

**WT1501, WT1502,
WT1503, WT1504**

Precision Power Analyzer

U S E R ' S M A N U A L

Thank you for purchasing the WT1501, WT1502, WT1503, or WT1504 Precision Power Analyzer. This user's manual explains the functions and operation of this instrument. To ensure correct use, please read this manual thoroughly before operation.

After reading this manual, keep it in a safe place.

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

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

Notes

- The contents of this manual are subject to change without prior notice as a result of improvements to the product's performance and functionality. Refer to our website to view our latest manuals.
- The screen images shown in this manual may differ slightly from the actual display.
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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 indicate panel keys and on-screen menu items that are used in the procedure.

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.

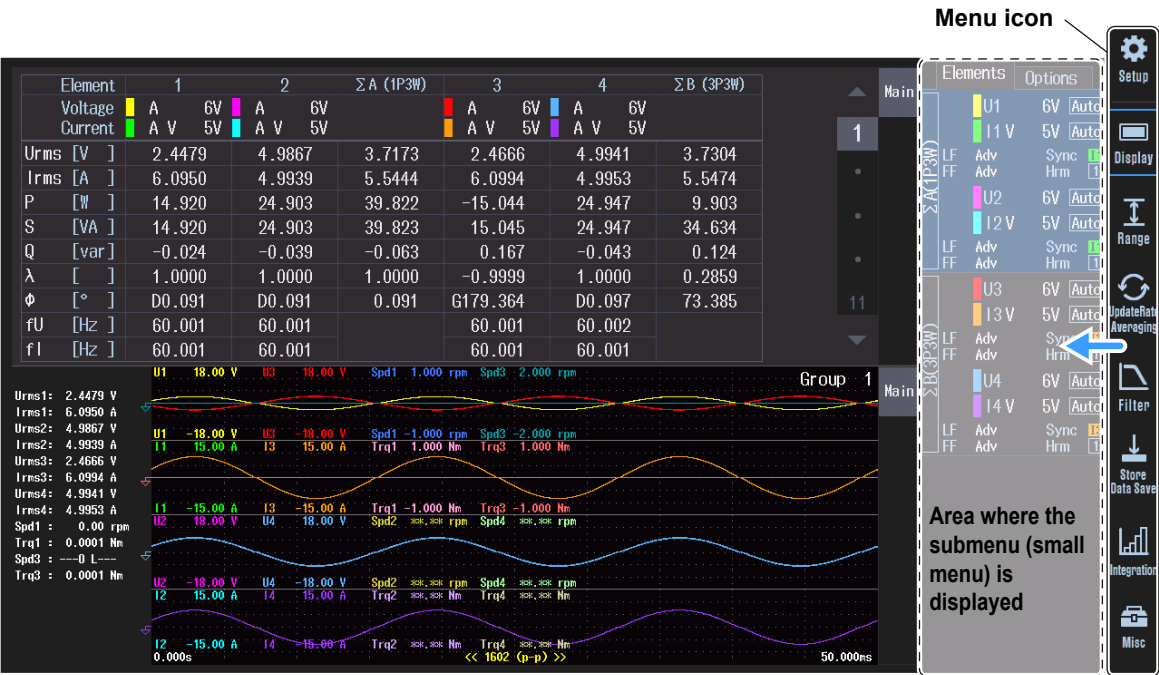
Menu Icons

The detailed settings for this instrument can be configured from the following screen by connecting an external monitor to the instrument or by using the Web server function. This section describes the menu icons and submenus displayed on the screen.

External monitor screen

The external monitor screen can be displayed in the following cases. (See section 2.1.)

- When operating by connecting an external monitor to this instrument
- When operating using the web server function



Displaying and operating the external monitor screen

See the table below for whether the external monitor screen can be displayed and operated. The WT1500 unit alone cannot display the screen shown above.

External monitor screen	Instrument only	With external monitor		Web server
		Without keyboard	With keyboard	
Display	No	Yes	Yes	Yes
Operation	No	Yes*	Yes	Yes

* You can operate the external monitor screen using the arrow keys (◀▶▲▼), SET key, ESC key, and MENU key on the front panel of the instrument.

Setup operations on the external monitor screen

All setup operations

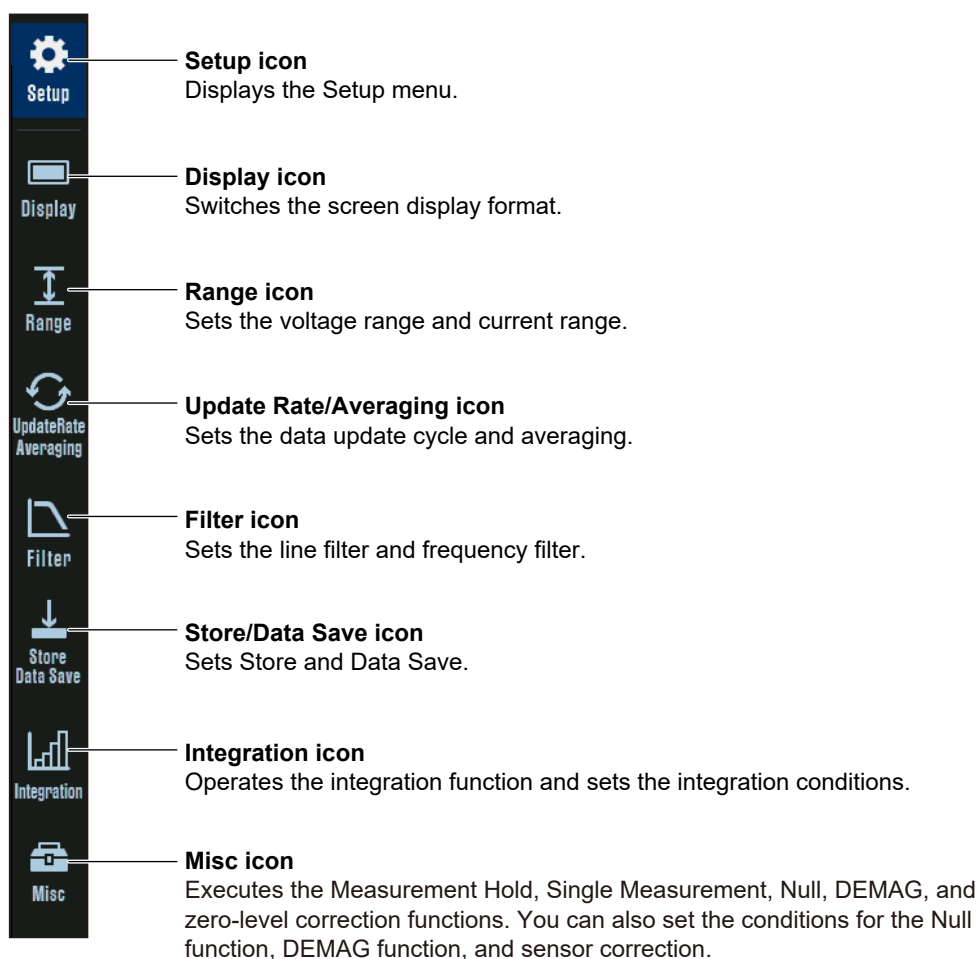
You can perform all setup operations from the “Setup menu” described in chapter 3.

Menu icon operations

Frequently used settings can be controlled separately from the setup menu via the menu icons.

Selecting a menu icon displays a submenu (small menu) to the left of the menu icon, allowing you to configure main settings and perform operations while viewing measurement results.

Menu icon types



Display icon and submenu

Used to change the display format of the screen.



Display menu

Close menu

Select screen display
A single screen can show only Numeric or Graph.
You can also split the screen into upper and lower areas and show the selected Numeric or Graph in each area. (See sections 5.1 or 9.1.)

Select numeric display format (All Items, 4 Items, 8 Items, 16 Items, Matrix, Hrm List Single, Hrm List Dual)
Set how many measurement results to display in a single screen. Hrm List Single and Hrm List Dual are harmonic lists (see section 8.2).

Select the unit to display (Main, Sub 1 to 4)* (see sections 5.1, 5.2)

Switch displayed page (Page Up/Page Down)
Switch the numeric data screen shown in each display format
This is the same as selecting ▲ or ▼ on the measurement display screen (see section 5.2).

Switch display item
Switch the measured value (measurement function) shown in the screen
Displays a menu for switching display items according to the selected numeric display format. (See the next page.)

Select display page switching (when Hrm List Single or Hrm List Dual is selected)
Header: Switches the page of the measurement function display area.
List: Switches the page of the harmonic data display area. (See section 5.1.)

Select graph display format (Wave, Bar, Vector)

Select the unit to display (Main, Sub 1 to 4)*

Switch display group (Group1 to Group4)

Set display format
Set the divisions and time scale of the graph screen

Switch graph display item
Select the graph to display on the screen, such as voltage or current

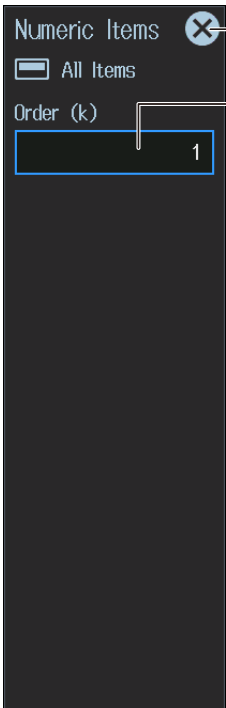
Cursor measurement (see chapter 10)

See sections 9.2 to 9.4.

* During multi-unit synchronization (option /SY1), you can select a subunit.

Switching the displayed items (Item)

• All Items display (All Items)



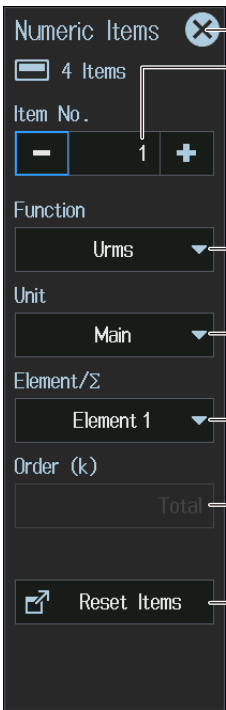
Close menu

Set harmonic order (Total, 0 to 100).
This setting is available only when you select the page for the measurement function with an order number among the harmonic data (pages 8 and 9).
For details on how to switch pages, see page 5-1.

Note

On the All Items display, you cannot select individual displayed items and change their measurement function, element, or wiring unit. If you switch to the matrix display, you can change the measurement functions, elements, and wiring units using the displayed table (see the next page).

• 4 Items, 8 Items, and 16 Items displays (4 Items/8 Items/16 Items)



Close menu

Select display item number
On the 4 Item, 8 Item, and 16 Item displays, the numbers increase from the upper left toward the bottom of the screen.
You can also perform the same operation by selecting on the measurement display screen (see page viii).

Set display item
Set measurement function to display (see section 5.1).

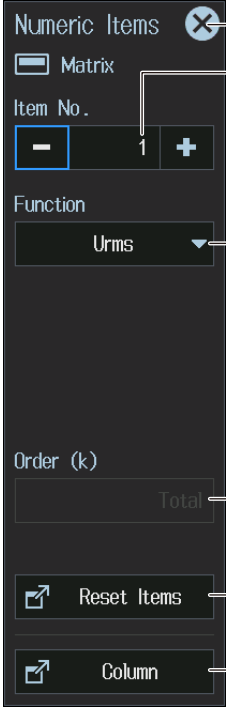
Select display target unit (Main, Sub 1 to 4) (see chapter 17)
When operating with multi-unit synchronization (option, /SY1), you can select a subunit.

Select input element or wiring unit to configure

Select harmonic order to configure
For harmonic display (see section 8.2).

Reset display items
(See page viii.)

- **Matrix display (Matrix)**



Numeric Items  **Close menu**

 **Matrix**

Item No.  1  **Select display item number (set display row)**
 Numbers increase from top to bottom in matrix display.
 Example: 3 indicates the third row from the top.
 You can also perform the same operation by selecting on the measurement display screen (see page viii).

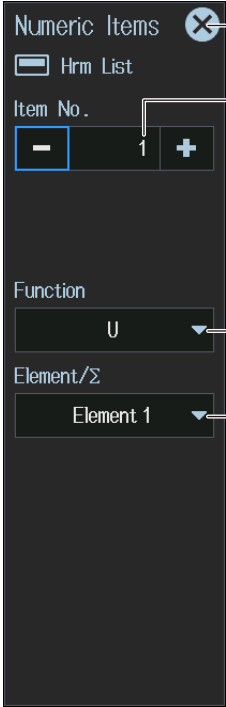
Function  **Urms** **Set display item**
 Set measurement function to display (see section 5.1).

Order (k)  **Total** **Select harmonic order to configure**
 For harmonic display (see section 8.2).

 **Reset Items** **Reset display items**
 (See page viii.)

 **Column** **Set display columns**
 Set the number of columns for the matrix display, etc.
 (see section 5.1).

- **Harmonics list single display (Hrm List Single) or harmonics list dual display (Hrm List Dual)**



Numeric Items  **Close menu**

 **Hrm List**

Item No.  1  **Select harmonic data display column**
 Use this when Harmonic List Display Dual is selected.
 Select 1 (left column) or 2 (right column).
 You can also perform the same operation by selecting on the measurement display screen (see page viii).

Function  **U** **Set display item**
 Set measurement function to display (see section 5.1).

Element/ Σ  **Element 1** **Select input element (Element 1 to Element 4) or wiring unit (ΣA , ΣB) to configure**

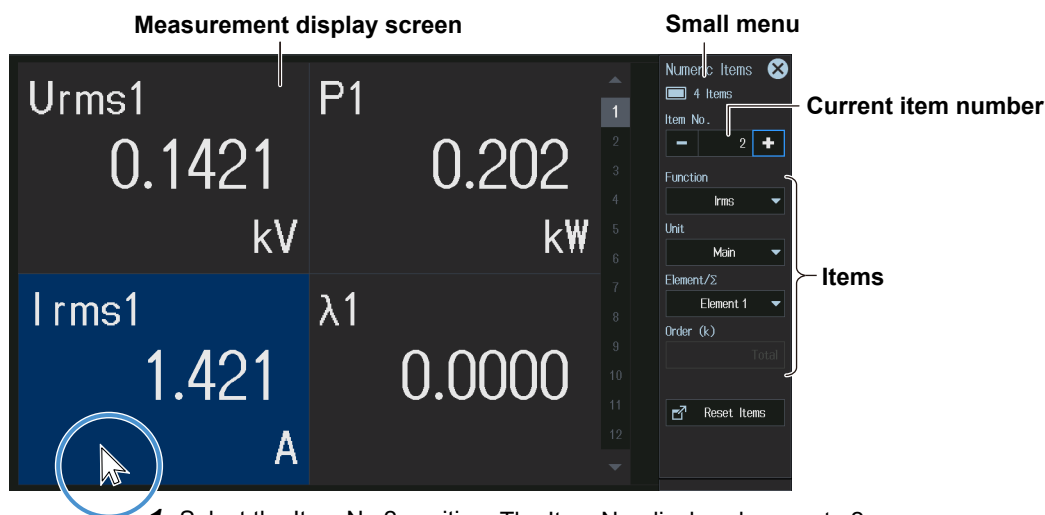
Note

On the harmonics list display, you can change the measurement function, element, and wiring unit for the selected list, but you cannot change these settings for each individual displayed item.

Selecting the displayed item number or displayed harmonic data column

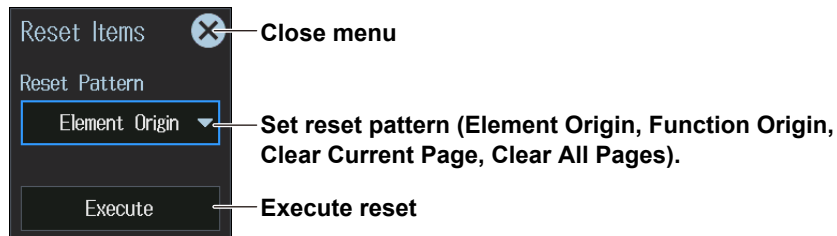
While changing displayed items, you can select the displayed item number or harmonic data column directly on the measurement display screen while the Small menu is displayed.

This is the same operation as selecting the displayed item number (on the 4-, 8-, and 16-value displays and matrix display) and selecting the displayed harmonic data column (on the harmonics list single display or harmonics list dual display).



1. Select the Item No.2 position. The Item No. display changes to 2.
2. Set the items (e.g., function).

Resetting the display items



Range icon and submenu

Used to set the voltage and current ranges.



Range menu

The Range menu is shown with the following components and annotations:

- Close menu:** A close button (X) at the top right of the menu.
- Select unit to be configured (Main, Sub 1 to 4):** A dropdown menu labeled 'Main' at the top. Below it, a table shows subunits:

	1	2	3	4
Σ A				
Σ B				
- Select element to configure:** A section labeled 'Elements' with four buttons: 1 (selected), 2, 3, and 4.
- Select voltage range:** A section with 'Voltage Range' set to 'Auto' and a dropdown menu showing '1000V'. A toggle switch for 'OFF' is also present.
- Select current range:** A section with 'Current Range' set to 'Auto' and a dropdown menu showing '50mV'. A toggle switch for 'OFF' is also present.
- Set current sensor:** A section labeled 'Sensor' with 'Model' set to 'CT1000S' and 'Output Type' set to 'Voltage'.
- Advanced measurement range settings:** Two expandable sections at the bottom: 'Sensor' and 'Advanced'.

Configuring the Current Sensor

The Sensor configuration menu is shown with the following components and annotations:

- Turn auto sensor setting on/off:** A label pointing to the 'Auto Sensor Setup' row, which contains four 'ON' toggle switches.
- Close menu:** A close button (X) at the top right of the menu.
- WB input element:** A label pointing to the first three columns (Element 1, 2, 3) which are all 'WB' type.
- HV input element:** A label pointing to the fourth column (Element 4) which is 'HV' type.
- Set sensor model:** A label pointing to the 'Sensor Model' row, which contains four dropdown menus: CT1000S, CT1000S, CT1000S, and CT2000A.
- Set sensor output type:** A label pointing to the 'Sensor Output Type' row, which contains four dropdown menus: Voltage, Voltage, Voltage, and Current.
- Turn scaling on/off:** A label pointing to the 'Scaling' row, which contains four 'ON' toggle switches.
- Set CT ratio:** A label pointing to the 'CT Ratio' row, which contains four input fields: 1.0000, 1.0000, 1.0000, and 2000.0000.
- Set output voltage rate:** A label pointing to the 'Output Voltage Rate [mV/A]' row, which contains four input fields: 2.0000, 2.0000, 2.0000, and an empty field.

Update Rate/Averaging icon and submenu

Used to set the data update interval and averaging.



Update Rate/Averaging menu

When the update mode is Constant or Trigger

Update Rate menu

Update Rate

Fast

Slow

-

500ms

+

Trigger

Advanced

Averaging

OFF

Averaging Type

Exp

Averaging Count

2

Close menu

Set data update interval (for parameters, see section 4.10)

Set trigger (for parameters, see section 4.10)
Displayed when the update mode is Trigger
Not displayed when the update mode is Constant

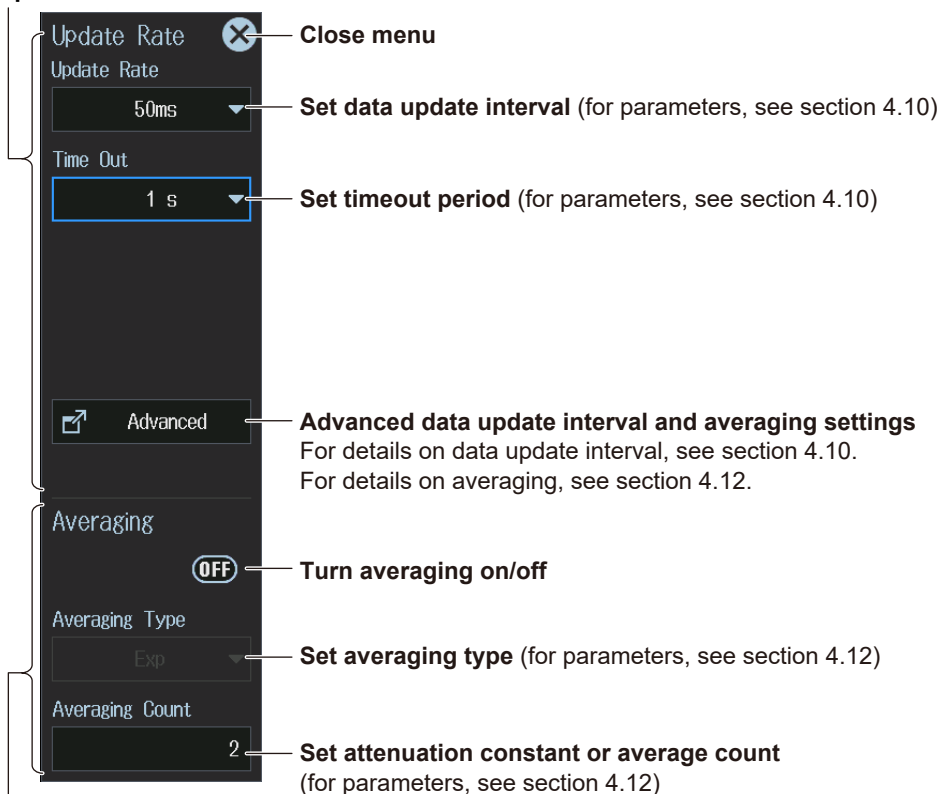
Advanced data update interval and averaging settings
For details on data update interval, see section 4.10.
For details on averaging, see section 4.12.

Turn averaging on/off

Set averaging type (for parameters, see section 4.12)

Set attenuation constant or average count
(for parameters, see section 4.12)

Averaging menu

When the update mode is Auto**Update Rate menu****Averaging menu**

Filter icon and submenu

Used to set the line filter and frequency filter.

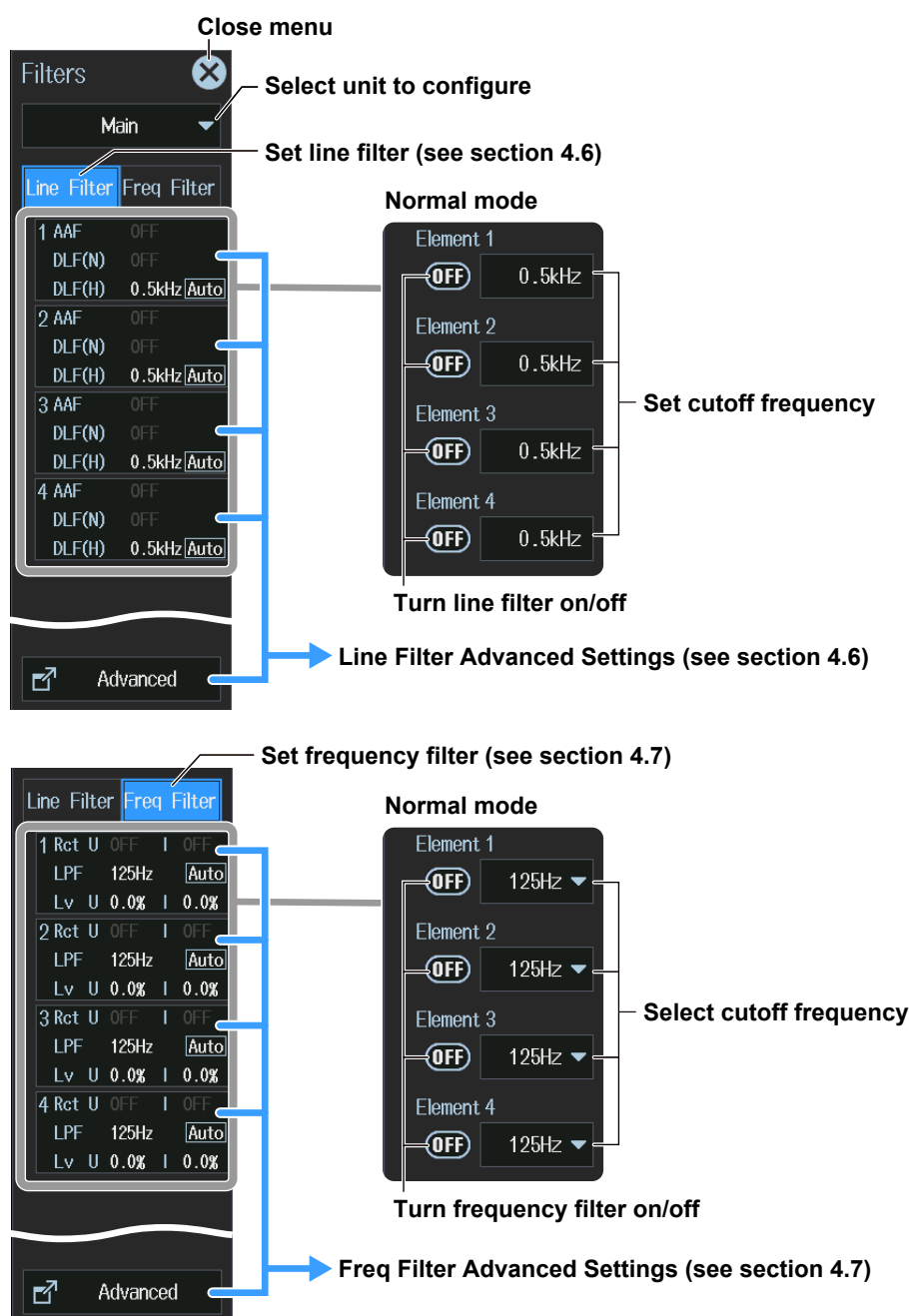
In the detailed settings for each filter, you can turn Advanced Settings on or off.

ON: Advanced mode The default setting is ON.

OFF: Normal Mode



Filter menu



Store/Data Save icon and submenu

Used to store data and save data.



Store/Data Save menu

Store menu



Close menu

Storage destination drive

Start storage

Storage starts according to the configured storage mode (see section 12.1).

Pause storage

Temporarily pauses storage.

Select REC to resume storage.

End storage

Storage operation ends, the storage status is reset, writing the stored data to the file is completed, and the file is closed.

Set storage conditions (see sections 12.1 to 12.3)

Save destination drive

Select data to save

Checked data is saved.

Execute save

Set saving conditions

(see sections 13.3 to 13.6)

Data Save menu

Integration icon and submenu

Used to set integration conditions.



Integration menu

Integration

Close menu

Independent Control

ON

Turn independent computation on/off

Element Objects

✓

1

✓

2

✓

3

✓

4

Check input elements for independent computation.
Available when independent computation is ON.

Select all input elements for independent computation

All ON: Select all input elements.

All OFF: Clear all input element check boxes.

All ON

All OFF

Start

Start integration

Start integration according to the configured integration conditions (see section 7.1).

Stop

Stop integration

Integration stops automatically according to the configured integration conditions.

Reset

Reset integration time and integrated values

All data related to integration is cleared, and "-----" is displayed to indicate no data.

Advanced

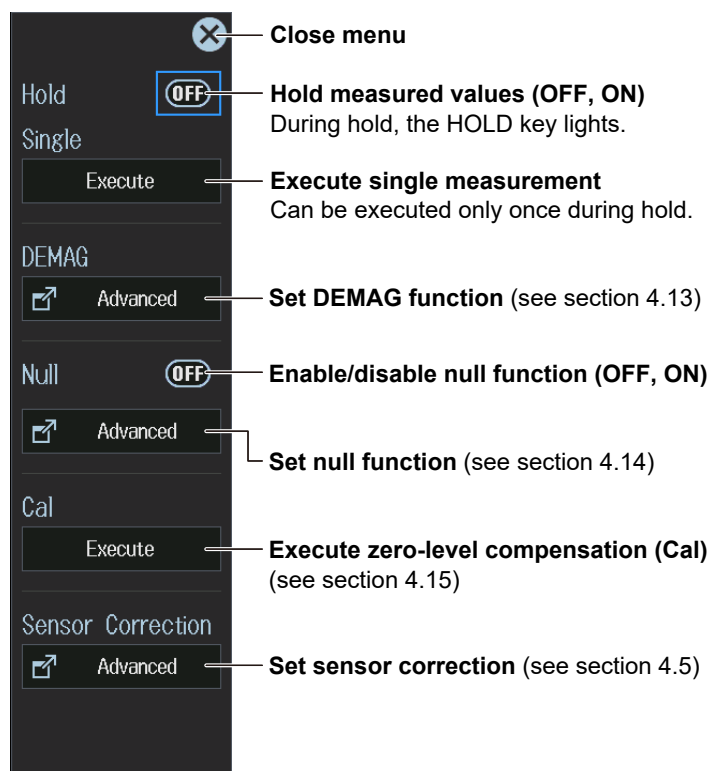
Set integration conditions (see section 7.1)

Misc icon and submenu

Used to perform measurement hold, single measurement, DEMAG function, Null function, and zero-level compensation functions. For the DEMAG function, Null function, and sensor correction, you can set the conditions.



Misc menu



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1.1 Items That This Instrument Can Measure

The items that this instrument can measure are as follows:

- Measurement functions for normal measurement
- Harmonic measurement functions
- Motor evaluation measurement functions (optional)
- Auxiliary input measurement functions (option)
- Measurement range
- Timestamp
- Data update status by element for auto update mode

For details on how each measurement function is derived, see appendix 1.

For terms such as measurement function, input element, and wiring unit, see section 1.2.

The input elements and wiring units referred to in each measurement function table are listed below. However, the input elements and wiring units that can be measured vary depending on the number of input elements installed.

- Input elements: Element 1 to Element 4
- Wiring units: ΣA and ΣB
- Motor numbers: Motor 1 to Motor 4

Measurement functions for normal measurement

Voltage

Symbol	Meaning	Input element	Wiring unit
Urms	True RMS voltage	Yes	Yes
Umn	Rectified mean voltage calibrated to the RMS value	Yes	Yes
Udc	Simple voltage average	Yes	Yes
Urmn	Rectified mean voltage	Yes	Yes
Uac	AC voltage component	Yes	Yes
Ufnd	Fundamental voltage component	Yes	Yes
U+pk	Maximum voltage	Yes	—
U−pk	Minimum voltage	Yes	—
CfU	Voltage crest factor	Yes	—
Urip	Voltage ripple rate	Yes	—

Current

Symbol	Meaning	Input element	Wiring unit
Irms	True RMS current	Yes	Yes
Imn	Rectified mean current calibrated to the RMS value	Yes	Yes
Idc	Simple current average	Yes	Yes
Irmn	Rectified mean current	Yes	Yes
Iac	AC current component	Yes	Yes
Ifnd	Fundamental current component	Yes	Yes
I+pk	Maximum current	Yes	—
I−pk	Minimum current	Yes	—
CfI	Current crest factor	Yes	—
Irip	Current ripple rate	Yes	—

Power

Symbol	Meaning	Input element	Wiring unit
P	Active power	Yes	Yes
S	Apparent power	Yes	Yes
Q	Reactive power	Yes	Yes
λ	Power factor	Yes	Yes
Φ	Phase difference	Yes	Yes
Pfnd	Fundamental active power	Yes	Yes
Sfnd	Fundamental apparent power	Yes	Yes
Qfnd	Fundamental reactive power	Yes	Yes
λ fnd	Fundamental power factor	Yes	Yes
Φ fnd	Fundamental phase difference	Yes	—
Pc	Corrected Power	Yes	Yes
P+pk	Maximum power	Yes	—
P−pk	Minimum power	Yes	—

Frequency

Symbol	Meaning	Input element	Wiring unit
fU	Voltage frequency	Yes	—
fI	Current frequency	Yes	—
fPLL1	Frequency of PLL1	—	—
fPLL2	Frequency of PLL2	—	—

Integrated power (watt hours)

Symbol	Meaning	Input element	Wiring unit
ITime	Integration time	Yes	–
WP	Sum of positive and negative watt hours	Yes	Yes
WP+	Sum of positive P values	Yes	Yes
WP–	Sum of negative P values	Yes	Yes
q	Sum of positive and negative ampere hours	Yes	Yes
q+	Sum of positive I values	Yes	Yes
q–	Sum of negative I values	Yes	Yes
WS	Volt-ampere hours	Yes	Yes
WQ	Var hours	Yes	Yes

Three-Phase Unbalance Factor

Symbol	Meaning	Input element	Wiring unit
Uubf Σ	Three-phase voltage unbalance factor	–	Yes
Iubf Σ	Three-phase current unbalance factor	–	Yes

The three-phase unbalance factor is computed for the following wiring systems.

- 3P3W(3V3A)
- 3P3W(3V3AR)
- 3P4W → 3P3W(3V3AS)
- 3P4W
- 3P3W(3V3A) → 3P4W
- 3P3W(3V3AR) → 3P4W

Efficiency

Symbol	Meaning
η_1 to η_4	Efficiency

User-defined functions

Symbol	Meaning
F1 to F20	User-defined functions

User-defined events

Symbol	Meaning
Ev1 to Ev8	User-defined events

Harmonic measurement functions

Symbol	Meaning	Input element	Wiring unit
$U(k)$	RMS value of the harmonic voltage of order k	Yes	Yes
$I(k)$	RMS value of the harmonic current of order k	Yes	Yes
$P(k)$	Active power of harmonic order k	Yes	Yes
$S(k)$	Apparent power of harmonic order k	Yes	Yes
$Q(k)$	Reactive power of harmonic order k	Yes	Yes
$\lambda(k)$	Power factor of harmonic order k	Yes	Yes
$\Phi(k)$	Phase difference between the voltage and current of harmonic order k	Yes	—
$\Phi U(k)$	Phase difference between the fundamental voltage $U(1)$ and harmonic voltage $U(k)$	Yes	—
$\Phi I(k)$	Phase difference between the fundamental current $I(1)$ and harmonic current $I(k)$	Yes	—
$Z(k)$	Impedance of the load circuit	Yes	—
$R_s(k)$	Series resistance of the load circuit	Yes	—
$X_s(k)$	Series reactance of the load circuit	Yes	—
$R_p(k)$	Parallel resistance of the load circuit	Yes	—
$X_p(k)$	Parallel reactance of the load circuit	Yes	—
$U_{hdf}(k)$	Voltage harmonic distortion factor	Yes	—
$I_{hdf}(k)$	Current harmonic distortion factor	Yes	—
$P_{hdf}(k)$	Active power harmonic distortion factor	Yes	—
U_{thd}	Total harmonic voltage distortion	Yes	—
I_{thd}	Total harmonic current distortion	Yes	—
P_{thd}	Total harmonic active power distortion	Yes	—
U_{thf}	Telephone harmonic factor of the voltage	Yes	—
I_{thf}	Telephone harmonic factor of the current	Yes	—
U_{tif}	Telephone influence factor of the voltage	Yes	—
I_{tif}	Telephone influence factor of the current	Yes	—
h_{vf}	Harmonic voltage factor	Yes	—
h_{cf}	Harmonic current factor	Yes	—
K-factor	K factor	Yes	—
$\Phi U_i-U_j^1$	Phase difference between the fundamental voltage of element i , $U_i(1)$, and the fundamental voltage of element j , $U_j(1)$	—	Yes
$\Phi U_i-U_k^1$	Phase difference between $U_i(1)$ and the fundamental voltage of element k , $U_k(1)$	—	Yes
$\Phi U_i-I_i^1$	Phase difference between $U_i(1)$ and the fundamental current of element i , $I_i(1)$	Yes ²	Yes
$\Phi U_j-I_j^1$	Phase difference between $U_j(1)$ and the fundamental current of element j , $I_j(1)$	—	Yes
$\Phi U_k-I_k^1$	Phase difference between $U_k(1)$ and the fundamental current of element k , $I_k(1)$	—	Yes

1 i , j , and k are input element numbers.

Example When the number of installed input elements is 6, and the wiring systems for elements 1, 2, and 3 are set to three-phase four-wire and assigned to wiring unit ΣA

- $i=1$, $j=2$, $k=3$
- ΦU_i-U_j indicates ΦU_1-U_2 and represents the phase difference of the fundamental voltage $U_2(1)$ of element 2 with respect to the fundamental voltage $U_1(1)$ of element 1.
- Likewise, ΦU_i-U_k , ΦU_i-I_i , ΦU_j-I_j , and ΦU_k-I_k indicate ΦU_1-U_3 , ΦU_1-I_1 , ΦU_2-I_2 , and ΦU_3-I_3 , respectively.

2 Setting i to an input element is the same as setting k to 1 in $\Phi(k)$.

Note

When the update mode is Constant and the data update interval is set to 10 ms, harmonic measurement is not performed.

Harmonic order of the measurement functions

The harmonic orders that you can specify are as follows:

Harmonic measurement function for each input element

measurement function	Characters or numbers in parentheses			
	Total	0(DC)	1	k
U()	Yes	Yes	Yes	2 to 100
I()	Yes	Yes	Yes	2 to 100
P()	Yes	Yes	Yes	2 to 100
S()	Yes	Yes	Yes	2 to 100
Q()	Yes	Always zero	Yes	2 to 100
λ ()	Yes	Yes	Yes	2 to 100
Φ ()	Yes	—	Yes	2 to 100
ΦU ()	—	—	—	2 to 100
ΦI ()	—	—	—	2 to 100
Z()	—	Yes	Yes	2 to 100
Rs()	—	Yes	Yes	2 to 100
Xs()	—	Yes	Yes	2 to 100
Rp()	—	Yes	Yes	2 to 100
Xp()	—	Yes	Yes	2 to 100
Uhdf()	—	Yes	Yes	2 to 100
Ihdf()	—	Yes	Yes	2 to 100
Phdf()	—	Yes	Yes	2 to 100
Uthd	Yes	—	—	—
Ithd	Yes	—	—	—
Pthd	Yes	—	—	—
Uthf	Yes	—	—	—
Ithf	Yes	—	—	—
Utif	Yes	—	—	—
Itif	Yes	—	—	—
hvf	Yes	—	—	—
hcf	Yes	—	—	—
K-factor	Yes	—	—	—

Functions with parentheses will produce different values depending on which of the following is contained in their parentheses.

- Total: Total value of all harmonic components from the minimum measured order to the Nth harmonic. For details on how it is derived, see appendix 1.)
- 0 (DC): Numeric data for the DC component
- 1: Numeric data for the fundamental wave
- k: Numeric data for each harmonic from the 2nd to the Nth harmonic*

* N is the upper limit of the measurable harmonic order. The upper limit of the measurable harmonic order is the smaller of the following:

- The specified maximum harmonic order to measure
- A value determined automatically by the PLL source frequency
See section 5.9 of the *Getting Started Guide* (IM WT1501-02EN).

1.1 Items That This Instrument Can Measure

Harmonic measurement functions for wiring units (Σ functions)

measurement function	Characters or numbers in parentheses	
	Total	1
U Σ ()	Yes	Yes
I Σ ()	Yes	Yes
P Σ ()	Yes	Yes
S Σ ()	Yes	Yes
Q Σ ()	Yes	Yes
$\lambda\Sigma$ ()	Yes	Yes

Functions with parentheses will produce different values depending on which of the following is contained in their parentheses.

- Total: Total value
- 1: Numeric data for the fundamental wave

Motor evaluation measurement functions (optional)

Symbol	Meaning	Motor Number	Input element
Speed	Motor rotating speed	Yes	—
Torque	Motor torque	Yes	—
SyncSp	Sync speed	Yes	—
Slip	Slip (%)	Yes	—
Pm	Mechanical output of the motor (mechanical power)	Yes	—
EaU, EaI	Electrical angle • Motor evaluation for encoder (/EM1, /EM2) Phase angles of the fundamental signals from U1 to I4 with respect to the falling edge of the Z-terminal input • Motor evaluation for resolver (/RM1, /RM2) Phase angles of the fundamental waves of U1 to I4 with respect to the zero-degree pulse signal of the mechanical angle generated from the resolver rotation angle	—	Yes

Auxiliary input measurement functions (option)

Symbol	Meaning
Aux1 to 8	Auxiliary inputs 1 to 8

Measurement range

Symbol	Meaning	Input element	Motor Number
RngU	Voltage measurement range	Yes	—
RngI	Current measurement range	Yes	—
RngSpd	Speed measurement range	—	Yes
RngTrq	Torque measurement range	—	Yes
RngAux1 to 8	Aux measurement range	—	—

For measurement range functions, data can be acquired using the following methods.

- By setting a user-defined function
- By storing or by saving numeric data
- By outputting through communication

Timestamp

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

Symbol	Meaning
TS Date ¹	Data update interval's date
TS Time ¹	Data update interval's time
TS Subsec ¹	Data update interval's fractional seconds
TS Date NrmPwr1 to 4 ²	Normal measurement: Date of the measurement period for power elements 1 to 4
TS Time NrmPwr1 to 4 ²	Normal measurement: Time of the measurement period for power elements 1 to 4
TS Subsec NrmPwr1 to 4 ²	Normal measurement: Fractional seconds of measurement period for power elements 1 to 4
TS Date NrmMtr1 to 4 ²	Normal measurement: Date of the measurement period for motor evaluation 1 to 4
TS Time NrmMtr1 to 4 ²	Normal measurement: Time of the measurement period for motor evaluation 1 to 4
TS Subsec NrmMtr1 to 4 ²	Normal measurement: Fractional seconds of measurement period for motor evaluation 1 to 4
TS Date NrmAux1 to 8 ²	Normal measurement: Date of the measurement period for auxiliary inputs 1 to 8
TS Time NrmAux1 to 8 ²	Normal measurement: Time of the measurement period for auxiliary inputs 1 to 8
TS Subsec NrmAux1 to 8 ²	Normal measurement: Fractional seconds of the measurement period for auxiliary inputs 1 to 8
TS Date HrmPwr1 to 4 ²	Harmonic measurement: Date of the measurement period for input elements 1 to 4
TS Time HrmPwr1 to 4 ²	Harmonic measurement: Time of the measurement period for input elements 1 to 4
TS Subsec HrmPwr1 to 4 ²	Harmonic measurement: Fractional seconds of measurement period for input elements 1 to 4

1 Timestamp valid in all update modes (Constant/Trigger/Auto).

2 Timestamps valid when the update mode is Auto.

For timestamp functions, data can be acquired using the following methods.

- By outputting through communication
- By storing timestamps as the storage times

Data update status by element for auto update mode

Symbol	Meaning
UpdateStsPwr	Normal measurement: Power element data update
UpdateStsMtr	Normal measurement: Motor evaluation data update
UpdateStsAux	Normal measurement: Auxiliary signal input data update
UpdateStsHrm	Harmonic measurement: Input element data update

For data update status functions, data can be acquired using the following methods.

- By outputting through communication
- By automatically storing data at the end of storage items in auto update mode

1.2 What Is a Measurement Function?

Measurement function

The physical values (such as RMS voltage, average current, power, and phase difference) that this instrument measures and displays and measurement range and other measurement information are called measurement functions. Each measurement function is displayed using symbols that correspond to its physical value.

Display example **Urms** Indicates the true RMS value of the voltage.

Element

Element refers to a set of input terminals that can receive a single phase of voltage and current to measure. This instrument can be equipped with up to four elements, numbered from 1 to 4. An element number is appended to the measurement function symbol for the measured data that this instrument displays, so that you can tell which data belongs to which element.

Display example **Urms1** Indicates the true RMS voltage of element 1.

Wiring system

To measure power in various single-phase and three-phase transmission systems, this instrument supports the following nine wiring systems.

- 1P2W Single-phase two-wire system
- 1P3W Single-phase three-wire system
- 3P3W Three-phase three-wire system
- 3P4W Three-phase four-wire system
- 3P3W(3V3A) Three-phase three-wire system with a three-voltage three-current method
- 3P3W(3V3AR) Three-phase three-wire system with a three-voltage three-current method
- 3P3W(3V3A) → 3P4W Converts three-phase three-wire systems that use a three-voltage three-current method to three-phase four-wire
- 3P3W(3V3AR) → 3P4W Converts three-phase three-wire systems that use a three-voltage three-current method to three-phase four-wire
- 3P4W → 3P3W(3V3AS) Converts three-phase four-wire to three-phase three-wire systems that use a three-voltage three-current method

Wiring unit

A wiring unit is a group of two or three input elements with the same wiring system for measuring three-phase power. Up to two wiring units can be defined.

Display example **ΣA, ΣB**

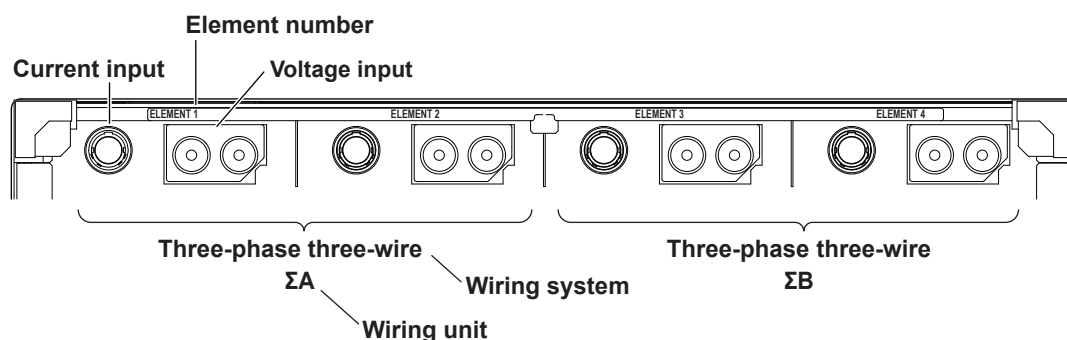
See pages 3-3 and 4-3.

Σ Functions

The measurement functions of a wiring unit are called Σ functions.

Display example $\text{Urms}\Sigma A$ Represents the true RMS value of the average voltage of the input elements assigned to wiring unit ΣA .

See page 5-10.



Measurement period

For details on the measurement period for calculating measurement functions, see “Measurement Period (Sync Source).”

See section 4.8.

Display unit

During multi-unit synchronization (option /SY1), you can specify the measurement function display unit.

Display unit	Display example	Description
Main unit	$\text{Urms}1$	No prefix
Subunit 1	$\text{SUB}1:\text{Urms}1$	Prefixed with “SUB#.”
Subunit 2	$\text{SUB}2:\text{Urms}1$	
Subunit 3	$\text{SUB}3:\text{Urms}1$	
Subunit 4	$\text{SUB}4:\text{Urms}1$	

2.1 Differences in operation interfaces

This instrument can be operated in various ways, including the WT1500 main unit, an external monitor, the Web server function, and WTVIEWERefree.* However, even when the same operating procedure is used, some operation interfaces and operating methods differ. This section explains the differences among those operation interfaces.

- * WTVIEWERefree is free software for our WT series instruments (WT5000, WT3000E, WT3000, WT1800R, WT1800E, WT1800, WT1500, WT500, WT300E, WT300).

To display detailed measured values and waveforms and perform settings and operations, connect an external monitor to the WT1500 or use the Web server function or WTVIEWERefree.

Operating the WT1500 using an external monitor

You can set and display all functions of this instrument.

Connect a monitor and keyboard to this instrument, and operate the setting menus on the external monitor screen (see section 2.5).

If you connect a touch-screen monitor, touch operation becomes available (see the next section).

Note

Arrow, ESC, SET, and MENU keys on the front panel

The operation keys on the WT1500 (arrow (◀▶▲▼), ESC, SET, and MENU) can be switched to operate either the LCD screen or the external monitor.

- Each time you press **KEY TO EXT MONITOR** on the front panel, the keys switch between operating the LCD screen and the external monitor.
- When the keys are set to operate the external monitor, KEY TO EXT MONITOR lights blue.

For details, see sections 1.2 and 3.1 of the Getting Started Guide (IM WT1501-02EN).

Operating with the WT1500 keys and LCD screen

Simple settings and key measured values can be displayed on the instrument's LCD.

- * For details on the display screens and basic operations of the LCD screen, see section 1.3 of the Getting Started Guide (IM WT1501-02EN).

Operating using the Web server function

Using a mouse connected to a PC, you can remotely control this instrument from the Web server function screen and key panel displayed on the PC screen (see section 14.4).

For details on connecting the Web server, see section 3.2 of the Getting Started Guide (IM WT1501-02EN).

Operating with WTVIEWERefree

You can use a mouse connected to a PC to operate the WTVIEWERefree display screens and setting menus.

For details on WTVIEWERefree, see section 3.3 of the Getting Started Guide (IM WT1501-02EN) and the WTVIEWERefree User's Manual.

2.2 Touch-Panel Operations and Functions

If you connect a touch-screen monitor to this instrument, touch operation becomes available.

Touch-panel operations

The basic touch-panel operations are as follows:

Tap

A tap is a light touch on the screen.

Use this operation to select items in the setting menu or close the setting menu.



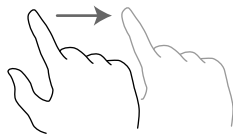
Drag, swipe, and slide

Place your finger on the screen and move it while keeping contact with the screen.

Selecting and moving an object is called dragging.

Moving across a relatively wide display area, such as scrolling through a setting menu, is called swiping.

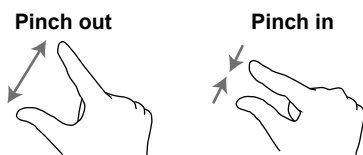
Depending on the movement, this operation may also be called sliding.



Pinch-out and pinch-in

Place two fingers on the screen and move them apart while keeping contact with the screen for a pinch-out, or move them together for a pinch-in.

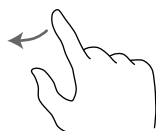
On waveform display screens, use a pinch-out to enlarge the waveform and a pinch-in to reduce it.



Flick

A flick is a quick, flicking motion on the screen with your finger.

Use this operation to change the screen display.



Key operations and functions

For details on key operations and functions, see section 1.2 of the Getting Started Guide (IM WT1501-02EN).

2.3 Setting Menu Operations and Functions

Note

When operating the WT1500 using an external monitor, press **KEY TO EXT MONITOR** on the front panel so that the arrow (◀▶▲▼), ESC, SET, and MENU keys operate the external monitor.
When the keys are set to operate the external monitor, KEY TO EXT MONITOR lights blue.

When you select an item in the setting menu by using the arrow keys and SET, the following operations are performed depending on the item.

- Choices are displayed.

Example: Voltage range



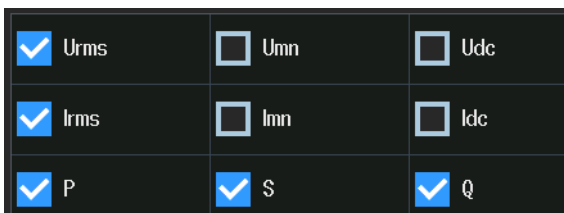
- ON/OFF is switched.

Example: Voltage auto range



- The selection status is switched (check mark on or off).

Example: Saved items



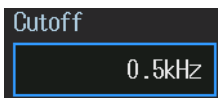
- The selected setting is switched.

Example: Integration resume action after power failure recovery



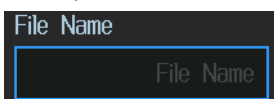
- Numeric values can be changed.

Example: Cutoff frequency of the line filter



- Text can be changed using the keyboard. (See section 2.4.)

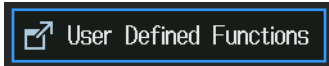
Example: File name to save



2.3 Setting Menu Operations and Functions

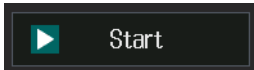
- The related setting menu is displayed.

Example: User-defined computation



- The function is executed.

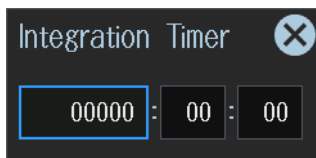
Example: Start integration



How to hide the setting menu

The setting menu disappears from the screen in either of the following ways.

- Press ESC
- Select  in the upper right of the menu.



2.4 Entering Numeric Values and Character Strings

Note

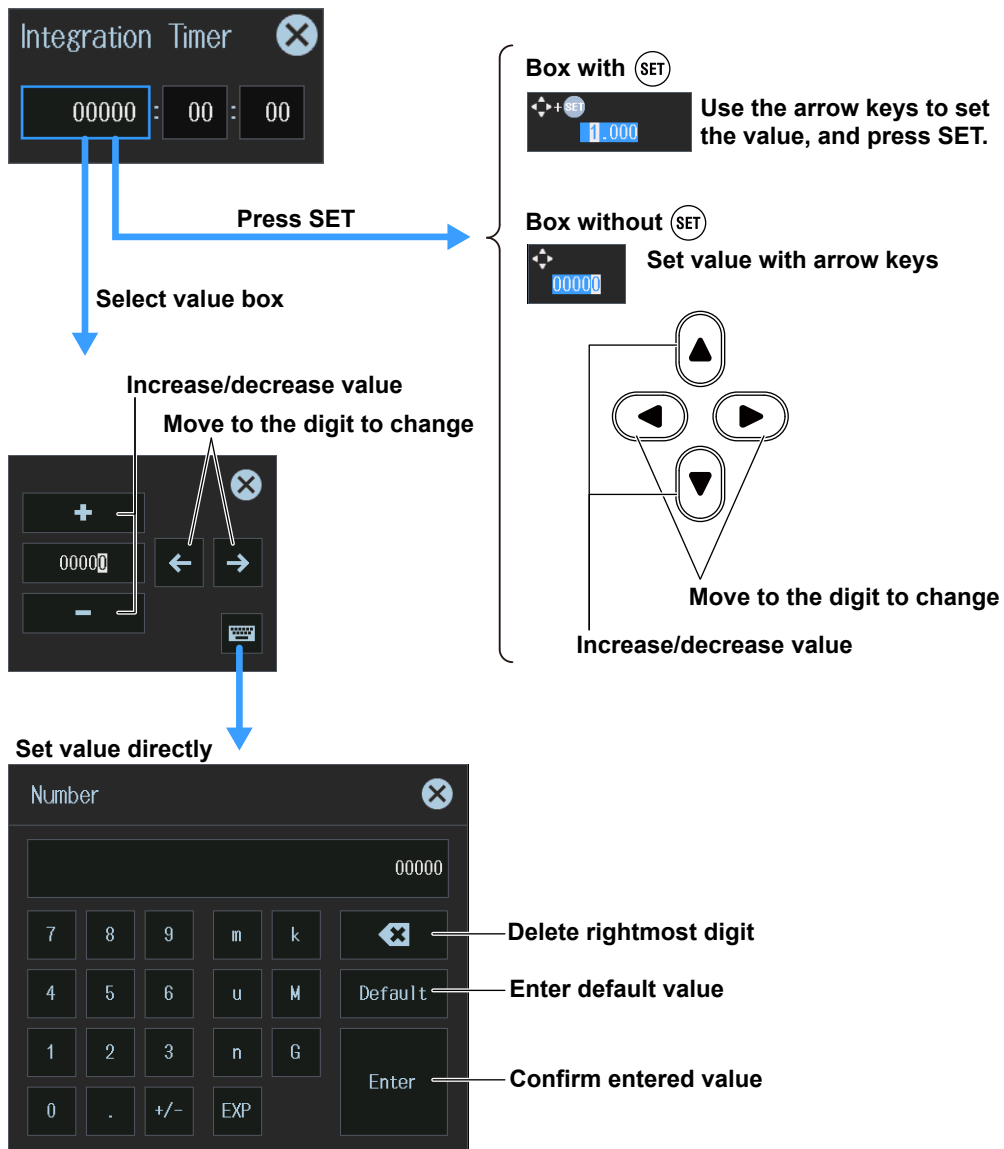
When operating the WT1500 using an external monitor, press **KEY TO EXT MONITOR** on the front panel so that the arrow ($\blacktriangleleft\blacktriangleright\blacktriangleup\blacktriangledown$), ESC, SET, and MENU keys operate the external monitor.

When the keys are set to operate the external monitor, KEY TO EXT MONITOR lights blue.

Entering values

Entering values using the arrow keys

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

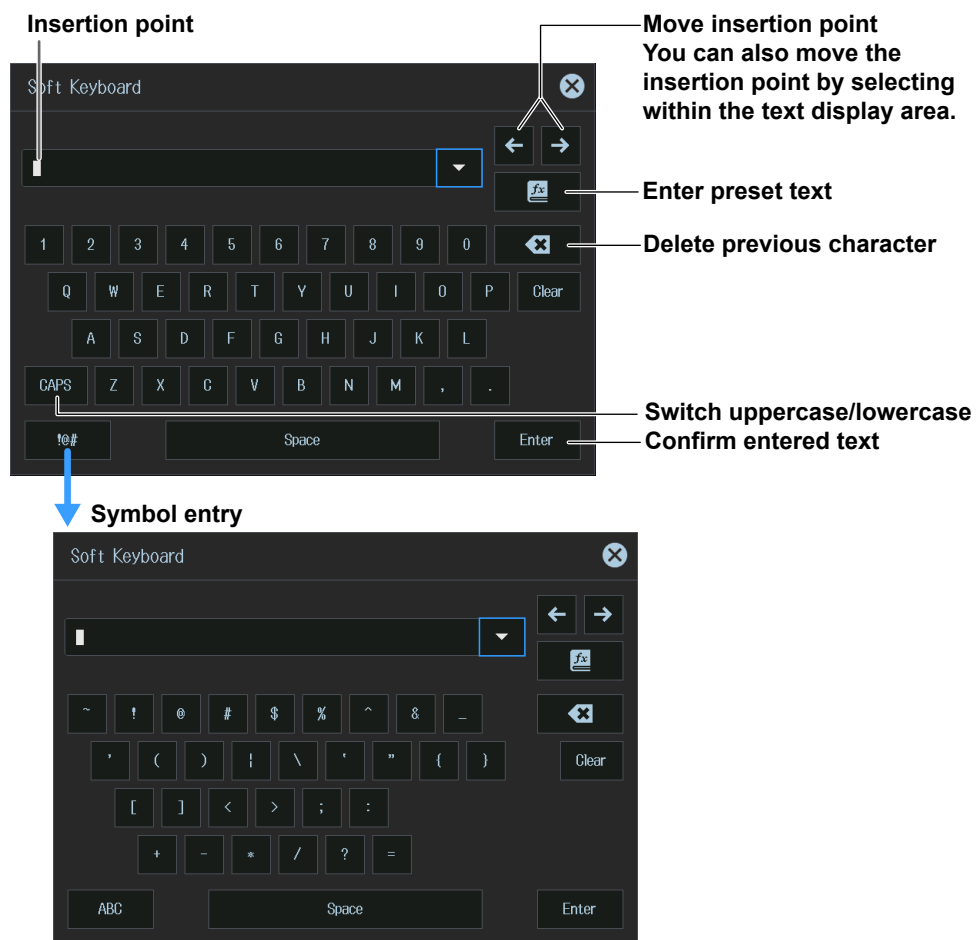


Entering character strings

For file names, comments, and other text, use the keyboard displayed on the screen. Select keys on the keyboard or use the arrow keys and SET to operate the keyboard and enter the character string.

How to use the keyboard

1. With the keyboard displayed, select the character to enter.
2. Repeat step 1 to enter all characters.
3. Select **ENTER**, or move the cursor to ENTER and press **SET**. The character string is entered, and the keyboard disappears.



Preset character strings

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

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

Note

-
- You cannot enter two or more @ signs in a row.
 - File names are not case-sensitive. Comments are case-sensitive. Also, due to MS-DOS restrictions, the following file names cannot be used.
AUX, CON, PRN, NUL, CLOCK, COM1 to COM9, LPT1 to LPT9
 - For details on file name restrictions, see page 3-26.
-

2.5 Using a USB Keyboard

If a monitor is connected to the instrument, connect a keyboard for operation.

Connecting a USB keyboard

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

Compatible keyboards

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

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

Note

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

USB ports for peripherals

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

Connection procedure

To connect a USB keyboard to this instrument, use one of the USB ports for peripherals. You can connect or remove the USB cable regardless of whether the instrument's power switch is on or off (hot-plugging is supported). When the power switch is turned on, the keyboard is detected and enabled approximately 6 seconds after it is connected.

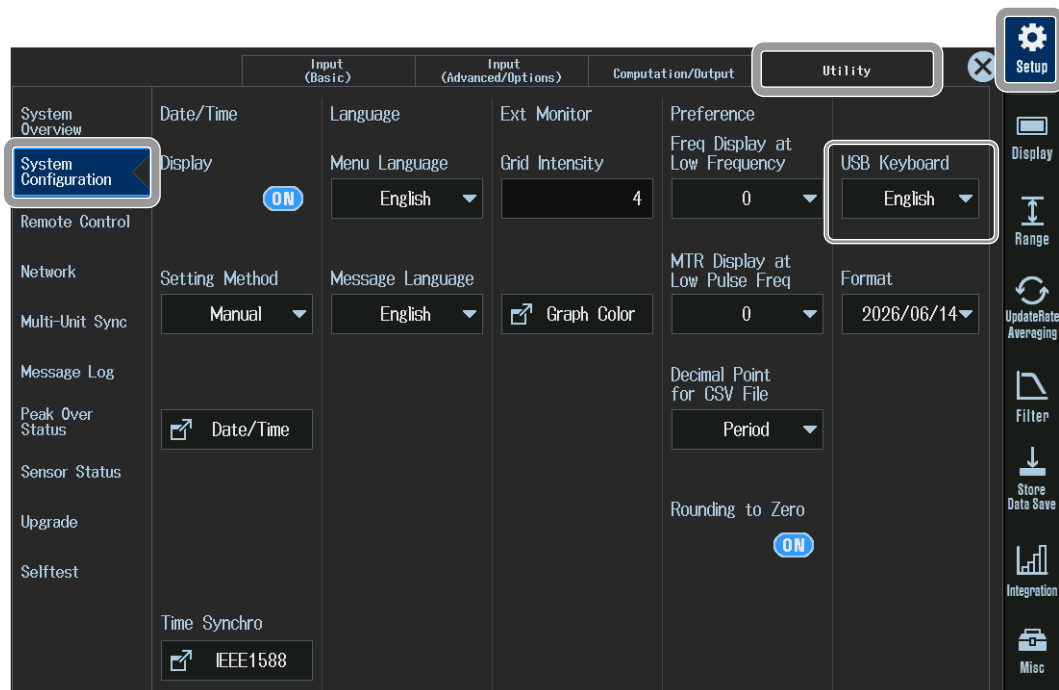
Note

- Connect only compatible USB keyboards, USB memory devices, or wireless LAN adapters to the USB ports for peripherals.
 - Connect only a single keyboard. Multiple keyboards cannot be connected.
 - Do not plug and unplug multiple USB devices in succession. Wait for at least 10 seconds after you plug or unplug one USB device before you plug or unplug another USB device.
 - After turning on the instrument, do not disconnect the USB cable until the instrument is ready for key operation (this takes at least 30 seconds).
-

Procedure

Setting the USB keyboard language

Setup menu icon  > Utility > System Configuration > USB Keyboard under Preference



USB keyboard language (USB Keyboard)

Select the USB keyboard language to use when entering file names, comments, and so on. You can use the following keyboards that conform to USB Human Interface Devices (HID) Class Ver. 1.1.

The available languages vary depending on the suffix code. For details on suffix codes, see the Getting Started Guide (IM WT1501-02EN).

- English: 104-key keyboard
- Japanese: 109-key keyboard

For details on how the instrument keys are mapped to the keys on a USB keyboard, see appendix 6.

Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.

Entering file names, comments, and other items

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

Entering values from a USB keyboard

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

- ↑ key or “8” on the numeric keypad: Increases the value
- ↓ key or “2” on the numeric keypad: Decreases the value
- → key or “6” on the numeric keypad: Moves the digit cursor to the next digit on the right.
- ← key or “4” on the numeric keypad: Moves the digit cursor to the next digit on the left.

Note

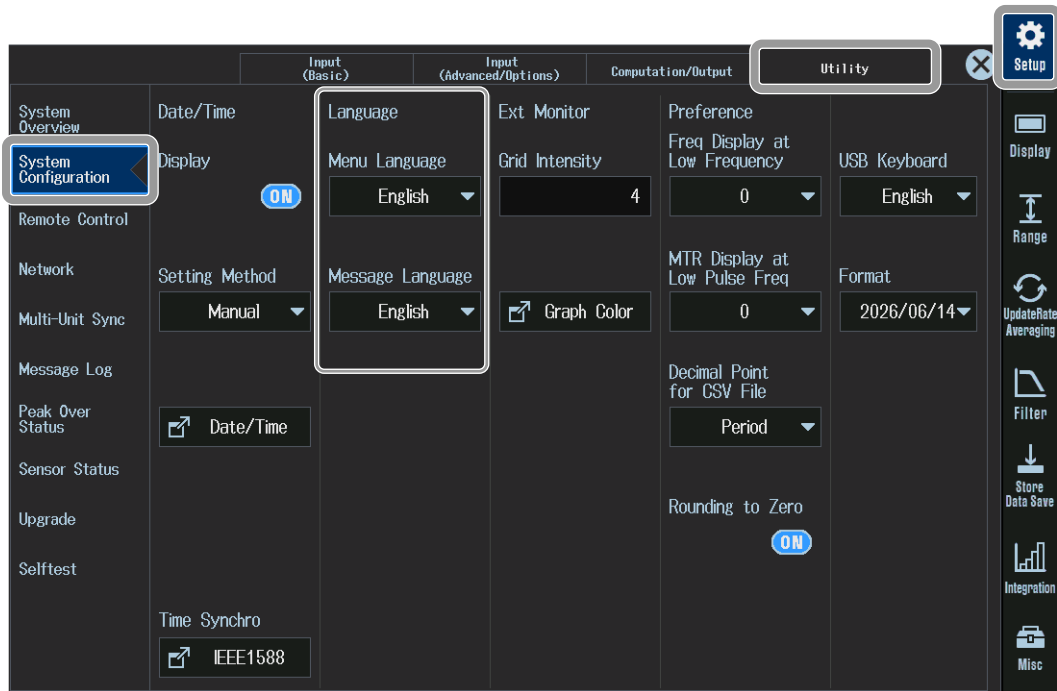
- Only plug compatible USB keyboards or USB memory devices to the USB ports for peripherals.
 - Even though there are two USB ports for peripherals, do not connect two keyboard devices to the instrument.
-

2.6 Setting the Menu and Message Languages

You can set the language that is used in the setting menu and messages.

Procedure

Setup menu icon  > **Utility** > **System Configuration** > **Menu Language**, **Message Language** under **Language**



Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.

Language settings for menus and messages (Language)

Menu language (Menu Language)

You can choose to display menus in any of the following languages. The available languages vary depending on the suffix code.

- English
- Japanese
- Chinese
- German

Message language (Message Language)

Error messages appear when errors occur. You can choose to display these messages and the help using one of the following languages. The available languages vary depending on the suffix code.

The error codes for error messages are the same for all languages.

For details on error messages, see appendix 12.

- English
- Japanese
- Chinese
- German

Note

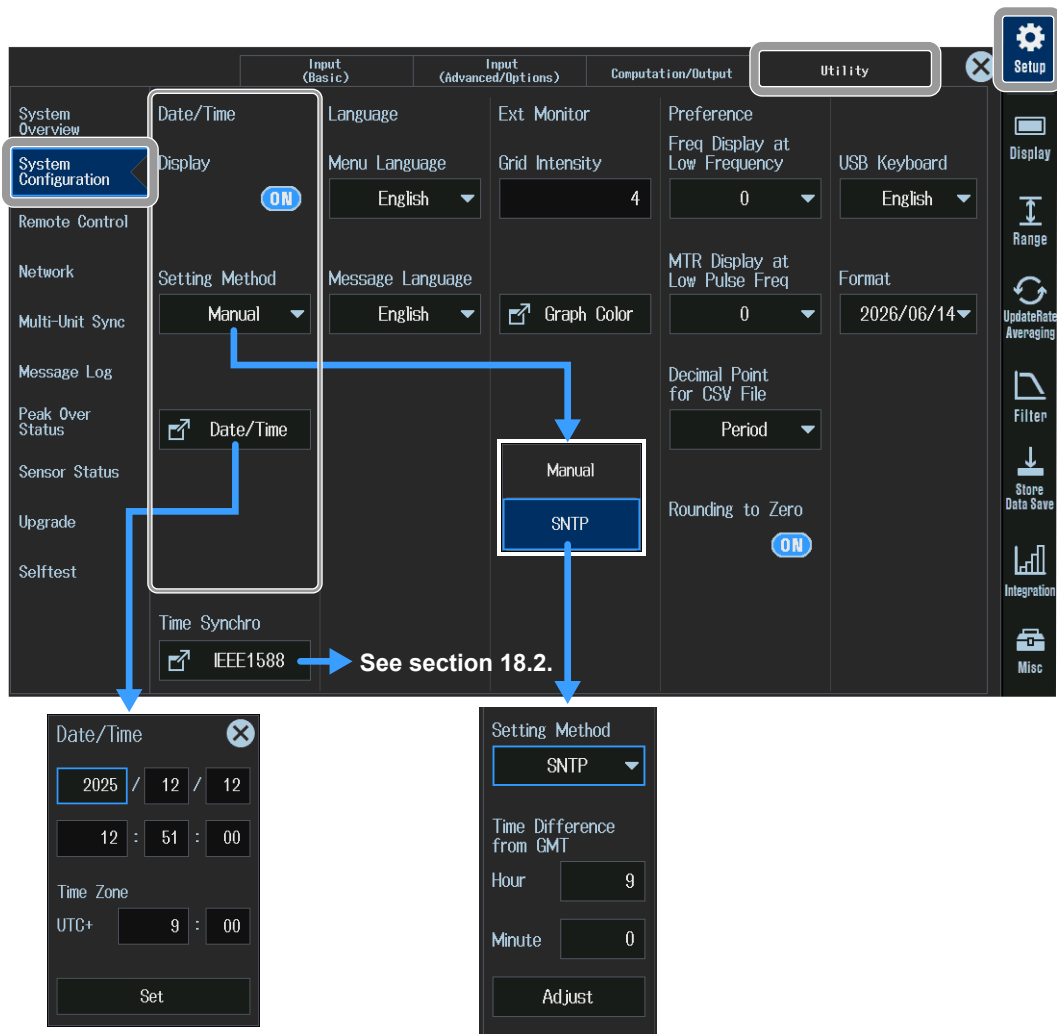
- Even if you set the menu or message language to a language other than English, some terms will be displayed in English.
 - On the WT1500 LCD, text is displayed in English regardless of the language setting.
-

2.7 Synchronizing the Clock

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

Procedure

Setup menu icon  > **Utility** > **System Configuration** > **Date/Time** menu > **Display, Setting Method, Date/Time**, or **Time Difference from GMT**



Note

Procedures using front-panel keys

See section 1.2 of the Getting Started Guide (IM WT1501-02EN).

- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.

Turning the display on and off (Display)

Select whether to show the clock on the screen.

Setting method (Setting Method)

You can set the method for setting the date and time to any of the following options.

- **Manual (Manual):** Set the clock and time zone manually.
- **SNTP:** Set the instrument's clock using the SNTP server time. For details on SNTP, see section 14.6. If you select SNTP, set the time difference from Greenwich Mean Time (Time Difference from GMT), and then select **Adjust**.

Date and time (Date/Time)

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

Set the date and time of the region where this instrument will be used.

- **Setting the date**
The format for setting the date is YYYY/MM/DD (year/month/day). Set the last two digits of the Western calendar year.
- **Setting the time**
The format for setting the time is HH:MM:SS (hour:minute:second). The hour can be set to a value from 0 to 23.
- **Time zone (Time Zone)**
Set the time difference between the region where you are using the instrument and Coordinated Universal Time (UTC) in the following range.
–12 hours 00 minutes to 13 hours 00 minutes
For example, Japan standard time (JST) is ahead of UTC by 9 hours. In this case, set Hour to 9 and Minute to 00.

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

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

Set the time difference between the region where you are using the instrument and Greenwich Mean Time in the following range.

–12 hours 00 minutes to 13 hours 00 minutes

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

Checking the standard time

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

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

Note

- This instrument does not support Daylight Saving Time. To set the Daylight Saving Time, reset the time difference from Greenwich Mean Time.
 - Date and time settings are backed up using an internal lithium battery. They are retained even if the power is turned off.
 - This instrument manages leap-year information.
 - The time zone and Time Difference from GMT settings are shared with the same settings found in the SNTP settings in the Ethernet communication (Network) settings. If you change this setting in the date and time settings, the Time Difference from GMT in the Ethernet communication (Network) settings also changes.
 - The time zone setting is shared with the IEEE1588 time synchronization feature.
-

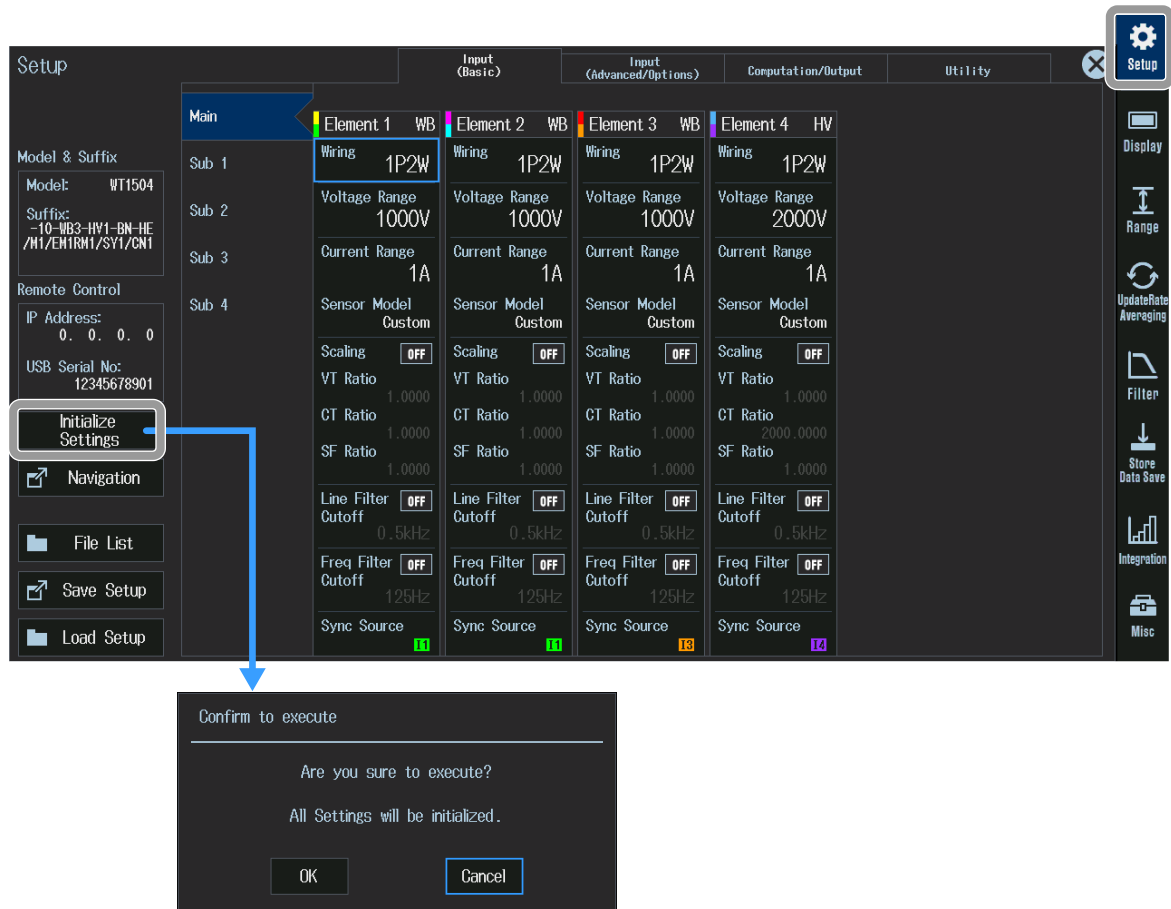
2.8 Initializing Settings

You can reset the instrument settings to their factory default values.

This is useful when you want to cancel the settings made so far or restart measurement from the beginning. For details on default settings, see appendix 7.

Procedure

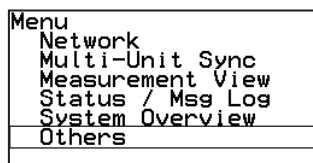
Setup menu icon  > Initialize Settings



Note

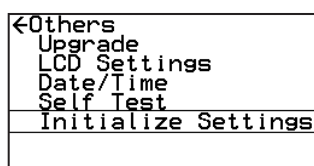
Operating using the WT1500 LCD

You can also initialize the settings using the WT1500 LCD and operation keys.

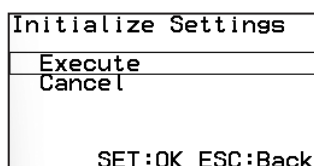


Use the ▲ and ▼ arrow keys to select **Others** on the Menu screen, and then press **SET**.





Use the ▲ and ▼ arrow keys to select **Initialize Settings**, and press **SET**.



If you select **Execute** and press **SET**, initialization is executed, and the previous screen returns.

If you select **Cancel** and press **SET**, the previous screen returns.

Initialize settings (Initialize Settings)

- OK: Executes initialization.
- Cancel: Cancels initialization.

Settings that cannot be reset to their factory default values

- Date and time settings
- Communication settings
- Menu and message language settings
- Environment settings
 - Frequency display when low frequency is being input
 - MTR display when low frequency pulse is being input
 - Decimal point and separator used when saving to ASCII format (.csv)
 - Date format
- Multi-unit synchronization mode

To reset all settings to their factory default values

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

* Keep holding down the ESC key until the menu screen is displayed on the instrument LCD.

Note

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

3.1 Overview of Input Settings

The settings applied to the input elements and wiring units that are installed in this instrument are shown in table format.

Procedure

Overview of input settings (basic measurement conditions, Input (Basic))

Setup menu icon  > **Input (Basic)**

During multi-unit synchronization (option /SY1), > **Main/Sub 1/Sub 2/Sub 3/Sub 4**



Show navigation window

WB input element

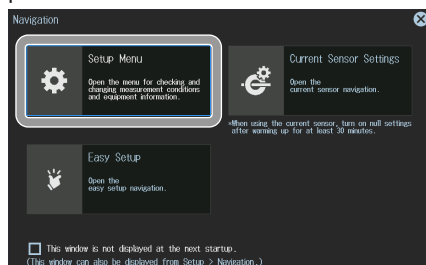
HV input element

Element 1 to Element 4 settings

You can also set each item for the input elements.

Note

- You can also display the setup menu screen from the navigation window that appears immediately after power-on.



- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - The input settings overview screen can also be displayed by selecting **Input (Basic)** with the arrow keys and pressing **SET**.

Setting input elements

You can edit settings by selecting the setting buttons in each input element area of the overview screen.

Element 1

WB

Wiring

1P2W

Voltage Range

Auto

300V

Current Range

Auto

V

50mV

Sensor Model

CT1000S

Scaling

OFF

VT Ratio

1.0000

CT Ratio

1.0000

SF Ratio

1.0000

Line Filter

Advanced

Freq Filter

Advanced

Sync Source

III

Element number and input element type

Set wiring system (see section 4.1)

Set voltage range (see section 4.2)

Set current range (see section 4.2)

Set sensor model (see section 4.2)

Set voltage transformer (VT)/current transformer (CT) ratio (see section 4.3)

Set line filter (see section 4.6)

Set frequency filter (see section 4.7)

Set sync source (see section 4.8)

Note You can also select a setting item with the arrow keys and press **SET** to change the value.

Procedure

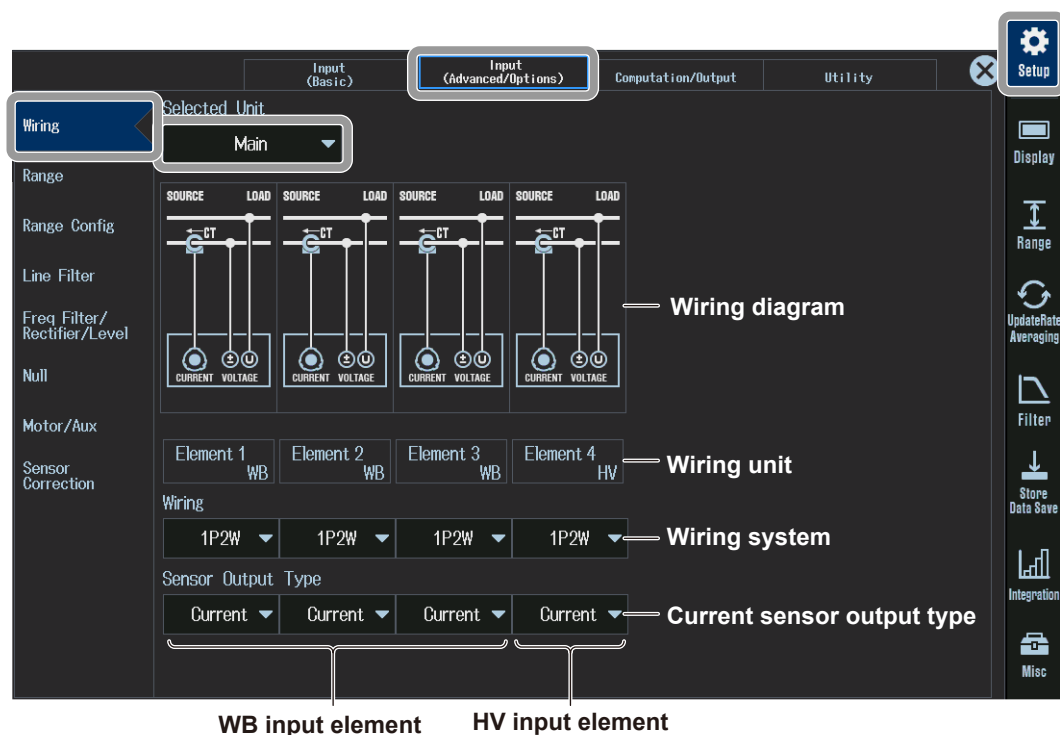
Overview of input settings (advanced, options) (Input (Advanced/Options))

Setup menu icon  > Input (Advanced/Options)

Advanced wiring system settings (Wiring) ► section 4.1

> Wiring

During multi-unit synchronization (option /SY1), > Main/Sub 1/Sub 2/Sub 3/Sub 4



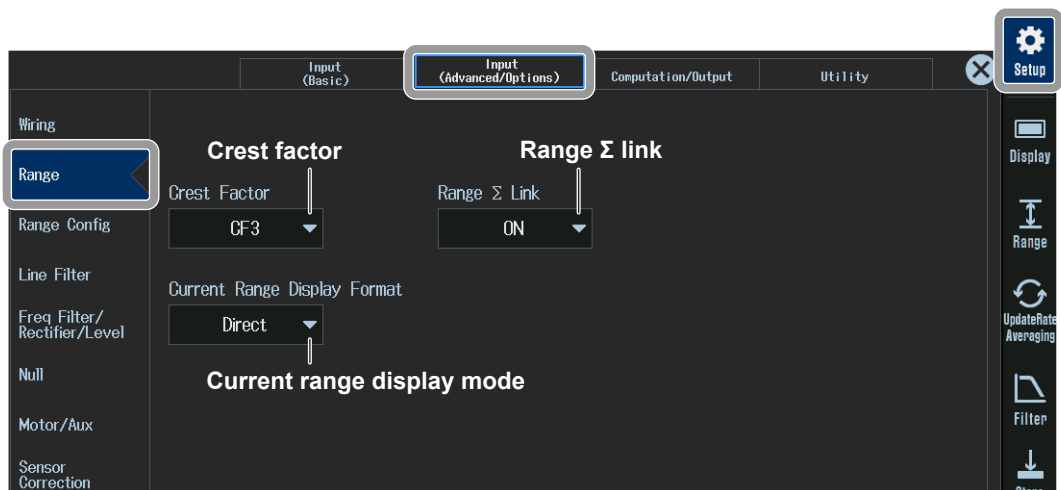
The display showing the wiring diagram and wiring units changes depending on the specified wiring system.

Note

- You can also display the setup menu screen from the navigation window that appears immediately after power-on. (See page 3-1.)
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - The input settings overview screen can also be displayed by selecting **Input (Advanced/Options)** with the arrow keys and pressing **SET**.

Common measurement range settings (Range) ▶ sections 4.1, 4.2, 4.9

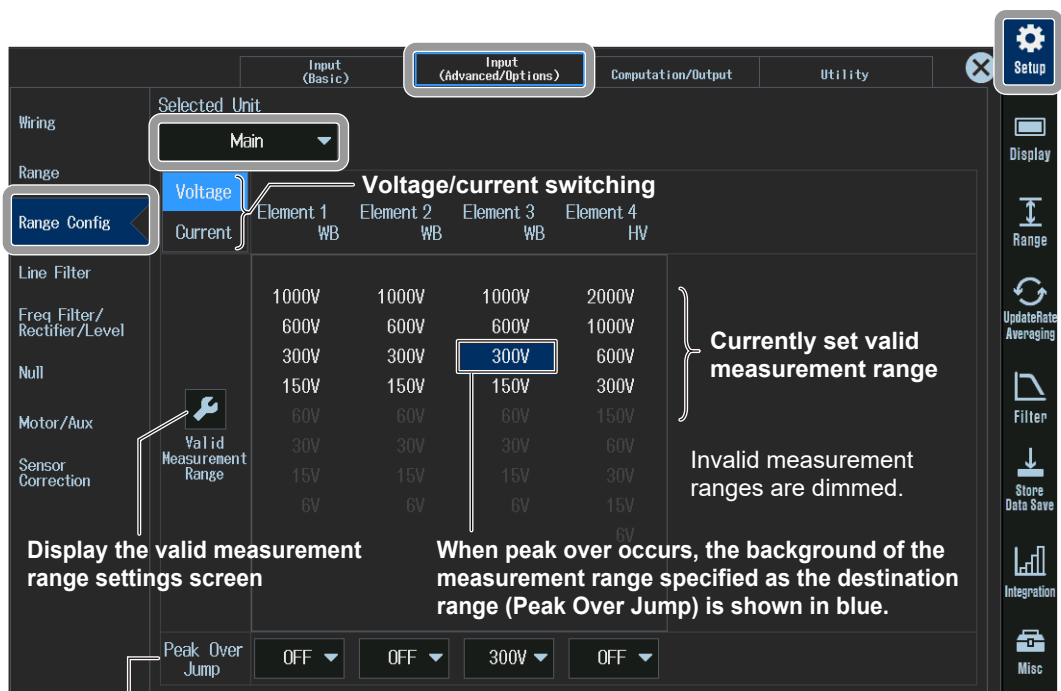
> Range



Measurement range configuration settings (Range Config) ▶ section 4.4

> Range Config > Main/Sub 1/Sub 2/Sub 3/Sub 4

During multi-unit synchronization (option /SY1), > Main/Sub 1/Sub 2/Sub 3/Sub 4



Display the valid measurement range settings screen

When peak over occurs, the background of the measurement range specified as the destination range (Peak Over Jump) is shown in blue.

