 18.7
- Instrument Information (System Overview) → sec. 18.1
- Multi-Unit Synchronization Setup (MultiUnitSync) (/SY1 option) → sec. 17
- Date and Time (Date/Time) → sec. 2.7
- Saving/Loading Setup Parameters, Saving Message Log (Setup/Msg File) → secs. 3.4 and 18.6
- Upgrade (Upgrade) → sec. 18.1

Press ESC to return to the previous screen.

```

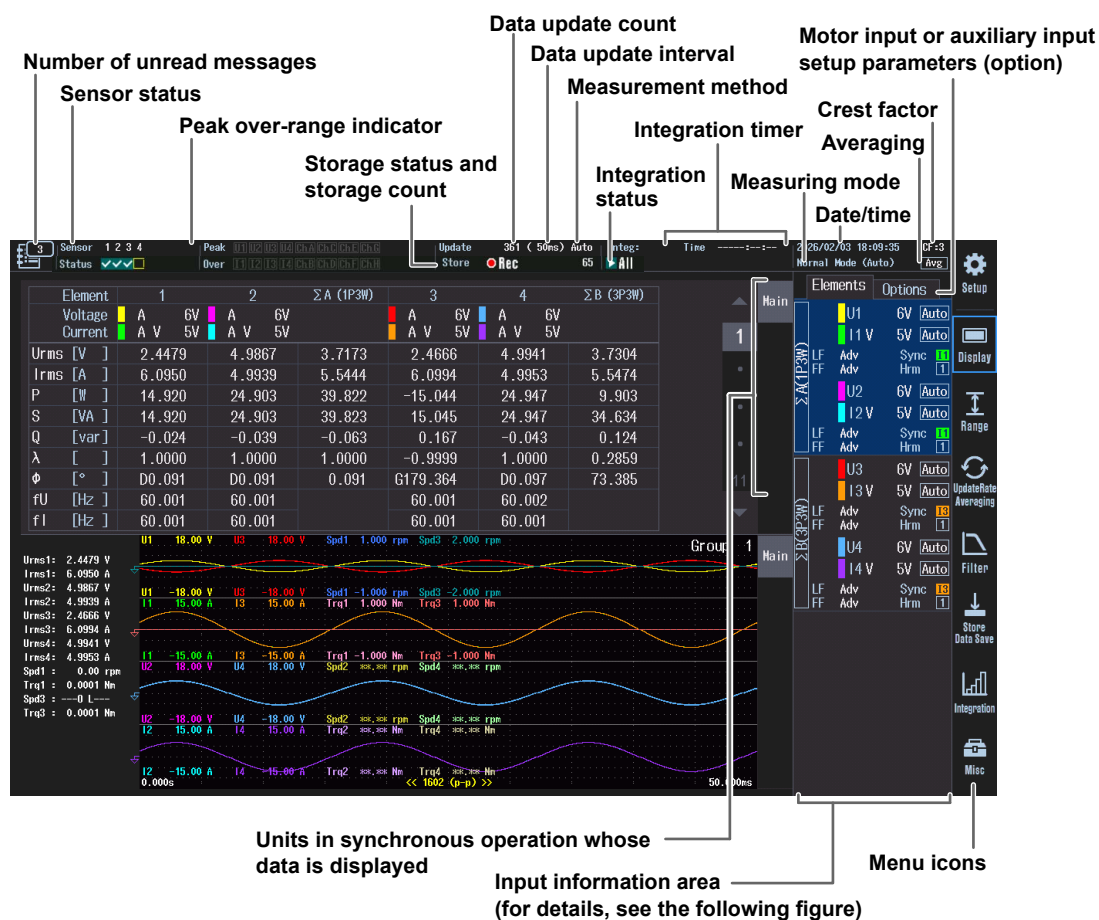
Menu
Network
Multi-Unit Sync
Measurement View
Status / Msg Log
System Overview
Others
  
```

Note

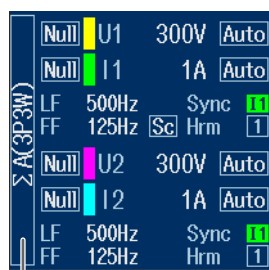
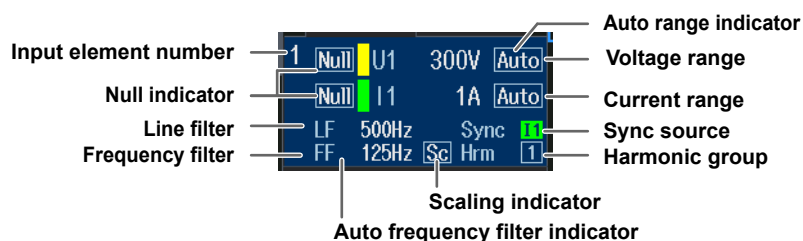
The LCD of this instrument may have a few defective pixels. For details, see section 5.5.

Display example when an external monitor is connected

Power measurement (numeric and waveform displays)



Input information (Elements tab)

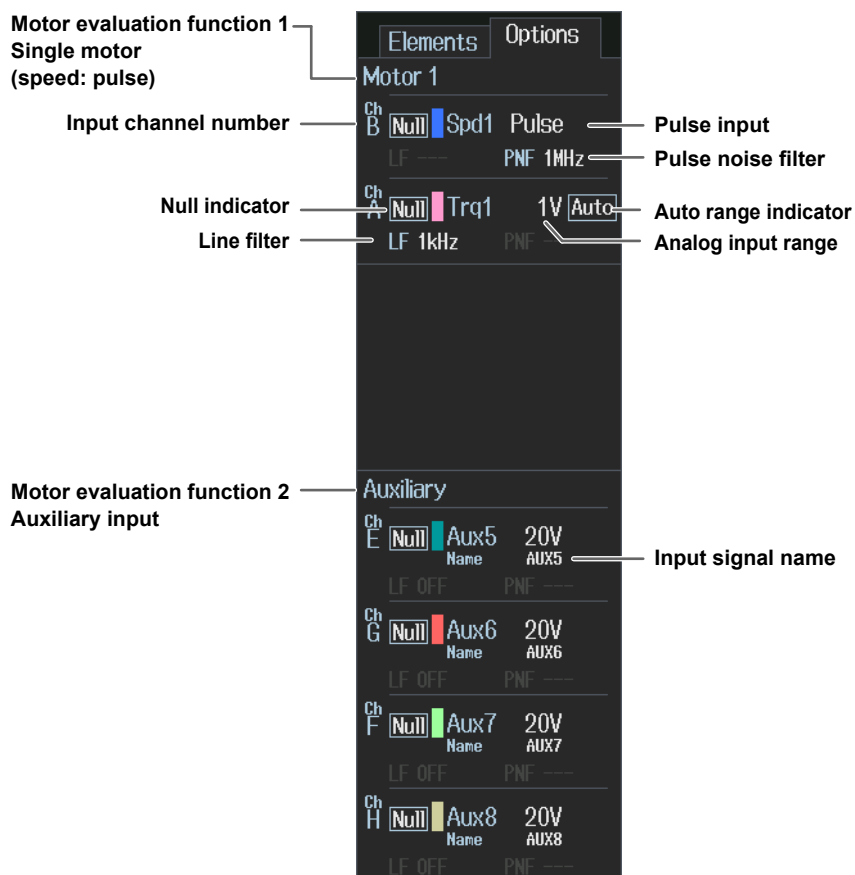


Wiring system

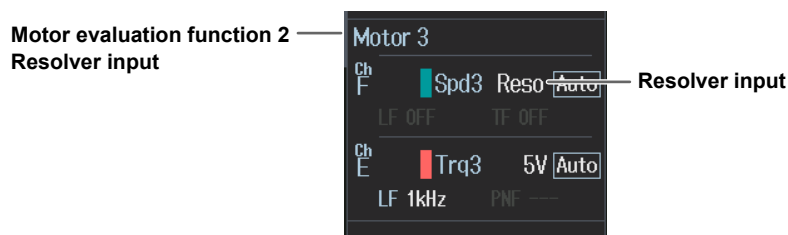
(displayed on the left side of input elements in the same wiring unit)

Input information (Options tab)

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



Display example when motor evaluation function 2 is set to single motor (speed: resolver)



Non-numeric displays

In addition to the measured values, the following information is displayed on the instrument's LCD screen and on external monitor and web server screens.

--OL--

Overload indicator

Displayed if the measured value exceeds 140 %* of the measurement range for crest factor CF3 or CF6.

*

- 110 % only for the 2000 V voltage input range of high-voltage element
- 125 % only for the 1 A range of current sensor input
- 125 % only for the 5 V range of current sensor input

When the crest factor is CF6A, the threshold is twice that for crest factor CF3.

--OF--

Overflow indicator

Displayed if the measured or calculated result cannot be displayed using the specified decimal place or unit.

No-data indicator

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

Error

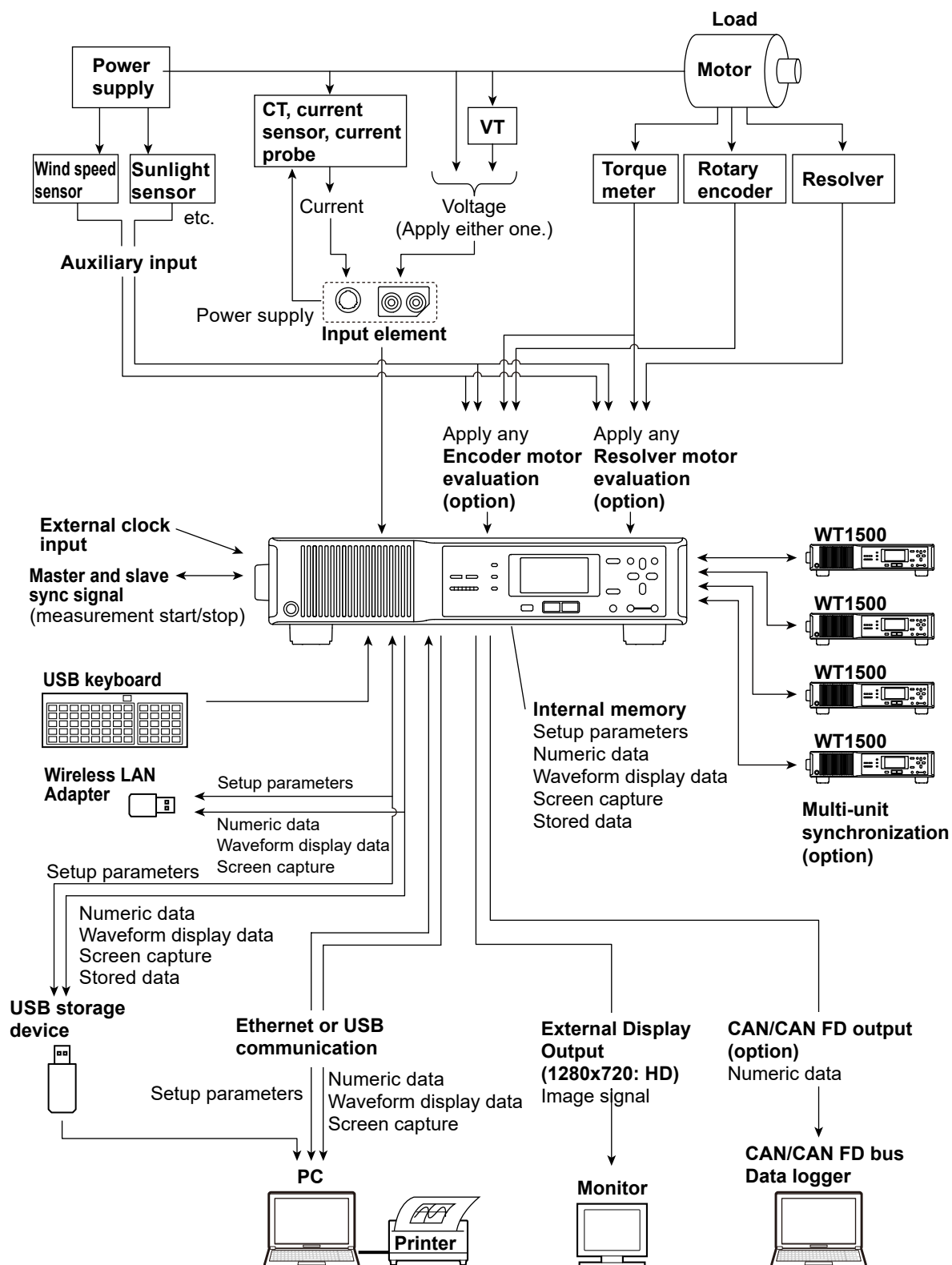
Error indicator

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

Note

In a wiring system with delta transformation, overload indication is determined on the data before delta transformation. When any of the elements in the wiring is overloaded, overload is indicated on all elements in the wiring.

1.4 System Configuration



2.1 Handling Precautions

Safety precautions

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

Do not remove the case

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

Unplug if abnormal behavior occurs

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

Do not damage the power cord

Nothing should be placed on top of the power cord. The power cord should also be kept away from any heat sources. When removing the plug from the power outlet, do not pull on the cord. Pull from the plug. If the power cord is damaged or if you are using the instrument in a location where the power supply specifications are different, purchase a power cord that matches the specifications of the region that the instrument will be used in.

Operating environment and conditions

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

General handling precautions

Do not place objects on top of the instrument

Never place other instruments or any objects containing water on top of the instrument. Doing so may damage the instrument. For details on stacking the instrument, see page 2-6.

Keep electrically charged objects away from the instrument

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

Do not damage the LCD

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

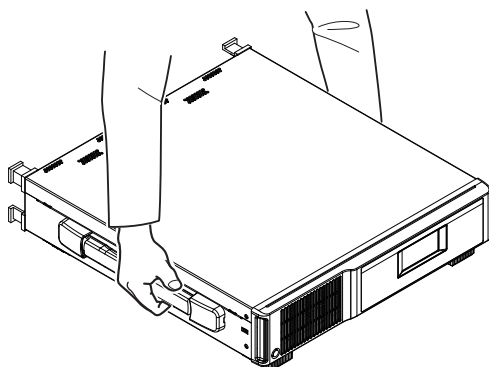
Remove the batteries during extended non-use

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

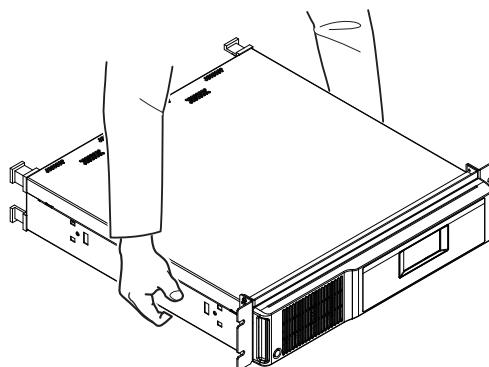
When carrying the instrument

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

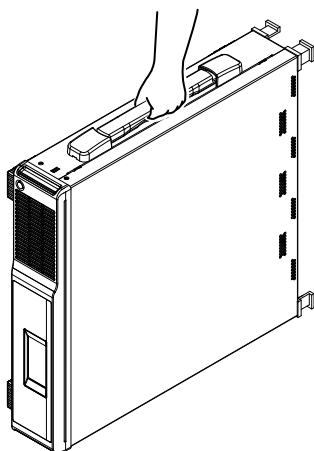
When carrying, hold with both hands or hold the handle on the left side, as shown in the following figure. In addition, if storage device is inserted in the instrument, be sure to remove the storage device before you move the instrument.



Standard model (-BN)



Rackmount models (-RE, -RJ)



Standard model (-BN)

WARNING

- When holding the handle, be careful not to get your hand caught between the handle and the case.
- When carrying the instrument or mounting it into a rack, be careful not to get your hand caught between the wall, installation surface, or other objects and the instrument.
- When removing this instrument from the rack, hold the left and right grips and pull it toward you. When lifting the instrument, do not use the grips. Doing so may cause damage and result in injury.

- Do not apply excessive force or impact to the measurement terminals. If a terminal is damaged, the insulation distance may become insufficient, resulting in a risk of electric shock.

French

AVERTISSEMENT

- Lorsque vous tenez la poignée, veillez à ne pas vous coincer la main entre la poignée et le boîtier.
- En transportant l'instrument ou en le montant sur un portant, veillez à ne pas vous coincer la main entre le mur, la surface d'installation, d'autres objets et l'instrument.
- Pour retirer cet instrument du portant, tenez les poignées gauche et droite et tirez-le vers vous. N'utilisez pas les poignées pour soulever l'instrument. Cela pourrait entraîner des dommages et des blessures.
- N'appliquez pas de force ou d'impact excessif sur les bornes de mesure. Si une borne est endommagée, la distance d'isolation peut devenir insuffisante, entraînant un risque de choc électrique.

When cleaning the instrument

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

2.2 Installing the Instrument

WARNING

- Do not install the instrument (1) outdoors or in locations subject to rain or water, (2) in an environment that is subject to large levels of mechanical vibration, or (3) on an unstable surface. Do not use the instrument in such locations.
- Install the instrument so that you can immediately remove the power cord if an abnormal or dangerous condition occurs.

CAUTION

Do not block the inlet and outlet ports. Also, ensure sufficient space is provided so that wiring cables or other items do not obstruct air intake or exhaust. The instrument may overheat and become damaged.

French

AVERTISSEMENT

- N'installez pas l'instrument (1) à l'extérieur ou dans des endroits exposés à la pluie ou à l'eau, (2) dans un environnement soumis à de fortes vibrations mécaniques, ou (3) sur une surface instable. N'utilisez pas l'instrument dans ces endroits.
- Installer l'instrument de manière à pouvoir immédiatement le débrancher du secteur en cas de fonctionnement anormal ou dangereux.

ATTENTION

Ne bloquez pas les orifices d'entrée ou de sortie. Assurez-vous également qu'un espace suffisant est prévu pour les câbles ou d'autres éléments.

Installation conditions

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

Flat, even surface

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

Well-ventilated location

Inlet and outlet ports 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 outlet ports.

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

Ambient temperature and humidity

Ambient temperature: 5 to 40 °C
 Ambient humidity: 20 to 80 % RH
 (No condensation)

Do not install the instrument in the following places:

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

Note

- For the most accurate measurements, use the instrument in the following kind of environment.
 Ambient temperature: 23 °C ± 5 °C; ambient humidity: 30 % RH to 75 % RH (no condensation)
 When using the instrument in a place where the ambient temperature is 5 °C to 18 °C or 28 °C to 40 °C, add the temperature coefficient to the accuracy as specified in chapter 5.
- When installing the instrument in a place where the ambient humidity is 30 % or less, take measures to prevent static electricity such as using an anti-static mat.
- Condensation may occur if the instrument is moved to another place where the ambient temperature or humidity is higher, or if the temperature changes rapidly. In such cases, allow the instrument to acclimate to the ambient temperature for at least one hour before using it under non-condensing conditions.

Storage location

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

When storing the instrument, avoid the following places.

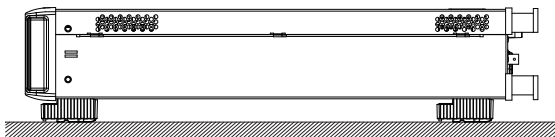
- Where the level of mechanical vibration is high
- In direct sunlight
- Where there are corrosive or explosive gases
- Where an excessive amount of soot, dust, salt, or iron is present
- Near a strong source of heat or moisture
- Where water, oil, or chemicals may splash onto the instrument

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

Installation orientation

Desktop

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



WARNING

Do not place the instrument in any position other than those shown in the above figures.

French

AVERTISSEMENT

Ne pas placer l'instrument dans des positions autres celles indiquées ci-dessus.

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.

Note

If you attach the front rubber leg cap, you will not be able to stack the LS3300.

Notes on stacking

Note the following points.

WARNING

- Only one instrument can be stacked on top of another. Do not stack multiple instruments on top of one instrument.
 - When stacking items, take the following measures to prevent tipping or falling.
 - Attach bottom legs.
 - Secure with a band.
 - Do not transport while stacked. There is a risk of tipping or falling.
-

French

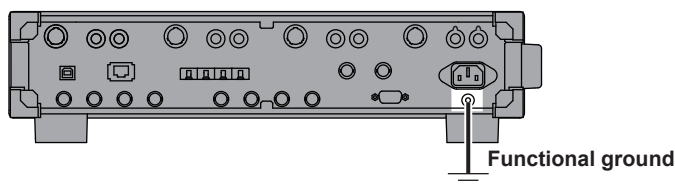
AVERTISSEMENT

- Un seul instrument peut être empilé sur un autre. N'empilez pas plusieurs instruments sur un seul instrument.
- Si vous empilez des articles, prenez les mesures suivantes pour éviter un basculement ou une chute.
 - Fixez les pieds inférieurs.
 - Fixez avec une sangle.
- Ne transportez pas d'instruments empilés. Il y a un risque de basculement ou de chute.

The CE mark indicates compliance when this instrument is used as a single unit.
If you have any questions, contact your nearest YOKOGAWA dealer.

Functional ground

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

**Rack mounting**

If the specification code for this instrument is -RE or -RJ, it can be mounted directly into a rack.
If the specification code for this instrument is -BN, it can be mounted into a rack using the optional rack mount kit 751543. For details, see the rack mount kit manual.

Note

- When rack-mounting the instrument, allow at least 20 mm of space around the inlet and outlet ports to prevent internal heating.
- Make sure to provide adequate support from the bottom. The support should not block the inlet and outlet ports. You can perform a self-test to confirm that the instrument's internal temperature is within the appropriate range (see section 18.9 in the User's Manual IM WT1501-01EN).

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 and fire, be sure to use the power cord for this instrument.
- To prevent electric shock, make sure to connect the instrument to a protective ground (earth). Connect the instrument's power cord to a properly grounded three-prong outlet.
- 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

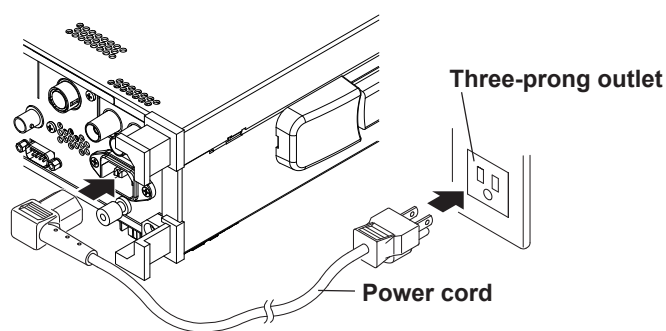
- Assurez-vous que la tension d'alimentation correspond à la tension d'alimentation nominale de l'appareil et qu'elle ne dépasse pas la plage de tension maximale du cordon d'alimentation à utiliser.
- Brancher le cordon d'alimentation après avoir vérifié que l'interrupteur d'alimentation de l'instrument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

Connecting the power cord

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

Item	Specifications
Rated supply voltage	100 VAC to 120 VAC, 220 VAC to 240 VAC
Permitted supply voltage range	90 VAC to 132 VAC, 198 VAC to 264 VAC
Rated power frequency	50 Hz/60 Hz
Permitted supply frequency range	48 Hz to 63 Hz
Maximum power consumption	300 VA

* This 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 voltage rating 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:

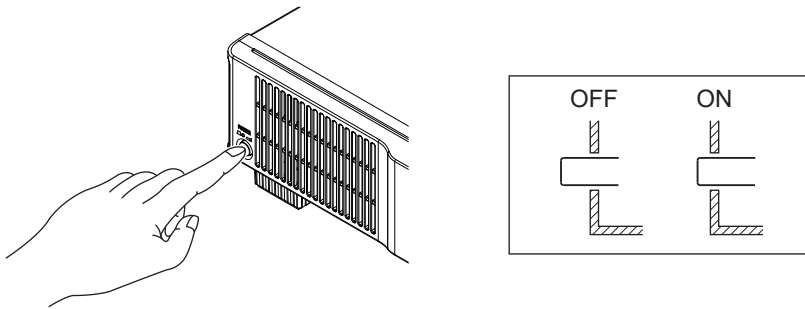
- The instrument is installed properly. See section 2.2, "Installing the Instrument."
- The power cord is connected properly. See section 2.3, "Connecting the Power Supply."

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 you turn the power switch on, the startup screen will appear. Then, the screen that was displayed immediately before the power was turned off will appear.

Note

- After turning the power off, wait at least 10 seconds before you turn it on again.
- If the instrument still does not work properly, contact your nearest YOKOGAWA dealer for repairs.
- It may take several tens of seconds for the startup screen to appear.

When the power-on operation does not finish normally

Turn off the power switch, and check that:

- The power cord is securely connected.
- Check that the correct voltage is coming to the power outlet. See section 2.3, "Connecting the Power Supply"
- Initialize the settings to their factory defaults by turning on the power switch while holding down the ESC key.

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

To make accurate measurements

- After turning on the power switch, wait at least 30 minutes to allow the instrument to warm up.
- After warm-up, execute zero-level compensation. See the User's Manual IM WT1501-01EN.

Operations performed when the power is turned off

The settings immediately before the power switch is turned off are stored. 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. You cannot replace batteries by yourself. Contact your nearest YOKOGAWA dealer to have the battery replaced.

CAUTION

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

French

ATTENTION

Le fait d'éteindre l'interrupteur d'alimentation ou de débrancher le cordon d'alimentation pendant que l'instrument enregistre des données peut corrompre le support sur lequel les données sont enregistrées. De plus, les données enregistrées ne sont pas garanties. Assurez-vous de mettre l'interrupteur hors tension une fois les données enregistrées.

2.5 Precautions When Wiring the Circuit under Measurement

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



WARNING

- Make sure to connect the instrument to a protective ground (earth) before connecting measurement cables. The power cord to use is a three-prong type power cord. Connect the power cord to a properly 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.
- 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.
- Use the cables specified as accessories in this manual to connect to the current input terminal.
- 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 ($2 U + 1000 \text{ V}$ recommended). Also, make sure that the secondary side of the CT does not become an open circuit while the power is being applied. If this happens, high voltage will appear at the secondary side of the CT, making it extremely dangerous.
- When using an external current sensor, make sure to use a sensor that comes in a case. The conductive parts and 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 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.
- When using a current sensor (CT), use a sensor with overload protection.
- When connecting current sensor cables (761964, 761965) or conversion adapters (761966) to the current sensor (CT), tightening the screws activates the protection function and non-isolation function. It is extremely dangerous if you do not fasten the screws.
- For safety reasons, when using the instrument after mounting it on a rack, furnish a switch for turning off the circuit under measurement from the front side of the rack.
- To make the protective features effective, before applying the voltage or current from the circuit under measurement, check that:
 - The power cord for the instrument is being used to connect to the power supply, and the instrument is grounded.
 - The instrument is turned on.

2.5 Precautions When Wiring the Circuit under Measurement

- When the signal being measured is in a pulse form and the rising waveform is steep, the instrument's maximum allowable input specification may be exceeded due to resonance, reflection, and so on depending on the measurement circuit and cable. Check the influence of the measurement circuit and cable before making a connection. We recommend checking the waveform at the instrument's input terminal.
- When the instrument is turned on, do not apply a signal that exceeds the following values to the voltage input terminals or the current input terminal. When the instrument is turned off, turn the circuit under measurement off. For information about other input terminals, see the specifications in chapter 5.

Instantaneous maximum allowable input

Voltage

WB element

3000 V peak, 1 s or less

Current

Current input

1.8 A peak, 0.1 s or less

Voltage input

10 V RMS, 0.1 s or less

Continuous maximum allowable input

Voltage

HV element

2100 V RMS

WB element

1300 V RMS

Input voltage frequency > 100 kHz: $(1400-f)$ Vrms or less

Input voltage frequency > 1 MHz: $400/(f/1000)^2$ Vrms or less

f is the frequency of the input voltage in units of kHz.

Current

Current input

1.1 A RMS

Voltage input

8 V RMS



CAUTION

- Use measurement cables with dielectric strengths and current capacities that are appropriate for the voltage or current being measured, and that are suitable for the application rating.
- 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

- Veillez à connecter l'instrument à une mise à la terre de protection 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 câblez pas un circuit de courant sur la borne d'entrée de tension ou un circuit de tension sur la 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.
- Utilisez les câbles spécifiés comme accessoires dans ce manuel pour la connexion à la borne d'entrée de courant.
- 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 ($2U + 1000\text{ V}$ 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.
- 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 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.
- Si vous utilisez un capteur de courant (CT), utilisez un capteur avec protection contre les surcharges.
- Quand vous connectez les câbles du capteur de courant (761964, 761965) ou les adaptateurs de conversion (761966) au capteur de courant (CT), le serrage des vis active la fonction de protection et la fonction de non-isolation. Ne pas serrer les vis est extrêmement dangereux.
- Pour des raisons de sécurité, lors de l'utilisation de l'instrument après son installation sur un rack, prévoir un commutateur pour mettre le circuit mesuré hors tension depuis l'avant du rack.
- Pour garantir la sécurité, avant d'appliquer la tension ou le courant depuis le circuit à mesurer, vérifier ce qui suit :
 - Le cordon d'alimentation 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.
- Lorsque le signal mesuré est sous forme d'impulsion et que la forme d'onde montante est forte, la spécification de l'entrée maximale admissible de l'instrument peut être dépassée en raison de la résonance, de la réflexion, etc., selon le circuit de mesure et le câble. Vérifiez l'influence du circuit de mesure et du câble avant d'effectuer une connexion. Nous vous conseillons de vérifier la forme d'onde à la borne d'entrée de l'instrument.
- Lorsque l'instrument est sous tension, n'appliquez pas de signal dépassant les valeurs suivantes aux bornes d'entrée de tension ou à la borne d'entrée de courant. Lorsque l'instrument est éteint, coupez le circuit en cours de mesure. Pour plus d'informations sur les autres bornes d'entrée, consultez les spécifications au chapitre 5.