Specify the measurement range to switch to when peak over occurs

Setting the line filter (Line Filter) ▶ section 4.6

> Line Filter

During multi-unit synchronization (option /SY1), > Main/Sub 1/Sub 2/Sub 3/Sub 4

The screen in the following figure is an example when Line Filter Advanced Settings are on. You can set the AAF, DLF (N) and DLF (H) filters separately.

Unit Common Items

Line Filter Advanced Settings **ON**

Turn advanced line filter settings on/off

Selected Unit: Main

	AAF	DLF(N)	DLF(H)
All	Anti-Aliasing Filter (300kHz/Bessel)	Digital Line Filter (Normal)	Digital Line Filter (Harmonics)
Element 1	ON	ON 0.5kHz	ON OFF 0.5kHz
Element 2	ON	ON 0.5kHz	ON OFF 0.5kHz
Element 3	ON	ON 0.5kHz	ON OFF 0.5kHz
Element 4	ON	ON 0.5kHz	ON OFF 0.5kHz

Anti-aliasing filter Digital line filter (for normal measurement) Digital line filter (for harmonic measurement)

Setting the frequency filter, rectifier, and cross level (Freq Filter/Rectifier/Level) ▶ sections 4.7, 4.8

> Freq Filter/Rectifier/Level

During multi-unit synchronization (option /SY1), > **Main/Sub 1/Sub 2/Sub 3/Sub 4**

The screen in the following figure is an example when Freq Filter Advanced Settings are on. You can set the HPF, Rectifier, LPF, and Level separately.

Unit Common Items

Freq Filter Advanced Settings **ON**

Turn advanced frequency filter settings on/off

Selected Unit: **Main**

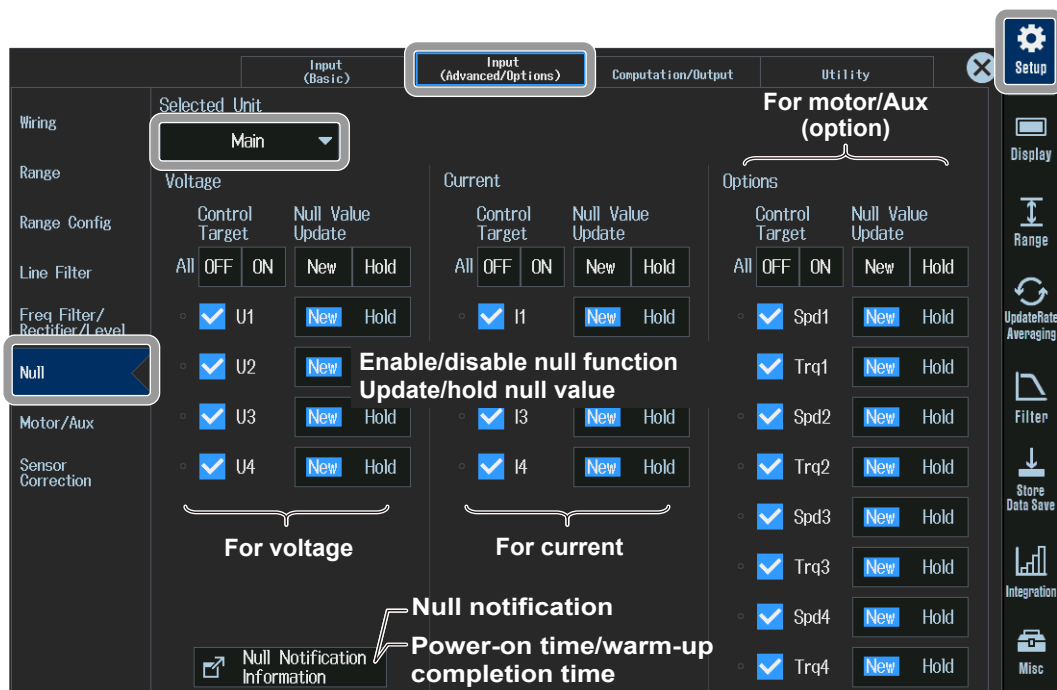
	Rectifier		LPF			Level	
	Voltage	Current	Freq Filter	Auto	Cutoff	Voltage	Current
Element 1	ON	ON	ON	ON	32kHz	0.0%	0.0%
Element 2	ON	ON	ON	ON	32kHz	0.0%	0.0%
Element 3	ON	ON	ON	ON	125Hz	0.0%	0.0%
Element 4	ON	ON	ON	ON	125Hz	0.0%	0.0%

Rectify voltage/current signal Frequency filter (LPF) Voltage/current cross level

Setting the Null function (Null) ▶ section 4.14

> Null

During multi-unit synchronization (option /SY1), > Main/Sub 1/Sub 2/Sub 3/Sub 4

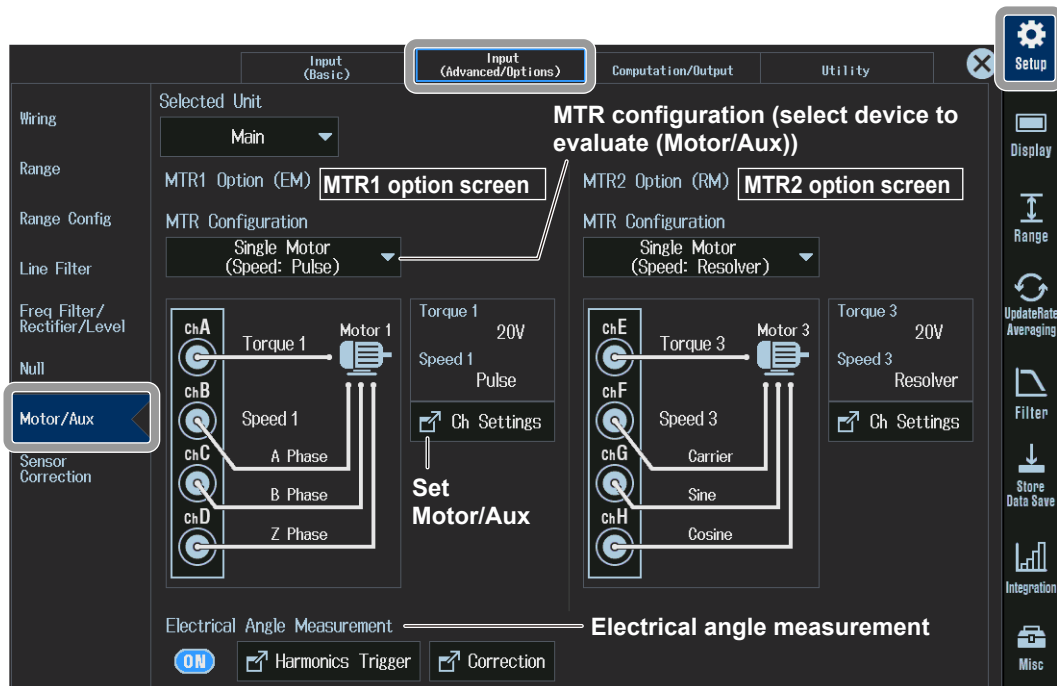


Setting the motor evaluation and auxiliary input (Motor/Aux) ▶ section 11.1

> Motor/Aux

During multi-unit synchronization (option /SY1), > Main/Sub 1/Sub 2/Sub 3/Sub 4

The following screen is an example for a model with the /EM1RM1 option.



Setting sensor correction (Sensor Correction) ▶ section 4.5

> Sensor Correction

During multi-unit synchronization (option /SY1), > Main/Sub 1/Sub 2/Sub 3/Sub 4

Selected Unit	All	Element 1 HV	Element 2 HV	Element 3 HV	Element 4 WB
Current Amplitude Correction		ON	OFF	ON	ON
Correction Ratio		1.000000	1.000000	1.000000	1.000000
Current DC Offset Correction		ON	OFF	OFF	ON
DC Offset		0.00000A	0.00000A	0.00000A	0.00000A
Current Phase Correction		ON	ON	OFF	ON
Frequency		60 Hz	60 Hz	60 Hz	60 Hz
Phase Difference between I/O		0.000°	0.000°	0.000°	0.000°
Time Difference between I/O		0.000s	0.000s	0.000s	0.000s

Current amplitude correction

Current DC offset correction

Current phase correction

3.2 Overview of Computation and Output Settings

The overview screen shows in a table the various settings related to the input signal computing method, harmonic measurement, integration conditions, numeric and graphic screen displays, data saving, CAN data output, UDP data output, and so on.

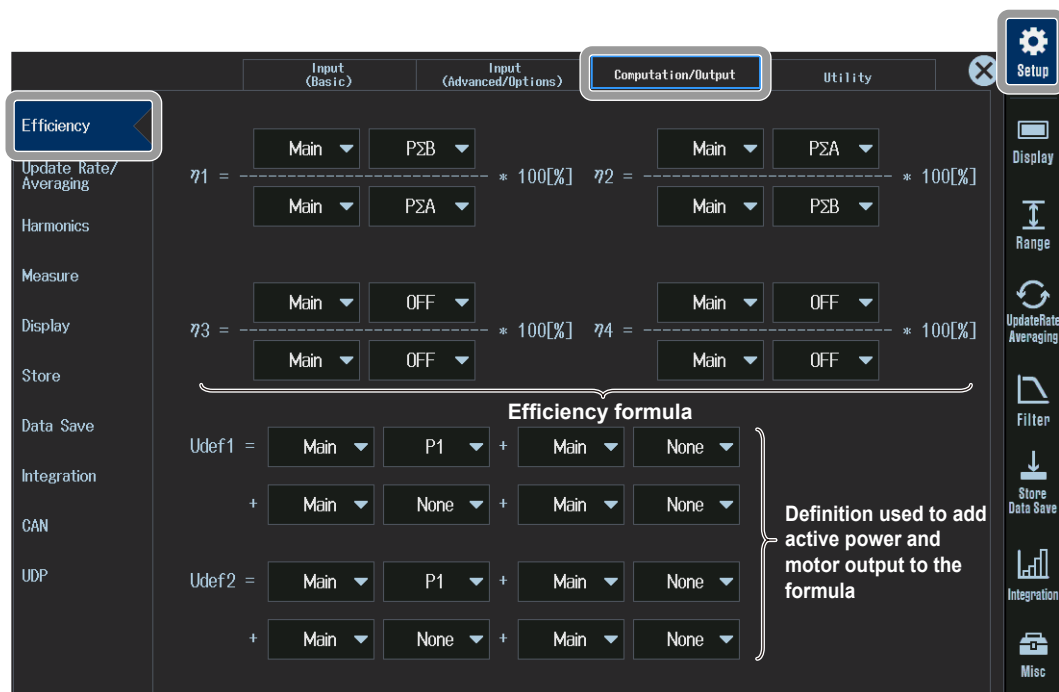
Procedure

Overview of computation and output settings (Computation/Output)

Setup menu icon  > Computation/Output

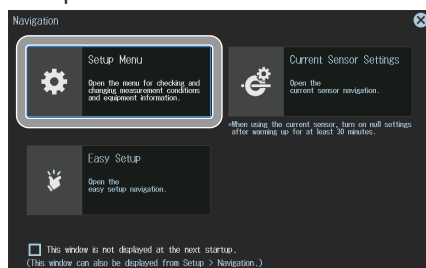
Efficiency formula settings (Efficiency) ▶ [section 4.11](#)

> Efficiency



Note

- You can also display the setup menu screen from the navigation window that appears immediately after power-on.

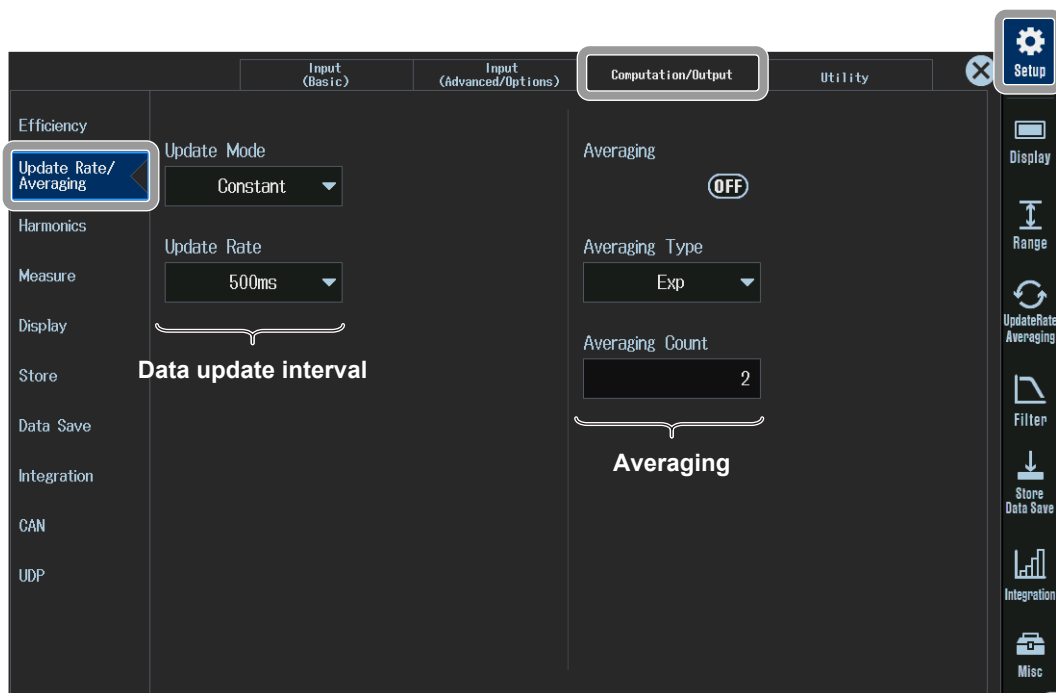


- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - The computation and output settings overview screen can also be displayed by selecting **Computation/Output** with the arrow keys and pressing **SET**.

Setting the data update interval and averaging (Update Rate/Averaging)

► sections 4.10, 4.12

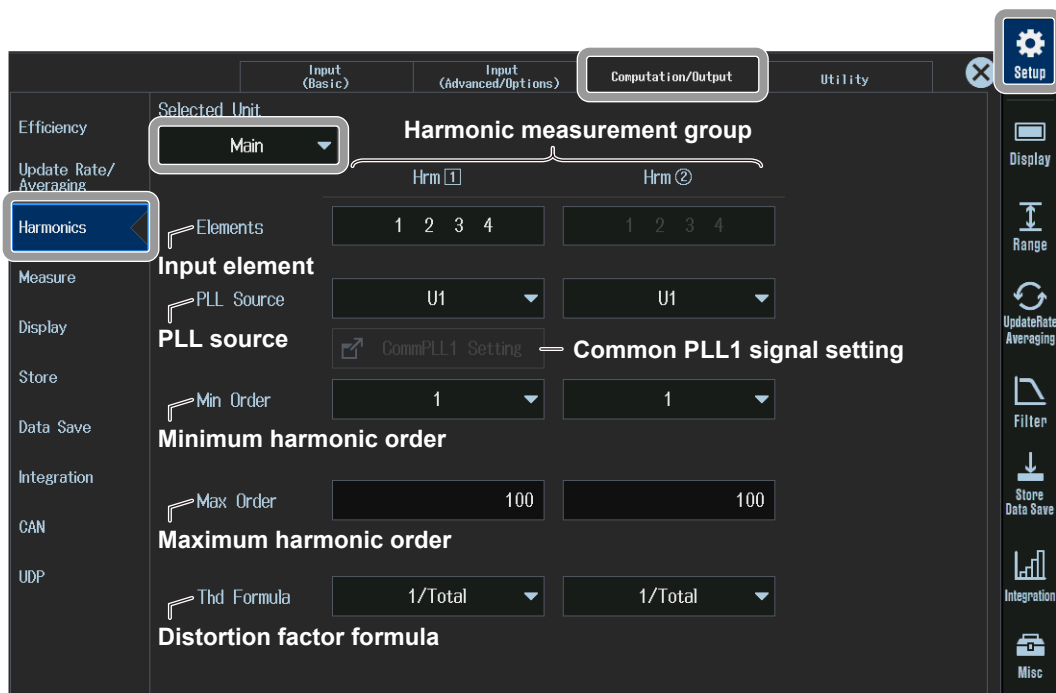
> Update Rate/Averaging



Setting the harmonic measurement (Harmonics) ► section 8.1

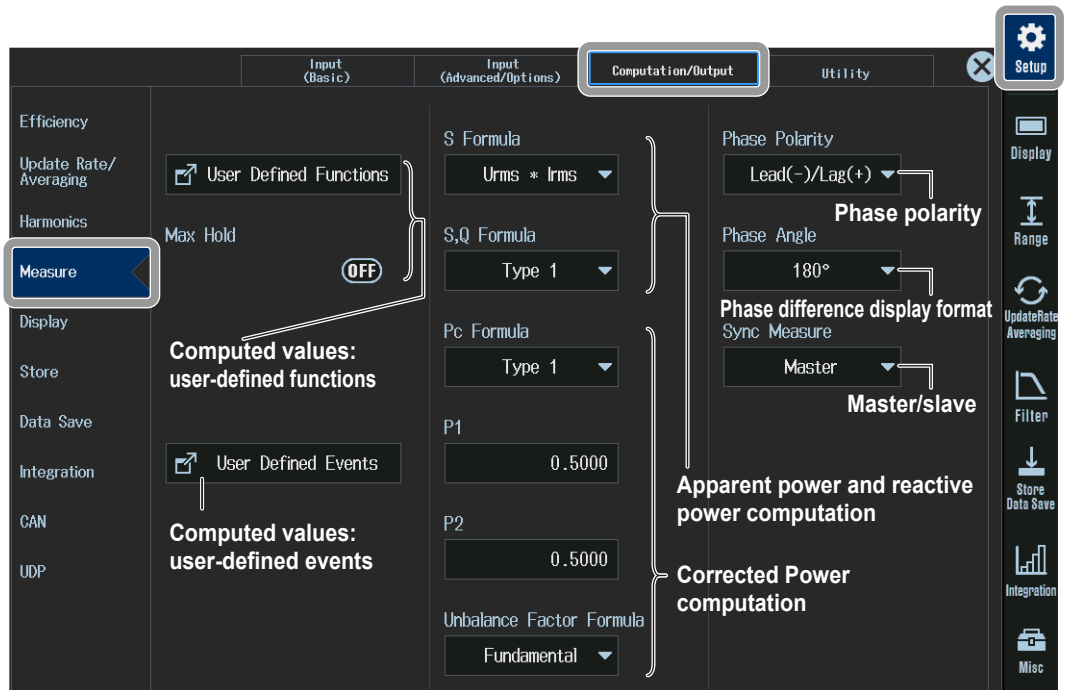
> Harmonics

During multi-unit synchronization (option /SY1), > Main/Sub 1/Sub 2/Sub 3/Sub 4



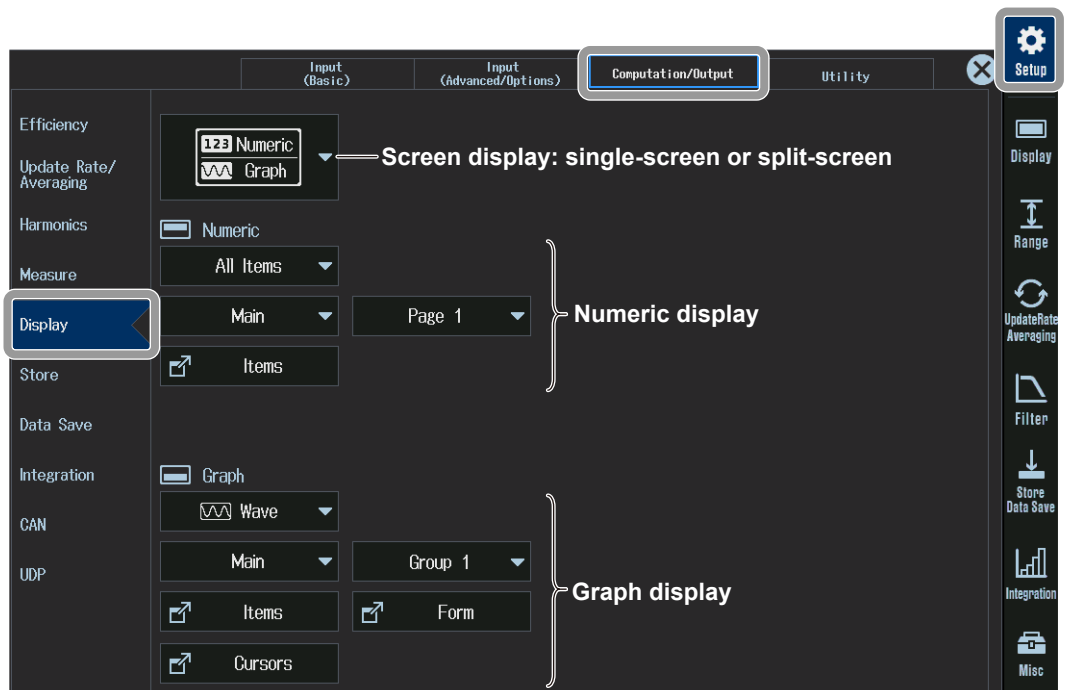
Setting computation (Measure) ▶ sections 4.16, 5.4, 5.5, 5.6

> Measure



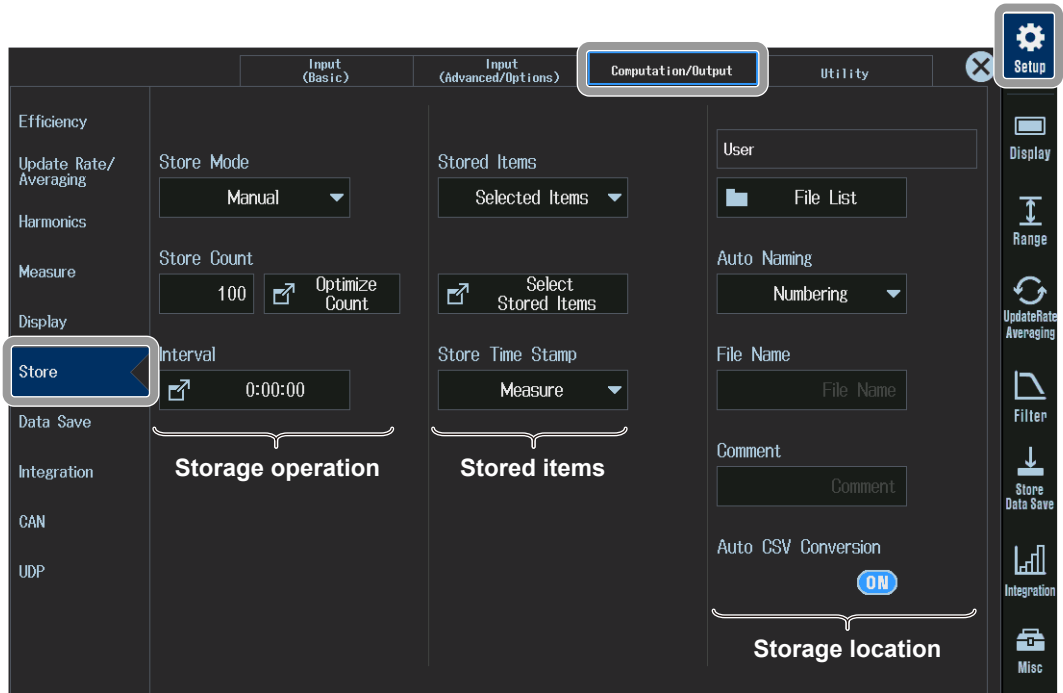
Setting the numeric and graph displays (Display) ▶ sections 5.1, 9.1

> Display



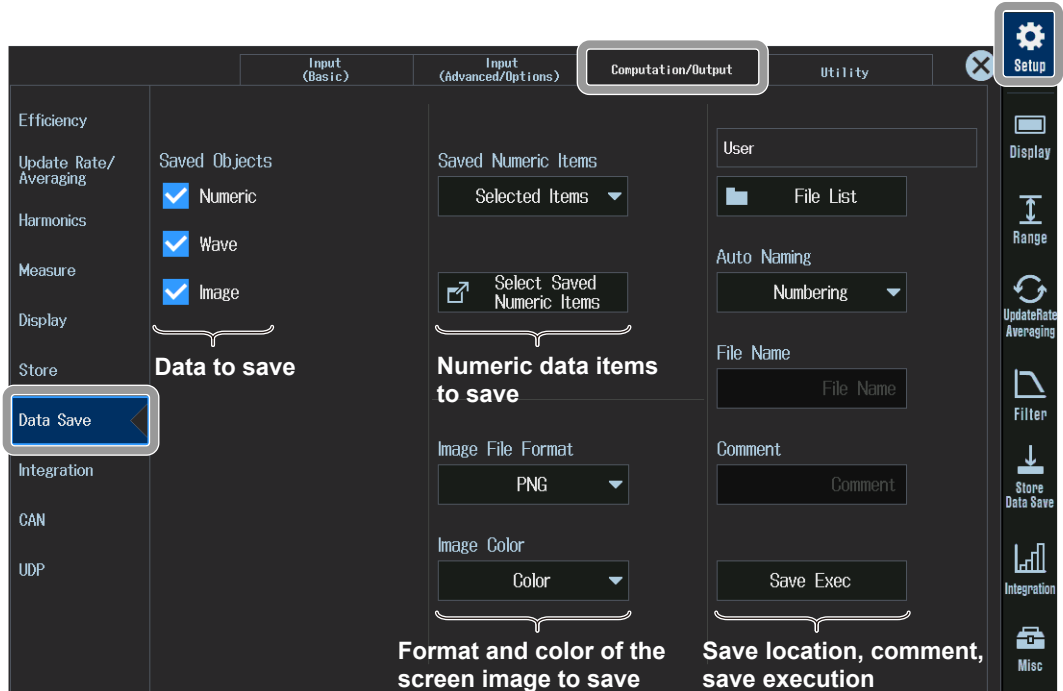
Setting storage (Store) ▶chapter 12

> Store



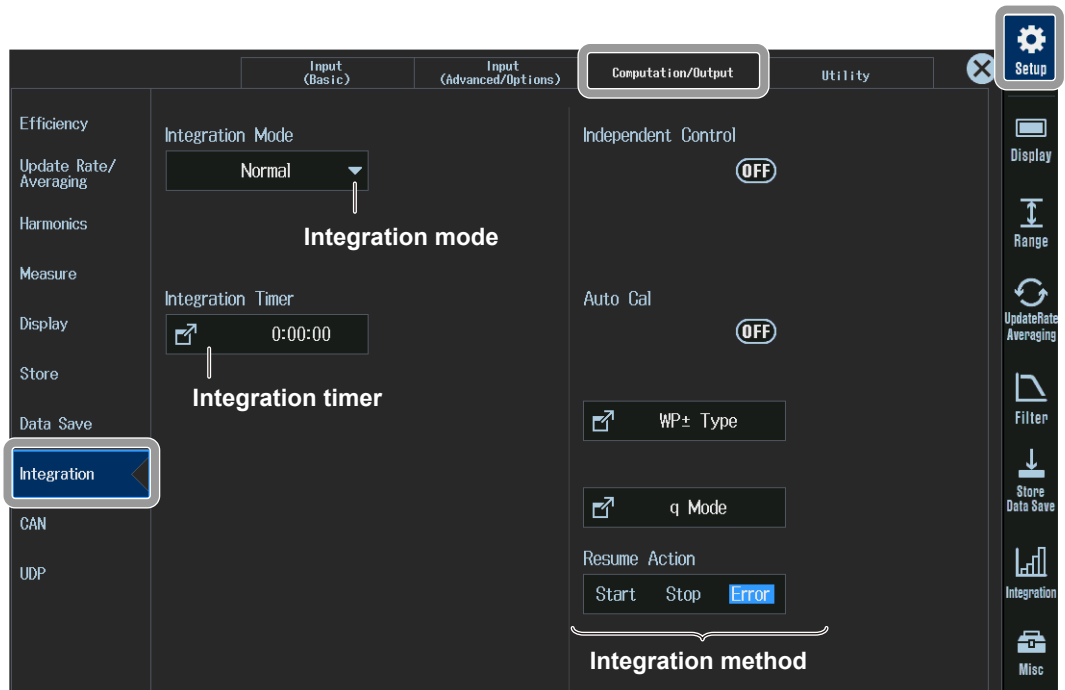
Setting saving (Data Save) ▶sections 13.3, 13.4, 13.5, 13.6

> Data Save



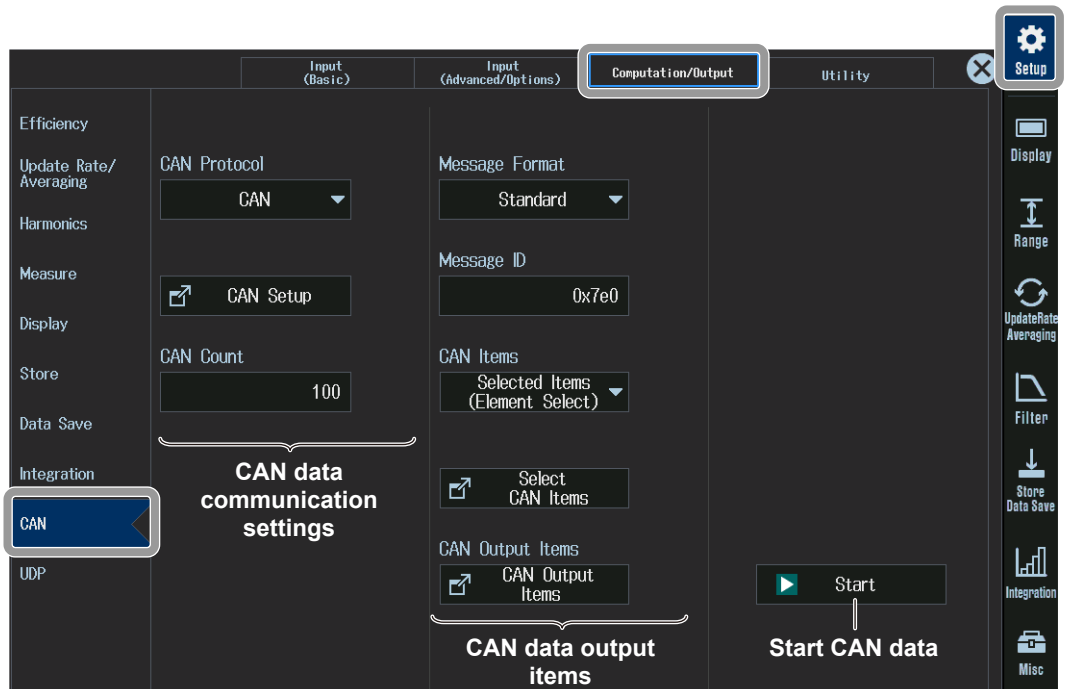
Setting integration conditions (Integration) ▶ section 7.1

> Integration



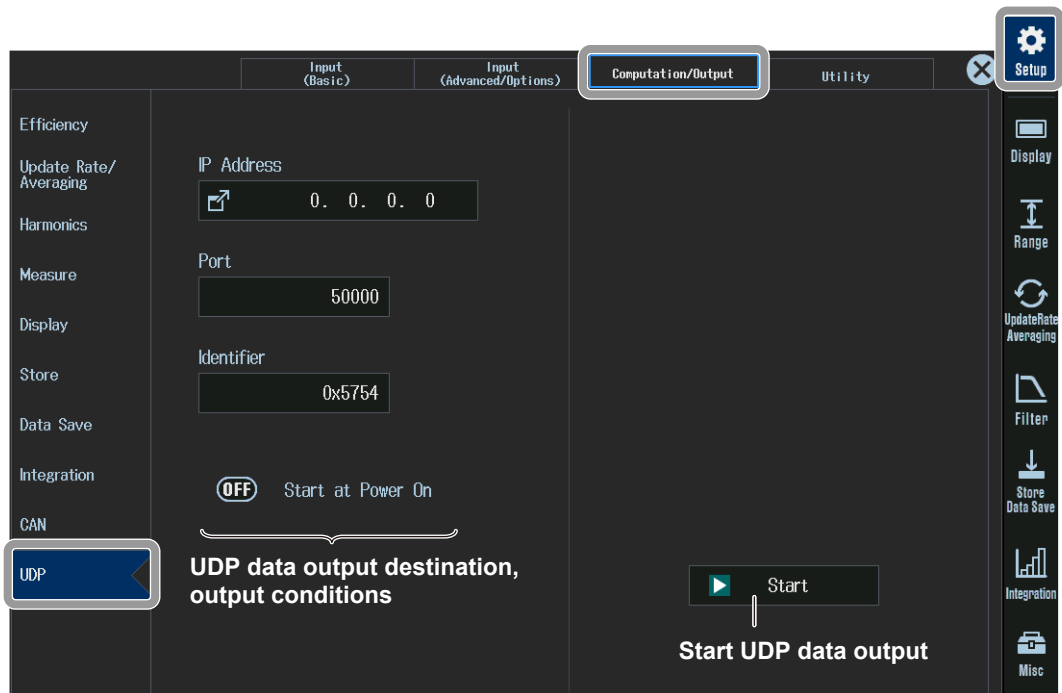
Setting the CAN data output (CAN) ▶ chapter 16

> CAN[CAN]



Setting the UDP data output (UDP) ▶ [section 15.1](#)

> UDP[UDP]



3.3 Overview of Utility Settings

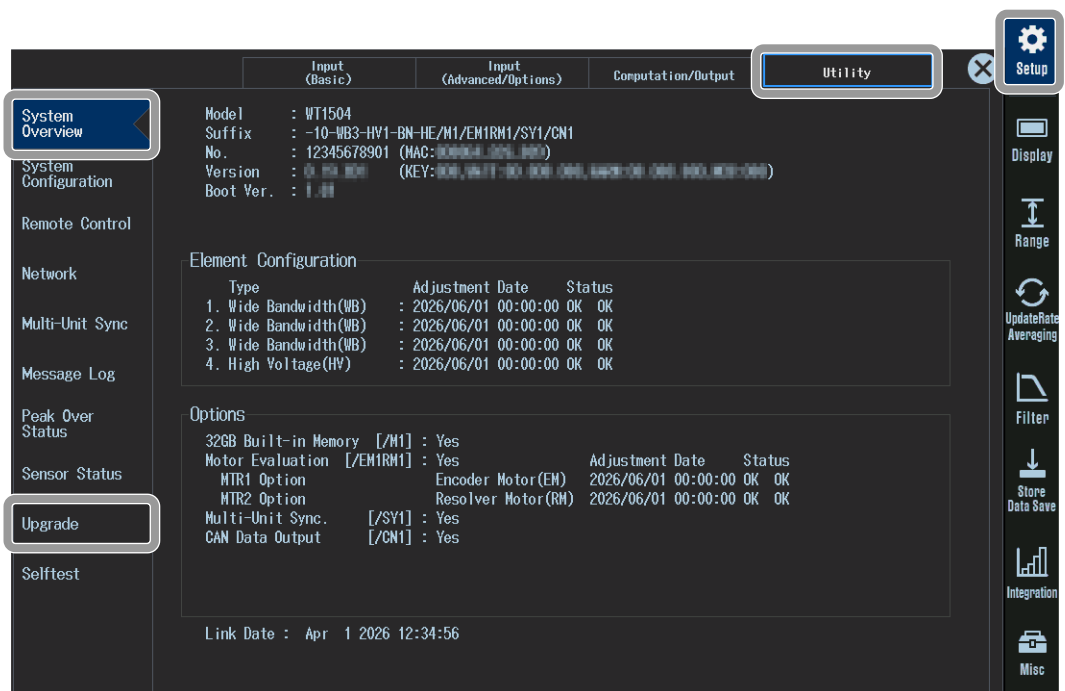
This section explains how to show an overview of the instrument's utility settings.

Procedure

Overview of utility settings (Utility)

Setup menu icon  > Utility

Instrument information and updating (System Overview/Upgrade) ► [section 18.1](#)
> System Overview/Upgrade



Note

- You can also display the setup menu screen from the navigation window that appears immediately after power-on.

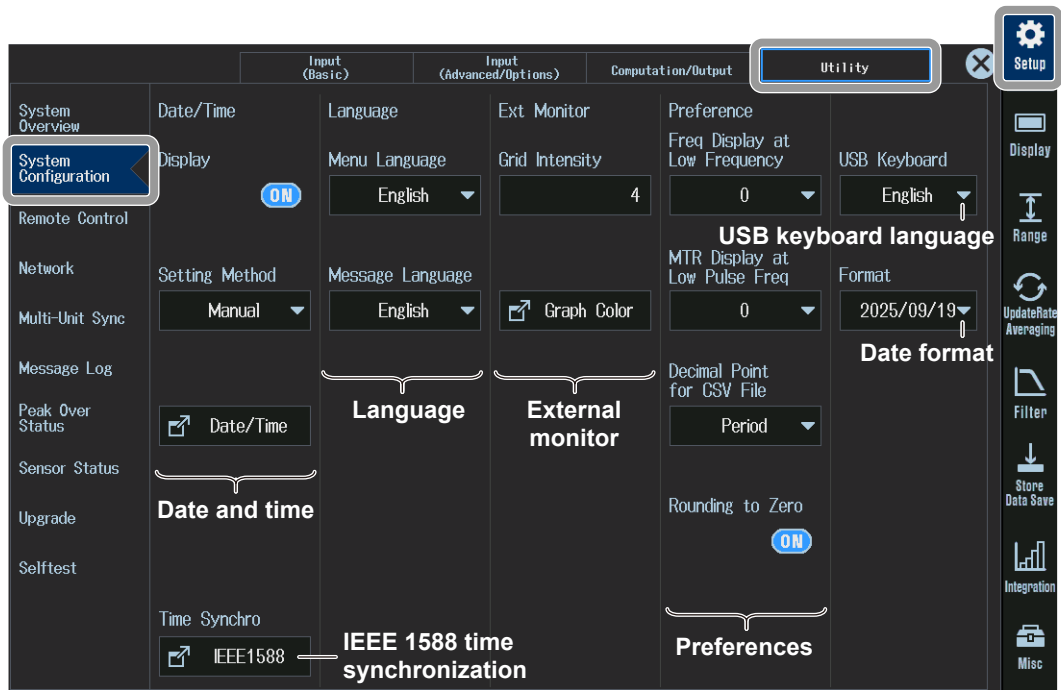


- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.

Configuring the system (System Configuration)

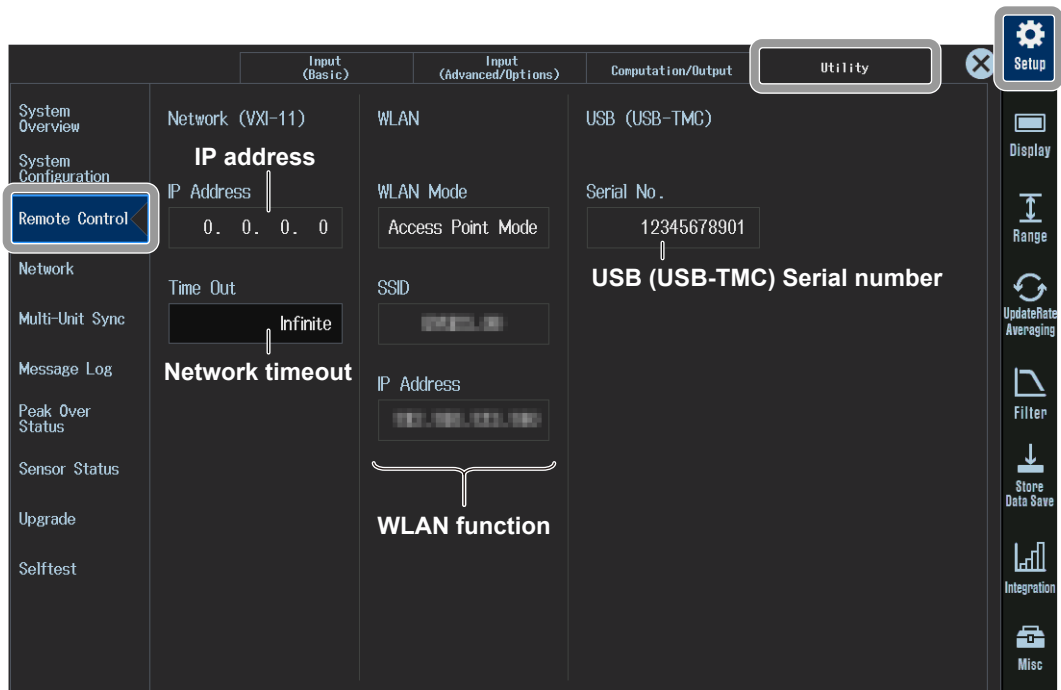
► sections 2.5, 2.6, 2.7, 18.2, 18.4

> System Configuration



Setting remote control (Remote Control) ► section 18.5

> Remote Control



Setting Ethernet communication (Network) ▶ chapter 14

- Setting TCP/IP (section 14.2)
 > Network > TCP/IP

The screenshot shows the 'Utility' tab in the Network settings menu. The 'TCP/IP' sub-tab is selected. The interface is divided into two main sections: DHCP and DNS. The DHCP section has a toggle switch set to 'ON'. The DNS section has a toggle switch set to 'Auto'. Below these are input fields for IP Address, Net Mask, Gate Way, Domain Name, DNS Server 1, DNS Server 2, Domain Suffix 1, and Domain Suffix 2. A 'Bind' button is located at the bottom right of the DNS section. The left sidebar contains various system management options, and the right sidebar contains utility options like Display, Range, UpdateRate Averaging, Filter, Store Data Save, Integration, and Misc.

Utility

TCP/IP | FTP/Web Server | Net Drive | SNTP | WLAN

DHCP **ON**

DNS **OFF** **ON** **Auto**

IP Address

Domain Name

Net Mask

DNS Server 1

Gate Way

DNS Server 2

Domain Suffix 1

Domain Suffix 2

Host Name

Bind

DHCP **DNS**

- Setting the FTP and Web servers (sections 14.3, 14.4)
 > Network > FTP/Web Server

The screenshot shows the 'Utility' tab in the Network settings menu. The 'FTP/Web Server' sub-tab is selected. The interface displays input fields for User Name (set to 'anonymous') and Password. Below these is a 'Time Out' field set to '90s' and an 'Entry' button. A label 'FTP server timeout' is positioned below the Time Out field. The left sidebar and right sidebar are identical to the previous screenshot.

Utility

TCP/IP | **FTP/Web Server** | Net Drive | SNTP | WLAN

User Name

anonymous

Password

Password

Time Out

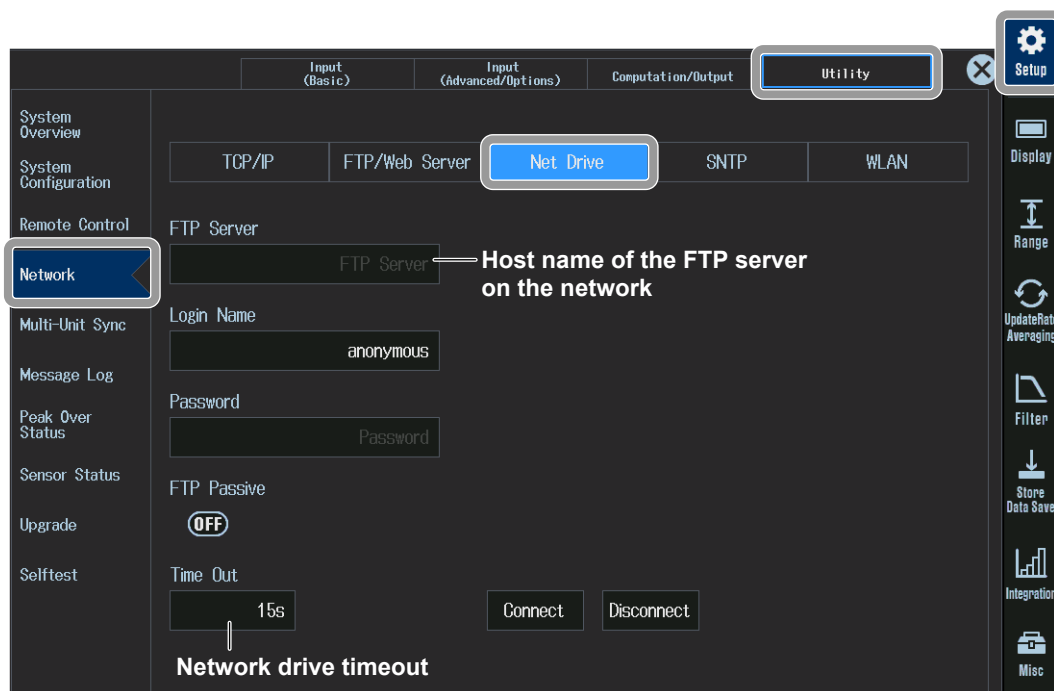
90s

Entry

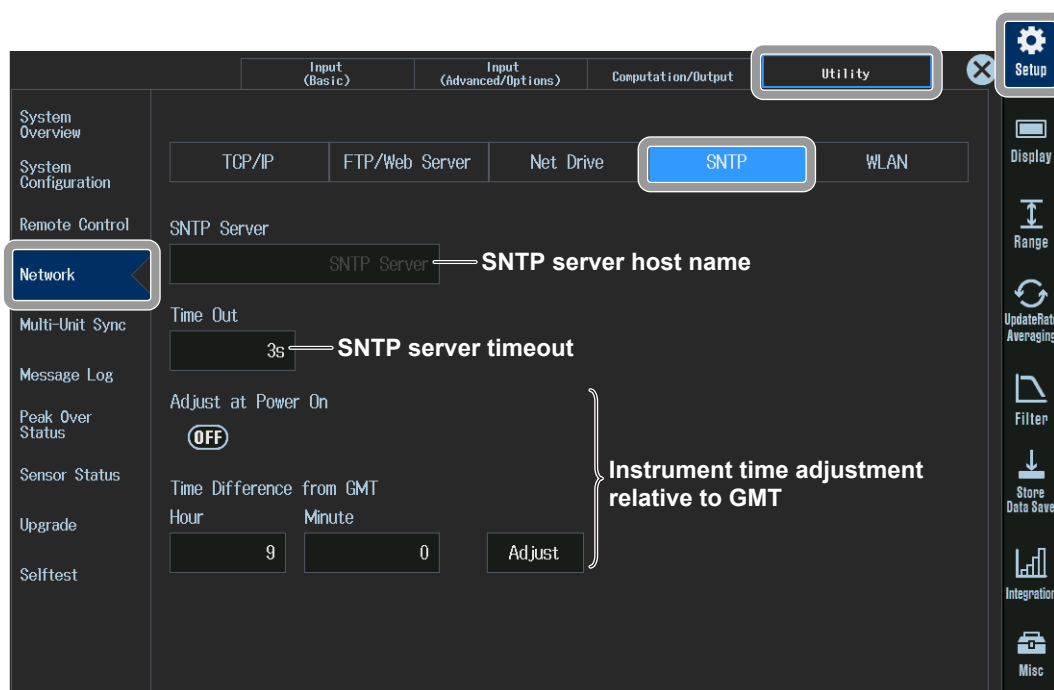
FTP server timeout

3.3 Overview of Utility Settings

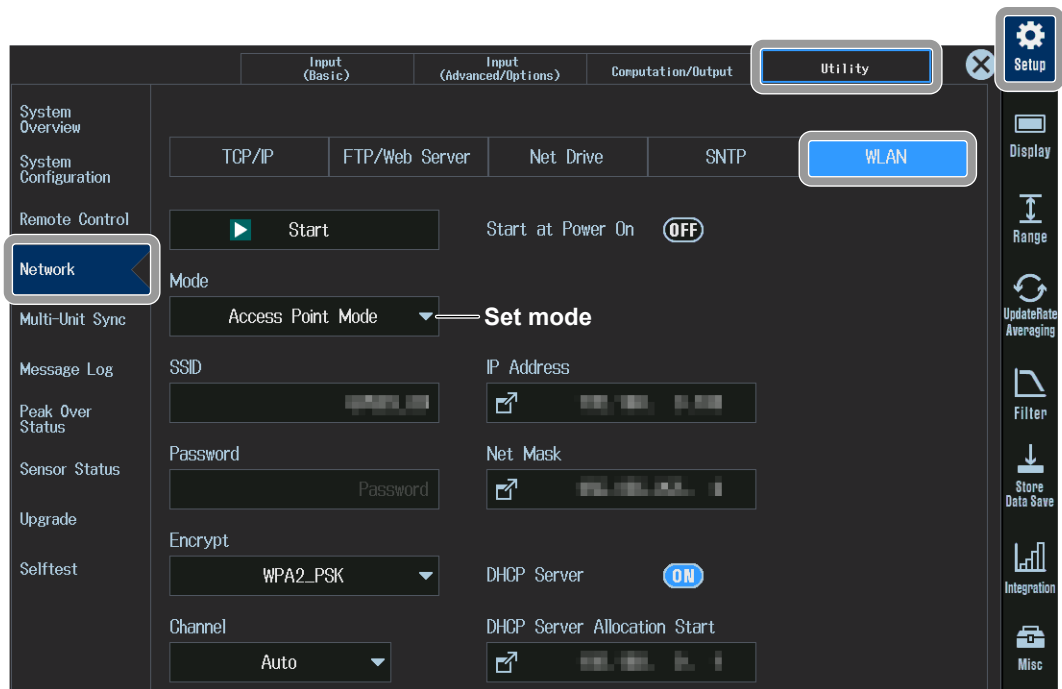
- Setting the network drive ([section 14.5](#))
 - > Network > Net Drive



- Setting SNTP (clock) ([section 14.6](#))
 - > Network > SNTP

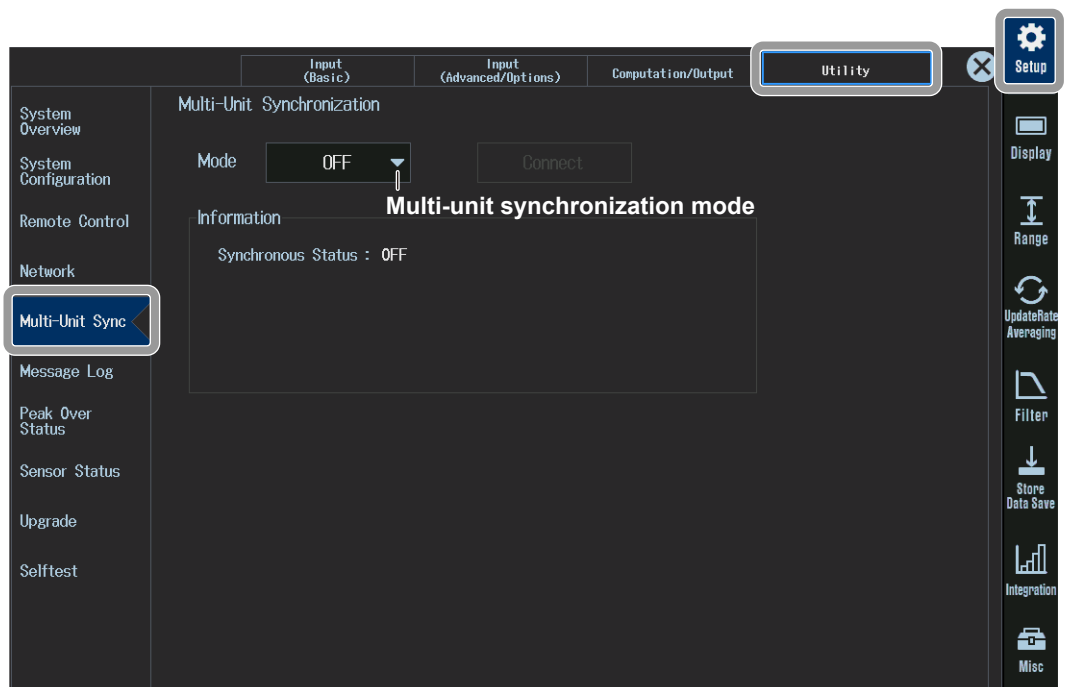


- **Setting wireless LAN (WLAN)** ([section 14.7](#))
 > **Network > WLAN**

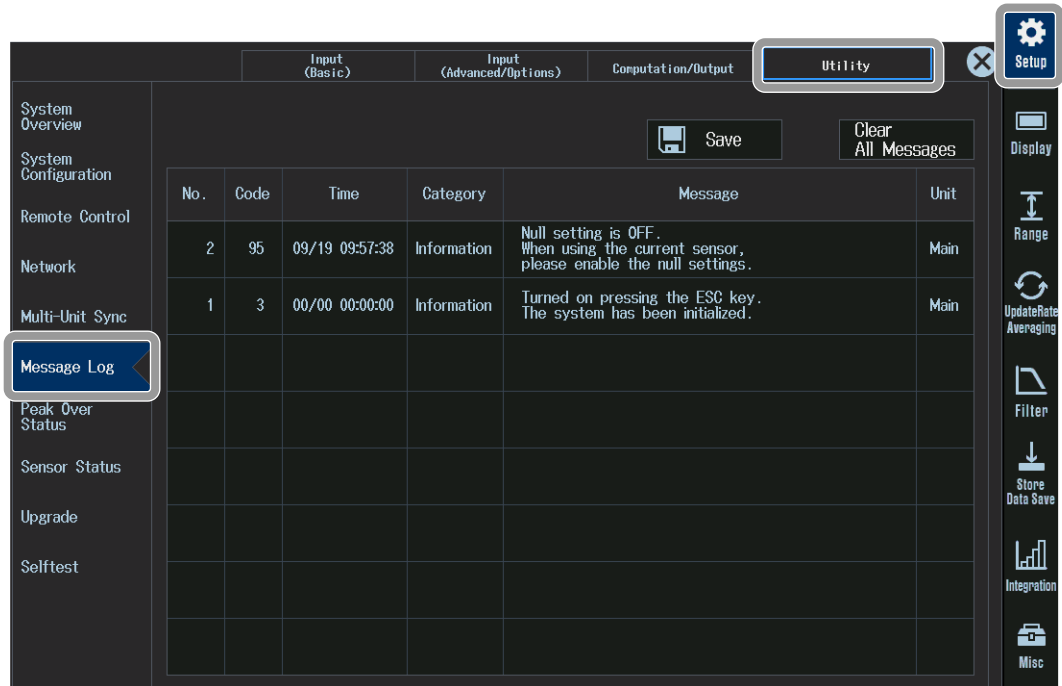


Multi-unit synchronization (Multi-Unit Sync) ▶ [chapter 17](#)

- > **Multi-Unit Sync**

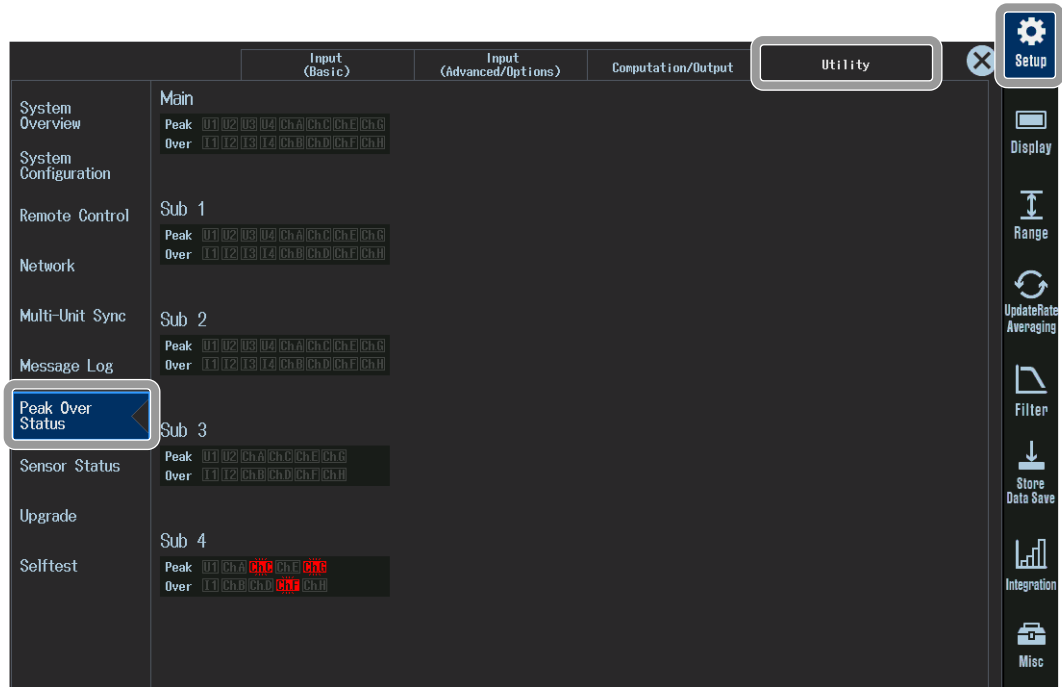


Displaying the message log (Message Log) ▶ section 18.6
> Message Log



Displaying peak over status (Peak Over Status) ▶ section 18.7
> Peak Over Status

The screen shown below is an example of the display for the main unit during multi-unit synchronized operation (option /SY1).

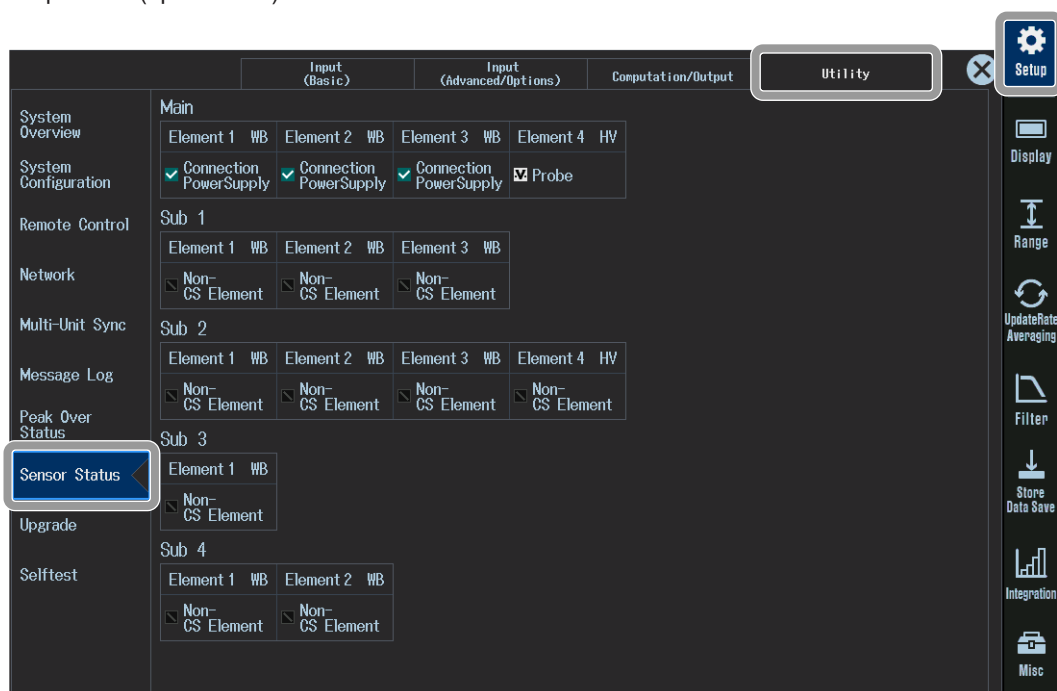


On the main unit during multi-unit synchronization (option /SY1), the status of the subunits (Sub 1 to 4) is also displayed.

Displaying the current sensor status (Sensor Status) ▶ [section 18.8](#)

> Sensor Status

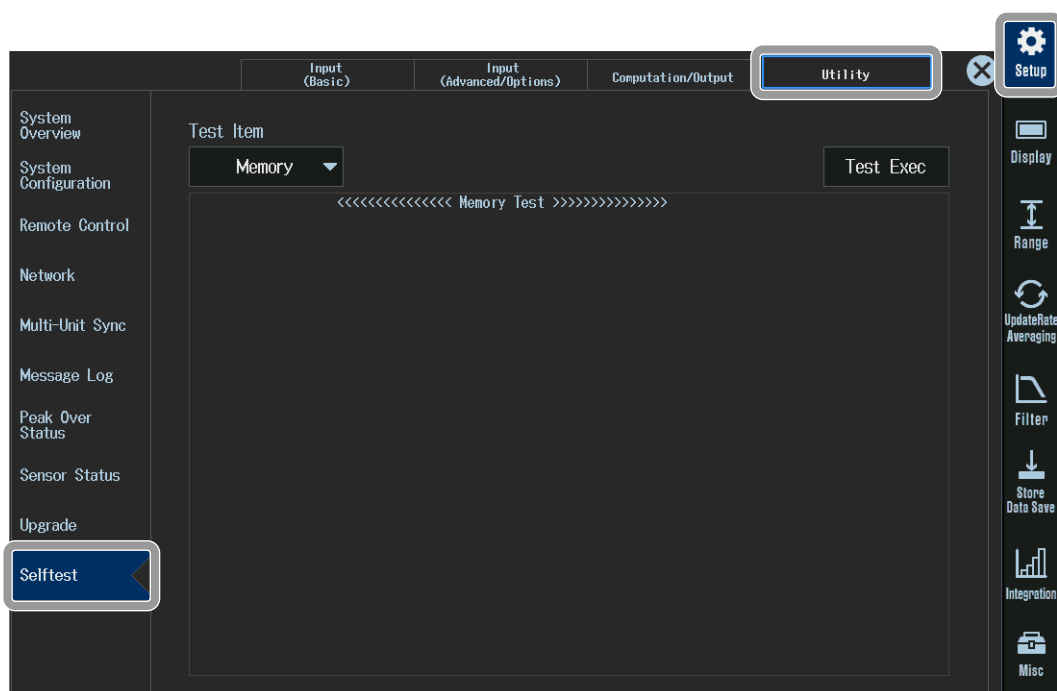
The screen shown below is an example of the display for the main unit during multi-unit synchronized operation (option /SY1).



On the main unit during multi-unit synchronization (option /SY1), the status of the subunits (Sub 1 to 4) is also displayed.

Self-test (Selftest) ▶ section 18.9

> Selftest

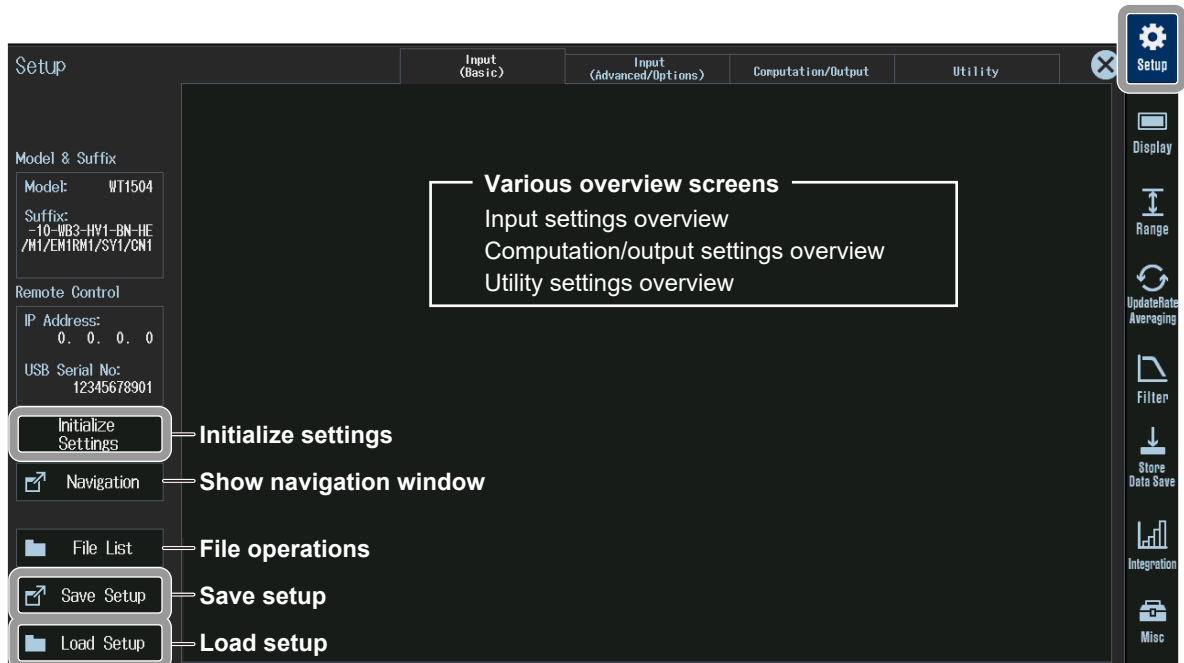


3.4 Saving, Loading, and Initializing Setup

The instrument setup can be saved, loaded, and initialized.

Procedure

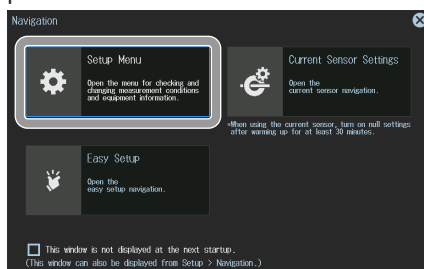
Setup menu icon



- Various overview screens see sections 3.1, 3.2, 3.3
- File operation see section 13.7

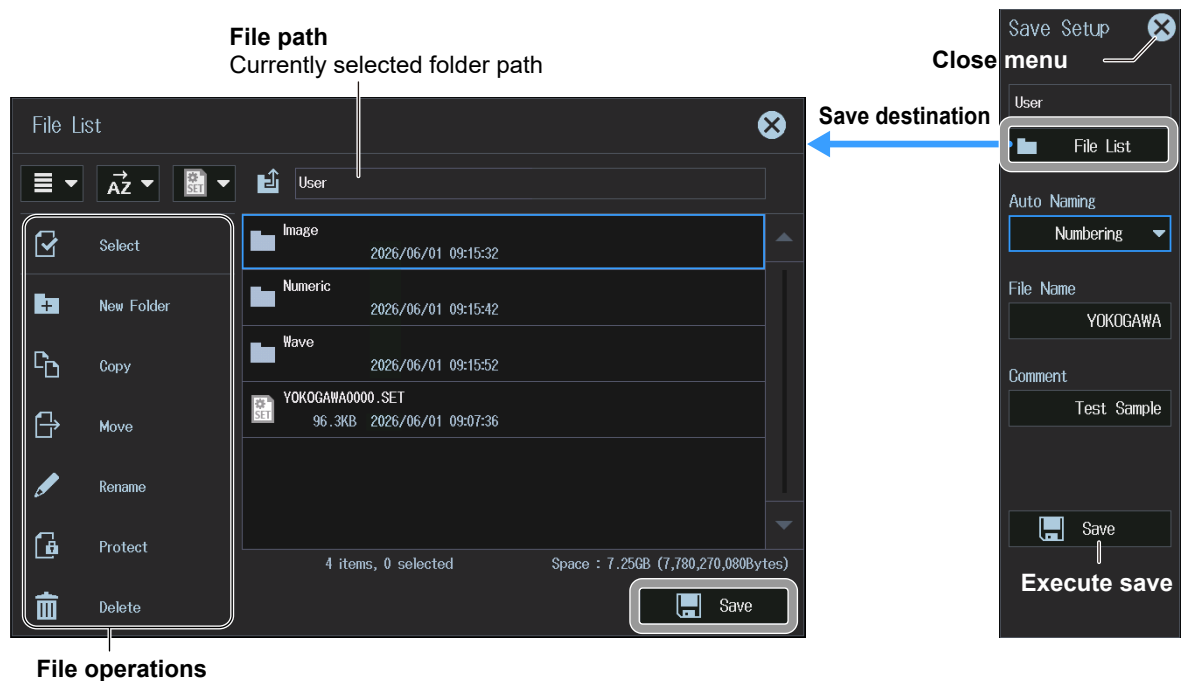
Note

- You can also display the setup menu screen from the navigation window that appears immediately after power-on.

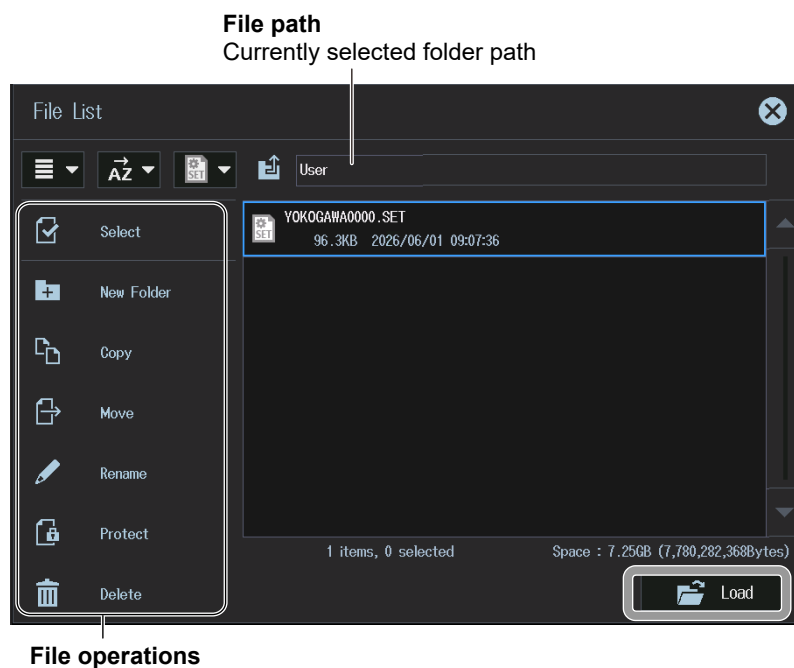


- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.

- **Saving a setup**
 - > **Save Setup** > **File List** > set save location, **Save**



- **Loading a setup**
 - > **Load Setup** > select setup to load from the file list, **Load**



- **Initializing settings**
 - > **Initialize Settings**

Note

Saving and loading a setup using the WT1500 LCD

You can also save and load a setup using the instrument's LCD and operation keys.

When operating from the instrument's LCD, the directory available for saving and loading is fixed to User, and the setup file name is selected from SetupFile1.SET to SetupFile4.SET.

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

Use the arrow keys (▲▼) to select **Status/Msg Log** on the Menu screen, and then press **SET**.



←Status / Msg Log
Peak Over
SensorPowerStatus
Message Log List
File Setup/Msg

Use the arrow keys (▲▼) to select File Setup/Msg, and then press **SET**.



←File Setup/Msg
Setup File Save
Load
Message Log Save

Saving a setup

Use the ▲ and ▼ arrow keys to select Save for Setup File, and then press **SET**.



Save Setup File
User
SET>Select ESC:Cancel

Select **User**, and then press **SET**.

When operating from the instrument's LCD, the save location is fixed to User.

To return to the previous screen, press **ESC**.



Save to:User
Setup1 -----
Setup2 -----
Setup3 -----
Setup4 -----
SET>Select ESC:Back

Use the ▲ and ▼ arrow keys to select **Setup1**, **Setup2**, **Setup3**, or **Setup4**, and then press **SET**.

To return to the previous screen, press **ESC**.



Save as:Setup1.SET
Execute
Cancel
SET:OK ESC:Back

Use the ▲ and ▼ arrow keys to select Execute, and then press **SET**.

The file is saved using the file name displayed on the first line.

To return to the previous screen, press **ESC**.



←File Setup/Msg
Setup File Save
Load
Message Log Save

Loading a setup

Use the ▲ and ▼ arrow keys to select Load for Setup File, and then press **SET**.



Load Setup File
User
SET>Select ESC:Cancel



Load from:User
Setup1 -----
Setup2 2026/01/20
Setup3 2026/01/21
Setup4 2026/01/22
SET>Select ESC:Back



Load from:Setup2.SET
Execute
Cancel
SET:OK ESC:Back

Select **User**, and then press **SET**.

When operating from the instrument's LCD, the directory available for loading is fixed to User.

To return to the previous screen, press **ESC**.

Use the ▲ and ▼ arrow keys to select **Setup1**, **Setup2**, **Setup3**, or **Setup4**, and then press **SET**.

To return to the previous screen, press **ESC**.

Use the ▲ and ▼ arrow keys to select **Execute**, and then press **SET**.

The setup file displayed on the first line is loaded.

To return to the previous screen, press **ESC**.

Saving a setup (Save Setup)

You can save the setup of this instrument to the specified storage device. The date, time, and communication setup is not saved. The extension is .SET.

File list (File List)

Specify the data save destination in the file list. You can perform file operations such as creating folders on the storage device, deleting and copying files, and changing file names. See section 13.7.

Auto naming (Auto Naming)

OFF

Auto naming is disabled. The name that you specify using the File Name setting is used. If a file with the same name already exists in the save destination folder, the data cannot be saved.

Auto numbering (Numbering)

The instrument automatically adds a four-digit number from 0000 to 0999 after the common name (specified with the File Name setting) and saves the file.

Date (Date)

The date and time when the file is saved are used as its name. The file name specified for the File Name setting is ignored.

20260130_121530_0 (2026/01/30 12:15:30)

YYYYMMDD hhmmss

Sequence number (0 to 9 then A to Z) for when multiple files are saved at the same time (second)

A sequence number is appended to the date and time when multiple files are saved at the same time (second). The number starts at 0 and is incremented by one each time a file is added. After 9, the letters A, B, C, and so on are used.

File name (File Name)

You can set the common file name that is used when the auto naming function is turned off or when the auto naming function is set to Numbering.

Maximum number of characters that can be used for a file name or folder name

Up to 32 characters from the beginning of the entered string

However, this is subject to the following conditions.

- **Types of characters that can be used**

Of those characters on the keyboard that appears on the screen, 0-9, A-Z, a-z, _, -, =, (,), {, }, [,], #, \$, %, &, ~, !, `, and @.

@ cannot be entered consecutively.

- **Characters that cannot be used**

The following exact strings cannot be used due to MS-DOS limitations:

AUX, CON, PRN, NUL, CLOCK, LPT1, LPT2, LPT3, LPT4, LPT5, LPT6, LPT7, LPT8, LPT9, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9

- **Character limit for the full path name (absolute path name from the root directory)**

Up to 255 characters

If this is exceeded, an error occurs when you perform file operations (save, copy, rename, create folder, etc.). When an operation is being performed on a folder, the full path is up to the name of the folder. When an operation is being performed on a file, the full path is up to the name of the file.

The following additional conditions apply when you use the file name auto naming function.

- **When Numbering (automatic numbering) is selected for auto naming**

A four-digit serial number is added to the characters entered for the file name.

- **When Date is selected for auto naming**

The file name consists only of the date information. The characters entered for the file name are not used.

Comment (Comment)

You can add and save a comment of up to 30 characters. A comment is optional.

You can use all characters and spaces that are displayed on the keyboard.

Settings that are shared with those of other menus

The following settings are linked across the Save/Load Setup, Data Store, and Data Save menus.

- File list display and save destination settings (File List)
- Automatic file naming settings (Auto Naming)
- File name (File Name)

The Comment setting is shared by Save Setup, Data Store, and Data Save.

Saving (Save)

Saves the data to the specified save destination using the specified file name.

Loading a setup (Load Setup)

On the file list, specify a file to load setup from. The extension is .SET. For how to configure the file list display and how to operate files and folders, see “File list (File List).”

See section 13.7.

Loading (Load)

Loads the data from the specified file.

Note

- If you change the extension of the saved data file, by using a PC or some other device, the instrument will no longer be able to load it.
 - When you load a setup saved in a file, the current setup is overwritten by the loaded setup and cannot be restored. Before loading, we recommend saving the current setup.
 - Date/time, date format, maximum hold reset at integration start, communication settings, and custom display settings are not included in Save/Load Setup. These settings do not change even when a setup is loaded from a file.
 - Setup saved on products with incompatible firmware versions cannot be loaded.
 - Setup saved on products that have different product element configurations, options, and the like cannot be loaded.
-

Initialize settings (Initialize Settings)

You can reset the instrument settings to their factory default values. This is useful when you want to cancel the settings made so far or restart measurement from the beginning.

See section 2.8.

3.5 Current Sensor Settings Menu

The Current Sensor Settings menu is a setup menu that contains only setup items related to current sensors. It is useful when you want to set only items related to current sensors.

This menu displays the current sensor settings that are currently in use.

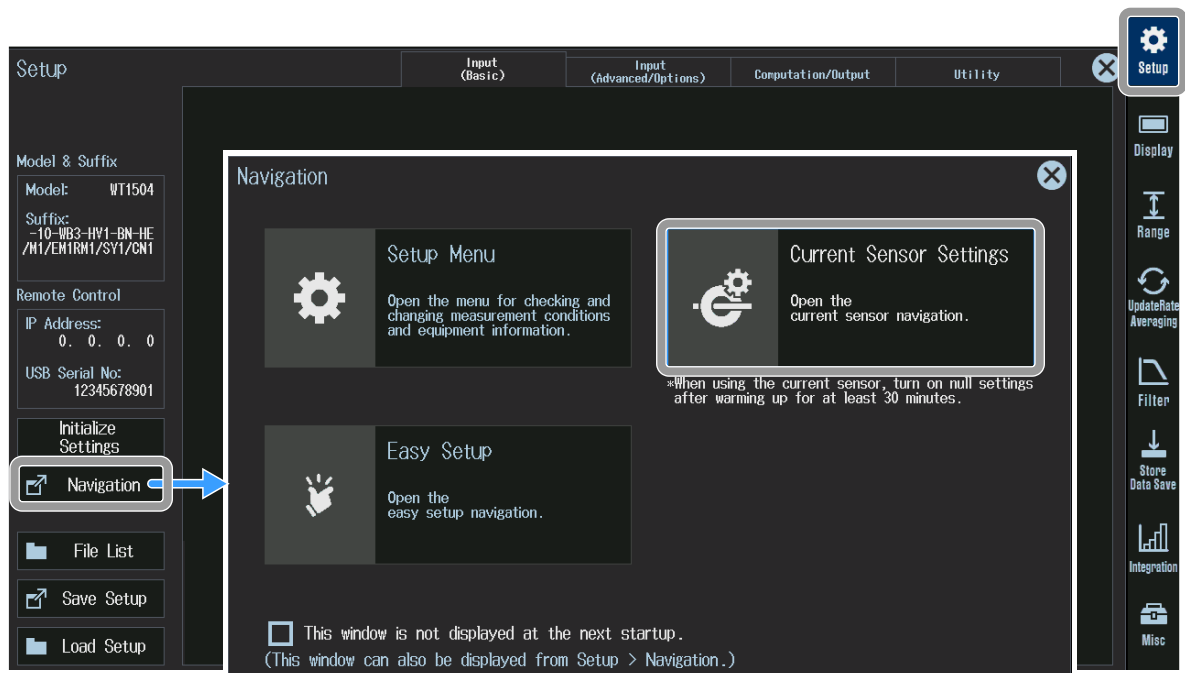
When you start current sensor settings, navigation begins for setting the following items in sequence.

- Sensor model and output type (Current Sensor Model & Output Type)
- Wiring system (Wiring)
- CT ratio and output voltage rate (CT Ratio, Output Voltage Rate)
- Current amplitude correction, current DC offset correction, and current phase correction (Current Amplitude Correction, Current DC Offset Correction, Current Phase Correction)
- Current range (Current Range)

Procedure

Displaying the Current Sensor Settings menu

Setup menu icon  > Navigation > Current Sensor Settings



Note

- You can also display the Current Sensor Settings menu from the navigation window displayed immediately after power-on.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.

Setting the current sensor ► sections 4.1, 4.2, 4.4, 4.5, 4.9

During multi-unit synchronization (option /SY1), > set Selected Unit to **Main/Sub 1/Sub 2/Sub 3/Sub 4**

> **Start Setup** > set displayed menu items > **Next/Back/View Settings/Close**

Current Sensor Settings

Selected Unit: **Main**

Start Setup

	ΣA 3P3W	Element 1 WB	Element 2 WB	Element 3 WB	Element 4 HV
Current Sensor Model & Output Type	Custom	Custom	Custom	Custom	Custom
Wiring	Wiring system, Range Σ Link				
CT Ratio	1.0000	1.0000	1.0000	1.0000	1.0000
Output Voltage Rate [mV/A]	Scaling on/off, CT ratio, output voltage rate				
Current Amplitude Correction	1.000000	1.000000	1.000000	1.000000	1.000000
Current DC Offset Correction	Current amplitude correction, current DC offset correction, current phase correction				
Current Phase Correction	0.000°	0.000°	0.000°	0.000°	0.000°
Current Range	(0.000ms)	(0.000ms)	(0.000ms)	(0.000ms)	(0.000ms)
	Current range, current range display mode, valid measurement range, crest factor				

Current Sensor Settings

Selected Unit: **Main**

View Settings

	ΣA 3P3W	Element 1 WB	Element 2 WB	Element 3 WB	Element 4 HV
Detected Current Sensor	Unknown	Unknown	Unknown	Unknown	CT2000A
Auto Sensor Setup	ON	ON	ON	ON	ON
Sensor Model	CT1000S	CT1000S	CT1000S	CT1000S	CT2000A
Sensor Output Type	Voltage	Voltage	Voltage	Voltage	Current

Current Sensor: CT1000S CT1000S CT1000S CT2000A

Next

Move to the next or previous settings screen

Back

Close

3.5 Current Sensor Settings Menu

You can also select a setup item on the left side of the screen to move to the setup screen for that item.

For details on the settings for each item, see the corresponding references.

Sensor model and output type (Current Sensor Model & Output Type)

Set the following items (See section 4.2).

- Auto sensor settings (Auto Sensor Setup)
- Sensor model (Sensor Model)
- Sensor output type (Sensor Output Type)

Wiring system (Wiring)

Set the following items. (See sections 4.1 and 4.2.)

- Range Σ link (Range Σ Link)
- Wiring system (Wiring)

The wiring diagram of the selected wiring system is displayed in a figure.

CT ratio and output voltage rate (CT Ratio, Output Voltage Rate)

Set the following items. (See section 4.4.)

- Scaling (Scaling)
- CT Ratio (CT Ratio)
- Output voltage rate (Output Voltage Rate)

Current amplitude correction, current DC offset correction, and current phase correction (Current Amplitude Correction, Current DC Offset Correction, Current Phase Correction)

Set the following items. (See section 4.5.)

- Current amplitude correction ON/OFF (Current Amplitude Correction)
- Correction ratio (Correction Ratio)
- Current DC offset correction ON/OFF (Current DC Offset Correction)
- DC offset correction value
- Current phase correction ON/OFF (Current Phase Correction)
- Frequency (Frequency)
- Phase difference between I/O (Phase Difference between I/O)
- Time difference between I/O (Time Difference between I/O)

The time difference between I/O is calculated and displayed from the set frequency and the phase difference between input and output.

Current range (Current Range)

Set the following items. (See sections 4.2 and 4.9.)

- Current range display format (Current Range Display Format)
- Crest factor (Crest Factor)
- Range configuration (Range Config)
- Auto current range (Auto Range)
- Setting the current range

Batch processing

If you select a cell in the leftmost column of the list, all the input elements that can be configured for that item can be set collectively.

Close

Moves from the Current Sensor Settings menu screen to the measured-results display screen.

To display the first screen of the Current Sensor Settings menu again, perform steps on pages 3-28 and 3-29.

3.6 Easy Setup Menu

The Easy Setup menu is a menu for setting the wiring system, measurement scene, and other items in sequence by following the on-screen guidance.

Configure each setting in wizard format according to the measured source.

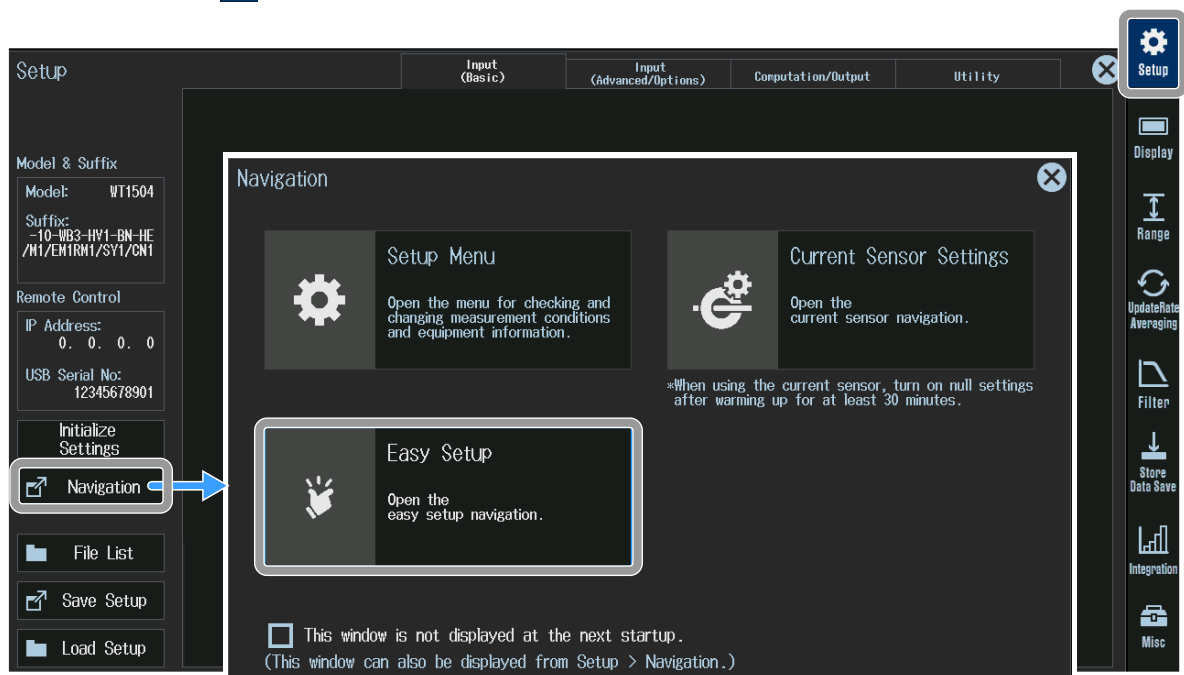
When you start Easy Setup, you can configure the following items in sequence.

- Wiring system (Wiring)
- Measurement scene (Measurement Scene)
- Other settings
 - Measurement period (Sync Source)
 - Current range (Current Range)
 - Frequency filter LPF (Freq Filter LPF)
 - Anti-aliasing filter (Anti-Aliasing Filter: AAF)
 - Digital line filter (for harmonic measurement) (Digital Line Filter (Harmonics): DLF(H))
 - Update mode (Update Mode)
 - Data update interval (Update Rate)

Procedure

Displaying the Easy Setup menu

Setup menu icon  > Navigation > Easy Setup



Note

- You can also display the Easy Setup menu screen from the navigation window displayed immediately after power-on.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.

Setting the wiring system (Wiring) ► section 4.1

> Main/Sub 1/Sub 2/Sub 3/Sub 4 > **Start Setup** > **Wiring** > set displayed menu items > **Next/View Settings**

The top screenshot shows the 'Easy Setup' menu with 'Main' selected. The 'Start Setup' button is highlighted. The 'Wiring' menu item is selected, showing the following settings:

ΣA 3P3W				
Element 1 WB	Element 2 WB	Element 3 WB	Element 4 HV	
Wiring system		3P3W	1P2W	1P2W
Measurement scene		None	None	None
Item list		I1	I3	I4
Current Range		Auto	Auto	1A
Freq Filter LPF		0.1kHz	0.1kHz	OFF
Line Filter AAF		ON	ON	OFF
Line Filter DLF (H)		0.5kHz	0.5kHz	OFF
Common		Update Mode	Constant	Update Rate 500ms

The bottom screenshot shows the 'Easy Setup' menu with 'Main' selected. The 'View Settings' button is highlighted. The 'Wiring' menu item is selected, showing the following settings:

ΣA 3P3W				
All	Element 1 WB	Element 2 WB	Element 3 WB	Element 4 HV
Current Sensor				
	Current	Current	Current	CT2000A

The 'Wiring unit' menu is also shown, with the following settings:

Wiring	3P3W	3P3W	1P2W	1P2W
Figure				

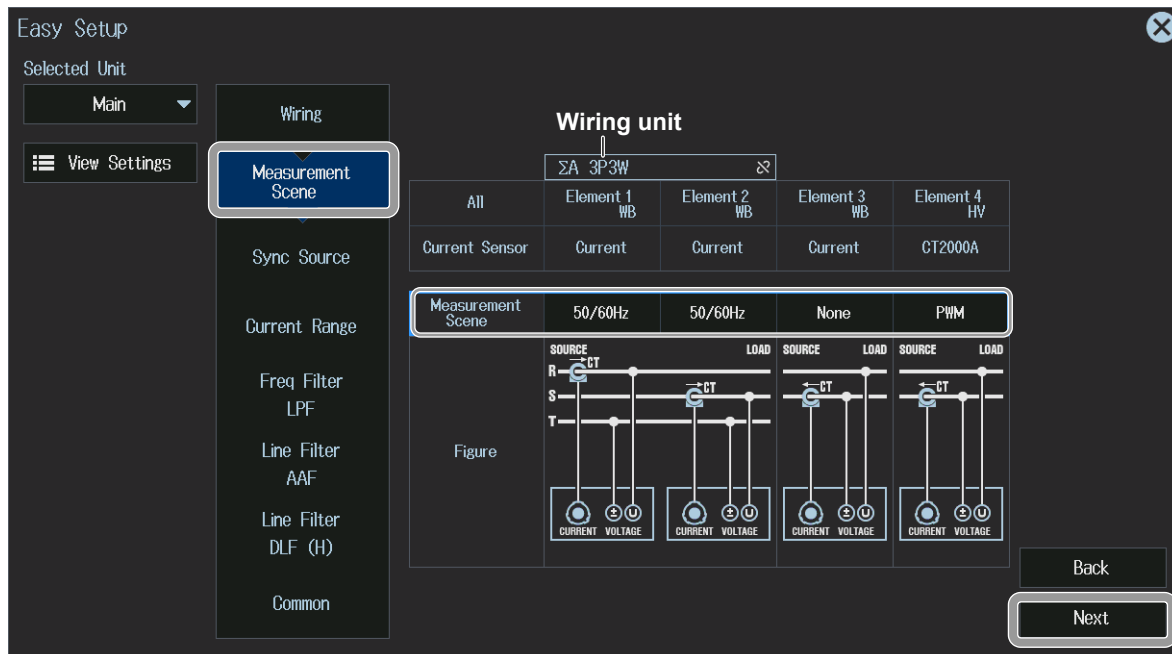
The 'Next' button is visible at the bottom right of the 'Wiring unit' menu.

Select the wiring system. For details on wiring systems, see section 4.1.

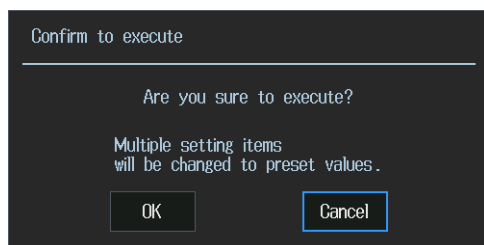
Setting the measurement scene (Measurement Scene)

> **Measurement Scene**, or **Next** at the lower right of the **Wiring** setting screen (see the previous page) > set displayed items > **Next/Back/View Settings**

If you do not select a measurement scene, proceed to “Other settings” on the next page.



Select the measurement scene for the wiring unit to configure or for elements that do not constitute a wiring unit. A confirmation screen is displayed asking whether to set the measurement scene.



- OK: The measurement scene is set.
- Cancel: Cancels measurement scene setting.

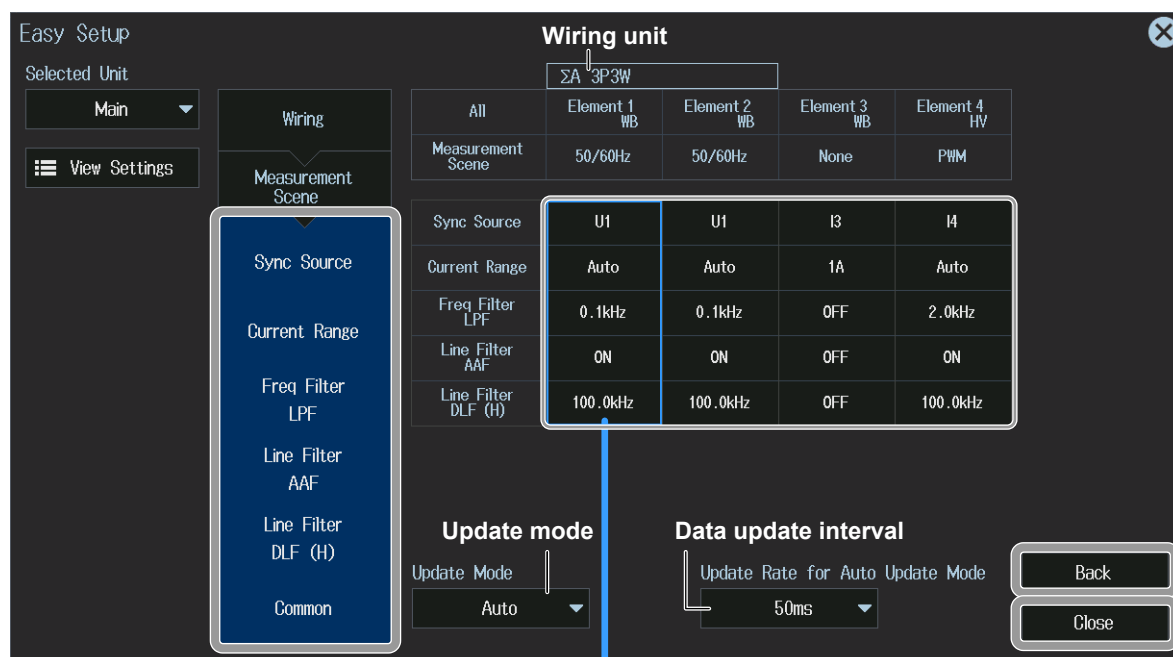
For details on the measurement scene settings, see page 3-36.

Note

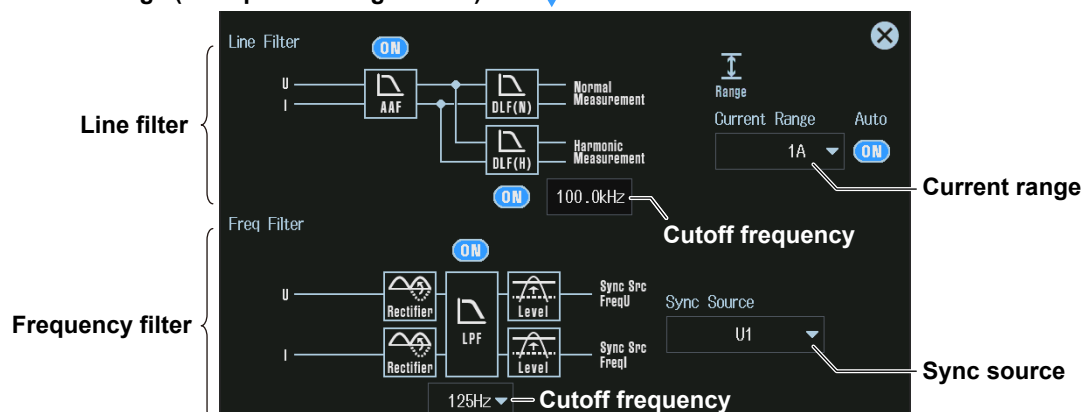
- Set the measurement scene (Measurement Scene) for each wiring unit or for each element that does not constitute a wiring unit.
- When the measurement scene is set:
 - Freq Filter Advanced Settings (see section 4.7) is turned on, and the LPF setting for the frequency filter becomes available.
 - Line Filter Advanced Settings (see section 4.6) is turned on, and individual settings for the line filter AAF (Anti-Aliasing Filter) and DLF(H) (Digital Line Filter (Harmonics)) become available.
- You can also move to each setting screen by selecting an item in the item list displayed on the left side of the setting screen (Wiring, Measurement Scene, Sync Source, and so on).

Other settings ► sections 4.2, 4.6, 4.7, 4.8, 4.10

> **Sync Source...Common**, or **Next** at the lower right of the Measurement Scene setting screen (see the previous page) > set displayed menu items > **Next/Back/View Settings/Close**



Detailed settings (example of wiring unit ΣA)



Set each item. For details on the settings for each item, see the corresponding references.

- **Update Mode** see page 4-47
- **Update Rate** see page 4-48

Note

- Configure the items in “Other settings” for each wiring unit or for each element that is not part of a wiring unit.
- Update mode (Update Mode) and update rate (Update Rate) are common to all wiring units and elements. (They cannot be set individually.)
- If the measurement scene for any of elements 1 to 4 is set to PWM or General, the update mode (Update Mode) is automatically set to Auto and the data update interval (Update Rate) to 50 ms. You can change these settings later.

Wiring system (Wiring)

The wiring diagram of the selected wiring system is displayed in a figure.

Measurement scene (Measurement Scene)

Select from the following according to the item to be measured. When a wiring unit is set, all input elements assigned to the same wiring unit are set.

- **None:** No setting
- **50/60Hz:** Measures commercial power lines.
- **DC:** Measures DC.
- **PWM:** Measures PWM (Pulse Width Modulation) waveforms.
- **High Freq:** Measures high frequencies with a fundamental frequency of 10 kHz or more.
- **General:** Used to measure anything other than the above. Select this setting when the details of the measured source are unknown.

Other settings

You can view the following settings that have been changed as a result of the measurement scene setting. If you need to change a setting, select the element column to display the advanced setup screen.

- Measurement Period (Sync Source) See section 4.8.
- Current range (Current Range) See section 4.2.
- Frequency filter LPF (Freq Filter LPF) See section 4.7.
- Anti-aliasing filter (Anti-Aliasing Filter: AAF) See section 4.6.
- Digital line filter (for harmonic measurement) (Digital Line Filter (Harmonics): DLF(H)) See section 4.6.
- Update Mode (Update Mode) See section 4.10.
- Data update interval (Update Rate) See section 4.10.

The following settings change according to the selected measurement scene.

Setting	Measurement Scene					
	None	50/60Hz	DC	PWM	High Freq	General ¹
Sync Source	No change	Voltage	None	Current	Voltage	Voltage
Current Range	No change	Auto	Auto	Auto	Auto	Auto
Freq Filter LPF	No change	100 Hz	OFF	2 kHz	OFF	OFF
Anti-Aliasing Filter: AAF	No change	ON	ON	ON	OFF	ON
Digital Line Filter (Harmonics): DLF(H)	No change	100 kHz	OFF	100 kHz	OFF	100 kHz
Update Mode ²	No change	Constant	Constant	Auto	Constant	Auto
Update Rate ²	No change	500 ms	500 ms	50 ms	500 ms	50 ms

In addition to the settings above, the following settings change if the measurement scene is set to anything other than None.

- Advanced frequency filter setting (Freq Filter Advanced Setting): ON
 - Advanced line filter setting (Line Filter Advanced Setting): ON
- 1 When the measurement scene is set to General, the voltage range (Voltage Range) is changed to Auto in addition to the above.
 - 2 Update Mode and Update Rate apply to all wiring units and elements (cannot be set individually). If the measurement scene for any of elements 1 to 4 is set to PWM or General, Update Mode changes to Auto and Update Rate changes to 50 ms. You can change these settings later.

Close

Closes the Easy Setup menu.

4.1 Setting the Wiring System

Procedure

- Setting the wiring system (Basic measurement conditions)

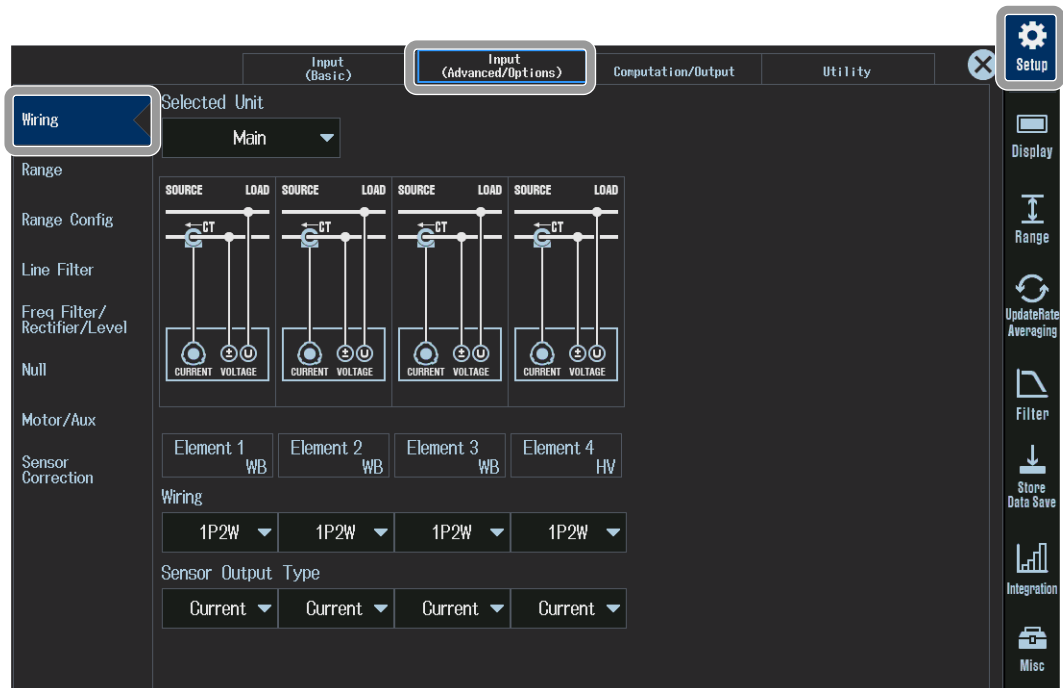
Setup menu icon  > **Input (Basic)** > **Main/Sub1/Sub2/Sub3/Sub4** (option /SY1) > **Wiring** of the input element to configure



4.1 Setting the Wiring System

- Setting the wiring system (advanced)

Setup menu icon  > Input (Advanced/Options) > Wiring



The same screen is displayed as when you select Figure on the basic wiring setting screen on the previous page.

Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Input (Basic)** or **Input (Advanced/Options)** with the arrow keys and press **SET** to display the input settings overview screen for input (basic) or input (advanced/options).

Wiring system display

The wiring system settings are displayed on the Elements tab in the input information area on the right side of the screen. The following figures show examples of wiring system displays for a model with four input elements installed:

When elements 1 to 4 are all set to 1P2W

Elements	Options
1	U1 1000V I1 1A LF Adv Sync FF Adv Hrm [1]
2	U2 1000V I2 1A LF Adv Sync FF Adv Hrm [1]
3	U3 1000V I3 1A LF Adv Sync FF Adv Hrm [1]
4	U4 2000V I4 1A LF Adv Sync FF Adv Hrm [1]

When elements 1 and 2 are set to 3P3W and elements 3 and 4 to 1P2W

Elements	Options
1	U1 1000V I1 1A LF Adv Sync FF Adv Hrm [1]
2	U2 1000V I2 1A LF Adv Sync FF Adv Hrm [1]
3	U3 1000V I3 1A LF Adv Sync FF Adv Hrm [1]
4	U4 2000V I4 1A LF Adv Sync FF Adv Hrm [1]

Wiring unit and system

A frame indicates the elements that make up the wiring unit.

Wiring system (Wiring)

This instrument supports nine wiring systems. The selectable wiring systems are limited by the number of installed input elements.

- 1P2W: Single-phase two-wire system
- 1P3W: Single-phase three-wire system
- 3P3W: Three-phase three-wire system
- 3P4W: Three-phase four-wire system
- 3P3W (3V3A): Three-phase three-wire system with a three-voltage three-current method
- 3P3W (3V3AR): Three-phase three-wire system with a three-voltage three-current method
- 3P3W (3V3A) → 3P4W: Three-voltage three-current method (wiring system with the delta transformation function)
- 3P3W (3V3AR) → 3P4W: Three-voltage three-current method (wiring system with the delta transformation function)
- 3P4W → 3P3W (3V3AS): Three-phase four-wire system (wiring system with the delta transformation function)

Wiring unit

A wiring unit is a group of two or three input elements with the same wiring system. Up to two wiring units can be defined. They are represented by the symbols ΣA and ΣB , respectively.

- When there is only one wiring unit, it is denoted by ΣA . ΣB cannot be assigned.
- When there are two wiring units, they are denoted by ΣA and ΣB .
The wiring units are assigned ΣA and then ΣB in order of increasing element number.
- A wiring unit is made up of adjacent input elements. A wiring unit cannot be made up of nonadjacent input elements.
- A wiring unit cannot be made up of input elements of different types.
- When Range Σ Link is enabled (see pages 4-7 and 4-14), a wiring unit cannot be made up of input elements with different sensor model settings.

To form a wiring unit, disable Range Σ Link, or make the settings above the same.

4.1 Setting the Wiring System

Σ Functions

The measurement functions of a wiring unit are called Σ functions.

Example “Urms Σ A” represents the true RMS value of the average voltage of the input elements assigned to wiring unit Σ A.

Wiring system combinations

You can set combinations that meet the wiring unit conditions described above.

- If you select a wiring system other than 1P2W (page 4-3), a wiring unit is set using the two or three input elements adjacent to and numbered higher than the selected element.
- On models with two or more installed input elements, wiring units are set automatically, and the symbols Σ A and Σ B are assigned in order from the smaller element number.

On models with two or three input elements installed, up to one wiring unit, Σ A, can be set. On models with four input elements installed, up to two wiring units, Σ A and Σ B, can be set.

For the relationship between the wiring system and how each function is computed, see appendix 1.

Note

- You cannot set a wiring unit for a larger element number before setting one for a smaller element number.
 - Input elements of different types cannot be set in the same wiring unit.
 - Select the wiring system according to the actual wiring of the circuit under measurement. The method used to compute Σ functions (measurement functions of a wiring unit) differs depending on the wiring system. To obtain correct measurement and computation results, select the wiring system that matches the actual wiring of the circuit under measurement.
-

Settings for elements grouped as a wiring unit

If a wiring system other than 1P2W is selected when the measurement range, valid measurement range, or sync source settings of each input element are different, these settings are changed in the manner described below:

- When Range Σ Link is ON (see pages 4-7 and 4-14), the measurement range is set to the largest measurement range among the input elements assigned to the same wiring unit. For the current range, the voltage input range takes precedence over the current input range.
- When Range Σ Link is ON, the Auto Range ON/OFF setting becomes that of the input element with the largest measurement range. If multiple input elements have the same largest measurement range, the setting of the input element with the smallest element number takes precedence.
- When Range Σ Link is ON, all measurement ranges in the valid measurement range settings are enabled (checked).
- The sync source, line filter, frequency filter, and the group of the harmonic measurement input element are set to the settings of the input element with the smallest input element number among the input elements assigned to the same wiring unit.

Setting the wiring system (advanced)

Displays the following information:

Unit to configure (Selected Unit)

During multi-unit synchronization (option /SY1), you can set the wiring system and sensor output type for the subunits on the main unit.

Select the target unit from the following:

Main, Sub 1, Sub 2, Sub 3, Sub 4

Wiring diagram

The wiring diagram of the specified wiring system is displayed.

The types of input elements are displayed as follows:

- WB: WB element (suitable for 2 MHz measurements)
- HV: HV element (suitable for 2000 V measurements)

Wiring system (Wiring)

See page 4-3.

Sensor output type (Sensor Output Type)

- Current (Current): You can set the current input range for current sensors with current output.
- Voltage (Voltage): You can set the current input range for current sensors with voltage output.

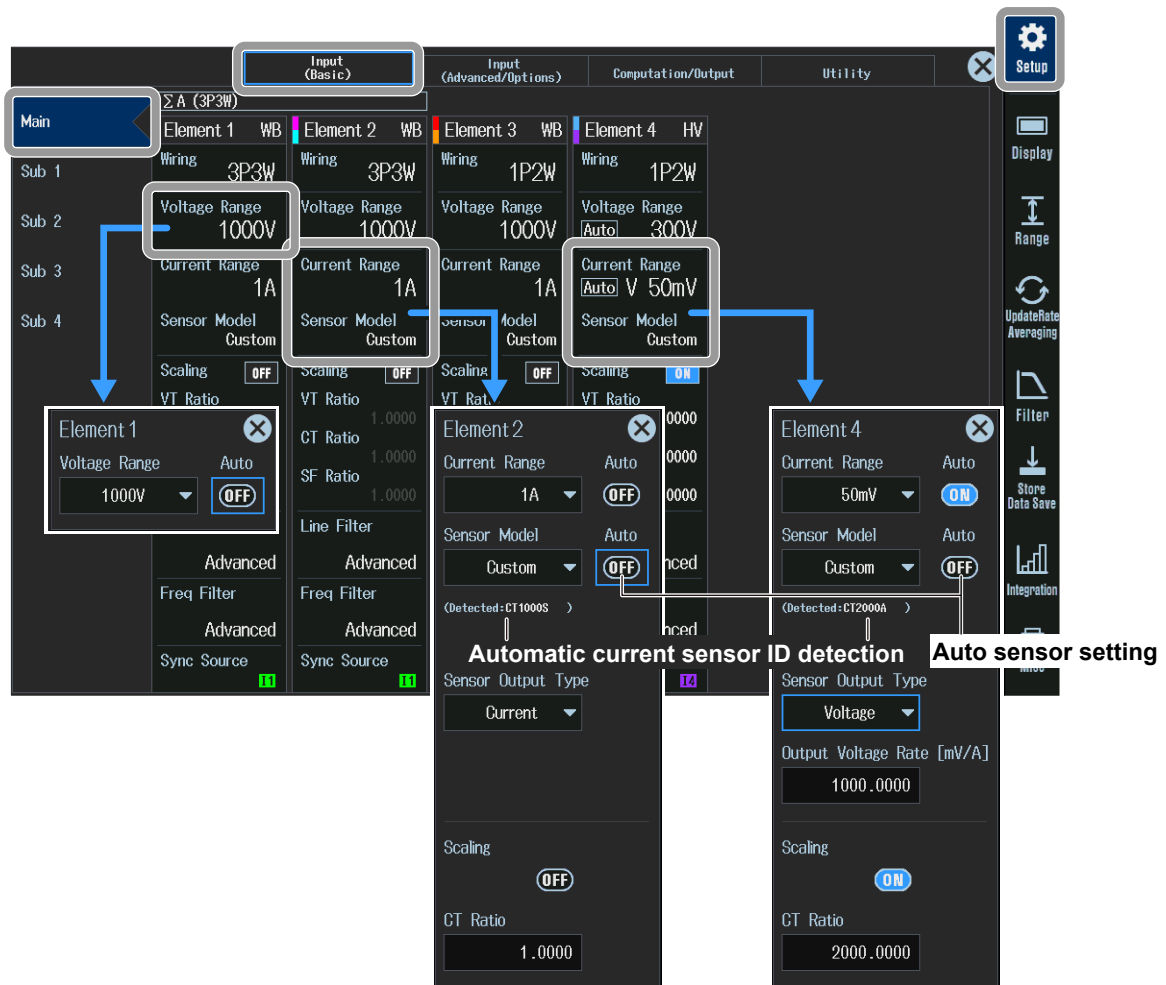
This setting is linked to “Sensor output type (Sensor Output Type)” under “Setting the current range” (page 4-12).

4.2 Setting the Voltage Range and Current Range

Procedure

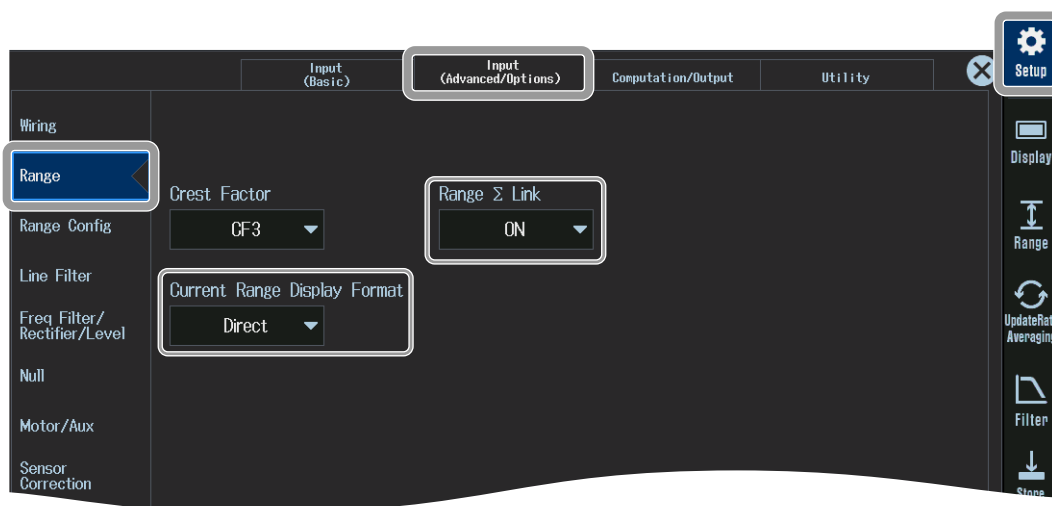
Setup menu icon  > **Input (Basic)** > **Main/Sub1/Sub2/Sub3/Sub4** (option /SY1)

- **Setting the voltage range**
 - > **Voltage Range** of the input element to configure > Auto ON/OFF
- **Setting the current range**
 - > **Current Range** of the input element to configure
 - **For current sensors with current output**
 - > Auto ON/OFF > **Current Range** > **Sensor Model** > set **Sensor Output Type** to **Current**
 - **For current sensors with voltage output**
 - > Auto ON/OFF > **Current Range** > **Sensor Model** > set **Sensor Output Type** to **Voltage** > **Output Voltage Rate [mV/A]**
 - > **Scaling** > **CT Ratio**



Setup menu icon  > Input (Advanced/Options) > Range

- Setting Range Σ Link
> Range Σ Link ON/OFF
- Setting the current range display format
>set Current Range Display Format to Direct/Measure

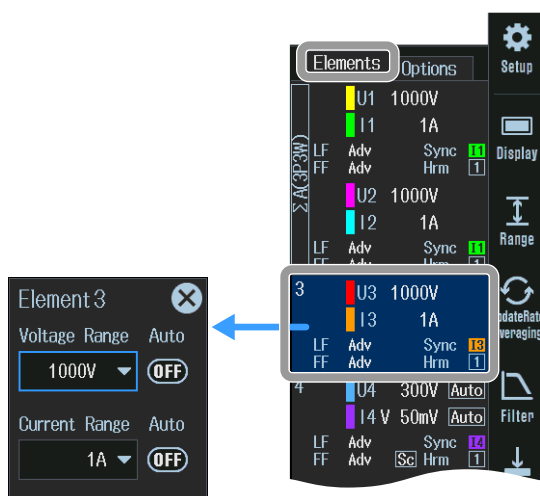


Note

- You can also use the **Range** menu icon  shown on the right side of the screen to set the voltage range and current range.
For details on the Range menu, see page ix.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Input (Basic)** or **Input (Advanced/Options)** with the arrow keys and press **SET** to display the input settings overview screen for input (basic) or input (advanced/options).

Operation in the input information area (Elements tab)

In the input information area displayed on the right side of the screen, you can set the voltage range and current range while checking the measurement display. The input information area is displayed when the overview screen is closed.



Setting the voltage range

Voltage range (Voltage Range)

AUTO ON/OFF

There are two methods for setting the voltage range. Select ON or OFF.

- OFF: Fixed range
- ON: Auto range (see the next page). **Auto** is displayed next to the value set by auto range.

Note

- Set the range based on the RMS value of the input signal.
Example: If you input a 100 Vrms sine wave, set the range to 100 V.
- When measuring a signal other than a sine wave, such as a distorted wave
You can obtain more accurate measurements by selecting the smallest measurement range that does not produce any of the conditions below:
 - The input peak over-range indicator at the top of the screen lights or blinks red.
 - The displayed measured value of voltage or current shows overload [--OL--].
- The peak over-range indicator may not light or blink in the following cases:
 - When the pulse width is so narrow that the waveform peak value cannot be captured at this instrument's sampling rate (approx. 2.5 MS/s).
 - When the high-frequency components of a pulse waveform are attenuated by the bandwidth limit of this instrument's measurement circuit and the waveform peak value falls below the peak over-range detection level.
- When applying the secondary output of a voltage transformer (VT) to the voltage input terminal, set the voltage range according to the maximum value of the VT output. Then set the VT ratio using the scaling function.

Fixed range

In fixed range mode, select a voltage range from the available options. The selected voltage range does not change even if the input signal level changes. Set the range based on the RMS value of the input signal.

Select from the following:

Voltage range (Voltage Range) options

The available options vary depending on the input element type and crest factor setting.

• HV element

Crest factor	Options
CF3	6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1000 V ¹ , 2000 V ²
CF6 or CF6A	3 V, 7.5 V, 15 V, 30 V, 75 V, 150 V, 300 V, 500 V ³ , 1000 V ⁴

- 1 The actual crest factor is 2.
- 2 The actual crest factor is 1.05.
- 3 The actual crest factor is 4.
- 4 The actual crest factor is 2.1.

• WB element

Crest factor	Options
CF3	6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1000 V ⁵
CF6 or CF6A	3 V, 7.5 V, 15 V, 30 V, 75 V, 150 V, 300 V, 500 V ⁶

- 5 The actual crest factor is 2.
- 6 The actual crest factor is 4.

Note

- When Range Σ Link (see pages 4-7 and 4-14) is ON, the voltage ranges of input elements assigned to the same wiring unit are set to the same range. When Range Σ Link is OFF, you can set the voltage range for each input element individually, even if the input elements are assigned to the same wiring unit.

- If the setup menu screen is displayed over the range display for each element, press **ESC** to close the setup menu screen.

Auto voltage range

When AUTO is set to ON, the voltage range switches automatically according to the input signal level as described below. The range options are the same as those for fixed range.

HV element, WB element

• Range increase

Depending on the crest factor setting, the measurement range is increased when any of the following conditions is met:

Crest factor			Range increase condition
CF3	CF6	CF6A	
✓	✓	–	• The data for measurement function Urms or Irms exceeds 110 % of the measurement range.
–	–	✓	• The data for measurement function Urms or Irms exceeds 220 % of the measurement range.
✓	–	–	• The data for Upk* or Ipk* exceeds approximately 310 % of the measurement range.
–	✓	✓	• The data for Upk* or Ipk* exceeds approximately 620 % of the measurement range.

* Even when the Null function is ON, the determination is made using the values that would be obtained when the Null function is OFF.

When a wiring unit is configured, if even one input element assigned to the same wiring unit meets any of the range increase conditions above, the measurement ranges of all input elements in the wiring unit are increased.

• Range decrease

Depending on the crest factor setting, the measurement range is decreased when all of the following conditions are met:

Crest factor			Range decrease condition
CF3	CF6	CF6A	
✓	✓	✓	• The data for Urms and Irms is 30 % or less of the measurement range.
✓	✓	✓	• The data for Urms and Irms is 105 % or less of the lower range (the range to which the measurement range is to be decreased).
✓	–	–	• The data for Upk and Ipk is 290 % or less of the lower range.
–	✓	✓	• The data for Upk and Ipk is 580 % or less of the lower range.

* Even when the Null function is ON, the determination is made using the values that would be obtained when the Null function is OFF.

When a wiring unit is configured, if all input elements assigned to the same wiring unit meet all of the range decrease conditions above, the measurement ranges of all input elements in the wiring unit are decreased.

Note

- If you disable a measurement range in the valid measurement range settings (see section 4.4), that measurement range is skipped, and autoranging operates using only the enabled measurement ranges.
- If an irregular pulse-like waveform is input, the range may not remain constant. In this case, use fixed range.
- The auto range setting used during integration switches to fixed range and turns OFF when integration starts.
- For a wiring system with the delta transformation function, range increase and range decrease are determined using the data before delta transformation.

Setting the current range

Current range (Current Range)

Auto (AUTO) ON/OFF

There are two methods for setting the current range. Select ON or OFF.

- OFF: Fixed range
- ON: Auto range (see page 4-9). **Auto** is displayed next to the value set by auto range.

Fixed range

In fixed range mode, select a current range from the available options. The selected current range does not change even if the input signal level changes. Set the range based on the RMS value of the input signal.

Select from the following:

Current range (Current Range) options

The available current range options vary depending on the Sensor Output Type setting (see page 4-12) and the crest factor setting.

• When the sensor output type is Current (Current)

Crest factor	Options
CF3	25 mA, 50 mA, 100 mA, 250 mA, 500 mA ¹ , 1 A ²
CF6 or CF6A	12.5 mA, 25 mA, 50 mA, 125 mA, 250 mA ³ , 500 mA ⁴

1 The actual crest factor is 2.4.

2 The actual crest factor is 1.2.

3 The actual crest factor is 4.8.

4 The actual crest factor is 2.4.

Note

- When measuring by applying the secondary output of a current transformer (CT) or a clamp-on current sensor with current output to the current sensor connection terminal, set the current range according to the maximum value of the CT or current sensor output. Then, use the scaling function to set the CT ratio or the conversion ratio of the clamp-on current sensor with current output.
- When the current range display format (see page 4-15) is set to Measure, you can display the current range according to the input range of the current sensor, CT, or probe.

• When the sensor output type is Voltage (Voltage)

Crest factor	Options
CF3	50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V ⁵
CF6 or CF6A	25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V ⁶

5 The actual crest factor is 1.2.

6 The actual crest factor is 2.4.

Note

When Range Σ Link (see pages 4-7 and 4-14) is ON, input elements assigned to the same wiring unit use the same settings for current range and sensor output type. When Range Σ Link is OFF, you can set the current range and sensor output type settings for each input element individually, even if the input elements are assigned to the same wiring unit.

Auto current range

This function is the same as auto voltage range (page 4-9).

Sensor model (Sensor Model)

Auto sensor setup (AUTO) ON/OFF

There are two methods for setting the sensor model. Select the method with auto sensor setup ON/OFF.

- **OFF**

You can select the sensor model from the following:

CT2000A, CT1000S, CT1000A, CT1000, CT200, CT60, 720930, 720931, Custom

When using a sensor that is not in the options, select Custom.

When you select a sensor model, the preset values for the items in the table below are automatically applied.

- **ON**

The sensor model is set automatically based on the automatically detected current sensor ID (CT-ID).

Automatic detection of the current sensor ID (CT-ID)

At startup, the instrument detects and displays the ID of the connected current sensor. If current sensor information is not detected, "Unknown" is displayed.

For a display example, see page 4-6.

Preset values by sensor model

When you change the sensor model, the preset values for the following items are applied.

Change each setting as necessary.

When the sensor model is set to anything other than Custom, the scaling function (Scaling) and phase correction (Current Phase Correction) are set to ON.

Item	Sensor model				
	CT2000A	CT1000A	CT1000	CT200	CT60
Sensor output type (Sensor Output Type)	Current	Current	Current	Current	Current
Scaling (Scaling)	ON	ON	ON	ON	ON
CT ratio (CT Ratio)	2000.0000	1500.0000	1500.0000	1000.0000	600.0000
Phase correction (Current Phase Correction)	ON	ON	ON	ON	ON
Frequency (Frequency)	10 kHz	5 kHz	5 kHz	10 kHz	10 kHz
Phase difference between I/O (Phase Difference between I/O)	-0.144°	-0.018°	-0.198	-0.252°	-0.252°

Item	Sensor model			
	CT1000S	720930	720931	Custom
Sensor output type (Sensor Output Type)	Voltage	Voltage	Voltage	
Scaling (Scaling)	ON	ON	ON	
CT ratio (CT Ratio)*	1.0000	1.0000	1.0000	
Output Voltage Rate [mV/A]	2.0000	10.0000	2.5000	
Phase correction (Current Phase Correction)	ON	ON	ON	
Frequency (Frequency)	10 kHz	Unchanged		
Phase difference between I/O (Phase Difference between I/O)	-1.746°			

* The CT ratio is overwritten with 1.0000 only when Scaling is ON.

Sensor output type (Sensor Output Type)

- Current (Current): You can set the current input range for current sensors with current output.
- Voltage (Voltage): You can set the current input range for current sensors with voltage output.

Output voltage rate [mV/A] (Output Voltage Rate)

This can be set when the sensor output type is Voltage.

Setting range: 0.0001 to 99999.9999

Set the conversion ratio used when measuring by applying the output of a voltage-output current probe to the current probe input terminal. Set the current probe conversion ratio (the output voltage produced when a current of 1 A flows). This setting enables the input signal to be converted into numeric data and waveform display data equivalent to those obtained through direct input of current at the current sensor connection terminal.

Note

If you change the Sensor Output Type setting or the output voltage rate [mV/A] (Output Voltage Rate) setting, the sensor model (page 4-11) changes to Custom.

Scaling (Scaling)

You can turn the scaling function ON or OFF.

- ON: The applicable measurement functions are multiplied by the voltage transformation ratio (VT ratio), current transformation ratio (CT ratio), and power coefficient.
- OFF: Select OFF if you do not want to use the scaling function.

This setting is linked to the scaling setting in section 4.3.

CT ratio (CT Ratio)

Set the CT ratio (or the conversion ratio of the current sensor with current output).

See page 4-17.

Power range

The measurement ranges (power ranges) for active power (P), apparent power (S), and reactive power (Q) are as follows:

Wiring system	Power range
1P2W (single-phase two-wire)	Voltage range × current range
1P3W (single-phase three-wire)	Voltage range × current range × 2 (when the voltage and current ranges are the same across all elements in the wiring unit)
3P3W (three-phase three-wire)	
3P3W (3V3A, three-voltage three-current method)	
3P3W (3V3AR, three-voltage three-current method)	
3P4W → 3P3W (3V3AS) (three-phase four-wire)	Voltage range × current range × 3 (when the voltage and current ranges are the same across all elements in the wiring unit)
3P4W (three-phase four-wire)	
3P3W (3V3A) → 3P4W (three-voltage three-current method)	
3P3W (3V3AR) → 3P4W (three-voltage three-current method)	

- When the result of voltage range × current range is 1000 W (VA or var) or more, the display unit becomes kW (kVA or kvar).
- Number of displayed digits (display resolution)
See page 5-1.

For a detailed table of the available voltage and current range combinations and power ranges when the voltage range and current range are the same across all elements, see appendix 3.

Note

When Auto Range is used, the voltage and current ranges switch independently according to the range increase and range decrease conditions. Therefore, the same power value may be assigned to different power ranges.

Range Σ Link (Range Σ Link)

In the wiring system settings, you can select whether to configure the settings related to the measurement ranges of input elements assigned to the same wiring unit collectively or individually.

Example: For a model with three input elements, set the wiring system as follows:

Input elements 1 to 3: Three-phase four-wire system (3P4W). Input elements 1 to 3 are assigned to a single wiring unit, ΣA .

- OFF: You can set the measurement range individually for each input element assigned to the same wiring unit.
- ON: The measurement range settings for input elements 1 to 3 are set to the same values. This is useful when measuring three-phase equipment because you can configure the measurement range settings for all input elements assigned to the same wiring unit at the same time.

Settings that are linked across input elements when Range Σ Link is set to ON

- Measurement range (including auto range ON/OFF)
- Sensor model and sensor output type for current input
- Valid measurement range

How settings are aligned when Range Σ Link is changed from OFF to ON

When Range Σ Link is changed from OFF to ON while a wiring unit (ΣA or ΣB) is configured, the measurement range, sensor model and sensor output type for current input, and valid measurement range settings for each input element are as follows:

- The measurement range is set to the largest measurement range among the input elements assigned to the same wiring unit. For current ranges, if the sensor output types are Current and Voltage, the input element whose sensor output type is Voltage takes precedence.
- Whether Auto Range is on or off is determined by the setting of the input element with the largest measurement range.

If multiple input elements have the same largest measurement range, the setting of the input element with the smallest input element number takes precedence.

- For the valid measurement range setting, all measurement ranges are enabled (checked).

Note

- When Range Σ Link is ON, the measurement ranges of input elements assigned to the same wiring unit are set to the same range.
When Range Σ Link is OFF, you can set the measurement range for each input element individually, even if the input elements are assigned to the same wiring unit.
 - If even one wiring unit is configured with input elements that have different current sensor model settings, Range Σ Link cannot be set to ON.
-

Current range display format (Current Range Display Format)

Select the current range display format from the following:

Current input range (when the sensor output type is Current (Current))

- **Direct input value (Direct)**

The current range value is displayed without being multiplied by the CT ratio. This is useful when setting the current input range (for current sensors with current output) using the output current of the current sensor (CT) applied to the current sensor connection terminal as a guide.

- **Measurement range (Measure)**

When the scaling function is ON, the value obtained by multiplying the current range by the CT ratio is displayed as the current range. This is useful when setting the current input range (for current sensors with current output) using the current measured by the current sensor (CT) as a guide.

Example: When a CT2000A is connected, the sensor model is set to CT2000A, and the CT ratio is 2000.0000, setting the current input range (for current sensors with current output) to 1 A displays the current range as 2.00 kA.

Current input range (when the sensor output type is Voltage (Voltage))

- **Direct input value (Direct)**

The probe input range (voltage) is displayed as the current range. This is useful when setting the probe input range using the output voltage of the current probe applied to the current probe input terminal as a guide.

- **Measurement range (Measure)**

The current input range (for current sensors with voltage output) is displayed as a range (current) obtained by dividing it by the output voltage rate. This is useful when setting the current input range using the current measured by the current probe as a guide.

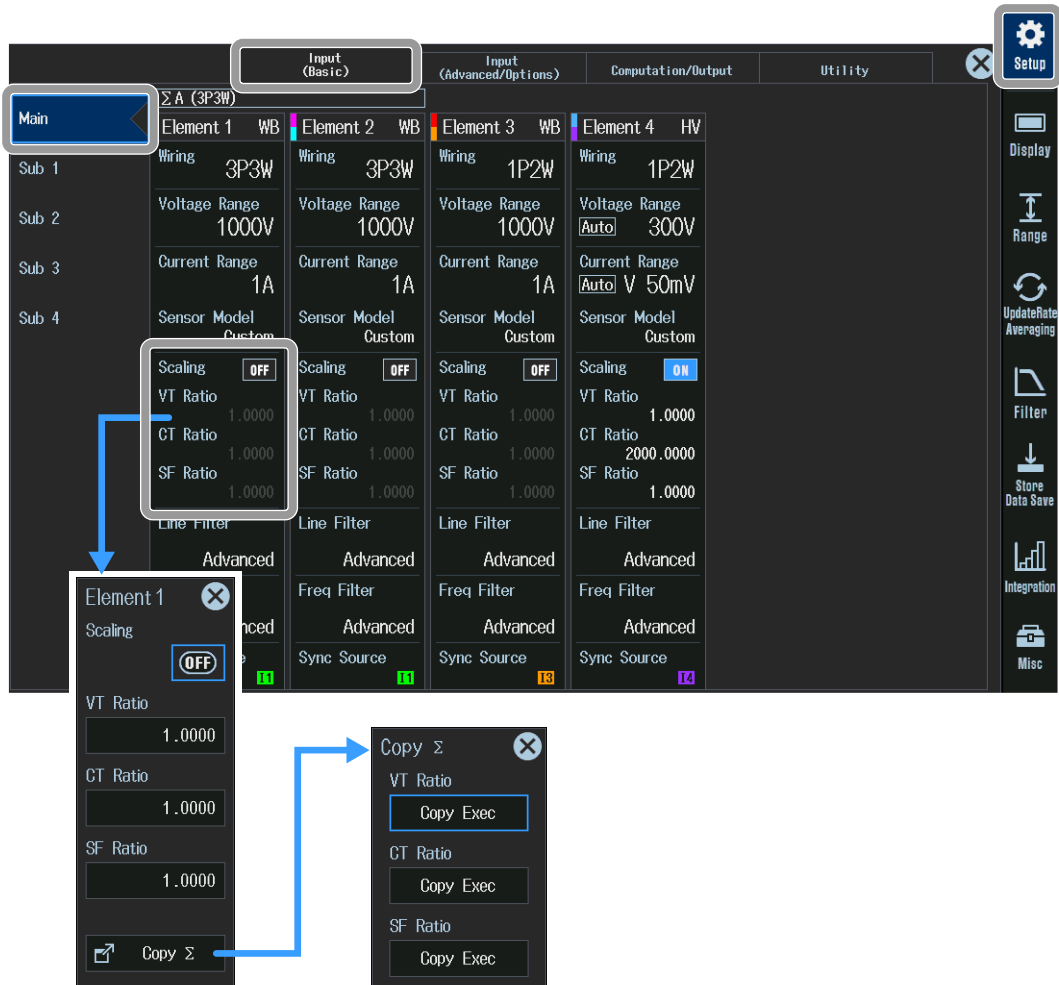
Example: When 720930 or 720931 (2.5 mV/A) is selected for the sensor model and the current input range (for current sensors with voltage output) is set to 500 mV, the current range is displayed as V 200 A.

4.3 Setting the Voltage Transformer (VT) and Current Transformer (CT) Ratios

You can set the coefficients to use when inputting voltage or current signals through an external voltage transformer (VT) or current transformer (CT).

Procedure

Setup menu icon  > **Input (Basic)** > **Main/Sub1/Sub2/Sub3/Sub4** (option /SY1) > **Scaling ON/OFF** for the input element to configure



Note

- Operation in the input information area (Elements) (see section 4.2)
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Input (Basic)** with the arrow keys and press **SET** to display the input settings (basic) overview screen.

Scaling (Scaling)

Scaling (Scaling) ON/OFF

You can select whether to multiply (ON) or not multiply (OFF) applicable measurement functions by the voltage transformation ratio (VT ratio), current transformation ratio (CT ratio), and power coefficient.

Set this to ON when using a VT or CT (or current sensor) to read measured values directly. When set to ON, the “Sc” indicator lights in the input information area on the right side of the screen.

Applicable measurement functions

Voltage U, current I, power (P, S, Q), maximum voltage (U+pk)/minimum voltage (U-pk), and maximum current (I+pk)/minimum current (I-pk)

- ON: The measurement functions above are multiplied by the VT ratio, CT ratio, or power coefficient. For a wiring system with the delta transformation function, the data before delta transformation is multiplied by the VT and CT ratios.
- OFF: The measurement functions above are not multiplied by the VT ratio, CT ratio, or power coefficient. The output values of the VT or CT are displayed directly as numeric data.

VT ratio (VT Ratio)

Set the VT ratio when applying the secondary output of a VT to the voltage input terminal. Then, set the voltage range according to the maximum VT output.

Setting range: 0.0001 to 99999.9999

CT ratio (CT Ratio)

Set the CT ratio (or the conversion ratio of the current sensor with current output) when applying the secondary output of a CT or clamp-on current sensor with current output to the current sensor connection terminal. Then, set the current range according to the maximum CT or current sensor output.

Setting range: 0.0001 to 99999.9999

Power coefficient, scaling factor (SF Ratio)

By setting the power coefficient (SF), you can display measured active power, apparent power, and reactive power after multiplying them by the coefficient.

Measurement function	Data before conversion	Conversion result	
Voltage U	U_2 (VT secondary output)	$U_2 \times V$	V: VT ratio
Current I	I_2 (CT secondary output)	$I_2 \times C$	C: CT ratio
Active power P	P_2	$P_2 \times V \times C \times SF$	SF: Power coefficient
Apparent power S	S_2	$S_2 \times V \times C \times SF$	
Reactive power Q	Q_2	$Q_2 \times V \times C \times SF$	
Max./min. voltage Upk	Upk_2 (VT secondary output)	$Upk_2 \times V$	
Max./min. current Ipk	Ipk_2 (CT secondary output)	$Ipk_2 \times C$	

Setting range: 0.0001 to 99999.9999

Note

- If the result of multiplying the measured value by the VT ratio, CT ratio, or power coefficient exceeds 9999.99M, [–OF–] is displayed in the numeric data display frame.
- To correctly compute the power and efficiency of Σ functions, set the power coefficients for all elements so that the units of all power values used in the computation are the same. For example, efficiency between elements or between wiring units that use different power units, such as watts (W) and joules (J), is not computed correctly. Use either W or J consistently as the power unit.

Copy Σ (Copy Σ)

You can copy the VT ratio/CT ratio/power coefficient of the input element selected by the cursor to all input elements in the wiring unit that contains that element.

Copying the VT ratio (VT Ratio Copy Exec)

Copies the VT ratio of the selected input element to the other input elements assigned to the same wiring unit.

Copying the CT ratio (CT Ratio Copy Exec)

Copies the CT ratio of the selected input element to the other input elements assigned to the same wiring unit.

Copying the power coefficient (SF Ratio Copy Exec)

Copies the power coefficient of the selected input element to the other input elements assigned to the same wiring unit.

Note

Regardless of the Range Σ Link ON/OFF setting (see pages 4-7 and 4-14), the scaling function is configured individually for each input element. Copy the settings as needed.

4.4 Setting the Valid Measurement Range

You can set the following items. Select voltage or current as the item to be configured.

- Valid measurement range (Valid Measurement Range)
- Measurement range to switch to when a peak overrange occurs (Peak Over Jump)

Procedure

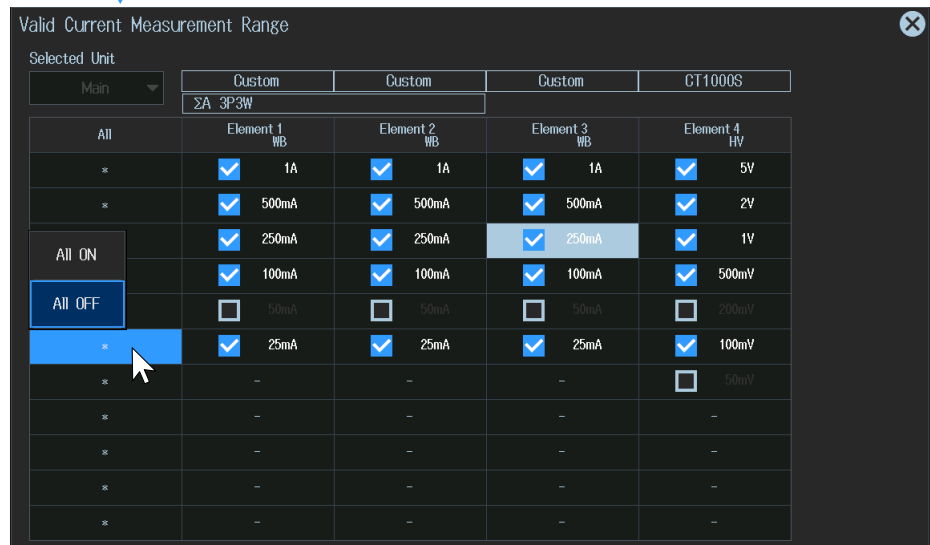
Setup menu icon  > **Input (Advanced/Options)** > **Range Config** > set Selected Unit to **Main/Sub1/Sub2/Sub3/Sub4** (option /SY1)

- **Setting the valid voltage measurement range**
> **Voltage**



4.4 Setting the Valid Measurement Range

- **Setting the valid current measurement range**
> **Current**



This section describes how to set the valid measurement range when the crest factor (see section 4.9) is set to CF3. When the crest factor is CF6 or CF6A, set the valid measurement range from the corresponding options.

Note

- Procedures using front-panel keys (see section 1.2 of the Getting Started Guide (IM WT1501-02EN))
You can also select **Input (Advanced/Options)** with the arrow keys and press **SET** to display the input settings (advanced/options) overview screen.

Unit to configure (Selected Unit)

During multi-unit synchronization (option /SY1), you can set the valid measurement range for subunits from the main unit.

Specify the unit to configure from the following, and then configure the settings below:

Main, Sub 1, Sub 2, Sub 3, Sub 4

Selecting the item to configure

Select the item to configure for range configuration from the following:

- Voltage [voltage range]
- Current [current range]

Valid measurement range (Valid Measurement Range)

The currently configured valid measurement ranges are displayed. Disabled measurement ranges are dimmed.

This instrument switches up or down between enabled measurement ranges, skipping disabled measurement ranges.

Example • When using auto range to measure a device that draws 2 A in operation mode and 100 mA in standby mode, disable the 200 mA, 500 mA, and 1 A ranges.

- If the device switches to operation mode while being measured in the 200 mA range during standby mode, the intermediate 200 mA, 500 mA, and 1 A ranges are skipped, and the range switches to the 2 A range.

Valid range setup screen

When you select , the valid range setup screen appears.

Display of input elements or wiring units (table header row)

For each input element (Element 1 to Element 4) or wiring unit, you can set all ranges as valid measurement ranges at once (All ON).

Measurement range box (* in the leftmost column of the table)

For each range, you can turn that range on (All ON) or off (All OFF) as a valid measurement range for all input elements at once.

Measurement range to switch to when a peak overrange occurs (Peak Over Jump)

You can specify which measurement range to switch to when the auto range function is enabled and a peak overrange occurs.

The background of the specified measurement range to switch to when a peak overrange occurs (Peak Over Jump) is displayed in gray.

* On the valid range setup screen, the background is displayed in gray.

- **When auto range is ON**

If a peak overrange occurs in a range higher than the range specified in Peak Over Jump, the measurement range is increased sequentially through the valid measurement ranges (checked ranges).

- **When fixed range is used (auto range is OFF)**

The measurement range is fixed. The range does not switch even if a peak overrange occurs.

- **When the current range display format (see page4-15) is Measure**

For the valid measurement range and the measurement range when a peak overrange occurs, measurement ranges that reflect the conversion ratio of the current sensor or CT are displayed.

Valid voltage measurement range options

The available options vary depending on the input element and crest factor settings.

- **HV element**

Crest factor	Options
CF3	OFF, 6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1000 V, 2000 V
CF6 or CF6A	OFF, 3 V, 7.5 V, 15 V, 30 V, 75 V, 150 V, 300 V, 500 V, 1000 V

- **WB element**

Crest factor	Options
CF3	OFF, 6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1000 V
CF6 or CF6A	OFF, 3 V, 7.5 V, 15 V, 30 V, 75 V, 150 V, 300 V, 500 V

Valid current measurement range options

The available options vary depending on the sensor output type (see page 4-12) and crest factor setting.

- **When the sensor output type is Current (Current)**

Crest factor	Options
CF3	OFF, 25 mA, 50 mA, 100 mA, 250 mA, 500 mA, 1 A
CF6 or CF6A	OFF, 12.5 mA, 25 mA, 50 mA, 125 mA, 250 mA, 500 mA

- **When the sensor output type is Voltage (Voltage)**

Crest factor	Options
CF3	OFF, 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V
CF6 or CF6A	OFF, 25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V

Note

- You cannot set all measurement ranges to OFF. The minimum number of valid ranges is 1.
- The settings for the valid range and for the measurement range to switch to when a peak overrange occurs are shared by all the input elements assigned to the same wiring unit.
- When Range Σ Link is ON, changing the wiring system resets the valid range settings so that all measurement ranges are ON (default value).
- When Range Σ Link is changed from OFF to ON, the valid range settings are reset so that all measurement ranges are ON (default value).
- If you set the current measurement range to OFF in the valid range settings, the measurement range changes to the next higher measurement range.
If there is no measurement range above the current one, it changes to the next lower measurement range.

4.5 Setting Sensor Correction

For current sensor correction, you can set the following items:

- Current gain correction
- Current phase adjustment

Procedure

Setup menu icon  > **Input (Advanced/Options)** > **Sensor Correction** > set Selected Unit to **Main/Sub1/Sub2/Sub3/Sub4** (option /SY1)



Selected Unit	Element 1 WB	Element 2 WB	Element 3 WB	Element 4 HV
Current Amplitude Correction	ON	OFF	OFF	ON
Correction Ratio	1.000000	1.000000	1.000000	1.000000
Current DC Offset Correction	ON	OFF	OFF	ON
DC Offset	0.00000A	0.00000A	0.00000A	0.00000A
Current Phase Correction	ON	OFF	OFF	ON
Frequency	60 Hz	60 Hz	60 Hz	10.0kHz
Phase Difference between I/O	0.000°	0.000°	0.000°	-1.746°
Time Difference between I/O	0.000s	0.000s	0.000s	-485.066ns

• Setting all input elements at once

When you select a cell in the leftmost column of the table, you can set the corresponding item for all input elements at once. (Except for Time Difference between I/O, which is at the bottom.)

Note

- You can also use the **Misc** menu icon  shown on the right side of the screen to set sensor correction. For details on the Misc menu, see page xv.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Input (Advanced/Options)** with the arrow keys and press **SET** to display the input settings (advanced/options) overview screen.

Unit to configure (Selected Unit)

During multi-unit synchronization (option /SY1), you can set sensor correction for subunits from the main unit.

Specify the unit to configure from the following, and then configure the settings below:

Main, Sub 1, Sub 2, Sub 3, Sub 4

Current amplitude correction

Current amplitude correction (Current Amplitude Correction)

- ON: Corrects the current amplitude.
- OFF: Does not correct the current amplitude.

Correction ratio (Correction Ratio)

Set the correction ratio.

Setting range: 0.800000 to 1.200000

Current DC offset correction

Current DC offset correction (Current DC Offset Correction)

- ON: Corrects the current DC offset.
- OFF: Does not correct the current DC offset.

Current DC offset (DC Offset)

Setting range: $\pm 9.99999\text{E}\pm 3$

Setting resolution: 6 digits, floating point from 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 DC offset correction and NULL zero-level compensation.

Current phase correction

To correctly measure power, impedance, power factor, watt hours, ampere hours, and other values from voltage and current, the voltage and current signals must be applied to the instrument's signal input terminals without any transmission time difference between the signals. However, a transmission time difference may occur between the two signals depending on the sensors or cables used. This instrument can make measurements by correcting the transmission time difference between the two signals.

Current phase correction (Current Phase Correction)

- ON: Corrects the transmission time difference between voltage and current.
- OFF: Does not correct the transmission time difference between voltage and current.

Frequency (Frequency)

Set the frequency used to correct the transmission time difference.

Setting range: 50 Hz, 60 Hz, 0.1 kHz to 999.9 kHz (0.1 kHz steps), 1 MHz

Phase difference between I/O (Phase Difference between I/O)

Set the phase difference between the input and output of the sensor or cable to be used.

Setting range: -180.000 to +180.000°*

- * The phase difference can be set within the range where the time difference between input and output is $\pm 10\mu\text{s}$.

When setting the phase difference that corresponds to the sensor's phase calibration value or propagation delay, set the sign as follows:

- Lead: + or no sign
- Lag: –

For example, to correct a lag of 1° , specify -1.000° .

Time difference between I/O (Time Difference between I/O)

The instrument computes and displays the correction value from the specified frequency and the phase difference between input and output according to the following equation:

$$\text{Input-output time difference [s]} = \frac{\text{phase difference [}^\circ\text{]}}{360} \times \frac{1}{\text{frequency [Hz]}}$$

4.6 Setting the Line Filter

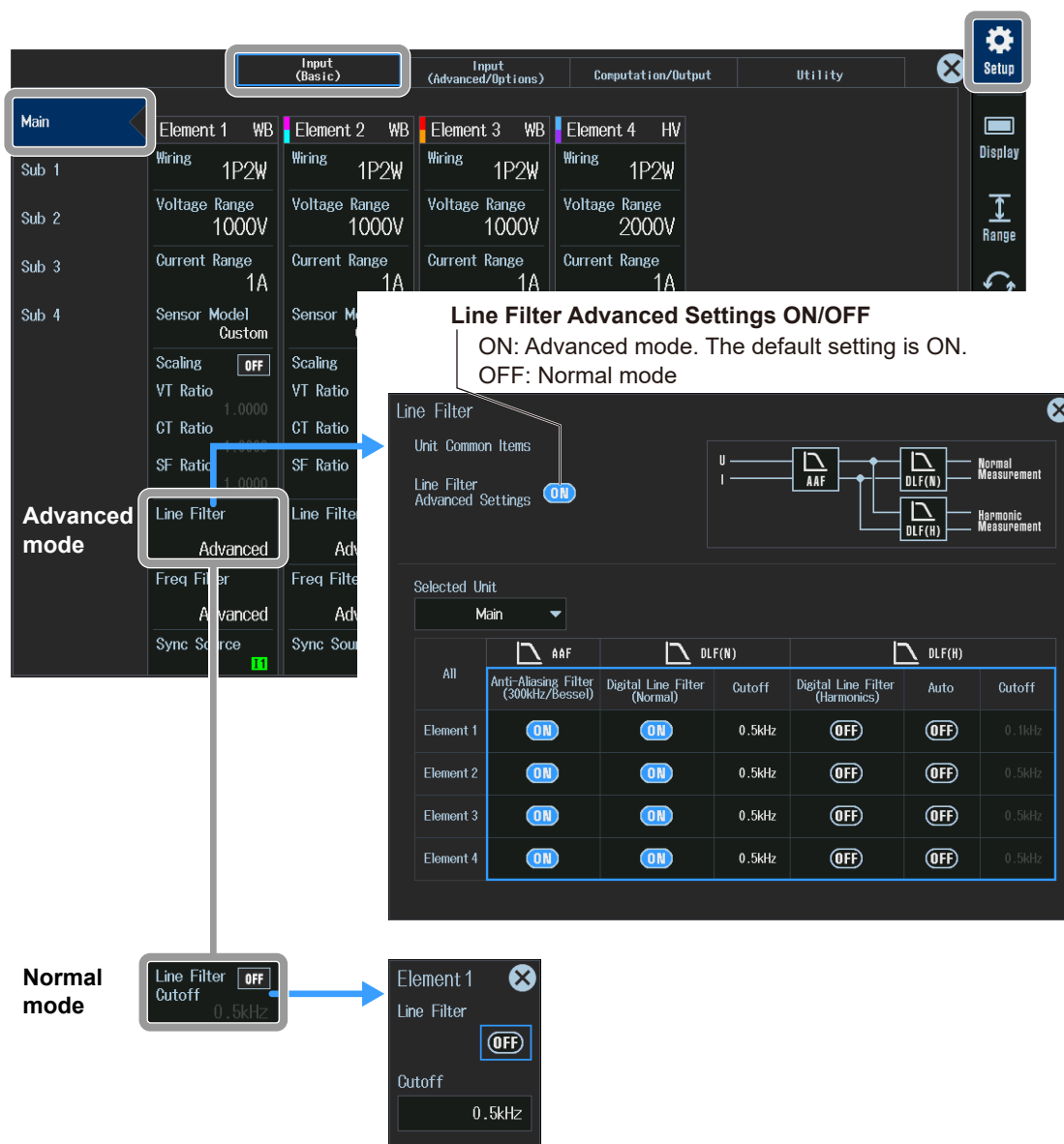
This section describes the following items:

- Line filter setting (Basic measurement conditions)
- Setting the line filter (Advanced)

Procedure

- **Line filter setting (Basic measurement conditions)**

Setup menu icon  > **Input (Basic)** > **Main/Sub1/Sub2/Sub3/Sub4** (option /SY1) > **Line Filter** of the input element to configure



Line Filter Advanced Settings ON/OFF
 ON: Advanced mode. The default setting is ON.
 OFF: Normal mode

Line Filter

Unit Common Items
 Line Filter Advanced Settings **ON**

Selected Unit
 Main

	AAF	DLF(N)	Cutoff	DLF(H)	Auto	Cutoff
All	Anti-Aliasing Filter (300kHz/Bessel)	Digital Line Filter (Normal)		Digital Line Filter (Harmonics)		
Element 1	ON	ON	0.5kHz	OFF	OFF	0.1kHz
Element 2	ON	ON	0.5kHz	OFF	OFF	0.5kHz
Element 3	ON	ON	0.5kHz	OFF	OFF	0.5kHz
Element 4	ON	ON	0.5kHz	OFF	OFF	0.5kHz

Normal mode

Line Filter **OFF**
 Cutoff 0.5kHz

Element 1
 Line Filter **OFF**
 Cutoff 0.5kHz

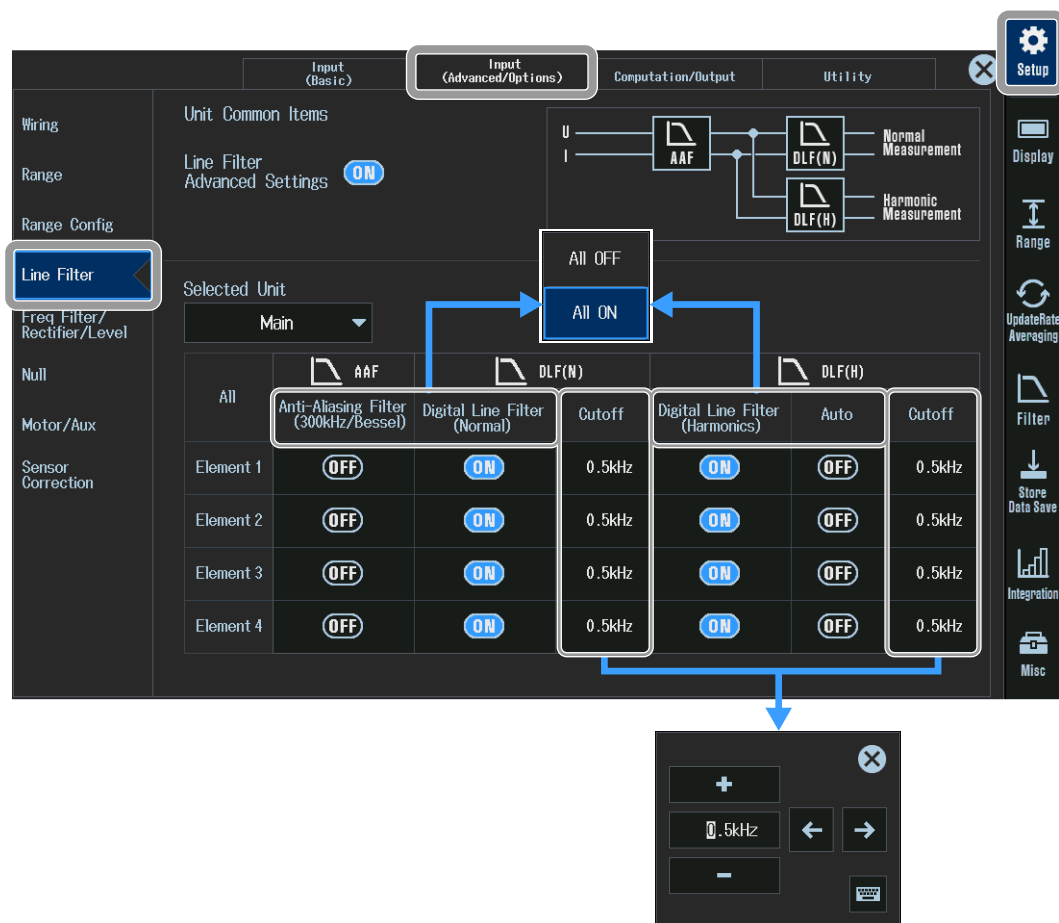
- **Setting the line filter (Advanced)**

Setup menu icon  > **Input (Advanced/Options)** > **Line Filter** > set **Line Filter Advanced Settings** to **ON/OFF**

When Line Filter Advanced Settings is ON (Advanced mode)

You can set the following filters individually:

- AAF (anti-aliasing filter (300 kHz/Bessel))
- DLF(N) (digital line filter (for normal measurement))
- DLF (H) (digital line filter (for harmonic measurement))



Setting all elements at once

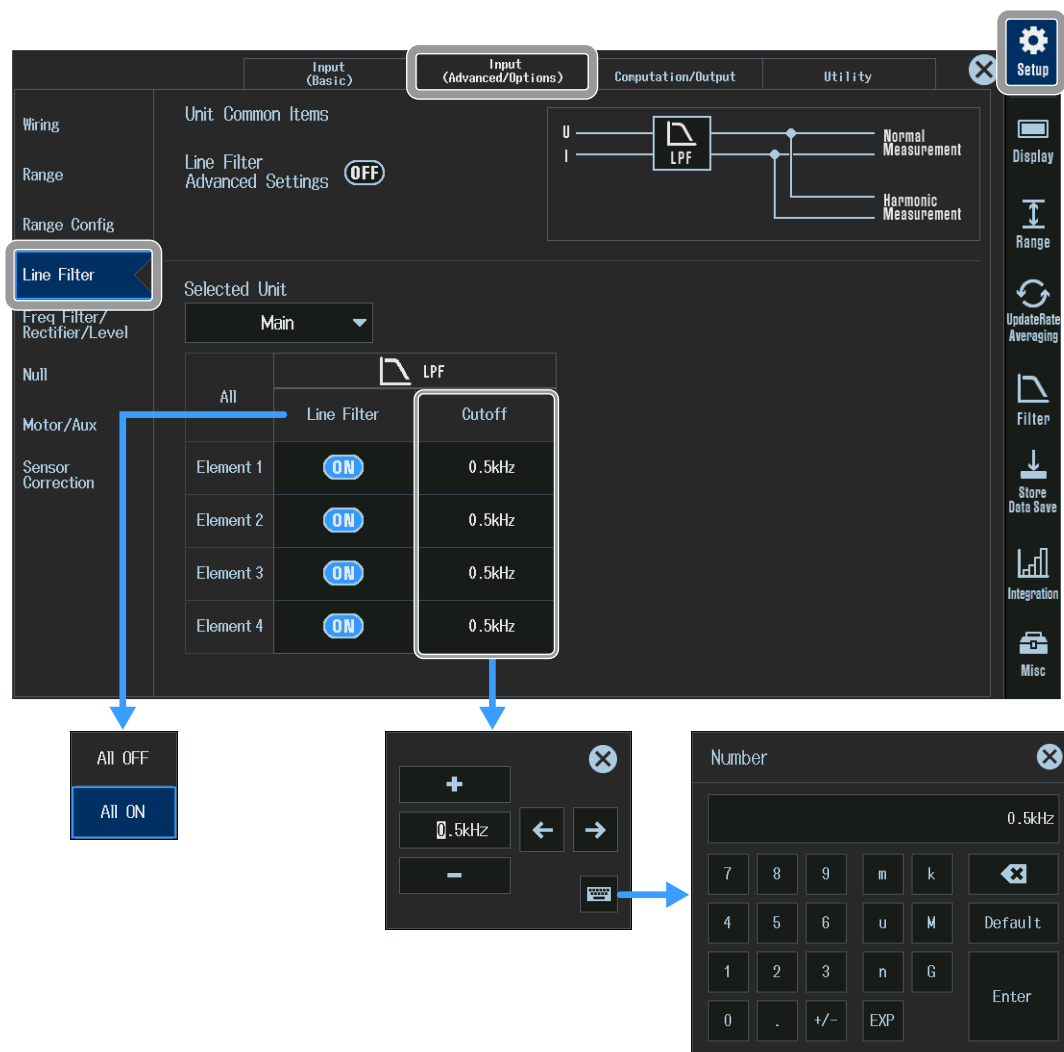
When you select the Anti-Aliasing Filter, Digital Line Filter (Normal), Digital Line Filter (Harmonics), or Auto display, you can turn the setting ON or OFF for all elements at once.

When you select the Cutoff display, you can set numeric values for all elements at once.

4.6 Setting the Line Filter

When Line Filter Advanced Settings is OFF (Normal mode)

You can set line filter ON/OFF and the cutoff frequency.



Setting all elements at once

When you select the Line Filter display, you can turn the setting ON or OFF for all elements at once.

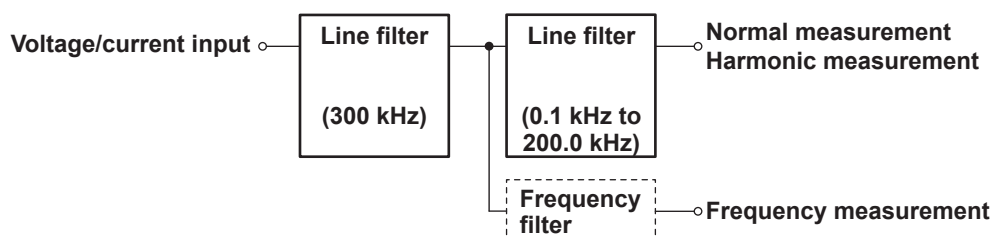
When you select the Cutoff display, you can set numeric values for all elements at once.

Note

- You can also use the **Filter** menu icon  shown on the right side of the screen to set the line filter. For details on the Filter menu, see page xii.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Input (Basic)** or **Input (Advanced/Options)** with the arrow keys and press **SET** to display the input settings overview screen for input (basic) or input (advanced/options).

Line filter setting (Basic measurement conditions)

There are two types of input filters: line filters and frequency filters. The 300 kHz line filter is inserted as shown in the figure below, so it affects normal measurement/harmonic measurement and frequency measurement (for details, see the block diagram in appendix 13).



Line filter ON/OFF (Line Filter)

- **ON:** The measured values do not include high-frequency components. This enables measurement of voltage, current, and power with the high-frequency components of inverter waveforms, distorted waveforms, and similar waveforms removed.
Turning on the line filter changes the accuracy and the upper limit of the measurement bandwidth. For details, see section 5.9 of the Getting Started Guide (IM WT1501-02EN).
- **OFF:** The line filter does not operate.

Cutoff frequency (Cutoff)

Set the cutoff frequency within the following range:

0.1 kHz to 200.0 kHz (0.1 kHz steps), 300 kHz

The line filter functions as shown in the figure above according to the specified frequency.

The line filter setting (OFF, or the cutoff frequency when set to ON) is displayed on the Elements tab in the input information area.

Note

- You can set the line filter type under Input (Advanced/Options) > Line Filter (Line Filter) > Line Filter Type (see page 4-31).
- If you set Line Filter Advanced Settings to ON under Input (Advanced/Options) > Line Filter, filter function is enabled, and the settings in Input (Basic) are disabled.
See page 4-30.

Depending on the measurement mode or the method used to compute measured values (computation method), the settings may differ from those described in this section, may be invalid, or may not be configurable. For details, see the next page.

Line filter setting (Advanced)

Line filter advanced setting ON/OFF (Line Filter Advanced Settings)

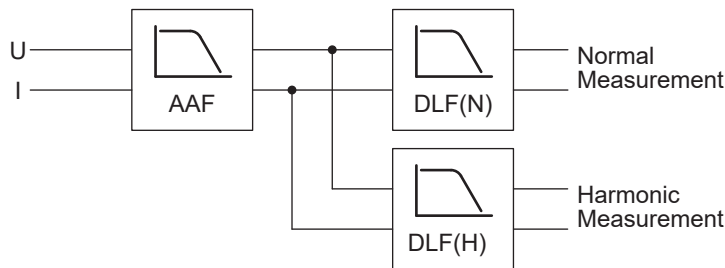
Set Line Filter Advanced Settings to ON or OFF.

Turning on the line filter changes the accuracy and the upper limit of the measurement bandwidth.

For details, see section 5.9 of the Getting Started Guide (IM WT1501-02EN).

When Line Filter Advanced Settings (Line Filter) is ON (Advanced mode)

The line filter consists of AAF, DLF(N), and DLF(H). You can set different line filters for normal measurement and for harmonic measurement.



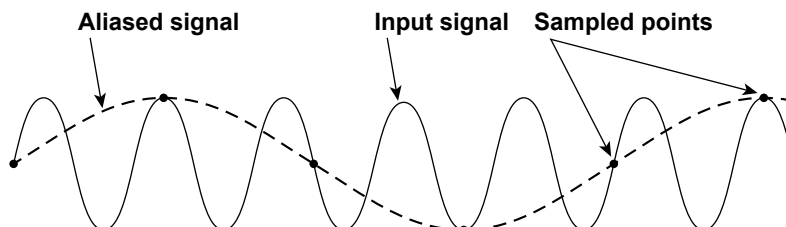
Line filter type (DLF) (Line Filter Type (DLF))

The types of DLF(N) and DLF(H) are Butterworth.

Anti-aliasing filter (Anti-Aliasing Filter: AAF)

Select OFF or ON (300 kHz) for the anti-aliasing filter.

When FFT computation is performed on an A/D-converted repetitive waveform, a phenomenon occurs in which frequency components higher than one-half the sampling frequency are recognized as low-frequency components. This phenomenon is called aliasing.



Using the 300 kHz anti-aliasing filter removes high-frequency components near 300 kHz and above and prevents aliasing.

Digital line filter (for normal measurement) (Digital Line Filter (Normal): DLF(N))

Set the digital line filter for normal measurement.

- **DLF(N) ON/OFF (Digital Line Filter (Normal))**

Turn DLF(N) ON or OFF.

- **Cutoff frequency (Cutoff)**

Set the DLF(N) cutoff frequency within the following range:

0.1 kHz to 200.0 kHz (0.1 kHz steps)

Digital line filter (for harmonic measurement) (Digital Line Filter (Harmonics): DLF(H))

Set the digital line filter for harmonic measurement.

- **DLF(H) ON/OFF (Harmonics (Digital Line Filter))**

Turn DLF(H) ON or OFF.

- **Auto**

Turn the auto harmonic filter ON or OFF.

When ON is selected, the cutoff frequency automatically switches according to the fundamental frequency.

For the relationship between the fundamental frequency and cutoff frequency, see “Harmonic analysis when auto harmonic filter is on” under “Harmonic measurement function” in section 5.9, “Specifications,” of the Getting Started Guide (IM WT1501-02EN).

- **Cutoff frequency (Cutoff)**

Set the DLF(H) cutoff frequency within the following range:

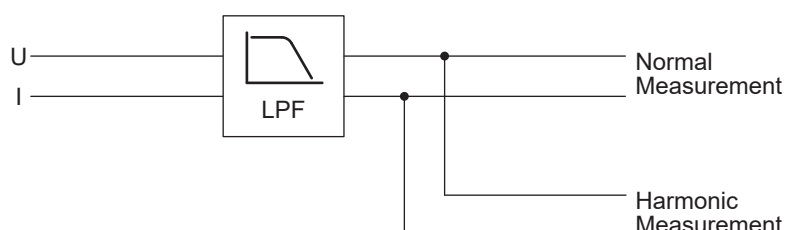
0.1 kHz to 200.0 kHz (0.1 kHz steps)

Setting all input elements at once

When you select a cell in the top row of the table, you can set the corresponding item for all input elements at once.

When Line Filter Advanced Settings is OFF (Normal mode)

The line filter is configured as shown in the figure below. The same low-pass filter is used for normal measurement and harmonic measurement.

**Line filter type (Line Filter Type)**

The line filter type is fixed to Bessel.

Line filter ON/OFF (Line Filter)

This is the same as the line filter ON/OFF setting in Input (Basic). The setting is also shared. See page 4-29.

Cutoff frequency (Cutoff)

This is the same as the line filter cutoff frequency setting in Input (Basic). The setting is also shared.

See page 4-29.

Setting all input elements at once

When you select a cell in the top row of the table, you can set the corresponding item for all input elements at once.

4.7 Setting the Frequency Filter

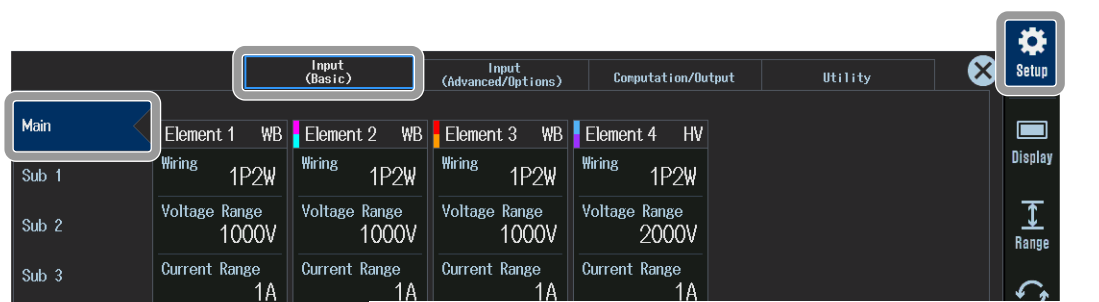
This section describes the following items:

- Setting the frequency filter (Basic measurement conditions)
- Frequency filter setting (Advanced)

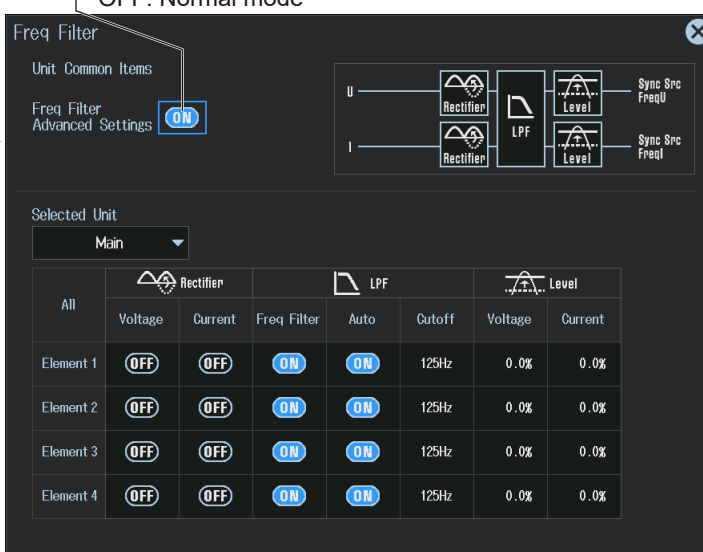
Procedure

- **Setting the frequency filter (Basic measurement conditions)**

Setup menu icon  > **Input (Basic)** > **Main/Sub1/Sub2/Sub3/Sub4** (option /SY1) > **Freq Filter** of the input element to configure

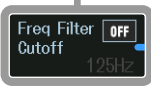


Freq Filter Advanced Settings ON/OFF
 ON: Advanced mode. The default setting is ON.
 OFF: Normal mode



All	Rectifier		LPF		Level		
	Voltage	Current	Freq Filter	Auto	Cutoff	Voltage	Current
Element 1	OFF	OFF	ON	ON	125Hz	0.0%	0.0%
Element 2	OFF	OFF	ON	ON	125Hz	0.0%	0.0%
Element 3	OFF	OFF	ON	ON	125Hz	0.0%	0.0%
Element 4	OFF	OFF	ON	ON	125Hz	0.0%	0.0%

Normal mode




- **Setting the frequency filter (Advanced)**

Setup menu icon  > **Input (Advanced/Options)** > **Freq Filter/Rectifier/Level** > set **Freq Filter Advanced Settings** to **ON/OFF**

When Freq Filter Advanced Settings is ON (Advanced mode)

You can set the following filters and items individually:

- Rectifier (Rectifier)
- Low-pass filter (LPF)
- Cross level (Level)



Setting all elements at once

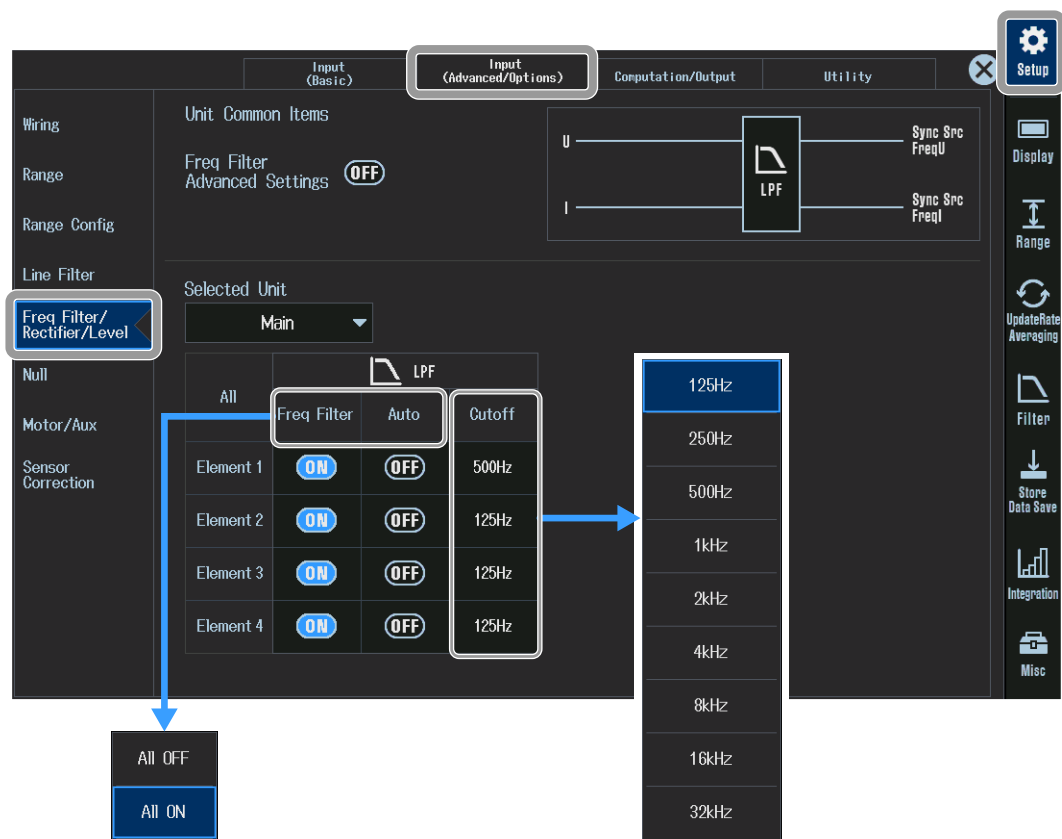
When you select the Voltage or Current display under Rectifier, or the Freq Filter or Auto display under LPF, you can turn the setting ON or OFF for all elements at once.