Entrée maximale instantanée admissible

Tension

Élément large bande

3000 V crête, 1 s ou moins

Courant

Entrée de courant

1,8 A crête, 0,1 s ou moins

Entrée de tension

10 V RMS, 0,1 s ou moins

Entrée maximale continue admissible

Tension

Élément haute tension

2100 V RMS

Élément large bande

1300 V RMS

Fréquence de tension d'entrée > 100 kHz : $(1400-f)$ Vrms ou moins

Fréquence de tension d'entrée > 1 MHz : $400/(f/1000)^2$ Vrms ou moins

f est la fréquence de la tension d'entrée en kHz.

Courant

Entrée de courant

1,1 A RMS

Entrée de tension

8 V RMS



ATTENTION

- Utiliser des câbles de mesure dont la rigidité diélectrique et la capacité de courant conviennent pour la tension ou le courant à mesurer.
- Le branchement d'un câble de mesure sur ce produit peut entraîner une interférence radio que l'utilisateur sera tenu de rectifier.

2.5 Precautions When Wiring the Circuit under Measurement

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 2.10 are the parts where the current flows. Use wires that are suitable for the current levels.
 - To make accurate measurements of the voltage of the circuit under measurement, connect the measurement cable that is connected to the voltage input terminal to the circuit as closely as possible.
 - To make accurate measurements, separate the measurement cables as far away from the ground wires and the instrument's case as possible to minimize static capacitance to the ground.
 - To measure the apparent power and power factor more accurately on an unbalanced three-phase circuit, we recommend that you use a three-phase three-wire system with a three-voltage three-current method (3P3W; 3V3A).
-

2.6 Assembling the Adapters for the Voltage Input Terminals

Assembling the 758931 Safety Terminal Adapter (for the WB element)

When connecting a signal cable to a voltage input terminal of this instrument's WB element, use Safety Terminal Adapter 758931 or 758923, sold separately. When using the 758931 Safety Terminal Adapter, assemble it according to the following procedure.

Assembly procedure

WARNING

Strip the insulation from the measurement cable so that, when the cable is connected to the safety terminal adapter, no conductive (exposed) part protrudes from the adapter. Then, securely tighten the screws on the safety terminal adapter to prevent the connected measurement cable from coming loose.

CAUTION

Use measurement cables with sufficient withstand-voltage margin for the voltage being measured and that are suitable for the applicable ratings.

French

AVERTISSEMENT

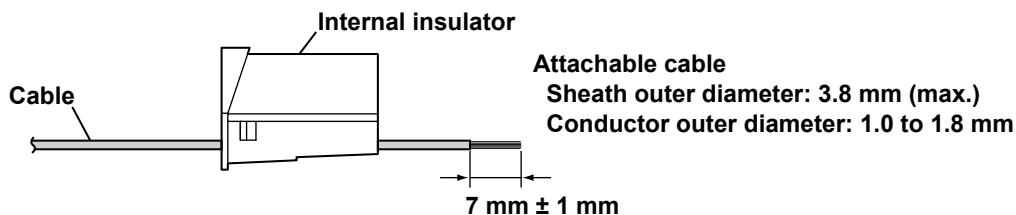
Dénudez le câble de mesure de sorte que, lorsqu'il est connecté à l'adaptateur de borne de sécurité haute tension, son conducteur (partie exposée) ne dépasse pas de l'adaptateur. De plus, serrez fermement les vis de l'adaptateur de borne de sécurité haute tension afin que le câble de mesure connecté ne se détache pas de l'adaptateur.

ATTENTION

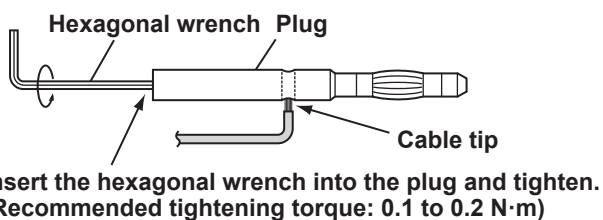
Utiliser des câbles de mesure dont la rigidité diélectrique et la capacité de courant conviennent pour la tension ou le courant à mesurer.

2.6 Assembling the Adapters for the Voltage Input Terminals

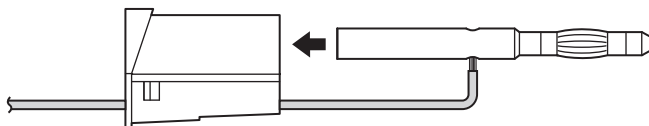
1. Remove approximately $7\text{ mm} \pm 1\text{ mm}$ of the covering from the end of the cable and pass the cable through the internal insulator.



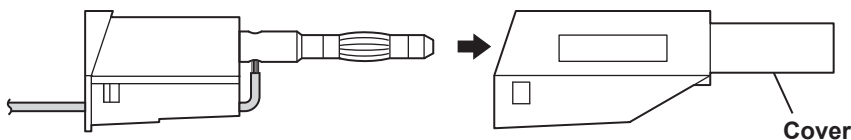
2. Insert the tip of the cable into the plug. Fasten the cable in place using the hexagonal wrench.



3. Insert the plug into the internal insulator.



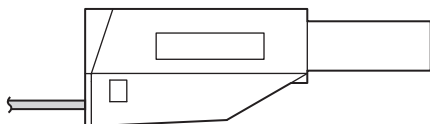
4. When the cover is installed correctly, it locks with a click. Make sure the cover does not come off.



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.



Assembling the High Voltage Safety Terminal Adapter Set (for the HV element)

When connecting a signal cable to a voltage input terminal of this instrument's HV element, use the 758932 high voltage safety terminal adapter set, sold separately. When using the 758932 high voltage safety terminal adapter, assemble it according to the following procedure.

WARNING

Strip the insulation from the measurement cable so that, when the cable is connected to the High Voltage Safety Terminal Adapter, its conductor (exposed part) does not protrude from the adapter. Also, securely tighten the screws on the high voltage safety terminal adapter so that the connected measurement cable does not come loose from the adapter.

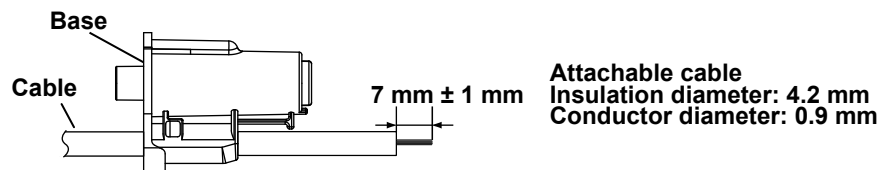
French

AVERTISSEMENT

Dénudez le câble de mesure de sorte que, lorsqu'il est connecté à l'adaptateur de borne de sécurité haute tension, son conducteur (partie exposée) ne dépasse pas de l'adaptateur. De plus, serrez fermement les vis de l'adaptateur de borne de sécurité haute tension afin que le câble de mesure connecté ne se détache pas de l'adaptateur.

Assembly Procedure

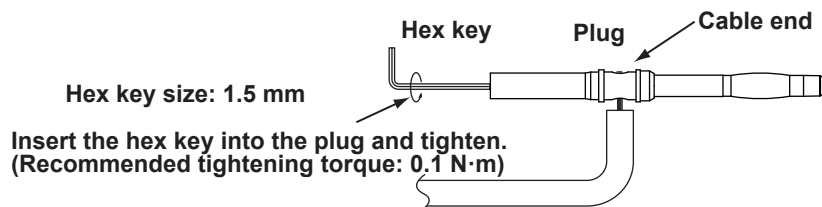
1. Strip $7 \text{ mm} \pm 1 \text{ mm}$ of insulation from the end of the cable, and pass the cable through the base.



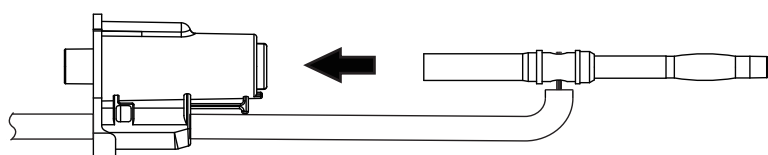
Note

- Installation may not be possible depending on the material or hardness of the cable insulation.
- A cable with silicone insulation is recommended.

2. Insert the end of the measurement cable into the plug.

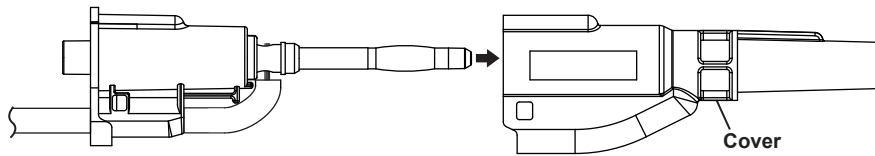


3. Insert the plug into the base.



2.6 Assembling the Adapters for the Voltage Input Terminals

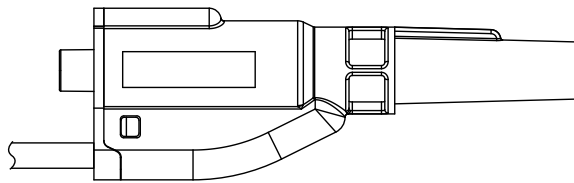
4. When the cover is attached correctly, it clicks and locks into place. Check that the tabs are securely engaged and that the cover does not come off.



Note

- Once the cover has been attached, it cannot be disassembled. Attach it carefully, making sure that it is installed correctly.
-

This is the completed assembly.



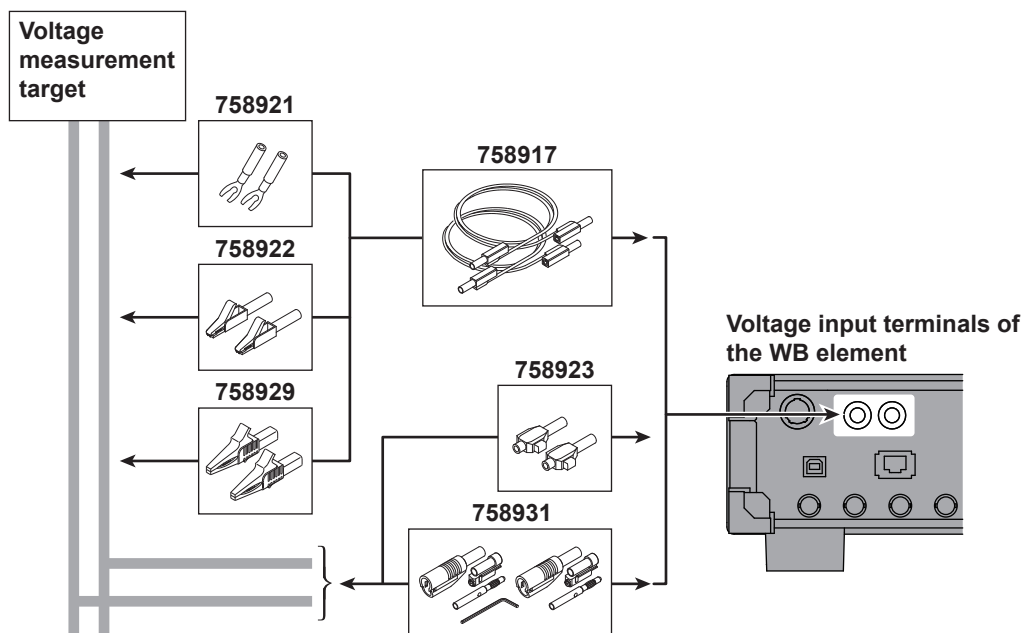
Note

- To reduce loss between the circuit under measurement and the instrument, keep the measurement cable as short as possible.
-

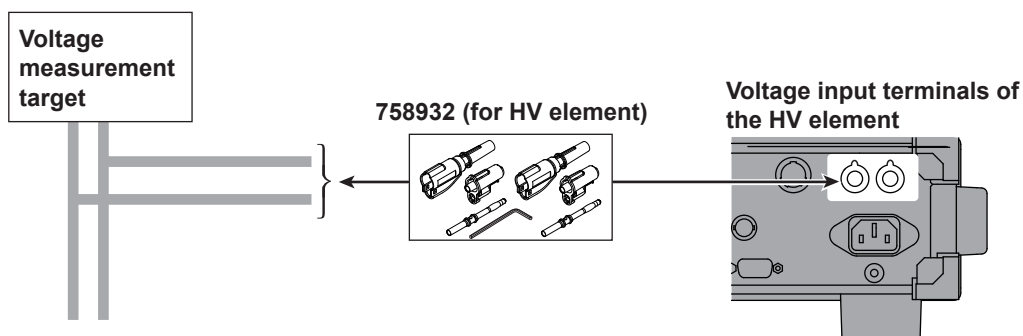
Description

Use the separately sold adapters and various sensors as follows, depending on the target device to be connected.

Wiring to the voltage measurement terminal (WB element)



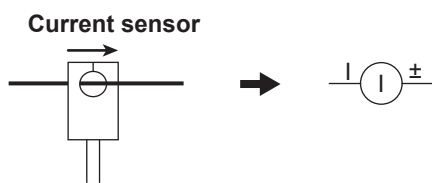
Wiring to the voltage measurement terminal (HV element)



2.7 Wiring for Accurately Measuring a Single-phase Device

In this section, we define each term as follows.

- Current input terminals ($\pm$): Conductor under test on the current sensor current direction LED mark end point side
- Current input terminals (I): Conductor under test on the current sensor current direction LED mark start point side
- Current measurement circuit: Current measurement circuit consisting of this instrument and current sensor
- Instrument loss (current measurement): Input impedance of the current sensor
- Measurement current: Input current of the current sensor (primary current)



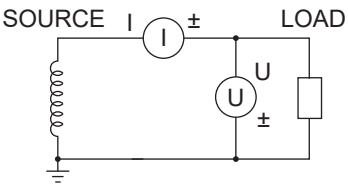
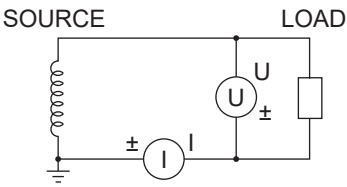
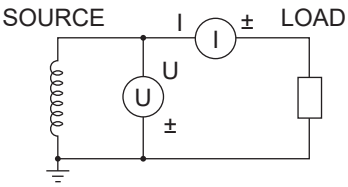
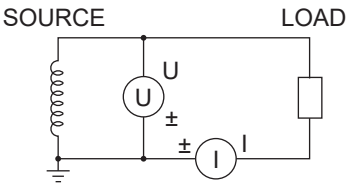
When measuring a single-phase device, there are four patterns for connecting the voltage input terminals and current sensors to the circuit under measurement, as shown in the following figure. Depending on the wiring positions, the effect of stray capacitance and the effect of instrument loss may become large. To make accurate measurements, refer to the items below when wiring the voltage input and current sensors.

Effect of instrument loss

When the measured current is relatively large, connecting the voltage measurement terminals to the load side rather than the current sensor side can reduce the effect on measurement accuracy. When the measured current is relatively small, connecting the current sensor on the load side rather than the voltage measurement terminals can reduce the impact on measurement accuracy.

Effect of stray capacitance

When measuring a single-phase device, connecting this instrument's current sensor closer to the ground potential of the power source (SOURCE) reduces the effect of stray capacitance within the instrument on measurement accuracy.

		Effect of stray capacitance (current side)	
		Not easily affected	Easily affected
Effect of Instrument Loss	Recommended wiring method when measured current is large		
	Recommended wiring method when measured current is small		

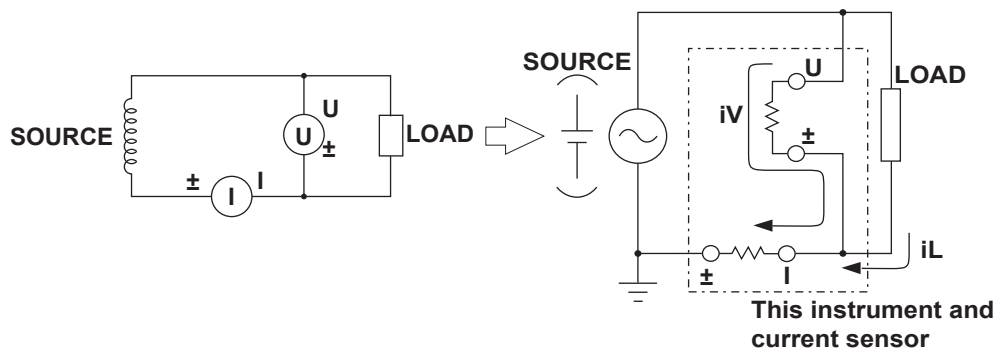
Effect of instrument loss (details)

By connecting the wiring to match to the load, the effect of instrument losses on measurement accuracy can be minimized. For low-frequency power sources (SOURCE) and resistive loads (LOAD), the following points should be considered.

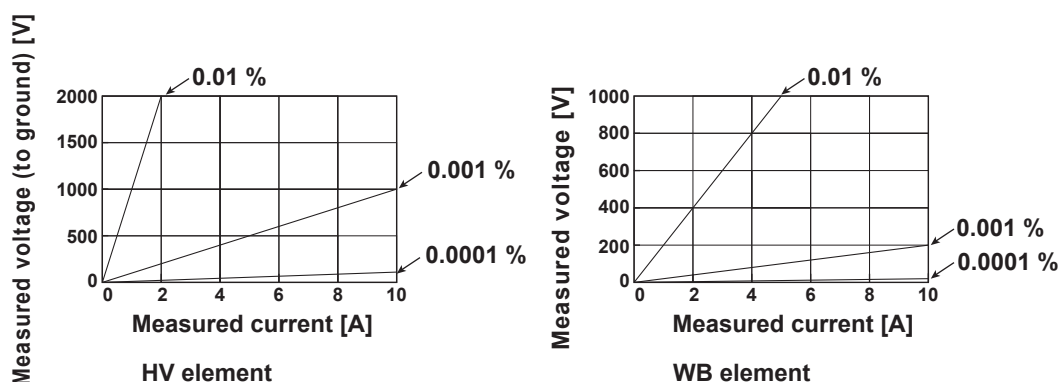
Instrument loss of the voltage measurement circuit

When the voltage measurement circuit is connected to the load side rather than the current measurement circuit side, the instrument loss of the voltage measurement circuit affects the current measurement value and the power measurement value. 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 this instrument's voltage measurement circuit is approximately 10 M Ω for the high-voltage element voltage input terminals (each terminal to ground) and approximately 2 M Ω for the WB element voltage input terminals (between terminals). At 1000 V input (to ground), i_V is approximately 0.1 mA (to ground) at the high-voltage element voltage input terminal and approximately 0.2 mA (between terminals) at the wideband element voltage input terminal. For example, when the measured voltage/current is 1000 V/1 A, the effect on measurement accuracy is 0.01 % for the high-voltage element voltage input terminal and 0.05 % for the wideband element voltage input terminal.

2.7 Wiring for Accurately Measuring a Single-phase Device



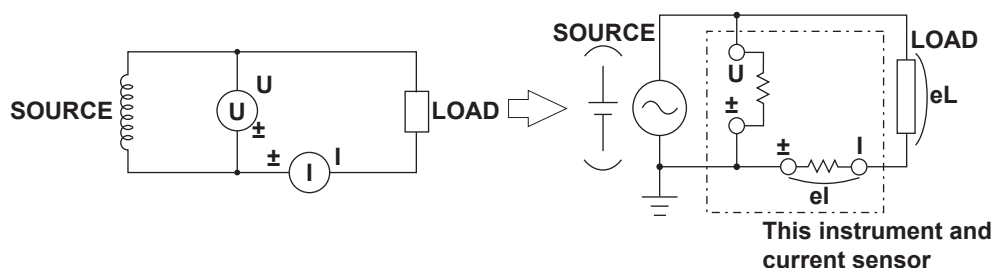
As a reference, the relationships between the voltages and currents that produce effects of 0.01 %, 0.001 %, and 0.0001 % are shown in the figure below.



Instrument loss of the current measurement circuit

When the current measurement circuit is connected to the load side rather than the voltage measurement circuit side, the instrument loss of the current measurement circuit affects the voltage measurement value and the power measurement value. The voltage measurement circuit measures the sum of the load voltage e_L and the current measurement circuit's voltage drop e_I , of which only e_I constitutes the error. The input resistance of the current measurement circuit for this instrument and the current sensor is approximately $1 \mu\Omega$ for the 720931 current clamp probe. At 100 A input, e_I is 0.1 mV.

For example, when the measured voltage/current is 100 V/100 A, the effect on measurement accuracy is 1 ppm.



Effect of stray capacitance (details)

Connecting the current sensor closer to the ground potential of the power source (SOURCE) reduces the effect of stray capacitance (current side) within the instrument on measurement accuracy.

The conductor under test, current sensor, and the case of this instrument are insulated from each other, resulting in the presence of stray capacitance C_s . For the CT1000 AC/DC current sensor and a rod-shaped busbar (28 mm diameter, cylindrical), C_s is approximately 30 pF. The current generated by stray capacitance C_s causes errors.

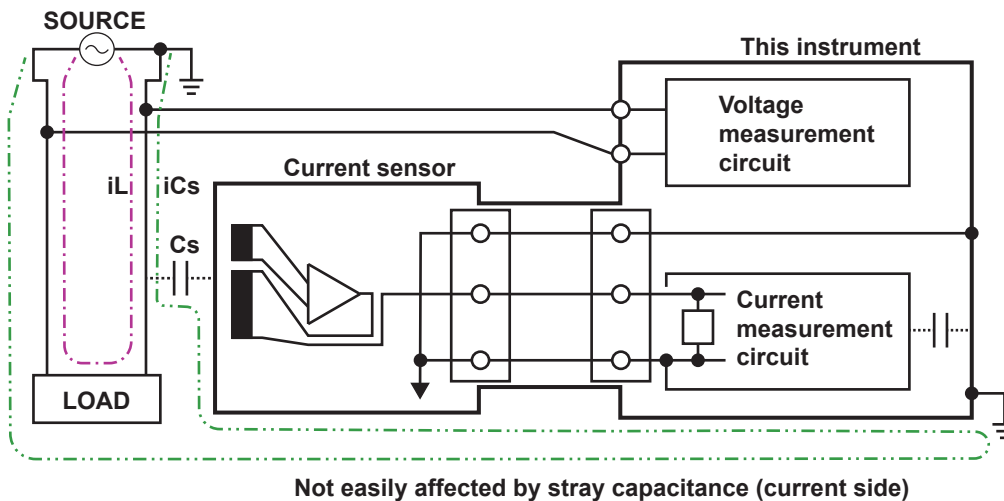
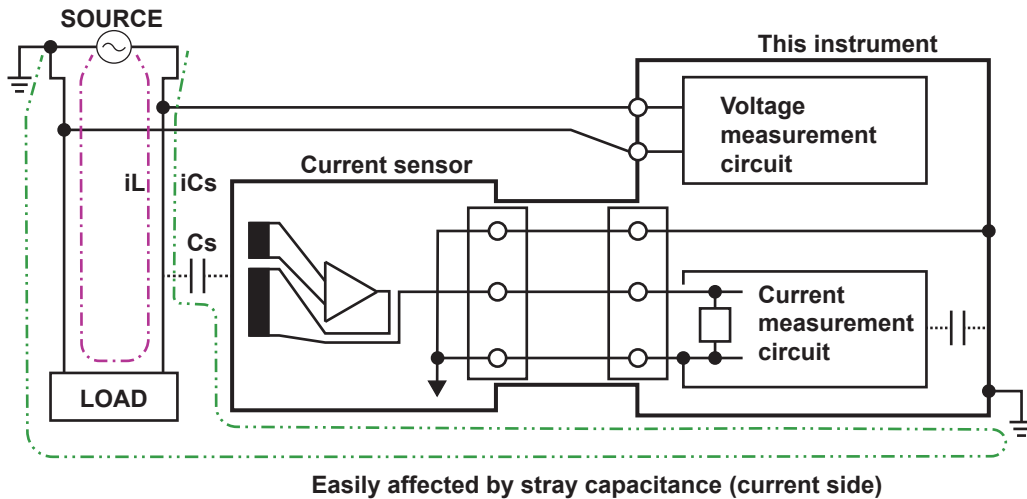
For example, consider a case where one side of the power supply, the current sensor, and the case of this instrument are grounded.

In this case, there are two conceivable current flows, i_L and i_{C_s} where i_L is the load current and i_{C_s} is the current that flows through the stray capacitance. i_L flows through the current measurement circuit, passes through the load, and returns to the power source (shown with a dash-dot line). i_{C_s} 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 dash-dot-dot line).

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

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

2.7 Wiring for Accurately Measuring a Single-phase Device



Because the instrument measures high frequencies, the effects of i_{Cs} cannot be ignored. If you connect the instrument's current input terminal to the side of the power supply (SOURCE) that is close to its earth potential, the instrument's current measurement circuit positive and negative terminals are close to the earth potential, so V_{Cs} becomes approximately zero and very little i_{Cs} flows. This reduces the effect on measurement accuracy.

2.8 Guide for Selecting the Method Used to Measure the Power

Voltage measurement methods

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

HV element

		Voltage at 2000 V or less	Voltage exceeding 2000 V
Voltage wiring	Direct input	→ sec. 2.9	Direct input is not possible.
	VT (voltage transformer)	→ sec. 2.10	

WB element

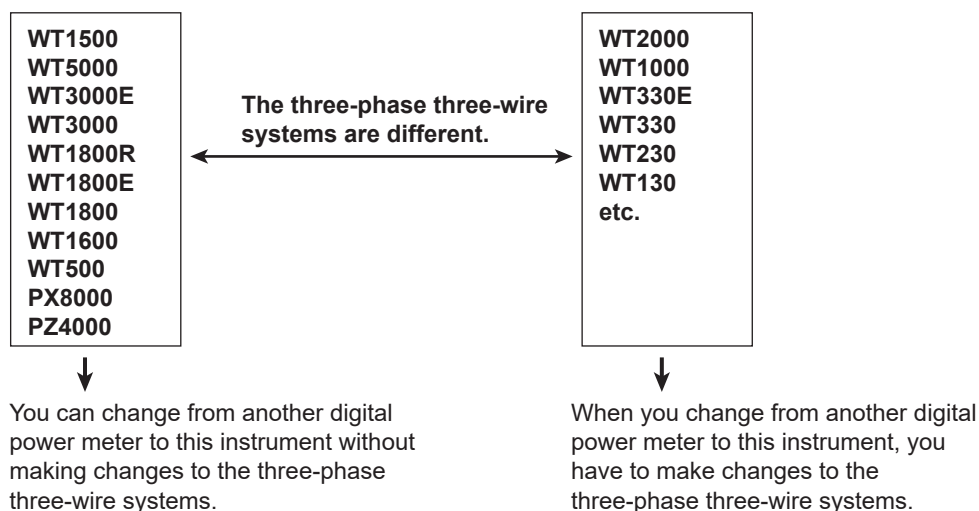
		Voltage at 1000 V or less	Voltage exceeding 1000 V
Voltage wiring	Direct input	→ sec. 2.9	Direct input is not possible.
	VT (voltage transformer)	→ sec. 2.10	

Current measurement methods

Confirm the maximum measurement current, maximum rated voltage, and rated voltage between circuit and ground of the current sensor being used, and operate within these specified ranges. For the wiring procedure, see section 2.9.

Notes on 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 is set to S phase or T phase when measuring the line voltage (see appendix 2 in the user's manual IM WT1501-01EN). 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 (when applying direct voltage)

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

For voltage, connect the measurement cable directly from the circuit under measurement to the voltage input terminals.

For current, measure using current sensors.

Connecting to the input terminal

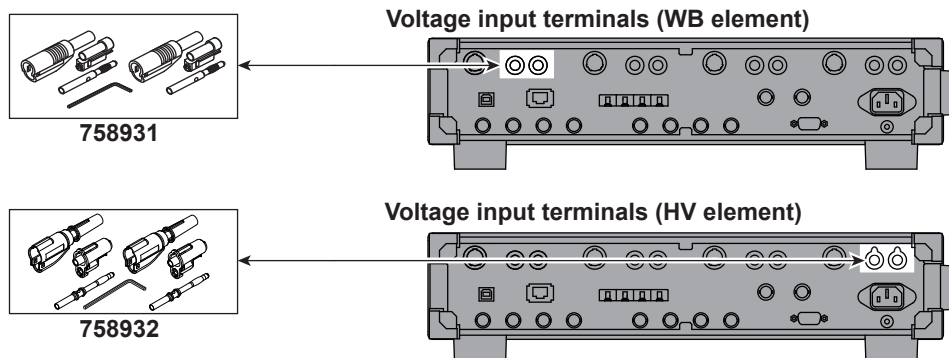
Voltage input terminals

- The voltage input terminals of the WB element are safety banana jacks (female) that are 4 mm in diameter.
- The voltage input terminals of the HV element are safety banana jacks (male) that are 4 mm in diameter.