When you select the Cutoff display or the Voltage or Current display under Level, you can set numeric values for all elements at once.

4.7 Setting the Frequency Filter

When Freq Filter Advanced Settings is OFF (Normal mode)

You can set the cutoff frequency of the low-pass filter (LPF).



Setting all elements at once

When you select the Freq Filter or Auto display, you can turn the setting ON or OFF for all elements at once.

When you select the Cutoff display, you can set numeric values for all elements at once.

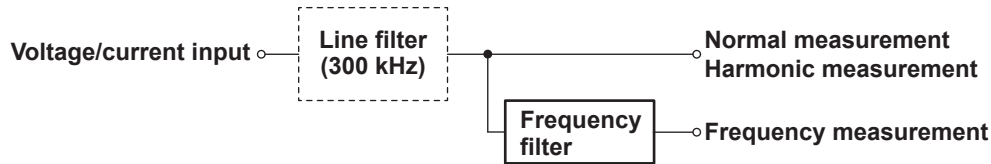
Note

- You can also use the **Filter** menu icon  shown on the right side of the screen to set the frequency filter. For details on the Filter menu, see page xii.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Input (Basic)** or **Input (Advanced/Options)** with the arrow keys and press **SET** to display the input settings overview screen for input (basic) or input (advanced/options).

Frequency filter setting (Basic measurement conditions)

Frequency filter ON/OFF (Freq Filter)

The frequency filter is inserted as shown in the figure below and affects frequency measurement (see the block diagram in appendix 13).



Because this instrument uses the sync source period average method as its computation method (see page 4-48), it also affects period detection for voltage, current, and power measurement. In addition, the frequency filter functions as a filter for detecting the cross point of the sync source signal (see section 4.8) with high accuracy.

However, the filter is not inserted for normal measurement or harmonic measurement. Therefore, the measured values include high-frequency components even when the frequency filter is ON.

- Cross points are detected with a hysteresis of approximately 5 % of the measurement range.
- The frequency filter setting (OFF, or the cutoff frequency when set to ON) is displayed on the Elements tab in the input information area.
- Even when the frequency filter is OFF, if the line filter (300 kHz) described above is ON, the line filter (300 kHz) affects frequency measurement.
- We recommend turning the frequency filter on and setting the cutoff frequency as follows according to the frequency of the input signal:

Input signal frequency	Frequency filter cutoff frequency
125 Hz or less	125 Hz
1 kHz or less	1 kHz
32 kHz or less	32 kHz

Cutoff frequency (Cutoff)

Select the cutoff frequency from the following:

125Hz, 250Hz, 500Hz, 1kHz, 2kHz, 4kHz, 8kHz, 16kHz, 32kHz

Frequency filter setting (Advanced)

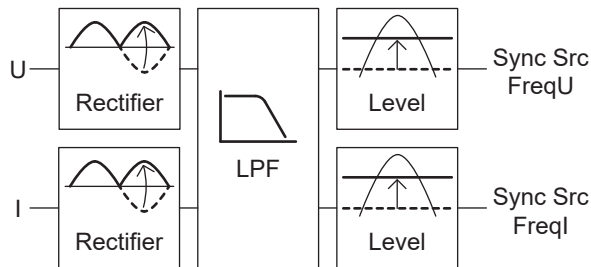
Frequency filter advanced setting ON/OFF (Freq Filter Advanced Settings)

Set Freq Filter Advanced Settings to ON or OFF.

You can configure the frequency filter in detail.

When Freq Filter Advanced Settings is ON (Advanced mode)

The frequency filter consists of a rectifier, a low-pass filter, and a cross-level setting.



Voltage signal rectifier/current signal rectifier ON/OFF (Voltage Rectifier/Current Rectifier)

Select whether to rectify the voltage/current (ON) or not (OFF).

- If rectification (ON) is selected, the measured values of reactive power Q , phase difference Φ , and $Q\Sigma$ may change. See appendix 1.
- Rectification cannot be turned ON for elements configured for a wiring system with the delta transformation function.

Frequency filter (LPF) ON/OFF (Freq Filter (LPF))

This is the same as the frequency filter ON/OFF setting in Input (Basic). The setting is also shared.

See page 4-35.

Cutoff frequency (LPF) (Cutoff (LPF))

This is the same as the frequency filter cutoff frequency setting in Input (Basic). The setting is also shared.

See page 4-35.

Voltage cross level/current cross level (Voltage Level/Current Level)

Set the voltage cross level and current cross level within the following range:

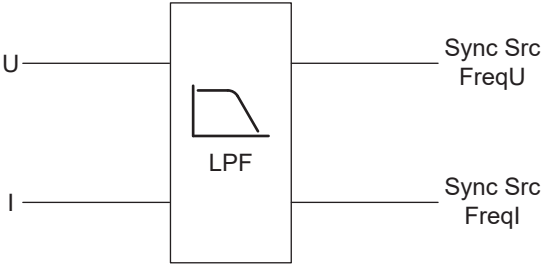
- When rectification is OFF: -100.0% to 100.0%
- When rectification is ON: 0.0% to 100.0% (absolute value)

Setting all input elements at once

When you select a cell in the top row of the table, you can set the corresponding item for all input elements at once.

When Freq Filter Advanced Settings is OFF (Normal mode)

The frequency filter consists of a low-pass filter.



Frequency filter (LPF) ON/OFF (Freq Filter (LPF))

This is the same as the frequency filter ON/OFF setting in Input (Basic). The setting is also shared.

See page 4-35.

Cutoff frequency (Cutoff)

This is the same as the frequency filter cutoff frequency setting in Input (Basic). The setting is also shared.

See page 4-35.

Setting all input elements at once

When you select a cell in the top row of the table, you can set the corresponding item for all input elements at once.

4.8 Setting the Measurement Period

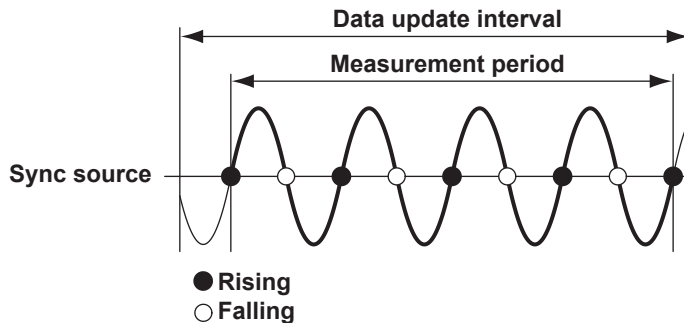
Overview

Measurement period (Sync Source)

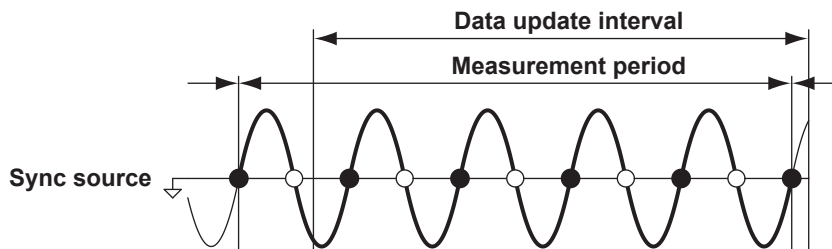
Measurement period for normal measurement functions

The measurement period is determined by the input signal that is used as the reference (sync source). The measurement period extends from the first point within the data update period at which the sync source crosses the set level (the initial value is the midpoint of the amplitude) on the rising (or falling) slope (cross point) to the last point within the data update period at which the sync source crosses the set level on the rising (or falling) slope.

- When the update mode is not Auto

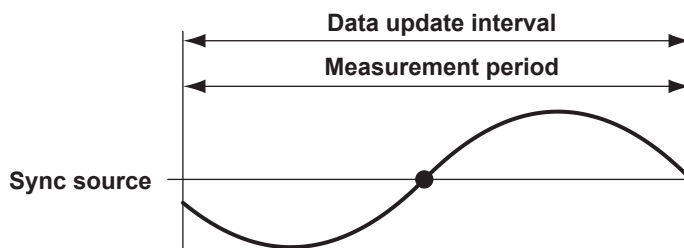


- When the update mode is Auto

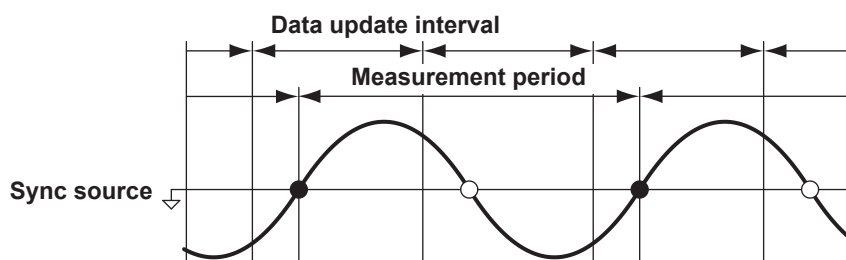


When the update mode is not Auto, if there is one or no zero crossing within the data update interval, the entire data update interval is used as the measurement period.

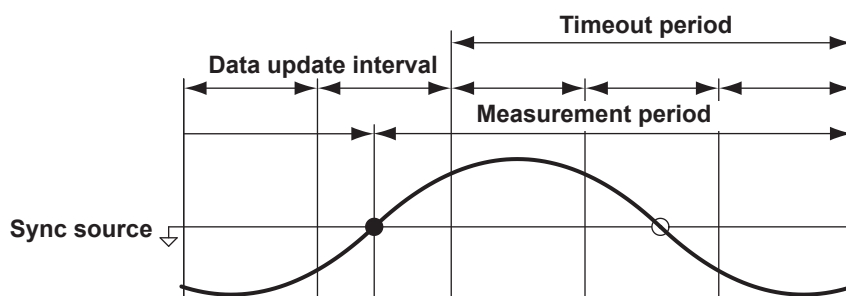
- When the update mode is not Auto



- When the update mode is Auto



- When the update mode is Auto and timeout occurs



When the update mode is not Auto, the numeric data for the peak values of voltage and current always uses the data update period as the measurement period. Therefore, the measurement period for the measurement functions U+pk, U-pk, I+pk, I-pk, P+pk, P-pk, CfU, and CfI, which are obtained from the peak values of voltage and current, is also the data update period.

For details, see appendix 4.

When the update mode is Auto, numeric data for the peak values of voltage and current is data within the measurement period.

Measurement period for harmonic measurement functions

The measurement period is 1024 or 8192 points, selected automatically according to the fundamental frequency and counted at the harmonic measurement sampling frequency from the first sampled data in the data update interval.

The instrument automatically determines the sampling frequency for harmonic measurement from the period of the signal set as the PLL source. The sampling data and measurement period used to determine the values of harmonic measurement functions may differ from those used to determine the values of normal measurement functions.

When the update mode is Auto, the number of times harmonic measurement data is updated may also differ from that for normal measurement.

4.8 Setting the Measurement Period

You can set the following items.

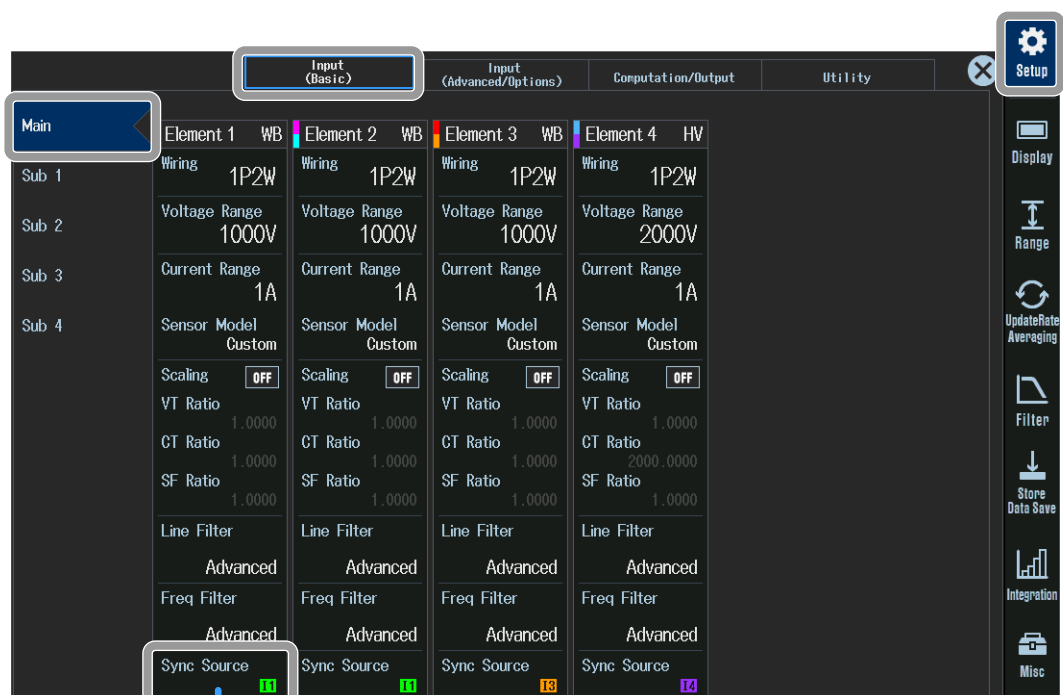
- Sync source (Sync Source)
- Cross level (Level)

Depending on the measurement mode or the method used to compute measured values (computation method), the settings may differ from those described in this section, may be invalid, or may not be configurable. For details, see page 4-42.

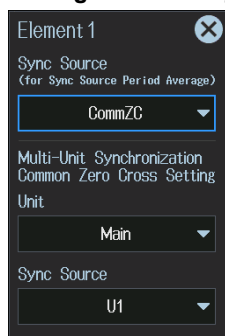
Procedure

- **Setting the sync source (Sync Source)**

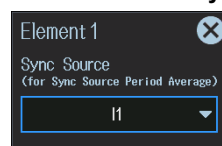
Setup menu icon  > **Input (Basic)** > **Main/Sub1/Sub2/Sub3/Sub4** (option /SY1) > **Sync Source** of the input element to configure



During multi-unit synchronization (option /SY1)

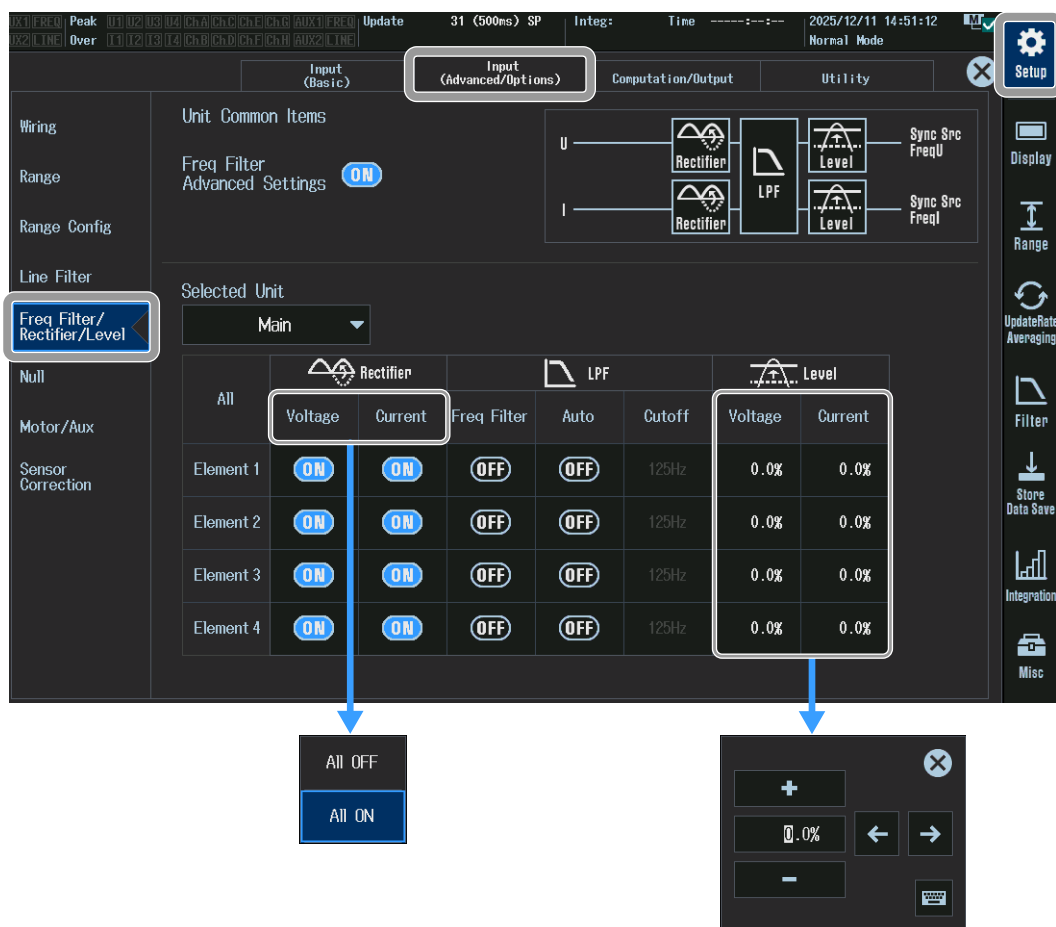


When multi-unit synchronization is OFF



- Setting the cross level (Level)

Setup menu icon  > Input (Advanced/Options) > Freq Filter/Rectifier/Level > set Freq Filter Advanced Settings to ON



Note

- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Input (Basic)** with the arrow keys and press **SET** to display the input settings (basic) overview screen.

Sync source (Sync Source)

Select the signal to use as the sync source from the following: The available options vary depending on the installed elements. When Range Σ Link is ON, the same sync source is set for elements assigned to the same wiring unit.

U1, I1, U2, I2, U3, I3, U4, I4, Ext Clk (external clock)¹, ZPhase 1 (Ch D)², ZPhase 3 (Ch H)², CommZC³, None

- 1 When Ext Clk is selected, the external signal input to the external clock input terminal (EXT CLK) on the rear panel is used as the sync source. For the specifications of the EXT CLK terminal, see section 2.15 of the Getting Started Guide (IM WT1501-02EN).
- 2 Models with the motor evaluation function (option /EM1, /RM1, /EM2, /RM2, or /EM1RM1)
- 3 Can be selected during multi-unit synchronization (option /SY1). See Common zero-crossing unit/source.

Note

- If sync source is set to None
 - When the update mode is not Auto, all sampling data within the data update interval is used to determine numeric data.
 - When the update mode is Auto, all sampling data acquired before the timeout period elapses is used to determine numeric data.
- When measuring DC signals, this setting can prevent incorrect detection of the measurement period due to noise.
- This instrument's computation method is the sync source period average method (see page 4-48). If the sync source is not set appropriately, the measured values may be unstable, and accurate values may not be obtained. Set the sync source by referring to appendix 4.

Common zero-crossing unit/source (Multi-Unit Synchronization Common Zero Cross Setting)

During multi-unit synchronization (option /SY1), you can select a common zero-crossing that can be shared among units as the sync source. For the common zero-crossing, specify the unit and source.

The common zero-crossing (CommZC) setting is for the main unit itself.

- **Common zero-crossing unit**
Options: Main, Sub 1, Sub 2, Sub 3, Sub 4
- **Common zero-crossing source**
Options: U1, I1, U2, I2, U3, I3, U4, I4, Ext Clk, ZPhase 1, ZPhase 3
- **Sync source setting (Sync Source)**
CommZC is added to the options for the sync source setting.
Options: U1, I1, U2, I2, U3, I3, U4, I4, Ext Clk, ZPhase 1, ZPhase 3, CommZC, None

Cross level (Level)

Voltage cross level/current cross level (Voltage Level/Current Level)

The voltage and current cross levels can be set when the rectifier function (Rectifier) is ON.

- When the rectifier function is OFF: -100.0 % to 100.0 %, in 0.1 % steps
- When the rectifier function is ON: 0.0 % to 100.0 %, in 0.1 % steps

See page 4-36.

Setting all input elements at once

When you select a cell in the top row of the table, you can set the corresponding item for all input elements at once.

4.9 Setting the Crest Factor

Procedure

Setup menu icon  > **Input (Advanced/Options)** > **Range** > set Crest Factor to **CF3/CF6/CF6A**



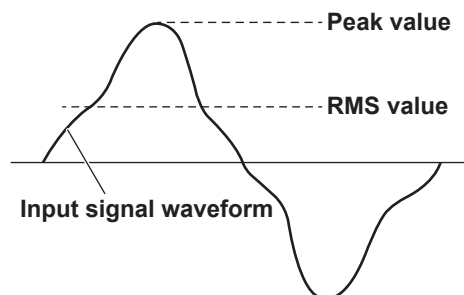
Note

- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Input (Advanced/Options)** with the arrow keys and press **SET** to display the input settings (advanced/options) overview screen.

Crest factor (Crest Factor)

The crest factor is defined as the ratio of the waveform peak value to the RMS value.

$$\text{Crest factor (CF)} = \frac{\text{peak value}}{\text{RMS value}}$$



4.9 Setting the Crest Factor

This instrument's crest factor indicates the maximum peak value that can be input as a multiple of the measurement range.

$$\text{Crest factor (CF)} = \frac{\text{maximum input peak value}}{\text{measurement range}}$$

Set the crest factor to CF3, CF6, or CF6A.

- CF3: Crest factor 3
- CF6: Crest factor 6
- CF6A: Compared with crest factor "6," the allowable input range relative to the measurement range is expanded as shown below. This suppresses frequent range changes while distorted waveforms are being measured in auto range mode.
 - Condition for increasing the range in auto range mode
The RMS value of the voltage or current exceeds 220 % of the measurement range.
 - Condition under which the overload display ("--OL--") appears
For details, see section 1.3 of the Getting Started Guide (IM WT1501-02EN).
The measured voltage or current exceeds 280 % of the measurement range.

The measurable crest factor is as follows:

$$\text{Crest factor (CF)} = \frac{\{\text{measurement range} \times \text{CF setting (3 or 6)}\}}{\text{measured value (RMS value)}}$$

- * The peak value of the input signal must not exceed the maximum allowable input.

If the crest factor of the input signal is greater than this instrument's specification (the specified crest factor at rated input), you can measure the signal by setting a larger measurement range.

Example Even when the CF3 setting is selected, signals with a crest factor of 5 or greater can be measured when the measured value (RMS value) is 60 % or less of the measurement range. In addition, when the CF3 setting is selected and the input is at the minimum valid input (1% of the measurement range), a signal with CF = 300 can be measured.

The voltage range, current range, effective input range, and measurement accuracy vary depending on the crest factor setting. For details, see chapter 5 of the Getting Started Guide (IM WT1501-02EN).

Note

- When you change the crest factor, the following settings for all elements are changed:
 - The voltage range and current range are changed to their maximum ranges.
 - All measurement ranges in the valid measurement range settings are enabled (checked).
 - Setting the crest factor to CF6 or CF6A satisfies the measurement conditions for a crest factor of 5 or greater required by IEC 62018 and other standards.
 - When measuring a waveform with a crest factor of 3 or less, setting the crest factor to CF3 enables more accurate measurement.
-

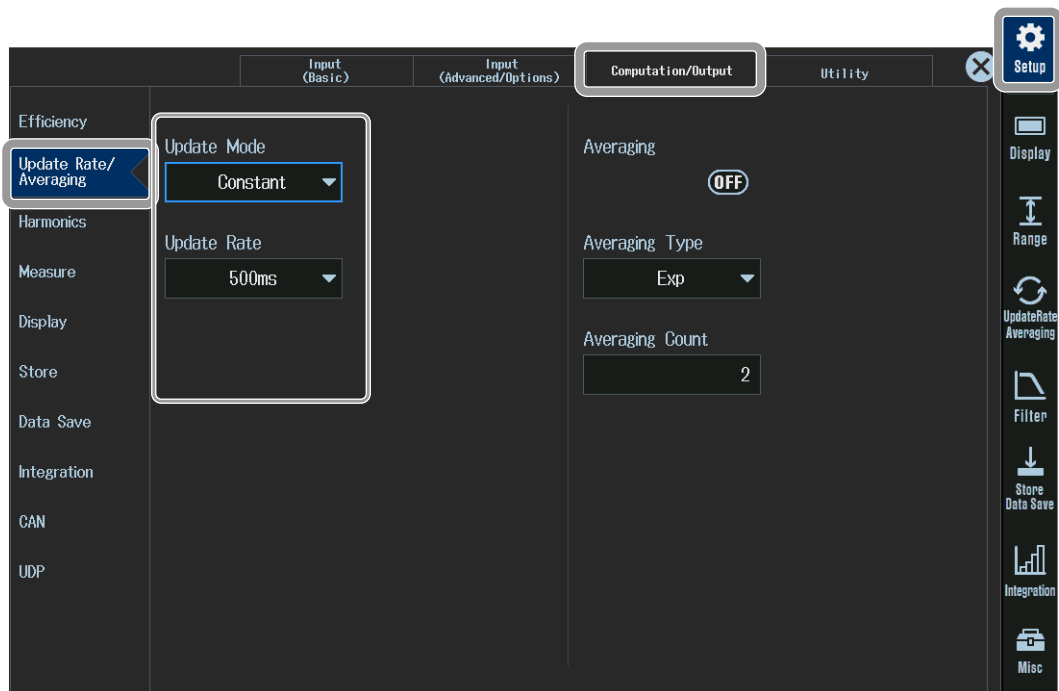
4.10 Setting the Data Update Interval

The data update interval is the interval at which sampling data used to determine measurement function values is acquired.

Procedure

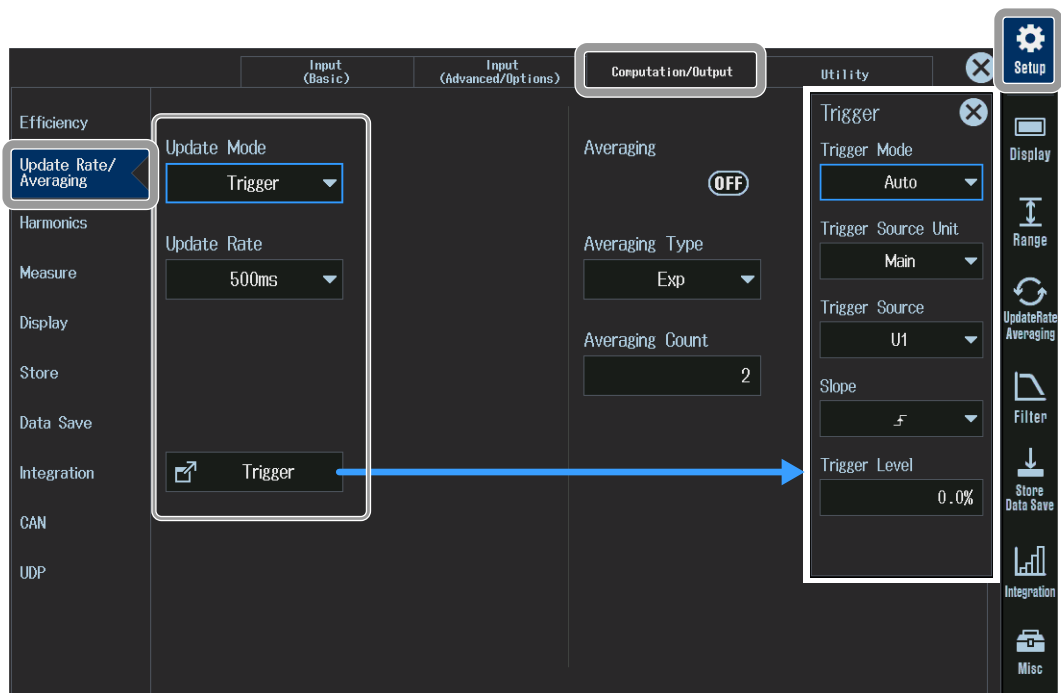
Setup menu icon  > **Computation/Output** > **Update Rate/Averaging** > set Update Mode to **Constant/Trigger/Auto**

- When the update mode is set to Constant



4.10 Setting the Data Update Interval

- When the update mode is set to Trigger



- When the update mode is set to Auto



* Only Exp is available as the averaging type when the update mode is Auto.

Note

- You can also use the **Update Rate/Averaging** menu icon  shown on the right side of the screen to set the data update interval.
- For details on the Update Rate/Averaging menu, see page x.
- When the trigger source is set to Ext Clk, the trigger slope cannot be set (↴ fixed to falling).
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Update mode (Update Mode)

Select what initiates data updating from the following:

Constant interval (Constant)

At each selected interval, numeric data is updated once, stored, transmitted through a communication interface, and output as CAN data.

To capture relatively fast load fluctuations in a power system, select a fast data update rate. To capture low-frequency signals, select a slow data update rate.

Trigger (Trigger)

Numeric data is updated once in accordance with the trigger operation for waveform display. The measurement mode display at the upper right of the screen shows Normal Mode (Trg).

When the update mode is Trigger, measurement is performed for the time interval specified by Update Rate after a trigger is detected. After that, the following amount of time is required for the instrument to perform computation on the measured data, perform display processing and other processing, and become ready for the next trigger:

- 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

Therefore, storage, communication output, and CAN data output operate in sync with that trigger. When the update mode is Constant or Auto, storage, communication output, and CAN data output are synchronized with the data update interval.

Note

- If the trigger level is not set properly, the waveform display start position (the signal level at the left edge of the screen) may become unstable, or the waveform may not be displayed.
- Even when the update mode is set to Trigger, the update mode becomes Constant during integration.
- For a wiring system with the delta transformation function, the update mode cannot be set to Trigger.

Auto (Auto)

Each time one cycle* of the input waveform specified as the sync source is detected, measurement data is updated, output as CAN data, and transmitted through a communication interface.

- * 10 ms or more, or 50 ms or more, can be selected.

Select Auto when the input signal period varies greatly.

Data update interval (Update Rate)

Set the data update interval when the update mode is set to Constant or Trigger.

Select from the following:

10ms, 50ms, 100ms, 200ms, 500ms, 1s, 2s, 5s, 10s, 20s

- When the update mode is set to Auto, the data update interval automatically switches to 10 ms or 50 ms.

Display update interval

Data update interval	Display update interval
1 s or less	1 s
1 s or more	Same as the data update interval

Note

When the data update interval is 10 ms, waveform display, acquisition of waveform display data through communication, and saving of waveform data are not available.

Computation method

Sync source period average

Measured values are calculated by processing the sampling data within the data update interval using the sync source period average method. (This excludes integrated power WP and integrated current q in DC mode.)

This method requires accurate detection of the period of the specified sync source signal. Check whether the frequency of the sync source signal is measured correctly by using the procedures in sections 5.1 and 5.6.

For details on the sync source, see page 4-42.

The computation method setting is displayed as SP at the top of the screen.

Trigger (Trigger)

Configure the trigger when the update mode is set to Trigger.

A trigger initiates waveform display. “Triggering” occurs when the trigger condition is met and the waveform is ready to be displayed.

Trigger mode (Trigger Mode)

Set the condition for updating the display. Select from the following:

- **Auto (Auto)**
If the trigger condition is met within the timeout period of approximately 100 ms, the displayed waveform is updated each time a trigger occurs. If the trigger condition is not met even after the timeout period elapses, the displayed waveform is updated automatically. If the period of the trigger signal is 100 ms or longer, the two conditions above are met alternately, and the display is updated. In this case, set the trigger mode to Normal.
- **Normal (Normal)**
The waveform display is updated only when the trigger condition is met. If no triggers occur, the display is not updated. To view the waveform when no triggers occur or to check the ground level, set the trigger mode to Auto.

Trigger source unit (Trigger Source Unit)

During multi-unit synchronization (option /SY1), specify the unit to use as the trigger source from the following options. The instrument detects triggers according to the trigger source unit and input channel settings.

Main, Sub 1, Sub 2, Sub 3, Sub 4

Trigger source (Trigger Source)

The signal used as the trigger condition is called the trigger source. Select from the following: The available options vary depending on the installed elements.

U1, I1, U2, I2, U3, I3, U4, I4, Ext Clk (external clock)*

* When Ext Clk is selected, the external signal applied to the external clock input terminal (EXT CLK) on the rear panel is used as the trigger source. For the specifications of the EXT CLK terminal, see section 2.15 of the Getting Started Guide (IM WT1501-02EN). When Ext Clk is selected as the trigger source, the trigger slope and trigger level settings are as follows:

- Trigger slope: Falling The trigger slope setting is disabled.
- Trigger level: 0.0 % The trigger level setting is disabled.

Trigger slope (Slope)

The movement of a signal from a low level to a high level (rising) or from a high level to a low level (falling) is called a slope. When this slope is used as one of the trigger condition settings, it is called the trigger slope.

For the trigger slope, select one of the following options to specify how the trigger source passes through the trigger level to trigger the instrument:

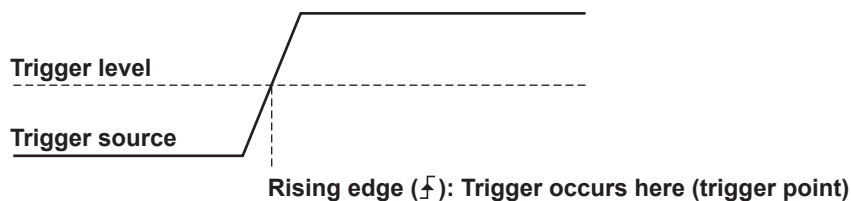
- $\nearrow$: Rising (when the trigger source changes from at or below the trigger level to at or above it)
- $\searrow$: Falling (when the trigger source changes from at or above the trigger level to at or below it)
- $\nearrow \searrow$: Either rising or falling

Trigger level (Trigger Level)

The trigger level is the threshold that the trigger source signal crosses to trigger.

A trigger occurs when the trigger source signal crosses the specified trigger level in the rising or falling direction.

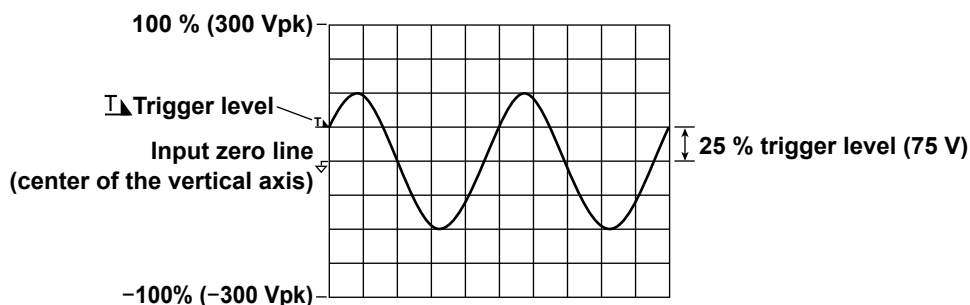
- You can set the trigger level in the range of 0.0 to ± 100.0 %.
- A value of 100 % corresponds to half the full vertical span of the waveform display. With the vertical center of the screen as the input zero line, 100 % corresponds to the top of the waveform display and -100 % to the bottom. When the crest factor setting is CF3, the upper and lower limits of the waveform display correspond to three times the voltage or current measurement range of each element (or the scaled range when scaling is applied). Similarly, when the crest factor setting is CF6 or CF6A, the limits correspond to six times the measurement range.
- When Ext Clk is set as the trigger source, the trigger level setting is disabled.



4.10 Setting the Data Update Interval

Example:

- Measurement range: 100 Vrms when the crest factor setting is CF3
50 Vrms when the crest factor setting is CF6 or CF6A
- Trigger level: 25 %



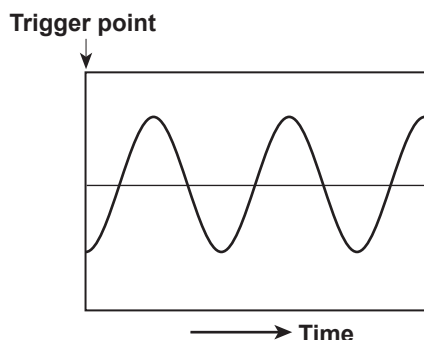
Note

If the trigger level is not set properly, the waveform display start position (the signal level at the left edge of the screen) may become unstable, or the waveform may not be displayed.

Trigger point

The trigger point is the point at which a trigger occurs. The trigger point is always displayed at the left edge of the screen.

After a trigger occurs, the waveform is displayed from left to right on the screen as time elapses. (The arrow below “Trigger point” in the figure below is for illustration only. It does not appear on the actual display.)



Note

To prevent malfunctions due to noise, the trigger function has a hysteresis of approximately 1 % when the crest factor setting is CF3. For example, if the trigger slope is set to $\downarrow$, a trigger occurs when the input signal level falls approximately 1 % below the trigger level and then passes through the trigger level on a rising slope. The trigger function has a hysteresis of approximately 2 % when the crest factor setting is CF6 or CF6A.

Data update interval for auto update mode (Update Rate for Auto Update Mode)

When the update mode is set to Auto, select 10 ms or 50 ms for the data update interval.

The data update interval setting is displayed at the top of the screen.

Display update interval

The display update interval is 1 s.

Timeout period (Time Out) when the update mode is Auto

This is the time limit for detecting the period of the input waveform.

Select 1 s, 5 s, 10 s, or 20 s.

If the input signal frequency is low and one cycle of the sync source cannot be detected within the timeout period, the frequency data is outside the measurement range, and an error (Error) occurs. Normal measurement functions determine measured values by using the entire interval up to the timeout as the measurement period.

Note

- The display update interval for numeric data and waveform data shown on the screen may be longer than the data update interval.
- The lower frequency limit for measurable AC signals differs depending on the data update interval. Measured values may become unstable when an AC signal with a frequency lower than the lower measurement frequency limit is measured (see section 5.1 of the Getting Started Guide (IM WT1501-02EN)).
- When the update mode is Auto, WS and WQ are not measured and are displayed as [-----] (no data).

Auto update mode's frequency update timing cannot be set under any of the following conditions:

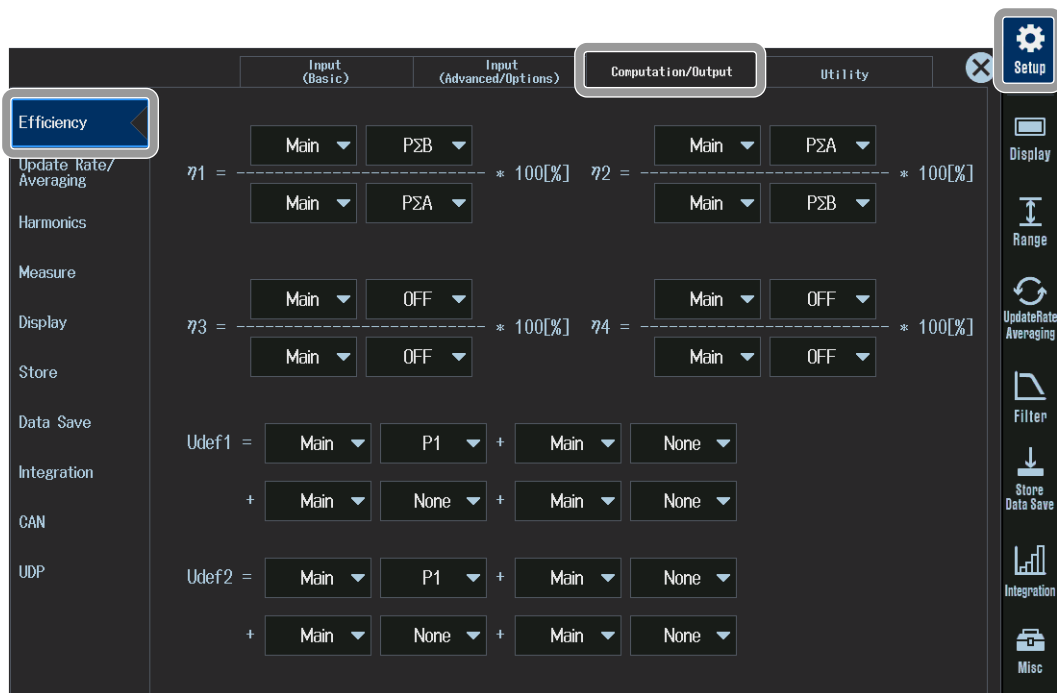
- When the integration status is not Reset
- When the storage status is not one of the following:
 - Reset
 - Complete

4.11 Setting Efficiency Formulas

You can create efficiency formulas by combining measurement function symbols and use their numeric data to determine the energy conversion efficiency of equipment.

Procedure

Setup menu icon  > **Computation/Output** > **Efficiency**



Note

- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

$\eta 1$ to $\eta 4$

Specify the measurement function unit and the active power and motor output measurement functions for the denominator and numerator of the efficiency formula.

You can create four efficiency formulas ($\eta 1$ to $\eta 4$), using the following measurement functions as operands:

- Measurement function unit (Main, Sub1 to Sub4)
During multi-unit synchronization (option /SY1), you can configure each subunit from the main unit.
- Active power of each element (P1 to P4)
Available within the range of the installed input elements.
- Active power of Σ functions (P Σ A, P Σ B)
Available within the range of the wiring unit determined automatically from the installed input elements.
- Motor output (Pm1 to Pm4)
Available on models with the motor evaluation function (option /EM1, /RM1, /EM2, /RM2, /EM1RM1).
- Udef1, Udef2

Udef1, Udef2

Define Udef1 and Udef2 when you want to add together active power values or motor output values and use the result as an operand for $\eta 1$ to $\eta 4$. Using the measurement functions above, you can set up to four addition operands in one formula.

Formula setting examples

Efficiency of a device with single-phase two-wire input and single-phase two-wire output

Input: Power of element 1 (P1)

Output: power of element 2 (P2)

-> Efficiency formula: $P2/P1 \times 100$ [%]



Efficiency of a device with single-phase two-wire input and three-phase three-wire output

Input: Power of element 1 (P1)

Output: Σ power of elements 2 and 3 (P Σ A)

-> Efficiency formula: $P\Sigma A/P1 \times 100$ [%]

Efficiency of a device with three-phase three-wire input and three-phase three-wire output

Input: Σ power of elements 1 and 2 (P Σ A)

Output: Σ power of elements 3 and 4 (P Σ B)

-> Efficiency formula: $P\Sigma B/P\Sigma A \times 100$ [%]

Efficiency of motor 1 with single-phase two-wire input

Input: Power of element 1 (P1)

Output: output of motor 1 (Pm1)

-> Efficiency formula: $Pm1/P1 \times 100$ [%]

4.11 Setting Efficiency Formulas

Efficiency of motor 1 with three-phase three-wire input

Input: Σ power of elements 1 and 2 ($P_{\Sigma A}$)

Output: output of motor 1 (P_{m1})

-> Efficiency formula: $P_{m1}/P_{\Sigma A} \times 100$ [%]

Note

To correctly compute efficiency, set the power coefficients for all elements so that the units of all power values used in efficiency computation are the same. For example, efficiency between elements or between wiring units that use different power units, such as watts (W) and joules (J), is not computed correctly.

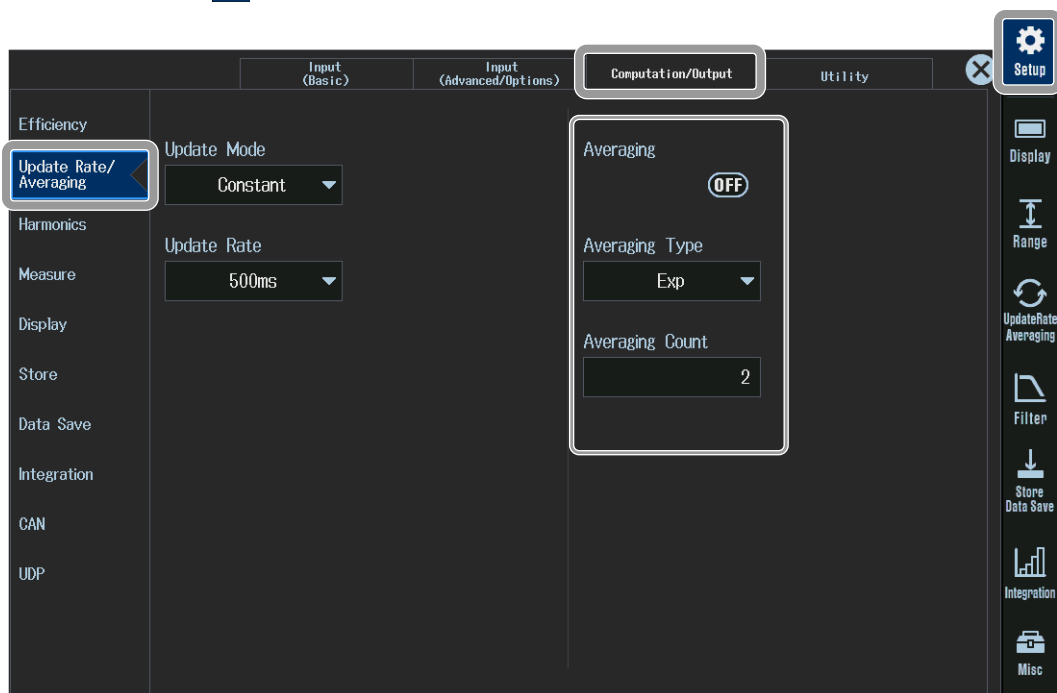
4.12 Setting Averaging

This function applies exponential averaging or moving average processing to numeric data. Averaging is useful when the numeric display fluctuates and is difficult to read due to large fluctuations in the power supply or load, or due to a low input signal frequency.

Depending on the measurement mode or the method used to compute measured values (computation method), the settings may differ from those described in this section, may be invalid, or may not be configurable.

Procedure

Setup menu icon  > **Computation/Output** > **Update Rate/Averaging**



Note

- You can also use the **Update Rate/Averaging** menu icon  shown on the right side of the screen to set averaging.
For details on the Update Rate/Averaging menu, see page x.
- When the trigger source is set to Ext Clk, the trigger slope cannot be set (↴ fixed to falling).
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Averaging ON/OFF (Averaging)

Normal measurement functions

You can select whether to perform averaging (ON) or not (OFF). When averaging is performed (ON), the AVG indicator lights at the top of the screen.

Harmonic measurement functions

- When averaging is set to ON and the averaging type is exponential averaging, averaging is applied to harmonic measurement functions.*
- Even when averaging is set to ON, averaging is not applied to harmonic measurement functions if the averaging type is moving average.*

* In addition to harmonic measurement functions, this averaging process is also applied to U_{fnd}, I_{fnd}, P_{fnd}, S_{fnd}, Q_{fnd}, λ_{fnd}, and Φ_{fnd}.

Averaging type (Averaging Type)

Select exponential averaging (Exp) or moving average (Lin).

Exponential averaging (Exp)

Numeric data is exponentially averaged using the specified decay constant according to the following formula:

$$D_n = D_{n-1} + \frac{(M_n - D_{n-1})}{K}$$

D_n: nth exponentially averaged displayed value (the first displayed value, D₁, is M₁)

D_{n-1}: (n – 1)th exponentially averaged displayed value

M_n: numeric data value at n

K: Decay constant (select from 2 to 64)

Moving average (Lin)

Numeric data is averaged using simple averaging according to the following formula with the specified averaging count:

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

D_n: Displayed value obtained as the simple average of m numeric data values from the n – (m – 1)th to the nth

M_{n-(m-1)}: numeric data value at n – (m – 1)

.....
.....

M_{n-2}: numeric data value at n – 2

M_{n-1}: numeric data value at n – 1

M_n: numeric data value at n

m: Averaging count (select from 8 to 64)

Note

Only Exp is available as the averaging type when the update mode is Auto.

Decay constant or averaging count (Averaging Count)

- When the averaging type is exponential averaging, set the decay constant in the following range:
2 to 64
- When the averaging type is moving average, set the averaging count in the following range:
8 to 64

Measurement functions to which averaging is applied

The measurement functions to which averaging is directly applied are as follows: Other measurement functions are also affected by averaging if they are computed using data from the following measurement functions: For details on how each measurement function is derived, see appendix 1.

Normal measurement functions

- Urms, Umn, Udc, Urmn, Uac, Irms, Imn, Idc, Irmn, Iac, P, S, Q, Ufnd, Ifnd, Pfnd, Sfnd, Qfnd, fU, fI
- Torque, Speed, Pm, Aux
(Models with the motor evaluation function option /EM1, /RM1, /EM2, /RM2, or /EM1RM1)
- λ , Φ , λ fnd, Φ fnd, CfU, CfI, Pc, q, q+, q-, and η 1 to η 4 are computed from averaged Urms, Irms, P, S, and Q.
- SyncSp is computed from averaged fU and fI
(Models with the motor evaluation function option /EM1, /RM1, /EM2, /RM2, or /EM1RM1)
- Slip is computed from averaged Speed
(Models with the motor evaluation function option /EM1, /RM1, /EM2, /RM2, or /EM1RM1)

Harmonic measurement functions

- U(k), I(k), P(k), S(k), Q(k)
- λ (k) and Φ (k) are computed from averaged P(k) and Q(k).
- Z, Rs, Xs, Rp, Xp, Uhdf, Ihdf, Phdf, Uthd, Ithd, Pthd, Uthf, Ithf, Utif, Itif, hvf, hcf, and K-factor are computed from averaged U(k), I(k), and P(k).
k: Harmonic order

Measurement functions to which averaging is not applied

The measurement functions to which averaging is not applied are as follows:

Normal measurement functions

U+pk, U-pk, I+pk, I-pk, P+pk, P-pk, ITime, WP, WP+, WP-, WP Σ , WP+ Σ , WP- Σ , WS, WQ

Harmonic measurement functions

$\Phi U(k)$, $\Phi I(k)$, ΦU_i-U_j , ΦU_i-U_k , ΦU_i-I_i , ΦU_j-I_j , ΦU_k-I_k , fPLL1, fPLL2, EaU, EaI

k: Harmonic order

Measurement functions common to normal measurement and harmonic measurement

F1 to F20, Event1 to Event8

Note

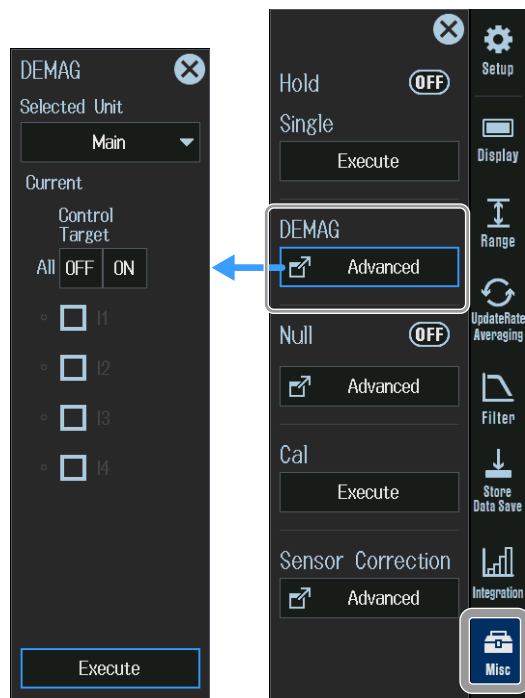
- When averaging is set to ON, the average value of multiple measurements is computed and displayed. As a result, if the input signal changes sharply, the measured values respond to the change more slowly.
 - For both the decay constant for exponential averaging and the averaging count for moving average processing, larger values make the measured values more stable (the response to input changes becomes slower).
 - When the update mode is Auto, averaging is performed at each data update interval.
-

4.13 Demagnetization (DEMAG) Function

When starting this instrument, run DEMAG (demagnetization) before executing the Null function.

Procedure

Misc menu icon  > DEMAG > **Advanced**



Note

For details on the Misc menu, see page xv.

Unit to configure (Selected Unit)

During multi-unit synchronization (option /SY1), you can set demagnetization for subunits from the main unit.

Specify the unit to configure from the following, and then configure the settings below:

Main, Sub 1, Sub 2, Sub 3, Sub 4

Items for setting DEMAG status (Control Target)

You can select the DEMAG status for each input signal to which the DEMAG function applies.

Current (Current)

The check boxes are enabled only for elements for which a split-core series sensor model is detected.

- All (All): Select ON or OFF to set the DEMAG status for the current signals of all elements at once.
- I1 to I4: Set the DEMAG status for the current signal of the specified element.

4.14 Setting, Executing, and Clearing Null

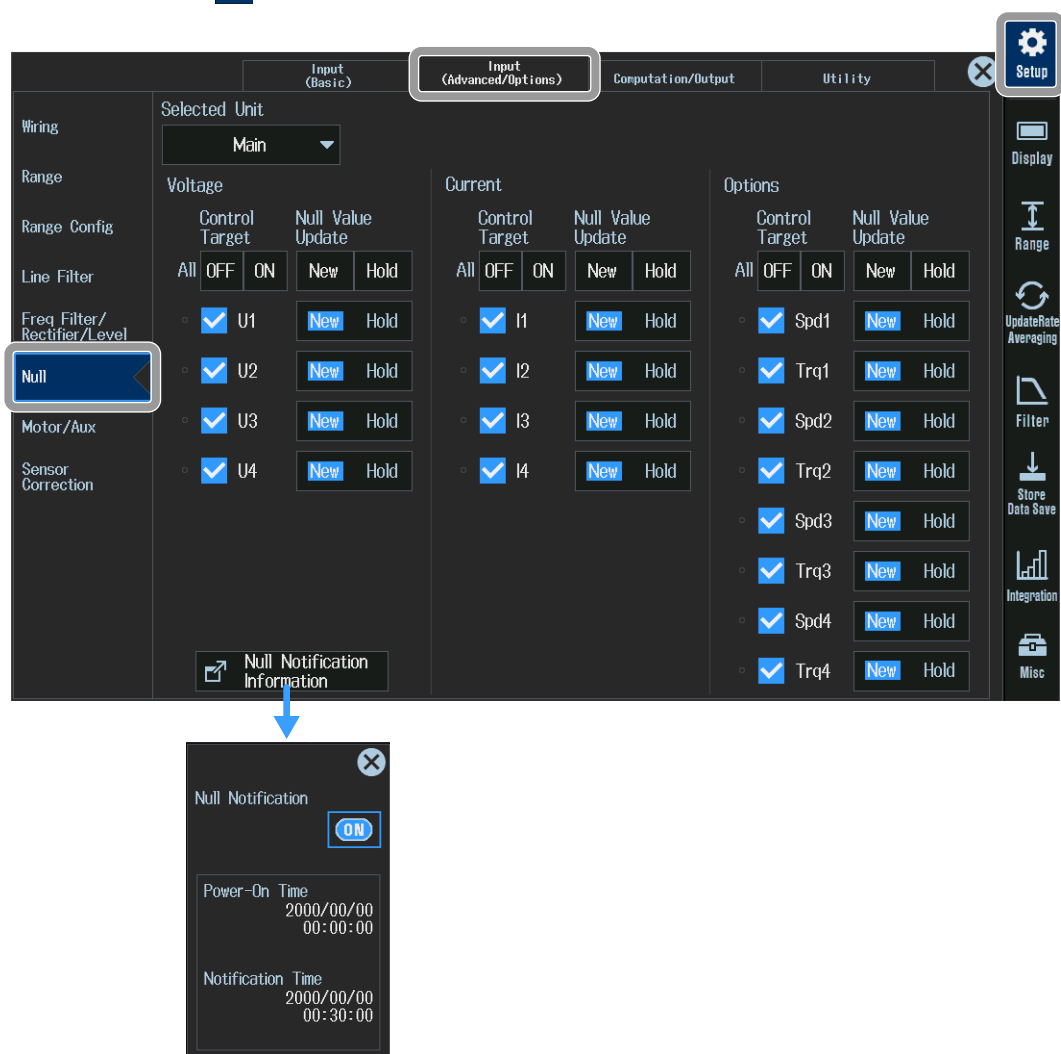
You can use the null function to remove the DC offset with measurement cables or external sensors connected.

Execute or clear the Null function from the **Misc** menu shown on the next page.

Procedure

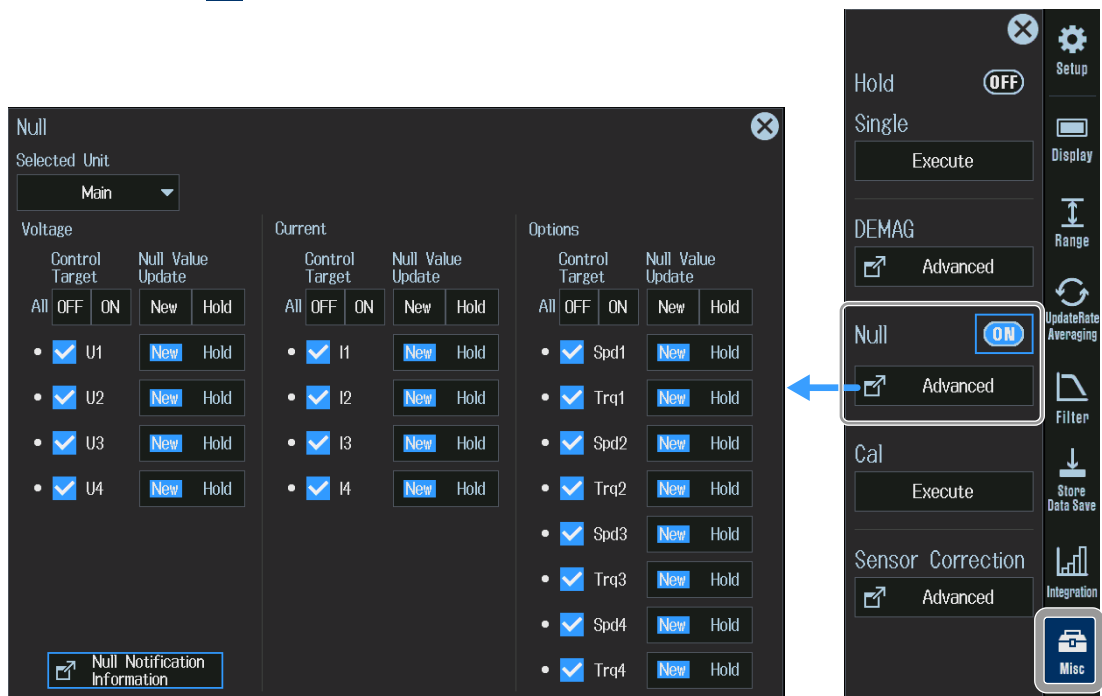
- Setting the Null function

Setup menu icon  > Input (Advanced/Options) > Null



- Executing and clearing the Null function

Misc menu icon  > Null **ON/OFF**



Note

- If you select the **Misc** menu icon  > Null > **Advanced**, you can configure the same settings as in the screen operation described earlier.
For details on the Misc menu, see page xv.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Input (Advanced/Options)** with the arrow keys and press **SET** to display the input settings (advanced/options) overview screen.
- If the motor setting is single motor (rotation signal: resolver), you cannot turn on the Null function for Speed.

Unit to configure (Selected Unit)

During multi-unit synchronization (option /SY1), you can set the subunit Null status from the main unit.

Specify the unit to configure from the following, and then configure the settings below:

Main, Sub 1, Sub 2, Sub 3, Sub 4

Items for setting Null status (Control Target)

You can select the Null status for each input signal to which the Null function applies.

Voltage (Voltage)

- All (All): Set the Null status for the voltage signals of all elements at once.
- U1 to U4: Set the Null status for the voltage signal of the specified element.

Current (Current)

- All (All): Set the Null status for the current signals of all elements at once.
- I1 to I4: Set the Null status for the current signal of the specified element.

Motor/Aux (Options)

- All (All): Set the Null status for Speed, Torque, and Aux at once.
- Speed1 to Speed4, Torque1 to Torque4, Aux1 to Aux8:
Set the Null status for the specified Speed, Torque, or Aux input.

Null value update (Null Value Update)

Select how to update the Null value for each input signal.

New

When the Null function is set to ON, Null is executed and the Null value is set or updated. After that, this Null value is used to compute the measurement function values.

Hold (Hold)

Operation varies depending on whether the Null value has been set.

- **When the Null value has not been set**

When the Null function is set to ON, Null is executed and the Null value is set. After that, this Null value is used to compute the measurement function values. Even if the Null function is set to OFF in this state, the set Null value remains stored in the instrument.

- **When the Null value has already been set**

The Null value is not updated even when the Null function is set to ON. The previously stored Null value is used to compute the measurement function values.

Example If the Null function is set to ON after power-on, the measured value is set as the Null value. Even if the Null function is set to OFF, the Null value remains stored in the instrument and is not updated even when the Null function is set to ON again. The held Null value is used to compute the measurement function values.

The held Null value is cleared in the following cases:

- Operations that clear the Null values for all inputs
 - Turning on the power (Null values are not backed up when the power is turned off)
 - Initializing settings
 - Loading a setup parameter file
- Operations that clear the Null value for the input whose settings were changed
 - Changing the sensor model
 - Switching the sensor output type for current input
 - Changing the input signal type (Sense Type) for Speed or Torque of motor evaluation

Null value

When the Null function is set to ON, the following measurement data is set as the Null value:

- Udc, Idc (numeric data for Simple voltage average/Simple current average)
- Speed,* Torque, Aux (models with the motor evaluation function option)
 - * If the motor setting is single motor (rotation signal: resolver), Speed is not affected by the Null value.

Measurement functions affected by the Null function

All measurement functions are affected by the Null value.

Note

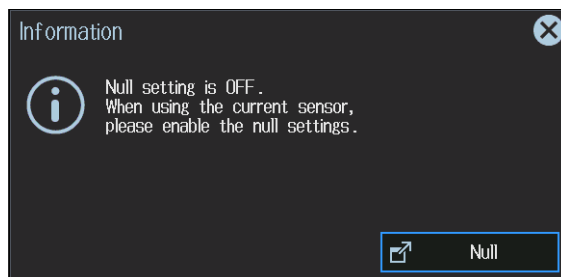
- If there is no measurement data for Udc, Idc, Speed, Torque, or Aux, the Null value is zero.
Example If the Null function is set to ON after power-on without any measurements being performed, the Null value is zero.
- For measurement functions computed from the voltage or current of an element, the Null value is subtracted from the voltage or current sampling data.
- For a wiring system with the delta transformation function, the DC value of the data before delta transformation is set as the Null value, and the Null value is subtracted from the data before delta transformation.

Null notification information (Null Notification Information)

Null notification (Null Notification)

Select whether to display a notification prompting you to enable the Null settings when the Null function is OFF after warm-up (30 minutes after power-on).

- ON: Displays the notification. If you are using a current sensor, current probe, CT, or similar device and want to avoid forgetting to use the Null function, we recommend setting this to ON.



- OFF: Does not display the notification.

Power-on time (Power-On Time)

The time when this instrument was turned on is displayed.

Notification time (Notification Time)

The time when the Null notification will appear (30 minutes after power-on) is displayed.

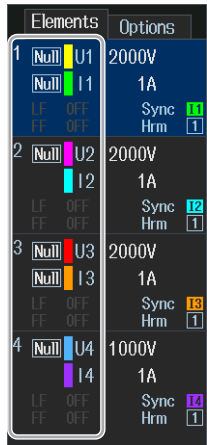
Executing and clearing the Null function (Null function ON/OFF)

ON

Executes the Null function.

For each input signal set to ON under Items for setting Null status (Control Target), the corresponding Null value is used.

- A Null indicator  lights up to the left of each element, motor, or Aux input that is set to ON under Items for setting Null status (Control Target).



- On the Null function setup screen, “●” is displayed to the left of each input signal for which the Null function is being executed.

OFF

The Null indicator goes off, and the Null function is cleared.

Note

- For accurate measurements, we recommend performing zero-level compensation before executing Null.
- The Null function is cleared in the following cases:
 - Turning on the power
 - Initializing settings
 - Loading a setup parameter file
 - Switching the sensor output type for current input
 - Changing the sensor model
 - Changing the input signal type (Sense Type) for Speed or Torque of motor evaluation
- If you execute or clear the Null function during Hold, the Null indicator lights up or goes off, but this is not reflected in the held data.
- The DC value when the Null function is ON is held as the Null value.
A correction that combines the current DC offset correction value (see page 4-24) and the Null value is applied to measured values.
Correction range: The following upper limits apply depending on the crest factor setting.

Crest factor	Correction range
CF3	Within ± 10 % of the range
CF6 or CF6A	Within ± 20 % of the range

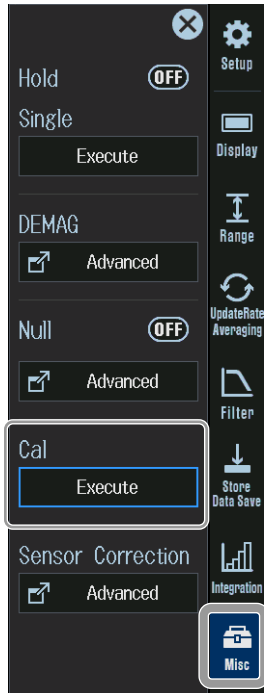
- If the range is changed, the Null value is limited to the Null upper limit for the new range. When the autoranging function ranges down, the Null value is limited in the same way.

4.15 Zero-Level Compensation (Cal)

This function creates a zero-input-signal condition in the instrument's internal circuits and uses the level at that time as the zero level so that the instrument can meet its specifications.

Procedure

Misc menu icon  > Cal > **Execute**



Zero-level compensation (Cal Execute, CAL)

- When you select **Execute**, zero-level compensation is performed.
- Zero-level compensation is performed automatically after the measurement range or input filter is changed.

Note

- For accurate measurements, we recommend warming up the instrument for at least 30 minutes and then performing zero-level compensation before taking measurements. The ambient temperature must also be stable within the specified range.
For the specifications, see chapter 5 of the Getting Started Guide (IM WT1501-02EN).
- If the measurement range or input filter has not been changed for a long time, the zero level may have changed because of changes in the environment around the instrument. In such cases, perform zero-level compensation.
- The integration auto calibration function automatically performs zero-level compensation during integration.
See page 7-12.
- For a wiring system with the delta transformation function, zero-level compensation is performed on the data before delta transformation.

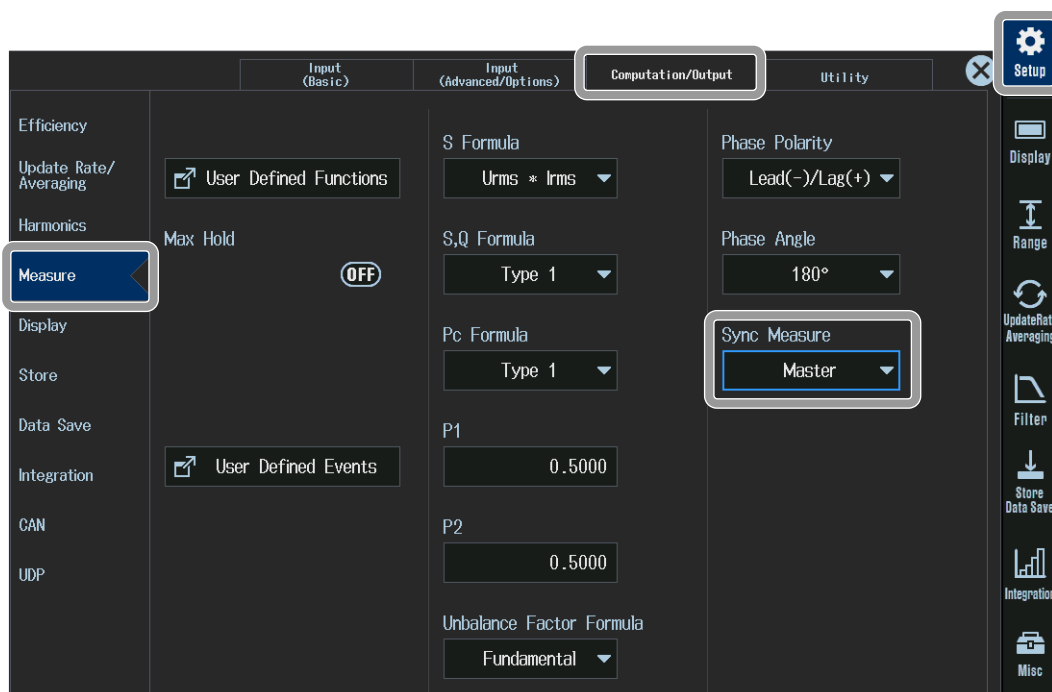
4.16 Master/Slave Synchronous Measurement

Connect the external start signal I/O terminals (MEAS. START) of the instruments set as the master and the slave using a BNC cable (sold separately). The instrument set as the master outputs a measurement start signal, and the instrument set as the slave receives this signal from the master, enabling synchronous measurement between two instruments.

For the specifications of the external start signal I/O terminal, see section 2.16 of the Getting Started Guide (IM WT1501-02EN).

Procedure

Setup menu icon  > **Input (Advanced/Options)** > **Measure** > set Sync Measure to **Master/Slave**



Note

- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Input (Advanced/Options)** with the arrow keys and press **SET** to display the input settings (advanced/options) overview screen.

Master/slave synchronous measurement (Sync Measure)

- Master: Sets the instrument as the master.
- Slave: Sets the instrument as the slave.

Note

Synchronous measurement is not possible when the master and slave have any of the following settings:

- The data update interval differs between the master and slave.
- The update mode differs between the master and slave.
- The instrument is in real-time integration mode or real-time storage mode.

For hold operations during synchronous measurement, perform the operations in the following order:

- Hold ON: First set Hold to ON for the instrument set as the master.
- Hold OFF: First set Hold to OFF for the instrument set as the slave.

When using the IEEE 1588 time synchronization function

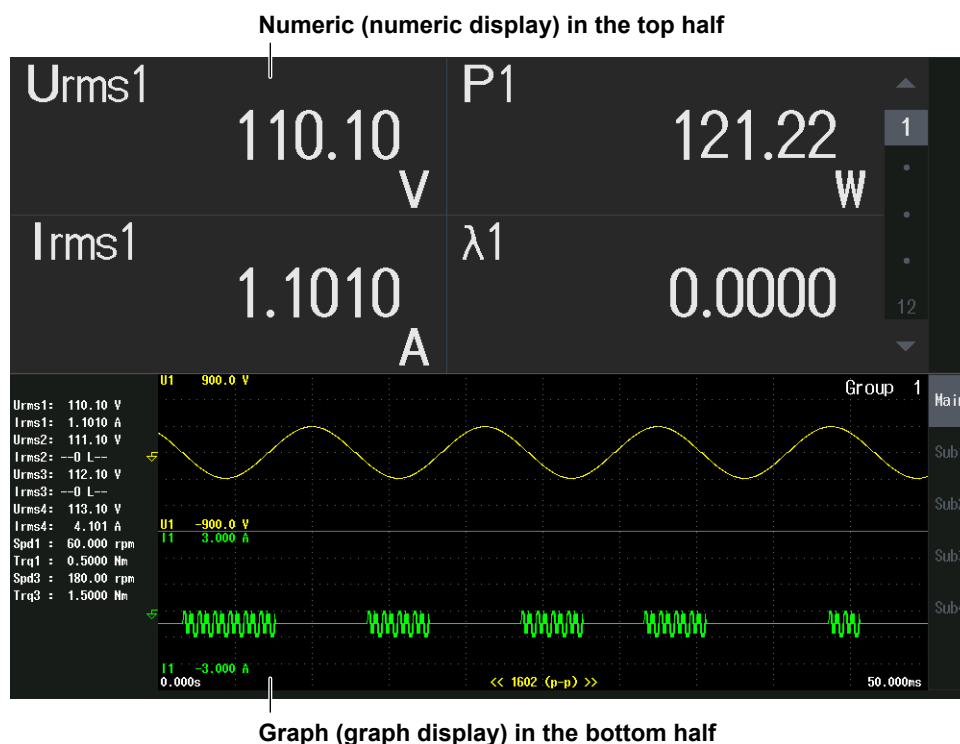
- When using the IEEE 1588 time synchronization function, see Utility > System Configuration > IEEE1588.
See section 18.2.
 - Even when using the IEEE 1588 time synchronization function, to perform synchronous measurement between two instruments, connect the two instruments with a BNC cable and perform master/slave synchronous measurement.
-

5.1 Setting Display Formats

Overview

This section describes the Numeric display format. For the Graph display format, see chapter 9.

Example of Numeric (numeric display) and Graph (graph display)



Number of displayed digits (display resolution)

The number of displayed digits (display resolution) for items such as voltage, current, active power, apparent power, and reactive power is as follows:

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

For details, see appendix 1.

When the range rating (rated value of the specified measurement range) is specified, the decimal place and unit applied to the Σ functions for items such as voltage, current, active power, apparent power, and reactive power are set to those of the element with the lowest number of displayed digits (display resolution) in the wiring unit.

For details on the display resolution during integration, see “Number of displayed digits (display resolution)” in section 7.2 (page 7-15).

Notes on numeric data display

- If no measurement function is selected or no numeric data exists, [-----] is displayed.
- If Urms, Umn, Udc, Urmn, Uac, Irms, Imn, Idc, Irmn, or Iac exceeds 140 %* of the measurement range, overload [--OL--] is displayed.
- For P, if the measured voltage or current exceeds 140 %* of the measurement range, overload display [--OL--] is displayed.
 - * 140 % of the rated voltage or current range
 - HV element voltage input, 2000 V range only: 125 %
 - WB element voltage input, 1000 V range only: 160 %
 - Current-sensor input, 1 A range only: 125 %
 - Current probe input, 5 V range only: 125 %
- If the measured or computed result cannot be displayed using the specified decimal place or unit, overflow [--OF--] is displayed.
- When rounding to zero is on, if the measured voltage or current value meets the following conditions relative to the measurement range, Urms, Umn, Urmn, Irms, Imn, Irmn, and other measurement functions based on these measurement functions are displayed as zero: λ or Φ is displayed as [Error].
 - When the crest factor is set to CF3
 - Urms, Uac, Irms, or Iac is 0.3 % or less. Umn, Urmn, Imn, or Irmn is 2 % or less.
 - When the crest factor is set to CF6 or CF6A
 - Urms, Uac, Irms, or Iac is 0.6 % or less. Umn, Urmn, Imn, or Irmn is 4 % or less.
- When the update mode is not Auto and the data update interval is shorter than the analysis window width (number of cycles of the fundamental signal) determined by the fundamental frequency, harmonic data is not measured, and [-----] (no data) is displayed. In this case, set a longer data update interval.

Example When the fundamental frequency is 10 Hz (period: 100 ms), the harmonic analysis window width is one cycle,* and the data sampling time is 100 ms.

* See section 5.9 of the Getting Started Guide (IM WT1501-02EN).

In this case, the time required for harmonic analysis is 100 ms or more, consisting of the data sampling time and the FFT computation time (several ms).

Therefore, to perform harmonic analysis on a signal with a 10 Hz fundamental frequency, set the data update interval to 200 ms or more.

If the data update interval is 100 ms or less, the processing required up to FFT cannot be completed within the update interval, and the harmonic analysis results are displayed as [--- --] (no data).

Check the fundamental frequency using the PLL frequency.

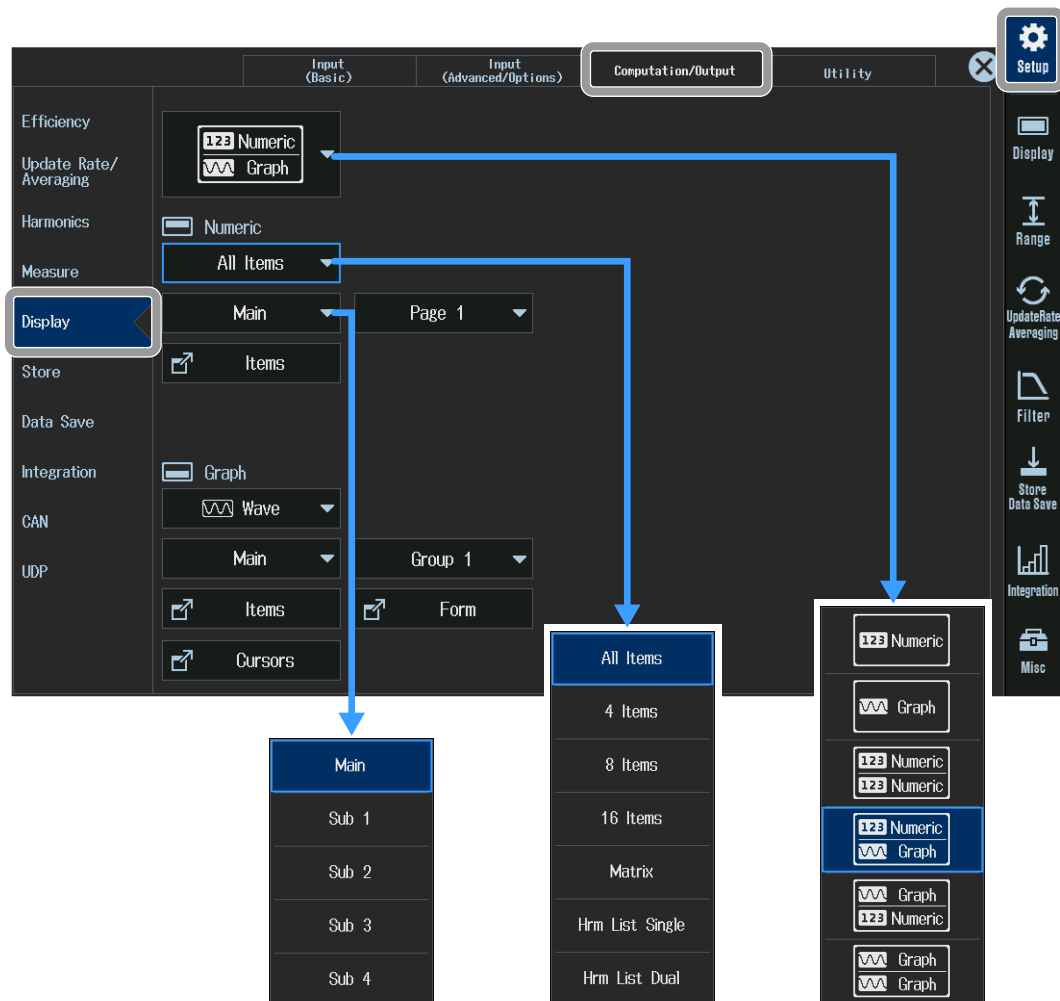
- When the update mode is Auto, WS and WQ are not measured and are displayed as [-----] (no data). Also, if the timeout period is shorter than the analysis window width (number of cycles of the fundamental signal) determined by the fundamental frequency, harmonic data is not measured, and [-----] (no data) is displayed.
- For harmonic numeric data from the 0th harmonic (DC) to the 100th harmonic, there is no overload indication [--OL--] or zero indication (rounding to zero).
- If the measured frequency is outside the measurement range, [Error] is displayed for fU, fI, fPLL1, and fPLL2.
- When λ is greater than 1 or less than -1, λ and Φ are displayed as follows:

	λ	Φ
$1 < \lambda \leq 2$	1	0.0
$-2 \leq \lambda < -1$	-1	180.0
$\lambda < -2$, or $2 < \lambda$	Error	Error

Procedure

Setup menu icon  > **Computation/Output** > **Display**

- **Setting the screen display**
 - > Numeric, Graph, Numeric/Numeric, Numeric/Graph, Graph/Numeric, Graph/Graph
- **Setting numeric display formats**
 - > Set the screen display to **Numeric** (other than Graph and Graph/Graph) > All Items/4 Items/8 Items/16 Items/Matrix/Hrm List Single/Hrm List Dual in the Numeric menu
- **Selecting the unit**
 - > Main, Sub 1, Sub 2, Sub 3, Sub 4 (option /SY1) in the Numeric menu



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to switch the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
 - See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Setting the screen display

You can switch the display format of the Numeric (numeric display) and Graph (graph display) screens. For Graph (graph display), see chapter 9.

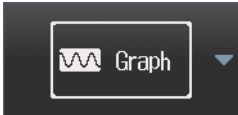
Single screen display (full screen display)

You can display the following screens:

Numeric: Numeric display



Graph: Graph display

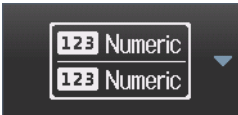


Split display

You can split the screen into top and bottom halves, and select a display to show in each half.

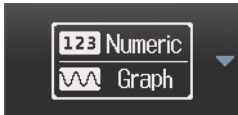
Numeric: Numeric display

Numeric: Numeric display



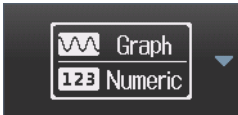
Numeric: Numeric display

Graph: Graph display



Graph: Graph display

Numeric: Numeric display



Graph: Graph display

Graph: Graph display



Setting numeric display formats

You can select the number of numeric data items displayed simultaneously from the choices below or choose to display a list of items.

All Items display (All Items)

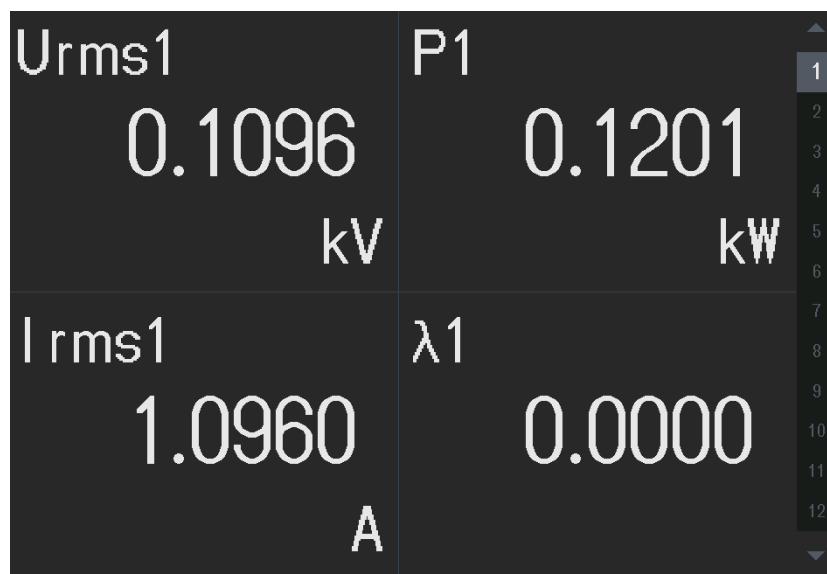
A table of numeric data is displayed with measurement functions listed vertically and symbols indicating elements and wiring units listed horizontally. You cannot change the order of the displayed items. The number of displayed items varies depending on the number of elements installed in this instrument.

Element	1	2	3	4
Voltage	1000V	1000V	1000V	2000V
Current	1A	1A	1A	A 25mA
Urms [V]	0.1021k	0.1031k	0.1041k	0.1051k
Irms [A]	1.0210	---0 L---	---0 L---	4.021
P [W]	0.1042k	---0 L---	---0 L---	0.42k
S [VA]	0.1042k	---0 F---	---0 F---	0.42k
Q [var]	0.1042k	---0 F---	---0 F---	0.42k
λ []	0.0000	---0 F---	---0 F---	0.0000
φ [°]	60.000	---0 F---	---0 F---	60.000
fU [Hz]	118.19k	118.19k	118.19k	118.20k
fI [Hz]	118.19k	118.19k	118.19k	118.20k
Urms [V]	0.1021k	0.1031k	0.1041k	0.1051k
Umn [V]	0.1031k	0.1041k	0.1051k	0.1061k
Udc [V]	0.1041k	0.1051k	0.1061k	0.1071k
Urmn [V]	0.1051k	0.1061k	0.1071k	0.1081k
Uac [V]	0.1061k	0.1071k	0.1081k	0.1091k
Ufnd [V]	-----	-----	-----	-----
U+pk [V]	0.0000k	0.0000k	0.0000k	0.0000k
U-pk [V]	0.0000k	0.0000k	0.0000k	0.0000k
CfU []	0.000	0.000	0.000	0.000
Pc [W]	0.0000k	---0 F---	---0 F---	0.00k
P+pk [W]	0.0000k	0.0000k	0.0000k	0.00k
P-pk [W]	0.0000k	0.0000k	0.0000k	0.00k

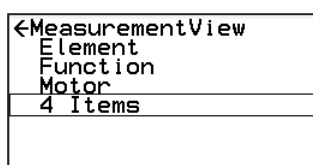
Switching the displayed page shows other items in this display area.

4 Items display (4 Items)

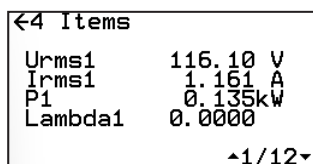
Four numeric data items are displayed in two columns.