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

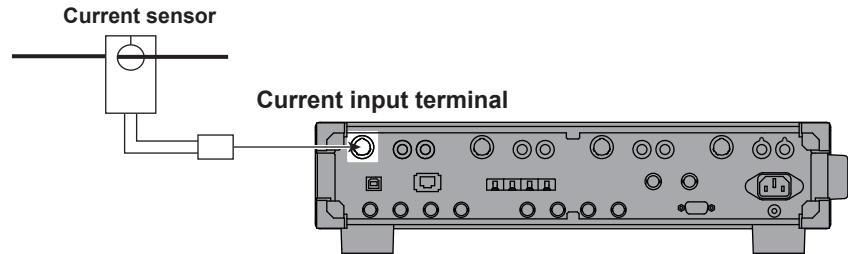
For use with adapters sold separately, see section 2.6.

- 758931 Safety Terminal Adapter: WB element
- 758932 High Voltage Safety Terminal Adapter Set: HV element



Current sensor connection terminal

- The terminal is a round 20-pin connector.
- Connect the appropriate dedicated cable or adapter to the current sensor connection terminal, and then connect the applicable type of current sensor.
- The terminal supplies power to the current sensors and receives signals from them.



The combinations of current sensors that can be connected and the cables/adapters to be used are as follows:

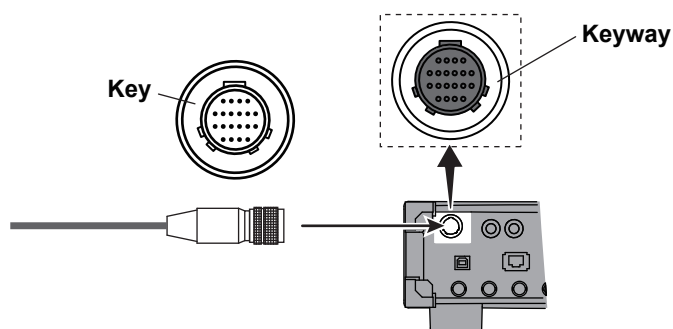
Current sensor	Output type	Power	Cable/adapter to be used
CT60/CT200/CT1000/CT1000A/CT2000A	Current output	±15 V	761964, 761965, 761966 ¹
CT1000S	Voltage output	±12 V	761962
720930/720931	Voltage output	Not required	761963

¹ A combination of model 761954, 761955, or 761956 is required.

Note

- Use only current sensors and current probes specified as accessories for this instrument.
- If you use any item other than an accessory specified in this manual, YOKOGAWA assumes no responsibility for its specifications or for any resulting failures, and such use is not covered by warranty.

Connecting to the round 20-pin connector



Turn off the instrument, and then connect the round 20-pin connector on the instrument to the connector on the dedicated cable or adapter.

Align the connector key with the keyway as shown in the figure, insert the connector straight in as far as it will go, and confirm that it is locked.

Power Supply to the Current Sensor

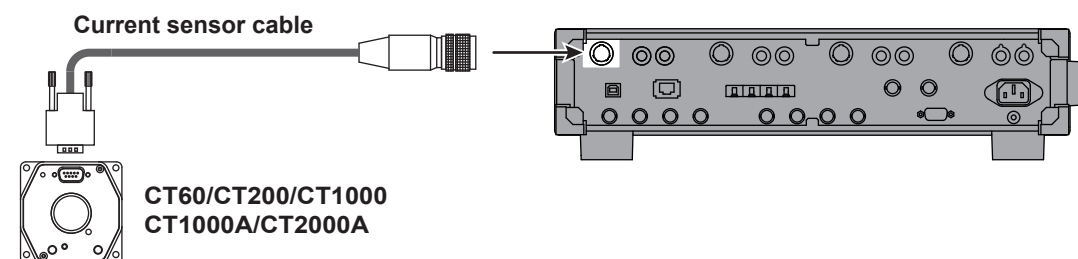
Item	specification
Output voltage	• ± 15 V • ± 12 V
Output current	• 1.8 A/1 output(± 15 V) • 0.8 A/1 output(± 12 V)

When connecting a current sensor that requires power, make sure that the output current shown above is not exceeded. If the overcurrent protection circuit in the instrument's power supply is activated, power to the current probe is shut off.

Connecting a CT60/CT200/CT1000/CT1000A/CT2000A

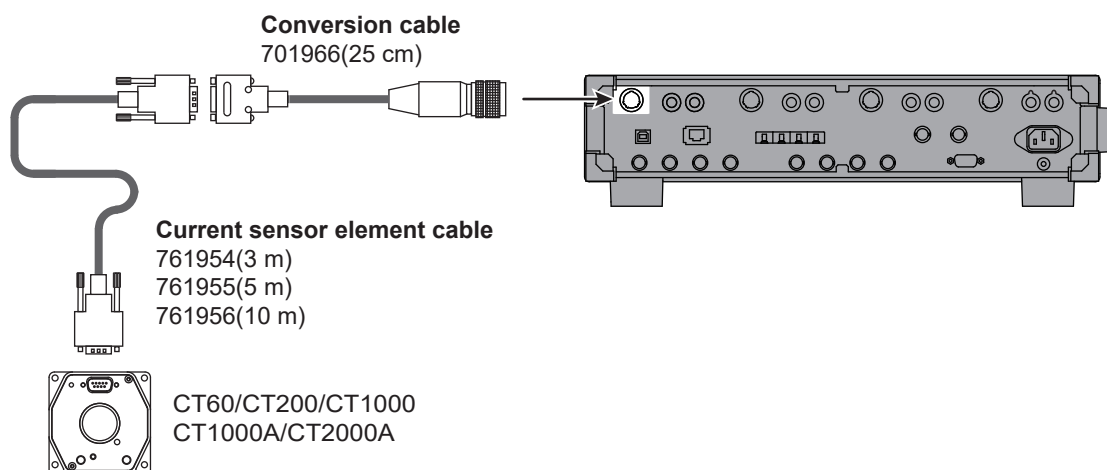
Power can be supplied to YOKOGAWA's AC/DC current sensor CT60/CT200/CT1000/CT1000A/CT2000A.

Connect the CT60/CT200/CT1000/CT1000A/CT2000A to this instrument as follows using the separately sold current sensor cables 761964 (3 m) or 761965 (5 m).



Alternatively, you can connect a CT60, CT200, CT1000, CT1000A, or CT2000A by combining the separately sold 701966 conversion cable (25 cm) with a 761954 (3 m), 761955 (5 m), or 761956 (10 m) current sensor element cable.

Connect the current sensor to the instrument through the 701966 as shown below.



WARNING

Do not connect a current transformer without protection.



CAUTION

- Do not use cables other than the dedicated cables. If you do, the instrument or other devices may malfunction.
- 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 the CT.
- Do not connect any current sensor other than the one specified for this instrument to the current input terminal on the rear panel of this instrument. Otherwise, the instrument or a device connected to the current input terminal may break.

French

**AVERTISSEMENT**

Ne pas brancher de transformateur de courant sans protection.

**ATTENTION**

- N'utilisez pas de câbles autres que les câbles dédiés. Sinon, l'instrument ou d'autres appareils pourraient dysfonctionner.
- Avant de connecter ou de déconnecter un CT de cet instrument, mettez cet instrument hors tension. La connexion ou la déconnexion du CT alors que l'appareil est sous tension peut endommager l'instrument ou le CT.
- Ne connectez aucun capteur de courant autre que celui spécifié pour cet instrument à la borne d'entrée de courant située sur le panneau arrière de cet instrument. Sinon, l'instrument ou un dispositif connecté à la borne d'entrée de courant pourrait tomber en panne.

Note

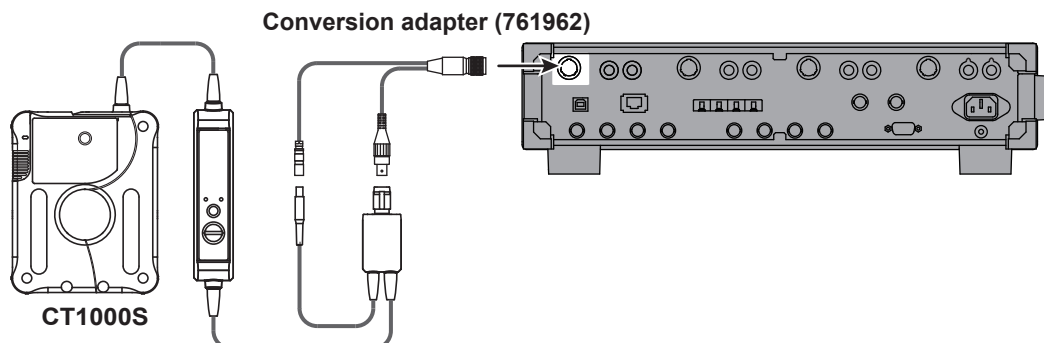
- Warm up the CT60/CT200/CT1000/CT1000A/CT2000A for at least 30 minutes without input.
- With the connection shown above, the common terminal on the secondary side of the current sensor is connected to ground.

Model	Rated current		Output current	Current transformation ratio
	Direct current	Alternating current		
CT60	0 to 60 A	60 Apeak	100.0 mA when the primary current is 60 A	600: 1
CT200	0 to 200 A	200 Apeak	200.0 mA when the primary current is 200 A	1000: 1
CT1000	0 to 1000 A	1000 Apeak	666.6 mA when the primary current is 1000 A	1500: 1
CT1000A	0 to 1000 A	1500 Apeak	666.6 mA when the primary current is 1000 A	1500: 1
CT2000A	0 to 2000 A	3000 Apeak	1000.0 mA when the primary current is 2000 A	2000: 1

For details of CT specifications, refer to their manuals.

Connect to a CT1000S

A 761962 conversion adapter (sold separately) can be used to supply power to YOKOGAWA's CT1000S AC/DC split core current sensor. Connect the 761962 and CT1000S to this instrument as follows:

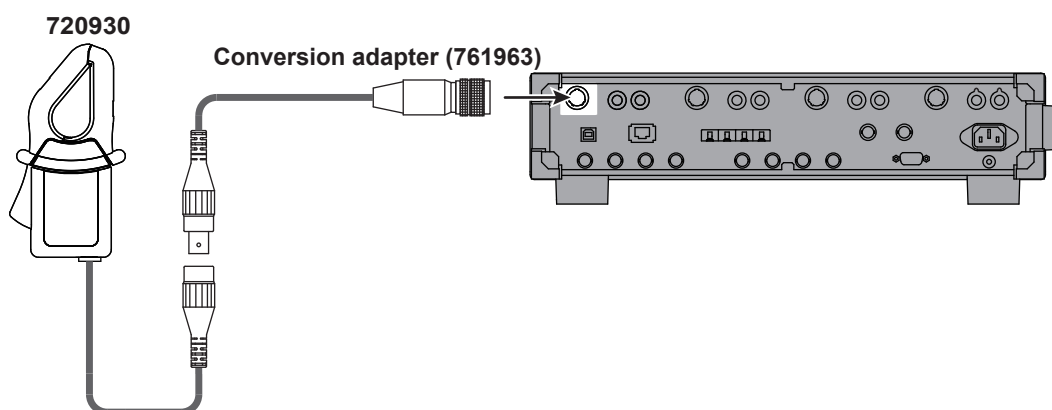


Note

- Warm up the CT1000S for at least 30 minutes without input.
 - With the connection shown above, the common terminal on the secondary side of the current sensor is connected to ground.
-

Connecting the 720930 and 720931

You can connect YOKOGAWA's current clamp probes 720930/720931 using the conversion adapter 761963 (sold separately).



General current sensor handling precautions

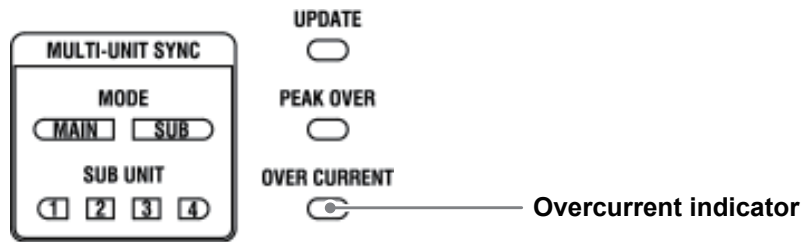
Do not open the secondary side of a current output type current sensor. Doing so may damage the current sensor. Also, follow the current sensor handling precautions in the manual that comes with the current sensor.

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).
-

Current sensor power status display

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



Overcurrent LED

The LED display overcurrent detection for current sensors of elements 1 to 4.

If an overcurrent is detected on a current sensor or probe in one or more elements, the LED blinks red and stops the current sensor power supply for that element.

To resume the power supply, resolve the cause of the overcurrent, and then restart the instrument. If the LED blinks red even after restarting the instrument, repair is required.

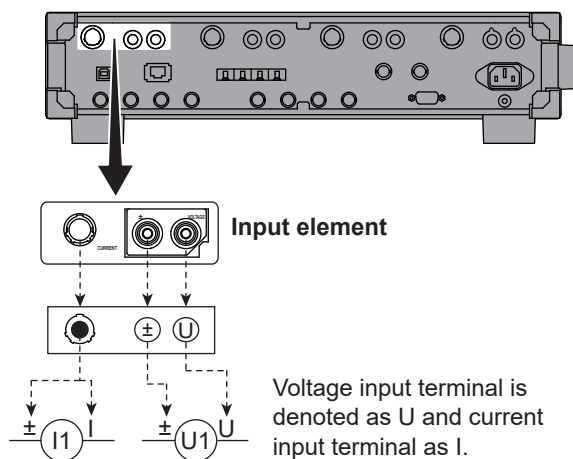
The current sensor power supply state can also be displayed on this instrument's LCD. For details, see section 1.3.

Configuration after connection

Set Sensor Model according to the instructions in section 2.17, "Displaying the Menu for Configuring All Elements," in the user's manual IM WT1501-01EN. If the configuration is not appropriate, readings will not be correct.

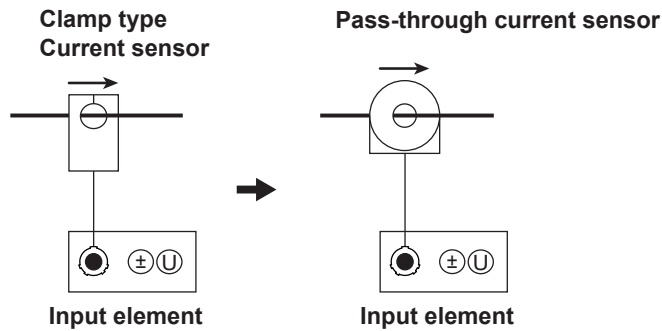
Connecting to this instrument

In the figures on the following pages, the input elements, voltage input terminals, and multi-function connector of this instrument are shown simplified as follows.



2.9 Wiring the Circuit under Measurement (when applying direct voltage)

Also, the wiring example is for when a clamp-type current sensor is connected. When connecting feed-through current sensors (such as the CT series) or current probes, replace the clamp-type current sensor with each respective sensor.



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, replace 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 circuits where the current flows. Use wires that are suitable for the current levels.

French



ATTENTION

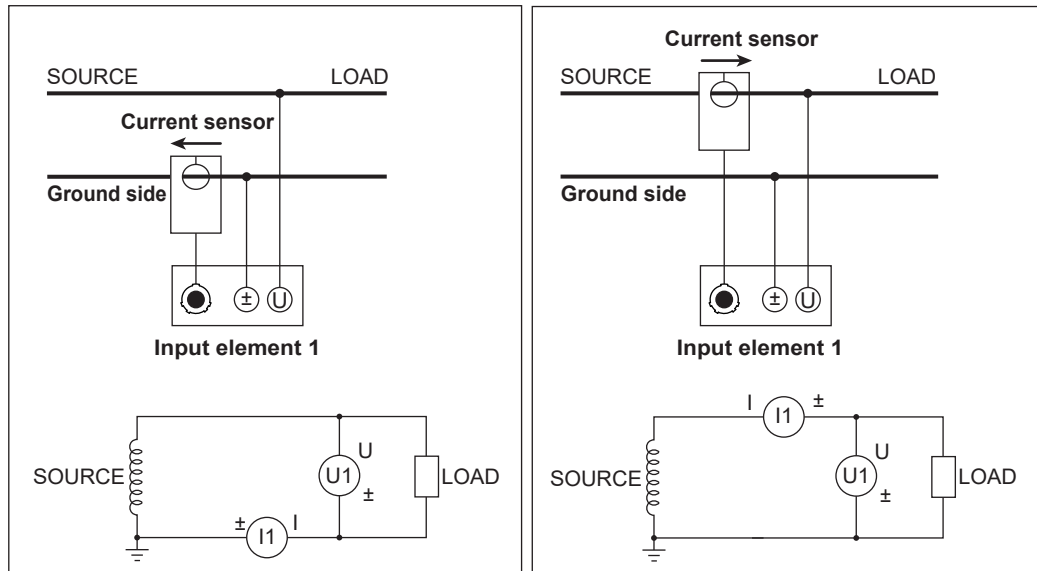
Les lignes épaisses dans les schémas de câblage sont les circuits où circule le courant. Utilisez des fils adaptés aux niveaux de courant.

Note

- Make sure that the polarity is correct when making connections. If the polarity is reversed, the measured current will have the opposite polarity, preventing correct measurement. Take particular care with clamp-on current sensors, as their orientation can easily be reversed when clamping them around the measurement circuit.
- The frequency response and phase characteristics of the current sensor affect the measurement data.
- For more accurate measurement of apparent power and power factor in an unbalanced three-phase circuit, we recommend using the three-phase three-wire system with a three-voltage three-current method [3P3W (3V3A)].

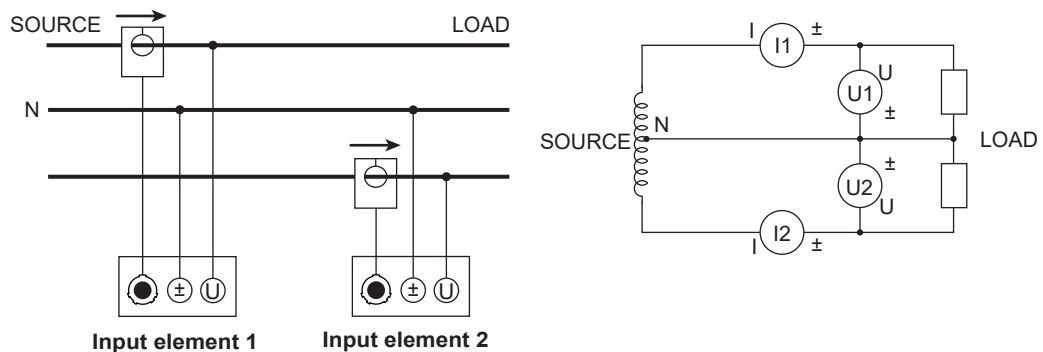
Wiring examples of single-phase two-wire systems (1P2W)

If four input elements are available, four single-phase two-wire systems can be configured. To decide which of the wiring systems shown below you should use, see section 2.7.



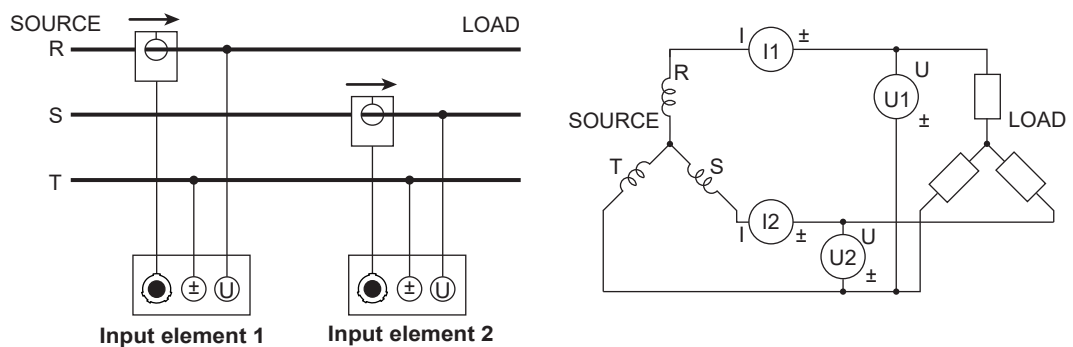
Wiring example of a single-phase three-wire system (1P3W)

If four input elements are available, two single-phase three-wire systems can be configured.



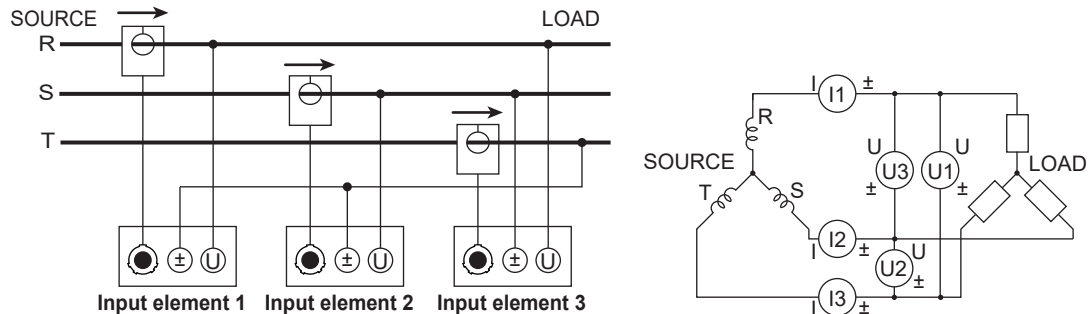
Wiring example of a three-phase three-wire system (3P3W)

If four input elements are available, two single-phase three-wire systems can be configured.



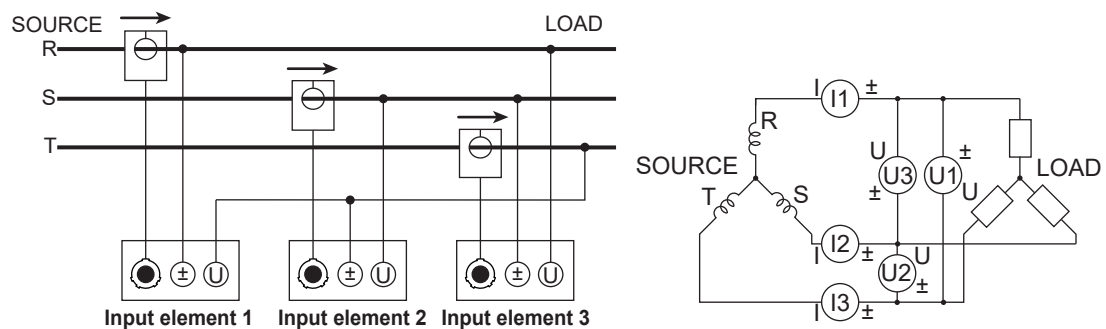
Wiring example of a three-phase three-wire system that uses a three-voltage three-current method [3P3W (3V3A), 3P3W (3V3A) → 3P4W]

If three or more input elements are available, one three-phase three-wire system that uses a three-voltage three-current method can be wired.



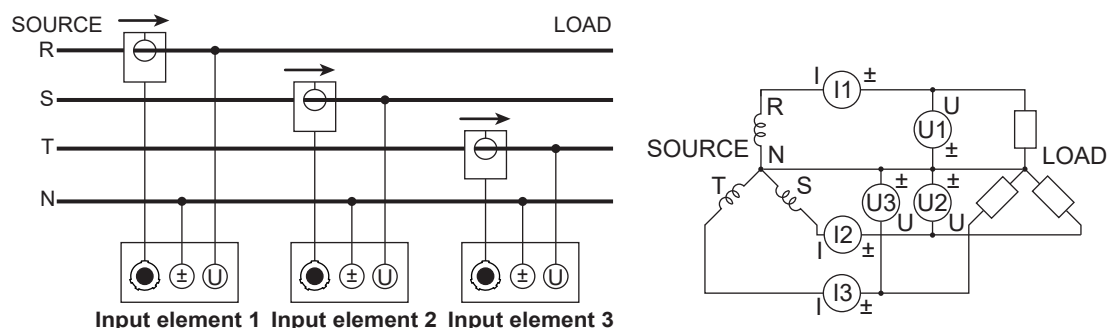
Wiring example of a three-phase three-wire system that uses a three-voltage three-current method [3P3W (3V3AR), 3P3W (3V3AR) → 3P4W]

If three or more input elements are available, one three-phase three-wire system that uses a three-voltage three-current method can be wired.



Wiring example of a three-phase four-wire system [3P4W, 3P4W → 3P3W (3V3AS)]

If three or more input elements are available, one three-phase four-wire system can be wired.



Note

For the relationship between the wiring system and how measurement and calculation values are determined, see appendix 1, "Symbols and Determination of Measurement Functions," in the user's manual IM WT1501-01EN.

2.10 Wiring the Circuit under Measurement (when applying voltage via VT)

Connect the measurement cable from the external voltage transformer (VT) to the voltage input terminal of the input element.

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

HV element

When the maximum voltage of the circuit under measurement exceeds 1500 VAC RMS or 2000 VDC, you can perform measurements by connecting an external VT to the voltage input terminal.

WB element

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

For current, measure using current sensors. For details, see section 2.9.

Connecting to the input terminal

Voltage input terminals

- The voltage input terminals of the WB element are safety banana jacks (female) that are 4 mm in diameter.
- The voltage input terminals of the HV element 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.

For using the optional accessories as follows, see section 2.6.

- Using the 758931 Safety Terminal Adapter with a WB element
- Using the 758932 High Voltage Safety Terminal Adapter Set with a HV element

Current input terminal

- The terminal is a circular 20-pin connector.
- Connect a dedicated cable or adapter to the current input terminal to connect various current sensors. For details, see section 2.9.

General VT handling precautions

Do not short the secondary side of a VT. Doing so may damage it. Also, follow the VT handling precautions in the manual that comes with the VT.

2.10 Wiring the Circuit under Measurement (when applying voltage via VT)

Note

- The thick lines on the wiring diagrams are the circuits 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 affect the measured data.
 - For safety reasons, the common terminals (+/-) of the secondary side of the VT are grounded in the wiring diagrams in this section. However, the necessity of grounding and the grounding location (ground near the VT 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 described below, the instrument is shown in simplified form. For details, see section 2.9.



CAUTION

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

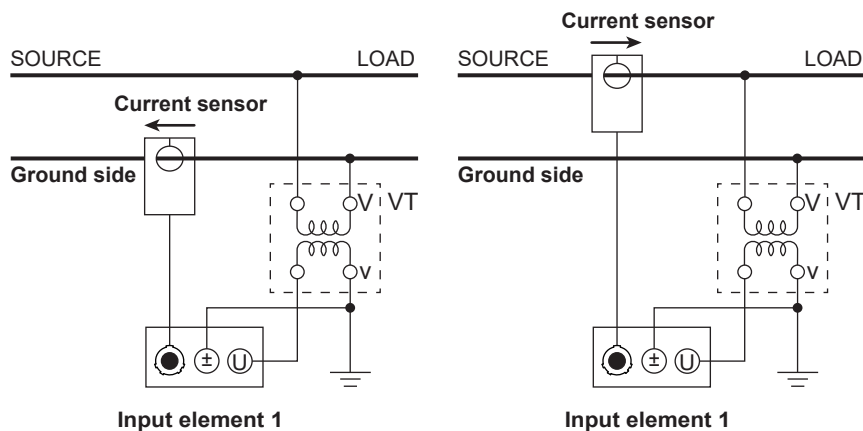
French



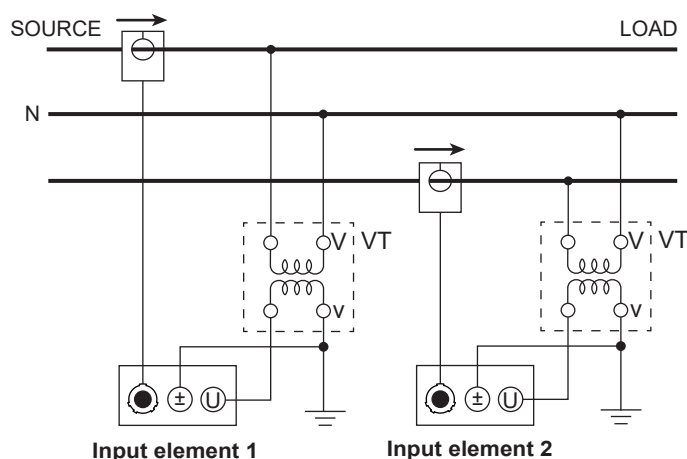
ATTENTION

Les lignes épaisses dans les schémas de câblage sont les circuits où circule le courant.
Utilisez des fils adaptés aux niveaux de courant.