**Note**

You can also display the 4 Items display on the WT1500 LCD using the operation keys.



Use the ▲ and ▼ arrow keys to select **Measurement View** on the Menu screen > **4 Items**, and then press **SET**.



48 items configured for 4 Items display are displayed across 12 pages.

Use the ▲ and ▼ arrow keys to switch pages.

8 Items display (8 Items)

- In single screen display (full screen display), eight numeric data items are displayed in two columns.
- When the display format is split display, eight numeric data items are displayed in four columns.

Urms1	0.1015 kV	Q1	0.1030 kvar	1
Irms1	1.0150 A	λ 1	0.0000	2
P1	0.1030 kW	ϕ 1	G0.000 °	3
S1	0.1030 kVA	fU1	137.99 kHz	4
				5
				6
				7
				8
				9
				10
				11
				12

16 Items display (16 Items)

Sixteen numeric-data items are displayed in four columns.

Urms1	Q1	fU1	I+pk1	1
0.1021 kV	0.1042 kvar	142.63 kHz	0.0000 A	2
Irms1	λ 1	fI1	I-pk1	3
1.0210 A	0.0000	142.63 kHz	0.0000 A	4
P1	ϕ 1	U+pk1	CfU1	5
0.1042 kW	G0.000 °	0.0000 kV	0.000	6
S1	Pc1	U-pk1	CfI1	7
0.1042 kVA	0.0000 kW	0.0000 kV	0.000	8
				9
				10
				11
				12

Matrix display (Matrix)

A table of numeric data is displayed with measurement functions listed vertically and symbols indicating elements and wiring units listed horizontally. You can change the order of the displayed items and the number of columns.

		Element1	Element2	Element3	Element4
Urms	[V]	0.1021 k	0.1031 k	0.1041 k	0.1051 k
Irms	[A]	1.0210	--OL--	--OL--	4.021
P	[W]	0.1042 k	--OL--	--OL--	0.42 k
S	[VA]	0.1042 k	--OF--	--OF--	0.42 k
Q	[var]	0.1042 k	--OF--	--OF--	0.42 k
λ	[]	0.0000	--OF--	--OF--	0.0000
Φ	[°]	G0.000	--OF--	--OF--	G0.000
fU	[Hz]	146.13 k	146.13 k	146.13 k	146.13 k
fI	[Hz]	146.13 k	146.13 k	146.13 k	146.13 k

Harmonics list single display (Hrm List Single)

- When the display format is single screen display, 42 harmonic data items of a single measurement function are displayed in two columns.
- When the display format is split display, 22 harmonic data items of a single measurement function are displayed in two columns.

Measurement function display area			Harmonic data display area		
			Order	U1 [V]	hdf[%]
rPLL1:U1	-----		Total		
rPLL2:U1	-----		1		
Urms1	103.00 V	1	3		
Irms1	1.030 A	2	5		
P1	0.106 kW	3	7		
S1	0.106 kVA	4	9		
Q1	0.106 kvar	5	11		
λ 1	0.0000	6	13		
Φ 1	G0.000 °	7	15		
Uthd1	-----	8	17		
Ithd1	-----	9	19		
Pthd1	-----	10	21		
Uthf1	-----	11	23		
Ithf1	-----	12	25		
Utif1	-----	13	27		
Itif1	-----	14	29		
hvf1	-----	15	31		
hcf1	-----	16	33		
Kfact1	-----	17	35		
		18	37		
		19	39		
		20			
		21			
		22			
		23			
		24			
		25			
		26			
		27			
		28			
		29			
		30			
		31			
		32			
		33			
		34			
		35			
		36			
		37			
		38			
		39			
		40			

Measurement function

Distortion factors of each harmonic

Numeric data for each harmonic

Measurement function display area

Displays data related to all harmonics.

5.1 Setting Display Formats

Harmonic data display area

Displays the harmonic data (Total, DC, and orders 1 to 100) for a single measurement function.

- When the display format is single screen display, 42 items per page (Total, DC, and 40 orders) are displayed in two columns.
- When the display format is split display, 22 items per page (Total, DC, and 20 orders) are displayed in two columns.

Distortion factors of each harmonic

When U, I, or P is selected as a measurement function, the corresponding value, Uhdf, Ihdf, or Phdf, is displayed.

Harmonics list dual display (Hrm List Dual)

- When the display format is single screen display, the harmonic data items of two measurement functions are displayed in two separate columns, each containing up to 22 items.
- When the display format is split display, the harmonic data items of two measurement functions are displayed in two separate columns, each containing up to 12 items.

Measurement function display area			Harmonic data display area Measurement function 1			Harmonic data display area Measurement function 2		
			Order	U1 [V]	hdf[%]	Order	I1 [A]	hdf[%]
fPLL1:U1	-----		Total	-----	-----	Total	-----	-----
fPLL2:U1	-----		dc	-----	-----	dc	-----	-----
Urms1	116.10 V	1	1	-----	-----	1	-----	-----
Irms1	1.161 A		2	-----	-----	2	-----	-----
P1	0.135 kW	2	3	-----	-----	3	-----	-----
S1	0.135 kVA		4	-----	-----	4	-----	-----
Q1	0.135 kvar		5	-----	-----	5	-----	-----
λ1	0.0000	3	6	-----	-----	6	-----	-----
φ1	60.000 °		7	-----	-----	7	-----	-----
			8	-----	-----	8	-----	-----
Uthd1	-----	4	9	-----	-----	9	-----	-----
Ithd1	-----		10	-----	-----	10	-----	-----
Pthd1	-----		11	-----	-----	11	-----	-----
Uthf1	-----	5	12	-----	-----	12	-----	-----
Ithf1	-----		13	-----	-----	13	-----	-----
Uthf1	-----		14	-----	-----	14	-----	-----
Ithf1	-----	6	15	-----	-----	15	-----	-----
hvf1	-----		16	-----	-----	16	-----	-----
hcf1	-----		17	-----	-----	17	-----	-----
Kfact1	-----	7	18	-----	-----	18	-----	-----
			19	-----	-----	19	-----	-----
			20	-----	-----	20	-----	-----

Measurement function Distortion factors of each harmonic
Numeric data for each harmonic

Measurement function display area

Displays data related to all harmonics.

Harmonic data display area

Displays the harmonic data (Total, DC, and orders 1 to 100) for two measurement functions.

- When the display format is single screen display, 22 items per page (Total, DC, and 20 orders) are displayed in a single column.
- When the display format is split display, 12 items per page (Total, DC, and 10 orders) are displayed in a single column.

Distortion factors of each harmonic

When U, I, or P is selected as a measurement function, the corresponding value, Uhdf, Ihdf, or Phdf, is displayed.

Switching display pages (Page Scroll)

By scrolling pages, you can switch pages and display a new set of items.

- ▼ on the screen or + in the Display menu: Displays the next page.
- ▲ on the screen or – in the Display menu: Displays the previous page.
- If you select a position between ▲ and ▼ on the screen, the page corresponding to the selected position is displayed.

All Items display

The first page is pinned to the top half of the screen. You can switch between other pages in the bottom half of the screen. When the display is split and the All Items display is shown, you can scroll through all pages sequentially starting from page 1.

4 Items, 8 Items, and 16Items displays

Pages 1 to 12 are displayed by page scrolling.

Matrix display

Pages 1 to 9 are displayed by page scrolling.

Harmonics list single or dual display

You can switch the measurement function display pages (on the left side of the screen) and the harmonic data display pages (on the right side of the screen), separately. When scrolling with the + and – in the Display menu, use the Header/List button in the same menu to select which side to scroll.

5.2 Switching Display Items

Overview

This section explains the display items (Numeric Items) in Numeric (numeric display).

Display items (Items, Numeric)

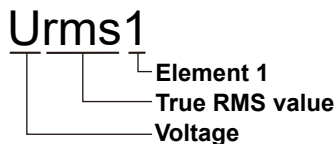
The display item options vary depending on the screen being displayed.

- All Items display (All Items)
- 4 Items, 8 Items and 16 Items displays (4 Items/8 Items/16Items)
- Matrix display (Matrix)
- Harmonics list single and dual displays (Hrm List Single/Dual)

For a list of the measurement functions and their descriptions, see chapter 1.

Example of how measurement functions are displayed in the numeric data display

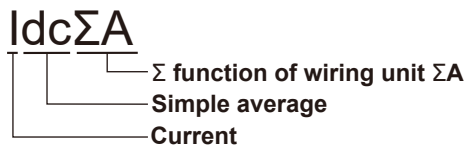
True RMS voltage of element 1



Display on each unit in multi-unit synchronization mode

Main: Urms1
Sub1: SUB1:Urms1
Sub2: SUB2:Urms1
Sub3: SUB3:Urms1
Sub4: SUB4:Urms1

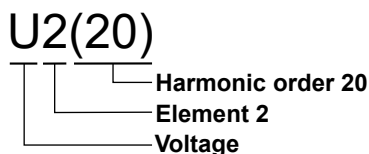
Simple average of the currents of the elements in wiring unit ΣA



Display on each unit in multi-unit synchronization mode

Main: IdcΣA
Sub1: SUB1:IdcΣA
Sub2: SUB2:IdcΣA
Sub3: SUB3:IdcΣA
Sub4: SUB4:IdcΣA

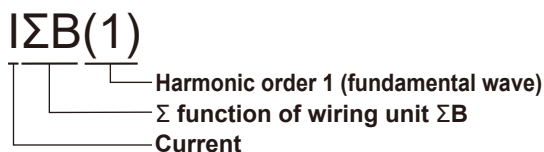
20th harmonic voltage of element 2



Display on each unit in multi-unit synchronization mode

Main: U2(20)
Sub1: SUB1:U2(20)
Sub2: SUB2:U2(20)
Sub3: SUB3:U2(20)
Sub4: SUB4:U2(20)

Average of the fundamental currents of the elements in wiring unit ΣB



Display on each unit in multi-unit synchronization mode

Main: IΣB(1)
Sub1: SUB1:IΣB(1)
Sub2: SUB2:IΣB(1)
Sub3: SUB3:IΣB(1)
Sub4: SUB4:IΣB(1)

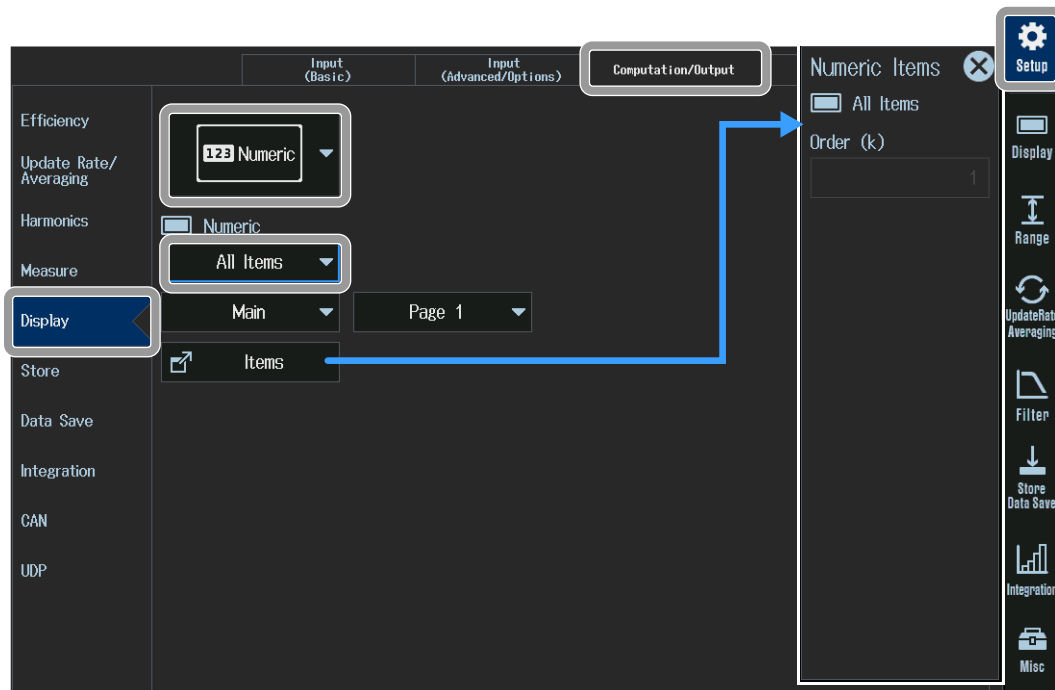
Procedure

Setup menu icon  > **Computation/Output** > **Display**

> Set the screen display to **Numeric** (other than Graph and Graph/Graph) >

All Items/4 Items/8 Items/16 Items/Matrix/Hrm List Single/Hrm List Dual in the Numeric menu >
Items in the Numeric menu

All Items display (All Items)



You cannot change individual measurement functions. Scroll through the pages to switch the display. The number of display pages is 12.

Harmonic order (Order (k))

In All Items display, this setting is available on page 9 or 10. The harmonic order setting appears in the upper left of the screen on page 9 or 10.

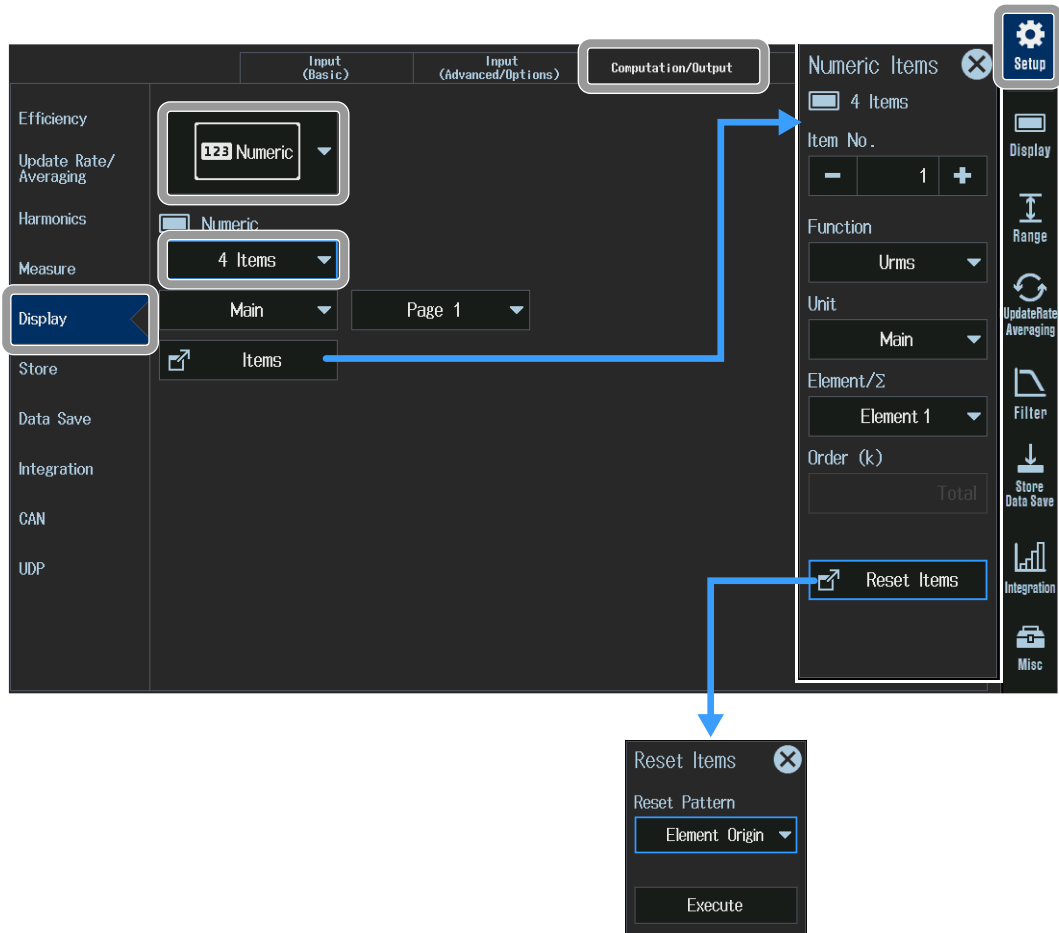
When you select a function that has harmonic data, you can set the displayed harmonic order within the following range:

Total (Total value) or 0 (dc) to 100

The harmonic orders that can be specified vary depending on the measurement function. For details, see “Harmonic order of the measurement functions” (page 1-5).

Numeric data fields for harmonics above the upper limit of the measurable harmonic order show [-----], indicating no data. For details on the upper limit of the measurable harmonic order, see “Maximum harmonic order to measure (Max Order) (page 8-4).”

4 Items, 8 Items, and 16 Items displays (4 Items/8 Items/16 Items)



Item number to edit (Item No.)

Select the number of the item that you want to edit. The number increases from the upper left of the screen downward.

Function (Function)

You can set the following items for displaying measurement functions: If you select None, no measurement function is displayed for the selected item.

- Voltage, current, active power, power factor
- Apparent power, reactive power, and corrected power
- Phase difference, frequency (voltage, current)
- Computed value (numeric, event)
- Integrated value
- Harmonics
- Motor evaluation
- Auxiliary signal

For details, see chapter 1.

Selecting the unit (Unit)

During multi-unit synchronization (option /SY1), you can select Main, Sub 1, Sub 2, Sub 3, or Sub 4.

Element (Element/ Σ)

When a function (Function) other than Speed, Torque, Pm, Slip, or SyncSp is selected

- The selected function determines whether you need to set an element or wiring unit from the following options or whether no setting is required. The available options vary depending on the installed elements.

Element 1, Element 2, Element 3, Element 4, ΣA , ΣB

- If no elements are assigned to the selected wiring unit, [-----] (no data) is displayed as there is no numeric data.

Example If elements are assigned to ΣA but not to ΣB , the measurement function for ΣB is displayed as [-----] (no data).

When Speed, Torque, Pm, Slip, or SyncSp is selected for the function (Function)

Select the motor number from the following options. The available options vary depending on the installed motor-evaluation option.

Motor 1, Motor 2, Motor 3, Motor 4

Harmonic order (Order (k))

This is the same function as the harmonic order in the All Items display.

Note

You can also display the following on the WT1500 LCD using the operation keys:

Numeric display by element

←MeasurementView
Element
Function
Motor
4 Items

Use the ▲ and ▼ arrow keys to select **Measurement View** on the Menu screen > **Element**, and then press **SET**.



←Element
← ELEMENT 1 ▶
Urms 198.10 V
Irms 1.981 A
P 0.392kW
Lambda 0.0000
Basic ▲ 1/3 ▼

Displays the measured values for each element.

Use the ◀ and ▶ arrow keys to select element 1 to 4 to display.

Use the ▲ and ▼ arrow keys to switch the page of measurement functions to display (1 to 3).

←Element
← ELEMENT 1 ▶
Irms 2.321 A
Idc 4.321 A
Iac 6.321 A
fI 11.937kHz
Current ▲ 3/3 ▼



←Element
← ELEMENT 4 ▶
Urms 271.11 V
Irms 5.681 A
P 1.540kW
Lambda 0.0000
Basic ▲ 1/3 ▼

←Element
← ELEMENT 1 ▶
Urms 198.10 V
Irms 1.981 A
P 0.392kW
Lambda 0.0000
Basic ▲ 1/3 ▼



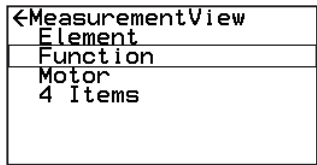
←Element
← ELEMENT 2 ▶
Urms 291.11 V
Irms 3.901 A
P 1.136kW
Lambda 0.0000
Basic ▲ 1/3 ▼



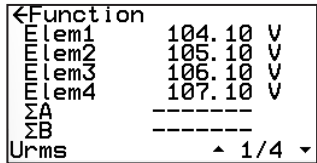
←Element
← ELEMENT 1 ▶
Urms 252.11 V
Udc 254.11 V
Uac 256.11 V
fU 13.736kHz
Voltage ▲ 2/3 ▼

5.2 Switching Display Items

Numeric display by measurement function



Use the ▲ and ▼ arrow keys to select **Measurement View** on the Menu screen > **Function**, and then press **SET**.



Displays the measured values for each function.
Use the ▲ and ▼ arrow keys to switch the page to display (1 to 4).

Numeric Display of Motor Function

See section 11.2.

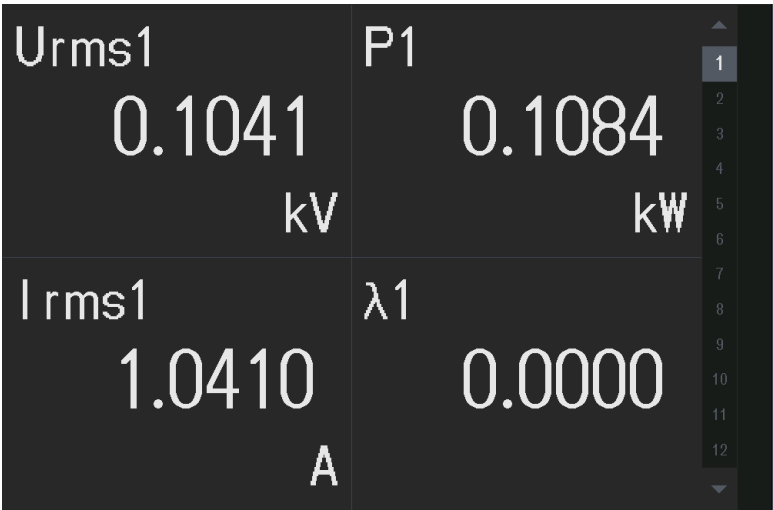
Resetting display items (Reset Items)

Reset patterns (Reset Pattern)

Select the reset method from the following:

- **Element origin (Element Origin)**
Arranges the numeric data for each element on each page. The arrangement pattern varies depending on the number of installed elements.

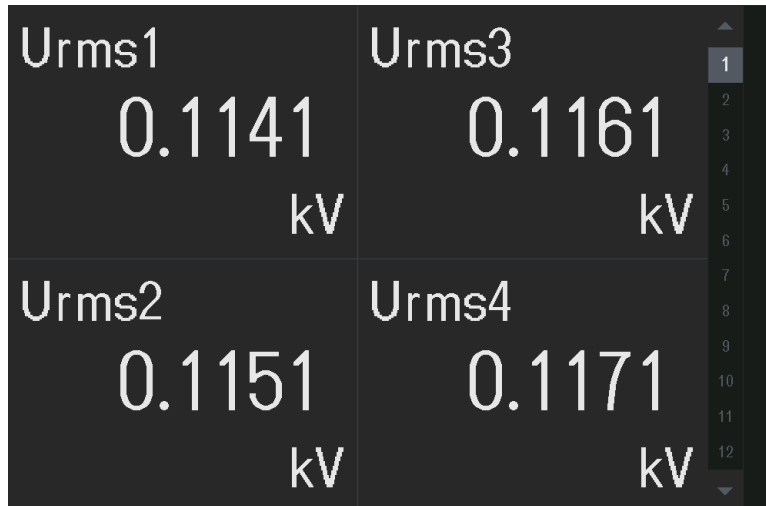
Display example (one element per page)



- **Function origin (Function Origin)**

Arranges the numeric data for each function on each page. The arrangement pattern varies depending on the number of installed elements.

Display example (one function per page)



- **Clear current page (Clear Current Page)**

Sets all displayed items on the current page to None.

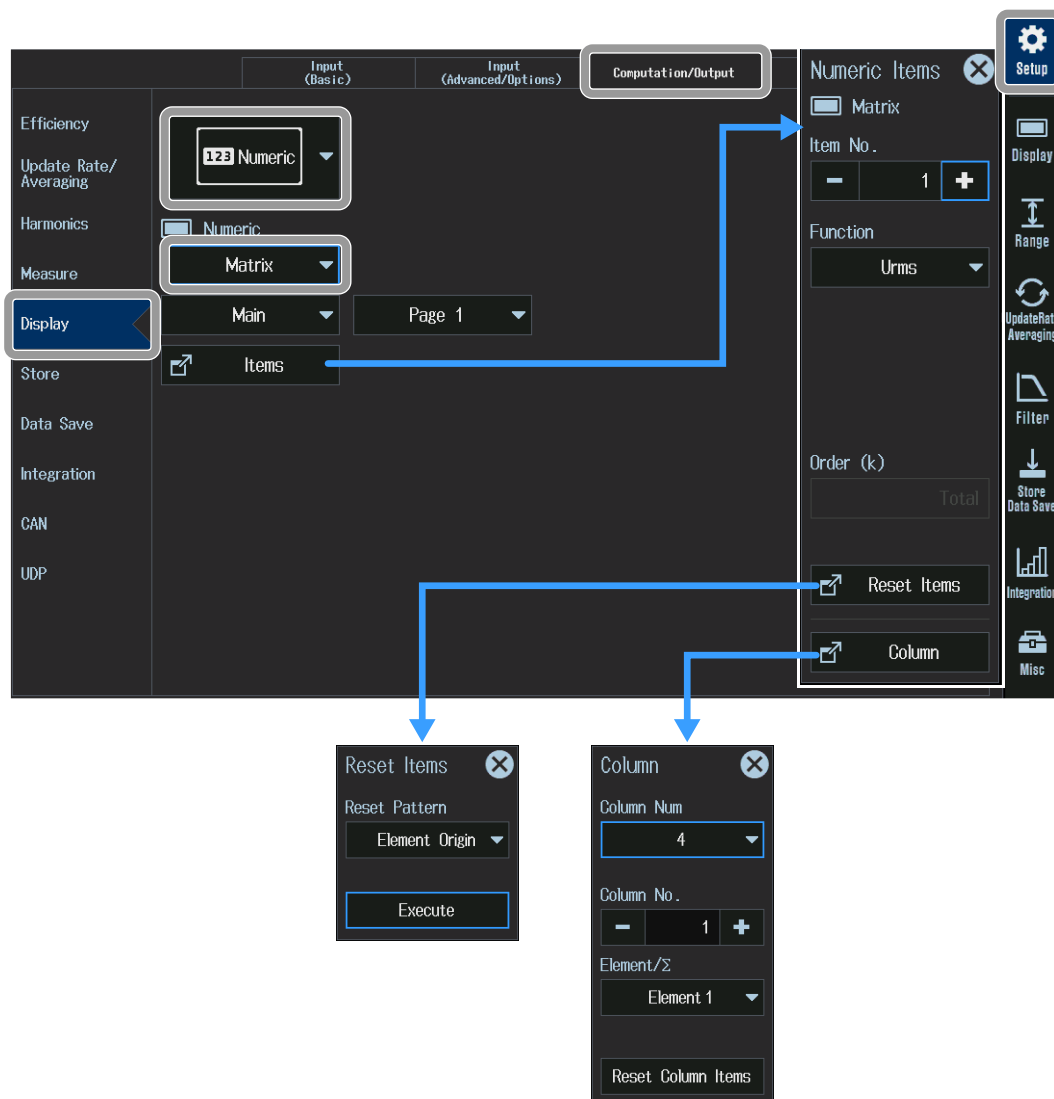
- **Clear all pages (Clear All Pages)**

Sets all displayed items on all pages to None.

Resetting items (Reset Items Exec)

Resets the items.

Matrix display (Matrix)



Item number to edit (Item No.)

This is the same function as setting the item number in the 4 Items, 8 Items, and 16 Items displays. The number increases from top to bottom in the matrix display.

Function (Function)

This is the same function as Function in the 4 Items, 8 Items, and 16 Items displays.

Note

- In matrix display, if you select a measurement function that does not require an element or wiring unit (η1 to η4, F1 to F20, Ev1 to Ev8, and so on), the data is displayed in the first column.
- When Speed, Torque, Pm, Slip, or SyncSp is selected for Function, the data is displayed as follows:
 Column 1: Motor1 data
 Column 2: Motor2 data
 Column 3: Motor3 data
 Column 4: Motor4 data

Harmonic order (Order (k))

This is the same function as the harmonic order in the All Items display.

Resetting display items (Reset Items)

This is the same function as resetting display items in the 4 Items, 8 Items, and 16 Items displays.

Column settings (Column Settings)**Number of columns (Column Num)**

Set the number of columns to 4 or 6.

Column number (Column No.)

Select the number of the column that you want to edit. The number increases from top to bottom in the matrix display.

Element (Element/ Σ)

- Select the element/wiring unit from the following: The available options vary depending on the installed elements.

None, Element 1, Element 2, Element 3, Element 4, ΣA , ΣB

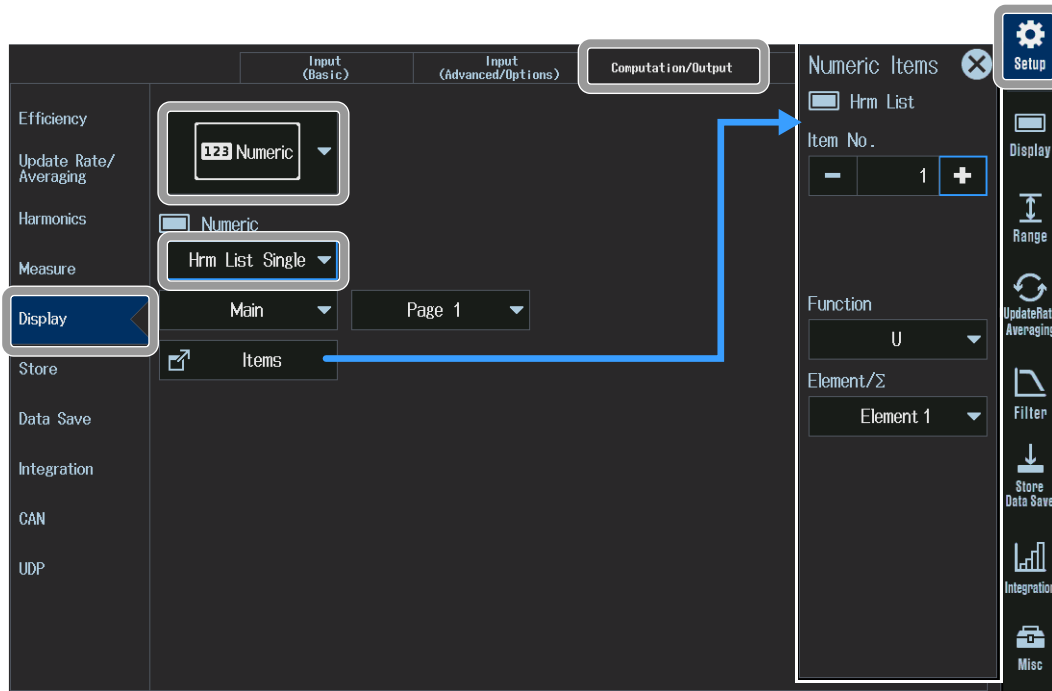
- If you select None, no measurement data is displayed in the selected column.
- If no elements are assigned to the selected wiring unit, [-----] (no data) is displayed as there is no numeric data.

Example If elements are assigned to ΣA but not to ΣB , the measurement function for ΣB is displayed as [-----] (no data).

Resetting settings (Reset Column Items)

Resets the column settings.

Harmonics list single display (Hrm List Single) and harmonics list dual display (Hrm List Dual)



For each measurement function, you can display the Total value and numeric data for harmonics from the 0th (DC) through the 100th order in two columns.

Item number to edit (List Item No.)

- You can specify two lists to show in the harmonic data display area (the right side of the screen). Select list number 1 or 2 to edit.
 - When harmonics list single display is selected, the data of List Item No.1 is listed in two columns.
 - When harmonics list dual display is selected, the data of List Item No.1 is listed in one column, and the data of List Item No.2 is listed in another column.
- You cannot change individual items in the measurement function display area (the left side of the screen). Switch display pages as follows:
 - ▼ on the screen: Displays the next page.
 - ▲ on the screen: Displays the previous page.
 - If you select a position between ▲ and ▼ on the screen, the page corresponding to the selected position is displayed.

Function (Function)

Select the measurement function to show in the harmonic data display area from the following options:

U, I, P, S, Q, λ , Φ , ΦU , ΦI , Z, Rs, Xs, Rp, Xp

Element (Element/Σ)

You can select the element or wiring unit to display in the harmonic data display area. This is the same function as setting the element in the 4 Items, 8 Items, and 16 Items displays.

Harmonic order

The Total value and 0th-order (DC) numeric data are always displayed at the top of the harmonic data display area. To switch between the displays of the numeric data from orders 1 to 100, use ▼/▲ or +/– on the screen.

The number of harmonic orders switched by page scrolling is as follows:

Display format	Single screen display	Split display
Harmonics list single display	40 orders	20 orders
Harmonics list dual display	20 orders	10 orders

Note

In the harmonics list display, you can change the measurement function, element, and wiring unit for the selected list, but you cannot change these settings for each individual displayed item.

5.3 Displaying Voltage, Current, Active Power, and Power Factor

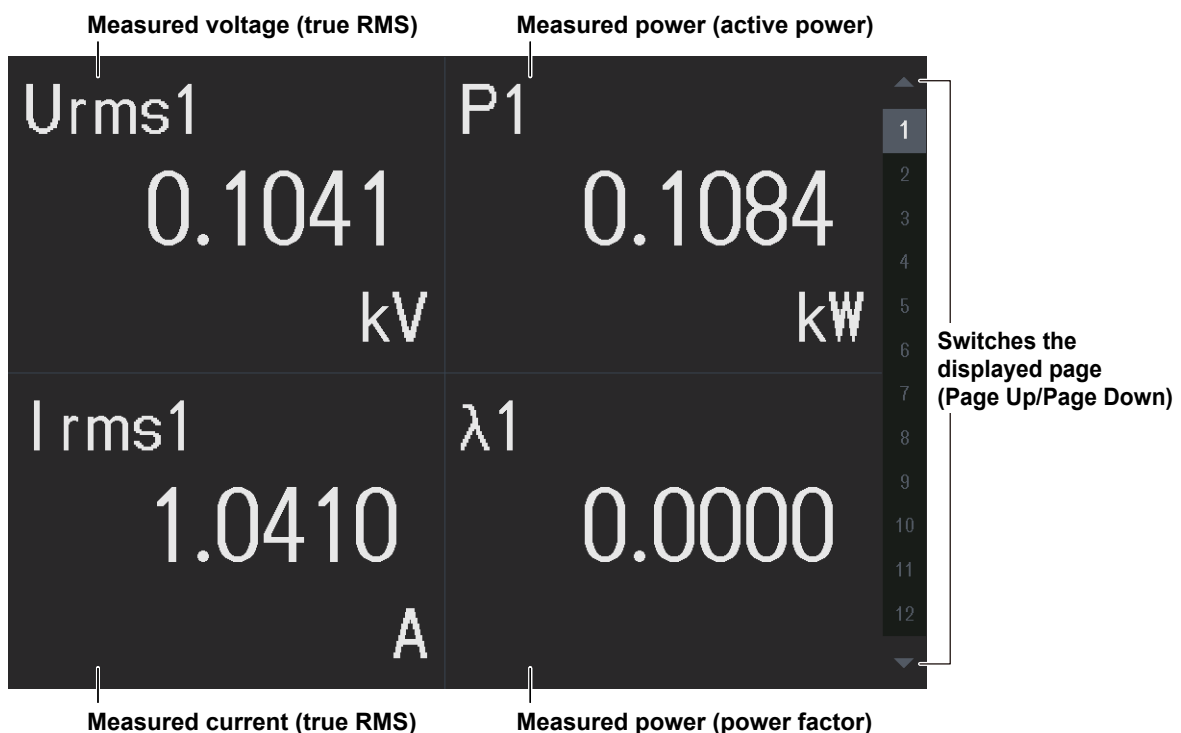
Overview

This instrument displays the measured values (measurement functions) of the voltage and current input to input elements or wiring units on the screen.

For measured values of voltage, current, active power, and power factor, no formula settings are required. The measured values are displayed as is on the screen. This section explains how to display measurement results numerically, using display examples.

Measurement display screen (4 Items display example)

Measurement display of input element 1



Switching display pages (Page Up/Page Down)

Switches to the measurement display for another input element.

Select ▼ or ▲ to switch the display pages sequentially from the current page number. Select the number directly to switch to the corresponding display page.

Switching display items (Numeric Items)

If you continue selecting the measurement display area for 3 seconds or more, you can perform the operation described later in "Switching display items (Numeric Items)."

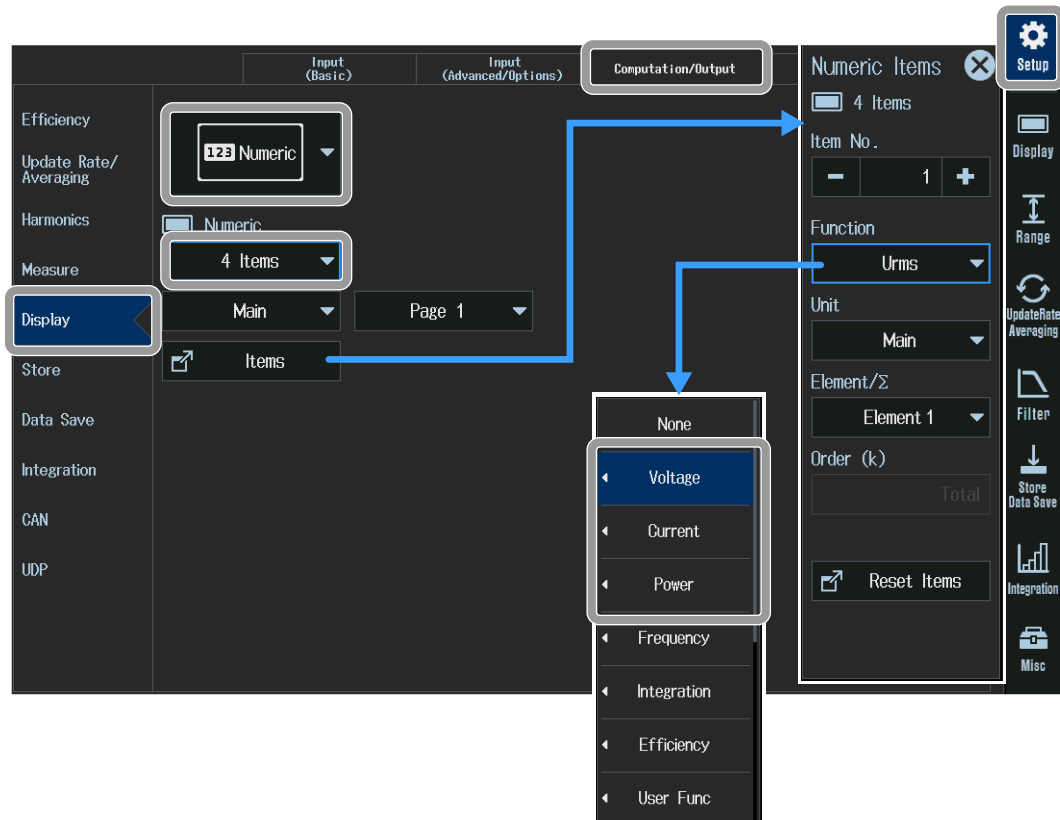
Note

You can also display voltage, current, active power, and power factor graphically (see chapter 9).
The waveform display function (see section 9.2) shows voltage and current waveforms.

Procedure

Setup menu icon  > **Computation/Output** > **Display**

- **Example of switching to 4 Items display**
> Set Numeric/Graph to **Numeric** > set All Items/4 Items/8 Items/16 Items/Matrix/Hrm List Single/Hrm List Dual in the Numeric menu to **4 Items**
- **Switching display items (Numeric Items)**
> **Items** in the Numeric menu > Item No., Function, Unit, Element/Σ, Reset Items



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to switch the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Selecting the displayed item number (Item No.)

See “Menu Icons” (page vi).

Setting display items (Function)

Set the display items related to voltage, current, power, and power factor.

Scroll through the display list, select Voltage, Current, or Power, and then set the display items.

Measured voltage (Voltage group):

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), U+peak (maximum value), U-peak (minimum value), CfU (crest factor), Urip (ripple rate), and Uubf (three-phase voltage unbalance factor)

Measured current (Current group):

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), I+peak (maximum value), I-peak (minimum value), Cfl (crest factor), Irip (ripple rate), and Iubf (three-phase current unbalance factor)

Measured power and power factor (Power group):

P (active power), S (apparent power), Q (reactive power), λ (power factor), Φ (phase difference), Pfnd (fundamental active power), Sfnd (fundamental apparent power), Qfnd (fundamental reactive power), λ fnd (fundamental power factor), Φ fnd (fundamental phase difference), Pc (Corrected Power), P+peak (maximum value), P-peak (minimum value)

Selecting the unit (Unit)

See “Menu Icons” (page vi).

Selecting the input element or wiring unit to configure (Element/ Σ)

See “Menu Icons” (page vi).

Resetting display items (Reset Items)

See “Menu Icons” (page viii).

5.4 Displaying Apparent Power, Reactive Power, and Corrected Power

Overview

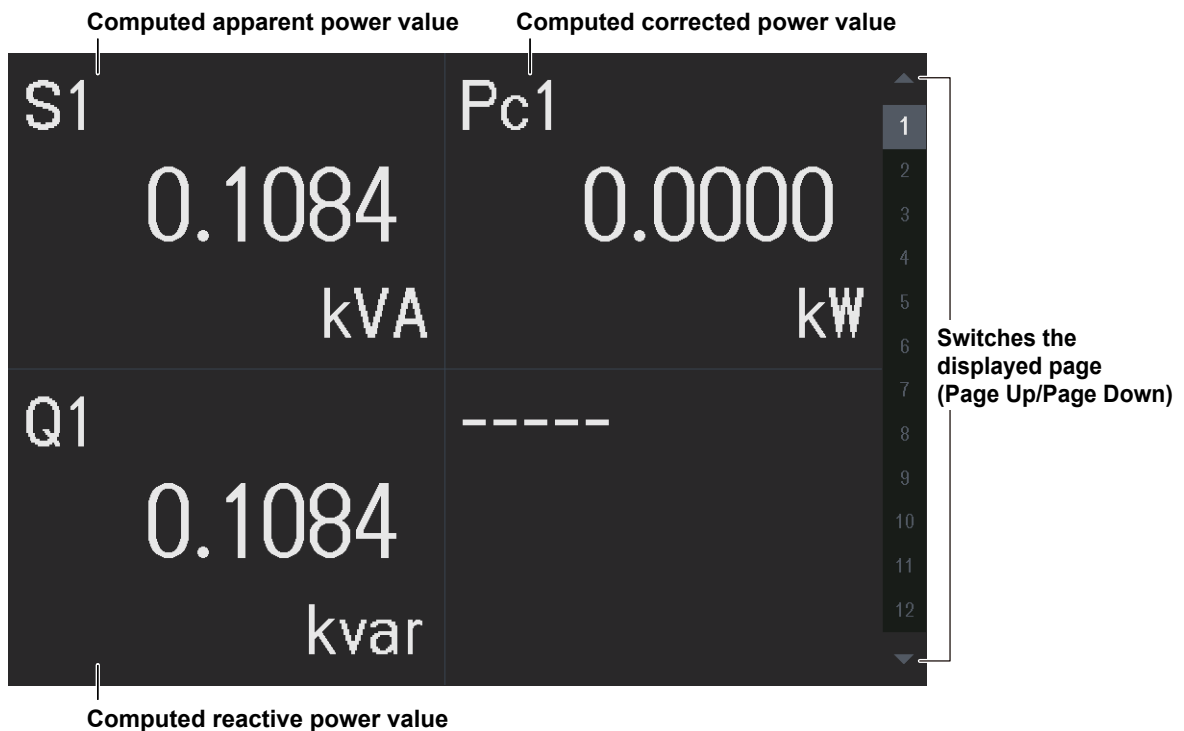
This instrument calculates, based on equations that are defined, apparent power (S), reactive power (Q), and corrected power (Pc) from the measurements of the voltage and current applied to the input elements or wiring units and shows calculated results on the screen.

To determine apparent power (S), reactive power (Q), and corrected power (Pc) values, you need to set equations.

This section explains how to display computed results numerically, using display examples.

Measurement display screen (4 Items display example)

Measurement display of input element 1



Switching display pages (Page Up/Page Down)

Switches to the measurement display for another input element.

Select ▼ or ▲ to switch the display pages sequentially from the current page number. Select the number directly to switch to the corresponding display page.

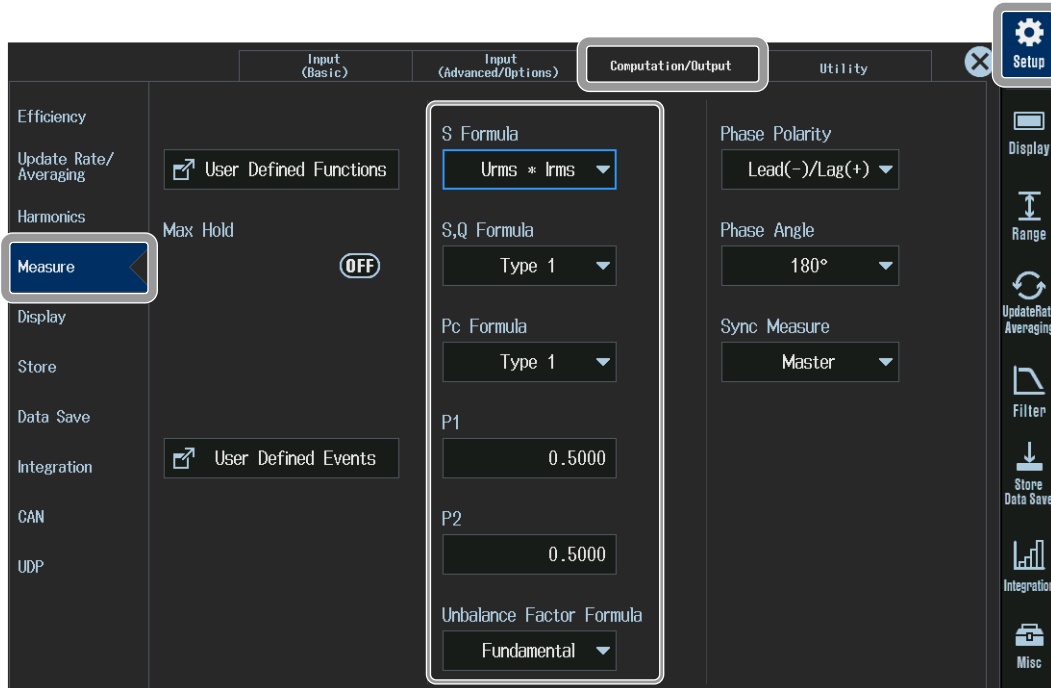
Switching display items (Numeric Items)

If you continue selecting the measurement display area for 3 seconds or more, you can perform the operation described later in “Switching display items (Numeric Items).”

Procedure

Setting computation

Setup menu icon  > **Computation/Output** > **Measure** > S Formula, S,Q Formula, Pc Formula, P1, P2, Unbalance Factor Formula



Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Apparent power formula (S Formula)

Select the voltage and current to use for apparent power computation (voltage × current) from the following:

- Urms*Irms
Product of the true RMS values of voltage and current
- Umean*Imean
Product of the rectified mean values of voltage and current calibrated to the RMS values
- Udc*Idc
Product of the simple averages of voltage and current
- Umean*Irms
Product of the rectified mean voltage calibrated to the RMS value and the true RMS current
- Urmean*Irmean
Product of the rectified mean values of voltage and current

Apparent power and reactive power computation types (S,Q Formula)

There are three types of power: active power, reactive power, and apparent power. In general, they are defined by the following formulas:

$$\text{Active power } P = UI \cos \Phi \quad (1)$$

$$\text{Reactive power } Q = UI \sin \Phi \quad (2)$$

$$\text{Apparent power } S = UI \quad (3)$$

U: RMS voltage, I: RMS current, Φ : phase difference between voltage and current

The relationship among these power values is as follows:

$$(\text{Apparent power } S)^2 = (\text{Active power } P)^2 + (\text{Reactive power } Q)^2 \quad (4)$$

Three-phase power is the sum of the power of each phase.

These definitions only apply to sine waves. However, in distorted waveform measurement, the measured values of apparent power and reactive power differ depending on which of the above formulas are combined for computation. Because the formulas for deriving the apparent and reactive power for distorted waveforms are not defined, none of the formulas can be said to be more correct than the other. Therefore, this instrument allows you to select the formulas for apparent power and reactive power.

Unlike apparent power and reactive power, active power is derived directly from the sampled data, so differences resulting from different definitions do not occur.

Type 1 (Type 1) (method used in the normal mode of conventional WT series models)

The instrument computes the apparent power of each phase using formula (3), computes the reactive power of each phase using formula (2), and then adds the results to obtain the power.

$$\text{Active power for a three-phase four-wire system} \quad P\Sigma = P1 + P2 + P3$$

$$\text{Apparent power for a three-phase four-wire system} \quad S\Sigma = S1 + S2 + S3 (= U1 \times I1 + U2 \times I2 + U3 \times I3)$$

$$\text{Reactive power for a three-phase four-wire system} \quad Q\Sigma = Q1 + Q2 + Q3$$

$$(\text{ } = s1 \times \sqrt{(U1 \times I1)^2 - P1^2} + s2 \times \sqrt{(U2 \times I2)^2 - P2^2} + s3 \times \sqrt{(U3 \times I3)^2 - P3^2} \text{)}$$

The signs for s1, s2, and s3 are negative when the current leads the voltage and positive when the current lags the voltage.

Type 2 (Type 2)

The instrument computes the apparent power of each phase using formula (3), and then adds the results to obtain the three-phase apparent power. The three-phase reactive power is computed from the three-phase apparent power and three-phase active power using formula (4).

$$\text{Active power for a three-phase four-wire system} \quad P\Sigma = P1 + P2 + P3$$

$$\text{Apparent power for a three-phase four-wire system} \quad S\Sigma = S1 + S2 + S3 (= U1 \times I1 + U2 \times I2 + U3 \times I3)$$

$$\text{Reactive power for a three-phase four-wire system} \quad Q\Sigma = \sqrt{S\Sigma^2 - P\Sigma^2}$$

Type 3 (Type 3) (method used in the harmonic measurement mode of the WT1600, WT3000, and PZ4000)

Reactive power for each phase is computed directly using formula (2). Three-phase apparent power is computed from formula (4).

$$\text{Active power for a three-phase four-wire system} \quad P\Sigma = P1 + P2 + P3$$

$$\text{Apparent power for a three-phase four-wire system} \quad S\Sigma = \sqrt{P\Sigma^2 + Q\Sigma^2}$$

$$\text{Reactive power for a three-phase four-wire system} \quad Q\Sigma = Q1 + Q2 + Q3$$

Corrected power formula (Pc Formula)

Some standards require the measured active power of a voltage transformer to be corrected when the load connected to the transformer is very small. You can select a formula to use for this correction and specify the coefficients.

Applicable standard (Pc Formula)

Select from the following:

- Type 1 (Type 1): IEC76-1 (1976)
- Type 2 (Type 2): IEC76-1 (1993)

Formulas for each applicable standard

Type 1: IEC76-1 (1976), IEEE-C57.12.90-1993

$$P_c = \frac{P}{P_1 + P_2 \left(\frac{U_{rms}}{U_{mn}} \right)^2}$$

Type 2: IEC76-1 (1993)

$$P_c = P \left(1 + \frac{U_{mn} - U_{rms}}{U_{mn}} \right)$$

P_c: Corrected Power

P: Active power

U_{rms}: True RMS voltage

U_{mn}: Rectified mean voltage calibrated to the RMS value

P₁, P₂: Coefficients specified in the applicable standard

Coefficients (P1, P2)

You can set coefficients P₁ and P₂ in the range from 0.0001 to 9.9999.

Note

The formula in IEEE C57.12.90-2010 is the same as that in IEC76-1 (1976).

Unbalance factor formula (Unbalance Factor Formula)

Select from the following:

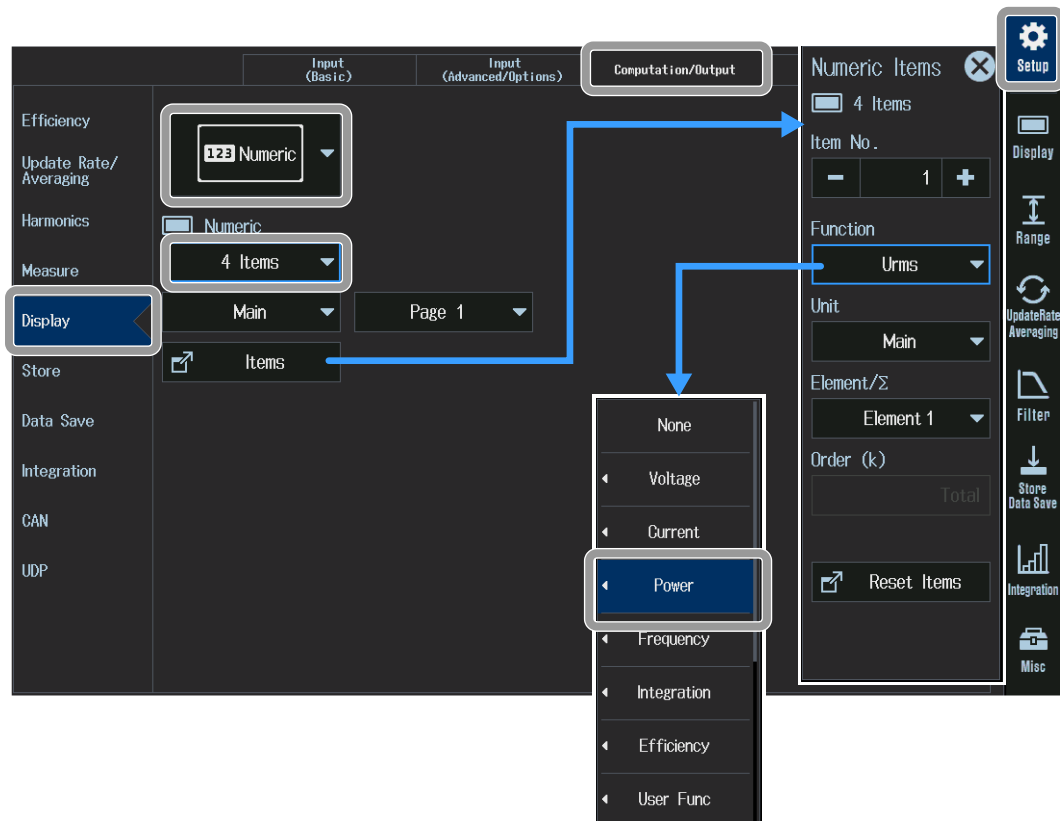
- Fundamental: Computes the unbalance factor from the fundamental component of the harmonics.
- RMS: Computes the unbalance factor from RMS values.

Procedure

Example of switching to 4 Items display

Setup menu icon  > Computation/Output > Display

- **Example of switching to 4 Items display**
 - > Set Numeric/Graph to **Numeric** > set All Items/4 Items/8 Items/16 Items/Matrix/Hrm List Single/Hrm List Dual in the Numeric menu to **4 Items**
- **Switching display items (Numeric Items)**
 - > **Items** in the Numeric menu > Item No., Function, Unit, Element/Σ, Reset Items



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to switch the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
 - See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Selecting the displayed item number (Item No.)

See “Menu Icons” (page vi).

Setting display items (Function)

Set the display items related to apparent power, reactive power, and corrected power.

Scroll through the display list, select Power, and then set the display items.

Computed apparent power value (Power group):

S (apparent power), Sfnd (fundamental apparent power)

Computed reactive power value (Power group):

Q (reactive power), Qfnd (fundamental reactive power)

Computed corrected power value (Power group):

Pc(Corrected Power)

Selecting the unit (Unit)

See “Menu Icons” (page vi).

Selecting the input element or wiring unit to configure (Element/ Σ)

See “Menu Icons” (page vi).

Resetting display items (Reset Items)

See “Menu Icons” (page viii).

5.5 Displaying Phase Difference and Frequency (Voltage and Current)

Overview

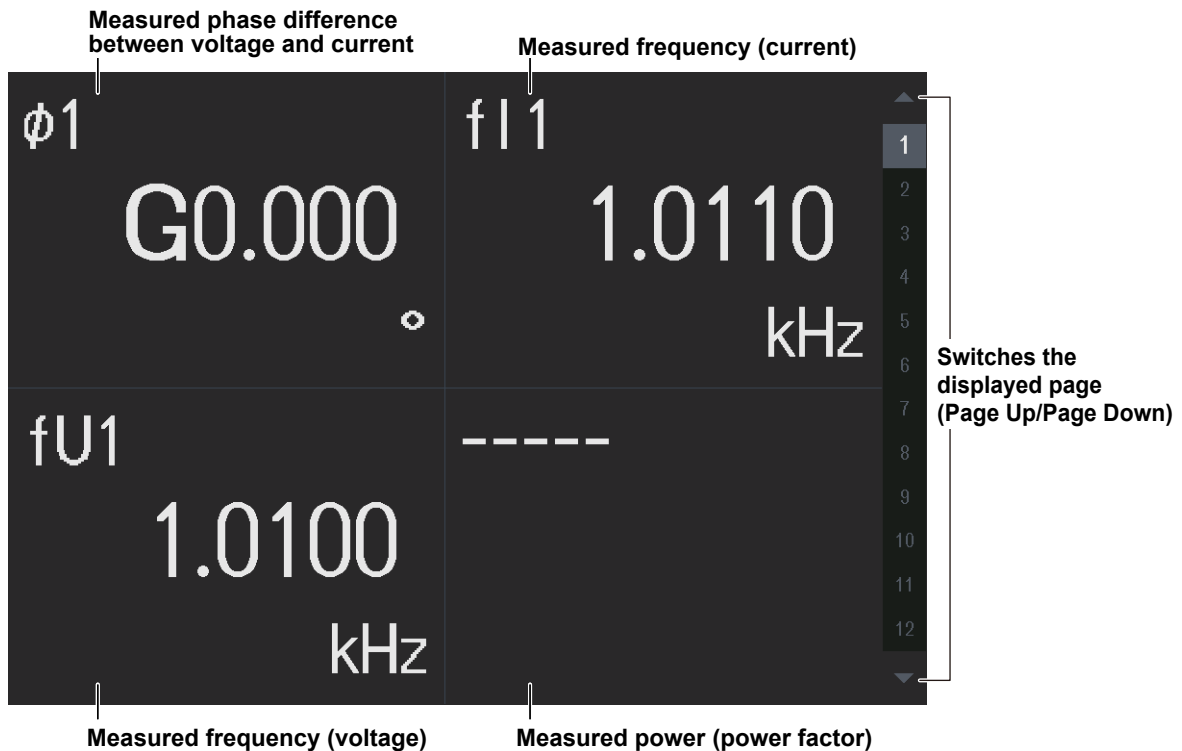
This instrument displays on the screen the measured values of the phase difference between voltage and current, and the frequency, for the voltage and current applied to the input elements or wiring units.

For measured values of phase difference and frequency, no formula settings are required.

The measured values are displayed as is on the screen. This section explains how to display measurement results numerically, using display examples.

Measurement display screen (4 Items display example)

Measurement display of input element 1



Switching display pages (Page Up/Page Down)

Switches to the measurement display for another input element.

Select ▼ or ▲ to switch the display pages sequentially from the current page number. Select the number directly to switch to the corresponding display page.

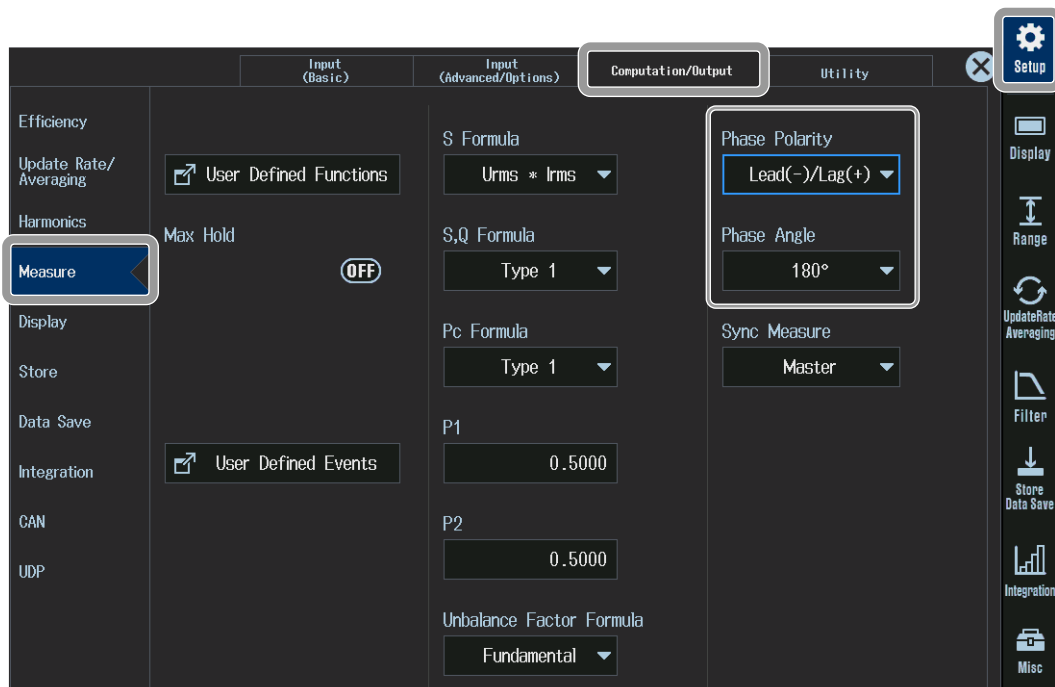
Switching display items (Numeric Items)

If you continue selecting the measurement display area for 3 seconds or more, you can perform the operation described later in “Switching display items (Numeric Items).”

Procedure

Setting phase difference display

Setup menu icon  > **Computation/Output** > **Measure** > Phase Polarity, Phase Angle



Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Phase difference polarity (Phase Polarity)

The phase difference Φ between voltage and current indicates the current phase relative to the voltage of each element.

- Lead(-)/Lag(+)
 - Lead: –
 - Lag: + or no sign
- Lead(+)/Lag(-)
 - Lead: + or no sign
 - Lag: –

Phase difference display format (Phase Angle)

- 180 degrees (180°)

If the current phase is in the counterclockwise direction with respect to voltage, the current is leading (D) the voltage. If the current phase is in the clockwise direction with respect to the voltage, the current is lagging (G) the voltage. The phase difference is displayed as an angle from 0 to 180° (see appendix 1).

- 360 degrees (360°)

The phase difference is displayed as an angle from 0 to 360° in the clockwise direction.

Note

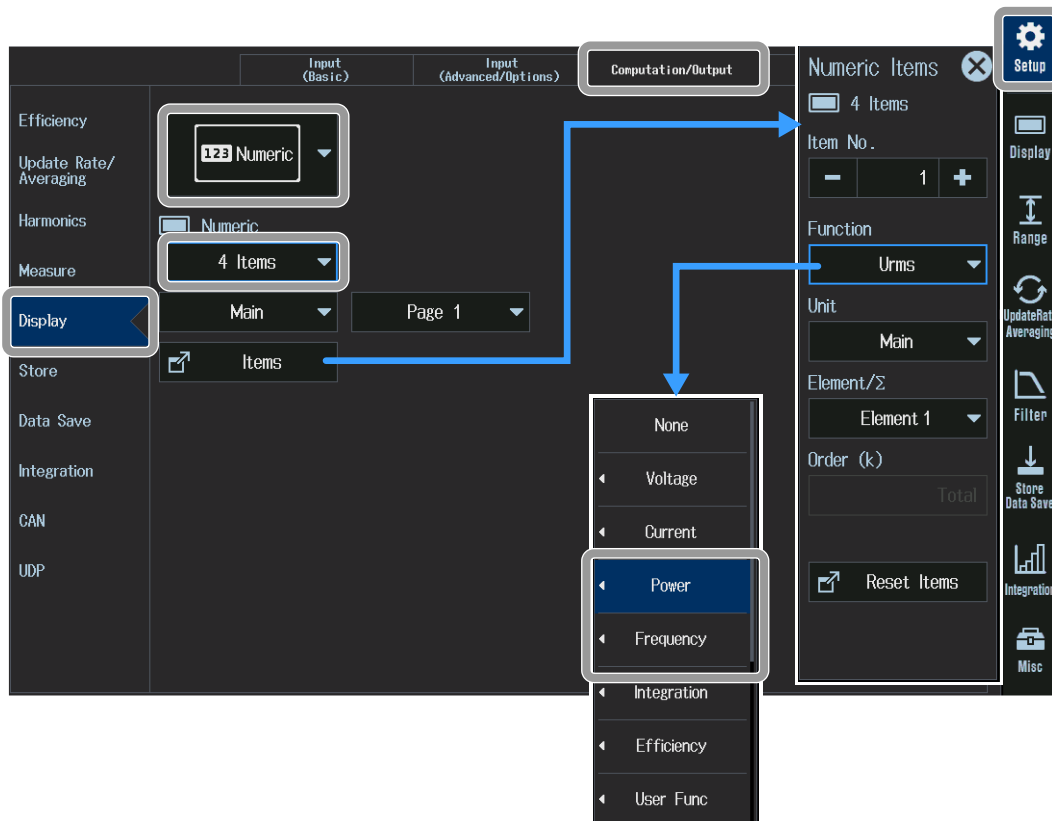
- If the measured voltage or current is zero, [Error] is displayed.
 - Phase difference Φ for lead (Lead) and lag (Lag) is displayed correctly only when both the voltage and current are sine waves and the ratio of the input to the measurement range is not greatly different between the voltage and current.
 - When the computation result of power factor λ exceeds 1, Φ is displayed as follows:
 - When λ is greater than 1 and less than or equal to 2, Φ returns 0.
 - If λ is greater than 2, Φ returns an error ("Error" is displayed).
 - Regardless of the setting in this section, the phase differences Φ_U and Φ_I for the 1st through 500th harmonics of voltage and current in harmonic measurement are always displayed using the 180° method, with lead shown without a sign and lag shown with a minus sign, as angles from 0 to 180°.
-

Procedure

Example of switching to 4 Items display

Setup menu icon  > Computation/Output > Display

- **Example of switching to 4 Items display**
> Set Numeric/Graph to **Numeric** > set All Items/4 Items/8 Items/16 Items/Matrix/Hrm List Single/Hrm List Dual in the Numeric menu to **4 Items**
- **Switching display items (Numeric Items)**
> **Items** in the Numeric menu > Item No., Function, Unit, Element/ Σ , Reset Items



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to switch the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Selecting the displayed item number (Item No.)

See "Menu Icons" (page vi).

Setting display items (Function)

Set the display items related to phase difference, voltage frequency, and current frequency. Scroll through the display list, select Power or Frequency, and then set the display items.

Measured phase difference (Power group):

Φ (phase difference), Φ_{fnd} (fundamental phase difference)

Measured frequency (voltage) (Frequency group):

FreqU (voltage frequency), Freq2U (voltage frequency)

Measured frequency (current) (Frequency group):

FreqI (current frequency), Freq2I (current frequency)

Selecting the unit (Unit)

See "Menu Icons" (page vi).

Selecting the input element or wiring unit to configure (Element/ Σ)

See "Menu Icons" (page vi).

Resetting display items (Reset Items)

See "Menu Icons" (page viii).

5.6 Displaying Computed Values (Numeric and Event)

Overview

This instrument displays the following numeric data and the judgment results (True/False) of defined events on the screen. This section explains how to display computed results, using display examples.

- **Numeric (user-defined function)**

You can create formulas by combining measurement function symbols and compute numeric data for the created formulas using the numeric data of those measurement functions. (See the next page.)

- **Event (user-defined event)**

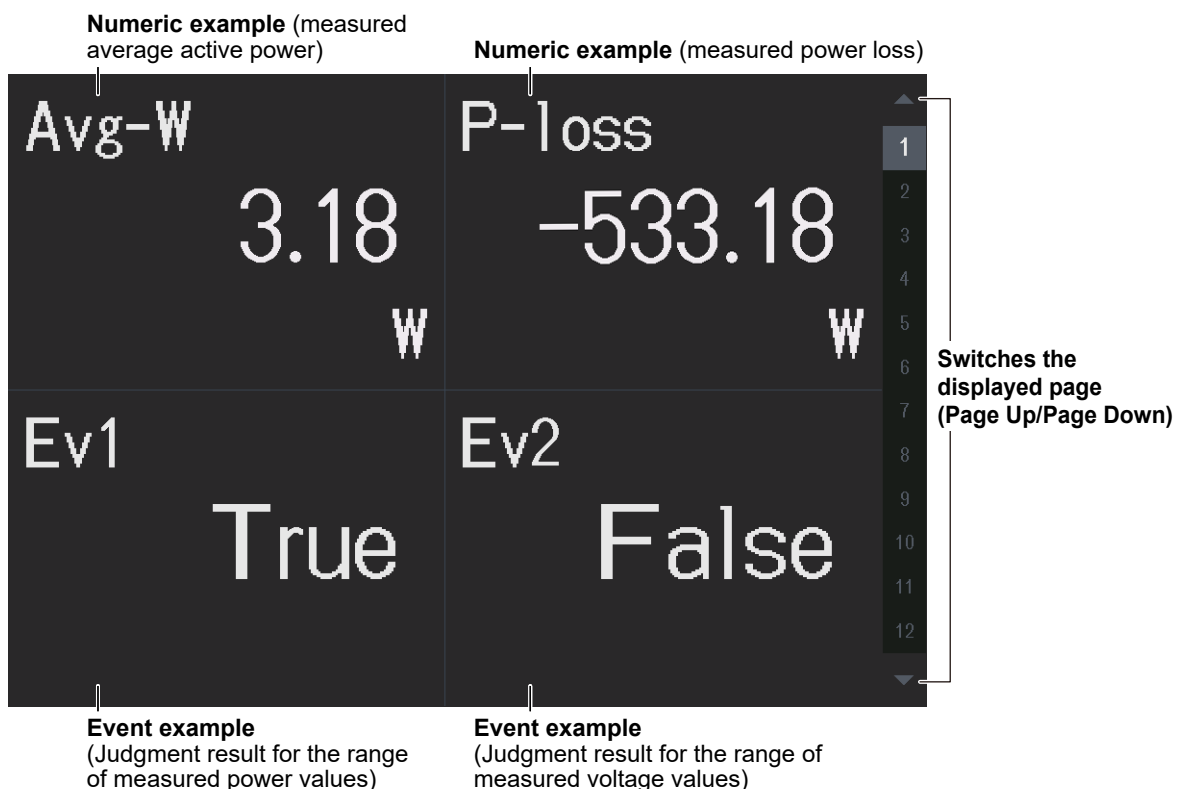
You can define events for making judgments based on measured-value ranges or comparisons with reference values. (See page 5-42.)

Measurement display screen (4 Items display example)

Measurement display of input element 1

The following computed values are shown.

- Average active power measurement (Avg-W) and power loss (P-loss): Value example (user-defined function)
- Power measurement range (Ev1) and voltage measurement range (Ev2): Event examples (user-defined events)



Switching display pages (Page Up/Page Down)

Switches to the measurement display for another input element.

Select ▼ or ▲ to switch the display pages sequentially from the current page number. Select the number directly to switch to the corresponding display page.

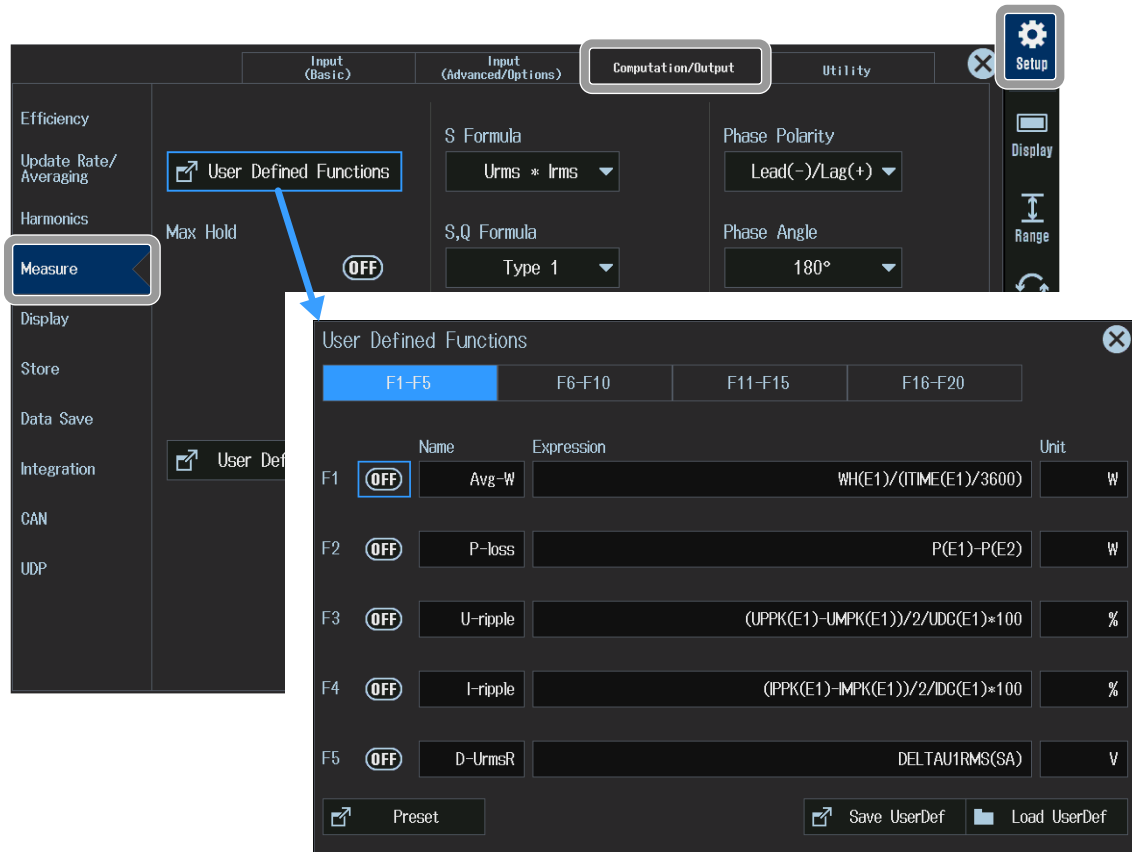
Switching display items (Numeric Items)

If you continue selecting the measurement display area for 3 seconds or more, you can perform the operation described later in "Switching display items (Numeric Items)."

Procedure

Displaying computed values (numeric) (User Defined Functions)

Setup menu icon  > **Computation/Output** > **Measure** > **User Defined Functions** > Name, Expression, Unit, Preset, Save UserDef, Load UserDef



The user-defined function setup screen shows five functions per screen. Up to 20 functions can be defined. In the setup example, the computed value of average active power is set in F1 and the computed value of power loss is set in F2.

F1: Average active power* Avg-W = Integrated power of element 1 $WH(E1)/\text{Elapsed integration time of element 1 } ITIME(E1)/3600$

F2: Power loss P-loss = Active power of element 1 $P(E1)$ – Active power of element 2 $P(E2)$

* The average active power can be calculated for devices, such as intermittent control devices, whose power fluctuates. The unit of $ITIME()$ is seconds.

When computation is set to ON, computed values (numeric) are displayed on the measurement display screen.

Note

- By default, the computed values of user definitions contain samples. Change them as necessary.
- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Selecting the user-defined function to edit

Select the number corresponding to the user-defined function that you want to edit from the following options:

- F1-F5: User-defined functions F1 to F5
- F6-F10: User-defined functions F6 to F10
- F11-F15: User-defined functions F11 to F15
- F16-F20: User-defined functions F16 to F20

Turning user-defined function computation ON or OFF

Select whether to perform user-defined function computation (ON) or not (OFF).

User-defined function name (Name)

- Number of characters: Up to 8
- Character type: Characters and spaces displayed on the keyboard

Expression (Expression)

Operand types

You can use a combination of a measurement function and element number (e.g., Urms1) as a single operand to configure up to 20 expressions (F1 to F20). There can be up to 16 operands in an expression.

The operand types are listed below (measurement function: operand).

Note

- With user-defined functions, you can combine operands to compute physical quantities that are not available as measurement functions. Efficiency formulas are limited to power and motor output. With user-defined functions, however, you can set formulas that use other measurement functions and compute ratios other than efficiency.
- During multi-unit synchronization (option /SY1), you can specify measurement items of the subunits on the main unit, excluding efficiency and user-defined functions (see page 5-40).

• Normal measurement

Voltage, current, and power

Urms: URMS()	Irms: IRMS()	P: P()	Pfnd: PFND()
Umn: UMN()	Imn: IMN()	S: S()	Sfnd: SFND()
Udc: UDC()	Idc: IDC()	Q: Q()	Qfnd: QFND()
Urmn: URMN()	Irmn: IRMN()	λ: LAMBDA()	λfnd: LAMBDADFND()
Uac: UAC()	Iac: IAC()	Φ: PHI()	Φfnd: PHIFND()
Ufnd: UFND()	Ifnd: IFND()	Pc: PC()	---
U+pk: UPPK()	I+pk: IPPK()	P+pk: PPPK()	---
U-pk: UMPK()	I-pk: IMPK()	P-pk: PMPK()	---
CfU: CFU()	Cfl: CFI()	---	---
fU: FU()	fl: FI()	---	---
Urip: URIP()	Irip: IRIP()	Uubf: UUBF()	Iubf: IUBF()

Integrated power

Wp: WH()	q: AH()	ITime: ITIME()
Wp+: WHP()	q+: AHP()	WS: SH()
Wp-: WHM()	q-: AHM()	WQ: QH()

Efficiency

η1: ETA1() to η4: ETA4()

User-defined functions

F1: F1() to F20: F20()

- Harmonic measurement**

U(k): UK(,)	I(k): IK(,)	P(k): PK(,)
S(k): SK(,)	Q(k): QK(,)	λ(k): LAMBDK(,)
ΦU(k): UPHI(,)	ΦI(k): IPHI(,)	Φ(k): PHIK(,)
Z(k): ZK(,)	Rs(k): RSK(,)	Xs(k): XSK(,)
---	Rp(k): RPK(,)	Xp(k): XPK(,)
Uhdf(k): UHDF(,)	lhdf(k): IHDF(,)	Phdf(k): PHDF(,)
Uthd: UTHD()	lthd: ITHD()	Pthd: PTHD()
Uthf: UTHF()	lthf: ITHF()	---
Utif: UTIF()	litf: ITIF()	---
hvf: HVF()	hcf: HCF()	---
fPLL1: PLLFRQ1()	fPLL2: PLLFRQ2()	Kfactor: KFACT()
ΦU1-U2: PHIU1U2()	ΦU1-U3: PHIU1U3()	ΦU1-I1: PHIU1I1()
ΦU2-I2: PHIU2I2()	ΦU3-I3: PHIU3I3()	---
FreqU: FREQU()	FreqI: FREQI()	

- Motor evaluation (Option)**

Speed: SPEED()	Torque: TORQUE()	Pm: PM()
Slip: SLIP()	SyncSp: SYNC()	---
EaU: EAU()	EaI: EAI()	---

- Auxiliary input (Option)**

Aux1: AUX1()	Aux2: AUX2()	Aux3: AUX3()
Aux4: AUX4()	Aux5: AUX5()	Aux6: AUX6()
Aux7: AUX7()	Aux8: AUX8()	---

- Measurement range**

RngU: Rngu()	RngI: RngI()
RngSpd: RngSPD()*	RngTrq: RngTRQ()*
RngAux: RngAUX1() to RngAUX8()*	

* Models with the motor evaluation 1 or 2 option

Setting arguments for operands

The arguments you need to enter depend on whether the function takes “(,)” or “()”.

• (,) Notation

Specify the element to the left of the comma, and specify the harmonic order to the right of the comma.

Example (E1,OR2)

- Symbols representing elements
E1 to E4: Elements 1 to 4
SA, SB: Wiring units ΣA and ΣB
- Symbols representing harmonic orders (Order)
ORT: Total value
OR0: dc
OR1: Fundamental wave
OR2 to OR100: Harmonic orders 2 to 100

• () Notation

- If you select a measurement function other than Speed, Torque, Pm, Slip, or SyncSp, the selected function determines whether you need to set the symbol representing the element or whether no setting is required.

Example (E1)

For the symbols that can be set as arguments for each operand, see appendix 5.

- For the Speed, Torque, Pm, Slip, and SyncSp measurement functions, set the symbols M1 to M4 representing the motor number.

Example (M1)

Values assigned to operands

- The unit of ITIME() is seconds.
- $\eta 1$ to $\eta 4$ are displayed as percentages (%) (see appendix 1), but ETA1 to ETA4 computed in this section are expressed as ratios.

Example When $\eta 1$ is 80 %, ETA1 is 0.8

- The U1 in PHIU1U2 represents the voltage signal of the element whose element number is the smallest in the wiring unit (ΣA or ΣB).

Example When input elements 2, 3, and 4 are assigned to wiring unit ΣA , PHIU1U2 is the phase difference between the voltage signals of input elements 2 and 3.

- User-defined expressions can use other user-defined expressions with smaller numbers as operands.

Example The expression for user-defined function F3 can be set to $F1() + F2()$. This allows expressions that would otherwise exceed 120 characters in length to be computed. Set expressions in F1 and F2, and then set $F1() + F2()$ or $F1() / F2()$ in F3.

This function is also useful when defining multiple expressions that include common operands.

Example Set common operands in F1, and then set $F4 = F3() / F1()$ and $F5 = F4() / F1()$.

However, if you enter a user-defined expression with a number that is greater than or equal to its own number, correct results will not be obtained.

Example If you set user-defined function F3 to $F1() + F3()$ or to $F1() + F4()$, the computed result will be displayed as [-----] (no data) or [--OF--] (overflow).

Operator

The following operators can be used in expressions:

Operator	Example	Description
+, -, *, /	U(E1,OR1)-U(E2,OR1)	Basic arithmetic
ABS	ABS(P(E1,ORT)+P(E2,ORT))	Absolute value
SQR	SQR(I(E1,OR0))	Square
SQRT	SQRT(ABS(I(E1,OR3)))	Square root
LOG	LOG(U(E1,OR25))	Natural logarithm
LOG10	LOG10(U(E1,OR25))	Common logarithm
EXP	EXP(U(E1,OR12))	Exponent
NEG	NEG(U(E1,OR12))	Negation
SIN	SIN(URMS(E1))	Sine
COS	COS(URMS(E1))	Cosine
TAN	TAN(URMS(E1))	Tangent
ASIN	ASIN(URMS(E1))	Arcsine
ACOS	ACOS(URMS(E1))	Arccosine
ATAN	ATAN(URMS(E1))	Arctangent

Number and type of characters that can be used in expressions

- Number of characters: Up to 60
- Character type: Characters and spaces displayed on the keyboard

Press  on the keyboard to enter strings for operands and expressions. The selectable strings are as follows:

ABS(	NEG(	CF	HCF(	MN(
SQR(	SIN(	ITIME(	KFACT(	RMN(
SQRT(	COS(	THD(	EAU(	DC(
LOG(	TAN(	THF(	EAI(	AC(
LOG10(	PPK(	TIF(	PLLFRQ1(	PC(
EXP(	MPK(	HVF(	RMS(	

Formula setting examples

- An expression to determine the RMS value of the harmonic components of the voltage signal of input element 2

$$\sqrt{(\text{Total RMS voltage value})^2 - (\text{RMS value of the fundamental voltage signal})^2}$$

$$\text{SQRT}(\text{SQR}(\text{UK}(\text{E2},\text{ORT})) - \text{SQR}(\text{UK}(\text{E2},\text{OR1})))$$

Note

If an operand in an expression is undetermined, the computed result is displayed as [-----] (no data).

Example If the expression includes a measurement function of an element that is not installed, the computed result is displayed as [-----] (no data).

Specifying measured values from subunits during multi-unit synchronization (option / SY1)

During multi-unit synchronization, you can specify measurement items from subunits as operands in user-defined expressions. Add the following subunit prefix to the beginning of the measurement function operand:

Subunit 1: "SUB1:"

Subunit 2: "SUB2:"

Subunit 3: "SUB3:"

Subunit 4: "SUB4:"

Example 1)

RMS voltage (Urms) of element 1 in subunit 1

SUB1:URMS(E1)

RMS voltage (Urms) of element 1 in the main unit

URMS(E1)

Example 2)

Harmonic current of order 1 of ΣA on subunit 2 (Ik(1) of ΣA)

SUB2: IK(SA,OR1)

Harmonic current of order 1 of ΣA on the main unit (Ik(1) of ΣA)

IK(SA,OR1)

- Subunit efficiency and user-defined functions cannot be specified as operands.
- When synchronized operation is not in progress, values are displayed as "NAN."

Unit (Unit)

- Number of characters: Up to 8
- Character type: Characters and spaces displayed on the keyboard

Loading presets (Preset)

This instrument provides preset expressions for rotating-coordinate voltages and currents, such as i_d , i_q , v_d , and v_q , used in vector control of three-phase motors. When computing these parameters, load the presets and modify the expressions as necessary.

There are several types of presets.

Saving user-defined functions (Save UserDef)

File list (File List)

Specify the data save destination in the file list. You can perform file operations such as creating folders on the storage device, deleting and copying files, and changing file names.

Auto naming (Auto Naming)

This is the same function as Auto Naming for saving a setup.

File name (File Name)

This is the same function as File Name for saving a setup.

Saving (Save)

Saves the user-defined functions to the specified save destination using the specified file name.

Measurement stops during saving. Measurement resumes when saving is complete or is canceled.

Loading user-defined functions (Load UserDef)

Loads the user-defined functions from the file specified in the file list. The extension is .TXT.

For how to configure the file list display and how to operate files and folders, see “File list (File List).”

Loading (Load)

Loads the data from the specified file.

- If you change the extension of the saved data file using a PC or other device, the instrument will no longer be able to load the file.
- When user-defined functions saved in a file are loaded, the current functions are overwritten and cannot be restored.