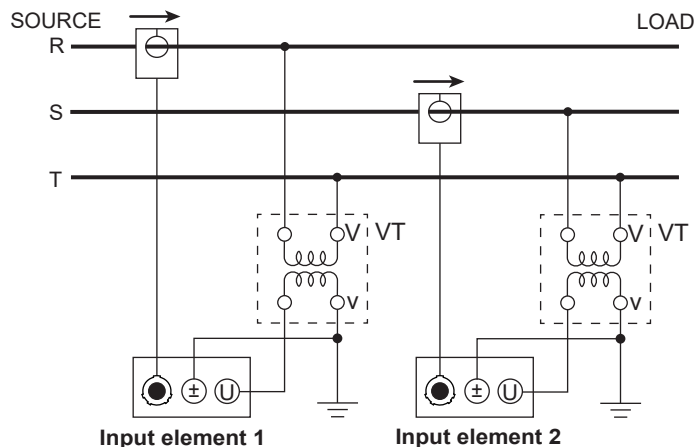
Wiring example of single-phase two-wire systems (1P2W) with a VT



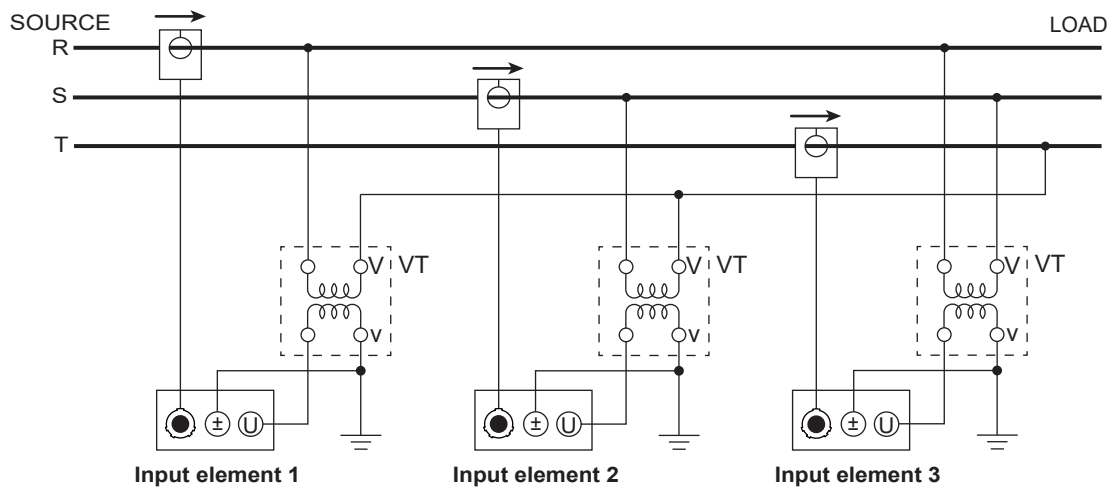
Wiring example of a single-phase three-wire system (1P3W) with VTs



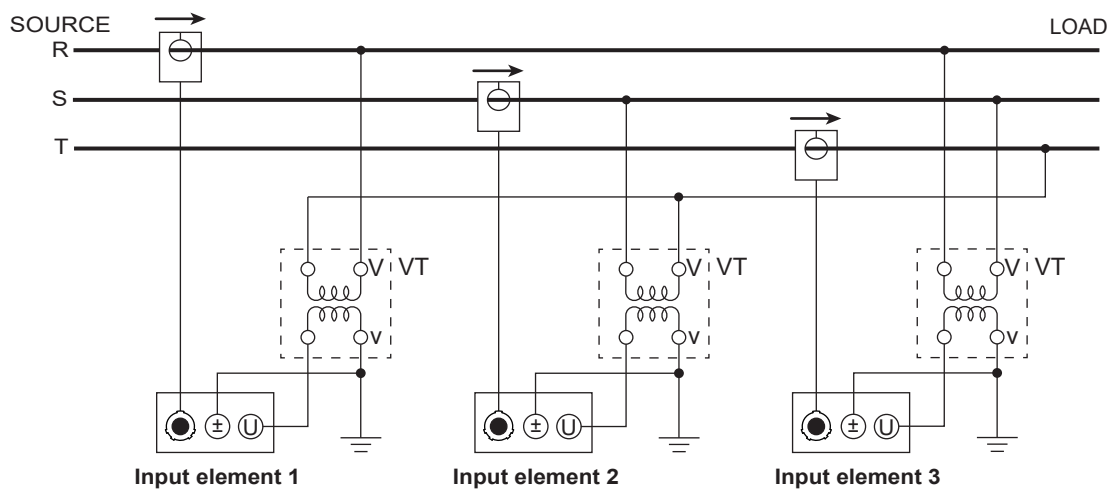
Wiring example of a three-phase three-wire system (3P3W) with VTs



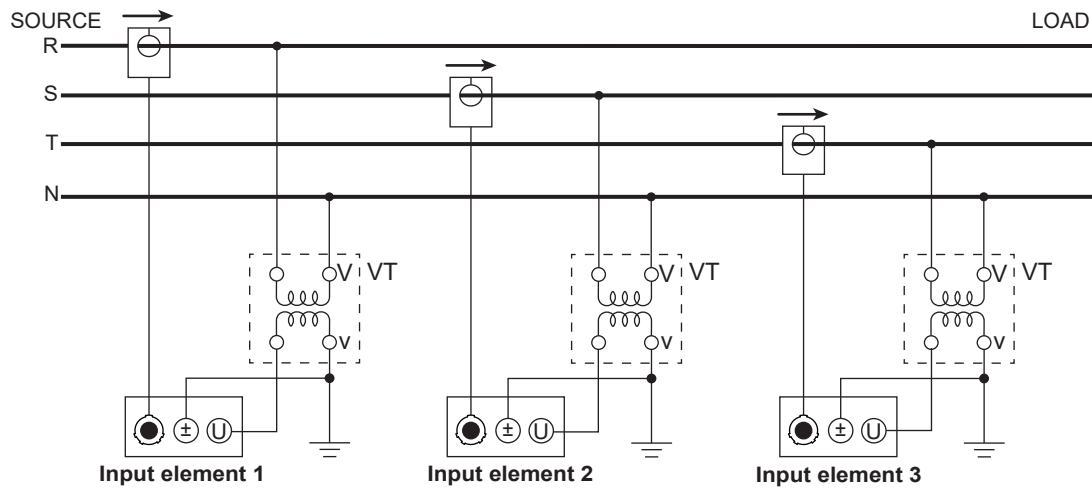
Wiring example of a three-phase three-wire system that uses a three-voltage three-current method [3P3W (3V3A), 3P3W (3V3A) → 3P4W] with VTs



Wiring example of a three-phase three-wire system that uses a three-voltage three-current method [3P3W (3V3AR), 3P3W (3V3AR) → 3P4W] with VTs



Wiring example of a three-phase four-wire system [3P4W, 3P4W → 3P3W (3V3AS)] with VTs



Note

For the relationship between the wiring system and how measurement and calculation values are determined, see appendix 1, "Symbols and Determination of Measurement Functions," in the user's manual IM WT1501-01EN.

2.11 Connecting to a Current Sensor (CT Series) and Using the Phase Correction Function

Phase errors can be corrected and accurate power can be calculated by connecting to a current sensor and using the phase correction function.

Propagation delay correction

When the propagation delay is corrected, phase errors can be minimized over the bandwidth up to the frequency corresponding to the propagation delay on each current sensor.

The following table shows the frequencies corresponding to propagation delay for the CT series. When the CT series is connected to this instrument, the frequency and phase error are set automatically. For details, see section 4.2, "Setting the Voltage Range and Current Range" in the user's manual.

Frequency and phase error corresponding to the propagation delay

Current sensor, current probe	Frequency [kHz]	Phase error [°]
CT60	10	-0.252
CT200	10	-0.252
CT1000	5	-0.198
CT1000A	5	-0.018
CT1000S	10	-1.746
CT2000A	10	-0.144

- The phase error is negative for phase lag.
- The above settings apply to all cases regardless of the current sensor cable 701964 (3 m), 701965 (5 m) or conversion adapter 701966 (0.25 m).

Note

Propagation delay

The propagation delay of each current sensor (CT series) is as follows:

Current sensor, current probe	Propagation delay (typical) [ns]
CT60	70
CT200	70
CT1000	110
CT1000A	10
CT1000S	485
CT2000A	40

Conditions

- Using current sensor cable 701964/701965, or conversion adapter 701966
- No influence from external magnetic fields or conductor position.
- The input resistance of the current measurement terminal is set to a CT preset.

2.12 Connecting Cables to the Motor/Auxiliary Input Connectors (option)



CAUTION

Only apply signals that meet the following specifications. Excessive voltage or the like may damage the instrument.

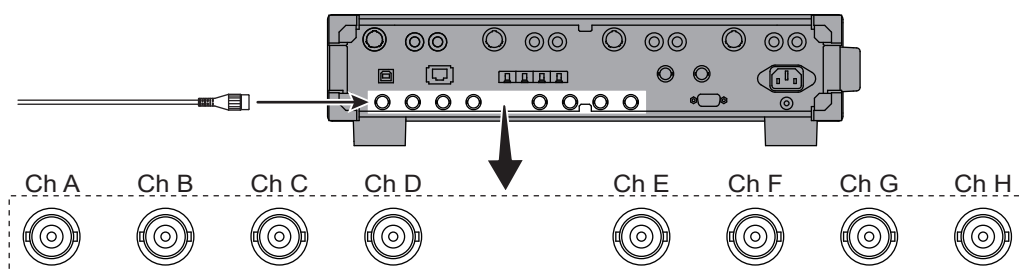
French



ATTENTION

Les signaux ne correspondant pas aux spécifications risquent d'endommager cet instrument, à cause de facteurs tels qu'une tension excessive.

Motor/Auxiliary input connector



You can apply the following types of signals. Apply the signal using a safety BNC cable (sold separately).

- Signal output from a torque meter
 - A DC voltage (analog signal) or pulse signal proportional to motor torque
- Signals output from a rotary encoder
 - A DC voltage (analog signal) or pulse signal proportional to motor speed
- Signals output from a resolver
 - Resolver excitation signal (Carrier), sine-phase signal (Sine), and cosine-phase signal (Cosine)
- A DC voltage signal (analog signal) output from a sensor

Input the signals above according to the specifications in the relevant chapters of this manual.

2.12 Connecting Cables to the Motor/Auxiliary Input Connectors (option)

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 M Ω
Maximum allowable input	± 22 V
Continuous maximum common-mode voltage	± 42 V _{peak} or less

Pulse inputs

Item	Specifications
Connector type	Isolated BNC
Frequency range	2 Hz to 1 MHz
Amplitude input range	± 12 V _{peak}
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 Ω
Continuous maximum common-mode voltage	± 42 V _{peak} or less

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

* See the user's manual IM WT1501-01EN.

When using the motor evaluation function for encoders

Motor evaluation function 1

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

Motor evaluation function 2

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

Terminal for pulse input

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

When using the motor evaluation function for resolvers

Motor evaluation function 1

Input terminal	Motor configuration	
	Single Motor(Speed:Resolver)	Auxiliary
ChA	Torque signal 1	External signal 1
ChB	Resolver excitation signal (Carrier)	External signal 3
ChC	Resolver sine signal	External signal 2
ChD	Resolver cosine signal	External signal 4

Motor evaluation function 2

Input terminal	Motor configuration	
	Single Motor (Speed:Resolver)	Auxiliary
ChE	Torque signal 3	External signal 5
ChF	Resolver excitation signal (Carrier)	External signal 7
ChG	Resolver sine signal	External signal 6
ChH	Resolver cosine signal	External signal 8

2.13 Connecting a Cable to the CAN/CAN FD Signal Output Connector (Option)



CAUTION

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

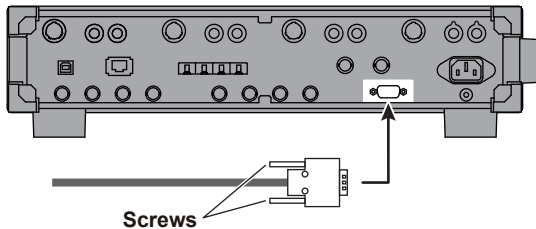
French



ATTENTION

- Ne court-circuitez pas et n'appliquez pas de tension externe à la borne de sortie de signal CAN/CAN FD. Cela pourrait endommager l'instrument.
- Lorsque vous connectez la sortie du signal CAN/CAN FD à un autre appareil, ne connectez pas la mauvaise broche de signal. Cela pourrait endommager cet instrument ou l'instrument connecté.

On models with the /CN1 option, To output CAN/CAN FD bus signals, connect a cable to the CAN/CAN FD D-sub connector.

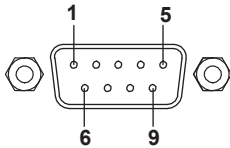


When you connect a cable to the D-sub connector, be sure to tighten the screws to ensure that the cable is connected securely.

Connector pinout

The pinout of the D-sub connector (9 pin, male) is shown below.

Pin arrangement



CAN/CAN FD signal output terminals		
Pin No.	Signal Name	Function
1	(NC)	Not used (cannot be connected to)
2	CAN_L	CAN low signal
3	GND	Ground (COM)
4	(NC)	Not used (cannot be connected to)
5	(NC)	Not used (cannot be connected to)
6	GND	Ground (COM)
7	CAN_H	CAN high signal
8	(NC)	Not used (cannot be connected to)
9	(NC)	Not used (cannot be connected to)

* One-inch screws (number 4-40 UNC) are used.

Note

The connector shell is connected to the case potential (earth) of the instrument. Pins 3 and 5 are connected and are isolated from the chassis ground (earth) of this instrument.

2.14 Installing a Optical Transceiver Module and Connecting an Optical Fiber Cord (multi-unit synchronization, option)



CAUTION

When using multi-unit synchronization, connect the main unit and all the sub units to be synchronized with optical fiber cords first and then execute the multi-unit synchronization connection procedure. The instrument may not operate properly if you insert or remove optical transceiver modules or optical fiber cords after executing the connection procedure.

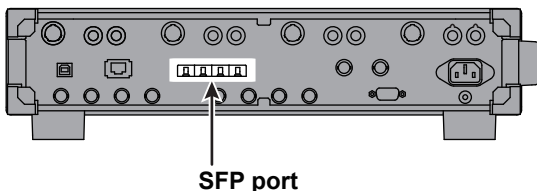
French



ATTENTION

Lors de l'utilisation de la synchronisation des multiunités, connecter d'abord l'unité principale et toutes les sous-unités à synchroniser avec des cordons de fibre optique, ensuite exécuter la procédure de connexion de synchronisation des multiunités. L'instrument ne pourrait pas fonctionner correctement si vous insérez ou retirez des modules d'émetteur-récepteur optique ou des cordons de fibre optique après avoir exécuté la procédure de connexion.

On models with the /SY1 option, multiple units of this instrument can be connected.



Optical port	SFP port
Transfer rate	2.125Gbps
Port position	Rear panel
Number of ports	4
Maximum cable length	300 m
Purpose	Multi-unit synchronization operation (up to five units)

Note

Attach a 720941 optical transceiver module, an accessory sold separately, to this instrument's SFP port. If you use a different optical transceiver module, the instrument's functions and performance are not guaranteed.

Installing the optical transceiver module



CAUTION

- Be extremely careful of static electricity when you install or remove optical transceiver modules. Electrostatic discharges during the installation or removal of these modules may cause them to malfunction.
- Do not install or remove optical transceiver modules while optical fiber cords are connected to them. Doing so may damage the instrument.
- Do not install or remove optical transceiver modules during measurement. This may cause the instrument to malfunction or fail. Turn off the power to the instrument before installing or removing optical transceiver modules..

French

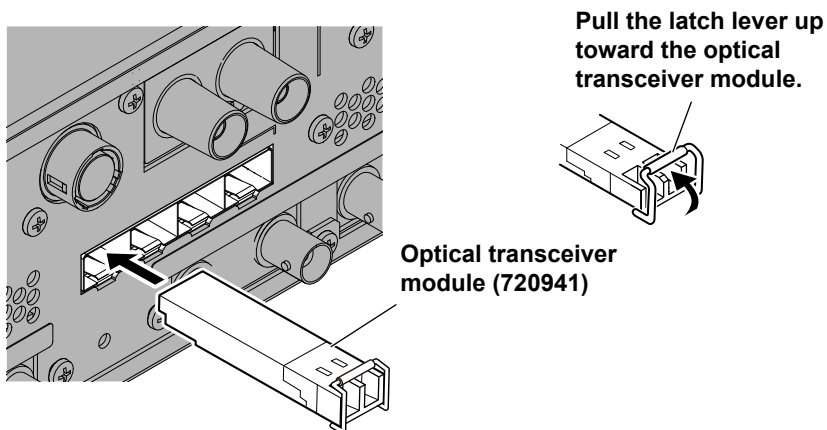


ATTENTION

- Se méfier extrêmement de l'électricité statique lors d'installer ou retirer des modules d'émetteur-récepteur optiques. La décharge électrostatique lors de l'installation ou du retrait de ces modules pourrait causer leur dysfonctionnement.
- Ne pas installer ou ne pas retirer les modules d'émetteur-récepteur optique lorsque des cordons de fibre optique y sont connectés. Cela pourrait endommager l'instrument.
- N'installez pas et ne retirez pas de modules émetteurs-récepteurs optiques pendant la mesure. Cela pourrait provoquer un dysfonctionnement ou une défaillance de l'instrument. Mettez l'instrument hors tension avant d'installer ou de retirer des modules émetteurs-récepteurs optiques.

How to Install the optical transceiver module

1. Make sure that the instrument's power switch is turned off.
2. Raise the latch lever of the optical transceiver module as shown below.
A protection cover is attached to the optical transceiver module (720941), an accessory sold separately. Remove it when connecting the optical fiber cord.
3. Check that the optical transceiver module is in the correct orientation, and slowly insert the module into the instrument's SFP port.
4. Push the optical transceiver module in until you hear a click.



Note

When connecting the main unit and sub unit, connect them as follows.

Main unit

Use the four SFP ports in order, starting from the leftmost SFP port.

Sub unit

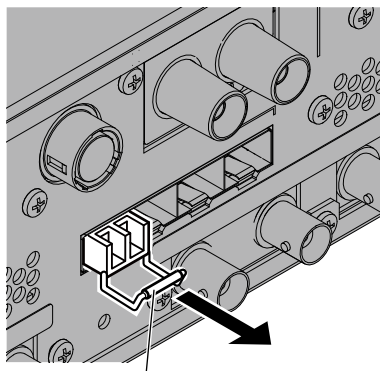
Be sure to use the leftmost SFP port out of the four available SFP ports.

Do not install optical transceiver modules in unused SFP ports on either the main unit or sub-unit.

If the above connection conditions are not met, even if you attempt a multi-unit synchronization connection, a connection error will occur, and the synchronization state will return to OFF.

How to remove the optical transceiver module

1. Make sure that the instrument's power switch is turned off.
If an optical fiber cord is connected, be sure to remove it.
2. Pull the latch lever down toward you to unlock it.
3. Pull the optical transceiver module straight out.



Push the latch lever toward you.

Connecting an optical fiber cord



WARNING

- If optical transceiver modules are installed in the instrument, light is emitted from the optical ports when the instrument is turned on. Do not disconnect the connected optical fiber cord. Visual impairment may occur if the light enters the eye.



CAUTION

- Do not pull, twist, or bend optical fiber cords with excessive force. Doing so may break the cord.
- Insert the optical fiber cord connector slowly and straight into the optical port by holding the connector part. If you shake the connector to the left and right or force it into the port, the connector or optical port may be damaged.

French



AVERTISSEMENT

- Si des modules d'émetteur-récepteur optiques sont installés dans l'instrument, de la lumière est émise par les orifices optiques lorsque l'instrument se démarre. Ne pas déconnecter le cordon de fibre optique connecté. Une déficience visuelle pourrait se présenter si la lumière pénètre dans l'oeil.



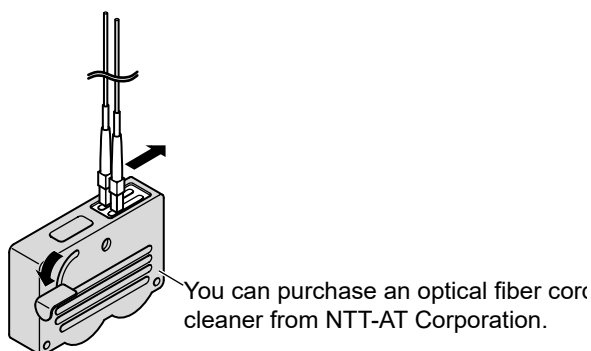
ATTENTION

- Ne pas tirer, ne pas tordre ou ne pas plier les cordons de fibre optique avec une force excessive. Cela pourrait casser le cordon.
- Insérer lentement et droit le connecteur du cordon de fibre optique dans l'orifice optique en tenant le connecteur. Si vous secouez le connecteur vers la gauche et la droite ou si vous le forcez dans l'orifice, le connecteur ou l'orifice optique pourrait être endommagé.

Clean the connector end face

Clean the connector end face of the optical fiber cord before connecting it to the instrument. If dust is adhered to the connector end face, it may damage the optical port. If this happens, the instrument will not be able to make correct measurements.

1. Firmly press the connector end face of the optical fiber cord against the cleaning surface of the cleaner.
2. With the end face pressed, rub it several times, turning it in small amounts.
3. With the end face pressed, slide it along the cleaning surface.
4. Repeat steps 1 to 3.

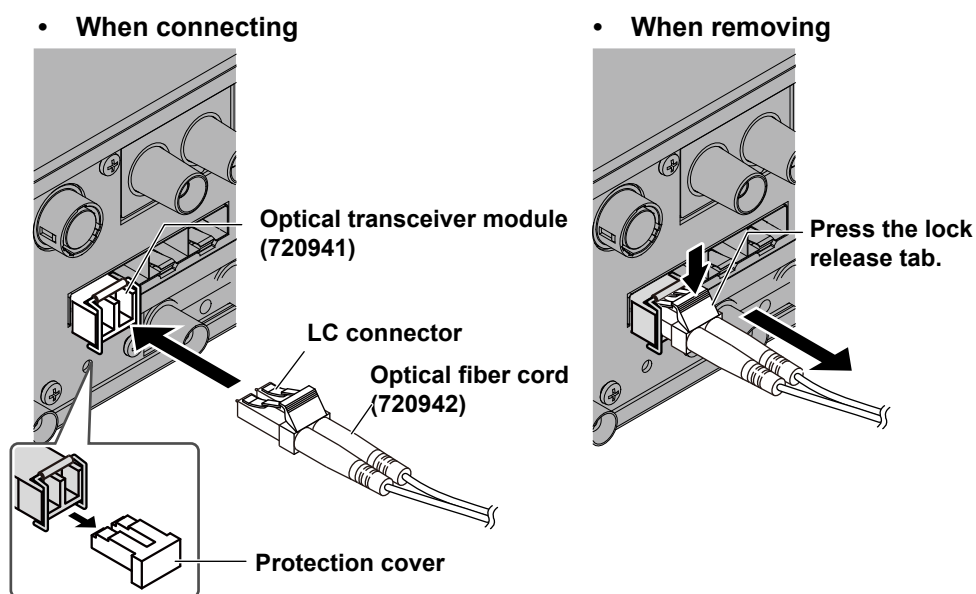


Note

Connect 720942 optical fiber cords, sold separately, to SFP ports that have 720941 optical transceiver modules, which are also accessories sold separately, installed. When connecting an off-the-shelf optical fiber cord, use a multi-mode LC connector type cord (up to 300 m). Single-mode optical fiber cords cannot be used.

How to connect an optical fiber cord

1. Make sure that the instrument's power switch is turned off.
2. Make sure that the fiber optic cord connector is oriented correctly, and then slowly insert it into the fiber optic module installed in the instrument.
 - For details on how to install the optical transceiver module, see page 2-47.
 - If a protection cover is attached to the optical transceiver module, remove it.
3. Push the connector until you hear a click.
4. When removing the optical fiber cord, pull the connector out slowly while pressing the lock release tab.

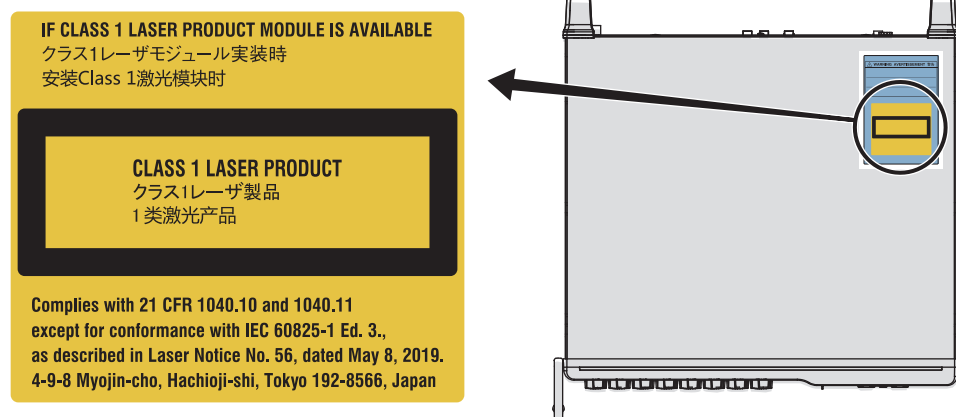


Setting up synchronized measurements across multiple units

For settings and operation of synchronized measurements with multiple units, see chapter 17 in the user's manual IM WT1501-01EN.

Safety precautions for laser products

When the optical transceiver module is installed in this instrument, it qualifies as a class 1 laser product as defined by IEC 60825-1:2014 Safety of Laser Products—Part1: Equipment Classification, and Requirements. In addition, this module complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3, as described in Laser Notice No. 56, dated May 8, 2019.



EN 60825-1:2014+A11:2021, IEC 60825-1:2014, GB/T 7247.1-2024

Laser specifications

SFP Optical Transceiver Module (720941)

Class	Center wavelength	Maximum output power*	Beam divergence angle (all angles @ 1/e ²)	Pulse duration and repetition frequency	Supplier code
1	850 nm	0.7 mW	20 deg	CW	FTLF8519P3BNL

* Under single fault conditions.

Laser classes differ depending on the standard number and year. Take safety measures according to the laser class corresponding to standard number and year of the country or region that the instrument will be used in.

If the instrument is used in a manner not specified in this manual, the protection provided by the instrument may be impaired. YOKOGAWA assumes no liability for the customer's failure to comply with these warnings and requirements.

2.15 Connecting a Cable to the External Clock Input Connector



CAUTION

Only apply signals that meet the following specifications. Excessive voltage or the like may damage the instrument.

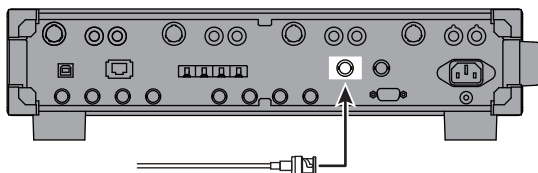
French



ATTENTION

Les signaux ne correspondant pas aux spécifications risquent d'endommager cet instrument, à cause de facteurs tels qu'une 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 to 5 V)

To apply a sync source that determines the measurement period

Item	Specifications
Frequency range	0.1 Hz to 1 MHz
Input waveform	50 % duty cycle rectangular wave

To apply a PLL source during harmonic measurement

Item	Specifications
Frequency range	0.1 Hz to 2.6 kHz
Input waveform	50 % duty cycle rectangular wave

To apply a trigger source for displaying waveforms

Item	Specifications
Input logic	Negative logic, falling edge
Minimum pulse width	1 μ s
Trigger delay	(Within 1 μ s + 3 sample cycles)

2.16 Connecting a Cable to the External Start Signal I/O Connector



CAUTION

- When the instrument is set to master, do not apply external voltage to the external start signal input/output connector (MEAS. START). Doing so may damage the instrument.
- When the instrument is set to slave, only apply signals that meet the following specifications to the external start signal I/O connector. Excessive voltage or the like may damage the instrument.