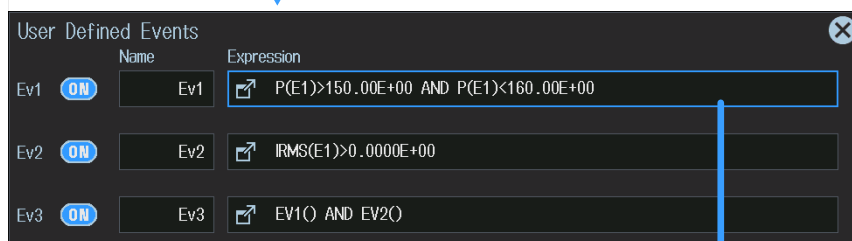
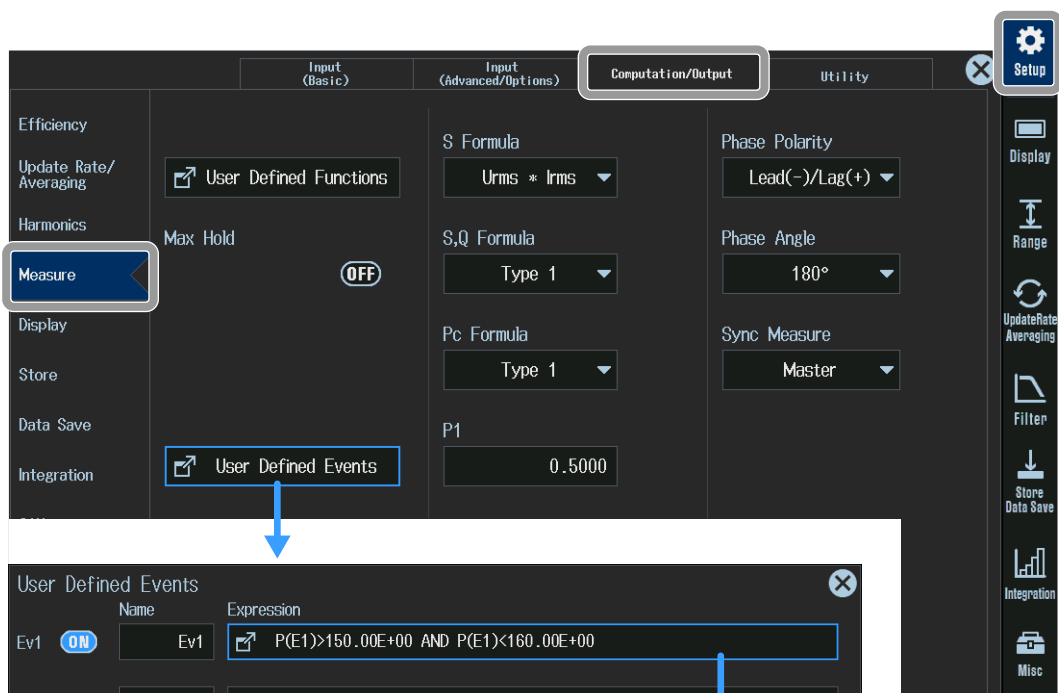
Save the current functions before loading, as necessary.

Procedure

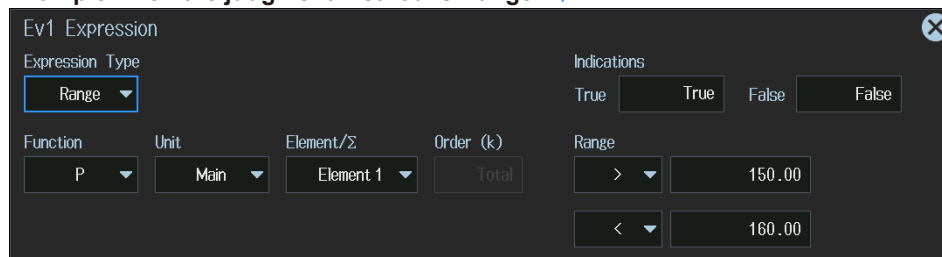
Displaying computed values (event) (User Defined Events)

Setup menu icon  > Computation/Output > Measure > User Defined Events > Name, Expression

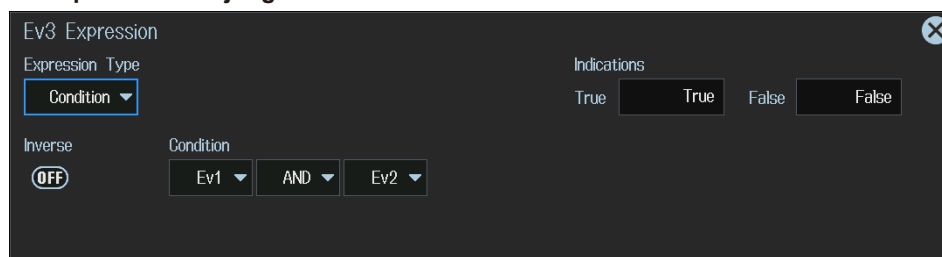
- When defining judgment conditions using a range of measured values:
 - > **Expression** > set Expression Type to **Range**
- When defining judgment conditions using a combination of events
 - > **Expression** > set Expression Type to **Condition**



Example when the judgment method is Range



Example when the judgment method is Condition



User-defined events can be used to trigger data storage. You can define up to eight user-defined events.

Note

- For procedures using the setup menu, see chapter 3.
 - Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.
-

Turning user-defined events ON or OFF

Select whether to enable (ON) or disable (OFF) user-defined events.

User-defined event name (Name)

- Number of characters: Up to 8
- Character type: Characters and spaces displayed on the keyboard

Judgment conditions (Expression)

Set the judgment conditions.

Judgment method (Expression Type)

Select the judgment method from the following options:

- Range (Range): Specify judgment conditions using ranges of measured values of measurement functions or comparisons with reference values.
- Condition (Condition): Specify judgment conditions using other user-defined events.

Indication of user-defined event occurrence (Indications)

Set the character strings to show when a user-defined event occurs (True) and when it does not occur (False).

- Number of characters: Up to 6
- Character type: Characters and spaces displayed on the keyboard

Range (Range)

Set the judgment condition for when you set the judgment condition specification method to Range.

- **Function (Function)**

The measurement function types that can be selected are the items listed in section 1.1, "Items That This Instrument Can Measure."

- **Unit (Unit)**

During multi-unit synchronization (option /SY1), you can specify operands of the subunits on the main unit, excluding efficiency and user-defined functions.

Select the target unit from the following:

Main, Sub 1, Sub 2, Sub 3, Sub 4

5.6 Displaying Computed Values (Numeric and Event)

- **Element (Element/Σ)**
 - If you select a function other than Speed, Torque, Pm, Slip, or SyncSp for Function (Function), the selected function determines whether you need to set an element or wiring unit from the following options or whether no setting is required. The available options vary depending on the installed elements.
Element 1, Element 2, Element 3, Element 4, ΣA, ΣB
 - When Speed, Torque, Pm, Slip, or SyncSp is selected for Function, select the motor number from the following: The available options vary depending on the installed motor-evaluation option.
Motor 1, Motor 2, Motor 3, Motor 4
- **Harmonic order (Order (k))**
This is the same as setting the harmonic order in All Items display of numeric data display.
- **Judgment condition**
Select the method for comparing the measured value and the reference value from the following:
OFF, <, <=, =, >, >=, != (not equal)
- **Reference value**
Set a value in the range from -9.9999 T to 9.9999 T.

Example: Settings for a condition that is true when 150 < the measured power value of element 1 < 160 W and false otherwise

Expression Type				Indications	
Range				True	False
				True	False
Function	Unit	Element/Σ	Order (k)	Range	
P	Main	Element 1	Total	>	150.00
				<	160.00

Condition (Condition)

Set the judgment condition for when you set the judgment condition specification method to Condition.

Invert judgment conditions AND/OR/END selection boxes

Inverse	Condition			
OFF	Ev1	AND	Ev2	END

Event selection boxes

- **Turning the judgment condition inversion ON or OFF (Inverse)**
Select whether to invert (ON) or not invert (OFF) the judgment (True/False) of the condition shown on the right.
- **Event selection box**
You can select the number of a user-defined event that is smaller than the number of the user-defined event that you are currently editing.

Example: When you are editing the conditions of user-defined event Ev3, you can select Ev1 or Ev2.

- **AND/OR/END selection box**

AND, OR

To use multiple user-defined events to configure a condition, select the method of combining the events from logical AND or logical OR.

When you select AND or OR, an event selection box appears to the right of the AND/OR/END selection box.

The number of user-defined events that you can combine is indicated below.

When you reach the maximum number of combinable user-defined events, no AND/OR/END selection box appears to the right of the last event.

- Ev1: 0 You cannot use other user-defined events as conditions. Set the judgment condition using a range.
- Ev2: 1 (Ev1)
- Ev3: 2 (Ev1 and Ev2)
- Ev4: 3 (Ev1 to Ev3)
- Ev5: 4 (Ev1 to Ev4)
- Ev6: 5 (Ev1 to Ev5)
- Ev7: 6 (Ev1 to Ev6)
- Ev8: 7 (Ev1 to Ev7)

END

Select END to end the definition of the condition. No event selection box appears to the right of an AND/ OR/END selection box that has been set to END.

Note

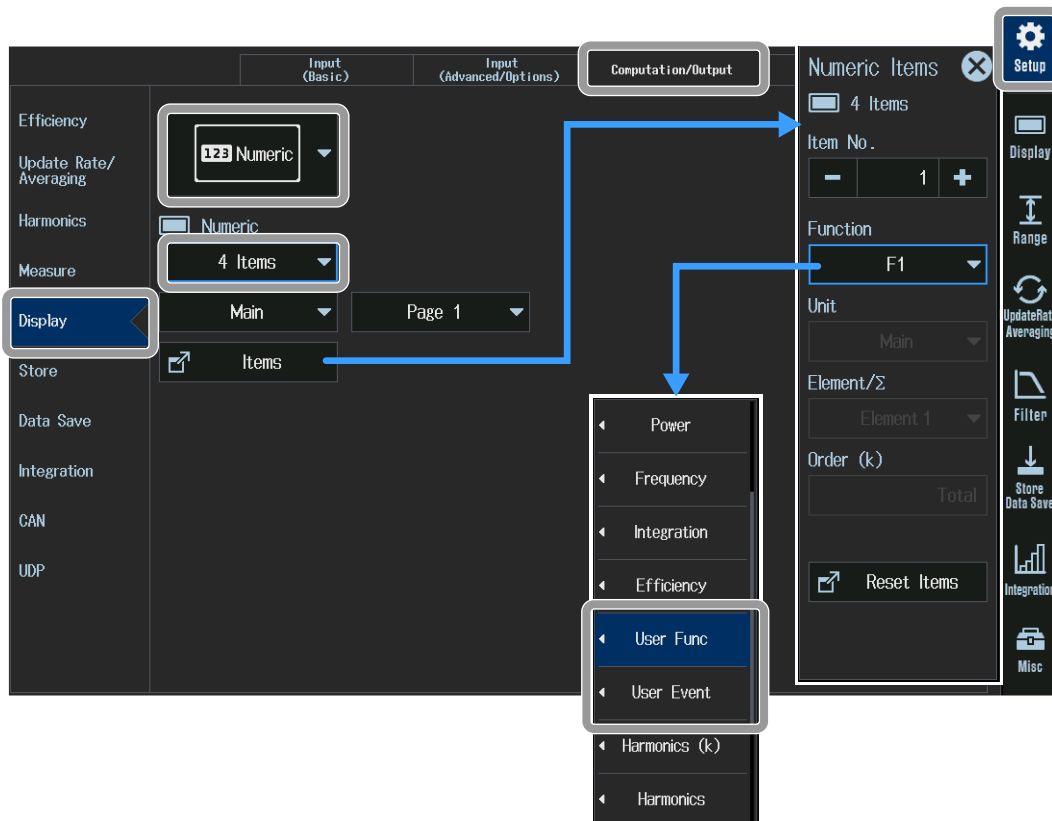
- If the event judgment condition is set using a range (Range) and the function of the judgment condition returns a value of [-----] (no data), judgment cannot be performed, so the judgment result will be FALSE.
Example The function for event Ev1 is set to integrated power (WP) and the judgment condition is set to $WH(E1) > 0$. When integration is not being performed, the measured data is displayed as [-----] (no data), so the judgment result for Ev1 is FALSE.
- If the judgment condition specification method is set to Condition and events that cannot be judged are included in the judgment condition, the judgment result is FALSE.
Example If the judgment condition for event Ev2 is set to $NOT(EV1())$ and the judgment for Ev1 is FALSE for the reason given above, the result for Ev2 is FALSE, not TRUE.

Procedure

Example of switching to 4 Items display

Setup menu icon  > Computation/Output > Display

- **Example of switching to 4 Items display**
> Set Numeric/Graph to **Numeric** > set All Items/4 Items/8 Items/16 Items/Matrix/Hrm List Single/Hrm List Dual in the Numeric menu to **4 Items**
- **Switching display items (Numeric Items)**
> **Items** in the Numeric menu > Item No., Function, Unit, Element/ Σ , Reset Items



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to switch the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Selecting the displayed item number (Item No.)

See "Menu Icons" (page vi).

Setting display items (Function)

Set the display items related to computed values (numeric, event).

Scroll through the display list, select User Func or User Event, and then set the display item.

Computed value (numeric) (User Func group):

F1 to F20 (user-defined function)

Computed value (event) (User Event group):

Ev1 to Ev8 (user-defined event)

Selecting the unit (Unit)

See "Menu Icons" (page vi).

Selecting the input element or wiring unit to configure (Element/ Σ)

See "Menu Icons" (page vi).

Resetting display items (Reset Items)

See "Menu Icons" (page viii).

5.7 Holding Maximum Values

Overview

This instrument displays the maximum measured values (measurement functions) for quantities such as voltage, current, and power on the screen.

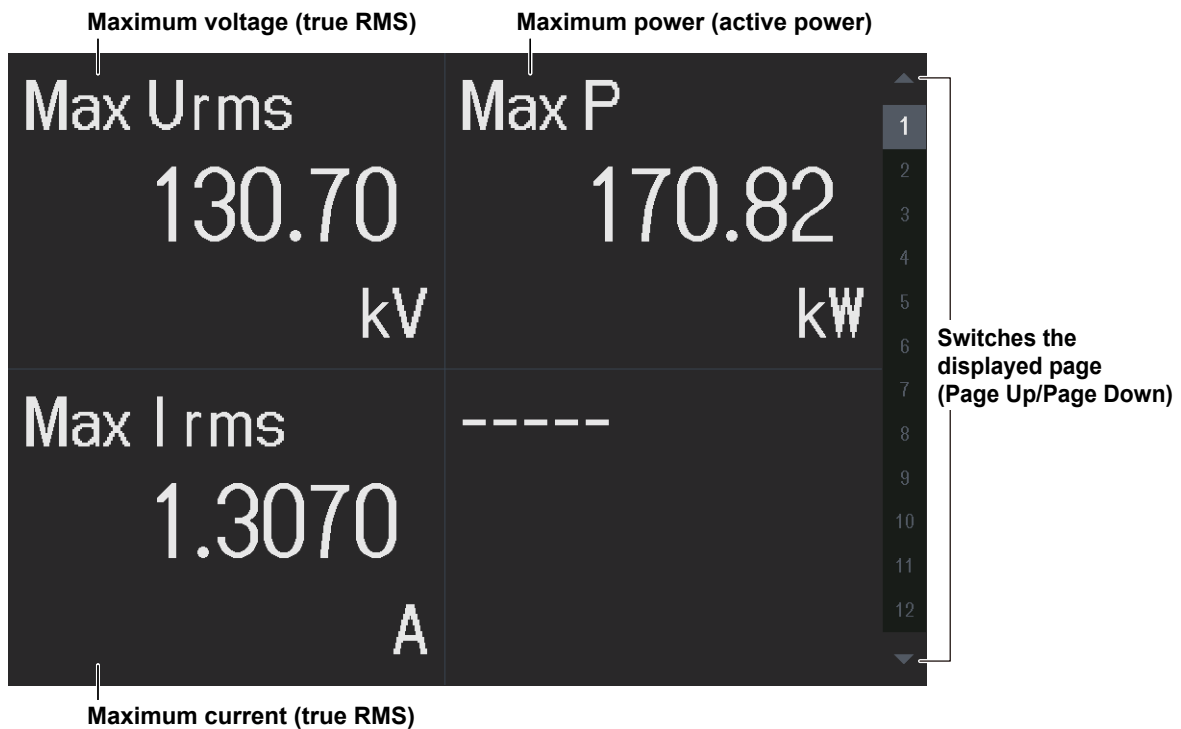
This section explains how to display maximum measured values, using display examples.

Measurement display screen (4 Items display example)

Measurement display of input element 1

The following maximum values are shown.

- Maximum true RMS voltage (Max Urms)
- Maximum true RMS current (Max Irms)
- Maximum active power (Max P)



Switching display pages (Page Up/Page Down)

Switches to the measurement display for another input element.

Select ▼ or ▲ to switch the display pages sequentially from the current page number. Select the number directly to switch to the corresponding display page.

Switching display items (Numeric Items)

If you continue selecting the measurement display area for 3 seconds or more, you can perform the operation described later in "Switching display items (Numeric Items)."

Procedure

Maximum hold (Max Hold)

Setup menu icon  > Computation/Output > Measure > set Max Hold to ON > User Defined Functions



The user-defined function setup screen shows five functions per screen. Up to 20 functions can be defined. In the setup example, the maximum true RMS voltage is set in F1, the maximum true RMS current is set in F2, and the maximum active power is set in F3.

F1: Maximum true RMS voltage (element 1) Max Urms1 = MAXURMS(E1)

F2: Maximum true RMS current (element 1) Max Irms1 = MAXIRMS(E1)

F3: Maximum active power (element 1) Max P1 = MAXP(E1)

When computation is set to ON, maximum values are displayed on the measurement display screen.

Note

- By default, the computed values of user definitions contain samples. Change them as necessary.
- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Maximum hold (Max Hold)

Select whether to hold the maximum numeric value (MAX value) (ON) or not (OFF). You can use user-defined functions to set the measurement functions whose maximum values are to be held. The operand types are listed below (measurement function: operand).

Urms: MAXURMS()	Irms: MAXIRMS()	P: MAXP()
Umn: MAXUMN()	Imn: MAXIMN()	S: MAXS()
Udc: MAXUDC()	Idc: MAXIDC()	Q: MAXQ()
Urmn: MAXURMN()	Irmn: MAXIRMN()	---
Uac: MAXUAC()	Iac: MAXIAC()	---
U+pk: MAXUPPK()	I+pk: MAXIPPK()	P+pk: MAXPPPK()
U-pk: MINUMPK()	I-pk: MINIMPK()	P-pk: MINPMPK()

For example, to hold the maximum value of the Urms for element 1, enter MAXURMS(E1) in the expression for a user-defined function, and enable maximum hold.

- For the symbols that can be set as arguments for each operand, see appendix 5.
- The maximum values of the above data are held while the maximum hold function is enabled.

Note

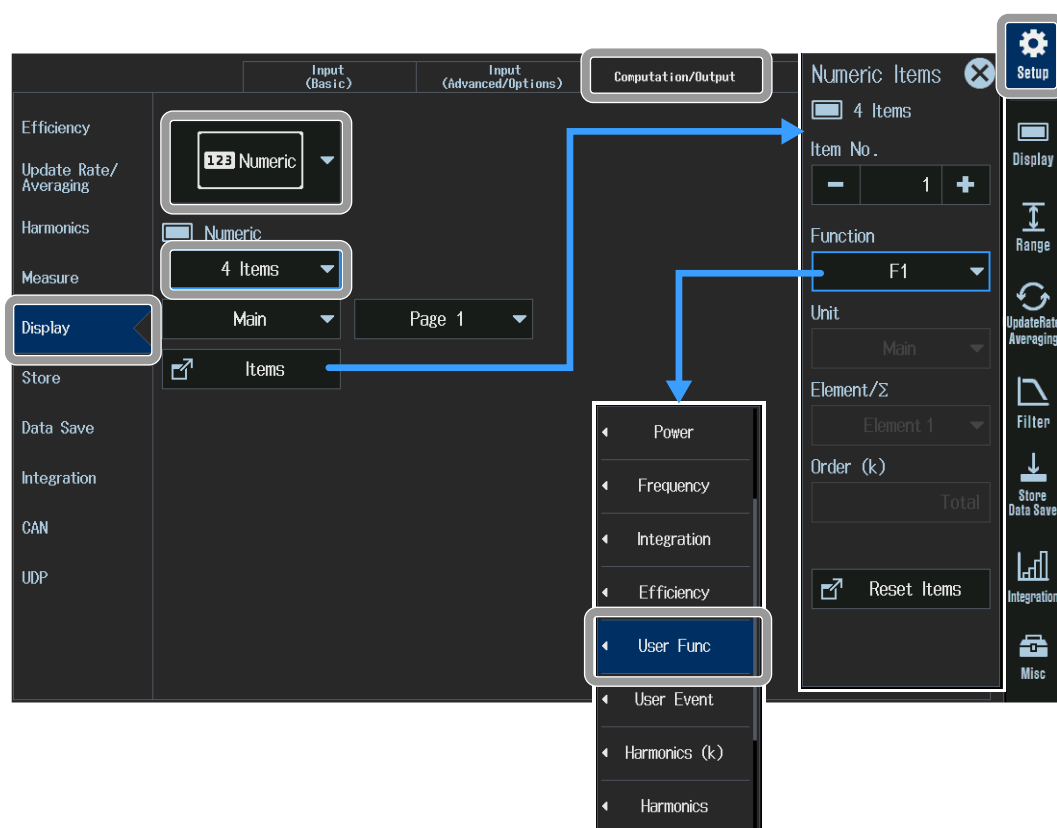
- When maximum hold is applied to measurement functions that have positive and negative values, this instrument compares the absolute values to determine the maximum value.
 - To reset held maximum values, turn maximum hold off, and then turn it on again.
-

Procedure

Example of switching to 4 Items display

Setup menu icon  > Computation/Output > Display

- **Example of switching to 4 Items display**
 - > Set Numeric/Graph to **Numeric** > set All Items/4 Items/8 Items/16 Items/Matrix/Hrm List Single/Hrm List Dual in the Numeric menu to **4 Items**
- **Switching display items (Numeric Items)**
 - > **Items** in the Numeric menu > Item No., Function, Unit, Element/ Σ , Reset Items



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to switch the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Selecting the displayed item number (Item No.)

See “Menu Icons” (page vi).

Setting display items (Function)

Set the display items related to maximum numeric values (Max Hold).

Scroll through the display list, select User Func, and then set the display item.

Maximum value (User Func group):

F1 to F20 (user-defined function)

Selecting the unit (Unit)

See “Menu Icons” (page vi).

Selecting the input element or wiring unit to configure (Element/ Σ)

See “Menu Icons” (page vi).

Resetting display items (Reset Items)

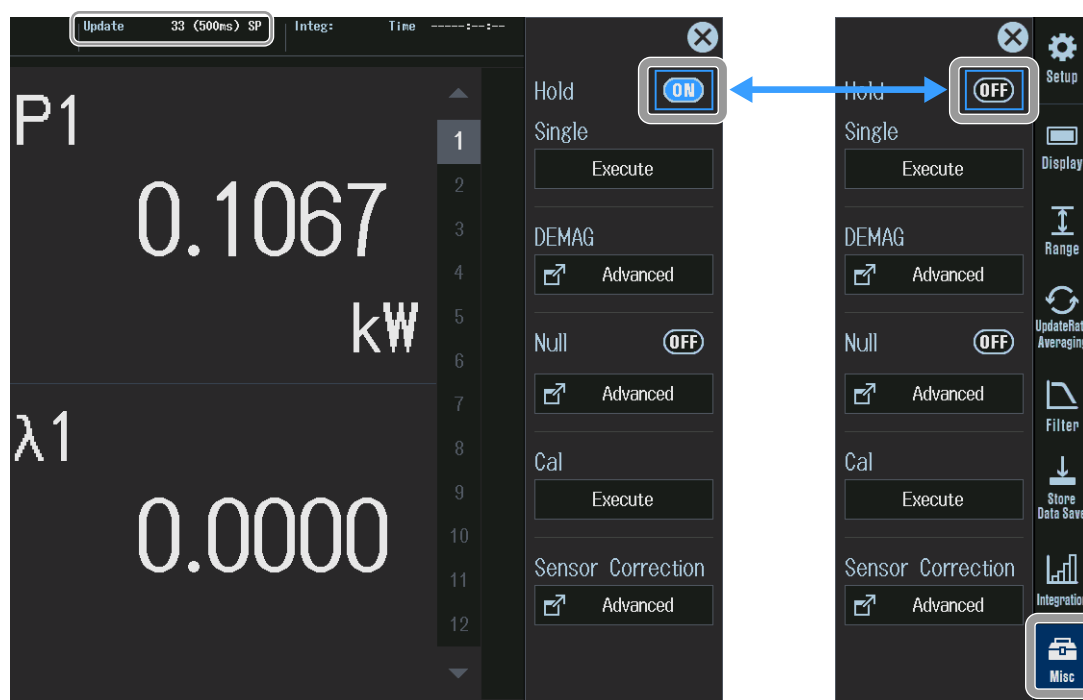
See “Menu Icons” (page viii).

6.1 Holding Measured Values

You can hold the data measurement and display operations that occur every data update interval and hold the display of all measurement function data. Values such as communication output also reflect numeric data that are being held.

Procedure

Misc menu icon  > Hold **ON/OFF**



Holding measured values (Hold, HOLD)

- **ON:** The HOLD key lights, and the displayed measured value is held. While holding is in effect, the data update counter at the top of the screen stops.
- **OFF:** This releases the held measured values. The measured data is then updated at the specified data update interval (see section 4.10).

Note

- Values in the numeric data list of communication output, and the like as well as the graph display are put on hold.
- During integration, the display is held, but measurement continues without stopping. For details on how holding works during integration, see the sections on holding and releasing integration (page 7-21).
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also press **HOLD** on the front panel to hold the measured values.



KEY TO
EXT MONITOR



6.2 Single Measurement

Procedure

Misc menu icon  > **Execute** under Single (single measurement)



Single measurement (Single Execute)

- While the display is held when the update mode is not Auto, the signal is measured once at the data update interval, and then the display is re-held.
If you select **Execute** for single measurement when the display is not held, measurement restarts from that point.
- When the update mode is Auto, single measurement is not available.

Note

- You can execute single measurement once while holding is in effect.
- For details on holding measurements, see section 6.1.

7.1 Setting Integration Conditions

This instrument can integrate the active power (watt hour), the current (ampere hour), the apparent power (volt-ampere hour), and the reactive power (var hour).

For the symbols and definitions of the measurement functions related to integrated power (watt hours), see page 1-3.

Note

Update mode and executing integration

- When the update mode is Constant or Auto, you can execute integration (start, stop, and reset).
 - If the update mode is Trigger and you execute integration, the update mode is automatically changed to Constant. When integration is reset, the update mode returns to Trigger.
-

Set the following items.

- Integration mode (Integration Mode)
- Integration timer (Integration Timer)
- Scheduled times for real-time integration (Start Time/End Time)
- Independent integration on/off (Independent Control)
- Integration source elements (Element Objects)
- Integration auto calibration on/off (Auto Cal)
- Watt hour integration method for each polarity (WP $\pm$ Type)
- Current mode for current integration (q Mode)
- Integration resume action after power failure recovery (Resume Action)

For details on start, stop, and reset (Start/Stop/Reset) operations for integration, see section 7.3.

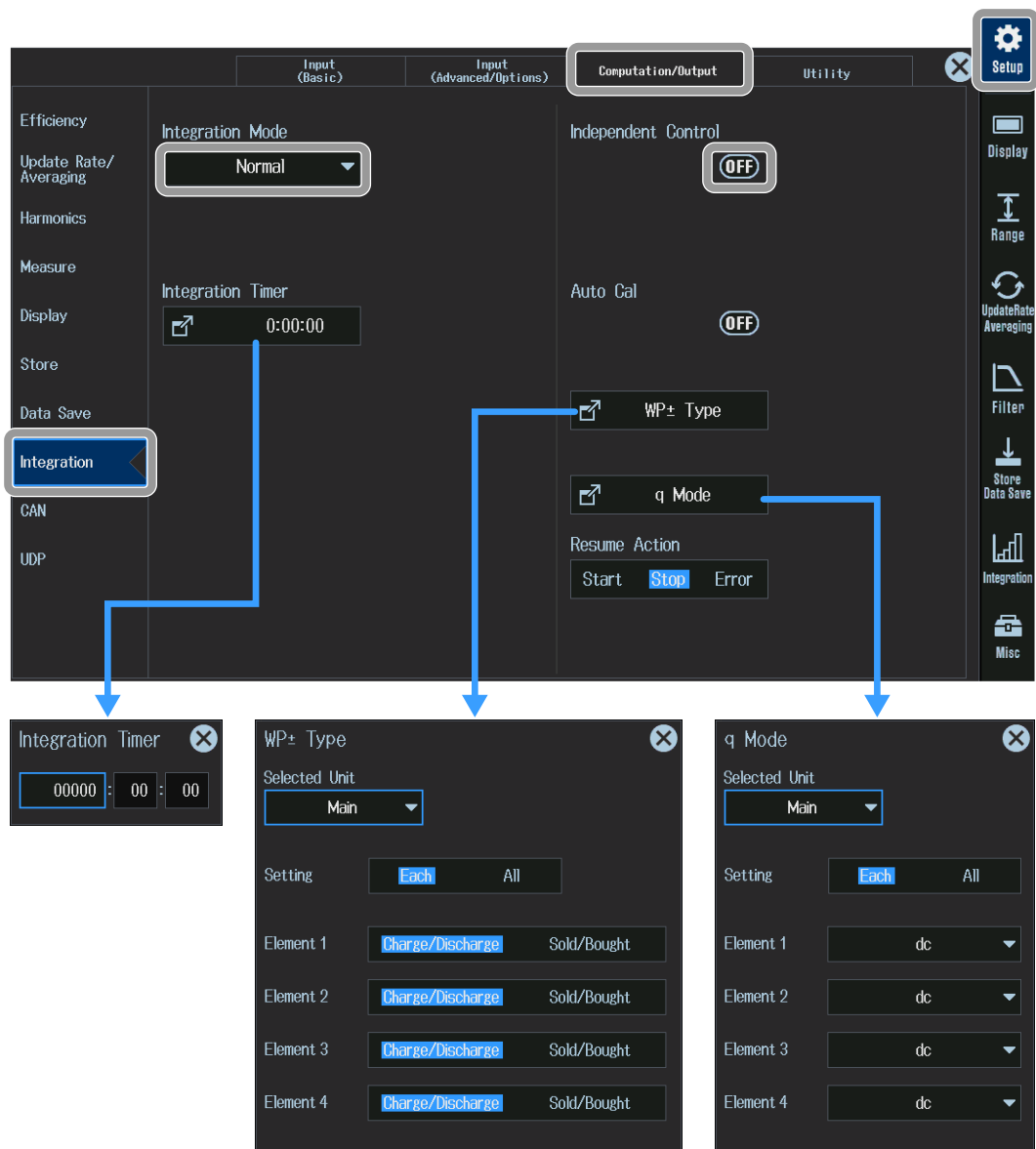
Procedure

Setup menu icon  > **Computation/Output** > **Integration**

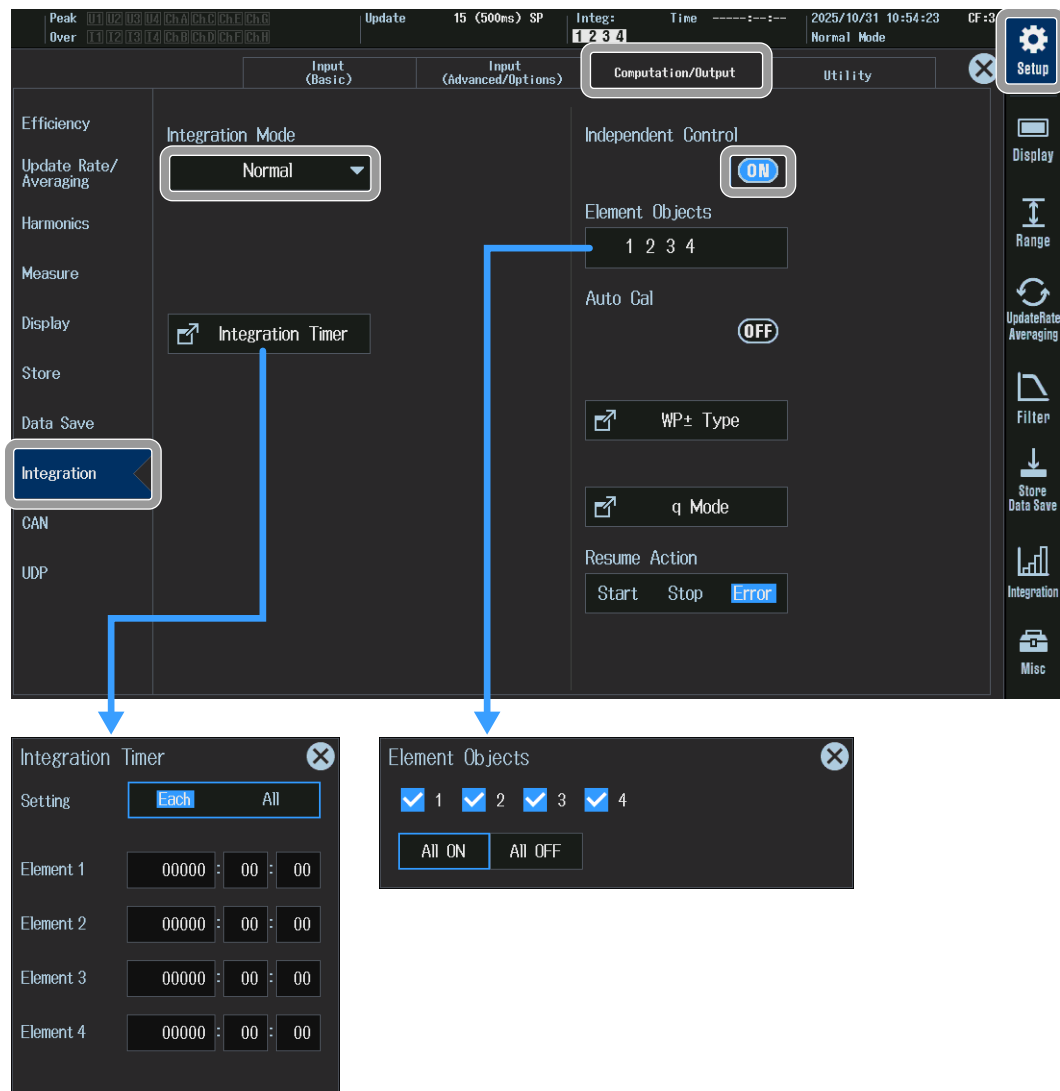
- **Setting the integration mode (Integration Mode)**
> Integration Mode menu, Normal/Continuous/R-Normal/R-Continuous
- **Independent integration on/off (Independent Control)**
> Independent Control menu, ON/OFF
- **Setting integration conditions (Integration)**
> Integration Mode, Integration Timer, Independent Control, Auto Cal, WP± Type, q Mode, Resume Action

When Integration Mode is set to Normal or Continuous

- **When independent integration is off**



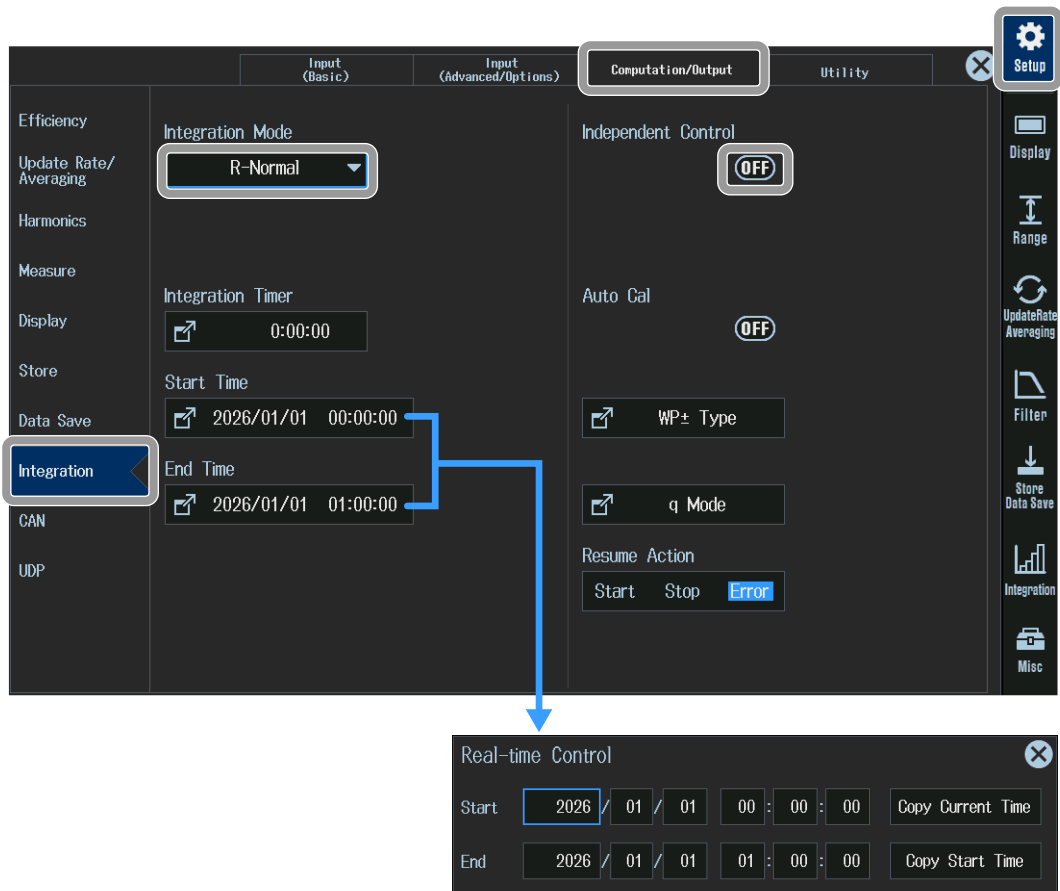
- When independent integration is on



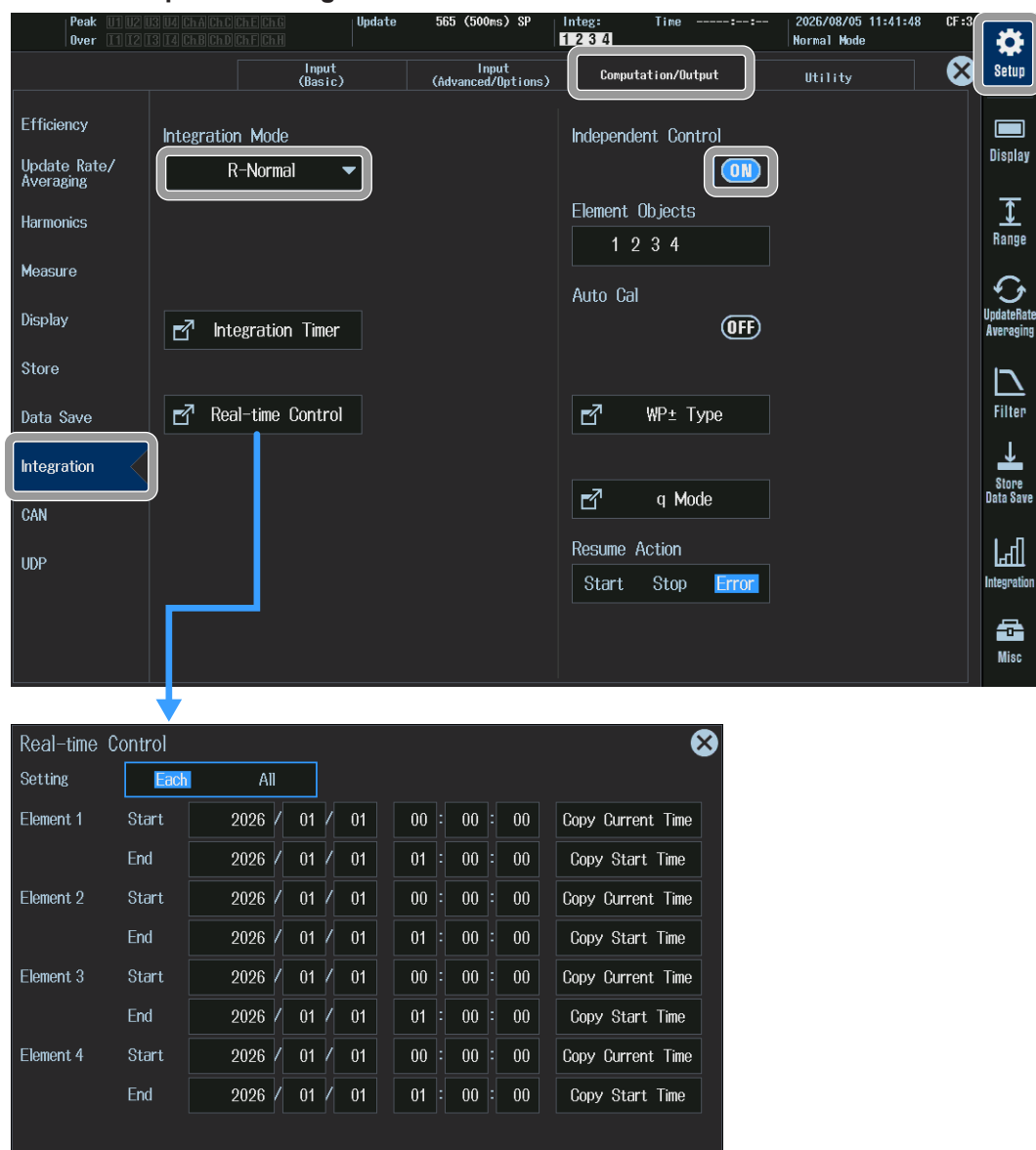
7.1 Setting Integration Conditions

When Integration Mode is set to R-Normal or R-Continuous

- When independent integration is off



- When independent integration is on



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Integration** menu icon  shown on the right side of the screen to set the integration conditions.
For details on the Integration menu, see page xiv.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Integration mode (Integration Mode)

The integration function has the following five modes.

Integration mode	Start	Stop	Repetition
Manual integration mode (Normal)	Select Start	Select Stop	---
Normal integration mode (Normal)	Select Start	Stopped by the timer	---
Continuous integration mode (Continuous)	Select Start	Select Stop	Repeats when the timer expires
Real-time normal integration mode (R-Normal)	Date and time	Date and time	---
Real-time continuous integration mode (R-Continuous)	Date and time	Date and time	Repeats when the timer expires

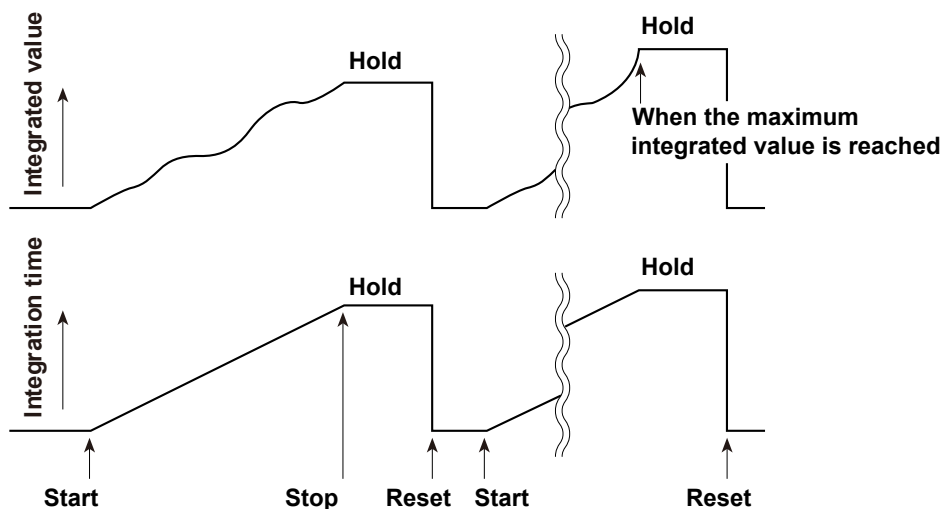
For details on start, stop, and reset (Start/Stop/Reset) operations for integration, see section 7.3.

When the update mode is Auto, only manual integration mode and normal integration mode can be used.

Manual integration mode

When you set the integration mode to **Normal** and the integration timer to 00000:00:00, this instrument performs integration in manual integration mode. After integration starts, it continues until you press **Stop**. However, if either of the conditions below is met, integration stops, and the integration time and integrated value are held.

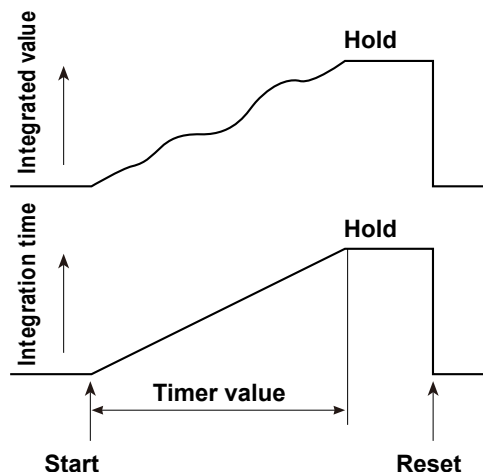
- The integration time reaches the maximum integration time (10000 hours).
- The integrated value reaches the maximum or minimum displayable value.



Normal integration mode (Normal)

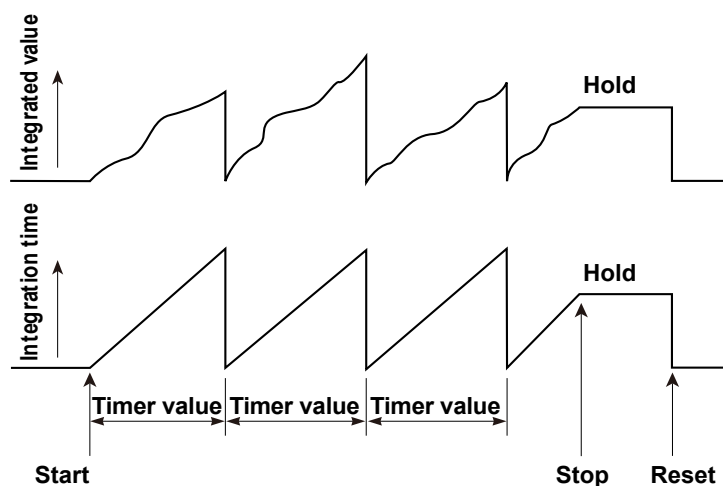
You can set a relative integration time (set a timer). Integration starts when you select **Start**. When any of the conditions below is met, integration is stopped, and the integration time and integrated value are held.

- The specified timer time elapses.
- Select **Stop**.
- The integrated value reaches the maximum or minimum displayable value.



Continuous integration mode (Continuous integration, Continuous)

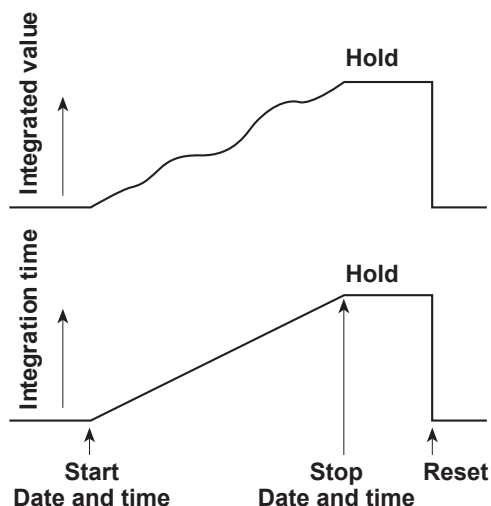
The integration time is set using relative time. Integration starts when you select **Start**. When the specified timer time elapses, integration resets, restarts, and repeats the process. Integration is repeated until you select **Stop**. However, if the integrated value reaches its maximum or minimum displayable value before the specified time elapses, integration stops, and the integration time and integrated value at that point are held.



Real-time normal integration mode (R-Normal)

Set the date and time when integration starts and stops and the duration of integration. Integration starts at the scheduled start time. When any of the conditions below is met, integration stops, and the integration time and integrated value are held.

- The scheduled stop time arrives.
- The specified timer time elapses.
- The integration time reaches the maximum integration time (10000 hours).
- The integrated value reaches the maximum or minimum displayable value.



Note

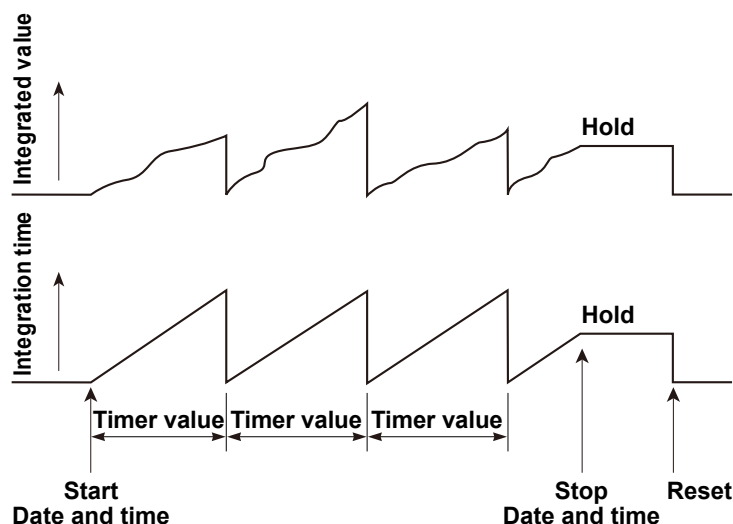
In real-time normal integration mode, when you set the integration time to 00000:00:00, integration starts at the scheduled start time. When any of the conditions below is met, integration stops, and the integration time and integrated value are held.

- The scheduled stop time arrives.
 - Select **Stop**.
 - The integration time reaches the maximum integration time (10000 hours).
 - The integrated value reaches the maximum or minimum displayable value.
-

Real-time continuous integration mode (Continuous integration, R-Continuous)

Set the date and time when integration starts and stops and the duration of integration. Integration starts at the scheduled start time. When the specified timer time elapses, integration resets, restarts, and repeats the process. If any of the conditions below is met, integration stops, and the integration time and integrated value are held.

- The scheduled stop time arrives.
- Select Stop.
- The integrated value reaches the maximum or minimum displayable value.



Integration timer (Integration Timer)

You can set the integration timer in the following range using the syntax hours:minutes:seconds. 00000:00:00 to 10000:00:00

When independent integration is off

The integration timer that you specified above applies to every element.

When independent integration is on

- **Setting (Setting)**

You can select the method for setting the integration timer from the following options.

- Each (Each): The setting is configured separately for each input element.
- All (All): The setting is configured collectively for all installed input elements.

- **Element 1 to Element 4**

You can set the integration timers for each element within the above range.

Note

When Mode is set to Normal and the integration timer is 00000 : 00 : 00, the instrument is in manual integration mode.

Scheduled times for real-time integration (Start Time/End Time)

This setting is valid in real-time normal integration mode and real-time continuous integration mode. You can set the year, month, day, hour, minute, and second of the integration start and stop times. Be sure to set the integration stop time later than the integration start time. You can set the values within the following ranges.

- Year: Four-digit year
- Hour:Minute:Second: 00:00:00 to 23:59:59
- Copy current time (Copy Current Time): The scheduled integration start time is set to the current time.
- Copy start time (Copy Start Time): The scheduled integration start time is copied to the scheduled integration stop time.

When independent integration is off

The scheduled times that you specified above apply to every element.

When Independent Integration is on (Scheduled time: Real-time Control)

- **Setting (Setting)**

You can select the method for setting the scheduled times from the following options.

- Each (Each): The setting is configured separately for each input element.
- All: The timer is set collectively for all installed input elements.

- **Element 1 to Element 4**

You can set the scheduled times for each element within the above range.

- **Copy current time (Copy Current Time)**

The scheduled integration start time is set to the current time.

- **Copy start time (Copy Start Time)**

The scheduled integration start time is copied to the scheduled integration stop time.

Note

- In the scheduled time settings, February can be set up to 31 days. If you specify an inappropriate date, an error message will appear when you start integration. Set the scheduled time again.
 - This instrument recognizes leap years when it performs integration.
 - In real-time normal integration mode and real-time continuous integration mode, after you select Start and this instrument enters into an integration-ready state, the numeric data may not be updated immediately. This is because the numeric data is updated in sync with the clock of this instrument. This ensures that the numeric data is updated at the same time as the scheduled integration start time and that the integration time is accurate.
-

Turning independent integration on/off (Independent Control)

You can select whether to start, stop, and reset integration on all elements simultaneously or separately.

- OFF: All elements are controlled simultaneously.
- ON: The following operation is performed depending on the Range Σ Link setting.
 - When Range Σ Link is on
Elements whose wiring system is 1P2W are controlled separately. For elements whose wiring system is not 1P2W, all elements assigned to the same wiring unit are controlled simultaneously.
 - When Range Σ Link is off
The integration of each element is controlled separately.

* When the update mode is Auto and independent integration is enabled, integration cannot be started.

Note

- When independent integration is enabled, Range Σ Link is disabled, and integration is controlled separately for elements in the same wiring unit, because the elements' integration periods differ, the Σ functions for those elements (the functions that deal with wiring unit integration, such as the integrated active power and apparent power functions) return errors.
- When multi-unit synchronization mode (page 17-8) is set to Main Unit or Sub Unit (not OFF), independent integration is disabled.

Integration source elements (Element Objects)

This setting is valid when independent integration is enabled.

- You can select which elements to start, stop, and reset the integration of by selecting the elements' check boxes.
- All ON (All ON): All elements are controlled.
- All OFF (All OFF): No elements are controlled.

Note

- Even if you enable independent integration, when Range Σ Link is enabled, the integration of elements in the same wiring unit is controlled simultaneously regardless of whether the elements' check boxes are selected.

Example

- Elements 1, 2, and 3 are assigned to wiring unit ΣA as a three-phase four-wire system.
- Under Element Object, the check box of element 1 is selected, but the check boxes of elements 2 and 3 are not.

If you start or stop the integration of element 1 under the above conditions, the integration of elements 2 and 3, whose check boxes are not selected, also starts or stops.

To independently control the integration of input elements that are assigned to the same wiring unit, you must enable independent integration and disable Range Σ Link.

- When multi-unit synchronization mode (page 17-8) is set to Main Unit or Sub Unit (not OFF), independent integration element is disabled.

Integration auto calibration on/off (Auto Cal)

Ordinary zero-level compensation takes place when the measurement range or line filter is changed, but you can also automatically calibrate the zero level during integration.

- ON: Zero-level compensation takes place automatically approximately once every hour during integration.
- OFF: Zero-level compensation does not take place automatically during integration.

When the update mode is Auto, integration auto calibration is set to off.

Note

When integration auto calibration is on and zero-level compensation is in progress, the power or current value measured immediately before is integrated.

Watt hour integration method for each polarity (WP ± Type)

Setting (Setting)

You can select the method for setting the integration method from the following options.

- Each (Each): The setting is configured separately for each input element.
- All (All): The setting is configured collectively for all installed input elements.

Element 1 to Element 4

Select the integration method from the following options.

- Charge/discharge (Charge/Discharge): Measure DC watt hours (for each sampled data item) by polarity.
- Sold/bought (Sold/Bought): Measure AC watt hours (for each data update) by polarity.

For the integration formulas, see appendix 1.

When the update mode is Auto, the integration method is set to Charge/Discharge.

Current mode for current integration (q Mode)

Setting (Setting)

You can select the method for setting the current mode from the following options.

- Each (Each): The setting is configured separately for each input element.
- All (All): The setting is configured collectively for all installed input elements.

Element 1 to Element 4

You can select the current mode from the following options. For the current formulas, see appendix 1.

- rms: true RMS value
- mean: Rectified mean value calibrated to the RMS value
- dc: Simple average
- r-mean: Rectified mean value
- ac: AC component

When the current mode is dc, the polarity (+ or -) is displayed.

Integration resume action after power failure recovery (Resume Action)

You can set how to resume the integration operation when the instrument is turned off due to a power failure or interruption and then turns back on.

Restart (Start)

The integration result at the time the power is turned off is stored. When the power recovers, integration starts (continues) automatically.

Stop (Stop)

The integration result at the time the power is turned off is stored. When the power recovers, the integration result up to the point when the power was turned off is displayed in the integration stopped state. You can start (continue) integration.

Error (Error)

The integration result at the time the power is turned off is stored. When the power recovers, the integration result up to the point when the power was turned off is displayed in the integration error state. You can start integration by resetting it. When integration is reset, the measurement result is displayed as “-----” (no data). If necessary, record the integration result up to that point before resetting it.

When the update mode is Auto, integration resume action after power failure recovery is according to the action described for “Error.”

Note

When multi-unit synchronization mode (page 17-8) is set to Main Unit or Sub Unit (not OFF), integration resume action is fixed to “Error.” If the instrument is turned off during integration, the integration status will be “Error” when the instrument is restarted, and integration cannot be restarted from the Start or Stop integration status.

7.2 Displaying Integrated Values (numeric display)

Overview

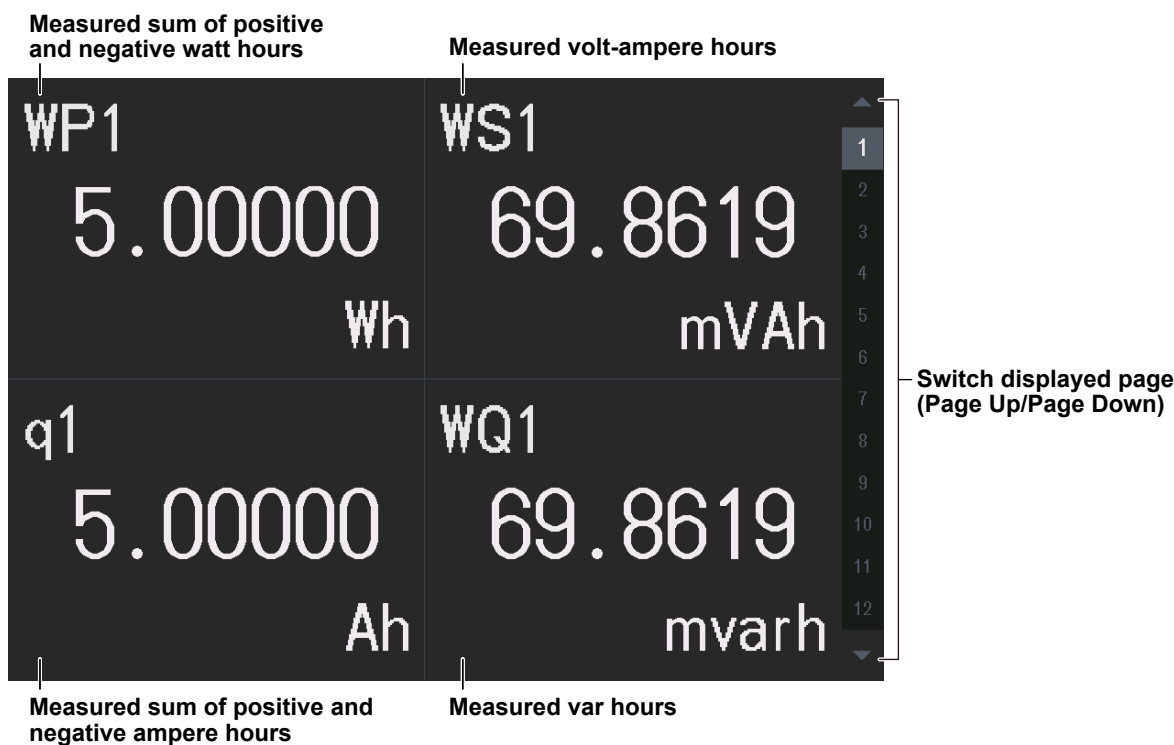
This instrument calculates the integrated value of power (watt hours) and the integrated value of current (ampere hours) from the voltage and current applied to the input elements or wiring units and shows the measurements (measurement functions) on the screen.

- Watt hours (WP, WP+, WP-) and ampere hours (q, q+, q-) do not require you to set formulas. The values are simply shown on the screen when integration is started.
- To determine the volt-ampere hours (WS) and var hours (WQ), you need to set the formulas for apparent power (S) and reactive power (Q). For the setup procedure, see section 5.4.

Using an example, this section explains how to display integrated values numerically.

Measurement display screen (4 Items display example)

Measurement display of input element 1



Switching display pages (Page Up/Page Down)

Switches to the measurement display for another input element.

Select ▼ or ▲ to switch the display pages sequentially from the current page number. Select the number directly to switch to the corresponding display page.

Switching display items (Numeric Items)

If you continue selecting the measurement display area for 3 seconds or more, you can perform the operation described later in "Switching display items (Numeric Items)."

Number of displayed digits (display resolution)

The number of displayed digits (display resolution) for an integrated value is six (the maximum value is 999999). When an integrated value reaches 1000000 counts, the decimal place shifts automatically.

Example If 0.001 mWh is added to 999.999 mWh, the display shows 1.00000 Wh.

Maximum and minimum displayable integrated values

Active power (WP): ± 999999 MWh
 Current (q): ± 999999 MAh
 Apparent power (WS): ± 999999 MVAh
 Reactive power (WQ): ± 999999 Mvarh

Display when integration overflow occurs

If either of the conditions below is met, integration stops, and the integration time and integrated value are held.

- The integration time reaches the maximum integration time (10000 hours).
- The integrated value of WP, q, WS, or WQ reaches the maximum or minimum displayable value given above.

Display when the update mode is Auto

WS and WQ are not measured and displayed as "-----" (no data).

Integration when the maximum hold function is enabled

This instrument determines and displays the integrated value by summing the value that is measured at every data update interval, irrespective of the maximum hold function (page 5-50).

Integration when the measured value exceeds the measurement limit

If a sampled instantaneous voltage or current exceeds the maximum or minimum measurement range limits of the AD circuit, the value is measured as the maximum or minimum measurement range limit value.

Integration when current input is small

If rounding to zero is on, when the current input meets the following conditions relative to the measurement range, integration is performed assuming the current to be zero.

- When the crest factor is set to CF3
 Irms or Iac is 0.3 % or less. Imn or Irmn is 2 % or less.
- When the crest factor is set to CF6 or CF6A
 Irms or Iac is 0.6 % or less. Imn or Irmn is 4 % or less.

Sample rate, and valid frequency ranges for integration

The sample rate during integration is approximately 2.5 MHz. The voltage/current signal frequencies that are valid for integration are as follows:

Integrated Item		Valid frequency range for integration
Active power		DC to approx. 1.25 MHz
Current	When integrating Irms	DC or the lower frequency limit determined by the data update interval to approximately 1.25 MHz
	When integrating Imn	DC or the lower frequency limit determined by the data update interval to approximately 1.25 MHz
	When integrating Idc	DC to approx. 1.25 MHz
	When integrating Irmn	DC or the lower frequency limit determined by the data update interval to approximately 1.25 MHz
	When integrating Iac	The lower frequency limit determined by the data update interval to approximately 1.25 MHz

7.2 Displaying Integrated Values (numeric display)

Limitations on modifying the settings during integration

During integration, there are some settings that you cannot change and functions that you cannot execute. For details, see appendix 8.

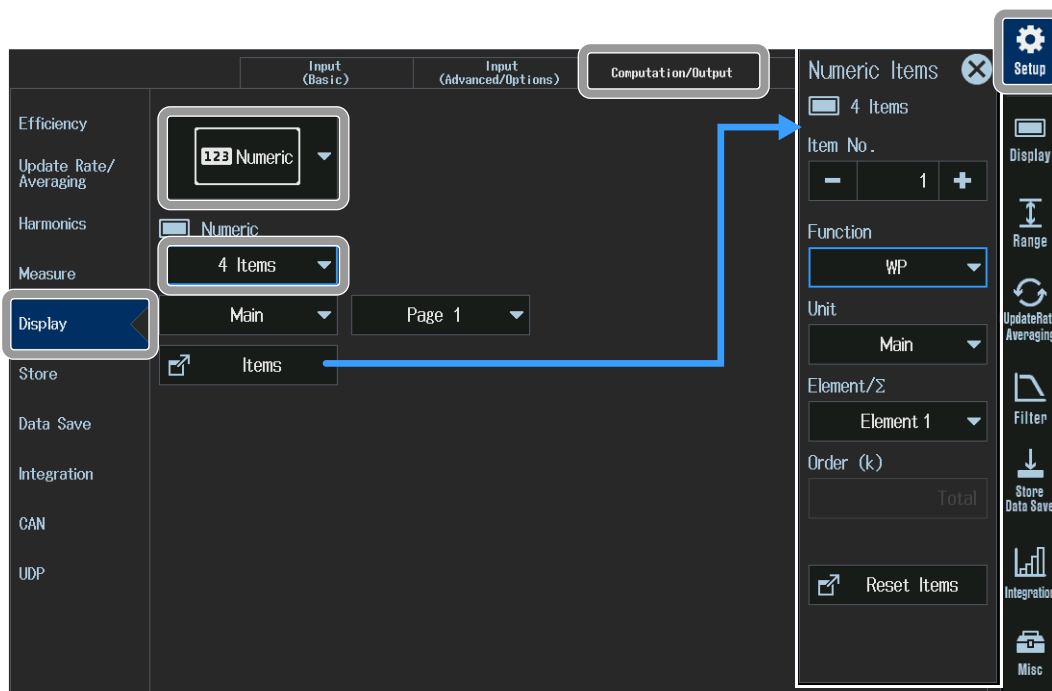
Limitations on waveform display during integration

- During integration, the waveform display trigger does not function. Therefore, the signal level of the waveform display at the left edge of the screen may not be stable.
- During integration, the shortest possible waveform data update interval is 1 s. If you select an update interval shorter than 1 s, the numeric data and waveform data will contain measured values for different measurement periods.

Procedure

Setup menu icon  > **Computation/Output** > **Display**

- **Example of switching to 4 Items display**
 - > Set Numeric/Graph to **Numeric** > set All Items/4 Items/8 Items/16 Items/Matrix/Hrm List Single/Hrm List Dual in the Numeric menu to **4 Items**
- **Switching display items (Numeric Items)**
 - > **Items** in the Numeric menu > Item No., Function, Unit, Element/ Σ , Order (k), Reset Items



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to switch the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Selecting the displayed item number (Item No.)

See “Menu Icons” (page vi).

Setting display items (Function)

Set the display items related to integration. Scroll through the display list and select Integration, and then set the display items. You can set display items from all of the following items.

Integrated value (Integration group):

ITime (integration time), WP (sum of positive and negative watt hours), WP+(sum of positive P values), WP-(sum of negative P values), q (sum of positive and negative ampere hours), q+(sum of positive I values), q-(sum of negative I values), WS (volt-ampere hour), WQ (var hour)

Selecting the unit (Unit)

See “Menu Icons” (page vi).

Selecting the input element or wiring unit to configure (Element/ Σ)

See “Menu Icons” (page vi).

Harmonic order (Order (k))

See “Menu Icons” (page vi).

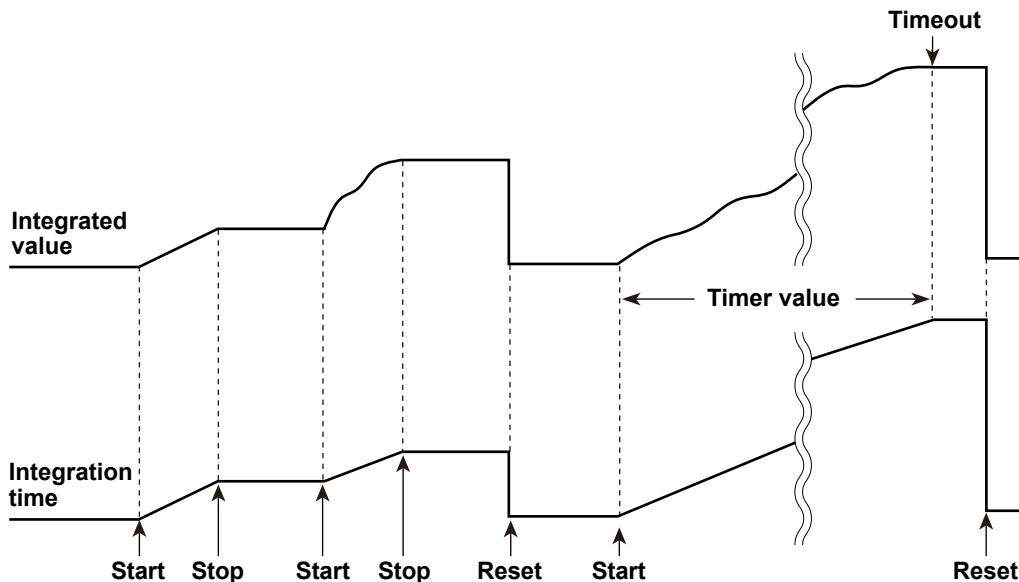
Resetting display items (Reset Items)

See “Menu Icons” (page viii).

7.3 Starting, Stopping, and Resetting Integration

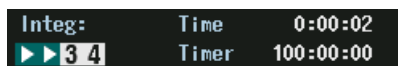
Overview

You can start, stop, and reset integration using the Integration menu or communication commands. The relationship between the integration operation and start, stop, and reset is as follows:



Integration indications

The integration status (running, paused, end), independent integration on/off state, integration time, and so on are shown at the top of the screen.



At integration reset

The following is displayed when the integrated value is reset and integration can be started.

- When independent integration is off: No display
- When independent integration is on: Element numbers in reset mode

When integration is running

 and the elapsed integration time appear when integration is running.

When integration is paused

 and the elapsed integration time appear when integration is not running.

- If you select **Stop** and integration is forcibly stopped,  is displayed. If you select **Start** at this point, integration resumes.
- If the integration mode is real-time normal integration or real-time continuous integration and the scheduled integration stop time arrives causing the integration to automatically stop,  is displayed. Even if you select Start at this point, integration cannot resume. To start integration, reset integration.

When integration is ready

If you select **Start** in a real-time integration mode and the current time is before the scheduled integration start time,  and the scheduled integration start time are displayed.



When integration times out

When the integration timer expires, integration stops automatically, and  and the elapsed integration time are displayed.

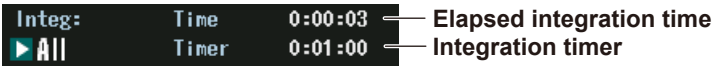
Error

In the following cases, integration stops automatically, and  and the elapsed integration time are displayed.

- The integration time reaches the maximum integration time (10000 hours).
- The integrated value reaches the maximum or minimum displayable value.
- A power failure occurs during integration.

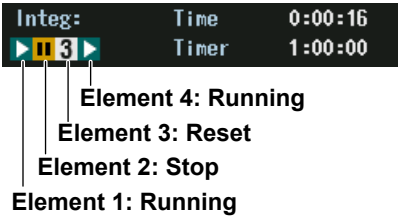
Even if a power failure occurs, this instrument retains the integration results. The operation when power is restored after a power failure is set using the integration resume action after power failure recovery.

Example of the display when the integration timer is set to a non-zero value



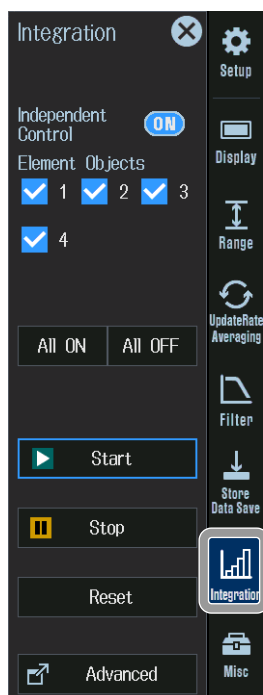
Example of the display when independent integration is enabled

Integration status of each element



Procedure

Integration menu icon  > Start, Stop, Reset



Integration start (Start)

- Integration starts under each of the following conditions depending on the integration mode.
 - Manual integration mode, normal integration mode, and continuous integration mode
Integration starts immediately.
 - Real-time normal integration mode and real-time continuous integration mode

This instrument enters into an integration-ready state. Integration starts when the scheduled start time arrives.

- When integration starts, the integration status shows .
- When integration is ready, the integration status shows .

Integration stop (Stop)

- You can manually stop integration. The integration time and integrated value are held.
- When integration is manually stopped, the integration status shows . If you select **Start** at this point, integration resumes. However, when integration stops automatically, as described later, you cannot resume integration by selecting Start.

Automatic stopping of integration

- Integration stops automatically under each of the following conditions depending on the integration mode. The integration time and integrated value are held. If integration stops automatically, you cannot resume integration by selecting Start. To start integration, reset integration.
- When the integration mode is set to manual integration, normal integration, or real-time normal integration
After the specified timer time elapses, integration stops automatically. The integration status shows .
- When the integration mode is set to real-time normal integration or real-time continuous integration
When the scheduled integration stop time arrives, integration stops automatically. The integration status shows .

Integration reset (Reset)

The integration time and integrated value are reset. The displays for integration-related functions change to “-----” (no data).

Note

When an integration error occurs, the integration status shows .

Holding integration and releasing the hold

Holding integration

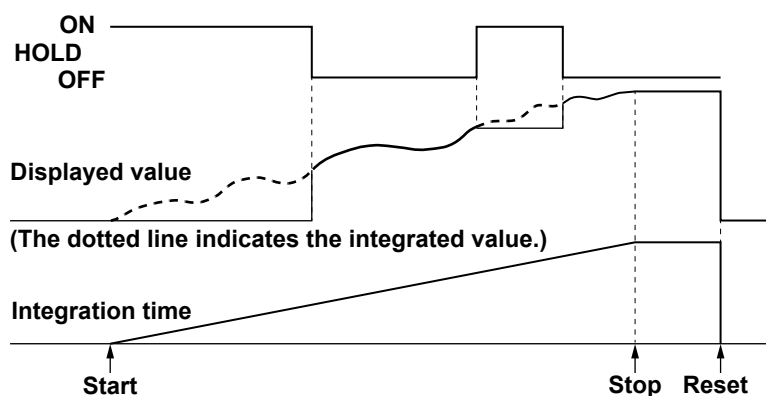
If you turn Hold on in the **Misc** menu (page xv) or press **HOLD** on the front panel, HOLD lights, and the integration result display and communication output are held. The integration operation continues regardless of whether the result is held.

Releasing hold

When hold is active, if you turn Hold on in the **Misc** menu or press **HOLD** on the front panel, HOLD turns off and the numeric data display is updated. When hold is active, you can also update the display by performing a single measurement (select Execute for Single measurement in the Misc menu).

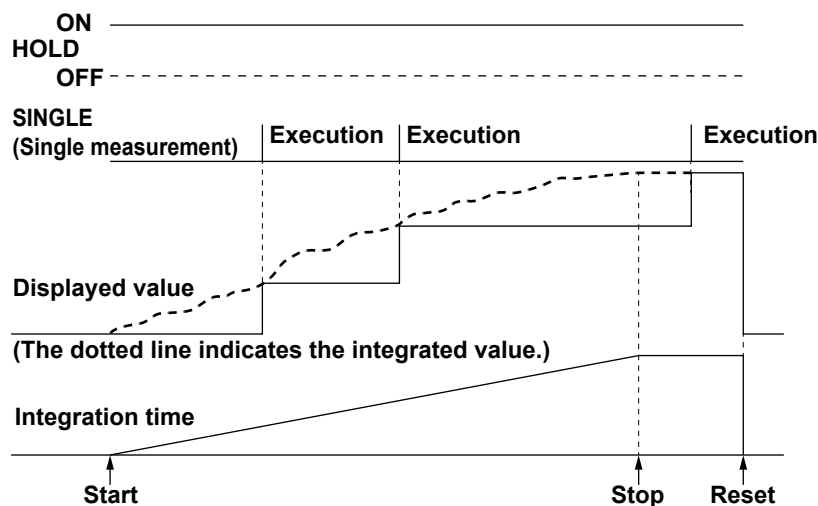
The relationship between the hold function and start and stop is as follows:

- Even if integration is started during hold, the display and communication output do not change. If hold is released (OFF) or a single measurement is performed, the integration result at that point is displayed and output through communication.



7.3 Starting, Stopping, and Resetting Integration

- Even if integration is stopped during hold, the display and communication output remain at the values held when hold was activated. If hold is released (OFF) or a single measurement is performed, the integration result at the time integration stopped is displayed and output through communication.



Note

When multi-unit synchronization mode (page 17-8) is set to Main Unit or Sub Unit (not OFF), start, stop, and reset operations for integration cannot be performed while the synchronized operation status is OFF or Standby. After connecting the multi-unit synchronization link, set the synchronized operation status to Operating, and then perform the integration start, stop, and reset operations.

- During multi-unit synchronized operation, integration hold and release are treated as display hold, so they do not operate in conjunction with the subunits, and only the main unit is held and released.
- When multi-unit synchronization is in progress, integration start, stop, and reset operations are linked across all units.

8.1 Setting Harmonic Measurement Conditions

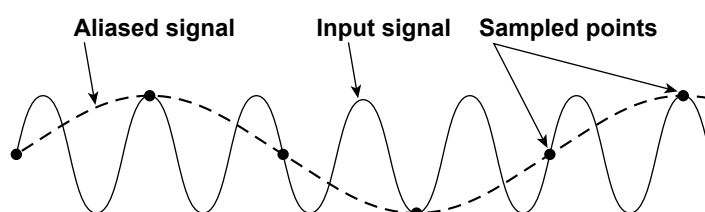
Using harmonic measurement, you can measure harmonic components and content ratios of voltage, current, and power, as well as the phase angle of each harmonic with respect to the fundamental wave. You can also compute the harmonic distortion factor for voltage and current.

Note

- For the symbols and meanings of the measurement functions that can be measured by harmonic measurement, see page 1-4.
- When the data update interval is 10 ms, harmonic measurement is disabled.

Anti-aliasing filter

When FFT computation is performed on an A/D-converted repetitive waveform, a phenomenon occurs in which frequency components higher than one-half the sampling frequency are recognized as low-frequency components. This phenomenon is called aliasing.



Aliasing causes problems in harmonic measurement for each harmonic order, such as increased measurement errors and incorrect phase-angle measurements. An anti-aliasing filter is used to prevent aliasing and remove high-frequency components that are unnecessary for harmonic measurement.

Example Measuring up to the 50th harmonic of an input signal with a fundamental frequency of 50 Hz. The frequency of the 50th harmonic is 2.5 kHz. A 5 kHz anti-aliasing filter is used to remove high-frequency components near 5 kHz and above that are unnecessary for harmonic measurement.

In this instrument, the line filter is used as an anti-aliasing filter for harmonic measurement. For the setup procedure, see section 4.6.

Turning on the anti-aliasing filter (line filter) changes the accuracy and the upper limit of the measurement bandwidth. For details, see section 5.9 of the Getting Started Guide (IM WT1501-02EN).

Procedure

Setup menu icon  > **Computation/Output** > **Harmonics**

- **Unit to configure (Selected Unit)**
> Main/Sub 1/Sub 2/Sub 3/Sub 4 in the Selected Unit menu
- **Setting harmonic measurement (Harmonics)**
> Elements, PLL Source, Min Order, Max Order, Thd Formula, FFT Points
- **Setting input element groups (Element Settings)**
> Elements menu > Hrm ①/Hrm ②



Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Unit to configure (Selected Unit)

During multi-unit synchronization (option /SY1), specify the unit on the main unit, and set the harmonic measurement conditions for each unit.

Select from the following:

Main, Sub 1, Sub 2, Sub 3, Sub 4

Input element groups (Elements)

You can divide the input elements into two groups, Hrm ① and Hrm ②, and measure harmonics using two PLL sources with different frequencies. This allows you to measure the input and output harmonics of an AC-AC converter whose input and output frequencies differ at the same time.

Element 1 to Element 4

Select Hrm ① or Hrm ② for the group of each element. Input elements assigned to the same wiring unit are set to the same group.

PLL source (PLL Source)

To perform harmonic measurement, you need to determine the fundamental period (the period of the fundamental wave) that serves as the reference for harmonic order analysis. The signal used to determine this fundamental period is called the PLL (Phase Locked Loop) source.

Select the PLL source for group Hrm ① or Hrm ② from the options below. The available options vary depending on the installed elements.

U1, I1, U2, I2, U3, I3, U4, I4, Ext Clk,¹ CommPLL1²

- 1 When Ext Clk is selected, harmonic measurement is performed using the frequency of the signal input to the external clock input terminal (EXT CLK) on the rear panel as the fundamental frequency. For the specifications of the EXT CLK terminal, see section 2.15 of the Getting Started Guide (IM WT1501-02EN).
- 2 This can be selected only for Hrm ① when operating in multi-unit synchronization mode (option /SY1).

Common PLL1 signal (CommPLL1 Setting)

During multi-unit synchronization (option /SY1), selecting CommPLL1 as the PLL source for Hrm ① lets you specify a common PLL signal that can be shared among units.

Common PLL1 signal (CommPLL1)

Use this when an input channel of a unit operating in synchronization with multiple units is used as the common PLL source.

- Common PLL1 signal unit: Select the unit for the Common PLL1 signal.
Main, Sub 1, Sub 2, Sub 3, Sub 4 (depending on the number of connected subunits)
- Common PLL1 signal source: Select the source for the Common PLL1 signal.
U1, I1, U2, I2, U3, I3, U4, I4 (depending on the number of installed elements), Ext Clk

Note

- Set a signal with the same period as the signal to use for harmonic measurement. For stable harmonic measurement, select an input signal with little distortion as the PLL source. If the fundamental frequency of the PLL source fluctuates or the waveform is distorted so that the fundamental frequency cannot be measured, correct measurement results cannot be obtained. If the measured device is a switching power supply or similar device and the voltage signal has less distortion than the current signal, we recommend setting the PLL source to voltage.
- If all input signals are distorted or their amplitude levels are small relative to the measurement range, the specifications may not be satisfied. To measure higher-order harmonics more stably and accurately, set the PLL source to external clock and input a signal with the same period as the input signal to the external clock input terminal.

8.1 Setting Harmonic Measurement Conditions

- If the fundamental frequency of the input signal is at or below the following frequencies and contains high-frequency components, we recommend turning the frequency filter on and setting the cutoff frequency as follows:

Fundamental frequency of input signal	Cutoff frequency of frequency filter
100 Hz or less	0.1 kHz
1 kHz or less	1 kHz
10 kHz or less	10 kHz
100 kHz or less	100 kHz

- If the amplitude level of the signal input to the element set as the PLL source is small relative to the measurement range, PLL synchronization may not be established.
 - If the crest factor is set to CF3 (see section 4.9), set the measurement range so that the amplitude level of the PLL source is 50 % or more of the measurement range.
 - If the crest factor is set to CF6 or CF6A, set the measurement range so that the amplitude level of the PLL source is 100 % or more of the measurement range.
 - When the frequency of the PLL source changes, correct measured values are displayed from the fourth data update after the change. Immediately after the PLL source frequency changes or the PLL source setting is changed, correct measured values may not be obtained because the PLL circuit in this instrument must redetect the PLL source frequency.
-

Measured harmonics (Min Order/Max Order)

You can set the harmonic measurement range for groups Hrm ① and Hrm ②. The harmonics specified here are used to obtain the numeric data for the distortion factor. See the next page.

Minimum harmonic order to measure (Min Order)

Select from the following:

- 0: Includes the 0th-harmonic (DC) component when obtaining Numeric data for harmonics.
- 1: Does not include the 0th-harmonic (DC) component when obtaining Numeric data for harmonics. Harmonic measurement data (harmonic data) is obtained starting from the 1st-harmonic (fundamental) component.

Maximum harmonic order to measure (Max Order)

Setting range: 1 to 100

However, the upper limit of the measurable harmonic order is the smallest of the following:

- The specified maximum harmonic order to measure
- A value determined automatically by the PLL source frequency
See section 5.9 of the Getting Started Guide (IM WT1501-02EN).

Numeric data fields for harmonics above the upper limit of the measurable harmonic order show [-----], indicating no data.

Note

- When the minimum harmonic order to measure is set to 1, DC component data is not included when obtaining numeric data for the distortion factor.
 - For harmonic numeric data from the 0th harmonic (DC) to the 100th harmonic, there is no overload indication [--OL--] or zero indication (rounding to zero). For overload indication and zero indication (rounding to zero) for measurement functions in normal measurement, see section 5.9 of the Getting Started Guide (IM WT1501-02EN).
 - When the update mode is Constant and the data update interval is set to 10 ms, harmonic measurement is not performed.
-

Distortion factor formula (Thd Formula)

When obtaining the harmonic measurement functions Uhdf, lhdf, Phdf, Uthd, lthd, and Pthd, select the denominator of the formula from the options below. For the formula, see appendix 1.

1/total (1/Total)

Measured data for all harmonics from the minimum measured harmonic (0th or 1st) to the maximum measured harmonic (within the upper limit of the measured harmonics) is used as the denominator.

1/fundamental (1/Fundamental)

Measured data for the fundamental (1st) component is used as the denominator.