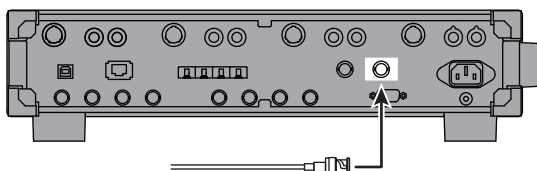
French



ATTENTION

- Lorsque l'instrument est réglé sur maître, n'appliquez pas de tension externe au connecteur d'entrée/sortie du signal de démarrage externe (DÉMAR. MESURE). Cela pourrait endommager l'instrument.
- Lorsque l'instrument est configuré en mode esclave, appliquez uniquement des signaux qui répondent aux spécifications suivantes au connecteur d'E/S du signal de démarrage externe. Une tension excessive, ou l'équivalent, pourrait endommager l'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 output signal delay	Within 1 μ s	Applies to the master
Measurement start delay	Within 2 μ s	Applies to slaves

Note

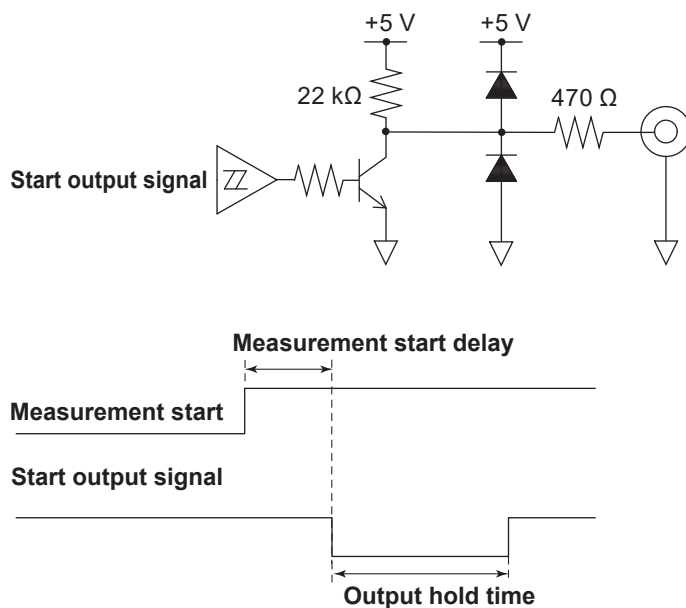
The measurement of the master and slave units cannot be synchronized under the following conditions:

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

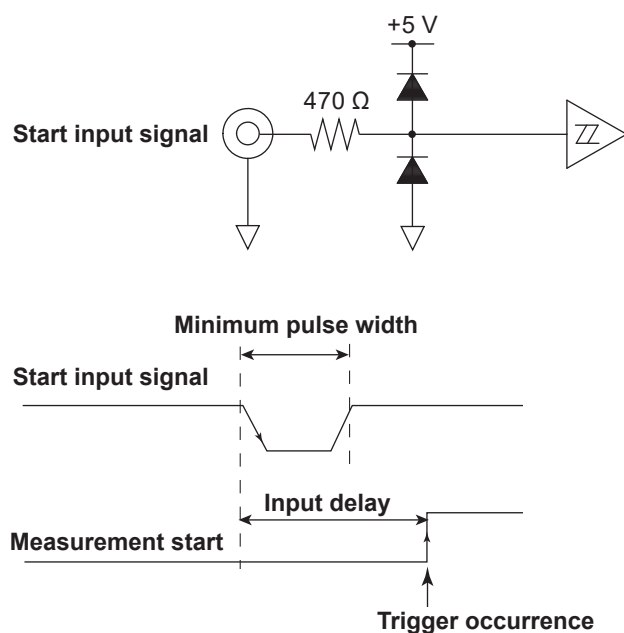
Follow the procedure below to hold values during synchronized measurement.

- To hold the display, hold the display on the master first.
- To release the hold, release the hold on the slaves first.

External start signal output circuit and timing chart



External start signal input circuit and timing chart



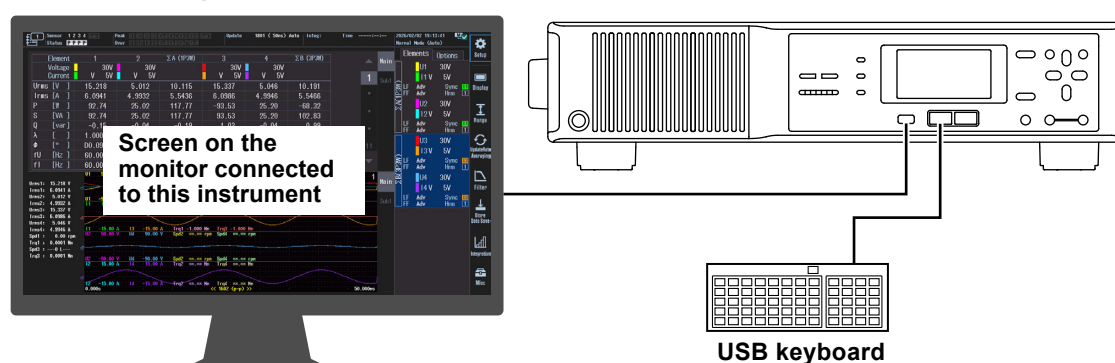
3.1 Operating the Instrument via a Monitor

The following methods are available for displaying the setup menu and for displaying measured data.

- Connecting a monitor to this instrument
- Using the web server feature
- Using WTVIEWerEfree

Some functions of this instrument can be configured on the display screen. For details, see section 1.3.

Connecting a monitor to this instrument



By connecting a monitor to this instrument, you can display the setup menu and measured data.

Connecting to a monitor

Connect this instrument and the monitor using an USB cable.

Note

The USB cable can be connected to or disconnected from the instrument and the monitor, regardless of whether their power is on or off.

The setup menu displayed on the monitor can be operated using a USB keyboard connected to the instrument.

If the monitor has touch functionality, you can operate the instrument by touching the screen.

For details, see chapter 2 in the User's Manual (IM WT1501-01EN).

Switching key control

You can use the KEY TO EXT MONITOR key to switch which device the following keys control.

- Arrow keys (▶◀▲▼ keys)
- SET key
- ESC key
- MENU key

Each time you press KEY TO EXT MONITOR, control of the above key switches between the instrument's LCD screen and the external monitor.

KEY TO EXT MONITOR key	Controlled device
Off	Instrument's LCD screen
Lit blue	External monitor

Responses to key and touch operations

The responses to key operations on the instrument and touch operations on the external monitor are as follows.

Key operation on the instrument	Touch operation on the external monitor	Instrument response
Press the arrow keys	---	Selects an item (Moves the cursor)
Press SET	Tap	Confirms or executes
Press ESC	Tap the  button (upper right of the menu)*	Closes the menu
Press the arrow keys while the cursor is at the edge of the display area	Slide	Scrolls the display

* The instrument responds when the finger is released from the screen.

When an external monitor is connected via USB, KEY TO EXT MONITOR lights, and the instrument keys are automatically switched to the external monitor.

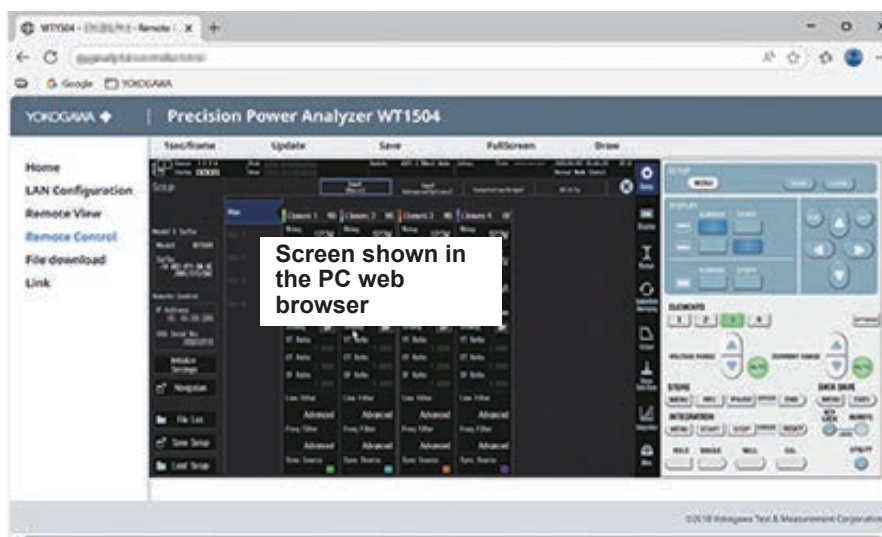
When a touch operation is performed, KEY TO EXT MONITOR lights, and control is automatically switched to the external monitor.

When KEY TO EXT MONITOR is lit, you can operate the external monitor screen with a or USB keyboard. To operate the external monitor screen, turn KEY TO EXT MONITOR on.

3.2 Using the Web Server Feature

Note

- A network connection between this instrument and a PC is required.
- For details on how to connect to the network and how to set the IP address, see chapter 14, “Ethernet Communication,” in the User’s Manual (IM WT1501-01EN).



Waveforms and setup menus displayed on the web server can be controlled directly on the screen. For details, see chapter 2 in the User’s Manual (IM WT1501-01EN).

Connecting to the web server

1. Connect the instrument to a network via Ethernet.
The Ethernet port is located on the rear panel of this instrument (see section 1.1).
2. Press the arrow keys to display the Utility > Network screen, and check the instrument’s IP address.

```

<Network
  TCP/IP
  IP 192.168. 0.100
  WLAN
  FTP/Web Server
  Serial No:12345678901
  
```

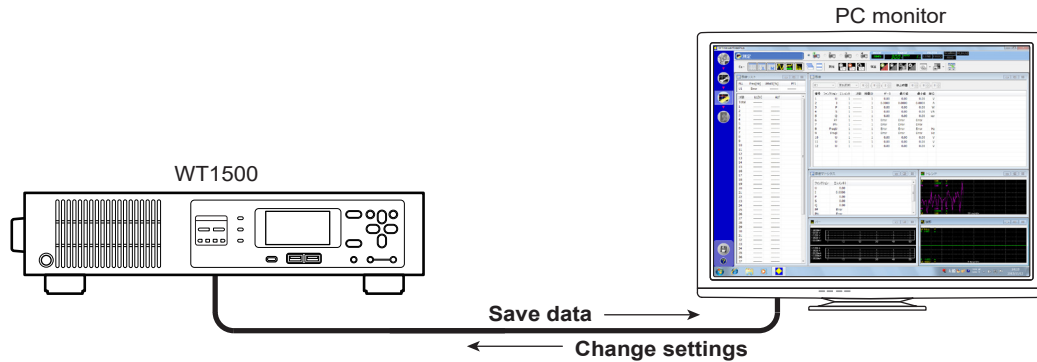
To set the IP address, see section 14.2 in the User’s Manual (IM WT1501-01EN).

3. Run a web browser on a PC connected to the network, enter in the address bar this instrument’s IP address that you confirmed or entered in step 2, and press **Enter**.
4. On the login screen, enter the user name “anonymous” (default value), and click **Entry**.
If you set the user name to “anonymous” (default value), you can omit the password. When the instrument screen is displayed on the web server, it is recommended that you set a user name and password. For details, see section 14.4 in the User’s Manual (IM WT1501-01EN).
5. A web server screen appears. On the Web server menu, click **Remote View** or **Remote Control**.

To control this instrument, select Remote Control.

3.3 Using WTVIEWERefree

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



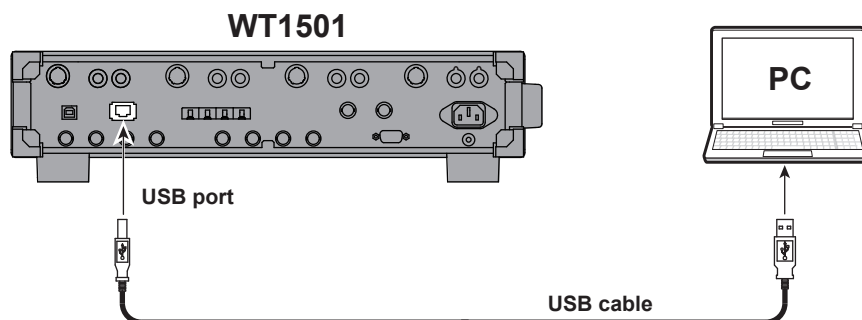
The instrument can be connected to a PC using the following communication interfaces.

- USB
- Ethernet

This section explains how to connect the instrument to a PC via USB. To connect to a PC via a different communication interface, see chapter 4 in the WTVIEWERefree User's Manual (IM760131-01EN).

Connecting the instrument to a PC via USB

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



Installing, starting, and closing WTVIEWERefree

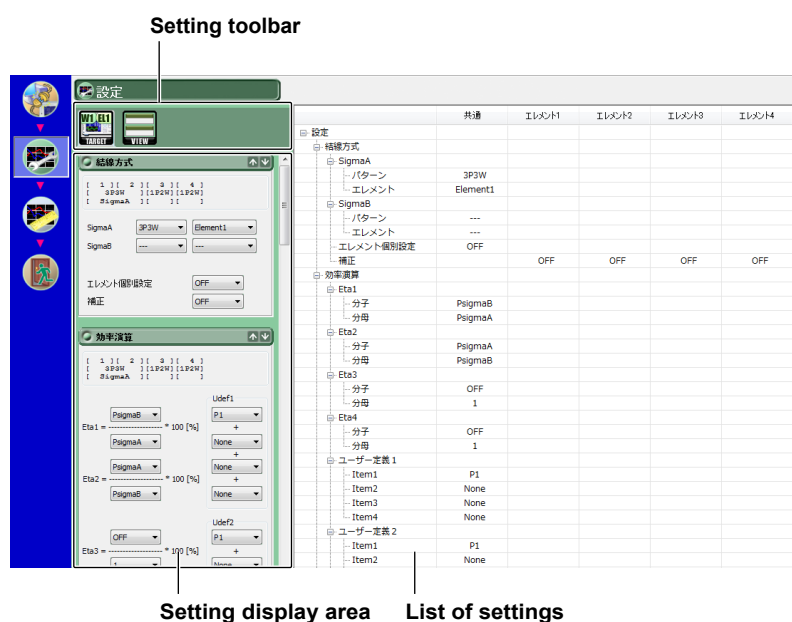
Download the WTVIEWERefree installer from our website.

<https://tmi.yokogawa.com/library/>

For instructions on how to start and close the software, see chapter 3 in the User's Manual (IM760131-01EN).

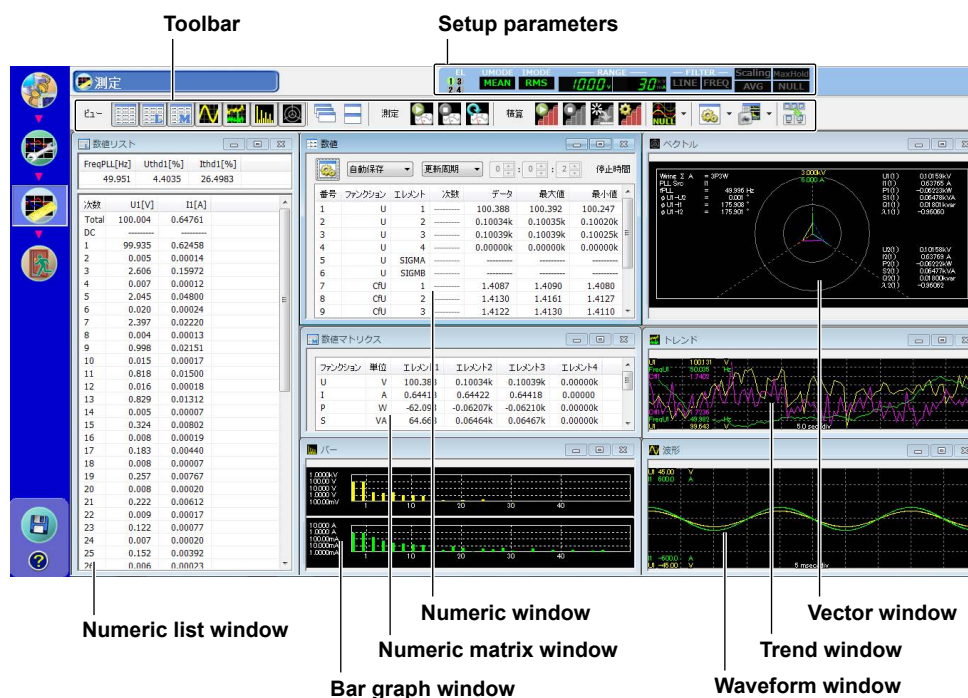
Example of a window for configuring this instrument

You can change the settings of this instrument from a PC.



Example of a window showing the measured data of this instrument

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



4.1 Troubleshooting

Faults and corrective actions

- If a message appears on the screen, see the appendix in the user's manual, IM WT1501-01EN.
- If servicing is necessary, or if the instrument does not operate properly even after you have attempted to deal with the problem according to the instructions in this section, contact your nearest YOKOGAWA dealer.

Problems and Solutions	Refer to Section
Nothing appears on the screen when the power is turned on.	
Securely connect the power cord to the instrument and to the power outlet.	2.3
Set the supply voltage to within the permitted range.	2.3
Check the screen settings.	14.4 ¹
The built-in power supply fuse may have blown. Servicing is required.	4.2
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 to 2.10
Check the wiring system.	2.8 to 2.10, 3.1 ¹
Confirm that the line filter is off.	3.1 ¹
Check the measurement period settings.	4.8 ¹
Turn the power off and then on again.	2.4
Keys do not work.	
Check the REMOTE LED. If the REMOTE LED is illuminated, press LOCAL to turn it off.	—
Confirm that keys are not locked.	18.10 ¹
Perform a key test. If the test fails, servicing is required.	18.9 ¹
Triggering does not work.	
Check the trigger conditions.	4.10 ¹
Confirm that the trigger source is being applied.	4.10 ¹
Unable to make harmonic measurements.	
Check the PLL source settings.	8.1 ¹
Confirm that the input signal that you selected for the PLL source meets the specifications.	8.1 ¹
Unable to recognize a storage device.	
Check the storage device format. If necessary, format the storage device.	—
The storage device may be damaged.	—
Unable to save data to the selected storage device.	
Check the free space on the storage device. Remove files or use a different storage device as necessary.	—
If necessary, format the storage device.	—
Unable to configure or control the instrument through the communication interface.	
Check to make sure that the IP address setting matches the specifications.	— ²
Confirm that the interface meets the electrical and mechanical specifications.	— ²

¹ See the user's manual IM WT1501-01EN.

² See the Communication Interface User's Manual, IM WT1501-17EN.

4.2 Power Supply Fuse

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

4.3 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.

Consumable parts

We recommend replacement at the following cycles.

Part name	Recommended replacement cycle
Cooling fan	3 year
LCD backlight	50,000 hours
Backup battery (lithium battery)	5 year

5.1 Signal Input Section

Power measurement element

Item	Specifications
Number of elements	Select from 1, 2, 3, and 4 (-HV, -WB).
Input terminal type	Voltage - HV element: Plug-in terminals (safety terminals) Ø4 mm safety banana jacks - WB element: Plug-in terminals (safety terminals) Ø4 mm safety banana jacks
I/O terminal type	Current Circular 20-pin connector
Input format	Voltage - HV element: Differential input through resistive voltage divider - WB element: Isolated input through voltage divider Current - When the sensor output type is current: Isolated input through shunt input - When the sensor output type is voltage: Isolated input through resistive voltage divider
Output voltage	±15 V ±12 V
Output current	1.8 A/output (±15 V) 0.8 A/output (±12 V)
Measurement range	Voltage - HV element: - When the crest factor is CF3 6 / 15 / 30 / 60 / 150 / 300 / 600 / 1000 / 2000 V - When the crest factor is CF6/CF6A 3 / 7.5 / 15 / 30 / 75 / 150 / 300 / 500 / 1000 V - WB element: - When the crest factor is CF3 6 / 15 / 30 / 60 / 150 / 300 / 600 / 1000 V - When the crest factor is CF6/CF6A 3 / 7.5 / 15 / 30 / 75 / 150 / 300 / 500 V - For the 2000 V range of the high-voltage element, the crest factor is 1.5 when the crest factor setting is CF3 and 3 when it is CF6. Current - When the sensor output type is current: - When the crest factor is CF3 25 m / 50 m / 100 m / 250 m / 500 m / 1 A - When the crest factor is CF6/CF6A 12.5 m / 25 m / 50 m / 125 m / 250 m / 500 mA - When the sensor output type is voltage: - When the crest factor is CF3 50 m / 100 m / 200 m / 500 m / 1 / 2 / 5 V - When the crest factor is CF6/CF6A 25 m / 50 m / 100 m / 250 m / 500 m / 1 / 2.5 V - For the 5 V voltage input range, the crest factor is 2 when the crest factor setting is CF3 and 4 when it is CF6.
Instrument loss	Voltage - HV element: Input resistance 10 MΩ ± 1 % (between each terminal and ground), input capacitance < 5 pF (between each terminal and ground) - WB element: Input resistance 2 MΩ ± 1 % (between terminals), input capacitance < 10 pF (between terminals)
Input impedance	Current - When the sensor output type is current: input resistance: approx. 500 mΩ - When the sensor output type is voltage: Input resistance: 1 MΩ ± 1 % (between terminals), input capacitance < 10 pF (between terminals)
Instantaneous maximum allowable input (within 1 s)	Voltage - WB element: 3000 V peak, 1 s or less Current - When the sensor output type is current: 1.8 A peak, 0.1 s or less - When the sensor output type is voltage: 10 V RMS, 0.1 s or less

5.1 Signal Input Section

Item	Specifications																								
Continuous maximum allowable input	Voltage - HV element: 2100 V RMS or ± 3000 V peak, whichever is lower - WB element: 1300 V RMS or ± 2000 V peak, whichever is lower Input voltage frequency > 100 kHz: $(1400 - f)$ Vrms or less Input voltage frequency > 1 MHz: $400/(f/1000)^2$ Vrms or less f is the frequency of the input voltage in units of kHz. Current - When the sensor output type is current: 1.1 A RMS or ± 1.6 A peak, whichever is less - When the sensor output type is voltage: 8 V RMS or ± 10 V peak, whichever is lower																								
Maximum rated voltage to ground (DC, 50/60 Hz)	Voltage - HV element voltage input terminals (VOLTAGE terminal, $\pm$ terminals) 2000 V AC/DC measurement category Other (estimated transient overvoltage 0 V) 1500 V DC CAT II 1000 V AC CAT II 1000 V AC/DC CAT III - WB element voltage input terminals (VOLTAGE terminal, $\pm$ terminals) 1000 V DC CAT II Current - When the sensor output type is current: 42 V peak - When the sensor output type is voltage: 42 V peak																								
Influence of isolation voltage	HV element voltage 50/60 Hz: 95 dB typ 100 kHz: 50 dB typ WB element voltage 50/60 Hz: 95 dB typ 100 kHz: 60 dB typ Current No specification (grounded when current sensor/current probe is connected) - Specified as CMRR (dB) according to the following formula. $CMRR (dB) = 20 \times \log_{10}(E_c / M)$ E_c: Voltage to ground; M: Measurement influence 1000 V is applied between an input terminal and case with the voltage input terminals shorted.																								
A/D converter	Simultaneous conversion of voltage and current inputs. Resolution: 16 bits Sample rate: 2.5 MS/s																								
Lower limit of measurement frequency	As follows. <table> <tr> <th>Data update interval</th><th>Lower limit of measurement frequency</th></tr> <tr> <td>10 ms</td><td>200 Hz</td></tr> <tr> <td>50 ms</td><td>45 Hz</td></tr> <tr> <td>100 ms</td><td>20 Hz</td></tr> <tr> <td>200 ms</td><td>10 Hz</td></tr> <tr> <td>500 ms</td><td>5 Hz</td></tr> <tr> <td>1 s</td><td>2 Hz</td></tr> <tr> <td>2 s</td><td>1 Hz</td></tr> <tr> <td>5 s</td><td>0.5 Hz</td></tr> <tr> <td>10 s</td><td>0.2 Hz</td></tr> <tr> <td>20 s</td><td>0.1 Hz</td></tr> <tr> <td>Auto</td><td>0.1 Hz (Time out 20 s)</td></tr> </table>	Data update interval	Lower limit of measurement frequency	10 ms	200 Hz	50 ms	45 Hz	100 ms	20 Hz	200 ms	10 Hz	500 ms	5 Hz	1 s	2 Hz	2 s	1 Hz	5 s	0.5 Hz	10 s	0.2 Hz	20 s	0.1 Hz	Auto	0.1 Hz (Time out 20 s)
Data update interval	Lower limit of measurement frequency																								
10 ms	200 Hz																								
50 ms	45 Hz																								
100 ms	20 Hz																								
200 ms	10 Hz																								
500 ms	5 Hz																								
1 s	2 Hz																								
2 s	1 Hz																								
5 s	0.5 Hz																								
10 s	0.2 Hz																								
20 s	0.1 Hz																								
Auto	0.1 Hz (Time out 20 s)																								
Maximum display	140 % of the rated voltage or current range Specifications by range are as follows. High-voltage element voltage input 2000 V range: 110 % 1 A current input range when the sensor output type is current: 125 % 5 V current input range when the sensor output type is voltage: 125 % Twice that of CF3 for CF6																								
Minimum display	Depending on the measurement range, the following are the minimum values that are displayed: - Urms, Uac, Irms, Iac: Up to 0.3 % - Umn, Urmn, Imn, Irmn: Up to 2 % Twice that of CF3 for CF6/CF6A When the input level is lower than the value above, the display shows zero if the zero suppression setting is on, otherwise it shows the measured value. Current integration value q depends on the current value.																								
Current sensor correction	See "General Functions."																								
Frequency measurement	See "Frequency Measurement Function"																								
Harmonic measurement	See "Harmonic Measurement Function"																								
Peak overrange detection	See "General functions"																								

5.2 Accuracy

Accuracy (6 months)	Conditions Temperature: 23 ± 5 °C, humidity: 30 to 75 % RH, input waveform: sine wave, λ(power factor): 1, isolation voltage: 0 V Crest factor: CF3, line filter: OFF Frequency filter: Used when the signal frequency is 1 kHz or less Sync source signal level: Same as the frequency measurement conditions AC specified in RMS, DC specified in DC After 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.
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Accuracy (6 months)	Voltage	
HV Element	Frequency	Accuracy
	DC	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
	0.1 Hz $\leq f < 10$ Hz	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
	10 Hz $\leq f < 45$ Hz	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
	45 Hz $\leq f \leq 66$ Hz	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
	66 Hz $< f \leq 1$ kHz	$\pm(0.03 \% \text{ of reading} + 0.05 \% \text{ of range})$
	1 kHz $< f \leq 10$ kHz	$\pm(0.2 \% \text{ of reading} + 0.1 \% \text{ of range})$
	10 kHz $< f \leq 50$ kHz	$\pm\{(0.1 \times f)\% \text{ of reading} + 0.3 \% \text{ of range}\}$
	50 kHz $< f \leq 100$ kHz	$\pm\{(0.15 \times f)\% \text{ of reading} + 0.3 \% \text{ of range}\}$
	Frequency Band	DC to 300 kHz (Typical)

Current	
Frequency	Accuracy
DC	$\pm (0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
0.1 Hz $\leq f < 10$ Hz	$\pm (0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
10 Hz $\leq f < 45$ Hz	$\pm (0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
45 Hz $\leq f \leq 66$ Hz	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
66 Hz $< f \leq 1$ kHz	$\pm (0.03 \% \text{ of reading} + 0.05 \% \text{ of range})$
1 kHz $< f \leq 10$ kHz	$\pm(0.2 \% \text{ of reading} + 0.1 \% \text{ of range})$
10 kHz $< f \leq 50$ kHz	$\pm\{(0.1 \times f)\% \text{ of reading} + 0.3 \% \text{ of range}\}$
50 kHz $< f \leq 100$ kHz	$\pm\{(0.15 \times f)\% \text{ of reading} + 0.3 \% \text{ of range}\}$
Frequency Band	DC to 300 kHz (Typical)

Power Factor (1)	
Frequency	Accuracy
DC	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
0.1 Hz $\leq f < 0$ Hz	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
10 Hz $\leq f < 45$ Hz	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
45 Hz $\leq f \leq 66$ Hz	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
66 Hz $< f \leq 1$ kHz	$\pm(0.05 \% \text{ of reading} + 0.05 \% \text{ of range})$
1 kHz $< f \leq 10$ kHz	$\pm(0.2 \% \text{ of reading} + 0.1 \% \text{ of range})$
10 kHz $< f \leq 50$ kHz	$\pm\{(0.1 \times f)\% \text{ of reading} + 0.3 \% \text{ of range}\}$
50 kHz $< f \leq 100$ kHz	$\pm\{(0.15 \times f)\% \text{ of reading} + 0.3 \% \text{ of range}\}$

5.2 Accuracy

Accuracy (6 months)
WB Element

Voltage

Frequency	Accuracy
DC	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
$0.1 \text{ Hz} \leq f < 10 \text{ Hz}$	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
$10 \text{ Hz} \leq f < 45 \text{ Hz}$	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
$45 \text{ Hz} \leq f \leq 66 \text{ Hz}$	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
$66 \text{ Hz} < f \leq 1 \text{ kHz}$	$\pm(0.05 \% \text{ of reading} + 0.05 \% \text{ of range})$
$1 \text{ kHz} < f \leq 10 \text{ kHz}$	$\pm(0.2 \% \text{ of reading} + 0.1 \% \text{ of range})$
$10 \text{ kHz} < f \leq 50 \text{ kHz}$	$\pm(0.3 \% \text{ of reading} + 0.1 \% \text{ of range})$
$50 \text{ kHz} < f \leq 100 \text{ kHz}$	$\pm(0.6 \% \text{ of reading} + 0.2 \% \text{ of range})$
$100 \text{ kHz} < f \leq 500 \text{ kHz}$	$\pm\{(0.006 \times f)\% \text{ of reading} + 0.5 \% \text{ of range}\}$
$500 \text{ kHz} < f \leq 1 \text{ MHz}$	$\pm\{(0.022 \times f - 8)\% \text{ of reading} + 1 \% \text{ of range}\}$
Frequency Band	DC to 2MHz (Typical)

Current

Frequency	Accuracy
DC	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
$0.1 \text{ Hz} \leq f < 10 \text{ Hz}$	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
$10 \text{ Hz} \leq f < 45 \text{ Hz}$	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
$45 \text{ Hz} \leq f \leq 66 \text{ Hz}$	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
$66 \text{ Hz} < f \leq 1 \text{ kHz}$	$\pm(0.03 \% \text{ of reading} + 0.05 \% \text{ of range})$
$1 \text{ kHz} < f \leq 10 \text{ kHz}$	$\pm(0.1 \% \text{ of reading} + 0.05 \% \text{ of range})$
$10 \text{ kHz} < f \leq 50 \text{ kHz}$	$\pm(0.2 \% \text{ of reading} + 0.05 \% \text{ of range})$
$50 \text{ kHz} < f \leq 100 \text{ kHz}$	$\pm(0.6 \% \text{ of reading} + 0.2 \% \text{ of range})$
$100 \text{ kHz} < f \leq 500 \text{ kHz}$	$\pm\{(0.012 \times f)\% \text{ of reading} + 0.5 \% \text{ of range}\}$
$500 \text{ kHz} < f \leq 1 \text{ MHz}$	$\pm\{(0.012 \times f)\% \text{ of reading} + 0.5 \% \text{ of range}\}$
Frequency Band	DC to 2 MHz (Typical)

Power Factor (1)

Frequency	Accuracy
DC	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
$0.1 \text{ Hz} \leq f < 10 \text{ Hz}$	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
$10 \text{ Hz} \leq f < 45 \text{ Hz}$	$\pm(0.08 \% \text{ of reading} + 0.1 \% \text{ of range})$
$45 \text{ Hz} \leq f \leq 66 \text{ Hz}$	$\pm(0.018 \% \text{ of reading} + 0.02 \% \text{ of range})$
$66 \text{ Hz} < f \leq 1 \text{ kHz}$	$\pm(0.05 \% \text{ of reading} + 0.05 \% \text{ of range})$
$1 \text{ kHz} < f \leq 10 \text{ kHz}$	$\pm(0.2 \% \text{ of reading} + 0.1 \% \text{ of range})$
$10 \text{ kHz} < f \leq 50 \text{ kHz}$	$\pm(0.3 \% \text{ of reading} + 0.2 \% \text{ of range})$
$50 \text{ kHz} < f \leq 100 \text{ kHz}$	$\pm(0.7 \% \text{ of reading} + 0.3 \% \text{ of range})$
$100 \text{ kHz} < f \leq 500 \text{ kHz}$	$\pm\{(0.015 \times f)\% \text{ of reading} + 1 \% \text{ of range}\}$
$500 \text{ kHz} < f \leq 1 \text{ MHz}$	$\pm\{(0.041 \times f - 13)\% \text{ of reading} + 2 \% \text{ of range}\}$

- For the HV element voltage input range, add the following values to the accuracies listed above:
 Voltage accuracy (6V range): $\pm 0.015 \% \text{ of range}$
 Voltage accuracy (15V range): $\pm 0.005 \% \text{ of range}$
 Add to the power accuracy according to the following formula. I is the current reading (A).
 Voltage-added accuracy (V) $\times$ I (W)
- For the current input range (sensor output type: current), add the following values to the accuracy values above.
 DC current accuracy: $\pm 12 \mu\text{A}$
 Add to the power accuracy according to the following formula. U is the voltage reading (V).
 Current-added accuracy (A) $\times$ U (W)
- For the current input range (sensor output type: voltage), add the following values to the accuracy values above.:
 Current accuracy (50 mV range): $\pm 0.02 \% \text{ of reading}$
 Current accuracy (100 mV range): $\pm 0.01 \% \text{ of reading}$
 Add to the power accuracy according to the following formula. U is the voltage reading (V).
 Current-added accuracy (A) $\times$ U (W)

- The accuracy for 110 to 130 % of the measurement range is range error $\times 1.5$.
- When the input voltage exceeds 600 V, add 0.02 % of reading to the voltage and power accuracies.
- Guaranteed accuracy ranges for frequency, voltage, and current
All accuracy figures for 0.1 Hz to 10 Hz are for reference only.
For voltages that exceed 30 kHz and also exceed 750 V, the voltage and power values are reference values.
- Influence of temperature changes after zero-level compensation or range change
Add the following values to the accuracies listed above.
DC voltage accuracy: ± 0.08 % of range/ $^{\circ}\text{C}$
When the sensor output type is current DC accuracy: ± 0.05 % of range/ $^{\circ}\text{C}$
When the sensor output type is voltage DC accuracy: ± 0.03 % of range/ $^{\circ}\text{C}$

Add to the power accuracy according to the following formula. I is the current reading (A). U is the voltage reading (V).
Voltage-added accuracy (V) $\times$ I (W)
Current-added accuracy (A) $\times$ U (W)
- Influence of self-generated heat caused by voltage input
Add the following values to the voltage accuracies.

HV element voltage
AC input signal: $\pm(0.025 \times U^2$ % of reading)
DC input signal: $\pm(0.025 \times U^2$ % of reading + $0.025 \times U^2$ % of range)

WB element voltage
AC input signal: $\pm(0.1 \times U^2$ % of reading)
DC input signal: $\pm(0.1 \times U^2$ % of reading + $0.1 \times U^2$ % of range)
Even if the voltage input decreases, the influence from self-generated heat continues until the temperature of the input resistor decreases. U is the voltage reading (kV).

Add to the power accuracy according to the following formula. I is the current reading (A).
Voltage-added accuracy (V) $\times$ I (W)

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 accuracies.
When the sensor output type is current
AC input signal: $\pm(0.06 \times I^2$ % of reading)
DC input signal: $\pm(0.06 \times I^2$ % of reading + $0.06 \times I^2$ % of range)
I is the current reading (CT scaling off) (A).
Add to the power accuracy according to the following formula. U is the voltage reading (V).
Current-added accuracy (A) $\times$ U (W)

Even if the current input decreases, the influence from self-generated heat continues until the temperature of the input resistor decreases.
- Influence of data update interval
Add the following values.
10 ms: ± 0.03 % of reading
50 ms: ± 0.03 % of reading
100 ms: ± 0.02 % of reading
- Accuracy when the crest factor is set to CF6 or CF6A:
The same as the accuracy when the crest factor is CF3 after doubling the range.

5.2 Accuracy

Item	Specifications
Power factor (λ) influence	Based on the following calculation formula When $\lambda = 0$ 45 - 66Hz: $\pm 0.07 \%$ of S Other frequencies: WB $\pm (0.07 + 0.05 \times f) \%$ of S (reference value) HV element $\pm (0.07 + 0.15 \times f) \%$ of S (reference value) $0 < \lambda < 1$ $\pm P \times [(\text{power reading accuracy } \%) + (\text{power range accuracy } \%) \times (\text{power range}/S) + \{\tan \phi \times (\text{influence } \% \text{ when } \lambda = 0)\}]$ S is the apparent power reading. P is the active power reading. ϕ is the phase angle reading between voltage and current. The unit of f is kHz.
Accuracy at 1 year	1.5 times the accuracy at 6 months
Temperature coefficient	At 5 °C to 18 °C or 28 °C to 40 °C, add the following value. $\pm 0.01 \%$ of reading/°C
Effective input range	Voltage, current As follows: Udc, Idc: 0 to $\pm 110 \%$ of range Urms, Irms: 1 to 110 % of range Umn, Imn: 10 to 110 % of range Urmn, Irmn: 10 to 110 % of range Below are range-specific specifications. Udc (HV element, range: 2000 V): 0 to $\pm 105 \%$ of range Urms (HV element, range: 2000 V): 1 to 105 % of range Umn (HV element, range: 2000 V): 10 to 105 % of range Urmn (HV element, range: 2000 V): 10 to 105 % of range Udc (WB element, range: 1000 V): 0 to $\pm 130 \%$ of range Urms (WB element, range: 1000 V): 1 to 130 % of range Umn (WB element, range: 1000 V): 10 to 130 % of range Urmn (WB element, range: 1000 V): 10 to 130 % of range Power Provided that the effective input ranges for voltage and current are satisfied, the following applies. DC: 0 to $\pm 110 \%$ of range AC: 0 to $\pm 110 \%$ of range Below are range-specific specifications. DC (HV element, range: 2000 V): 0 to $\pm 105 \%$ of range AC (HV element, range: 2000 V): 0 to $\pm 105 \%$ of range DC (WB element, range: 1000 V): 0 to $\pm 130 \%$ of range AC (WB element, range: 1000 V): 0 to $\pm 130 \%$ of range The sync source level must meet the frequency measurement conditions. See "Frequency Measurement Function."
Accuracies of waveform data Upk and Ipk	Add the following value to the voltage or current accuracy (reference value). The effective input range is within the crest factor of each range. HV element voltage $\pm (5 / \text{range} + 0.1) \%$ of range WB element voltage $\pm (33 / \text{range} + 0.3) \%$ of range Current (When the sensor output type is current) $\pm (0.02 / \text{range} + 0.1) \%$ of range Current (When the sensor output type is voltage) $\pm (0.1 / \text{range} + 0.1) \%$ of range
Accuracy of apparent power S	Voltage accuracy + current accuracy
Accuracy of reactive power Q	Accuracy of apparent power $\pm \{\sqrt{(1.0002 - \lambda^2)} - \sqrt{(1 - \lambda^2)}\} \times 100 \%$ of range λ is the power factor reading between voltage and current.
Accuracy of power factor λ	$\pm [\lambda - \lambda/1.0002 + \cos \phi - \cos\{\phi + \sin^{-1}(\text{influence of power factor of power when } \lambda = 0 (\%/100))\}] \pm 1 \text{ digit}$ ϕ is the phase angle reading between voltage and current. λ is the power factor reading between voltage and current. When the voltage or current is rated range input.
Accuracy of phase difference ϕ	$\pm [\cos^{-1}(\lambda) - \cos^{-1}(\lambda/1.0002) + \sin^{-1}\{(\text{influence from the power factor when } \lambda = 0 (\%/100))\}] \text{ deg} \pm 1 \text{ digit}$ λ is the power factor of the voltage and current. When the voltage or current is rated range input
Lead and lag detection	- Phase difference: $\pm(5^\circ \text{ to } 175^\circ)$ - Frequency: 20 Hz to 10 kHz - Condition: Sine wave - At least 50 % of the measurement range (at least 100 % for CF6 and CF6A)

Item	Specifications
Line filter	When the line filter is on, add the following to the voltage, current, and active power accuracies. Voltage, current $f \leq (f_c/10)$: $\pm(20 \times f/f_c)$ % of reading Active power $f \leq (f_c/10)$: $\pm(40 \times f/f_c)$ % of reading When applying 300 kHz for f_c, add the following to the “influence of temperature changes after zero-level compensation or range change.” ± 0.015 % of range/°C In the accuracy formula, f_c is the cutoff frequency and f is the input frequency. The unit is kHz. The upper limit of the guaranteed accuracy range is $f_c/10$. For filter function specifications, see “Filter Function.”
Accuracy of VT and CT combinations	Accuracy when combined with CTs Calculate the accuracy when this instrument is combined with a CT as follows: This applies to combinations with the various sensors (CT) described in this manual. Current accuracy Add the CT amplitude accuracy to the current accuracy of this instrument. Active power (power factor 1) accuracy Add to the power accuracy of this instrument the value (%) calculated from the CT amplitude accuracy (the value converted to A) using the following formula. $\pm(\text{CT amplitude accuracy}/I) \times 100\%$ Effect of the power factor (λ) When $\lambda = 0$ Calculate from the CT phase accuracy and the effect of the power factor on power when $\lambda = 0$ for this instrument (%) using the following formula. $\pm \sin(\sin^{-1}(\text{effect of the power factor on power when } \lambda = 0 \text{ for this instrument } (\%)/100) + \text{CT phase accuracy}) \times 100\%$ of S When $0 < \lambda < 1$ Calculate from the CT amplitude accuracy (the value converted to A), CT phase accuracy, and the effect of the power factor on power when $\lambda = 0$ for this instrument (%) using the following formula. $\pm P \times [(\text{power reading accuracy } (\%) + (\text{CT amplitude accuracy}/I) \times 100\%) + (\text{power range accuracy } (\%)) \times (\text{power range}/S) + \{\tan \phi \times (\text{effect of the power factor on power when } \lambda = 0 \text{ } (\%))\}]$ The unit of CT amplitude accuracy is A, and the unit of phase accuracy is °. I is the current reading [A], S is the apparent power reading [VA], and P is the active power reading [W]. ϕ is the phase angle between voltage and current [°].

CT, cable combination restrictions

Item	Specifications
Combination with CT1000	Use within the following ambient temperature derating. CT ambient temperature 45 °C or more: Primary current 900 A peak or less CT ambient temperature 45 °C or less: Follows the CT1000 specifications
Combination with a dedicated 10-m current sensor connection cable	CT2000 A primary current: 2100 A peak or less

5.3 Motor Evaluation for Encoder (/EM1, /EM1RM1, /EM2 option)

Item		Specifications
Input connector type		Isolated BNC
Input format		Isolated input
Input resistance		Input resistance: 1 MΩ ± 1 %, input capacitance: approx. 47 pF
Continuous maximum allowable input		Peak and DC ± 22 V or less
Maximum rated voltage to ground		±42 V _{peak} or less
Input channels		/EM1, /EM2, /EM1RM1
		ChA (torque signal 1/external signal 1): Analog input/pulse input ChB (speed signal 1/external signal 3): Pulse input ChC (phase B/torque signal 2/external signal 2): Analog input/pulse input ChD (phase Z/speed signal 2/external signal 4): Pulse input
		/EM2
		ChE (torque signal 3/external signal 5): Analog input/pulse input ChF (phase A/speed signal 3/external signal 7): Pulse input ChG (phase B/torque signal 4/external signal 6): Analog input/pulse input ChH (phase Z/speed signal 4/external signal 8): Pulse input
Input type	Analog input	Range
		1/2/5/10/20 V
		Range setting
		Fixed/Auto range
		Auto range
		Range increase:
		When the measured value exceeds 110 % of range or when the peak value exceeds approx. 150 %
		Range decrease:
		When the measured value is 30 % of the range or less and the peak value is less than 125 % of the next lower range
		Input range
		±110 % of range
		Maximum display
		±130 % of the rated range
		Bandwidth
		20kHz (-3 dB) Typ
		Sample rate
		2.5 Ms/s
		Resolution
		16 bit
	Pulse inputs	Accuracy (6 months)
		±(0.05 % of reading + 0.05 % of range)
		Accuracy guarantee conditions
		Humidity: 30% RH to 75% RH
		Voltage to ground: 0 V
		After the warm-up time has elapsed, perform zero-level compensation with the wiring connected.
		Add the temperature coefficient from 5 °C to 18 °C and from 28 °C to 40 °C.
		For 1-year accuracy, multiply the reading component (% of reading) of the 6-month accuracy by 1.5.
		Temperature coefficient
		± 0.03 % of range/°C
		Line filter
		Low-pass filter
		Filter response: Butterworth
		Cutoff frequency f _c : 100 Hz, 500 Hz, 1 kHz
		Range
		10 V
		Input range
		±12 V _{peak}
		Detection level
		H level: Approx. 2 V or more
		L level: Approx. 0.8 V or less
		Pulse width
		500 ns or more
		However, 50 % duty cycle for detecting forward rotation
		Frequency measurement range
		2 Hz to 1 MHz
		Maximum display
		1000000 rpm when the number of pulses per revolution of the rotational signal is 60
		Rotation direction detection
		2 Hz to 1 MHz
		When the pulse noise filter is in use:
		10 kHz: 2 Hz to 3 kHz
		100 kHz: 2 Hz to 30 kHz
		1 MHz: 2 Hz to 300 kHz

5.3 Motor Evaluation for Encoder (/EM1, /EM1RM1, /EM2 option)

Item	Specifications
	Accuracy(1 year) $\pm(0.03 + f / 10000)$ % of reading ± 1 mHz The unit of f is kHz.
	Detection level H level: Approx. 2 V or more L level: Approx. 0.8 V or less
	Pulse noise filter Low-pass filter fc 10kHz, 100kHz, 1MHz
	Z pulse delay correction See "Phase correction of electric angle."
Peak overrange detection	150 % of the range or more

5.4 Motor Evaluation for Resolver (/RM1, /EM1RM1, /RM2 option)

Item		Specifications	
Input connector type		Isolated BNC	
Input format		Isolated input	
Input resistance		Input resistance: 1 M Ω $\pm$ 1 %, input capacitance: approx. 47 pF	
Continuous maximum allowable input		Peak and DC $\pm$ 22 V or less	
Maximum rated voltage to ground		$\pm$ 42 V peak or less	
Input channels		/RM1, /EM1RM1, /RM2:	ChA (torque signal 1/external signal 1): Analog input/pulse input ChB (carrier signal 1/external signal 3): Analog input/resolver input ChC (sine signal 1/external signal 2): Analog input/resolver input ChD (cosine signal 1/external signal 4): Analog input/resolver input
		/EM1RM1, /RM2:	ChE (torque signal 3/external signal 5): Analog input/pulse input ChF (carrier signal 3/external signal 7): Analog input/resolver input ChG (sine signal 3/external signal 6): Analog input/resolver input ChH (cosine signal 3/external signal 8): Analog input/resolver input
Input type	Analog input	Range	1/2/5/10/20 V
		Range setting	Fixed/auto range setting Auto range setting function Range up: When the measured value exceeds 110 % of the range or the peak value exceeds approximately 150 %. Range down: When the measured value is 30 % of the range or less and the peak value is less than 125 % of the next lower range.
		Input range	$\pm$ 110 % of range
		Maximum display	$\pm$ 130 % of the rated range
		Bandwidth	ChA, E: 20 kHz (–3 dB) Typ ChB, C, D, F, G, H: 1 MHz (–3 dB) Typ
		A/D converter	Resolution: 16 bits Sample rate: Approx. 2.5 MS/s
		Accuracy (6 months)	ChA, E: $\pm$ (0.05 % of reading + 0.05 % of range) ChB, C, D, F, G, H: $\pm$ (0.1 % of reading + 0.2 % of range) Accuracy guarantee conditions Humidity: 30 % RH to 75 % RH Isolation voltage 0 V Zero-level compensation performed under wired conditions after warm-up time has elapsed For 5 °C to 18 °C and 28 °C to 40 °C, add the temperature coefficient. For the accuracy at 1 year, multiply the accuracy at 6 months by 1.5.
		Temperature coefficient	ChA, E: $\pm$ 0.03 % of range/°C ChB, C, D, F, G, H: $\pm$ 0.04 % of range/°C
		Line filter	Off or low-pass filter Low-pass filter Filter response: Butterworth Cutoff frequency fc: Select from 100 Hz, 500 Hz, and 1 kHz.
	Pulse inputs	Range	10 V
		Input range	$\pm$ 12 V peak
		Detection level	H level: Approx. 2 V or more L level: Approx. 0.8 V or less
		Pulse width	500 ns or more
		Frequency measurement range	2 Hz-1 MHz
		Maximum display	A measured value equivalent to the maximum display pulse input of 1 MHz, or 1,000,000 rpm when the number of pulses per rotation of the rotation signal is 60
		Accuracy (1 year)	$\pm$ (0.03 + f / 10000) % of reading $\pm$ 1 mHz f is the measured frequency in units of kHz.
		Pulse noise filter	Off or low-pass filter Low-pass filter Cutoff frequency: 10 kHz, 100 kHz, 1 MHz

5.4 Motor Evaluation for Resolver (/RM1, /EM1RM1, /RM2 option)

Item	Specifications	
Resolver input	Range	1/2/5/10/20 V
	Range setting	Fixed/auto range setting Auto range setting function Range up When the peak value exceeds 110 % of the range or when peak over occurs Range down When the peak value is less than 105 % of the next lower range
	Input range	±110 % of range
	Bandwidth	1 MHz (-3 dB) Typ
	Electrical angle measurement error	±0.1 ° Typ Provided that the motor has one pole pair, the resolver axis multiplication factor is 1, the carrier frequency is not more than one-tenth of the line filter cutoff frequency, and the motor frequency is 16 Hz or less.
	A/D converter	Resolution: 16 bits Sample rate: 2.5 MS/s
	Rotating speed accuracy (1 year)	±(0.05 + f / 10000) % of reading ± 1 mHz f is the measured frequency in units of kHz. Specified as the frequency measurement value of the Z pulse after calculation by the resolver operation function Accuracy guarantee conditions • Peak-to-peak resolver input amplitude is at least 50 % of the range. • The carrier frequency of the resolver input is within the supported carrier frequency range of the resolver operation function. • The post-calculation Z-pulse frequency is within the pulse input frequency measurement range.
	Maximum display	150,000 rpm
	Line filter	Off or low-pass filter Low-pass filter Filter response: Butterworth Cutoff frequency fc: Select from 10 kHz, 20 kHz, 50 kHz, 100 kHz, and 200 kHz.
	Tracking filter	See "Resolver operation function."
Peak overrange detection	150 % of the range or more	

5.5 Display

Instrument screen

Item	Specifications
Display	2.9-inch monochrome STN LCD module
Resolution of the entire screen*	256 × 128 dots (H × V)
Display language	English
Display update interval	1) When the update mode is Constant or Auto: 1 s However, if the data update interval exceeds 1 second, it is the same as the data update interval. 2) When the update mode is Trigger: After trigger detection, the measurement range and measured data for the data update rate are calculated, and the display is updated based on the results. The time it takes for the next trigger to become ready after a trigger is as follows: • When the data update interval is 10 ms to 500 ms: approx. 1 s • When the data update interval is 1 s to 20 s: data update interval + 500 ms
Measurement display	Number of displayed digits: For 60000 and less: 5 digits For values exceeding 60000: 4 digits Display format: element-based numeric display, measurement function-based numeric display, four-value numeric display No-data display symbol: --- Error display symbol: Error For errors that occur when the frequency measurement or motor or AUX pulse measurement is less than the lower limit, Error or zero can be selected.
Information Display	Communication settings (IP address), input status (peak overrange, current sensor status), system overview, message log, and error display
Other screens	Setup menu Settings menu: save/restore settings file, save message log, multi-device synchronization settings, time settings, firmware update/add options

* About 0.002 % of the pixels on the LCD screen may be defective.

External monitor output and Web server screen

Item	Specifications
Display language	Japanese, English, Chinese, German
Display update interval	1) When the update mode is Constant or Auto: 1 s However, if the data update interval exceeds 1 second, it is the same as the data update interval. 2) When the update mode is Trigger: The display is updated after a trigger is detected and the measurement range and measurement data determined from the data update rate are calculated. The time it takes for the next trigger to become ready after a trigger is as follows: • When the data update interval is 50 ms to 500 ms: approx. 1 s¹ • When the data update interval is 1 s to 20 s: data update interval + 500 ms¹ The web server screen is not updated when the data update interval is 10 ms. 1 During synchronous operation in multi-unit synchronization mode, add 150 ms per connected sub unit.
Measurement display	Number of displayed digits: For 60000 and less: 5 digits For values exceeding 60000: 4 digits Display format: ALL, 4, 8, 16, Matrix, Hrm List Single, Hrm List Dual No-data display symbol: --- Error display symbol: Error For errors that occur when the frequency measurement or motor or AUX pulse measurement is less than the lower limit, Error or zero can be selected.

Item	Specifications
Waveform display	Peak-to-peak compressed data Waveform display items Voltage, current: elements 1 to 4 Torque, speed: Motors 1 and 2 (/EM1, /RM1¹, /EM2, /EM1RM1¹, /RM2¹) Motors 3 and 4 (/EM2, /EM1RM1¹, /RM2¹) External signal: Aux1 to 4 (/EM1, /RM1, /EM2, /EM1RM1, /RM2) Aux5 to 8 (/EM2, /EM1RM1, /RM2) 1 Motor Evaluation for Resolver only for motors 1 and 3 Split screen: Single, Dual, Triad, Quad, Hexa Vertical axis: Auto, Manual (set zoom and position) Time scale : Time/div range of 0.1 ms to 2 s when the update mode is not Auto² Time/div range of 0.1 ms to 5 ms when the update mode is Auto² 2 In 1-2-5 steps for times less than or equal to 1/10th of the data update interval Triggering Trigger type: edge Trigger mode: select from auto and normal. Trigger source: select from voltage, current, and Ext Clk (external clock) During synchronous operation in multi-unit synchronization mode, select the trigger source unit from Main and Sub1 to 4. Trigger slope: select from rising, falling, or rising and falling. Fixed to rising when the trigger source is Ext Clk (external clock). Trigger level When the trigger source is 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 $\pm 100\%$ (to the top and bottom edges of the screen). Resolution: 0.1 % Trigger delay: $\leq 2\ \mu\text{s}$ When the trigger source is Ext Clk (external clock) TTL level When wiring with delta transformation is specified, the trigger is based on the input after delta conversion. Time axis zoom feature: none Amplitude zoom feature: set between 0.1x to 100x Display interpolation: off, two-point linear interpolation Grid: selectable (frame, grid, X-Y) When the data update interval is 10 ms, the waveform data is not updated.
Bar graph display	Displays a bar graph of the amplitude and phase of each harmonic Split graph: Single, Dual, T Vertical scale: Log, Linear Range setting: auto or manual (set the upper and lower limits) Display range: start harmonic: 0 to 90, end harmonic: 10 to 100
Vector display	Displays the phase difference between the fundamental voltage signal and fundamental current signal as a vector. Divisions: 2 Screen zoom feature: 0.1x to 100x Numeric display: available
Other measurement screen display items	Setup menu Measurement mode, time, data update interval, data update count, peak overrange information, sensor status information, integration settings/status, storage status, crest factor, averaging, element settings/status, option settings/status

5.6 Controls

Control devices	Power switch, control keys
Key control functions	Functions controlled directly with keys Direct control items: • Menu, HOLD key, key control to external monitor, key lock, release remote • Panel menus can be controlled using the arrow, SET, and ESC keys.
LED Indicator	(1) Data update LED (UPDATE) Green light blinks during data update. (2) Peak overrange LED (PEAK OVER) The LED lights red when a peak overrange is detected on the voltage/current/optional input channel. (3) Hold LED (HOLD key) The LED lights green when measurement hold is on. (4) Current sensor power supply overcurrent LED (OVER CURRENT) If an overcurrent occurs in the current sensor or probe, one or more elements with interrupted power supply will blink red. During synchronous operation in multi-unit synchronization mode, the power supply status of sub units is also reflected. (5) Multi-unit synchronization mode and synchronous mode LED (MAIN/SUB) Lights as follows according to the multi-unit synchronization mode • MAIN on/blinking: multi-unit synchronization mode main unit • SUB on/blinking: multi-unit synchronization mode sub unit • MAIN/SUB both off: multi-unit synchronization mode off Lights green as follows according to the synchronous operation status • Solid: synchronous operation on (Operating) • Blinking: Synchronous operation off (OFF) or standby (STANDBY) (6) Multi-unit synchronization sub unit number and unit connection status LED (SUB UNIT) When multi-unit synchronization mode is Main Unit, the connection status with the sub unit is displayed. When multi-unit synchronization mode is Sub unit, the sub unit number assigned to this instrument and the connection status with the main unit are displayed. • Off: Not used • Green solid: normal connection • Green blinking: connecting • Red blinking: connection error (7) External monitor key control LED (KEY TO EXT MONITOR) Lights blue when the cross key, SET key, ESC key, and MENU key are controlling an external monitor output or web server. (8) Key lock (KEY LOCK) Lights green when front panel key operations are locked. (9) Remote (REMOTE) Lights green when remote mode is enabled via communications and key operations are restricted. (10) Emergency operation stop LED (MENU key) The MENU key lights red when the system has automatically shutdown due to a fan stoppage or internal temperature error detection.

5.7 Wiring Systems

Item	Specifications
Method	Single-phase two-wire (1P2W) Single-phase three-wire (1P3W) Three-phase three-wire (3P3W, 3P3W (3V3A), 3P3W (3V3AR)), 3P3W (3V3A)→3P4W*, 3P3W (3V3AR)→3P4W* Three-phase four-wire (3P4W)(3P4W, 3P4W→3P3W (3V3AS)*)

* Wiring system with the delta transformation function

Waveform, basic measurement values, and harmonics, as well as measured values computed from them, are computed based on values that have been transformed between phase voltage and line-to-line voltage.

The original measured values before delta transformation are displayed as delta computation values.

The rectifier cannot be turned on when a wiring system with the delta transformation function is set.