8.2 Displaying Harmonic Measurements (numeric display)

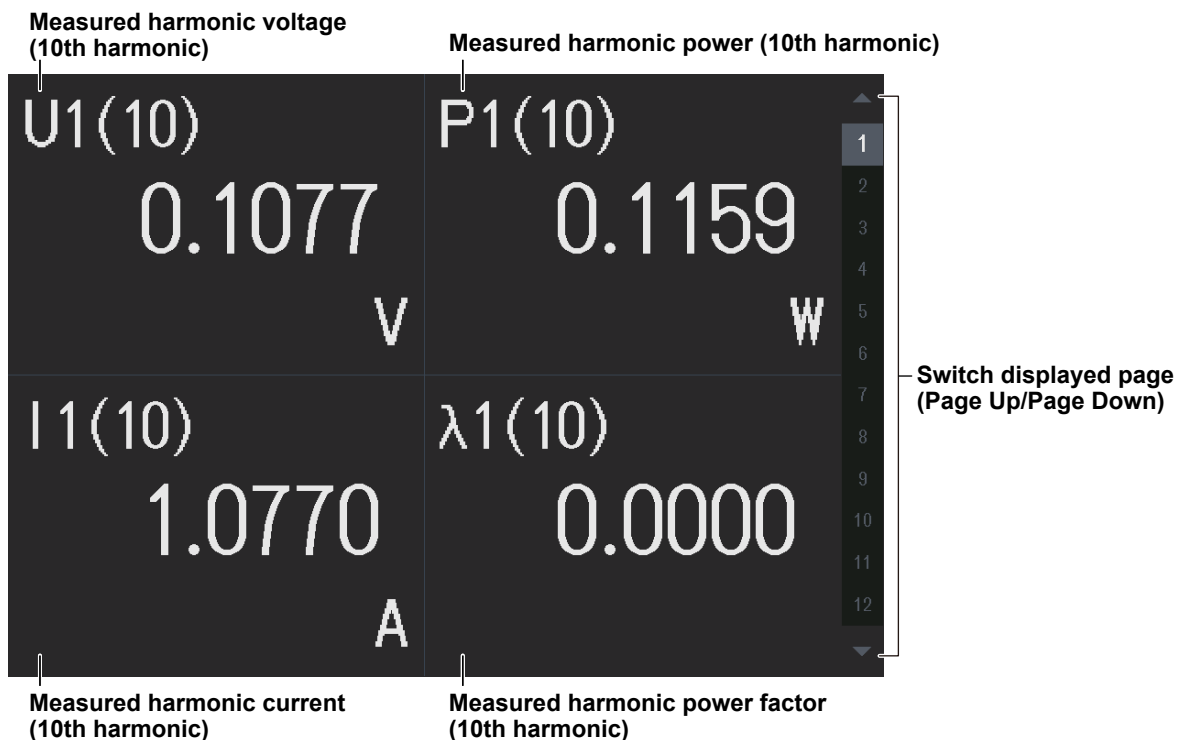
Overview

This instrument displays harmonic measurements (measurement functions) on the screen based on the voltage and current input to the input elements or wiring units.

This section explains how to display harmonic measurements numerically, using display examples.

Measurement display screen (4 Items display example)

Measurement display of input element 1



Switching display pages (Page Up/Page Down)

Switches to the measurement display for another input element.

Select ▼ or ▲ to switch the display pages sequentially from the current page number. Select the number directly to switch to the corresponding display page.

Switching display items (Numeric Items)

If you continue selecting the measurement display area for 3 seconds or more, you can perform the operation described later in "Switching display items (Numeric Items)."

Note

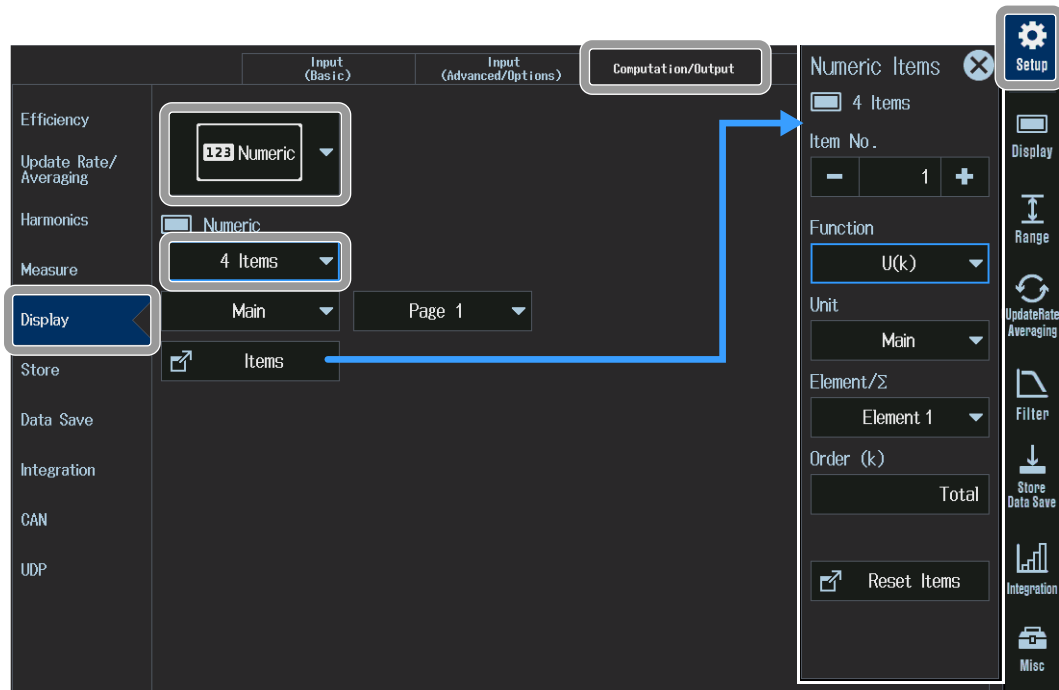
Harmonic measurements can be shown graphically.

- The bar graph display (see section 9.3) shows the magnitude of each harmonic graphically.
- The vector display (see section 9.4) shows the phase difference and magnitude relationship between the fundamental voltage U(1) and current I(1) of each element in the wiring unit.

Procedure

Setup menu icon  > Computation/Output > Display

- **Example of switching to 4 Items display**
 > Set Numeric/Graph to **Numeric** > set All Items/4 Items/8 Items/16 Items/Matrix/Hrm List Single/Hrm List Dual in the Numeric menu to **4 Items**
- **Switching display items (Numeric Items)**
 > **Items** in the Numeric menu > Item No., Function, Unit, Element/ Σ , Order (k), Reset Items



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to switch the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
 See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Selecting the displayed item number (Item No.)

See “Menu Icons” (page vi).

Setting display items (Function)

Set the displayed harmonic items. Scroll through the display list and select **Harmonics(k)**, and then set the display items. You can set display items from all of the following items.

Harmonics of order k (Harmonics(k) group)

U(k) (RMS value of the harmonic voltage of order k), I(k) (RMS value of the harmonic current of order k),
P(k) (active power of the harmonics of order k), S(k) (apparent power of the harmonics of order k),
Q(k) (reactive power of the harmonics of order k), $\lambda(k)$ (power factor of the harmonics of order k),
 $\Phi(k)$ (phase difference between the voltage and current of the harmonics of order k),
 $\Phi U(k)$ (phase difference of each harmonic voltage U(k) with respect to the fundamental voltage U(1)),
 $\Phi I(k)$ (phase difference of each harmonic current I(k) with respect to the fundamental current I(1)),
Z(k) (load circuit impedance), Rs(k) (load circuit series resistance),
Xs(k) (load circuit series reactance), Rp(k) (load circuit parallel resistance),
Xp(k) (load circuit parallel reactance), Uhdf(k) (voltage harmonic content ratio),
lhdf(k) (current harmonic content ratio), Phdf(k) (active power harmonic content ratio)

Harmonics (Harmonics group)

Uthd (total harmonic distortion of voltage), Ithd (total harmonic distortion of current),
Pthd (total harmonic distortion of active power), Uthf (telephone harmonic factor of voltage),
Ithf (telephone harmonic factor of current), Utif (telephone influence factor of voltage),
Itif (telephone influence factor of current), hvf (harmonic voltage factor),
hcf (harmonic current factor), K-factor (K factor),
 ΦU_i-U_j (phase angle of the fundamental voltage $U_j(1)$ of element j with respect to the fundamental voltage $U_i(1)$ of element i),
 ΦU_i-U_k (phase angle of the fundamental voltage $U_k(1)$ of element k with respect to $U_i(1)$),
 ΦU_i-I_i (phase angle of the fundamental current $I_i(1)$ of element i with respect to $U_i(1)$),
 ΦU_j-I_j (phase angle of the fundamental current $I_j(1)$ of element j with respect to $U_j(1)$),
 ΦU_k-I_k (phase angle of the fundamental current $I_k(1)$ of element k with respect to $U_k(1)$)

PLL source frequency (Frequency group)

FreqPLL1 (PLL1 frequency), FreqPLL2 (PLL2 frequency)

Selecting the unit (Unit)

See “Menu Icons” (page vi).

Selecting the input element or wiring unit to configure (Element/ Σ)

See “Menu Icons” (page vi).

Setting the order (Order (k))

Select from the following values.

Total, 0, 1 to 100

Resetting display items (Reset Items)

See “Menu Icons” (page viii).

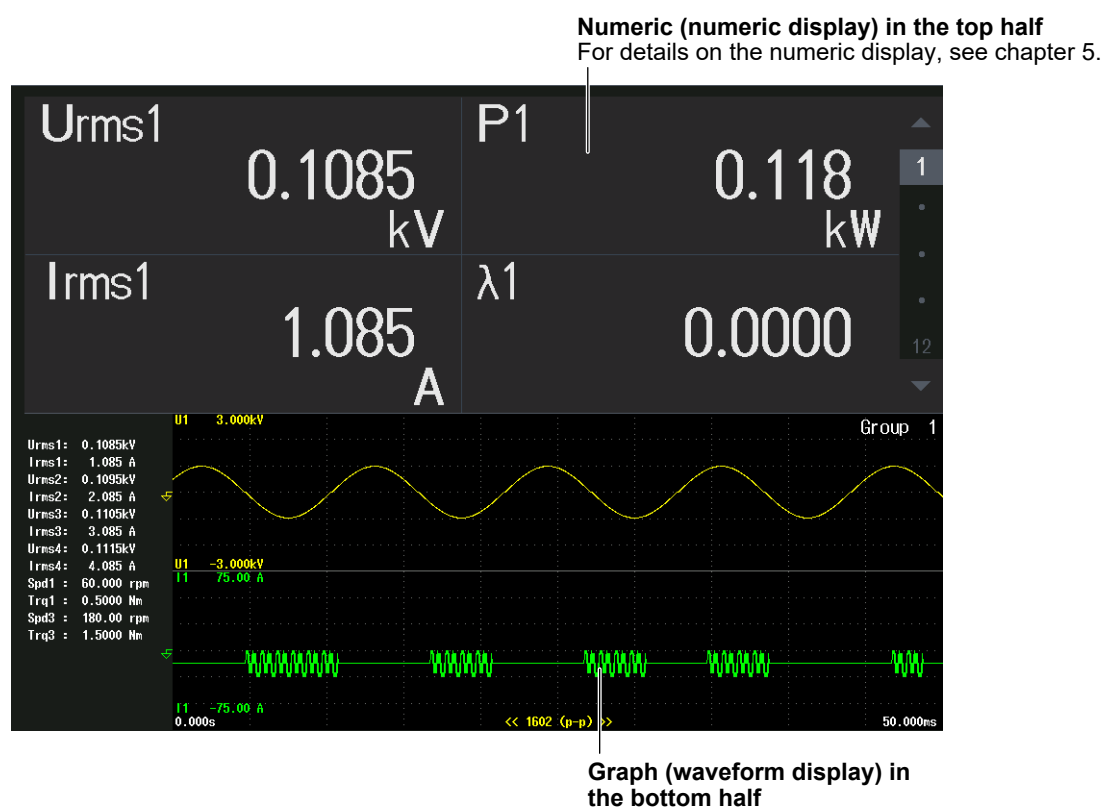
9.1 Setting Display Formats

Overview

This instrument displays waveforms, bar graphs, and vectors of the voltage or current applied to the input elements or wiring units.

This section explains how to display measurement results, using display examples.

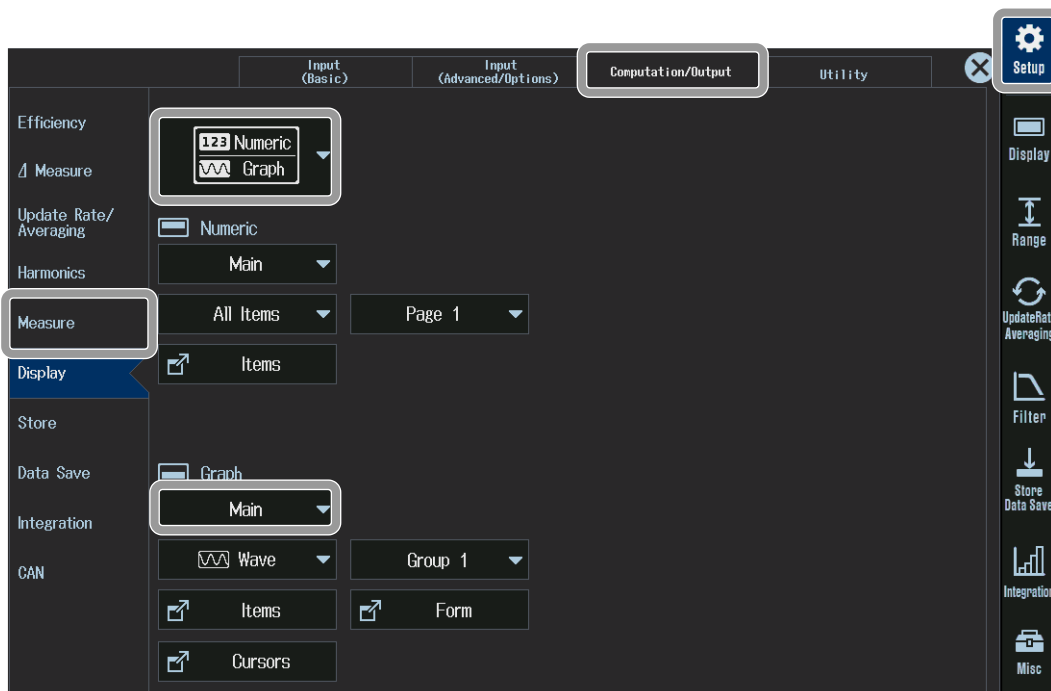
Example of Numeric (numeric display) and Graph (graph display)



Procedure

Setup menu icon  > **Computation/Output** > **Display**

- **Setting the screen display**
 - > Numeric, Graph, Numeric/Numeric, Numeric/Graph, Graph/Numeric, Graph/Graph
- **Types of graph displays**
 - > Wave/Bar/Vector in the Graph menu



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to set the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Setting the screen display

You can switch the display format of the Numeric (numeric display) and Graph (graph display) screens. Select from the following:

- **Numeric**
Shows only numeric data in a single screen. For details on the numeric display, see chapter 5.
- **Graph**
Shows only graphs in a single screen
- **Numeric/Numeric**
Shows numeric data in the top and bottom halves of the screen
- **Numeric/Graph**
Shows numeric data in the top half of the screen and graphs in the bottom half
- **Graph/Numeric**
Shows graphs in the top half of the screen and numeric data in the bottom half
- **Graph/Graph**
Shows graphs in the top and bottom halves of the screen

Types of graph displays

You can select from the following three types.

- Wave: Waveform (see section 9.2)
- Bar: Bar graph (see section 9.3)
- Vector: Vectors (see section 9.4)

9.2 Displaying Waveforms

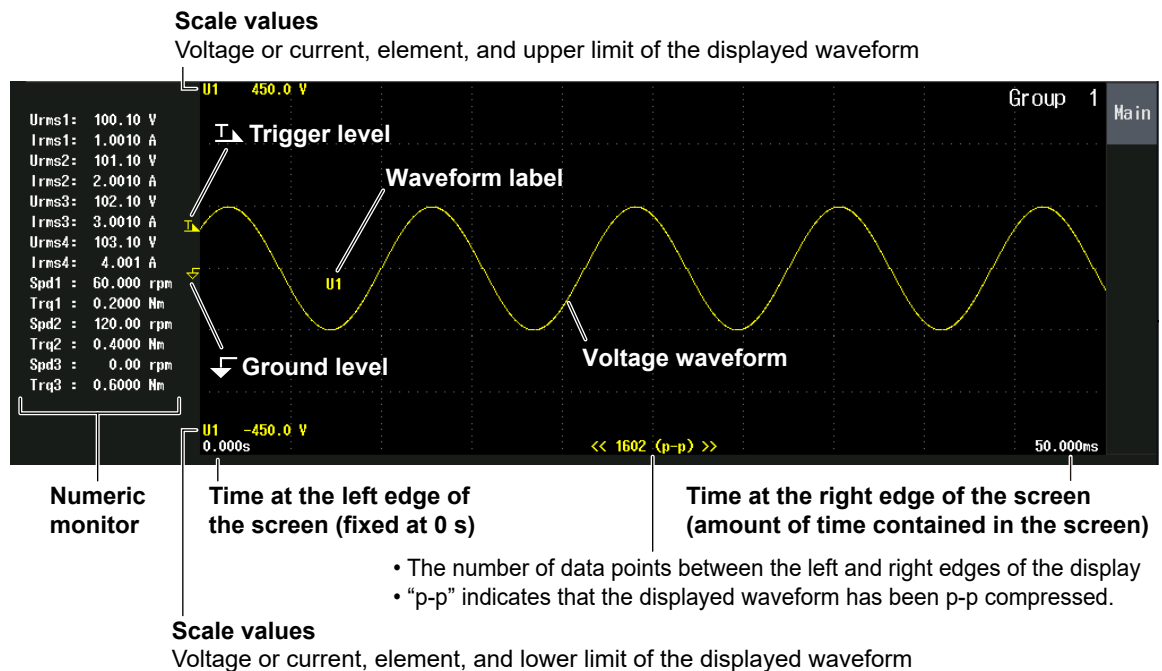
Overview

This instrument displays waveforms of the voltage or current applied to the input elements or wiring units.

This section explains how to display measurement results as waveforms, using display examples.

Waveform display screen (display example for Group 1)

Waveform display of input element 1



Note

- If the trigger level setting is inappropriate, the waveform start position may become unstable or the waveform may not be displayed.
- When the data update interval is 10 ms, waveform display is not available.

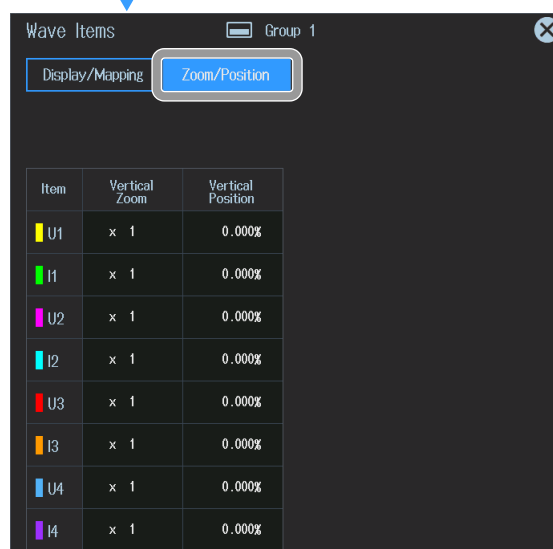
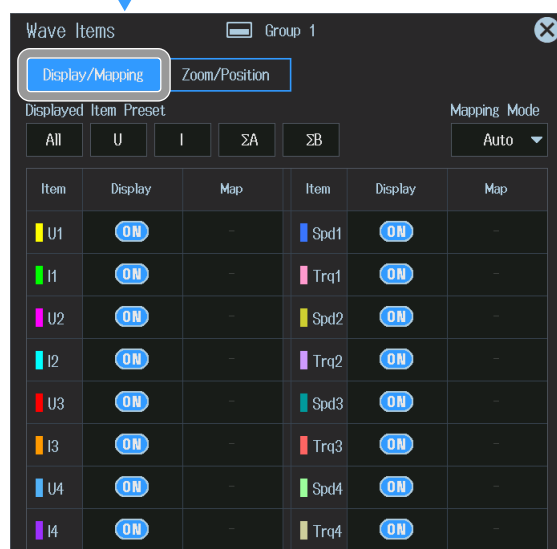
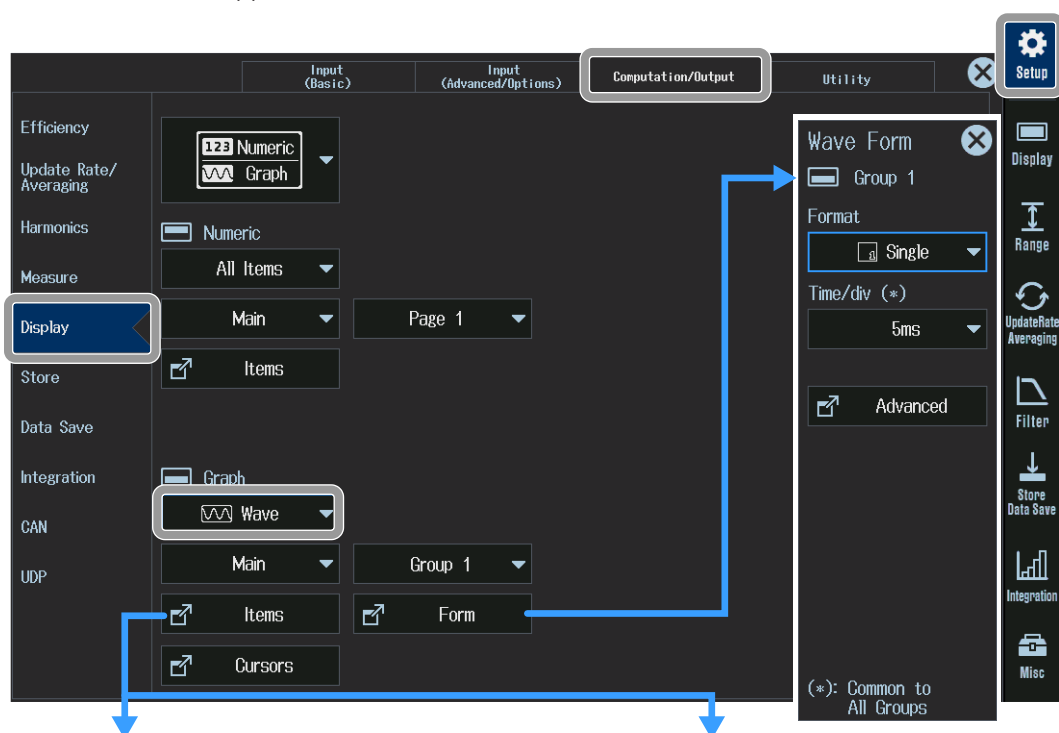
Numeric monitor

Displays the RMS voltage and current values for each of the specified elements and the optional speed (Spd), torque (Trq), or auxiliary input (Aux) values.

Procedure

Setup menu icon  > **Computation/Output** > **Display** > In the Graph menu, set Wave/Bar/Vector to Wave

- **Selecting the unit (Unit)**
> Main/Sub 1/Sub 2/Sub 3/Sub 4
- **Display group (Group)**
> Group1/Group2/Group3/Group4
- **Display items (Items)**
> Display/Mapping, Zoom/Position in the Wave Items menu
- **Display format (Form)**
> Format, Time/div (*), Advanced in the Wave Form menu



Note

- For procedures using the setup menu, see chapter 3.
 - You can also use the **Display** menu icon  shown on the right side of the screen to set the display items. For details on the Display menu, see page v.
 - Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.
-

Selecting the unit (Unit)

During multi-unit synchronization (option /SY1), specify the unit you want to operate from the following:

Main, Sub 1, Sub 2, Sub 3, Sub 4

Display group (Group)

Select the group you want to display from 1 to 4.

You can select up to four groups. The settings for “Wave Items” and “Wave Form,” described later, apply to the Group number selected here.

For each group, set the waveforms to display in “Wave Items.”

Example If Wave Items are set as follows:

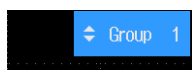
- Group 1: Inverter input waveforms
- Group 2: Inverter output waveforms
- Group 3: Motor speed and torque

With split-screen display, you can easily observe the inverter input and output waveforms and the motor speed and torque by switching the groups shown in the upper and lower screens among Groups 1 to 3.

Switching display groups during graph display

If a touch-screen monitor is connected, flicking the Graph screen upward or downward switches the display group.

The group number after switching is highlighted for several seconds in the group display area at the upper right of the Graph screen.



Display items (Wave Items)

Select the voltages and currents of the input elements to display with waveforms.

Display and waveform mapping (Display/Mapping)

Set display on or off and waveform mapping. Waveform mapping can be set for each item.
(divided screens 1 to 6)

Display item preset (Displayed Item Preset)

- **All (All)**
Turns waveform display on or off for all input signals.
- **Voltage (U)**
Turns waveform display on or off for all voltage signals.
- **Current (I)**
Turns waveform display on or off for all current signals.
- **$\Sigma A/\Sigma B(\Sigma A/\Sigma B)$**
Turns waveform display on or off for the voltage and current signals of ΣA and ΣB .
- **Display (Display)**
Switches the waveform display on/off state of each input signal in the display setting table.
 - You can turn on and off waveform display of the voltage or current signal of each element. Only the input signals of installed elements are displayed.
 - On models with the motor evaluation option, you can turn on and off the waveform displays of the speed, torque, and Aux input signals.
- **Waveform mapping (Mapping Mode)**
You can assign waveforms to different windows on the screen. Select the assignment mode from the following options:
 - **Auto**
Waveforms whose displays are turned on are assigned to the split screens in the following order.
 - U1, I1, U2, I2, U3, I3, U4, I4
Speed1, Speed2, Torque1, Torque2, Aux1 to 4
(Models with the motor evaluation option (/EM1, /RM1, or /EM1RM1))
 - Speed3, Speed4, Torque3, Torque4, Aux5 to 8
(Models with the motor evaluation option (/EM2, /RM2, or /EM1RM1))
 - **Fixed**
Waveforms are assigned to the windows by element number in the following order: voltage (U) and current (I), regardless of whether their displays are turned on. Speed1 and Aux1 are displayed in the top window. Torque1 and Aux2 are displayed in the second window from the top.
 - **User**
Waveforms of your choice can be assigned to the windows, regardless of whether their displays are turned on. On the display setting table, you can select the display positions using numbers from 1 to 6. Waveforms are assigned in order from the top window, starting with number 1.

Zoom and position (Zoom/Position)

Set the vertical zoom factor and vertical position. (U1 to U4, I1 to I4).

Vertical zoom (Vertical Zoom)

Each displayed waveform can be scaled. You can select from the following zoom factors:

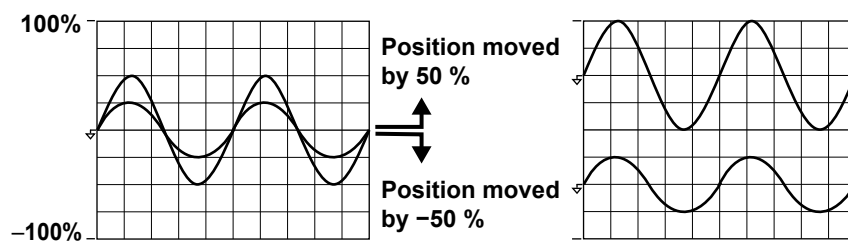
0.1, 0.2, 0.25, 0.4, 0.5, 0.75, 0.8, 1, 1.14, 1.25, 1.33, 1.41, 1.5, 1.6, 1.77, 2, 2.28, 2.66, 2.83, 3.2, 3.54, 4, 5, 8, 10, 12.5, 16, 20, 25, 40, 50, 100

Vertical position (Vertical Position)

If you want to see the relationship between the voltage and current waveforms, or if the part you want to view with zoom extends beyond the screen frame, you can move the waveform display position (vertical position) along the vertical axis.

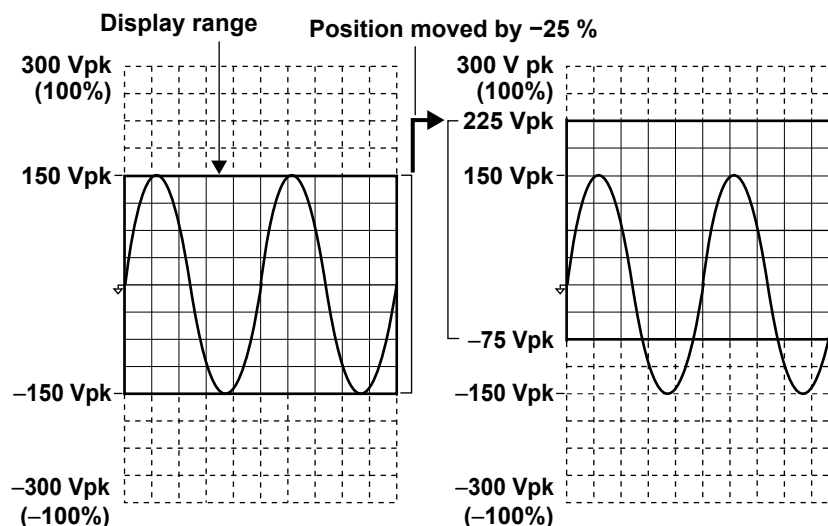
Setting range: 0.000 to $\pm 130.000\%$

- When the zoom factor is set to 1, a value of 100 % corresponds to half the height (display range) of the waveform display (which is three times the measurement range when the crest factor is set to CF3 and six times the measurement range when the crest factor is set to CF6 or CF6A). The upper and lower vertical display limits of the screen are 100 % and -100 % from the center.



- As shown in the figure below, when the zoom factor is set to a value other than 1, the upper and lower display limits of the screen do not correspond to three times the measurement range (or to $\pm 100\%$) when the crest factor is set to CF3 and six times the measurement range (or to $\pm 100\%$) when the crest factor is set to CF6 or CF6A. Take the zoom factor into account when you set a waveform's position.

Example When the crest factor is set to CF3, the voltage range is 100 V, the zoom factor is 2, and the vertical position is shifted by -25 %
The waveform is shifted by the same amount that it would be if the zoom factor were set to 1 and the vertical position were shifted by -50 %.



Note

If you want to zoom in on a specific part of a waveform, we recommend that you take the steps below.

1. Set the zoom factor to 1.
2. Following the instructions in this section for shifting a waveform's vertical position, shift the specific part of the waveform that you want to view closely to the center of the display.
3. Set the vertical zoom factor.

Display format (Wave Form)

Set the division of the waveform display screen and time scale (Time/div).

Number of Windows (Format)

You can divide the screen equally into windows, and assign waveforms to those windows. This function is useful when there are many waveforms and it is difficult to view them all in a single display.

You can choose the number of windows from the following:

- 1 division (Single): No windows
- 2 divisions (Dual): Two windows
- 3 divisions (Triad): Three windows
- 4 divisions (Quad): Four windows
- 6 divisions (Hexa): Six windows

Depending on the number of windows, the number of points displayed vertically in each window changes as described below.

Single: 720 points, Dual: 360 points, Triad: 240 points, Quad: 180 points, Hexa: 120 points

When the screen is split, the number of displayed points along the vertical axis of a single window is halved.

Waveform mapping

Waveforms whose displays are turned on are assigned to the divided windows in the following order.

- U1, I1 to U4, I4
- Spd1, Trq1 to Spd4, Trq4
- Aux1 to Aux8

Time scale (Time/div(*))

The time axis is set in time per grid division (time/div).

When the update mode is not Auto

Setting range: 0.1 ms to 2 s

Up to the point where the time span of one screen matches the data update interval
(in 1-2-5 steps)

Example When the data update interval is 500 ms

If the time per division is changed in the following order: 0.1 ms, 0.2 ms, 0.5 ms, 1 ms, 2 ms, 5 ms, 10 ms, 20 ms, and 50 ms, the time span of one screen can be changed in the following order: 1 ms, 2 ms, 5 ms, 10 ms, 20 ms, 50 ms, 100 ms, 200 ms, and 500 ms.

When the update mode is Auto

- **When the data update interval is 10 ms**

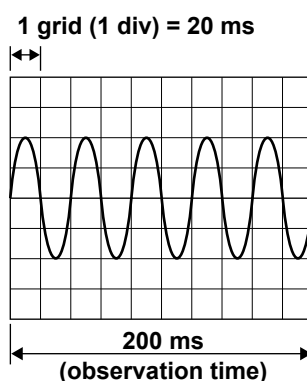
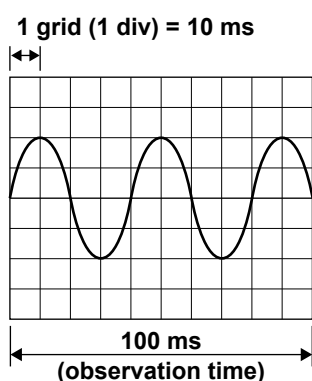
Setting range: 0.1 ms to 1 ms

The time span of one screen can be changed within the range from 1 ms to 10 ms.

- **When the data update interval is 50 ms**

Setting range: 0.1 ms to 5 ms

The time span of one screen can be changed within the range from 1 ms to 50 ms.



Advanced waveform display settings (Advanced)

Items that are marked with (*) after the menu name are shared among all groups.

Display interpolation (Interpolate (*))

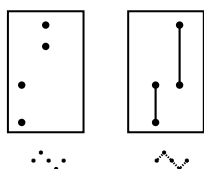
When fewer than 800 sampled data points are available along the time axis, the displayed points (rasters) are not connected. The region where the displayed points are not connected is called the interpolation region. In this region, the waveform is displayed more smoothly by connecting the waveform data points with straight lines.

Select the interpolation method from the following:

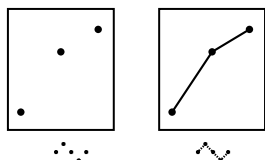
-  : No interpolation is performed. Only the data points are displayed.
-  : Linearly interpolates between two points.

- **When outside the interpolation region**

The dots are connected vertically. When the number of data points is 1602 or more, p-p compressed values are calculated (the maximum and minimum values of sampled data within each fixed interval), and the maximum and minimum p-p compressed values are displayed on one vertical line (one raster).



- **When within the interpolation region**



Grid (Graticule(*))

Select the window graticule from the following:

-  : The grid is displayed with dotted lines.
-  : The grid is displayed with a frame.
-  : The grid is displayed with a cross hair.

Turning the Scale Value Display On and Off (Scale Value(*))

For each waveform, select whether to display (ON) or hide (OFF) the following values.

- Upper and lower limits of the vertical axis
- Values at the left and right edges of the horizontal axis (time axis)

Turning the display of waveform labels on and off (Wave Label(*))

Select whether to display (ON) or hide (OFF) waveform labels.

Cursor measurement (Cursors)

See section 10.1.

Difference between waveform sampling data and waveform display data

Waveform sampling data and waveform display data are both measured waveform data, but they differ in the following manner.

- **Waveform sampling data: Data obtained by A/D conversion of the input signal**

The A/D conversion rate of this instrument is approximately 2.5 MS/s. For example, when the data update interval is set to 1 s, approximately 2 500 000 waveform sampling data points are obtained for one input signal in a single measurement (see the figure below). Waveform sampling data may also be referred to as acquisition data (Acquisition Data) or raw wave data (Raw Wave Data).

- **Waveform display data: Waveform display data shown on the screen of this instrument (1602 points)**

When a waveform is displayed on this instrument, data points (waveform display data) are shown in display divisions along the horizontal axis (time axis), called rasters. There are 801 rasters. Each raster contains two waveform display data points. These two points represent the maximum and minimum values of the waveform data within that raster. Therefore, one input signal is displayed using 1602 waveform display data points (the number of displayed points on the screen).

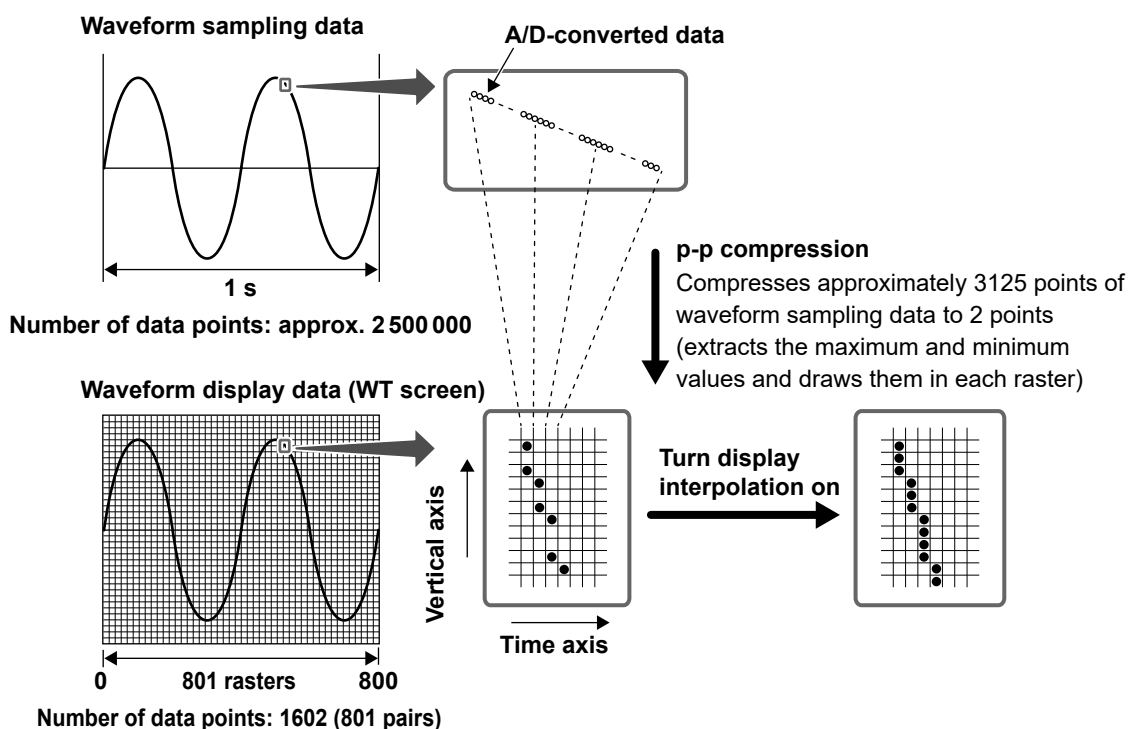
p-p compression

Peak-to-peak (p-p) compression is the data compression method used to extract waveform display data from waveform sampling data.

Example When measuring a 2 Hz sine wave with the data update interval set to 1 s

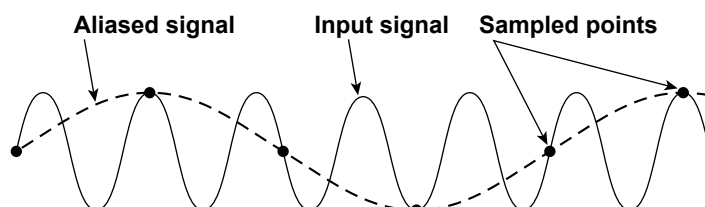
To display this waveform on this instrument, the data is converted from approximately 2 500 000 points to 1602 points (801 pairs of maximum and minimum values). In other words, approximately 3125 waveform sampling data points are converted (compressed) into two waveform display data points (one pair).

The compression ratio of p-p compression varies depending on the data update interval and the horizontal scale (time axis) in waveform display.



Aliasing

When the sample rate is relatively low compared with the frequency of the input signal, high-frequency components contained in the signal are lost. According to the Nyquist sampling theorem, high-frequency sampled data may appear as lower-frequency data. This phenomenon is called aliasing.

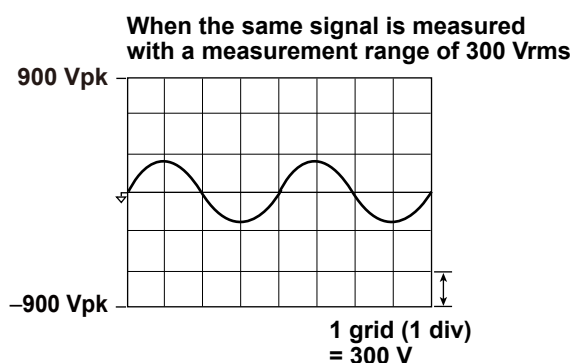
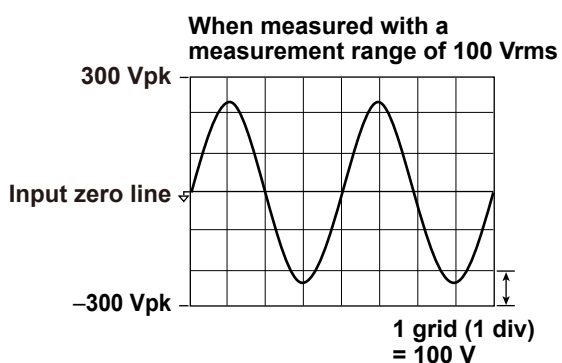


Vertical axis (Amplitude)

The vertical display range is determined based on the set crest factor and measurement range.

Example

- When the crest factor is set to CF3 and the voltage measurement range is set to 100 Vrms
The display range is ± 300 Vpk ($\pm 3 \times 100$ Vrms) centered on the input zero line. If this range is exceeded, the waveform is clipped.
- When the crest factor is set to CF6 or CF6A and the voltage measurement range is set to 50 Vrms
The display range is ± 300 Vpk ($\pm 6 \times 50$ Vrms) centered on the input zero line.



Note

If a touch-screen monitor is connected, pinching in or out on the Graph screen changes the time scale step by step according to the pinch movement. The new time scale is highlighted for several seconds in the group display area at the upper right of the Graph screen.

9.3 Bar Graph Display

Overview

This instrument displays the harmonic orders and levels of voltage, current, and other input signals on a bar graph screen.

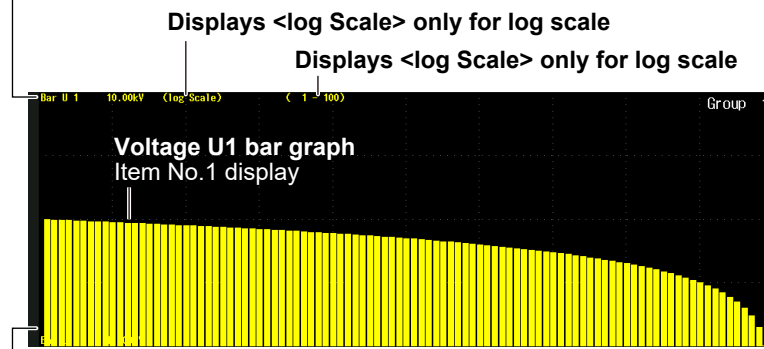
This section explains how to display measurement results as bar graphs, using display examples.

Bar graph display screen (triad display example for Group 1)

The magnitude of each harmonic can be displayed in a bar graph, with harmonic order on the horizontal axis and harmonic magnitude on the vertical axis. You can configure three types of bar graphs.

Bar graph display for input element 1

Bar graph number, measurement function, element, and upper limit shown on the bar graph



Bar graph number, measurement function, element, and lower limit shown on the bar graph

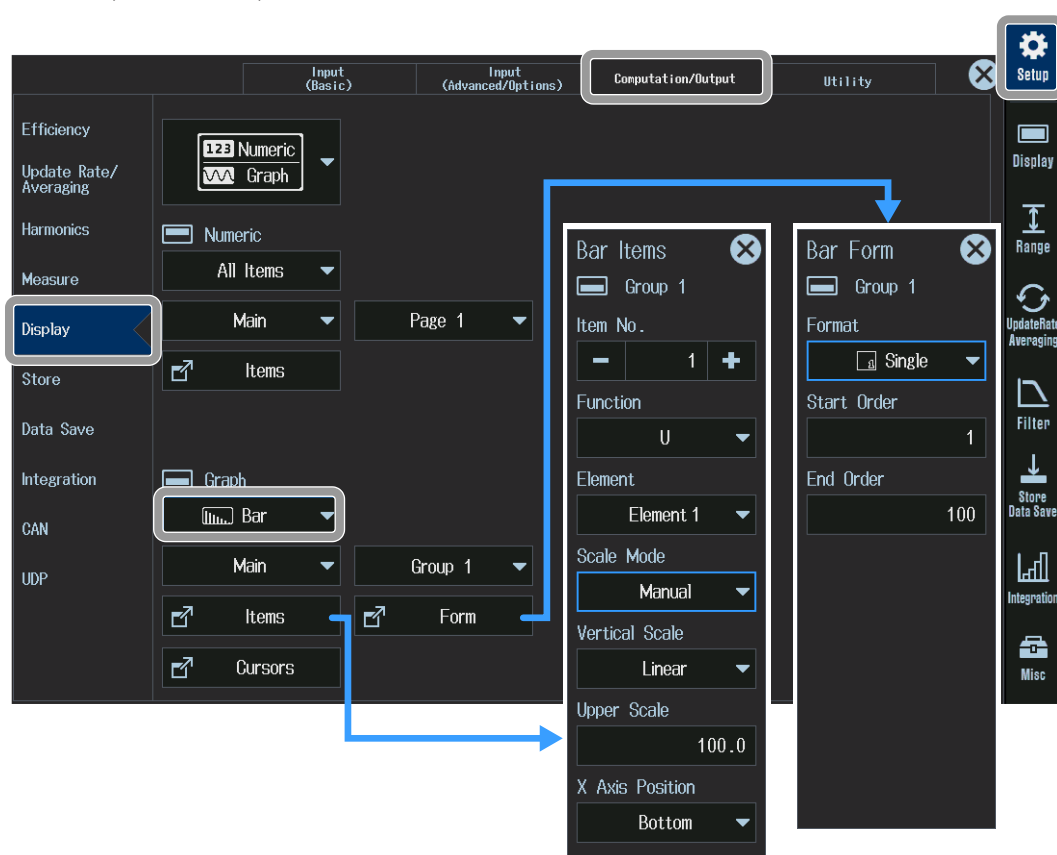
Note

- On the logarithmic scale (Log Scale), data with negative values is displayed as red bar graphs using the absolute values of the data.
- If the data update interval is shorter than the analysis window width (the number of fundamental-wave cycles), which is determined by the fundamental frequency, bar graphs are not displayed. Set a longer data update interval.
For details, see "Notes about the numeric data display" (page 5-2).
- Bar graphs for harmonics above the upper limit of the measurable harmonic order are not displayed. For details on the upper limit of the measurable harmonic order, see "Maximum harmonic order to measure (Max Order) (page 8-4)."

Procedure

Setup menu icon  > **Computation/Output** > **Display** > In the Graph menu, set Wave/Bar/Vector to Bar

- **Selecting the unit (Unit)**
> Main/Sub 1/Sub 2/Sub 3/Sub 4
- **Display group (Group)**
> Group1/Group2/Group3/Group4
- **Display items (Items)**
> Item No., Function, Element, Scale Mode in the Bar Items menu
- **Display format (Form)**
> Format, Start Order, End Order in the Bar Form menu



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to set the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Selecting the unit (Unit)

During multi-unit synchronization (option /SY1), specify the unit you want to operate from the following:

Main, Sub 1, Sub 2, Sub 3, Sub 4

Display group (Group)

Select the group you want to display from 1 to 4.

You can select up to four groups. The settings for “Bar Items” and “Bar Form,” described later, apply to the Group number selected here.

To assign waveforms to each group (1 to 4), set the **displayed item (Bar Items)**. If you assign the functions of elements 1, 2, and 3 to each group, you can easily switch the bar graph displays simply by changing the display group.

Switching display groups during bar graph display

If a touch-screen monitor is connected, you can switch display groups by flicking, just as in graph display (see page 9-6).

Display items (Bar Items)

Select the voltages and currents of the input elements to display with bar graphs.

Bar graph number (Item No.)

Select the bar graph you want to edit from 1 to 3.

The number increases from top to bottom on the bar graph screen. To show the No.2 and No.3 item numbers on the bar graph display, set the screen division to Dual or Triad in the display format (Form) explained later.

Function (Function)

Select the measurement function to display from the following:

U (harmonic voltage), I (harmonic current), P (harmonic active power),
S (harmonic apparent power), Q (harmonic reactive power), λ (harmonic power factor),
 Φ (phase difference between harmonic voltage and harmonic current),
 ΦU (phase difference of each harmonic voltage with respect to the fundamental voltage U),
 ΦI (phase difference of each harmonic current with respect to the fundamental current I),
Z (load circuit impedance), R_s (series resistance of the load circuit),
 X_s (series reactance of the load circuit), R_p (parallel resistance of the load circuit),
 X_p (parallel reactance of the load circuit)

Element (Element)

Select the element from the options below. The available options vary depending on the installed elements.

Element 1, Element 2, Element 3, Element 4

Bar graph display scale

Setting the vertical scale mode (Scale Mode)

You can set the upper limit of a bar graph window.

Select the setup mode from the following:

- **Fixed (Fixed)**
 - When the function (Function) is U, I, P, S, or Q, the vertical scale uses logarithmic (Log) scaling.
 - When the function is λ , Φ , ΦU , ΦI , Z, Rs, Xs, Rp, or Xp, the vertical scale uses linear (Linear) scaling.
 - The upper and lower limits of the bar graph window are automatically determined based on the maximum and minimum displayed bar graph data values. However, λ is displayed from -1 to 1 . Φ , ΦU , and ΦI are displayed from -180° to 180° , with leading shown without a sign and lagging shown with a minus sign.
- **Manual (Manual)**

Manual scaling is enabled. The following settings are enabled.

Vertical scale type (Vertical Scale)

Select either of the following:

- Linear

The X-axis position (X Axis Position) setting is enabled.
- Log

Upper limit (Upper Scale)

Setting range: 0 to 9.999 T

X-axis position (X Axis Position)

You can set this when the vertical scale type is linear.

Select one of the following positions for the point where the Y-axis coordinate is zero.

- Bottom (bottom edge of the screen)
- Center (center of the screen)

Display format (Bar Form)

Set the divisions of the bar graph screen and the range of harmonic orders to display (Start Order, End Order).

Number of Bar Graph Display Windows (Format)

You can choose the number of windows from the following:

- Single (Single): No windows. The data of bar graph (Item No.) 1 is displayed.
- Dual (Dual): Two windows. The data of bar graphs (Item No.) 1 and 2 is displayed.
- Triad (Triad): Three windows. The data of bar graphs (Item No.) 1 to 3 is displayed.

Bar graph display range (Start Order/End Order)

You can set the range of harmonic orders to show in a bar graph. The range is the same for bar graphs 1 to 3.

Start harmonic order (Start Order)

Setting range: 0 to 90

However, the start harmonic order cannot be more than 10 orders less than the end order.

- When the measurement function of a bar graph is Φ , order 0 has no values, so you cannot display it in the bar graph.
- When the measurement function of a bar graph is ΦU or ΦI , orders 0 and 1 have no values, so you cannot display them in the bar graph.

End harmonic order (End Order)

Setting range: 10 to 100

However, the lower limit of the end harmonic order is the start harmonic order plus 10.

In addition, bar graphs for orders exceeding the upper measurement-order limit are not displayed.

For the upper measurement-order limit, see section 5.9 of the Getting Started Guide (IM WT1501-02EN).

Cursor measurement (Cursors)

See section 10.2.

9.4 Displaying Vectors

Overview

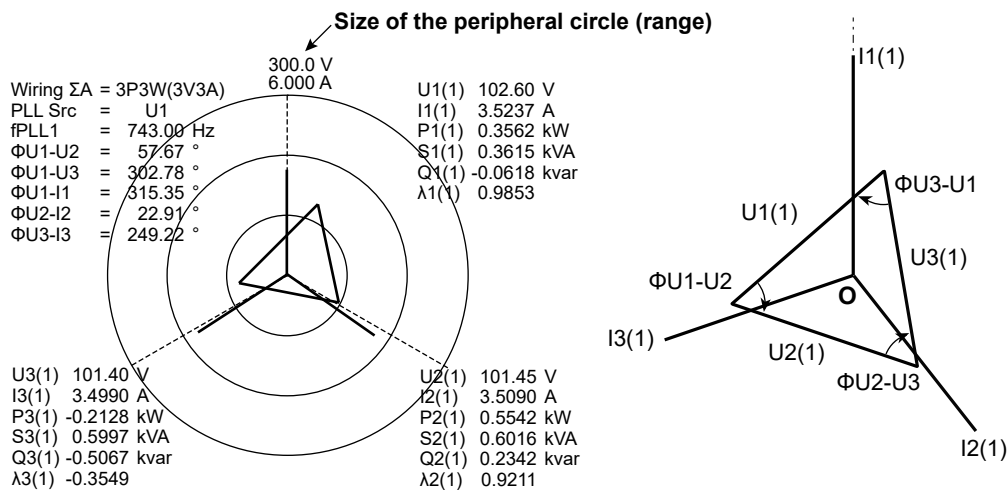
This instrument displays on the vector screen the phase difference and magnitude relationship of the fundamental and harmonic components of voltage, current, and other signals applied to the wiring unit. This section explains how to display measurement results as vectors, using display examples.

Vector display screen (example of Group1 ΣA display)

The vector display can show the phase difference and magnitude (RMS value) relationship of the fundamental voltage $U(1)$ and current $I(1)$ for each element assigned to the selected wiring unit. The vectors of the input signals are displayed with the upward direction of the vertical axis as 0 (zero degrees).

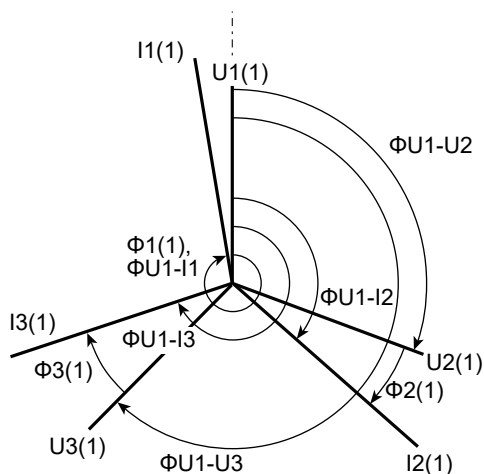
For a 3V3A system with a three-voltage three-current method

- $U1(1)$, $U2(1)$, and $U3(1)$ are line voltages.
- $I1(1)$, $I2(1)$, and $I3(1)$ are line currents.



For a 3P4W (three-phase four-wire system)

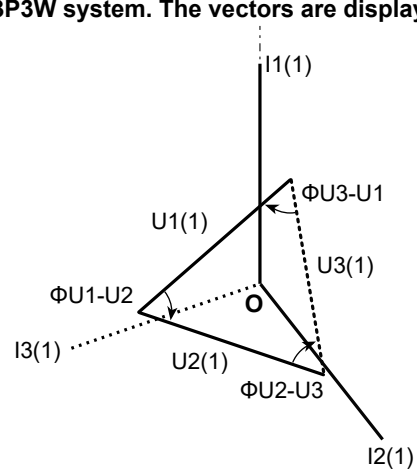
- $U1(1)$, $U2(1)$, and $U3(1)$ are phase voltages.
- $I1(1)$, $I2(1)$, and $I3(1)$ are line currents.



For a 3P3W (three-phase three-wire system)

- $U1(1)$, $U2(1)$, and $U3(1)$ are line voltages.
- $I1(1)$, $I2(1)$, and $I3(1)$ are line currents.

However, $U3(1)$ and $I3(1)$ are not actually measured for the 3P3W system. The vectors are displayed through



Note

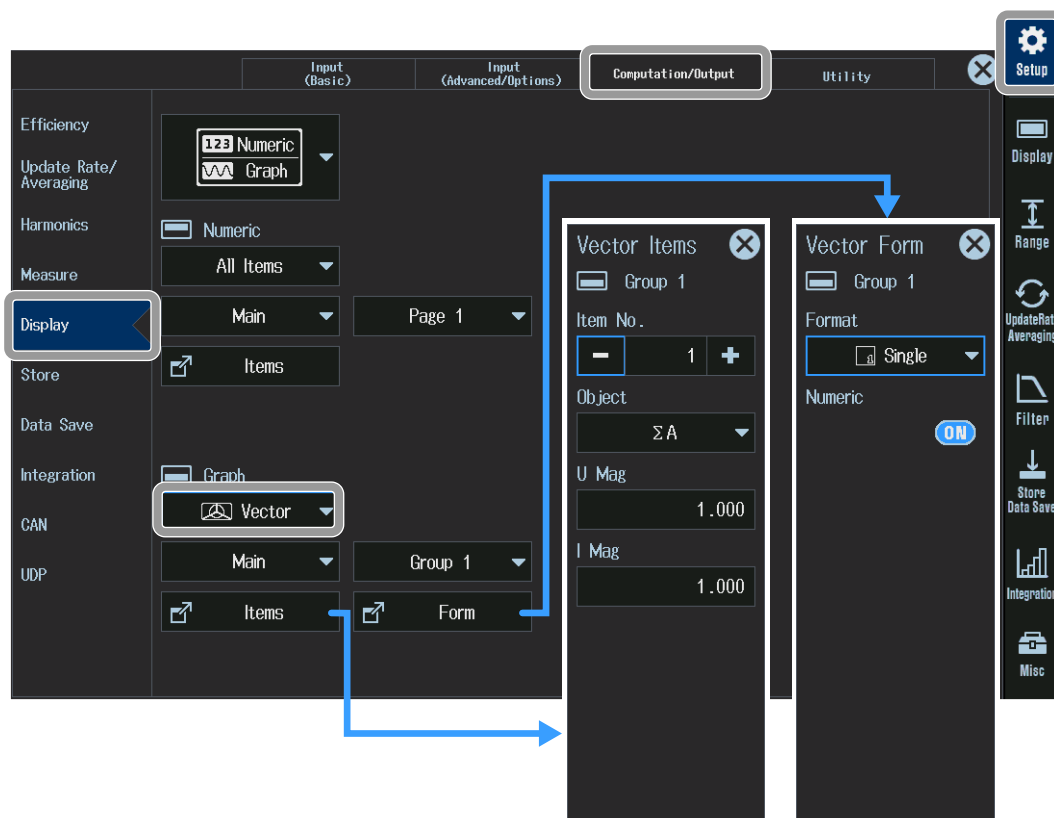
If the data update interval is shorter than the analysis window width (the number of fundamental-wave cycles), which is determined by the fundamental frequency, vectors are not displayed. Set a longer data update interval.

For details, see “Notes about the numeric data display” (page 5-2).

Procedure

Setup menu icon  > **Computation/Output** > **Display** > In the Graph menu, set Wave/Bar/Vector to Vector

- **Display group (Group)**
> Group1/Group2/Group3/Group4
- **Display items (Items)**
> Display, Mapping in the Wave Items menu
- **Display format (Form)**
> Format, Time/div (*), Advanced



Example of a vector split display

Display menu icon  > set Numeric, Graph, Numeric/Numeric, Numeric/Graph, Graph/Numeric, Graph/Graph to Graph/Graph in the screen display settings.

In split display, only the vector for Item No. 1 is displayed, so use “Group” described later to set the vector to display on the second screen to Group 2. Also, if you select single display for “Graph” in the screen display settings, the same split (two-screen) display can be used in “Vector Form” as well.



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to set the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Display group (Group)

Select the group you want to display from 1 to 4.

You can select up to four groups. The settings for “Vector Items” and “Vector Form,” described later, apply to the Group number selected here.

To assign waveforms to each group (1 to 4), set the **display item (Vector Items)**.

Switching display groups during vector display

If a touch-screen monitor is connected, you can switch display groups by flicking, just as in graph display (see page 9-6).

Display items (Vector Items)

Select the input element or wiring unit to display as a vector on the screen. You can also change the vector magnification. The zoom factors for the fundamental voltage U(1) and current I(1) can be set separately. When a vector is zoomed, the value representing the size of the outer circle in the vector display changes according to the zoom factor.

Vector number (Item No.)

Select the vector you want to set: 1 or 2.

Vector source (Object)

Select the element or wiring unit to display from the following: The available options vary depending on the installed elements.

Element 1, Element 2, Element 3, Element 4, ΣA , ΣB

Voltage zoom factor (U Mag)

You can set the zoom factor for the vector of the fundamental voltage U(1).

Setting range: 0.100 to 100.000

Current zoom factor (I Mag)

You can set the zoom factor for the vector of the fundamental current I(1).

Setting range: 0.100 to 100.000

Note

If the zoom factor is too large, the vector extends beyond the display range and is not displayed correctly. Reduce the zoom factor so that the vector fits within the display range.

Display format (Vector Form)

Number of vector display windows (Format)

You can choose the number of windows from the following:

- Single (Single): No windows. The data of vector (Item No.) 1 is displayed.
- Dual (Dual): Two windows. The data of vectors (Item No.) 1 and 2 is displayed. However, in the split display, the data of vector 1 is displayed.

Turning the Display of Numeric Data On and Off (Numeric)

Select whether to show numeric data (on or off).

You can display the size of each signal and the phase differences between signals. For the phase difference display formats, see "Phase difference display formats" (page 5-31).

10.1 Waveform Cursor Measurement

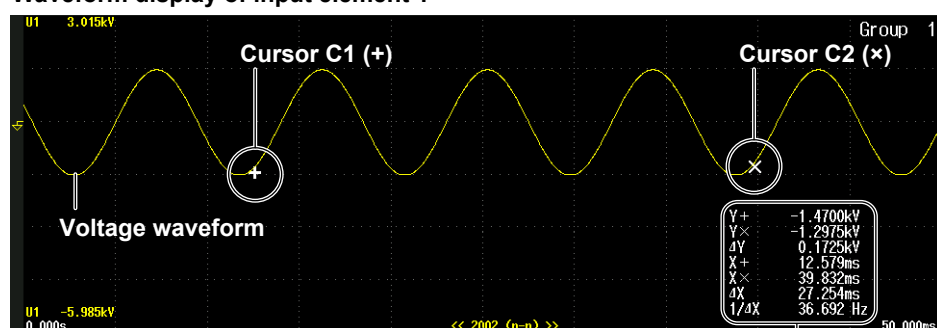
Overview

This instrument displays the waveforms of the voltage or current signals applied to the input element or wiring unit. By placing the cursor on a waveform, you can display the measured value at the cursor position.

This section explains how to display waveform cursor measurement results, using display examples.

Waveform cursor measurement (voltage display example)

Waveform display of input element 1



Cursor measurement items

Measurement items (waveform display)

Y+	Vertical-axis (Y-axis) value of Cursor 1 (+)
Yx	Vertical-axis (Y-axis) value of Cursor 2 (x)
ΔY	Difference between the vertical-axis (Y-axis) values of Cursor 1 (+) and Cursor 2 (x)
X+	Horizontal-axis (X-axis) value of Cursor 1 (+)
Xx	Horizontal-axis (X-axis) value of Cursor 2 (x)
ΔX	Difference between the horizontal-axis (X-axis) values of Cursor 1 (+) and Cursor 2 (x)
1/ΔX	Reciprocal of the difference between the horizontal-axis (X-axis) values of Cursor 1 (+) and Cursor 2 (x)

Moving the cursors

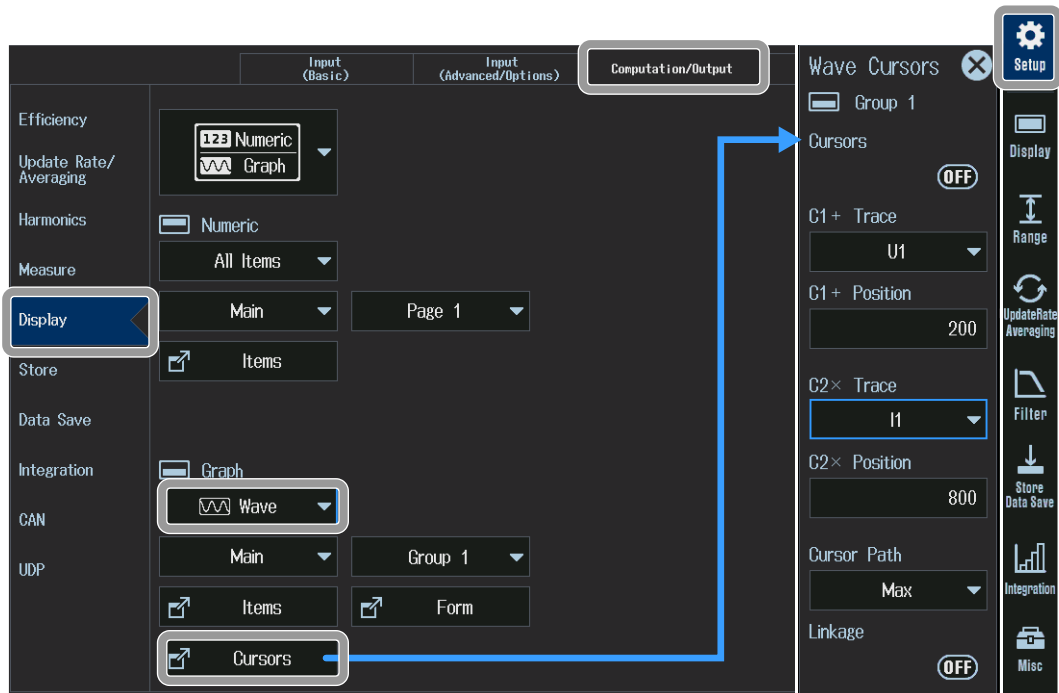
- The cursors move along the selected waveform.
- The cursor movement step is (time span of one screen) ÷ 800.

Note

- If unmeasurable data is present, "****" is displayed in the measurement display area.
- ΔY is measured even when the units are different. However, it is shown without a unit.
- The vertical range in which cursor measurement is possible is within ±300 % of the range when the crest factor is set to CF3. When the crest factor is set to CF6 or CF6A, it is within ±600 % of the range.

Procedure

Setup menu icon  > **Computation/Output** > **Display** > In the Graph menu, set Wave/Bar/Vector to **Wave** > **Cursors**



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to set the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Turning cursor measurement on and off (Cursors)

- ON: Cursor measurement is performed.
- OFF: Cursor measurement is not performed.

Waveform measured by Cursor 1 (+) (C1+ Trace)

You can select the waveform to measure with Cursor 1 (+) from the options below.

The available options vary depending on the installed elements.

- U1, I1, U2, I2, U3, I3, U4, I4
- Spd1, Spd2, Trq1, Trq2, Aux1 to 4
(Models with the motor evaluation option (/EM1, /RM1, or /EM1/RM1))
- Spd3, Spd4, Trq3, Trq4, Aux5 to 8
(Models with the motor evaluation option (/EM2, /RM2, or /EM1/RM1))

Position of Cursor 1 (+) (C1+ Position)

You can set the position of cursor 1 (+) in the following range.

Setting range: 0 (left edge of the screen) to 800 (right edge of the screen)

Waveform measured by Cursor 2 (×) (C2× Trace)

You can select the waveform to measure with Cursor 2 (×).

The options are the same as those for Cursor 1 (+) (C1+ Trace).

Position of Cursor 2 (×) (C2× Position)

You can set the position of Cursor 2 (×).

The ranges within which you can set the position are the same as those for Cursor 1 (+) (C1+ Position).

Cursor path (Cursor Path)

Because this instrument uses p-p compression on the sampling data (see page 9-12), the maximum and minimum values are displayed as two data points at the same time-axis position. You can select from the following the path along which the cursor moves and the data points to use for cursor measurement.

- Max (Max): Moves along the maximum values at the same time-axis position and measures the value at each point.
- Min (Min): Moves along the minimum values at the same time-axis position and measures the value at each point.
- Mid: Moves along the midpoint between the maximum and minimum values at the same time-axis position and measures the value at each point.

Linking cursor movement (Linkage)

Set Linkage to ON to move Cursor 1 (+) and Cursor 2 (×) without changing the distance between them. Specify C1+ Position to set the positions of the cursors.

10.2 Bar Graph Cursor Measurement

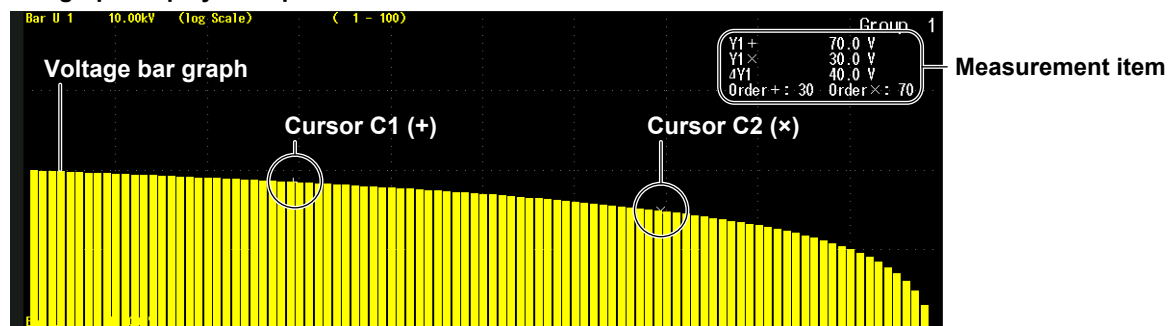
Overview

This instrument displays on the bar graph screen the harmonic order and magnitude of voltage, current, and other signals applied to the input elements. By placing the cursor on the bar graph, you can display the measured value at the cursor position.

This section explains how to display bar graph cursor measurement results, using display examples.

Bar graph cursor measurement (voltage display example)

Bar graph display for input element 1



Measurement items (bar graph display)

Y1+	Vertical-axis (Y-axis) value of Cursor 1 (+) for Bar Graph 1
Y1×	Vertical-axis (Y-axis) value of Cursor 2 (x) for Bar Graph 1
ΔY1	Difference between the vertical-axis (Y-axis) values of Cursor 1 (+) and Cursor 2 (x) for Bar Graph 1
Y2+	Vertical-axis (Y-axis) value of Cursor 1 (+) for Bar Graph 2
Y2×	Vertical-axis (Y-axis) value of Cursor 2 (x) for Bar Graph 2
ΔY2	Difference between the vertical-axis (Y-axis) values of Cursor 1 (+) and Cursor 2 (x) for Bar Graph 2
Y3+	Vertical-axis (Y-axis) value of Cursor 1 (+) for Bar Graph 3
Y3×	Vertical-axis (Y-axis) value of Cursor 2 (x) for Bar Graph 3
ΔY3	Difference between the vertical-axis (Y-axis) values of Cursor 1 (+) and Cursor 2 (x) for Bar Graph 3

Moving the cursors

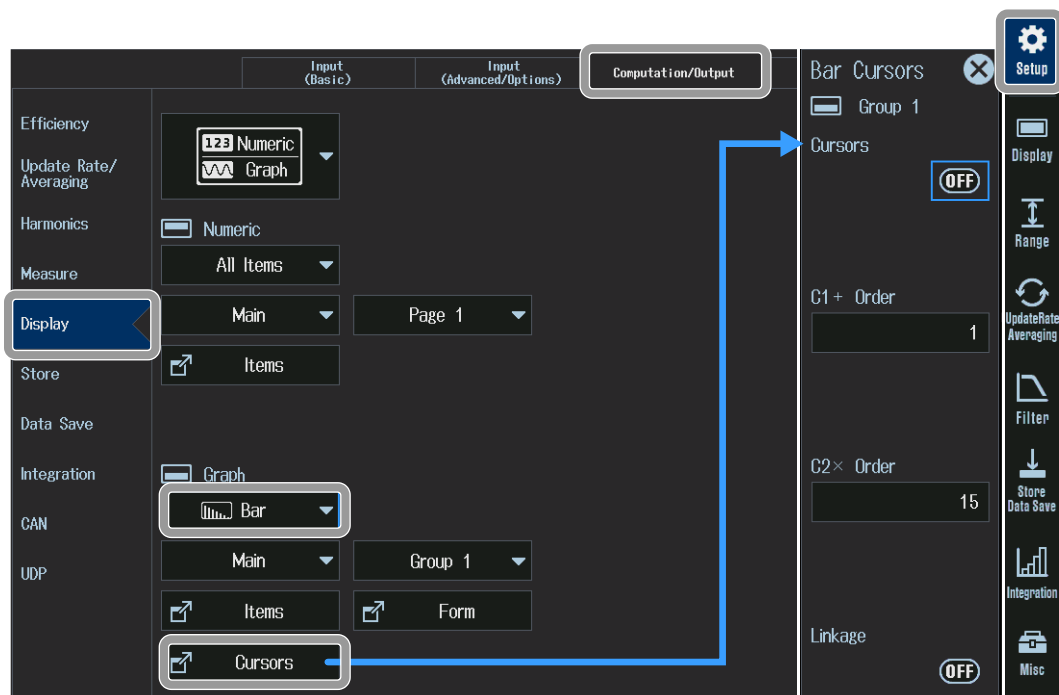
- Two cursors (+ and x) are displayed in each graph (bar graph 1 to bar graph 3).
- The cursor positions are set by harmonic order.
- The harmonic order indicating the cursor position is displayed on the bar graph.
 - The position of Cursor 1 (+) is displayed as Order+: 2, for example.
 - The position of Cursor 2 (x) is displayed as Orderx: 55, for example.
- The harmonic orders indicating the positions of Cursor 1 (+) and Cursor 2 (x) are common to Bar Graph 1 to Bar Graph 3.

Note

If unmeasurable data is present, "****" is displayed in the measurement display area.

Procedure

Setup menu icon  > **Computation/Output** > **Display** > In the Graph menu, set Wave/Bar/Vector to **Bar** > **Cursors**



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to set the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Turning cursor measurement on and off (Cursors)

- ON: Cursor measurement is performed.
- OFF: Cursor measurement is not performed.

Position of Cursor 1 (+) (C1+ Order)

You can set the position of cursor 1 (+) in the following range.

Setting range: 0 (DC) to 100 (100th harmonic)

Position of Cursor 2 (×) (C2× Order)

You can set the position of Cursor 2 (×).

The ranges within which you can set the position are the same as those for cursor 1 (+) (C1+ Order).

Linking cursor movement (Linkage)

Set Linkage to ON to move Cursor 1 (+) and Cursor 2 (×) without changing the distance between them.

Set the cursor position using C1+ Order or C2× Order.

11.1 Setting Motor Evaluation and Auxiliary Input

Overview

Motor evaluation function

Motor speed, torque, and motor output

Motor speed, torque, and motor output are measured from the rotation sensor signal, which is proportional to motor speed, and the torque meter signal, which is proportional to torque.

- You can select either an analog signal (DC voltage) or a pulse signal as the input signal.
- If the rotation sensor is a resolver, input the excitation signal, sin signal, and cos signal.

Motor synchronous speed and slip

Set the number of motor poles to measure synchronous speed and slip.

Motor efficiency and total efficiency

Motor efficiency, which is the ratio of motor output to the power consumed by the motor, and total efficiency can be computed from the active power measured by this instrument and the motor output. For how to set formulas, see page 11-30 and section 4.11.

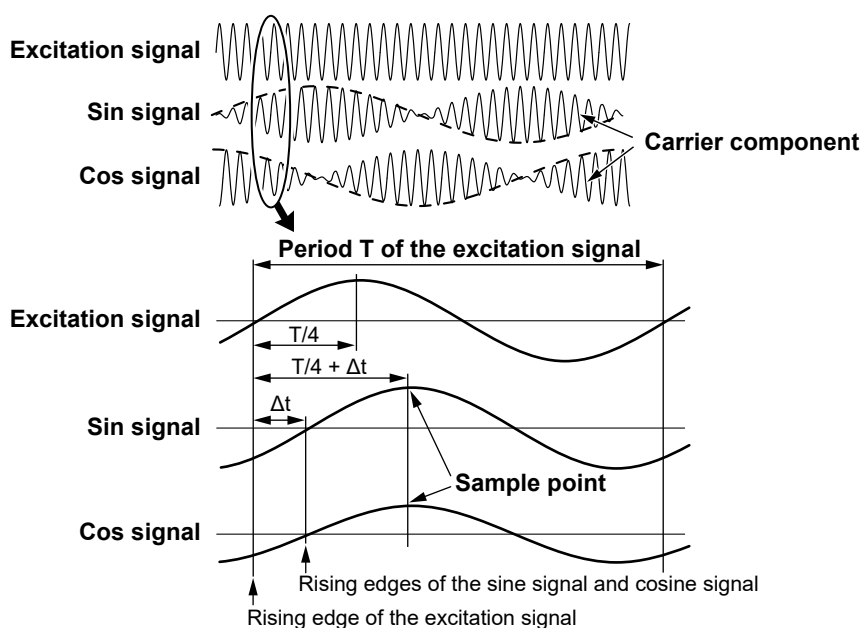
For the symbols and meanings of the measurement functions available with the motor evaluation function, see page 1-6.

Resolver input

The rotation angle is computed from the excitation signal input to the resolver and the Sin and Cos signals output from the resolver detection coil. The motor speed is computed using a rotation angle of zero degrees as the reference.

To compute the rotation angle accurately, the data at the point where the carrier component of the Sin and Cos signals is greatest (peak value) is sampled and used in the computation.

The rising edge of the excitation signal is detected, and period T of the excitation signal is measured. The rising edges of the Sin and Cos signals are also detected, and the time difference Δt from the rising edge of the excitation signal is measured. The data at the point $T/4 + \Delta t$ is sampled from the period T and the time difference Δt .

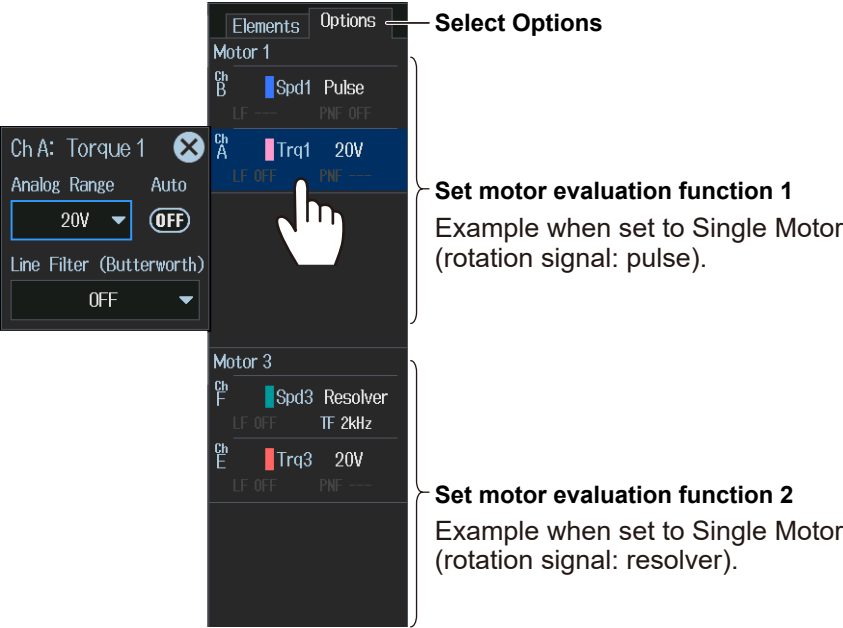


Auxiliary input

You can input signals from illuminance sensors, wind sensors, temperature sensors, and similar devices and display these physical quantities. For the symbols and meanings of the measurement functions available for auxiliary input, see page 1-6.

Display example of motor evaluation and auxiliary input

The settings for motor evaluation and auxiliary input are displayed under Options in the input information area on the right side of the screen.
For details on the operation, see page 11-32.



Setting motor configuration

The following motor evaluation and auxiliary input options are available.

- /EM1 Motor Evaluation for Encoder 1
- /RM1 Motor Evaluation for Resolver 1
- /EM2 Motor Evaluation for Encoder 2
- /RM2 Motor Evaluation for Resolver 2
- /EM1RM1 Motor Evaluation for Encoder/Resolver

The available functions vary depending on the motor evaluation and auxiliary input option installed in this instrument.

For details on the operation, see “Setting MTR Configuration (MTR Configuration)” (pages 11-7 and 11-14) and “Motor/Aux settings (channel settings, Ch Settings)” (pages 11-8 and 11-14).

In MTR Configuration Settings, you can select the function of signal input channels Ch A to Ch H for Motor Evaluation Function from the following:

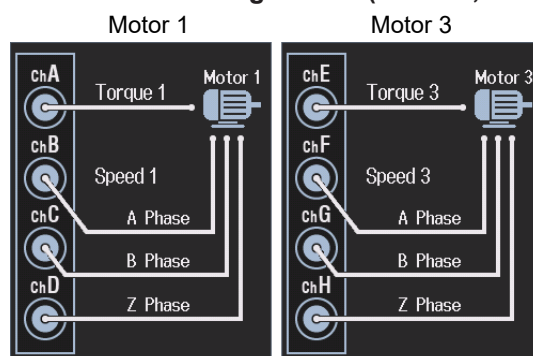
- Single Motor (Speed: Pulse)
- Single Motor (Speed: Analog)
- Double Motor
- Single Motor (Speed: Resolver)
- Auxiliary

Single motor (rotation signal: pulse) (Single Motor (Speed: Pulse))

- On models with the /EM1 or /EM1RM1 option, you can set Motor 1.
- On models with the /EM2 option, you can set Motor 1 and Motor 3.
- The rotation signals are A-, B-, and Z-phase pulses.

MTR1(EM)	MTR2(EM)	Function	Signal
Ch A	Ch E	Torque	Analog/pulse
Ch B	Ch F	Speed A	Pulse A phase (used for speed measurement)
Ch C	Ch G	Speed B	Pulse B phase (used for rotation direction detection)
Ch D	Ch H	Speed Z	Pulse Z phase (used for electrical-angle reference measurement)

Motor number assignments (Motor 1, Motor 3)

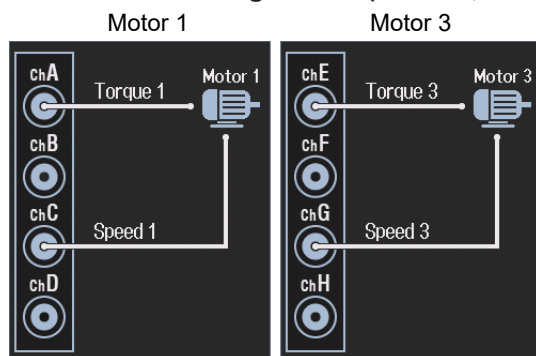


Single motor (rotation signal: analog) (Single Motor (Speed: Analog))

- On models with the /EM1 or /EM1RM1 option, you can set Motor 1.
- On models with the /EM2 option, you can set Motor 1 and Motor 3.
- The rotation signal is analog.

MTR1(EM)	MTR2(EM)	Function	Signal
Ch A	Ch E	Torque	Analog/pulse
Ch B	Ch F	-	Not used
Ch C	Ch G	Speed	Analog
Ch D	Ch H	-	Not used

Motor number assignments (Motor 1, Motor 3)

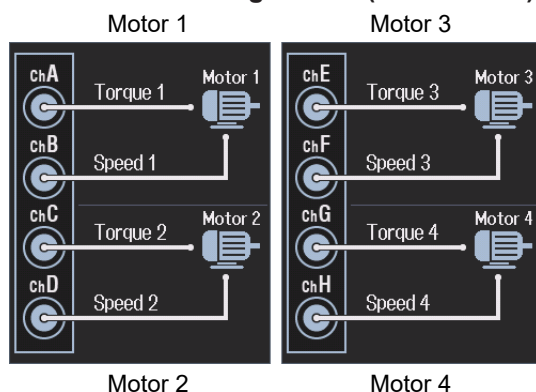


Double motor (Double Motor)

- On models with the /EM1 or /EM1RM1 option, you can set Motor 1 and Motor 2.
- On models with the /EM2 option, you can set Motor 1 to Motor 4.
- You can input two channels of torque and speed (pulse) signals.

MTR1(EM)	MTR2(EM)	Function	Signal
Ch A	Ch E	Torque	Analog/pulse
Ch B	Ch F	Speed	Pulse
Ch C	Ch G	Torque	Analog/pulse
Ch D	Ch H	Speed	Pulse

Motor number assignments (Motor 1 to 4)

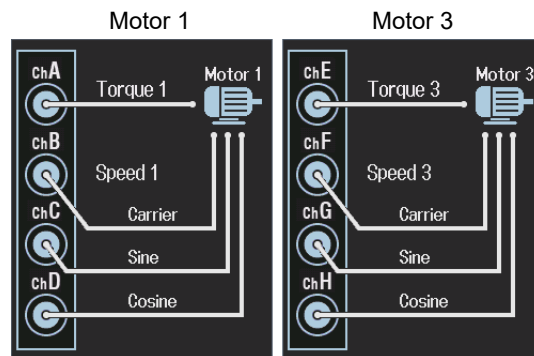


Single motor (rotation signal: resolver) (Single Motor (Speed: Resolver))

- On models with the /RM1 option, you can set Motor 1.
- On models with the /RM2 option, you can set Motor 1 and Motor 3.
- On models with the /EM1RM1 option, you can set Motor 3.
- The rotation signals are excitation signals, sin signals, and cos signals.

MTR1(RM)	MTR2(RM)	Function	Signal
Ch A	Ch E	Torque	Analog/pulse
Ch B	Ch F	Speed Carrier	Excitation signal (ref)
Ch C	Ch G	Speed Sine	sin signal
Ch D	Ch H	Speed Cosine	cos signal

Motor number assignments (Motor 1, Motor 3)



Auxiliary (Aux) (Auxiliary)

You can apply analog voltage signals or pulse signals (e.g., frequency) from illuminance sensors, wind sensors, temperature sensors, and the like and display these physical quantities.