5.8 Measuring Mode

Measurement functions determined for each input element

Item	Specifications
During normal measurement	Computing method
	Sync source period average
	Calculated using sync source period average in auto update mode
	Constant-interval update mode
	Data update interval
	10 ms/50 ms/100 ms/200 ms/500 ms/1 s/2 s/5 s/10 s/20 s
	Display screen:
	LCD: numeric display
	External monitor output: numeric, waveform (free run), bar, vector
	Single or split display
	Measurement function: normal, harmonic
	Trigger update mode
	Display screen:
	LCD: numeric display
	External monitor output: numeric, waveform (trigger operation), bar, vector
	Single or split display
	Measurement function: normal, harmonic
	However, the integration feature is not available.
	Auto update mode
	Data update interval: 10 ms, 50 ms
	Timeout: 1 s, 5 s, 10 s, or 20 s
	Screen: same as constant-interval update mode
	Measurement function: same as constant-interval update mode

5.9 Function

General functions

Item	Specifications
Crest factor setting	Select crest factor CF3, crest factor CF6, or crest factor CF6A.
Element	Can be set for each input element and wiring unit
Range setting	Fixed/set Fixed range setting Manually set the range of your choice. (only ranges that are selected by the valid measurement range selection function) Range Σ link: ON: Set the range for each wiring unit. OFF: Set the range for each element. Auto range setting Auto range setting function Range increase The range is increased if any of the following conditions are met. - When the measured value of Urms or Irms exceeds 110 % of the selected range (220 % when the crest factor is set to CF6A) - The input signal peak value (Upk, Ipk) is greater than or equal to approximately 310 % of the present range. (greater than or equal to 620 % for crest factor CF6/CF6A) Range decrease The measurement range is decreased when all the following conditions are met. - The data of Urms or Irms is less than or equal to 30 % of the measurement range. - The data of Urms or Irms is less than or equal to 105 % of the next lower range. - For CF3, the data of Upk or Ipk is less than or equal to 290 % of the next lower range. - CF6/CF6A, the data of Upk or Ipk is less than or equal to 580 % of the next lower range. Peak overrange occurrence range setting function A function that changes the range to the specified range when a peak overrange occurs Valid measurement range selection function A function that lets you select the valid measurement range according to the usage conditions. Ranges set to Use are included in the range configuration. All other ranges are excluded from range selection.
Element scaling	A feature that allows direct reading by setting the current sensor conversion ratio, VT ratio, CT ratio, and power coefficient SF CT ratio can be set automatically by selecting a model name of CT series. Source measurement function Set voltage U, current I, power (P, S, Q), maximum voltage (U+pk)/minimum voltage (U-pk), maximum current (I+pk)/minimum current (I-pk), maximum power (P+pk)/minimum power (P-pk), and VT ratio in the following range. Selectable range: 0.0001 to 99999.9999 For wiring with delta transformation, scaling is applied to VT and CT ratio data before delta transformation. Scaling is applied to SF data after delta transformation.

Item	Specifications
Averaging	Type: Exponential average, moving average Target: Normal measurement function Urms, Umn, Udc, Urmn, Uac, Irms, Imn, Idc, Irmn, Iac, P, S, Q, fU, fI, Torque, Speed, Pm, Aux (/EM1, /RM1, /EM2, /EM1RM1, /RM2 option) Harmonic measurement function U(k), I(k), P(k), S(k), Q(k) Exponential averaging, attenuation constant: 2 to 64 Moving average, average count: 8 to 64 Data reset: Averaging is reset if a setting of any of the functions below is changed. Averaging type, averaging attenuation constant Range, crest factor, range Σ link, wiring Scale value Line filter, frequency filter Data update interval, averaging method, sync source Zero-level compensation Maximum harmonic order, minimum harmonic order, harmonic window span Waveform observation time, measurement mode, update mode, multi-unit synchronization mode * During auto update mode, only exponential averaging can be used. * When multi-unit synchronization mode is on, only exponential averaging can be used.
Hold	Measurement hold: Suspends the measurement and display operations and holds the data display of each measurement function. However, measurement is not suspended during integration. Only the display is held. Communication output, and the like are also held. However, if only the display is held and measurement is continuing during integration, the storage function saves the measured values that are being updated.
Single measurement	A single measurement is performed at the specified data update rate while a measurement is being held and the hold state is maintained. If you press SINGLE when the measurement is not being held, measurement is performed again from that point. * When the update mode is Auto, single measurement is not possible.
Zero-level compensation (CAL)	Measurement element's circuit offset correction feature Manual: Executed under the current settings through a key operation or communication. Auto: Automatically executed when the measurement range is changed, when the filter is changed, or when integration is started. For wiring with delta transformation, zero-level compensation (Cal) is performed on data before delta transformation.
Zero-level compensation (Null)	Offset correction feature for all measurement circuits including measurement elements Executed under the current settings through a key operation or communication. Null state setting target: Set the target channel for the null ON operation. Null value update: Select the correction value for when null is ON: New: most recent DC measurement value or Hold: previous null value held last time [Upper null limit] For current input, the sum of the current offset correction value and the null correction value is considered the total offset. For voltage input, the null correction value is considered the total offset. The following is the upper limit for the total offset value. Analog input (Element/Motor/Aux): 10 % of range rating Pulse and resolver input (Motor/Aux) Speed: 10 % of [60/N 10000 Hz] [rpm] Torque: 10 % of the absolute value of Rated Upper [Nm] Rated Upper: The larger of "Nm-Hz coordinates $\times$ 2 points" for determining the linear scaling value Aux: 10 % of the upper pulse input specification limit 2 MHz [Hz] For wiring with delta transformation, zero-level compensation (Null) is performed on data before delta transformation. Do not perform zero-level correction (NULL) on resolver input.

5.9 Function

Item	Specifications																		
Phase difference polarity	The phase difference ϕ between the voltage and current indicates the current phase relative to the voltage of each element. Select the signs to apply to the lead and lag of this phase difference. • Lead(-)/Lag(+) Lead: negative (-) Lag: positive (+) • Lead(+)/Lag(-) Lead: positive (+) Lag: negative (-) The following measurement functions change signs depending on the phase difference polarity. Phase difference: ϕ, phase difference between the fundamental components: ϕ_{fnd}, Phase difference of harmonic measurement: $\phi(k)$, ϕ_{U1-U2}, ϕ_{U1-U3}, ϕ_{U1-I1}, ϕ_{U2-I2}, ϕ_{U3-I3} Other angles, the phase angle between $U(1)$ and $U(k)$: $\phi U(k)$, the phase angle between $I(1)$ and $I(k)$: $\phi I(k)$, and the electric angles: $EaU1$ to $EaU7$ are not affected by the phase difference polarity setting. Lead is positive (+), and lag is negative (-). For wiring with delta transformation, phase difference polarity is calculated based on the phase difference after delta transformation.																		
Current sensor correction	Input element current correction function Can be set for each element. Can be turned on or off. <table> <tr> <td>Amplitude correction</td><td>Selectable range: 0.800000 - 1.200000 Resolution: 0.000001</td></tr> <tr> <td>Offset correction</td><td>Selectable range: $\pm 9.99999E\pm 3$ Resolution: 6 digits, floating point E-3 to E+3 Valid resolution: resolution of the measurement range Correction range: Up to $\pm 10\%$ of the measurement range for the combined total of current offset correction and null zero level correction.</td></tr> <tr> <td>Phase correction</td><td>Frequency setting range: 50 Hz, 60 Hz, 0.1 kHz to 999.9 kHz (0.1 kHz steps), 1 MHz Phase difference setting range: -180.000° to $+180.000^\circ$ * The phase difference can be set within the range where the time difference between input and output is $\pm 10\ \mu\text{s}$. * Correction accuracy: 1 ns typ</td></tr> </table>	Amplitude correction	Selectable range: 0.800000 - 1.200000 Resolution: 0.000001	Offset correction	Selectable range: $\pm 9.99999E\pm 3$ Resolution: 6 digits, floating point E-3 to E+3 Valid resolution: resolution of the measurement range Correction range: Up to $\pm 10\%$ of the measurement range for the combined total of current offset correction and null zero level correction.	Phase correction	Frequency setting range: 50 Hz, 60 Hz, 0.1 kHz to 999.9 kHz (0.1 kHz steps), 1 MHz Phase difference setting range: -180.000° to $+180.000^\circ$ * The phase difference can be set within the range where the time difference between input and output is $\pm 10\ \mu\text{s}$. * Correction accuracy: 1 ns typ												
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Phase correction of electric angle	Phase correction of electric angle function of the motor evaluation option Selectable range: -180.00 to 180.00°																		
Auto sensor setting	Detected current sensors are automatically set to the corresponding current sensor models. For each element, the function can be turned on or off. Detectable current sensors: CT2000A, CT1000A Connect the current sensor before turning on the instrument. Current sensors connected after the instrument is turned on are not detected. • Auto sensor setting is ON • Current sensor detected To set different types of current sensors for the elements in the same wiring unit, set Range Σ Link to OFF.																		
Storage	<table> <tr> <td colspan="2">Stores numeric data to internal memory and a USB memory device</td></tr> <tr> <td>Save interval</td><td>Data update interval, specified time, or specified interval</td></tr> <tr> <td>Synchronization</td><td>Manual, real time, integration, event, single shot</td></tr> <tr> <td>Storage count</td><td>1 to 9999999</td></tr> <tr> <td>Time interval</td><td>10 ms to 99 h59 m59 s</td></tr> <tr> <td>File format</td><td>Binary</td></tr> <tr> <td>Maximum data file size</td><td>1 GB</td></tr> <tr> <td>Saved data conversion</td><td>Converts to CSV. Saves to USB memory. • CSV file size of up to 4 GB can be converted. • When the binary file is in the internal memory, a CSV file is saved in the root directory of the USB memory device.</td></tr> <tr> <td>Auto CSV conversion</td><td>CSV conversion is performed automatically when the binary file is completed after storage is completed or finished. (ON/OFF)</td></tr> </table>	Stores numeric data to internal memory and a USB memory device		Save interval	Data update interval, specified time, or specified interval	Synchronization	Manual, real time, integration, event, single shot	Storage count	1 to 9999999	Time interval	10 ms to 99 h59 m59 s	File format	Binary	Maximum data file size	1 GB	Saved data conversion	Converts to CSV. Saves to USB memory. • CSV file size of up to 4 GB can be converted. • When the binary file is in the internal memory, a CSV file is saved in the root directory of the USB memory device.	Auto CSV conversion	CSV conversion is performed automatically when the binary file is completed after storage is completed or finished. (ON/OFF)
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File format	Binary																		
Maximum data file size	1 GB																		
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Auto CSV conversion	CSV conversion is performed automatically when the binary file is completed after storage is completed or finished. (ON/OFF)																		
Data save	Save numeric data, waveform data, and screen images to the internal memory, a USB memory device, or a network drive																		
Saving and Loading Setup Parameters	Save setup parameters to the internal memory, a USB memory device, or a network drive Load saved setup parameters.																		
File operation	Create folder, copy, move, rename, protect, delete																		

Item	Specifications
Master and Slave Synchronized Measurement	A feature for synchronizing the measurement start on slave devices to the master device Connector type BNC: Same for master and slaves TTL: Same for master and slaves Output logic Negative logic, falling edge: Applies to the master Output hold time Low level, 500 ns or more: Applies to the master Input logic Negative logic, falling edge: Applies to slaves Minimum pulse width Low level, 500 ns or more: Applies to slaves Measurement start output signal delay Applies to the master: within 1 μs Measurement start delay Applies to slaves: within 2 μs Maximum number of connected units 4 units Data update interval 50 ms to 20 s Measuring mode During normal measurement
History	Holds the past measurement update data history up to the maximum number of history entries - Maximum number of historical entries: 40 The data in the history is transmitted according to the history communication output mode. History communication output mode - N update: Notifies via the status register after every N data updates since measurement began. The range of numerical data transmitted from the history is over the history communication output count (N), counting backward from the notification point. History communication output count - Manually select the number times to output update data at once during history communication output. - Range: 1 to 20 Communication output command - History communication numeric data output - History communication numeric list output
User-defined function	A function for performing computation by combining measurement function symbols Calculation count: 20 Maximum number of operands: 16 Number of characters in an expression: Up to 120 Number of unit characters: Up to 8 Operators: +, -, $\times$, $\div$, ABS, SQR, SQRT, LOG, LOG10, EXP, NEG, SIN, COS, TAN, ASIN, ACOS, ATAN Parameters: Element, Σ unit, harmonic order
MAX Hold	Can be defined using the user-defined function
Efficiency formula	4
User-defined events	Uses measurement functions and user-defined events as criteria. Event: Measurement condition Reference condition: <, <=, =, >, >=, != Number of events: 8
Peak overrange detection	Elements, Motor(/EM1, /RM1, /EM2, /EM1RM1, /RM2) When any element or motor range tolerance is exceeded, the peak overrange indicator LED lights red. Peak overrange information is displayed on the LCD screen's peak overrange status display and on the external monitor output screen. Peak overrange detection for elements is determined before the digital LPF. For wiring with delta transformation, peak overrange detection for elements is performed before delta transformation.
System configuration	Date and time, message language, menu language
Time setting	Sets the time at startup using the Simple Network Time Protocol (SNTP)
Time synchronization feature	Synchronization source: Supports IEEE1588-2008 (PTP v2) (slave only) Supports PTP packets of Layer3 (UDP/IPv4) and Layer2 (Ethernet) Supports Ordinary Clock Supports E2E and P2P delay correction Synchronization target: time data (excluding data update rate and sampling clock) Synchronization accuracy: $\pm 10 \mu$s Typical (when synchronized), ± 0.02 % (when not synchronized)
Initialization function	Returns the settings to their factory default values Settings that are not initialized: date and time, communication settings, menu language, message language, environmental settings* Maximum hold reset function for integration start * Environmental settings (Preference): Indication that appears when the frequency or motor pulse frequency is less than the lower limit, decimal point and separator used when saving to ASCII format (.csv), date format Starting the instrument with the ESC key held down returns all settings except the date and time to their factory default values.

5.9 Function

Item	Specifications
Self-test	Memory, keyboard
Upgrading	Updates the firmware and prompts the user to input the add-on package license keys

Averaging function

Method	Math
Sync source period average	Averaging performed over a specified period Set the calculation period using the set reference signal (sync source) (excluding WP and DC q) Synchronization source: UE, IE, EXT CLK, Z (/EM1, /RM1, /EM2, /EM1RM1, /RM2 option) The period of UE and IE is detected using a specified trigger value from the waveform sampling data (E is the element number.) For wiring with delta transformation, if the sync source is set to UE or IE, the computation period is set based on the data after delta transformation. Data update interval: • When the update mode is Constant or Trigger: 10 ms/50 ms/100 ms/200 ms/500 ms/1 s/2 s/5 s/10 s/20 s • When the update mode is Auto: 10 ms/50 ms Averaging period: • When the update mode is Constant or Trigger: Data update interval or less • When the update mode is Auto: Timeout period or less

Filter function

Item	Specifications																										
Line filter	For elements 1 to 4 Can be set separately for each element Calculation rate Calculation rate: 2.5 MS/s Filter response Butterworth Filter form: IIR Filter type: LPF Filter order: 2 Cutoff characteristics: -12 dB/Oct (typical) LPF: cutoff frequency: 100 Hz - 200 kHz, 300 kHz Resolution: 100 Hz * Analog filter Filter response: Bessel Filter type: LPF Filter order: 4 Valid for the following cases when the line filter is on • When advance line filter setting is off • When advance line filter setting is on and AAF is on Anti-aliasing Set using the analog filter																										
	For Elements 1 to 4 harmonic measurement The anti-aliasing filter used for resampling in harmonic measurement can be configured independently of the filter used for normal measurement. It can be configured independently for each element. When advanced line filter setting is OFF, the filter follows the element line filter. When advanced line filter setting is ON, the filter is used for harmonic measurement (independent of the element line filter). Calculation rate Calculation rate: 2.5 MS/s When advance line filter setting is off According to the line filter for the element When advance line filter setting is on For harmonic measurement (independent of the line filter for the element) Filter response Butterworth Filter form: IIR Filter type: LPF Filter order: 4 Cutoff characteristics: -24 dB/Oct (typical) LPF: cutoff frequency 100 Hz to 200 kHz, 300 kHz* Resolution: 100 Hz * Analog filter Filter response: Bessel Filter type: LPF Filter order: 4 Auto Harmonic Filter Settings Automatic setting of the cutoff frequency based on the fundamental frequency <table> <tr> <th>fundamental frequency</th><th>cutoff frequency</th></tr> <tr> <td>0.10 Hz to 0.35 Hz</td><td>0.1 kHz</td></tr> <tr> <td>0.35 Hz to 1.8 Hz</td><td>0.5 kHz</td></tr> <tr> <td>1.8 Hz to 9.0 Hz</td><td>2.5 kHz</td></tr> <tr> <td>9.0 Hz to 45 Hz</td><td>12.6 kHz</td></tr> <tr> <td>45 Hz to 75 Hz</td><td>64.3 kHz</td></tr> <tr> <td>75 Hz to 98 Hz</td><td>105.8 kHz</td></tr> <tr> <td>98 Hz to 197 Hz</td><td>139.6 kHz</td></tr> <tr> <td>197 Hz to 395 Hz</td><td>140.3 kHz</td></tr> <tr> <td>395 Hz to 760 Hz</td><td>139.9 kHz</td></tr> <tr> <td>760 Hz to 1410 Hz</td><td>134.6 kHz</td></tr> <tr> <td>1410 Hz to 1970 Hz</td><td>124.6 kHz</td></tr> <tr> <td>1970 Hz to 2600 Hz</td><td>175.1 kHz</td></tr> </table> Valid for the following cases when the line filter is on • When advance line filter setting is off • When advance line filter setting is on and AAF is on Anti-aliasing Set with the analog filter and digital filter	fundamental frequency	cutoff frequency	0.10 Hz to 0.35 Hz	0.1 kHz	0.35 Hz to 1.8 Hz	0.5 kHz	1.8 Hz to 9.0 Hz	2.5 kHz	9.0 Hz to 45 Hz	12.6 kHz	45 Hz to 75 Hz	64.3 kHz	75 Hz to 98 Hz	105.8 kHz	98 Hz to 197 Hz	139.6 kHz	197 Hz to 395 Hz	140.3 kHz	395 Hz to 760 Hz	139.9 kHz	760 Hz to 1410 Hz	134.6 kHz	1410 Hz to 1970 Hz	124.6 kHz	1970 Hz to 2600 Hz	175.1 kHz
fundamental frequency	cutoff frequency																										
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9.0 Hz to 45 Hz	12.6 kHz																										
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75 Hz to 98 Hz	105.8 kHz																										
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395 Hz to 760 Hz	139.9 kHz																										
760 Hz to 1410 Hz	134.6 kHz																										
1410 Hz to 1970 Hz	124.6 kHz																										
1970 Hz to 2600 Hz	175.1 kHz																										

5.9 Function

Item	Specifications
	For motor/resolver (/EM1, /RM1, /EM2, /EM1RM1, /RM2) Can be set for the analog input of each channel Calculation rate Calculation rate: 2.5 MS/s Filter response Butterworth
Frequency filter	Elements 1 to 4, for frequency measurement and sync source Can be set separately for each element Calculation rate Calculation rate: 2.5 MS/s Filter response Butterworth Filter form: IIR+FIR Filter type: LPF Filter order: 2 Select from OFF, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, 16 kHz, 32 kHz Automatically selects from OFF, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, and 32 kHz based on the input voltage frequency Cutoff characteristics: -12 dB/Oct (typical)

Integration function

Item	Specifications
Sample rate	2.5 MS/s
Calculation period	Manual, integration time, real-time control Integration time repetition, real-time control repetition Integration timer range: 0 h00 m00 s to 10000 h00 m00 s Count over: When the maximum integration time (10000 hours) is reached or when an integrated value reaches the maximum or minimum displayable integrated value (± 999999 MWh, ± 999999 MAh, ± 999999 MVAh, ± 999999 Mvarh), the integration time and value at that point are held and integration is stopped. Runs manually when the update mode is Auto. Does not run during integration-time or real-time control.
Power failure recovery	The integration restart function resumes integration operation upon power restoration if a power outage occurs during integration. This function cannot be used during auto update mode or multi-unit synchronization mode. Integration results in error and cannot be continued.
Independent integration	Integration can be executed separately for each element. Independent integration is fixed to off during multi-unit synchronization.
Auto calibration	Auto offset calibration function Zero-level compensation is performed at the current range of all elements approximately every hour.
Timer accuracy	± 0.02 % of reading
Integration accuracy	$\pm$ [Power accuracy (or current accuracy) + timer accuracy]

Frequency measurement function

Item	Specifications
Device under measurement	Measures the frequency of the voltage or current applied to all input elements
Measurement system	A/D data level trigger gate generation Reciprocal method
Display resolution	99999
Minimum frequency resolution	0.0001 Hz

Item	Specifications																						
Measurement time period	$0.1 \text{ Hz} \leq f \leq 1 \text{ MHz}$ 100 kHz or less for HV element voltage The measurement range is limited by the element's measurement bandwidth. The measurement range is limited by the data update interval. As follows: <table> <tr> <th>Data update interval</th><th>Measurement time period</th></tr> <tr><td>10 ms</td><td>$200 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> <tr><td>50 ms</td><td>$45 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> <tr><td>100 ms</td><td>$20 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> <tr><td>200 ms</td><td>$10 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> <tr><td>500 ms</td><td>$5 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> <tr><td>1 s</td><td>$2 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> <tr><td>2 s</td><td>$1 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> <tr><td>5 s</td><td>$0.5 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> <tr><td>10 s</td><td>$0.2 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> <tr><td>20 s</td><td>$0.1 \text{ Hz} \leq f \leq 1 \text{ MHz}$</td></tr> </table> In auto update mode, refer to the table above by substituting "timeout period" with "data update interval". The display limit is 1.1 times the upper limit of the measurement range (1.1 MHz). Display: Error, 32-bit floating-point value: 0xFFFFFFFF	Data update interval	Measurement time period	10 ms	$200 \text{ Hz} \leq f \leq 1 \text{ MHz}$	50 ms	$45 \text{ Hz} \leq f \leq 1 \text{ MHz}$	100 ms	$20 \text{ Hz} \leq f \leq 1 \text{ MHz}$	200 ms	$10 \text{ Hz} \leq f \leq 1 \text{ MHz}$	500 ms	$5 \text{ Hz} \leq f \leq 1 \text{ MHz}$	1 s	$2 \text{ Hz} \leq f \leq 1 \text{ MHz}$	2 s	$1 \text{ Hz} \leq f \leq 1 \text{ MHz}$	5 s	$0.5 \text{ Hz} \leq f \leq 1 \text{ MHz}$	10 s	$0.2 \text{ Hz} \leq f \leq 1 \text{ MHz}$	20 s	$0.1 \text{ Hz} \leq f \leq 1 \text{ MHz}$
Data update interval	Measurement time period																						
10 ms	$200 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
50 ms	$45 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
100 ms	$20 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
200 ms	$10 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
500 ms	$5 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
1 s	$2 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
2 s	$1 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
5 s	$0.5 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
10 s	$0.2 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
20 s	$0.1 \text{ Hz} \leq f \leq 1 \text{ MHz}$																						
Accuracy	$\pm 5 \text{ mHz}$ (45 to 66 Hz, update rate 50 ms or more) $\pm 0.06 \%$ of reading $\pm 0.1 \text{ mHz}$ (otherwise)																						
Conditions	45 to 66 Hz and update rate 50 ms or higher: for inputs whose signal level is 50 % or higher of the measurement range. For input that is 100 % or higher if the crest factor is CF6/CF6A In all other cases: For inputs whose signal level is 30 % or higher of the measurement range For input that is 60 % or higher if the crest factor is CF6/CF6A where Frequency filter setup condition <table> <tr> <th>Measurement range</th><th>Cutoff frequency</th></tr> <tr><td>0.1 Hz to 100 Hz</td><td>fc=125 Hz</td></tr> <tr><td>100 Hz to 200 Hz</td><td>fc=250 Hz</td></tr> <tr><td>200 Hz to 400 Hz</td><td>fc=500 Hz</td></tr> <tr><td>400 Hz to 800 Hz</td><td>fc=1 kHz</td></tr> <tr><td>800 Hz to 1.6 kHz</td><td>fc=2 kHz</td></tr> <tr><td>1.6 kHz to 3.2 kHz</td><td>fc=4 kHz</td></tr> <tr><td>3.2 kHz to 6.4 kHz</td><td>fc=8 kHz</td></tr> <tr><td>6.4 kHz to 12.8 kHz</td><td>fc=16 kHz</td></tr> <tr><td>12.8 kHz to 30 kHz</td><td>fc=32 kHz</td></tr> </table>	Measurement range	Cutoff frequency	0.1 Hz to 100 Hz	fc=125 Hz	100 Hz to 200 Hz	fc=250 Hz	200 Hz to 400 Hz	fc=500 Hz	400 Hz to 800 Hz	fc=1 kHz	800 Hz to 1.6 kHz	fc=2 kHz	1.6 kHz to 3.2 kHz	fc=4 kHz	3.2 kHz to 6.4 kHz	fc=8 kHz	6.4 kHz to 12.8 kHz	fc=16 kHz	12.8 kHz to 30 kHz	fc=32 kHz		
Measurement range	Cutoff frequency																						
0.1 Hz to 100 Hz	fc=125 Hz																						
100 Hz to 200 Hz	fc=250 Hz																						
200 Hz to 400 Hz	fc=500 Hz																						
400 Hz to 800 Hz	fc=1 kHz																						
800 Hz to 1.6 kHz	fc=2 kHz																						
1.6 kHz to 3.2 kHz	fc=4 kHz																						
3.2 kHz to 6.4 kHz	fc=8 kHz																						
6.4 kHz to 12.8 kHz	fc=16 kHz																						
12.8 kHz to 30 kHz	fc=32 kHz																						
Frequency detection signal level setting	Setting range Rectifier OFF: $\pm 100 \%$ of range Rectifier ON: 0 % to +100 % of range																						

When auto frequency filter is on Measurement range Cutoff frequency

Input frequency	Cutoff frequency
0.1 Hz to 100 Hz	125 Hz
97 Hz to 200 Hz	250 Hz
194 Hz to 400 Hz	500 Hz
388 Hz to 800 Hz	1 kHz
776 Hz to 1.6 kHz	2 kHz
1.5 kHz to 3.2 kHz	4 kHz
3.1 kHz to 30 kHz	32 kHz
30 kHz	32 kHz

- A 3 % hysteresis is applied for range-down switching.
- When the input frequency exceeds 30 kHz, turn OFF the auto frequency filter.

Harmonic measurement function

Measurement functions determined for each input element

Item	Specifications
Device under measurement	All installed elements
Method	PLL synchronization method
Frequency range	Fundamental frequency: 0.1 Hz to 2.6 kHz Analysis frequency: 0.1 Hz to 260 kHz
PLL source	Select the input element's voltage or current or external clock. Input level: • 50 % or more of the rated measurement range when the crest factor is CF3. • 100 % or more of the rated measurement range when the crest factor is CF6 or CF6A. The conditions in which frequency filters are turned on are the same as those for frequency measurements.
Number of FFT points	Auto set to 1024 or 8192
Window function	Rectangular
Anti-aliasing	Set with the analog filter or harmonic measurement filter

Harmonic analysis when auto harmonic filter is off

Fundamental frequency	Number of FFT points	Sample rate	Window width	Upper limit of harmonic analysis*
0.1 Hz to 197 Hz	8192	f×8192	1 waves	100
197 Hz to 395 Hz	8192	f×4096	2 waves	100
395 Hz to 760 Hz	8192	f×2048	4 waves	100
760 Hz to 1410 Hz	1024	f×1024	1 waves	100
1410 Hz to 2600 Hz	1024	f×512	2 waves	100

The upper measured harmonic limit is 50 when multi-unit synchronization mode is Main or Sub Unit.

Harmonic analysis when auto harmonic filter is on

Fundamental frequency	Number of FFT points	Sample rate	Window width	Upper limit of harmonic analysis*	Harmonic filter Cutoff frequency [Hz]
0.10 Hz to 0.35 Hz	8192	f×8192	1 waves	100	0.1 k
0.35 Hz to 1.8 Hz	8192	f×8192	1 waves	100	0.5 k
1.8 Hz to 9.0 Hz	8192	f×8192	1 waves	100	2.5 k
9.0 Hz to 45 Hz	8192	f×8192	1 waves	100	12.6 k
45 Hz to 75 Hz	8192	f×8192	1 waves	100	64.3 k
75 Hz to 98 Hz	8192	f×8192	1 waves	100	105.8 k
98 Hz to 197 Hz	8192	f×8192	1 waves	50	139.6 k
197 Hz to 395 Hz	8192	f×4096	2 waves	25	140.3 k
395 Hz to 760 Hz	8192	f×2048	4 waves	13	139.9 k
760 Hz to 1410 Hz	1024	f×1024	1 waves	7	134.6 k
1410 Hz to 1970 Hz	1024	f×512	2 waves	5	124.6 k
1970 Hz to 2600 Hz	1024	f×512	2 waves	3	175.1 k

The upper measured harmonic limit is 50 when multi-unit synchronization mode is Main or Sub Unit.

Item	Specifications								
Harmonic measurement accuracy	Accuracy Add the following accuracy values to the normal measurement accuracy values. • When the line filter is off • When the crest factor is set to CF3 • When λ (the power factor) is 1 <table> <tr> <td>Frequency</td><td>Voltage, current</td></tr> <tr> <td>0.1 Hz ≤ f ≤ 260 kHz</td><td>±(0.05 % of reading + 0.25 % of range)</td></tr> <tr> <td>Frequency</td><td>Power</td></tr> <tr> <td>0.1 Hz ≤ f ≤ 260 kHz</td><td>±(0.1 % of reading + 0.5 % of range)</td></tr> </table>	Frequency	Voltage, current	0.1 Hz ≤ f ≤ 260 kHz	±(0.05 % of reading + 0.25 % of range)	Frequency	Power	0.1 Hz ≤ f ≤ 260 kHz	±(0.1 % of reading + 0.5 % of range)
Frequency	Voltage, current								
0.1 Hz ≤ f ≤ 260 kHz	±(0.05 % of reading + 0.25 % of range)								
Frequency	Power								
0.1 Hz ≤ f ≤ 260 kHz	±(0.1 % of reading + 0.5 % of range)								

- When the line filter is on
Add the line filter influence to the accuracy values when the line filter is off.
- Power figures that exceed 10 kHz are for reference only.
- Add $(n/500)$ % of reading to the n th component of the voltage and current, and add $(n/250)$ % of reading to the n th component of the power.
- The accuracy when the crest factor is CF6 or CF6A is the same as that 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 ordinary measurement.
- The neighboring harmonic orders may be affected by the side lobes from the input harmonic order.

For n th order component input, add $\{[n/(m+1)]/50\}$ % of (the n th order reading) to the $n + m$ th order and $n - m$ th order of the voltage and current, and add $\{[n/(m+1)]/25\}$ % of (the n th order reading) to the $n + m$ th order and $n - m$ th order of the power.

- When the update mode is Constant or Trigger:
When the data update interval is 10 ms, the harmonic analysis function is not available.
- When the update mode is Auto:
When the data update interval is 10 ms, there is a 100-ms measurement pause (10 data update intervals) between harmonic calculations.
The maximum harmonic order that can be measured is 10.
- The measured harmonic order upper limit is set to the lowest value among the input elements in the group.

Resolver operation function

Item	Specifications
Feature overview	Rotating speed is calculated by calculating the angle from the carrier signal, sine signal, or cosine signal applied to the Motor Evaluation Function for Resolver (input type: resolver) and converting to Z pulse.
Computation result storage format	Single-precision floating-point (32 bit)
Calculation rate	2.5 MS/s
Calculation type	The angle of rotation is computed from the carrier signal, sine signal, and cosine signal. Supported carrier frequencies: 1 kHz to 20 kHz Tracking filter bandwidth setting: 100 Hz, 250 Hz, 1 kHz, 2 kHz

Multi-unit synchronization(/SY1 Option)

Item	Specifications
Synchronization Configuration	4 (dedicated ports) Up to four sub units can be connected to a main unit.
Synchronized measurement	Measurement modes available for multi-unit synchronization Normal measurement mode's constant-interval update mode, trigger update mode, and auto update mode
Synchronization accuracy	±400 ns - Measurement start delay applied to sub units ±400 ns - Time synchronization applied to sub units: ±400 ns - Common ZC signal and common PLL signal shared between units 1) Synchronization accuracy between units sharing common ZC signals and common PLL signals for the specified synchronization source or PLL source: ±400 ns 2) Maximum delay time from ZC detection at the input source designated for the common ZC signal and common PLL signal shared between units to ZC detection at each unit's synchronization source or PLL source: cable length [m] × 20 ns ± 400 ns
Synchronization	Synchronization function for main unit and sub units - Data update interval synchronization - Synchronized integration - Time synchronization - Synchronization source synchronization - PLL source synchronization - Harmonic analysis trigger synchronization for electrical angle measurement - Trigger source synchronization for triggered measurement mode Synchronized operation of sub units from main unit - Integration start, stop, reset; hold, single; manual calibration; NULL - Set the sub unit's measurement range and other measurement conditions from the main unit
Measurement data collected by main unit	The following items are collected from each sub unit from the main unit. - All normal measurement values, all harmonic analysis values (up to the 50th harmonic), all PP compressed waveform data Measurement data collected from sub units are output from the main unit. - Output target: external monitor output screen, communication output, store, data save to file, CAN output Measurement data collected from sub units can be used in efficiency calculation, user-defined computation, and user-defined events of the main unit.
Setup synchronization	Set measurement conditions from the main unit to sub units - Unit-specific setting range, line filter, frequency filter, various types of scaling, wiring, harmonic settings, etc. Unit common settings - Update mode, update interval, averaging, measurement settings, etc. Setting File - The main unit saves and restores the settings for all units in a single setting file.

Item	Specifications
Synchronization configuration	Setting synchronization Sets measurement conditions from the main unit to the subunits. - Unit-specific settings: ranges, line filters, frequency filters, various scaling, wiring, harmonic settings, etc. Common unit settings - Update mode, update interval, averaging, measurement settings, etc. Setup file - The main unit saves and restores the settings of all units in one setup file.
Compatible devices	WT1500

During multi-unit synchronization, the data update interval cannot be set to 10 ms.

5.10 Measurement Function Computation

Normal measurement function

Measurement functions determined for each input element

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, Ufnd: fundamental 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, Ifnd: fundamental component
Active power (W)	P Pfnd: Fundamental power component
Apparent power (VA)	S Sfnd: Fundamental component
Reactive power (var)	Q Qfnd: Fundamental component
Power factor	λ λ fnd: Fundamental component
Phase difference (°)	Φ Φ fnd: Fundamental component
Frequency (Hz)	fU (FreqU): voltage frequency, fI (FreqI): current frequency The fU and fI of elements 1 to 4 can be measured simultaneously.
Corrected Power(W)	Pc Applicable standards: IEC76-1 (1976), IEC76-1 (2011)
Voltage max. and min. (V)	U+pk: maximum voltage, U-pk: minimum voltage
Current max. and min. (A)	I+pk: maximum current, I-pk: minimum current
Power max. and min. (W)	P+pk: maximum power, P-pk: minimum power
Crest factor (peak-to-rms ratio)	CfU: voltage crest factor, CfI: current crest factor
Integration	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, Iac, or Irmn.
Voltage ripple rate	Urip
Current ripple rate	Irip

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

Item	Symbols and Meanings
Voltage (V)	Urms Σ : true rms value, Umn Σ : rectified mean value calibrated to the rms value, Udc Σ : simple average, Urmn Σ : current rectified mean value, Uac Σ : AC component
Current (A)	Irms Σ : true rms value, Imn Σ : rectified mean value calibrated to the rms value, Idc Σ : simple average, Irmn Σ : current rectified mean value, Iac Σ : AC component
Active power (W)	P Σ
Apparent power (VA)	S Σ
Reactive power (var)	Q Σ
Corrected Power(W)	Pc Σ Applicable standards IEC76-1(1976), IEC76-1(2011)

Item	Symbols and Meanings
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) $WS\Sigma$: Integration of $S\Sigma^*$ $WQ\Sigma$: Integration of $Q\Sigma^*$
Power factor	$\lambda\Sigma$
Phase difference (°)	$\Phi\Sigma$
Three-phase voltage unbalance factor	$Uubf\Sigma$
Three-phase current unbalance factor	$Iubf\Sigma$

Harmonic measurement function

Measurement functions determined for each input element

Item	Symbols and Meanings
Voltage (V)	$U(k)$: rms voltage value of harmonic order k k^1
Current (A)	$I(k)$: rms current value of harmonic order k I : total rms current ²
Active power (W)	$P(k)$: active power of harmonic order k P : total active power ²
Apparent power (VA)	$S(k)$: apparent power of harmonic order k S : total apparent power ²
Reactive power (var)	$Q(k)$: reactive power of harmonic order k Q : total reactive power ²
Power factor	$\lambda(k)$: power factor of harmonic order k λ : total power factor (Total value ²)
Phase difference (°)	$\Phi(k)$: phase difference between the voltage and current of harmonic order k , Φ : 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 (Ω)	$Z(k)$: impedance of the load circuit in relation to harmonic order k
Load circuit resistance and Reactance (Ω)	$R_s(k)$: 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
Fundamental voltage component (V)	U_{fnd} : $U(1)$
Fundamental current component (A)	I_{fnd} : $I(1)$
Fundamental active power (W)	P_{fnd} : $P(1)$
Fundamental apparent power (VA)	S_{fnd} : $S(1)$
Fundamental reactive power (var)	Q_{fnd} : $Q(1)$
Fundamental power factor	λ_{fnd} : $\lambda(1)$
Phase difference between the fundamental voltage signal and fundamental current signal (°)	Φ_{fnd} : $\Phi(1)$
Harmonic distortion factor (%)	$Uhdf(k)$: ratio of harmonic voltage $U(k)$ to $U(1)$ or U $Ihdf(k)$: ratio of harmonic current $I(k)$ to $I(1)$ or I $Phdf(k)$: ratio of harmonic active power $P(k)$ to $P(1)$ or P
Total harmonic distortion (%)	$Uthd$: ratio of the total harmonic voltage to $U(1)$ or U^3 $Ithd$: ratio of the total harmonic current to $I(1)$ or I^3 $Pthd$: ratio of the total harmonic active power to $P(1)$ or P^3

5.10 Measurement Function Computation

Item	Symbols and Meanings
Telephone harmonic factor (applicable standard IEC34-1 (1996))	Uthf: voltage telephone harmonic factor, lthf: current telephone harmonic factor
Telephone influence factor (applicable standard IEEE Std 100 (1996))	Utif: voltage telephone influence factor, Itif: current telephone influence factor
Harmonic voltage factor ⁴	hvf: harmonic voltage factor
Harmonic current factor ⁴	hcf: harmonic current factor
K-factor	Ratio of the 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 100th harmonic order.
- 2 The total value is determined according to the equation on page App-5 of IMWT1501-01EN from the fundamental wave (1st harmonic) and all harmonic components (2nd harmonic to the upper limit of harmonic analysis). The DC component can also be included.
- 3 Total harmonic values are determined from all harmonic components (the 2nd harmonic to the upper limit of harmonic analysis) according to the equations on page App-7 of IMWT1501-01EN.
- 4 The expression may vary depending on the definitions in the standard. For details, see the corresponding standard.

Motor evaluation function for encoder and resolver

The number of motors that can be measured varies depending on the type of revolution signal and whether electrical angle measurement is available.

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

The number of motors that can be measured varies depending on the type of rotation signal and whether electrical angle measurement is used.

Conditions		Maximum number of motors for which motor output (Pm) and motor efficiency can be measured				
Revolution signal input type	Electrical angle measurement	/EM1	/RM1	/EM1RM1	/EM2	/RM2
Encoder	Yes	1	N/A	1	2	N/A
Encoder	No	2	N/A	2	4	N/A
Resolver	Yes	N/A	1	1	N/A	2
Resolver	No	N/A	1	1	N/A	2

Measurement range

Applicable for communication output and storage function

Item	Symbols and Meanings
Voltage measurement range	RngU[V]
Current measurement range	RngI[A] (when the sensor output type is Voltage, the unit is [V])
Speed measurement range	RngSpd[V]
Torque measurement range	RngTrq[V]
Aux measurement range	RngAux[V]

Timestamp

Measurement data timestamp

Item ¹	Symbols and Meanings
Data update interval's date ²	TS Date
Data update interval's time ²	TS Time
Data update interval's fractional time ²	TS Subsec[usec]
Normal measurement: Measurement period's date of power elements 1 to 4 ³	TS Date NrmPwr1-4
Normal measurement: Measurement period's time of power elements 1 to 4 ³	TS Time NrmPwr1-4
Normal measurement: Measurement period's fractional time of power elements 1 to 4 ³	TS Subsec NrmPwr1-4[usec]
Normal measurement: Measurement period's date of motor evaluation 1 to 4 ³	TS Date NrmMtr1-4
Normal measurement: Measurement period's time of motor evaluation 1 to 4 ³	TS Time NrmMtr1-4
Normal measurement: Measurement period's fractional time of motor evaluation 1 to 4 ³	TS Subsec NrmMtr1-4[usec]
Normal measurement: Measurement period's date of auxiliary inputs 1 to 8 ³	TS Date NrmAux1-8
Normal measurement: Measurement period's time of auxiliary inputs 1 to 8 ³	TS Time NrmAux1-8
Normal measurement: Measurement period's fractional time of auxiliary inputs 1 to 8 ³	TS Subsec NrmAux1-8
Harmonic measurement: Measurement period's date of power elements 1 to 4 ³	TS Date HrmPwr1-4
Harmonic measurement: Measurement period's time of power elements 1 to 4 ³	TS Time HrmPwr1-4
Harmonic measurement: Measurement period's fractional time of power elements 1 to 4 ³	TS Subsec HrmPwr1-4[usec]

1 The data update interval's timestamp is the start position of the data update interval. The measurement period's timestamp is the first sample of the measurement period.

2 Timestamps valid in all update modes (Constant, Trigger, and Auto).

3 Timestamps valid when the update mode is Auto.

Update status

Applicable for communication output and storage function

Item	Symbols and Meanings
Power element measurement update status for normal measurement ⁴	UpdateStsPwr
Motor evaluation data update status for normal measurement ⁴	UpdateStsMtr
Auxiliary signal input data update status for normal measurement ⁴	UpdateStsAux
Power element data update status for harmonic measurement ⁴	UpdateStsHrm

4 Valid when the update mode is Auto.

5.11 Auxiliary I/O

External start signal I/O connector

Item	Specifications
Input connector type	BNC: Same for master and slaves
Input level	TTL: Same for master and slaves
Output logic	Negative logic, falling edge: Applies to the master
Output hold time	Low level, 500 ns or more: applies to the master
Input logic	Negative logic, falling edge: Applies to slaves
Minimum pulse width	Low level, 500 ns or more: applies to the slave
Measurement start delay	Master: Within $(6\ \mu\text{s} + 12.8\ \mu\text{s} + \text{phase correction time})$ Slave: $(-2\ \mu\text{s} - 12.8\ \mu\text{s} - \text{phase correction time})$ to $(-12.8\ \mu\text{s} - \text{phase correction time})$

External clock input section

Item	Specifications
Input connector type	BNC
Input level	TTL
Sync signal input	Input frequency range: Same as the frequency measurement range Input waveform: 50 % duty cycle rectangular wave
Trigger input	Input logic: Negative logic, falling edge Minimum pulse width: 1 μs Trigger delay: $(-12\ \mu\text{s} - \text{phase correction time})$ to $(2\ \mu\text{s} - 12\ \mu\text{s} - \text{phase correction time})$
Harmonic measurement PLL source input	Frequency range: 0.5 Hz to 2.6 kHz Input waveform: 50 % duty cycle rectangular wave

CAN data output(/CN1 option)

Item	Specifications																																								
Connector type	D-sub 9 pin (male)																																								
	The pin arrangement is as follows.																																								
	<table><tr><th>Pin</th><th>Signal name</th><th>I/O</th><th>Function</th></tr><tr><td>1</td><td>N.C</td><td>—</td><td>Not used</td></tr><tr><td>2</td><td>CAN_L</td><td>Out</td><td>CAN low signal</td></tr><tr><td>3</td><td>GND</td><td>—</td><td>Ground (COM)</td></tr><tr><td>4</td><td>N.C.</td><td>—</td><td>Not used</td></tr><tr><td>5</td><td>N.C.</td><td>—</td><td>Not used</td></tr><tr><td>6</td><td>N.C.</td><td>—</td><td>Not used</td></tr><tr><td>7</td><td>CAN_H</td><td>Out</td><td>CAN high signal</td></tr><tr><td>8</td><td>N.C.</td><td>—</td><td>Not used</td></tr><tr><td>9</td><td>N.C.</td><td>—</td><td>Not used</td></tr></table>	Pin	Signal name	I/O	Function	1	N.C	—	Not used	2	CAN_L	Out	CAN low signal	3	GND	—	Ground (COM)	4	N.C.	—	Not used	5	N.C.	—	Not used	6	N.C.	—	Not used	7	CAN_H	Out	CAN high signal	8	N.C.	—	Not used	9	N.C.	—	Not used
Pin	Signal name	I/O	Function																																						
1	N.C	—	Not used																																						
2	CAN_L	Out	CAN low signal																																						
3	GND	—	Ground (COM)																																						
4	N.C.	—	Not used																																						
5	N.C.	—	Not used																																						
6	N.C.	—	Not used																																						
7	CAN_H	Out	CAN high signal																																						
8	N.C.	—	Not used																																						
9	N.C.	—	Not used																																						
	One-inch screws (number 4-40 UNC) are used.																																								
	The shell and the enclosure case are internally connected.																																								
	Pin 3 is internally isolated from the enclosure case.																																								
Number of ports	1																																								
I/O type	Isolated unbalanced																																								
Maximum input voltage	−3 V to +10 V (between CAN_H & CAN_L and GND)																																								
Supported protocols	CAN, CAN FD (ISO 11898-1: 2015 or non-ISO) Physical layer: ISO-11898 (High Speed Communication)																																								
Terminator	Can be enabled or disabled																																								
Terminator resistance	110 Ω to 130 Ω																																								
Bit rate (CAN)	125 kbps, 250 kbps, 500 kbps, 1 Mbps																																								
Bit rate (CAN FD)	500 kbps, 1 Mbps																																								
Data bit rate (CAN FD)	500 kbps, 1 Mbps, 2 Mbps, 4 Mbps																																								
Sample point	Setting resolution varies according to the 50.0 % to 91.6 % bit rate																																								
Format	Standard, extended																																								
Setup ID	Standard format: 0x000 to 0x7FF, extended format: 0x00000000 to 0x1FFFFFFF																																								
Data output interval	Output at the update rate																																								
Output data	Select normal measurement data or harmonic analysis data																																								

5.12 Peripheral Device Connection

USB

Item	Specifications
Connector type	Type A connector (receptacle)
Number of ports	2
Electrical and mechanical specifications	USB Rev. 2.0 compliant
Supported transfer mode	HS(High Speed)mode(480 Mbps), FS(Full Speed)mode(12 Mbps), LS(Low Speed)mode(1.5 Mbps)
Compatible devices	Mass storage devices that comply with USB Mass Storage Class Ver. 1.1 Available space: 8 TB, partition format: MBR/GPT, format type: FAT32/FAT16/exFAT 104 or 109 keyboards that comply with USB HID Class Ver. 1.1 Wireless LAN adapter
Power supply	5 V, 500 mA (for each port)

Item	Specifications
Connector type	Type C connector (receptacle)
Number of ports	1
Electrical and mechanical specifications	USB Rev. 2.0 compliant
Supported transfer mode	HS(High Speed)mode(480 Mbps), FS(Full Speed)mode(12 Mbps), LS(Low Speed)mode(1.5 Mbps)
Compatible devices	Mass storage devices that comply with USB Mass Storage Class Ver. 1.1 Available space: 8 TB, partition format: MBR/GPT, format type: FAT32/FAT16/exFAT 104 or 109 keyboards that comply with USB HID Class Ver. 1.1 USB HID Class Ver. 1.1-compliant touch panel (supports multi-touch with up to two touch points) Wireless LAN adapter
Video output	Equivalent to DisplayPort Alternate Mode Resolution: 1280x720 dot Approx. 60-Hz Vsync (75 MHz dot clock frequency)
Power supply	Equivalent to USB Power Delivery 5 V, 3 A (15 W max.)

5.13 Computer Interface

Ethernet interface

Item	Specifications
Connector type	RJ-45
Number of ports	1
Electrical and mechanical specifications	IEEE802.3 compliant, Auto-MDIX
Transmission system	Ethernet1000Base-T/100BASE-TX/10BASE-T
Communication protocol	TCP/IP
Supported services	FTP server, DHCP client, DNS client, multicast DNS (mDNS), remote control (VXI-11, Socket, HiSLIP), UDP, SNTP client, FTP client, Modbus/TCP server, web server

USB PC interface

Item	Specifications
Connector type	Type B connector (receptacle)
Number of ports	1
Electrical and mechanical specifications	USB Rev. 2.0 compliant
Supported transfer mode	HS(High Speed)mode(480 Mbps), FS(Full Speed)mode(12 Mbps), LS(Low Speed)mode(1.5 Mbps)
Supported protocols	USBTMC-USB488(USB Test and Measurement Class Ver.1.0)
System requirements	A PC running Windows 11 with a standard USB port (a separate device driver is required for connection to the PC)

5.14 Multi-unit Synchronization Interface

Item	Specifications
Connector type	SFP • Uses optical transceiver module 720941, sold separately
Optical fiber cable	50/125 µm multi mode optical fiber With Duplex-LC (2-core LC) connector
Maximum cable length	300 m
Number of ports	4

5.15 Storage

Item	Specifications
Format	FAT16/FAT32/exFAT
Internal memory	2 GB (standard) or 32 GB (/M1 option)

* FAT16/FAT32 format used by this instrument is not compatible with Windows.
8.3 format is case-insensitive.
LFN is case-sensitive.

5.16 System Maintenance Processing

Alarm generation and operation

Item	Specifications
Fan stop	Fan stop alarm indication Emergency operation stop after about 60 seconds ¹
Internal temperature error	Temperature error alarm indication Emergency operation stop ¹

- ¹ Emergency operation stop
Stops supplying power to each power element and motor input (/EM1, /RM1, /EM2, /EM1RM1, /RM2), CAN output (/CN1)
System Failure LED lights red

5.17 General Specifications

Item	Specifications
Warm-up time	Approx. 30 minutes
Operating environment	Temperature: 5 °C to 40 °C Humidity: 20 % RH to 80 % RH (no condensation)
Operating altitude	2000 m or less
Installation location	Indoor use
Storage environment	Temperature: -25 °C to 60 °C Humidity: 20 % RH to 80 % RH (no condensation)
Rated supply voltage	100 Vac to 120 Vac, 220 Vac to 240 Vac
Permitted supply voltage range	90 Vac to 132 Vac, 198 Vac to 264 Vac
Rated power frequency	50/60 Hz
Permitted supply frequency range	48 to 63 Hz
Maximum power consumption	300 VA
Cooling method	Forced air cooling, exhaust through left and right side panels and top panel
Installation orientation	Horizontal
External dimensions (see the external dimensions figure.)	426 mm (W) x 88 mm (H) x 484.2 mm (D) (excluding handles and protrusions)
Weight	Weight: Approx. 7.6 kg (-BN, main unit with 4-input element and /EM2/CN1 option installed)
Battery backup	The setup parameters and internal clock are backed up by a lithium battery.
Safety standards	Compliant standards (complies with one unit only) EN 61010-1, EN IEC 61010-2-030, EN 61010-031 Overvoltage Category II ¹ Measurement category O (Other), CAT II, CAT III ² Pollution degree 2 ³
Emissions	Compliant standards (complies with one unit only) EN 61326-1 Class A Group 1⁴, EN 61000-3-2, EN 61000-3-3 EMC Regulatory Arrangement in Australia and New Zealand EN 61326-1 Class A Group 1⁴ Korea Electromagnetic Conformity Standard (한국 전자파적합성기준) 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. In addition, when a measurement lead or probe is connected to an input element or when the device under measurement is connected to the instrument, the emission requirements may no longer be met. In such cases, the user will be required to take appropriate measures. Cable conditions • Functional ground terminal Use a cable.⁵ • Voltage measurement cables Attach by passing the two measurement cables through the ferrite core⁸ • Current sensor connection terminals Use dedicated cables. • EXT CLK, MEAS. START input terminals Use BNC cables.⁵ • Motor evaluation function terminals, AUX input terminals Use safety BNC cables.⁵ • The external monitor output connector Use a shielded USB cable.⁵ • USB port (PC) Use a shielded USB cable.⁵ • USB ports (for peripheral devices) Use shielded USB cables.⁵ • Ethernet port Use a category 7 or better Ethernet cable (STP)⁶ • CAN/CAN FD signal output connector Use a shielded CAN FD cable.⁵

5.17 General Specifications

Item	Specifications
Immunity	Compliant standards (complies with one unit only) EN 61326-1 Table 2 (for use in industrial locations) When a measurement lead or probe is connected to an input element or when the device under measurement is connected to the instrument, the immunity requirements may no longer be met. In such cases, the user will be required to take appropriate measures. Influence in the immunity environment Measurement input: within ± 20 % of range (within ± 40 % of range when CF6 is specified) Current probe input: within ± 300 mV Cable conditions Same as the cable conditions for emission above.
Environmental standard ⁷	EU RoHS Directive compliant

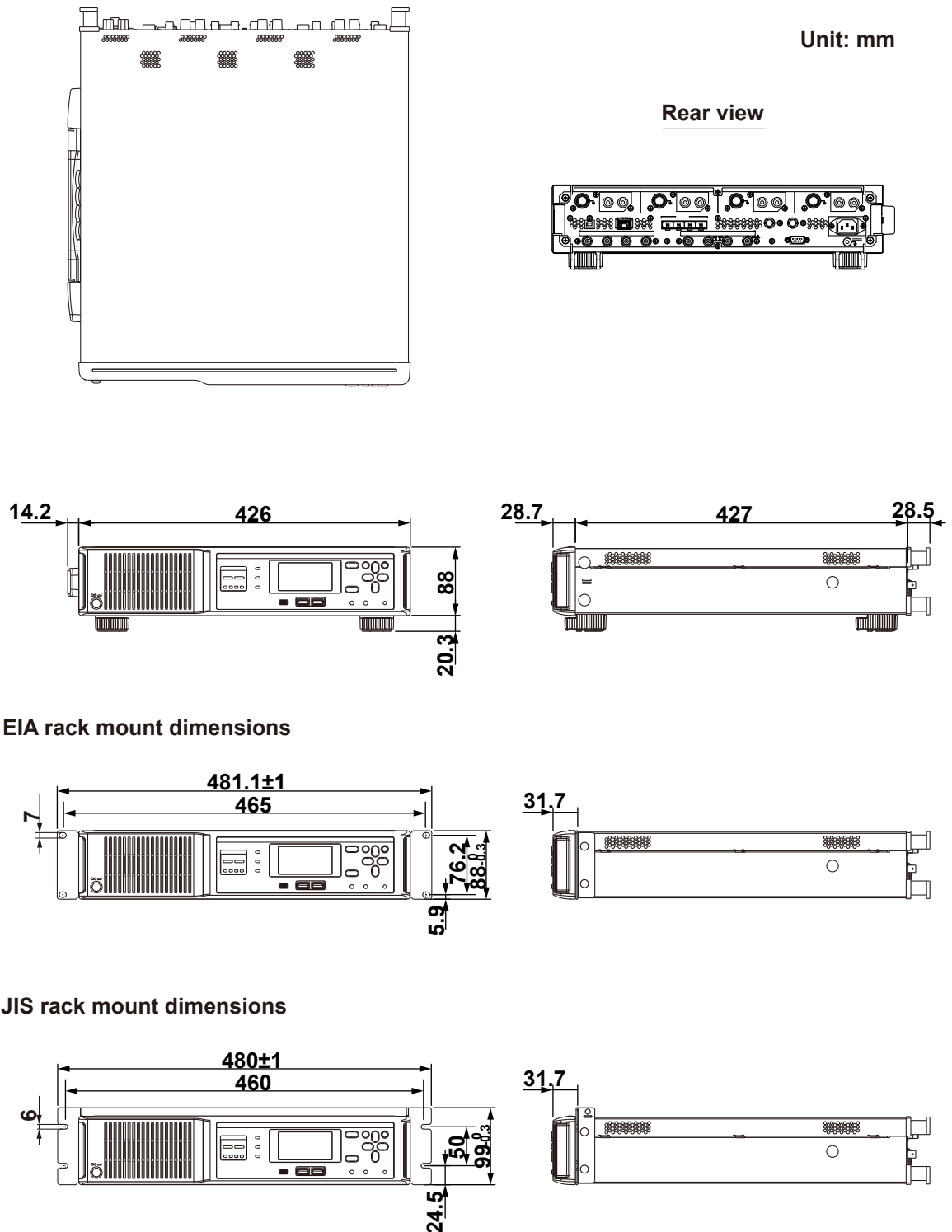
If you obtained this manual separately from the product, the specifications in this manual may differ from those of the product.

- 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 The measurement category of this instrument is CAT II, CAT III, and Other (O). Do not use for measurements in Measurement Category IV.
Measurement category O (Other) applies to measurement of other types of circuits that are not directly connected to a main power source.
Measurement Category II applies to electrical equipment that is powered through a fixed installation, such as a wall outlet wired to a distribution board, and to measurement performed on such wiring.
Measurement category III applies to measurement of facility circuits, such as distribution boards and circuit breakers.
Measurement category IV applies to measurement of power source circuits, such as entrance cables to buildings and cable systems, for low-voltage installations.
- 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
- 5 Use cables of length 3 m or less.
- 6 Use cables of length 30 m or less.
- 7 For conformity to environmental regulations and/or standards other than EU, contact your nearest YOKOGAWA office (PIM 113-01Z2).
- 8 TDK ZCAT2436-1330A

5.18 External Dimensions

Unit: mm

Rear view



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

This document describes changes to the Getting Started Guide IM WT1501-02EN. Please review them before using the manual.

■ Page xv "Regulations and Sales in Various Countries and Regions"

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Batteries and waste batteries



(EU Battery 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 Regulation and UK Battery Regulation.

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Compliance with the Radio Waves Act (Republic of Korea)

This product complies with the Radio Waves Act (Republic of Korea).

- 1) Trade Name: Yokogawa Test & Measurement Corporation
- 2) Model & Model Name: See the table below.
- 3) Date of Manufacture: Listed on the instrument
- 4) Manufacturer: Yokogawa Test & Measurement Corporation
- 5) Country of origin: Korea

Model	Model Name	Registration Website URL
WT1501, WT1502, WT1503, WT1504	Precision Power Analyzer	http://www.rra.go.kr/selform/IMY-EEN549-1

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■ Page 5-4 "5.2 Accuracy"

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- For the current input range (sensor output type: voltage), add the following values to the accuracy values above.:
Current accuracy (50 mV range): ± 0.02 % of range
Current accuracy (100 mV range): ± 0.01 % of range

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