When the /EM1 or /EM2 option is installed

MTR1(EM)	MTR2(EM)	Function	Signal
Ch A	Ch E	Aux	Analog/pulse
Ch B	Ch F	Aux	Pulse
Ch C	Ch G	Aux	Analog/pulse
Ch D	Ch H	Aux	Pulse

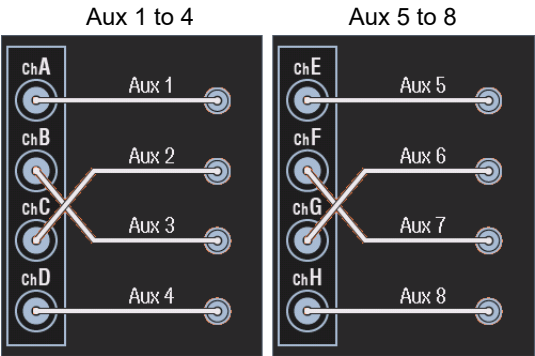
When the /RM1 or /RM2 option is installed

MTR1(RM)	MTR2(RM)	Function	Signal
Ch A	Ch E	Aux	Analog/pulse
Ch B	Ch F	Aux	Analog
Ch C	Ch G	Aux	Analog
Ch D	Ch H	Aux	Analog

When the /EM1RM1 option is installed

MTR1(EM)	Function	Signal	MTR2(RM)	Function	Signal
Ch A	Aux	Analog/pulse	Ch E	Aux	Analog/pulse
Ch B	Aux	Pulse	Ch F	Aux	Analog
Ch C	Aux	Analog/pulse	Ch G	Aux	Analog
Ch D	Aux	Pulse	Ch H	Aux	Analog

Aux number assignments (Aux 1 to 8)



Procedure

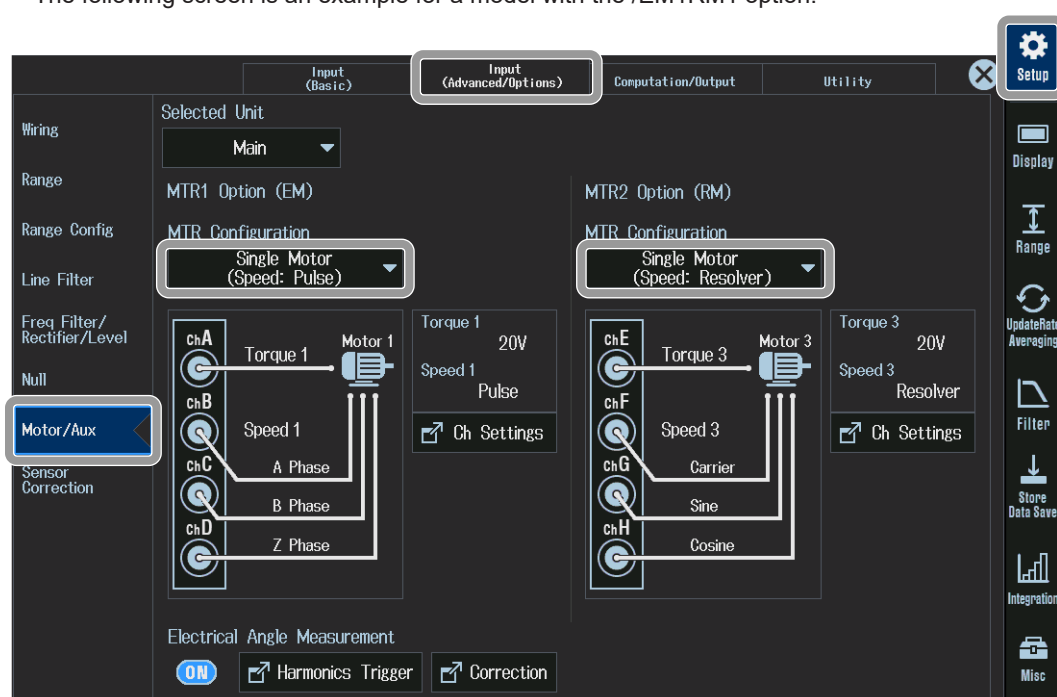
Motor evaluation and auxiliary input (Aux)

Setup menu icon  > Input (Advanced/Options)

> Motor/Aux

- **Unit to configure (Selected Unit)**
 - > Main/Sub 1/Sub 2/Sub 3/Sub 4 (/SY1 option) in the Selected Unit menu
- **Setting MTR configuration**
 - > Single Motor (Speed: Pulse)/Single Motor (Speed: Analog)/Single Motor (Speed: Resolver)/Double Motor/Auxiliary in the MTR Configuration menu

The following screen is an example for a model with the /EM1RM1 option.



Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
 - See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - The input settings overview screen can also be displayed by selecting **Input (Advanced/Options)** with the arrow keys and pressing **SET**.

11.1 Setting Motor Evaluation and Auxiliary Input

- Motor/Aux settings (Ch Settings)

- > Ch Settings

For single motor (rotation signal: pulse)

The image shows the MTR Configuration screen and the Ch Settings screen. The MTR Configuration screen has a dropdown menu set to "Single Motor (Speed: Pulse)". It shows connections for Torque 1, Speed 1, and Motor 1. The Ch Settings screen is divided into three tabs: Ch A: Torque 1, Ch B: Speed 1, and Pm 1. The Ch A: Torque 1 tab is selected, showing settings for Scaling (1.0000), Unit (Nm), Sense Type (Analog), Analog Auto Range (OFF), Analog Range (20V), Linear Scale A (1.000), B (0.000), Line Filter (Butterworth) (OFF), and Pulse Noise Filter (OFF). A blue arrow points from the "Ch Settings" button in the MTR Configuration screen to the Ch Settings screen. Another blue arrow points from the "Calculation" button in the Ch Settings screen to the Calculation dialog box. The Calculation dialog box shows the formula $Y = AX + B$ and fields for Point 1 X [V] (1.000), Point 1 Y [Nm] (1.000), Point 2 X [V] (-1.000), and Point 2 Y [Nm] (-1.000). A third blue arrow points from the "Multi-Unit Synchronization Common Zero Cross Setting" button in the Ch Settings screen to the Multi-Unit Synchronization Common Zero Cross Setting dialog box. The Multi-Unit Synchronization Common Zero Cross Setting dialog box shows fields for Unit (Main) and Sync Source (U1). Annotations with arrows point to the "Sense Type" dropdown, the "Calculation" button, and the "Multi-Unit Synchronization Common Zero Cross Setting" button, stating: "You can set these when Sense Type is set to Analog." and "You can set these when Sync Source is set to CommZC.*".

Torque signal input range
This appears when Sense Type is set to Analog.

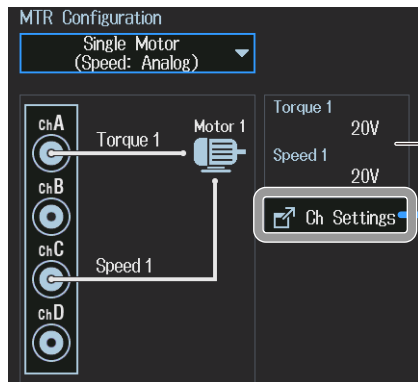
You can set these when Sense Type is set to Analog.

You can set these when Sync Source is set to CommZC.*

Items after Pulse Noise Filter are displayed using the scroll bar on the right side of the screen or by dragging the screen.

* During multi-unit synchronization (option /SY1), you can select CommZC for Sync Source.
(See "Sync source (Sync Source)" on page 11-23).

For single motor (rotation signal: analog)



The input ranges for the torque signal and rotation signal are displayed.

For the torque signal, the input range is displayed when Sense Type is Analog.

You can set the torque signal range, scale, filter, and so on when Sense Type is Analog.

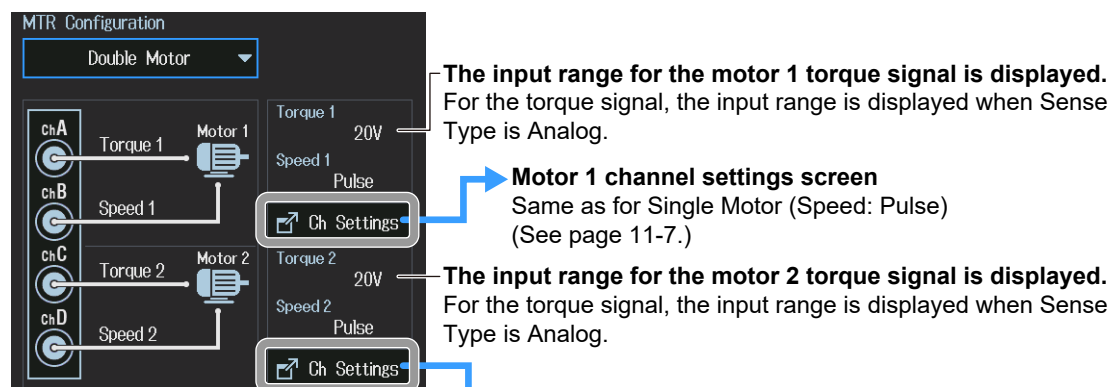
You can set these when Sense Type is set to Pulse.

Items after Pulse Noise Filter are displayed using the scroll bar on the right side of the screen or by dragging the screen.

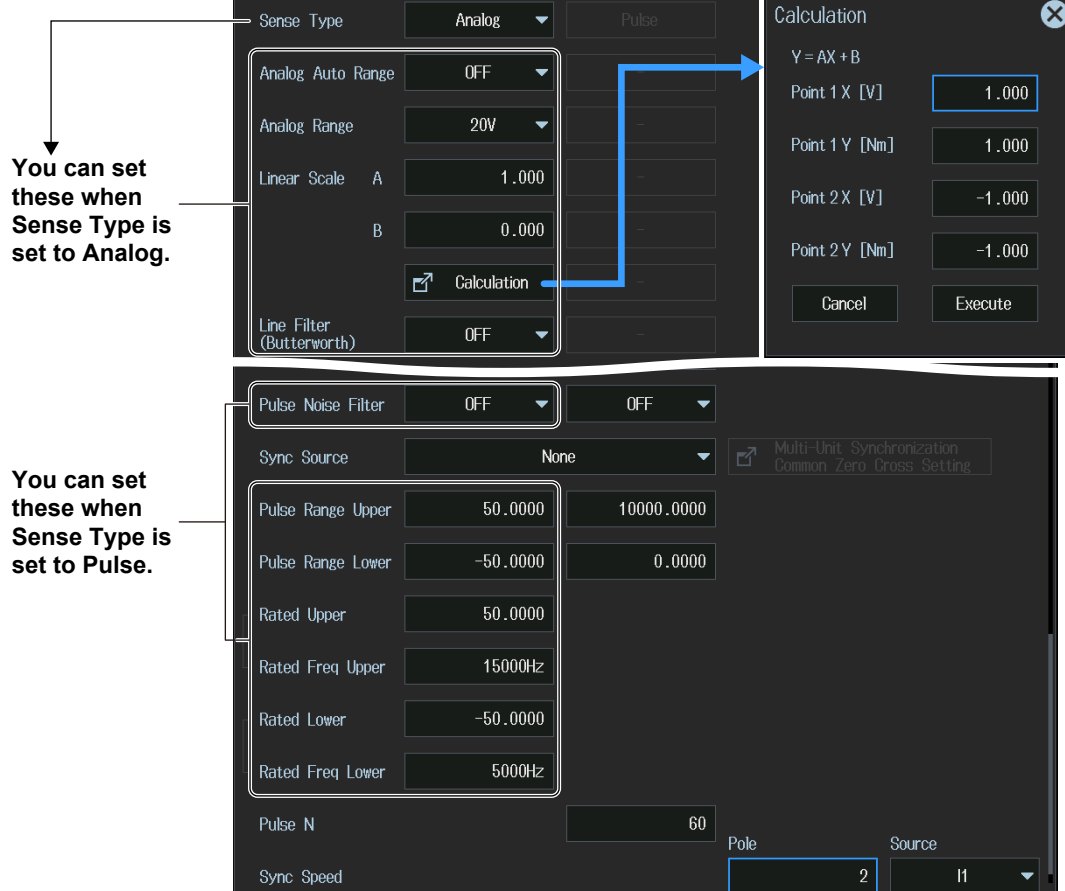
* During multi-unit synchronization (option /SY1), you can select CommZC for Sync Source. (See "Sync source (Sync Source)" on page 11-23). For a display example, see the previous page.

11.1 Setting Motor Evaluation and Auxiliary Input

For double motor



Motor 2 channel settings screen



Items after Pulse Noise Filter are displayed using the scroll bar on the right side of the screen or by dragging the screen.

* During multi-unit synchronization (option /SY1), you can select CommZC for Sync Source. (See "Sync source (Sync Source)" on page 11-23). For a display example, see page 11-8.

For single motor (rotation signal: resolver)

MTR Configuration
Single Motor (Speed: Resolver)

chE Torque 3 Motor 3
chF Speed 3
chG Carrier
chH Sine
Cosine

Torque 3 20V
Speed 3 Resolver
Ch Settings

The input ranges for the torque signal and rotation signal are displayed.
For the torque signal, the input range is displayed when Sense Type is Analog.

You can set the torque signal range, scale, filter, and so on when Sense Type is Analog.

You can set these when Sense Type is set to Pulse.

Ch Settings
Ch E: Torque 3 Ch F: Speed 3 Pm 3

Setting	Ch E: Torque 3	Ch F: Speed 3	Pm 3
Scaling	1.0000	1.0000	1.0000
Unit	Nm	rpm	W
Sense Type	Analog	Resolver	
Analog Auto Range	OFF	OFF	
Analog Range	20V	Analog Range	
Linear Scale	A: 1.000 B: 0.000		
Line Filter (Butterworth)	OFF		

Analog Range
Linkage OFF
Carrier 20V
Sine 20V
Cosine 20V

Calculation
Y = AX + B
Point 1 X [V] 1.000
Point 1 Y [Nm] 1.000
Point 2 X [V] -1.000
Point 2 Y [Nm] -1.000
Cancel Execute

Pulse Noise Filter OFF

Sync Source None

Parameter	Value
Pulse Range Upper	50.0000
Pulse Range Lower	-50.0000
Rated Upper	50.0000
Rated Freq Upper	15000Hz
Rated Lower	-50.0000
Rated Freq Lower	5000Hz

Sync Speed Pole 2 Source I1

Hysteresis Low
Line Filter OFF
Tracking Filter 2kHz
Resolver Pole Pair 1
Electrical Angle Averaging ON

Items after Pulse Noise Filter are displayed using the scroll bar on the right side of the screen or by dragging the screen.

* During multi-unit synchronization (option /SY1), you can select CommZC for Sync Source. (See "Sync source (Sync Source)" on page 11-23). For a display example, see page 11-8.

11.1 Setting Motor Evaluation and Auxiliary Input

For auxiliary input (Aux)

MTR Configuration

Auxiliary

Ch A

Ch B

Ch C

Ch D

Aux 1

Aux 2

Aux 3

Aux 4

20V

20V

Pulse

Pulse

Ch Settings

Torque signal input range

This appears when Sense Type is set to Analog.

Ch Settings

Ch A: Aux 1

Ch C: Aux 2

Ch B: Aux 3

Ch D: Aux 4

Name	AUX1	AUX2	AUX3	AUX4
Scaling	1.0000	1.0000	1.0000	1.0000
Unit	V	V	Hz	Hz
Sense Type	Pulse	Analog	Pulse	Pulse
Analog Auto Range	-	OFF		
Analog Range	-	20V		
Linear Scale	A	1.000	1.000	1.000
	B	0.000	0.000	0.000
		Calculation	Calculation	Calculation

Line Filter (Butterworth)

OFF

Pulse Noise Filter

OFF

OFF

OFF

Pulse Range Upper

10.00k

10.00k

10.00k

Pulse Range Lower

0.000

0.000

0.000

Calculation

Y = AX + B

Point 1 X [V]

1.000

Point 1 Y [Unit.]

1.000

Point 2 X [V]

-1.000

Point 2 Y [Unit.]

-1.000

Cancel

Execute

You can set these when Sense Type is set to Analog.

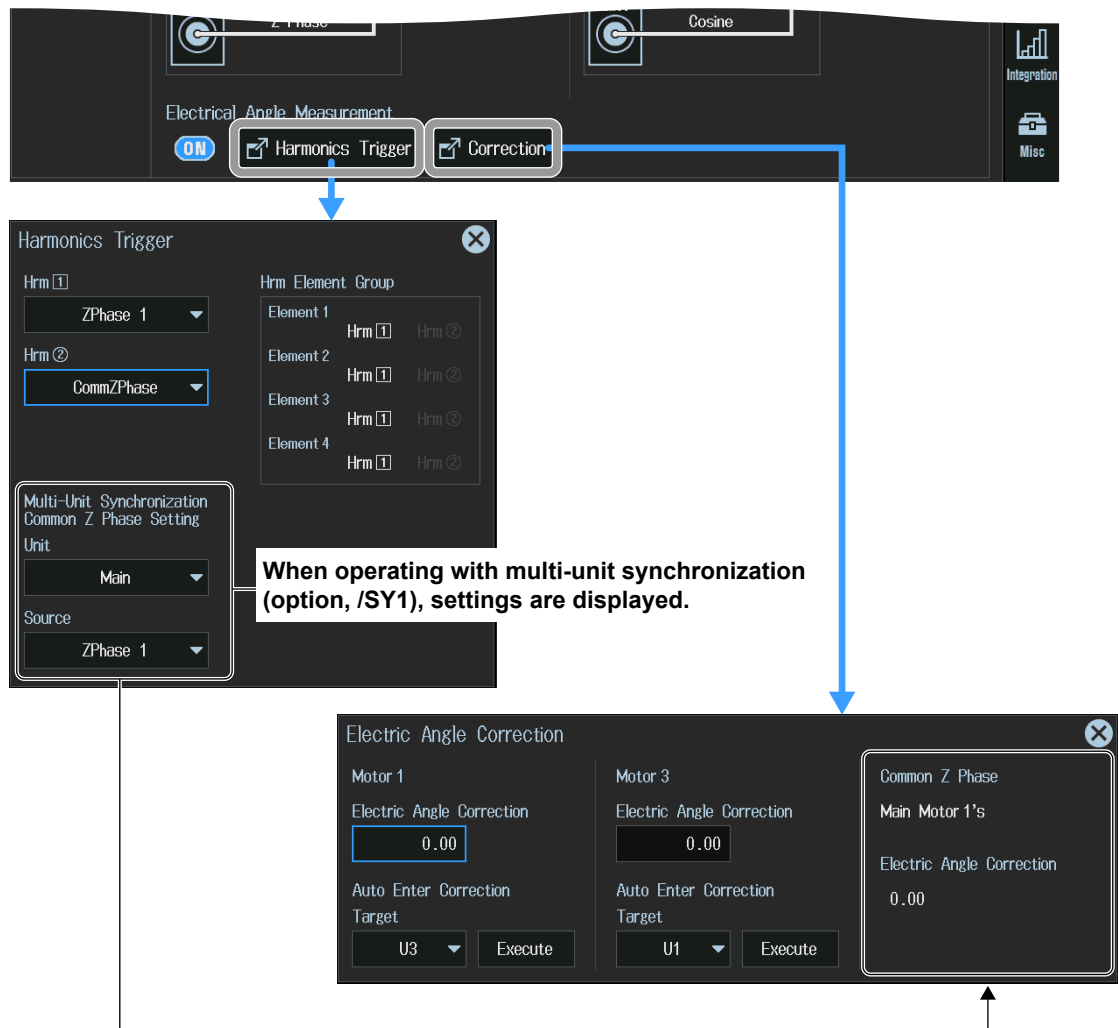
You can set these when Sense Type is set to Pulse.

Items after Line Filter (Butterworth) are displayed by using the scroll bar on the right side of the screen or by dragging the screen.

Note When operating from the “input information area” displayed on the right side of the screen, you can set the analog range, line filter, and pulse noise filter while viewing the measurement display. (See page 11-32.)

- **Electric angle measurement settings**

> Set Electrical Angle Measurement to **ON** > **Harmonics Trigger**, **Correction**



When operating with multi-unit synchronization (/SY1 option), this item is displayed.

Information is displayed when Multi-Unit Synchronization Common Z Phase Setting is configured.

For details on the settings, see page 11-28.

Unit to configure (Selected Unit)

During multi-unit synchronization (/SY1 option), use the main unit to specify the unit to configure, and configure motor evaluation/auxiliary input for each unit.

Select from the following:

Main, Sub 1, Sub 2, Sub 3, Sub 4

MTR configuration (MTR Configuration)

Select the signal input channel A to channel H functions for the motor evaluation function from the following:

The available items vary depending on the installed option.

The connection diagram for the rotation speed and torque signals is displayed according to the MTR Configuration setting.

- Single Motor (Speed: Pulse)
- Single Motor (Speed: Analog)
- Double Motor
- Single Motor (Speed: Resolver)
- Auxiliary

See page 11-3.

Motor/Aux settings (channel settings, Ch Settings)

Set the following items according to the MTR Configuration setting.

When MTR Configuration is set to Single Motor (Speed: Pulse), Single Motor (Speed: Analog), or Double Motor

- Scaling factor (Scaling)
- Unit (Unit)
- Input signal type (Sense Type)
- Analog auto range (Analog Auto Range) on/off
- Analog Range (Analog Range)
- Setting the analog input linear scale manually (Linear Scale A, B)
- Calculating the analog input linear scale from two points (Calculation)
- Line filter (Butterworth)
- Pulse noise filter (Pulse Noise Filter)
- Sync source (Sync Source)
- Upper and lower limits of the pulse range (Pulse Range Upper, Pulse Range Lower)
- Rated values for the torque signal pulse
- Rotation Signal Pulses per Revolution (Pulse N)
- Motor poles (Pole)
- Frequency measurement source (Source)

When MTR Configuration is set to Single Motor (Speed: Resolver)

- Scaling factor (Scaling)
- Unit (Unit)
- Input signal type (Sense Type)
- Analog auto range (Analog Auto Range) on/off
- Analog Range (Analog Range)(Linkage ON/OFF, excitation signal, sin signal, cos signal)
- Sync source (Sync Source)
- Upper and lower limits of the pulse range (Pulse Range Upper, Pulse Range Lower)
- Rotation Signal Pulses per Revolution (Pulse N)
- Motor poles (Pole)
- Frequency measurement source (Source)
- Hysteresis (Hysteresis)
- Line filter (Line Filter)
- Tracking filter (Tracking Filter)
- Resolver pole-pair count (Resolver Pole Pair)

When MTR Configuration is set to auxiliary input (Aux)

- Input signal name (Aux Name)
- Scaling factor (Scaling)
- Unit (Unit)
- Input signal type (Sense Type)
- Analog auto range (Analog Auto Range) on/off
- Analog Range (Analog Range)
- Setting the analog input linear scale manually (Linear Scale A, B)
- Calculating the analog input linear scale from two points (Calculation)
- Line filter (Butterworth)
- Pulse noise filter (Pulse Noise Filter)
- Upper and lower limits of the pulse range (Pulse Range Upper, Pulse Range Lower)

Input signal name (Aux Name)

When MTR Configuration is set to auxiliary input (Aux), set the input signal name.

- Number of characters: Up to 8
- Character type: Characters and spaces displayed on the keyboard

Scaling factor (Scaling)

When MTR Configuration is set to Single Motor (Speed: Pulse), Single Motor (Speed: Analog), Double Motor, or Single Motor (Speed: Resolver)

- **Setting the scaling factor for converting the rotation signal**

Setting range: 0.0001 to 99999.9999

- When the rotation signal type is analog or resolver

This is used as the scaling factor in the formula for “Linear Scale for Analog Input” (page 11-20).

- When the rotation signal type is pulse

This is used as the scaling factor in the formula for “Pulses per Revolution of the Rotation Signal” (page 11-25).

- **Setting the scaling factor for converting the torque signal**

Setting range: 0.0001 to 99999.9999

- When the torque signal type is analog

This is used as the scaling factor in the formula for “Linear Scale for Analog Input” (page 11-20).

- When the torque signal type is pulse

This is used as the scaling factor in the formula for “Rated Values for the Torque Signal Pulse” (page 11-24).

- **Setting the scaling factor for calculating the motor output**

You can set the scaling factor for calculating motor output (mechanical power) from speed and torque within the following range.

Setting range: 0.0001 to 99999.9999

The formula is shown below. When the scaling factors for speed and torque are set so that the unit of speed is min^{-1} (rpm) and the unit of torque is $\text{N}\cdot\text{m}$, and the motor output scaling factor set here is 1, the unit of motor output P_m is W.

In efficiency computations (see section 4.11), P_m is computed in W, so we recommend setting the scaling factors for each item so that the unit of P_m is W.

$$\text{Motor output } P_m = \frac{2\pi}{60} 60 \times \text{Speed} \times \text{Torque} \times S$$

Speed: Rotation speed obtained from the pulses per revolution

Torque: torque obtained from the rated values for the torque signal pulse

S: Scaling factor

When MTR Configuration is set to Auxiliary (Aux)

You can set the scaling factor for converting the auxiliary signal within the range from 0.0001 to 99999.9999.

This is used as the scaling factor in the formula for “Linear Scale for Analog Input.”

Unit (Unit)

- Number of characters: Up to 8
- Character type: Characters and spaces displayed on the keyboard

Input signal type (Sense Type)

Select the input signal from the following three types.

- Analog: Select this when the signal type is DC voltage (analog signal).
- Pulse: Select this when the signal type is a pulse signal.
- Resolver: Select this when the rotation speed signal type is a resolver signal.
This can be selected on the RM motor evaluation board of models with the /RM1, /RM2, or /EM1RM1 option.

Input signal types and setting items

The required settings vary as follows depending on the input signal type.

• Settings related to the signal type

Setting	Signal type		
	Analog	Pulse	Resolver
Analog auto range	Yes	No	Yes
Analog range	Yes	No	Yes
Analog linear scale A, B	Yes	No	No
line filter	Yes	No	Yes
Pulse noise filter	No	Yes	No
Sync source*	Recommended	Recommended	Recommended
pulse range upper/lower	No	Yes	Yes
Pulses per revolution*	No	Yes	No
Hysteresis	No	No	Yes
Tracking filter	No	No	Yes
Resolver pole-pair count	No	No	Yes
Angle offset	No	No	No

Yes: Setting required.

No: No setting required

Recommended: Measurement is possible even with None (default), but setting this improves simultaneity with power measurement.

• Common settings unrelated to the signal type

- Scaling factor
- Unit
- Motor poles
- Frequency measurement source for sync speed

* These settings are not required when MTR Configuration is set to Auxiliary (Aux).

Analog input range

Set the analog input range. It is not required for Pulse.

When the input signal type is Analog

Analog auto range (Analog Auto Range) on/off

- OFF: The analog input range is fixed. Set it in “Analog range” below.
- ON: The analog input range is set automatically. Depending on the input signal level, “Analog Range” below switches automatically within the following range:

20 V, 10 V, 5 V, 2 V, 1 V

Range up: The measurement range increases when either of the following conditions is met.

- The input signal exceeds 110 % of the measurement range.
- The peak value of the input signal exceeds approximately 150 % of the measurement range.

Range down: The measurement range decreases when the following condition is met.

The input signal is less than 30 % of the measurement range, and the peak value of the input signal is less than 125 % of the next lower range.

Note

When Analog Auto Range is ON, the range may not remain fixed if an irregular pulse-like waveform is input. In this case, turn Analog Auto Range off and set Analog Range.

Analog Range (Analog Range)

When Analog Auto Range is OFF, you can select the input range from the following:

20 V, 10 V, 5 V, 2 V, 1 V

- * When Analog Auto Range is ON, this setting is not required. The range switches automatically according to the input signal level. (See the previous page.)

When the input signal type is Resolver

Analog auto range (Analog Auto Range) on/off

- OFF: The analog input range is fixed. Set it in “Analog range” below.
- ON: The analog input range is set automatically. Depending on the input signal level, “Analog Range” below switches automatically within the following range:

20 V, 10 V, 5 V, 2 V, 1 V

Range up: The measurement range increases when either of the following conditions is met.

- The peak value of the input signal exceeds 110 % of the measurement range.
- The input signal is in a peak over condition.

Range down: The measurement range decreases when the following condition is met.

The peak value of the input signal is less than 105 % of the lower range.

Note

When Analog Auto Range is ON, the Sine and Cosine ranges are linked and adjusted according to the Sine input signal, so they are set to the same range.

The Carrier range is adjusted according to the Carrier input signal.

Analog Range (Analog Range)

- **Range linkage (Linkage) on/off**

- ON: Carrier, Sine, and Cosine can be set together. When you select the analog range for Carrier, Sine and Cosine are set to the same analog range as Carrier.
If you turn Analog Auto Range ON while range linkage is ON, range linkage turns off.
- OFF: Carrier, Sine, and Cosine can each be selected individually.

- **Carrier**

You can select the range of the resolver excitation signal from the following:

20 V, 10 V, 5 V, 2 V, 1 V

- **Sine**

When Linkage is OFF, you can select the range of the resolver Sin signal from the following:

20 V, 10 V, 5 V, 2 V, 1 V

- **Cosine**

When Linkage is OFF, you can select the range of the resolver Cosine signal from the following:

20 V, 10 V, 5 V, 2 V, 1 V

Analog input linear scale

When the input signal type is Analog, set the slope and offset of the input signal.

When MTR Configuration is set to Auxiliary (Aux), these can also be set when the input signal type is Pulse.

There are two ways to set them:

- Set them manually.
- Calculate them from two points.

Setting the analog input linear scale manually (Linear Scale A, B)

Set the slope (A) and offset (B) of the input signal within the following ranges.

Slope (A)

- When MTR Configuration is set to Single Motor (Speed: Pulse), Single Motor (Speed: Analog), Double Motor, or Single Motor (Speed: Resolver)
1.000 m to 1.000 M
- When MTR Configuration is set to Auxiliary (Aux)
–1.000 M to 1.000 M

However, A cannot be set to zero.

Offset (B)

–1.000 M to 1.000 M

The measured value of the input signal is computed using the following formula.

$$\text{Measured value of input signal} = S(A \cdot X + B - \text{NULL})$$

When the input signal type is Analog

S: Scaling factor

A: Slope of the input signal

X: Voltage of the input signal

B: Offset

NULL: Null value (see page 4-63)

When MTR Configuration is set to Auxiliary (Aux) and the input signal type is Pulse

S: Scaling factor

A: Pulse coefficient

X: Pulse frequency

B: Offset

NULL: Null value (see page 4-63)

When there is no offset in the input signal voltage

If $A = 1$ and $B = 0$, the linear scale settings do not affect the computation, so the formula above becomes:

$$\text{Measured value of input signal} = S(X - \text{NULL})$$

If you set the scaling factor to the value of the input signal per 1 V of input voltage, the input signal is converted.

When there is an offset in the input signal voltage

If S is set to 1, the scaling factor does not affect the computation, so the formula above becomes:

$$\text{Measured value of input signal} = AX + B - \text{NULL}$$

If A is set to the input-signal value per 1 V of input voltage and B is set to the offset value, the input signal is converted.

Note

If you change the slope (A) or offset (B) of the input signal while Null is ON, the correction based on the null value shifts. Set the null value again.

Calculating the analog input linear scale from two points (Calculation)

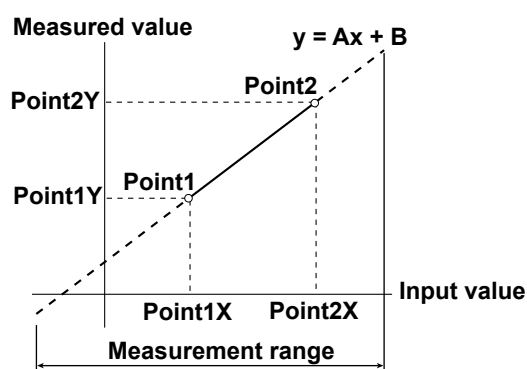
The input signal slope and offset are calculated from two points.

On the input characteristic graph, set the measured values (Point1Y, Point2Y) (rpm or N·m) corresponding to the input values (Point1X, Point2X) (V) within the following ranges:

Input values (Point1X, Point2X): -1.000 T to 1.000 T

Measured values (Point1Y, Point2Y): -1.000 T to 1.000 T

When you select Execute, the slope (A) and offset (B) of the input signal are computed from these four values and set automatically.



Line filter (Butterworth)

A line filter can be inserted into the input-signal measurement circuit to remove high-frequency noise.

The filter type is Butterworth.

Select the cutoff frequency from the following:

OFF, 100 Hz, 500 Hz, 1 kHz

When OFF is selected, the filter is disabled.

Note

The line filter setting is valid when the input signal type is Analog. It is not required for Pulse.

Pulse noise filter (Pulse Noise Filter)

A pulse noise filter can be inserted into the input-signal measurement circuit to remove high-frequency noise.

The filter type is Butterworth.

Select the cutoff frequency from the following:

OFF, 10 kHz, 100 kHz, 1 MHz

When OFF is selected, the filter is disabled.

Note

The Pulse Noise Filter setting is valid when the input signal type is Pulse. It is not required for Analog.

Sync source (Sync Source)

This instrument's computation method is the sync source period average (see page 4-48).

When MTR Configuration is set to Single Motor (Speed: Pulse), Single Motor (Speed: Analog), Double Motor, or Single Motor (Speed: Resolver), set the sync source.

When measuring analog signals for the rotation signal and torque signal, select the input signal of the element to use as the Sync Source from the options below. The available options vary depending on the installed elements.

U1, I1, U2, I2, U3, I3, U4, I4, Ext Clk (external clock),* ZPhase 1 (Ch D), ZPhase 3 (Ch H), CommZC, None

The analog signals for the rotation signal and torque signal are measured over the measurement period determined from the cross point of the selected Sync Source signal.

- If sync source is set to None
 - When the update mode is not Auto, all sampling data within the data update interval is used as the data for calculating rotation speed (Speed) and torque (Torque).
 - When the update mode is Auto, all sampling data up to the timeout time is used as the data for calculating rotation speed (Speed) and torque (Torque).
- When the rotation signal and torque signal are pulse signals, measured values are calculated using the average pulse period within the measurement period determined by the pulse period of the pulse signal. If the measurement period does not include a pulse cycle, measured values are calculated from the previous period.
- When measuring motor efficiency, we recommend using the same sync source signal as the one set in the basic measurement conditions (pages 4-40 and 4-42) so that the measurement period matches that of measurement functions such as voltage, current, and active power. This stabilizes the measured values.
- "CommZC" is available during multi-unit synchronization (option /SY1).
For details on the common ZC signal (CommZC) settings, see the next section, "Multi-unit synchronization common ZC signal setting (Multi-Unit Synchronization Common Zero Cross Setting)."

Multi-unit synchronization common ZC signal setting (Multi-Unit Synchronization Common Zero Cross Setting)

When CommZC is selected for the sync source, you can configure the common ZC signal (CommZC), which can be shared between units. On the main unit, specify the unit and sync source.

- **Unit (Unit)**

Select the unit from the following:

Main, Sub 1, Sub 2, Sub 3, Sub 4

This can be selected only for units with the /EM1, /RM1, /EM2, /RM2, or /EM1RM1 option.

You can select subunit numbers up to the number of connected subunits.

- **Sync source (Sync Source)**

Select the input signal of the element to be used as the sync source from the following options.

The available options vary depending on the installed elements.

U1, I1, U2, I2, U3, I3, U4, I4, Ext Clk (external clock),* ZPhase 1 (Ch D), ZPhase 3 (Ch H)

- * For the specifications of the EXT CLK terminal, see section 2.15 of the Getting Started Guide (IM WT1501-02EN).

Upper and lower limits of the pulse range (Pulse Range Upper, Pulse Range Lower)

Set an appropriate range that includes the maximum and minimum values of the input signal.

Example When measuring a signal with a rotation speed of 120 rpm to 180 rpm and a torque of –18 N·m to +18 N·m, set the following:

- Pulse input range for rotation speed: 100 rpm to 200 rpm
- Pulse input range for torque: –20 N·m to +20 N·m

Set the pulse range for each input signal within the following ranges.

- Torque signal: –10000.0000 to 10000.0000 [N·m]
- Rotation signal: –99999.9999 to 99999.9999 [rpm]
- Aux signal: –10.00 M to 10.00 M

When the input signal type is Pulse, the lower and upper limits of waveform display are the values set here.

Rated values for the torque signal pulse

When the torque signal type is Pulse, set the positive and negative rated values of the torque sensor. Check the torque sensor specifications before making the setting.

Positive and negative rated values for the torque signal (Rated Upper, Rated Lower)

Setting range: –10000.0000 to 10000.0000 [N·m]

Positive and negative rated frequency values of the torque signal pulse (Rated Freq (Upper), Rated Freq (Lower))

Setting range: 1 to 100000000 [Hz]

Torque is computed using the following formula.

$$\text{Torque} = S(\text{AX} + \text{B} - \text{NULL})$$

S: Scaling factor¹

A: Torque pulse coefficient²

X: Pulse frequency

B: Torque pulse offset²

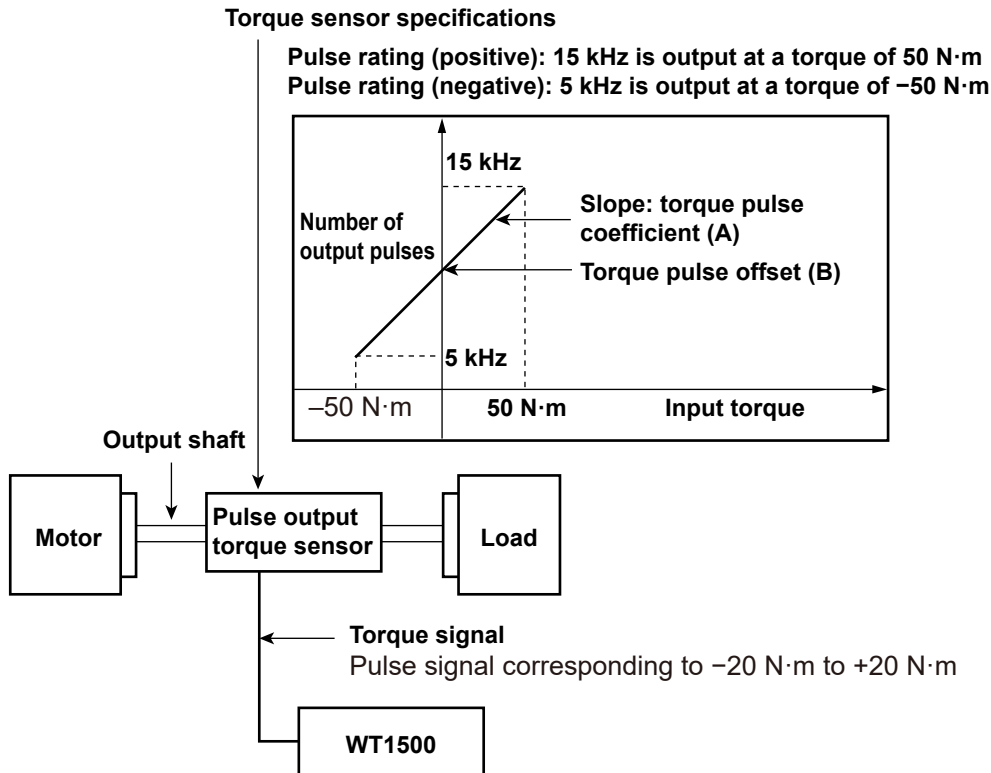
NULL: Null value (see page 4-63)

- 1 If the torque signal is a speed-converted signal, the torque before conversion can be calculated by setting the scaling factor (page 11-16)
- 2 The torque pulse coefficient and torque pulse offset are set from the rated values for the torque signal pulse, as shown in the figure on the next page.

- **Relationship between the pulse input range and rated values for the torque signal pulse**

When using a torque sensor with the specifications shown in the figure below to measure torque from –20 N·m to 20 N·m, set the pulse input range and rated values as follows:

- Upper limit of the pulse range (Pulse Range Upper): 20.0000
- Lower limit of the pulse range (Pulse Range Lower): –20.0000
- Positive rated value of the torque signal (Rated Upper): 50.0000
- Negative rated value of the torque signal (Rated Lower): –50.0000
- Positive rated frequency value of the torque signal pulse (Rated Freq (Upper)): 15000
- Negative rated frequency value of the torque signal pulse (Rated Freq (Lower)): 5000

**Note**

The pulse input range setting is valid when the input signal type is Pulse. It is not required for Analog or Resolver.

Rotation Signal Pulses per Revolution (Pulse N)

Set the number of pulses per rotation.

Setting range: 1 to 9999

Rotation speed is computed using the following computation formula.

$$\text{Rotation speed} = S \left(\frac{X}{N} - \text{NULL} \right)$$

S: Scaling factor*

X: Number of input pulses from the rotation sensor per minute

N: Number of pulses per revolution

NULL: Null value (see page 4-63)

- * When the scaling factor is 1, rotation speed is expressed in revolutions per minute [$\text{min}^{-1}(\text{rpm})$]. If the rotation signal is a speed-converted signal, the rotation speed before conversion can be calculated by setting the scaling factor (page 11-16).

Note

The setting for the number of pulses per revolution of the rotation signal is valid when the input signal type is Pulse. It is not required for Analog.

Sync speed (Sync Speed)

Motor poles (Pole)

Set the number of motor poles. This setting is used to compute the sync speed.

Setting range: 1 to 99

Frequency measurement source (Source)

- Select the frequency measurement source used to compute the sync speed from the options below. This setting is used to compute the sync speed. The available options vary depending on the installed elements.

U1, I1, U2, I2, U3, I3, U4, I4

- Normally, select the voltage or current supplied to the motor. If you select a frequency other than the voltage or current supplied to the motor, the sync speed may not be calculated correctly.

Sync speed formula

The unit of sync speed is fixed at min^{-1} (= rpm).

$$\text{Sync speed SyncSp}(\text{min}^{-1}) = \frac{120 \times F_s}{\text{Pole}}$$

F_s : Frequency of the frequency measurement source (Hz)

Pole: Number of motor poles

Slip formula

The unit of sync speed is fixed at min^{-1} (= rpm). To determine slip, set the scaling factor for the rotation speed so that its unit is also min^{-1} (see page 11-16).

$$\text{Slip (\%)} = \frac{\text{SyncSp} - \text{Speed}}{\text{SyncSp}} \times 100$$

SyncSp: Sync speed (min^{-1})

Speed: Rotation speed (min^{-1})

Note

Set the frequency measurement source to a stable voltage or current signal that is being applied to the motor and that has low distortion and noise.

Hysteresis (Hysteresis)

When the input signal type (Sense Type) is resolver, select the hysteresis for the rising edges of the excitation signal, Sin signal, and Cos signal from the following:

Low, Mid, High

Line filter (Line Filter)

If the input signal type (Sense Type) is Resolver, set the line filter cutoff frequency using approximately 10 times the resolver carrier frequency as a guideline.

Select the cutoff frequency from the following:

OFF, 10 kHz, 20 kHz, 50 kHz, 100 kHz, 200 kHz

When OFF is selected, the filter is disabled.

Tracking filter (Tracking Filter)

If the Sin and Cos signal data changes in steps, select the cutoff frequency of the tracking filter to smooth the data used to compute the rotation angle.

2 kHz, 1 kHz, 250 Hz, 100 Hz

Note

When the input signal type (Sense Type) is resolver, the tracking filter (Tracking Filter) is enabled. The pulse noise filter is disabled.

Resolver pole-pair count (Resolver Pole Pair)

When the input signal type (Sense Type) is resolver, set the resolver pole-pair count.

Setting range: 1 to 15

Electrical angle averaging (Electrical Angle Averaging)

When the input signal type (Sense Type) is resolver, you can apply moving average processing to measured electrical angle values. Set this to ON when the measured electrical angle values are unstable.

- ON: Applies a moving average to measured electrical angle values.
- OFF: Does not apply a moving average to measured electrical angle values.

Electrical angle measurement (Electrical Angle Measurement)

Electrical angle measurement on/off (Electrical Angle Measurement)

When MTR Configuration is set to Single Motor (rotation signal: pulse) or Single Motor (rotation signal: resolver), select whether to measure the electrical angle.

Note

- If the motor evaluation function (option /EM1, /RM1, /EM2, /RM2, or /EM1RM1) is not installed, you cannot turn on electrical angle measurement.
 - During multi-unit synchronization (option /SY1), you can turn on electrical angle measurement if at least one unit with the motor evaluation function (option /EM1, /RM1, /EM2, /RM2, or /EM1RM1) is connected.
-

Harmonic analysis trigger (Harmonics Trigger)

Hrm ①, Hrm ②

You can measure harmonics by assigning each input element to one of two groups: Hrm ① and Hrm ②.

Select the harmonics analysis trigger for Hrm ① and Hrm ② from the following:

- **None**
- **ZPhase 1 (Ch D)**
Motor 1 Z phase (for EM), or post-computation Z pulse from the resolver computation function (for RM)
- **ZPhase 3 (Ch H)**
Motor 3 Z phase (for EM), or post-computation Z pulse from the resolver computation function (for RM)
(Models with the /EM2, /RM2, or /EM1RM1 option)
- **CommZPhase (option)**
During multi-unit synchronization (option /SY1), you can select the common Z Phase signal (CommZPhase) shared among units.
For details on configuring the common Z Phase signal, see “Multi-unit synchronization common Z Phase signal setting (Multi-Unit Synchronization Common Z Phase Setting)” later in this manual.

Harmonic element group (Hrm Element Group)

This setting assigns each input element to Hrm ① or Hrm ②. (See page 8-3.)

Multi-unit synchronization common Z Phase signal setting (Multi-Unit Synchronization Common Z Phase Setting)

During multi-unit synchronization, you can set the common Z Phase signal (CommZPhase) shared among units. On the main unit, specify the unit and source.

- **Unit (Unit)**
Select the unit from the following:
Main, Sub 1, Sub 2, Sub 3, Sub 4

This can be selected only for units with the /EM1, /RM1, /EM2, /RM2, or /EM1RM1 option. You can select subunit numbers up to the number of connected subunits.
- **Source (Source)**
Select the source from the following:
ZPhase 1, ZPhase 3

ZPhase 3 is available when you specify a unit with the /EM2, /RM2, or /EM1RM1 option.

Note

- When motor evaluation function 1 and motor evaluation function 2 are set to single motor (rotation signal: pulse), turning on electrical angle measurement initializes the harmonic analysis triggers for electrical angle measurement as follows.

MTR configuration		Hrm ① trigger	Hrm ② trigger
Motor evaluation function 1	Motor evaluation function 2		
Rotation signal: Pulse or resolver	Any	ZPhase 1	ZPhase 1
Rotation signal: Other than pulse or resolver	Rotation signal: Pulse or resolver	ZPhase 3	ZPhase 3
Rotation signal: Other than pulse or resolver	Rotation signal: Other than pulse or resolver	None	None
Unit without the motor evaluation function*		CommZPhase	CommZPhase

* During multi-unit synchronization, if at least one unit with the motor evaluation function (option /EM1, /RM1, /EM2, /RM2, or /EM1RM1) is connected, the harmonic analysis triggers for a unit without the motor evaluation function are initialized to CommZPhase.

When the synchronization status of multi-unit synchronization is OFF, electrical angle measurement is turned off for units without the motor evaluation function, and ON cannot be selected.

- CommZPhase is available during multi-unit synchronization.
- On units without the motor evaluation function, only CommZPhase can be set during multi-unit synchronization.
- If multi-unit synchronization is disconnected while CommZPhase is selected (synchronization status OFF), the setting changes to None.

Electrical angle correction (Correction)

You can set the electrical angle correction value.

Electrical angle correction (Electrical Angle Correction)

Set the correction value in the range of -180.00 to 180.00° .

Auto enter correction (Auto Enter Correction)

The phase difference between the phase of the voltage or current for which the correction value is automatically entered and the current electrical angle phase is automatically set as the correction value.

Target for auto enter correction (Target)

Select the voltage or current for which the correction value is automatically entered from the options below. The available options vary depending on the installed elements.

U1, I1, U2, I2, U3, I3, U4, I4

Executing auto enter correction (Execute)

Executes automatic entry of the correction value.

Common Z Phase (Common Z Phase)

Displays the unit and motor number set for Common ZPhase.

Common Z Phase electrical angle correction (Common Z Phase Electric Angle Correction)

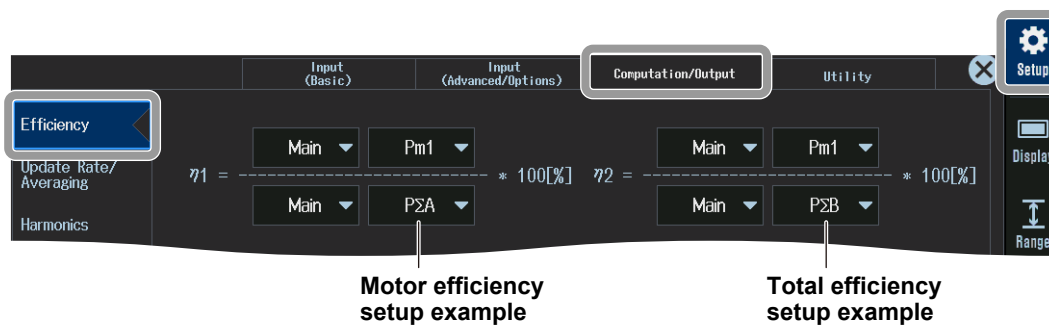
Displays the electrical angle correction value for Common ZPhase. This electrical angle correction value uses the electrical angle correction value of the unit set for Common Z Phase and the motor number set for Common Z Phase.

Procedure

Setting the motor efficiency computation

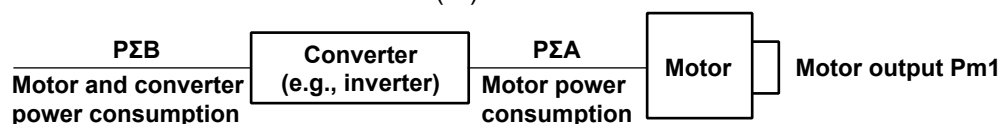
Setup menu icon  > Computation/Output > Efficiency

Example in which motor efficiency is set to η_1 and total efficiency to η_2



$$\text{Motor efficiency } \eta_1 (\%) = \frac{\text{Motor output } P_m (W)}{P_{\Sigma A}(W)} \times 100$$

$$\text{Total efficiency } \eta_2 (\%) = \frac{\text{Motor output } P_m (W)}{P_{\Sigma B}(W)} \times 100$$



Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Calculating the motor efficiency and total efficiency

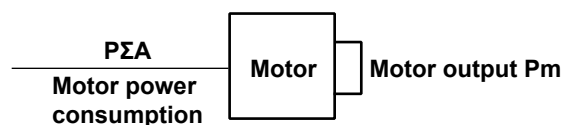
From the active power measured by this instrument and the motor output, this instrument can compute motor efficiency (the ratio of motor output to the power consumed by the motor) and total efficiency.* For setting the computation formula, see section 4.11.

- * The ratio of motor output to the total power consumed, including not only the power consumed by the motor but also the power consumed by the converter through which power is supplied to the motor

Examples of the computation are as follows:

When the motor input is connected to ΣA

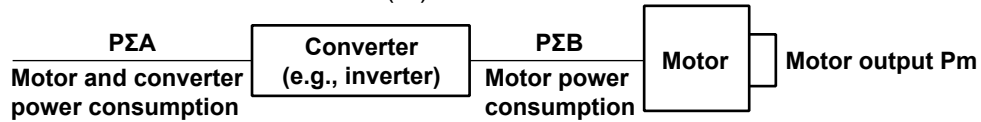
$$\text{Motor efficiency } (\%) = \frac{\text{Motor output } P_m (W)}{P_{\Sigma A}(W)} \times 100$$



When the converter input is connected to ΣA and the motor input is connected to ΣB

$$\text{Motor efficiency (\%)} = \frac{\text{Motor output } P_m \text{ (W)}}{P_{\Sigma B} \text{ (W)}} \times 100$$

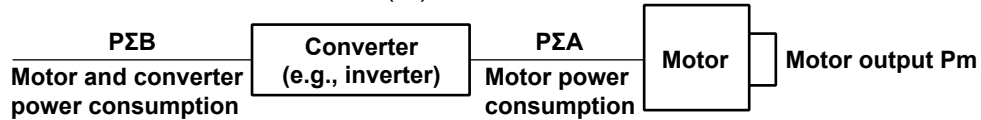
$$\text{Total efficiency (\%)} = \frac{\text{Motor output } P_m \text{ (W)}}{P_{\Sigma A} \text{ (W)}} \times 100$$



When the converter input is connected to ΣB and the motor input is connected to ΣA

$$\text{Motor efficiency (\%)} = \frac{\text{Motor output } P_m \text{ (W)}}{P_{\Sigma A} \text{ (W)}} \times 100$$

$$\text{Total efficiency (\%)} = \frac{\text{Motor output } P_m \text{ (W)}}{P_{\Sigma B} \text{ (W)}} \times 100$$



Note

During multi-unit synchronization (option /SY1), you can set the subunit P_m in the efficiency computation formula.

Procedure

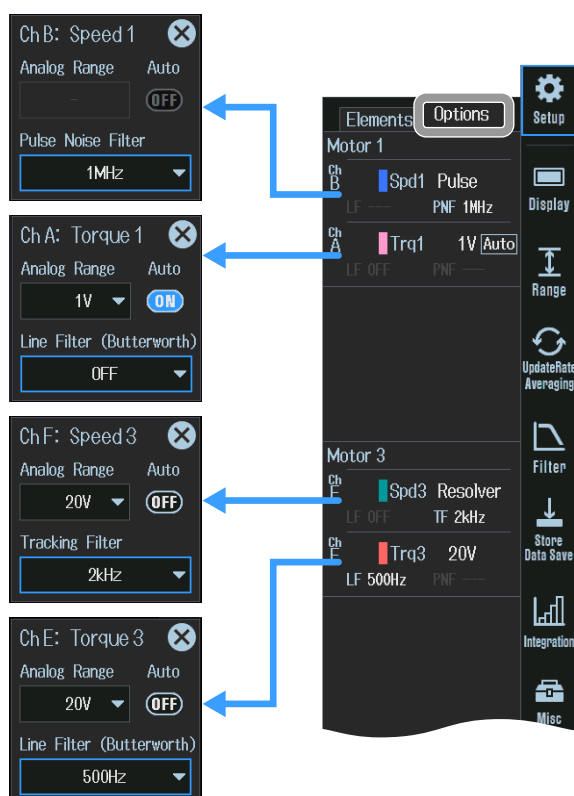
Procedure Using the Input Information Area (Options tab)

- In the input information area displayed on the right side of the screen, you can configure the analog range, line filter, pulse noise filter, and tracking filter while viewing the measurement display.

The settings here are the same as those in “Motor/Aux settings (channel settings, Ch Settings)” (see pages 11-8 and 11-14).

- The input information area is displayed when the overview screen is closed.

Select **Option** > the channel to operate (Ch A to Ch H) in the input information area.



- * The displayed channels and the channel setting screens vary depending on the motor evaluation configuration.
Ch C and Ch D, and Ch G and Ch H are available when the motor evaluation configuration is Double Motor or Auxiliary.

Analog range

Available when the input signal type is analog. (See page 11-18.)

Analog auto range on/off

Available when the input signal type is analog. (See page 11-18.)

Pulse noise filter

You can use this when the input signal type is pulse. (See page 11-32.)

Line filter

Available when the input signal type is analog. (See page 11-32.)

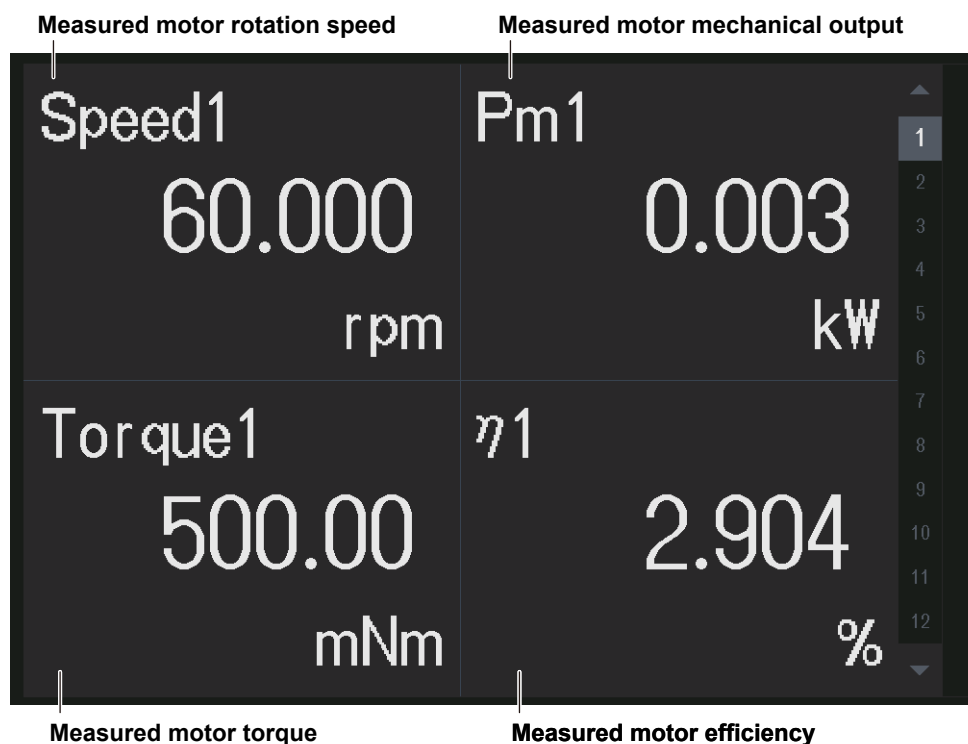
Tracking filter

Available when the input signal type is resolver. (See page 11-32.)

11.2 Displaying motor evaluation measurements (numeric display)

This section explains how to display motor evaluation measurements numerically, using display examples. To obtain motor efficiency and total efficiency values (η), you need to set the computation formula (see sections 4.11 and 11.1).

Example of the measurement display screen (4 Items display)



- This instrument displays motor evaluation measurements (measurement functions) on the screen based on the rotation sensor and torque meter signals input to Ch A to Ch H on the rear panel of the instrument.
- It also displays measurements (measurement functions) of the motor power consumption on the screen based on the voltage and current input to the wiring unit.

Switching display pages (Page Up/Page Down)

Switches to the measurement display for another input element.

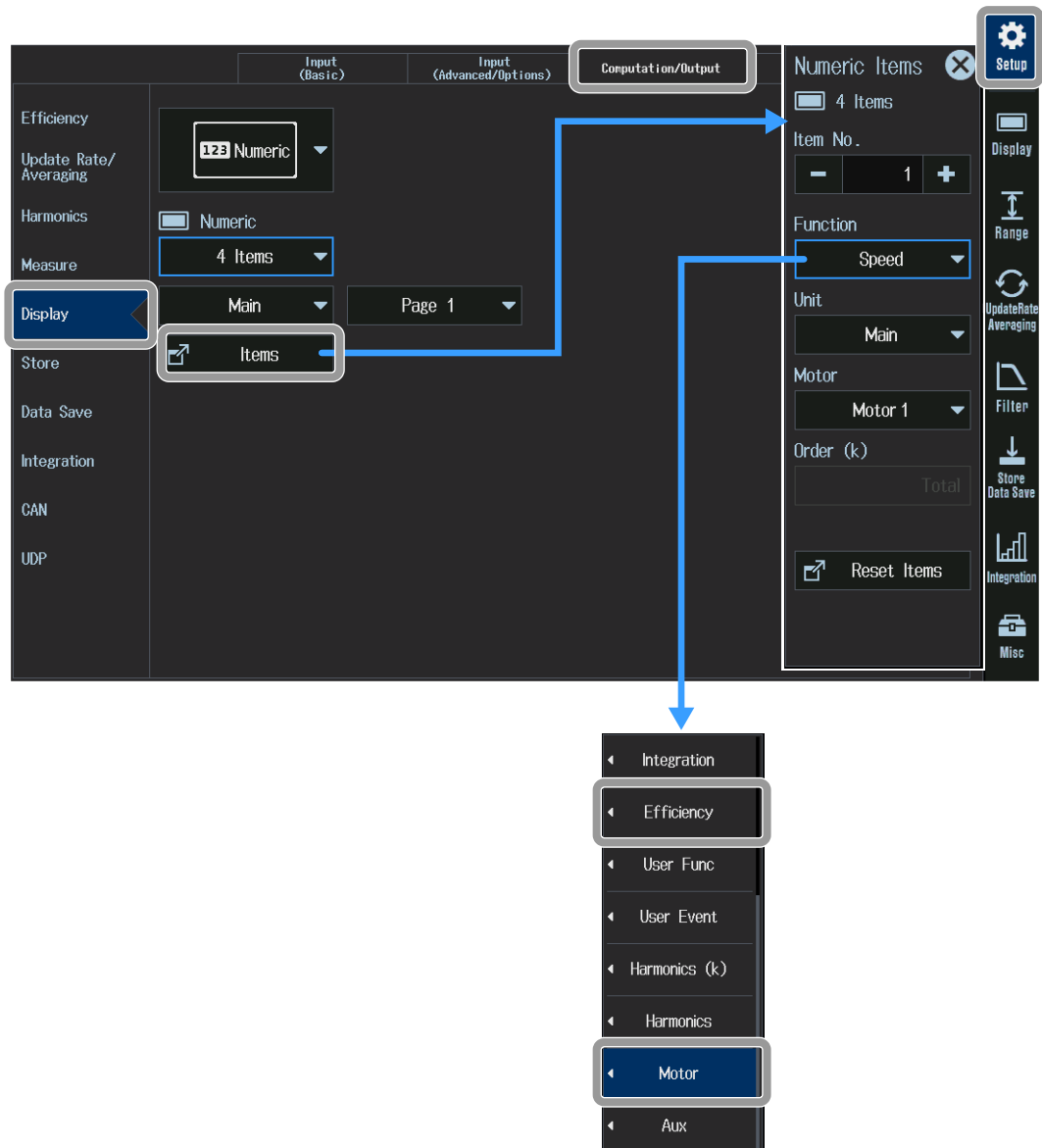
Select ▼ or ▲ to switch the display pages sequentially from the current page number. Select the number directly to switch to the corresponding display page.

Procedure

- Switching display items (Items)

Setup menu icon  > Computation/Output > Display

> Items in the Numeric menu > Efficiency or Motor under Function



Note

- For procedures using the setup menu, see chapter 3.
- You can also use the **Display** menu icon  shown on the right side of the screen to switch the display items. For details on the Display menu, see page v.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Displaying numeric values on the WT1500 LCD

You can also display the motor function numeric display on the WT1500 LCD and use the operation keys.

←MeasurementView
Element
Function
Motor
4 Items

Use the ▲ and ▼ arrow keys to select Measurement View > Motor, and then press **SET**.



←Motor
Motor 1
Speed 50.000 rpm
Torque 0.2000 Nm
SyncSP 1.4998Mrpm
Slip 99.996 %
PM 0.0013kW

Displays the measured values for each motor: rotation speed (Speed), torque (Torque), sync speed (SyncSP), slip (Slip), mechanical output (Pm), and auxiliary input (AUX1 to 8).

Use the ◀ and ▶ arrow keys to switch the displayed motor (1 or 2).

Setting display items (Function)

You can set the following items for motor evaluation display.

Efficiency group (Efficiency)

- η_1 to η_4 (efficiency)

Motor evaluation (Motor) group

- Speed (motor speed)
- Torque (motor torque)
- SyncSP (sync speed)
- Slip (slip (%))
- Pm (motor mechanical output (mechanical power))
- EaU1 to EaU4 (electrical angle: phase angles of U1 to U4 referenced to the falling edge of the Z-phase input of the Speed1 signal)
- EaI1 to EaI4 (electrical angle: phase angles of I1 to I4 referenced to the falling edge of the Z-phase input of the Speed1 signal)

12.1 Setting Storage Operations

Overview

Storing data (Store, MENU(STORE))

Numeric data can be stored in internal memory or USB memory in binary format. Data can be stored at the data update interval or at a specified time interval (however, when the update mode is set to Trigger, the data update interval depends on the trigger operation). Stored binary data can also be converted to ASCII format (.CSV). This is useful for analyzing data on a PC. Stored data cannot be recalled to this instrument.

Note

The storage function cannot be used simultaneously with the CAN data output function (optional) (see chapter 16).

Storage status display

When storage is in any state other than reset, the storage status and storage count are displayed at the top of the screen.

Storage state Storage count

Store  Rec 39

Rec  Rec Storage in progress.

Pause  Pause Storage paused.

Ready  Ready Storage ready when the storage mode is set to real-time storage mode, integration-synchronized storage mode, or event-synchronized storage mode.

Cmpl(Complete)  Cmpl

- When the specified number of storage operations has been completed
- When the scheduled storage stop time has passed in real-time storage mode

When storage is in the reset state, nothing is displayed in the storage status display at the top of the screen.

Restrictions on changing settings during storage

While storage is in progress, some functions cannot be changed or executed. For details, see appendix 8.

Storage conditions

The storage condition setting menu includes the following items:

- Storage control (see the next page)
- Storage items (see section 12.2)
- Save conditions (see section 12.3)

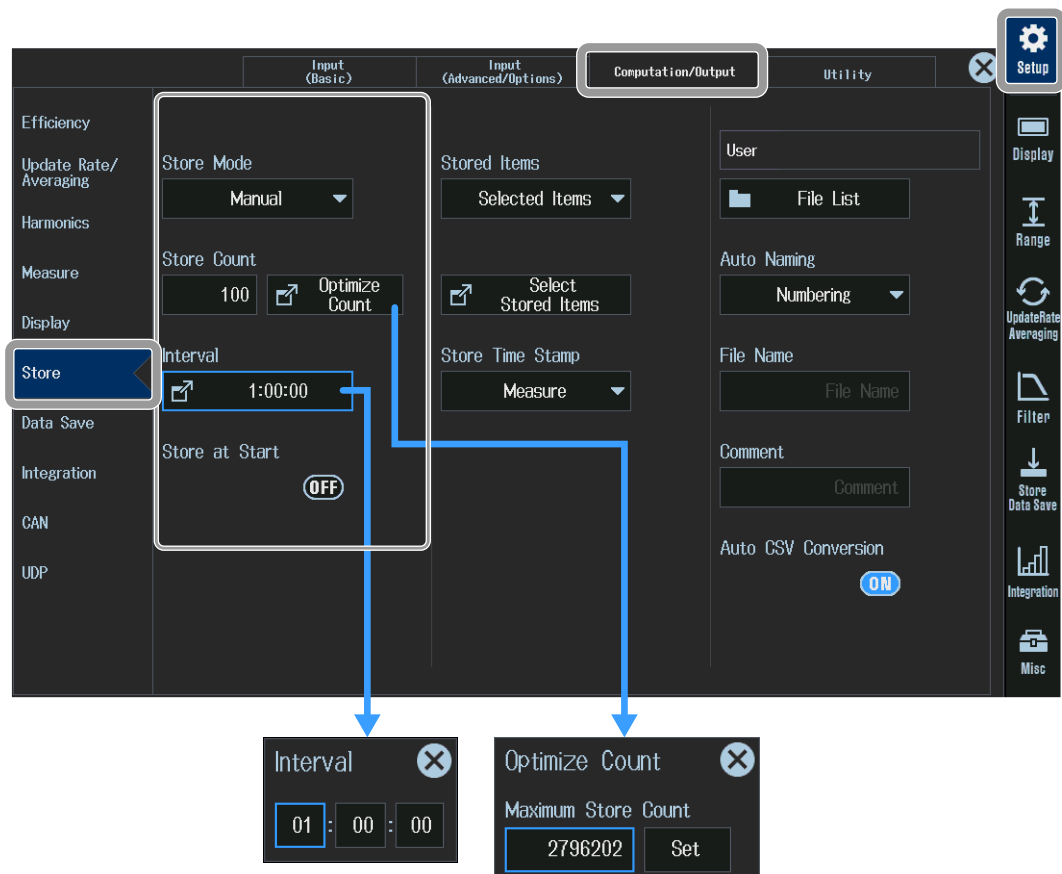
12.1 Setting Storage Operations

After selecting the storage mode, set the storage control items.

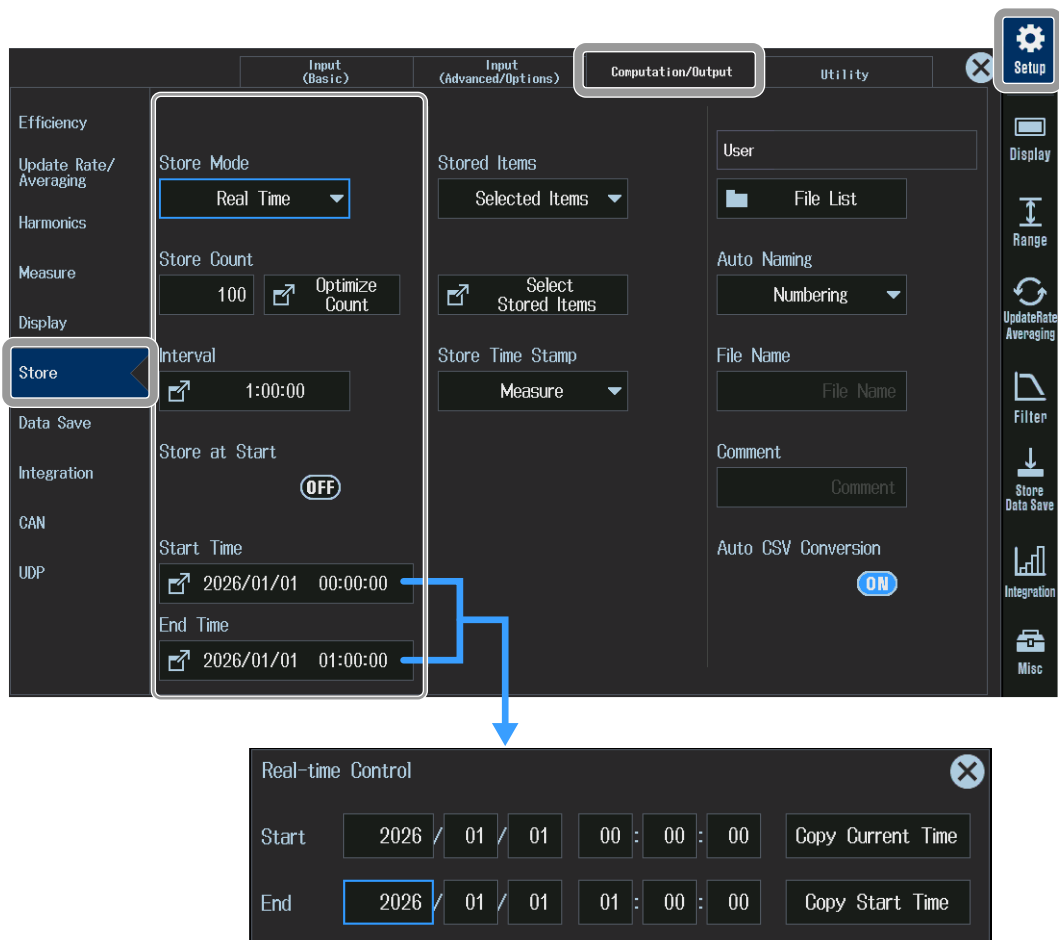
Procedure

Setup menu icon  > **Computation/Output** > **Data Save** > **Store** > set Store Mode to Manual/Real Time/Integ Sync/Event/Single Shot

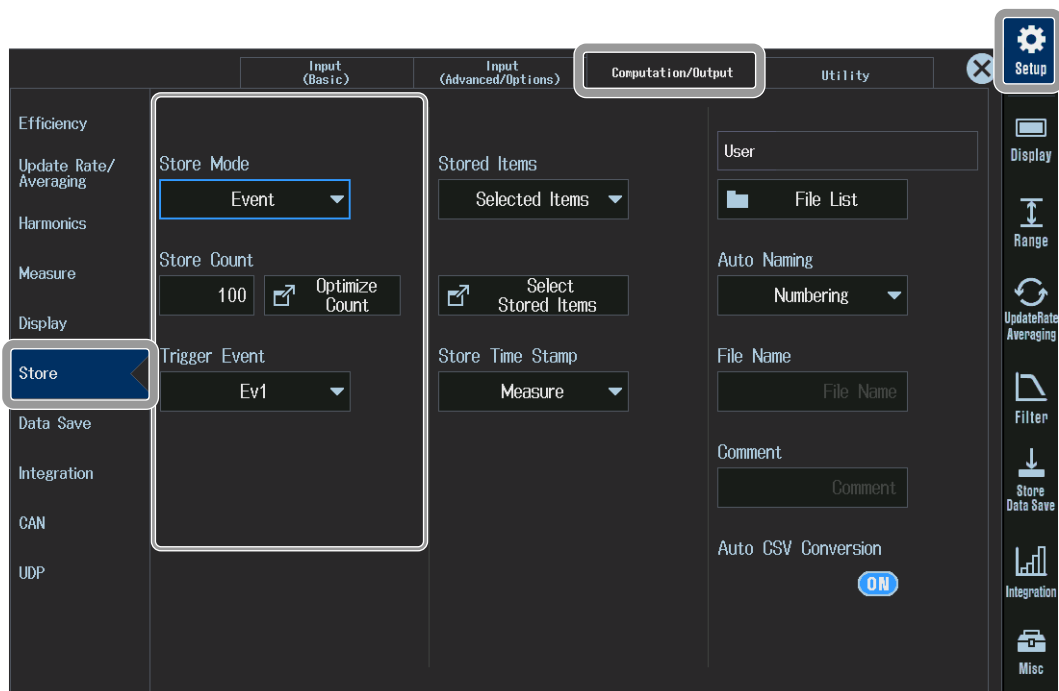
- When the storage mode is Manual or Integ Sync



- When the storage mode is Real Time



- When the storage mode is Event



- **When the storage mode is Single Shot**

There are no storage control settings.

Note

- For procedures using the setup menu, see chapter 3.
 - Select the **Store/Data Save** menu icon . The Store/Data Save menu appears in the submenu area on the right side of the screen. For details on the Store/Data Save menu, see page xiii.
 - Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.
-

Storage mode (Store Mode)

You can select from the following options for when to start or pause storage.

Manual (Manual)

When **Rec** is selected (see section 12.4), numeric data can be stored at each storage interval for the specified storage count.

Real-time control (Real Time)

After **Rec** is selected, storage starts at the scheduled storage start time. Numeric data can be stored at each storage interval until the scheduled storage stop time (or for the specified storage count).

Integration synchronization (Integ Sync)

After **Rec** is selected, storage starts when integration starts. Numeric data can be stored at each storage interval until integration stops (or for the specified storage count).

- Data is also stored when integration is reset by the integration timer. At that time, the storage interval timer is also reset together with the integration timer reset.

Note

- Storage is not available in integration-synchronized storage mode when independent integration is on.
 - When the update mode is Auto, storage is not available in integration-synchronized storage mode if the storage interval is other than 00:00:00.
-

Event synchronization (Event)

After **Rec** is selected, storage starts when the conditions for a user-defined event are met during a measurement data update. Numeric data can be stored for the specified storage count each time the measurement data is updated.

Single shot (Single Shot)

Each time **Rec** is selected, the numeric data at that point is stored. Numeric data can be stored for the specified storage count.

Storage count (Store Count)

You can set this to Infinite or from 1 to 9999999.

- If Infinite is selected, the storage count is set to 9999999.
- If the free space in the storage destination memory runs out or the stored data size exceeds the maximum value (1 GB) before the specified storage count is reached, the storage operation completes.

Optimizing the storage count (Optimize Count)

You can automatically calculate and set the maximum storage count from the capacity of the storage destination and the amount of numeric data to store.

- **Maximum storage count (Maximum Store Count)**

Based on the number of numeric data items set in the storage items, the instrument computes and displays the maximum number of times data can be stored in the storage destination.

- This value can be changed from 0 to the computed maximum storage count.
- When **Set** is selected, the maximum storage count is set as the storage count. If the value is 0, the storage count is not set.

Note

- Even if USB memory is selected as the storage destination, removing the USB memory automatically switches the storage destination to internal memory. If you close the screen once, then select Optimize Count and display this screen again, the maximum storage count changes to a value determined from the free space in internal memory.
- The maximum number of times data can be stored depends on the number of configured storage items and the free space in the storage destination.
The maximum storage count is calculated from the size of one storage operation, using the smaller of 1 GB and the free space in the destination memory as the effective memory size.
For details on how to set the stored items, see section 12.2. For details on how to set the save destination, see section 12.3.
- When Auto CSV Conversion is ON and the storage destination is USB memory device, the maximum storage count is calculated using 20 % of the free space on the USB memory device as the effective memory for stored data (*.WTS and *.HDS files).
- If the maximum storage count is displayed as 0, there is not enough free space on the storage media. Delete files or take other action to secure enough free space.
- If you change the number of items to store after setting the storage count with this function, the maximum storage count changes, so reset the storage count with this function.

Storage interval (Interval)

You can set the storage period.

- Set the value in hours:minutes:seconds in the following range:
00:00:00 to 99:59:59
If set to 00:00:00, data is stored in sync with numeric data updates.
- When the storage mode is Integ Sync, data is also stored when integration is reset by the integration timer. At that time, the storage interval timer is also reset together with the integration timer reset.
- This setting is invalid when the storage mode is set to Event or Single Shot.
- When the update mode is Auto, data is stored at the output update timing, every 10 ms or 50 ms.
- When the update mode is Trigger, the data update interval depends on the trigger operation.
See section 4.10.

Storing numeric data at the start of storage (Store At Start)

This setting is available in the following cases:

- The storage mode is set to manual (Manual), and the storage interval is not 00:00:00.
- The storage mode is set to real-time control (Real Time), and the storage interval is not 00:00:00.
- The storage mode is set to integration synchronization (Integ Sync)

ON

Stores the numeric data at the start of storage.

OFF

Does not store the numeric data at the start of storage.

Scheduled storage start/end time (Start Time/End Time)

This setting is valid only when the storage mode is real-time control (Real Time).

Set the storage start time and storage stop time using year/month/day and hours:minutes:seconds.

Be sure to set the scheduled storage stop time later than the scheduled storage start time. You can set the values within the following ranges.

- Year: Four-digit year
- Hour:minute:second: 00:00:00 to 23:59:59
- Copy Current Time: Sets the current time as the scheduled storage start time.
- Copy Start Time: Sets the scheduled storage stop time to the same time as the scheduled storage start time.

Note

- In the scheduled time settings, February can be set up to 31 days. In this case, an error message appears when storage starts. Set the scheduled time again.
 - This instrument recognizes leap years when it executes the storage operation.
-

Trigger event for event-synchronized storage mode (Trigger Event)

This setting is only valid when the storage mode is set to event synchronization (Event).

Select which user-defined event condition starts storage when the condition is met. If a user-defined event that is OFF is selected as the trigger event, storage cannot be started.

For user-defined event settings, see “User-defined events” in section 5.6.

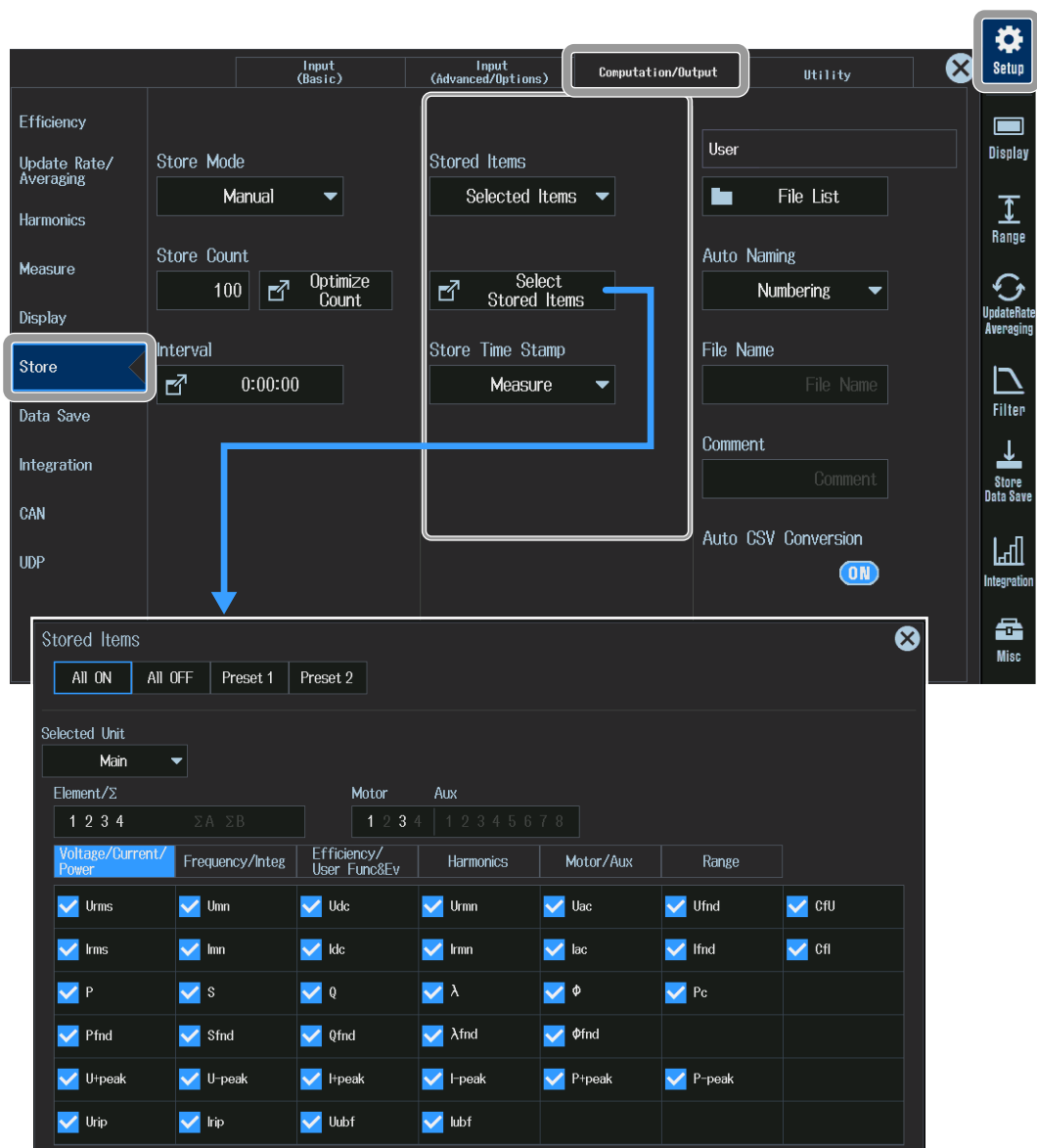
12.2 Setting Stored Items

After specifying how to select the numeric data items to store, set which numeric data items to store.

Procedure

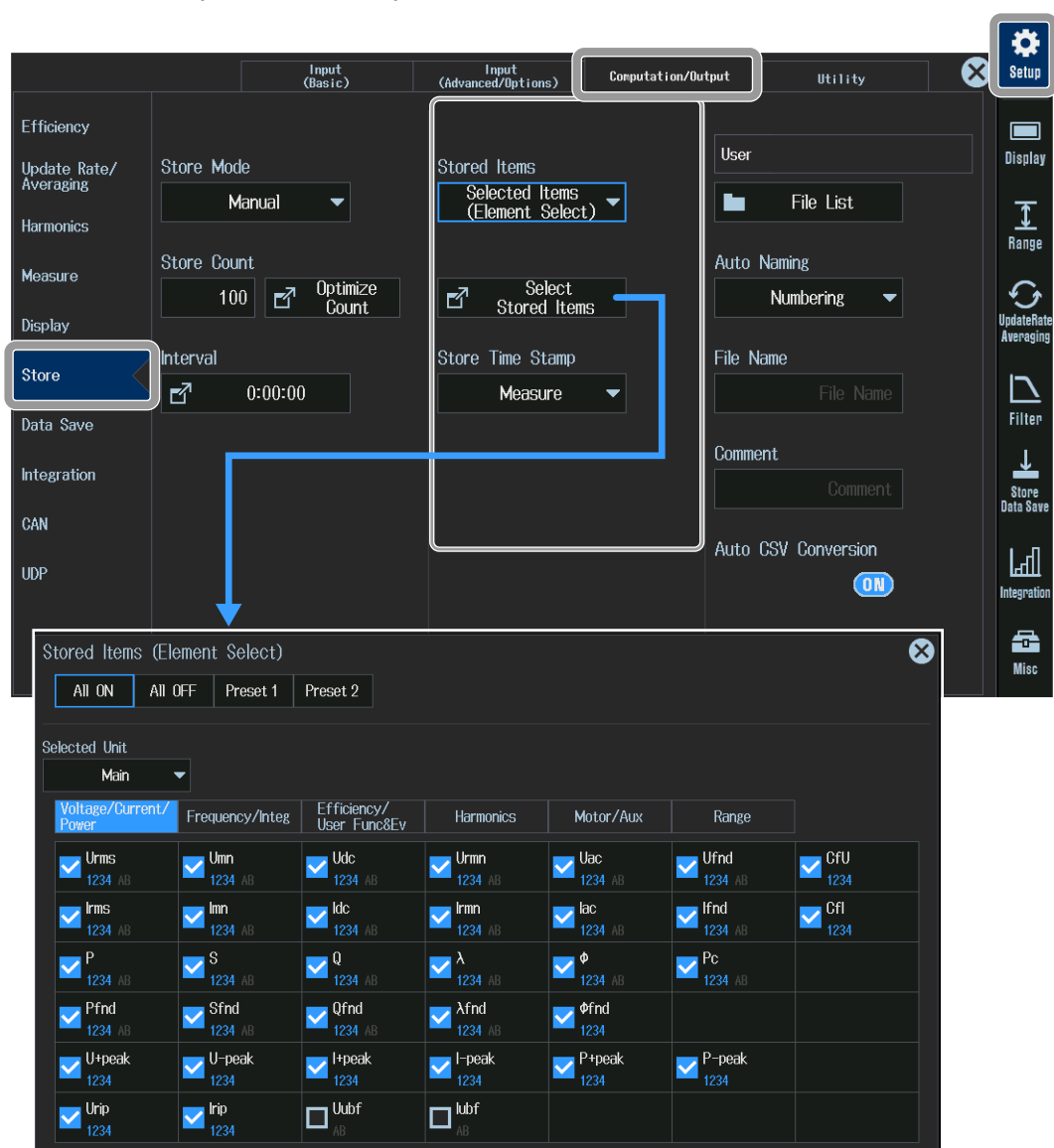
Setup menu icon  > **Computation/Output** > **Data Save** > **Store** > select **Selected Items** or **Selected Items (Element Select)** under Stored Items

- **Selected Items** > **Select Stored Items**



12.2 Setting Stored Items

- Selected Items (Element Select) > Select Stored Items



Note

- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Stored items (Stored Items)

Select one of the following methods for setting the stored items.

Selected items (Selected Items)

Select the measurement functions to store and the element number, motor number, or auxiliary input number. The selected element number, motor number, or auxiliary input number is applied in common to all selected measurement functions. For measurement functions that do not require an element number or similar specification, the data is stored simply by selecting the measurement function.

Selected items (Element Select) (Selected Items (Element Select))

Select the element number, motor number, or auxiliary input number for each measurement function to store.

For measurement functions that do not require an element number or similar specification, the data is stored simply by selecting the measurement function.

Selecting stored items (Select Stored Items)

Select the channels for the input elements, wiring units, motor evaluation, and auxiliary input of the numeric data items to store. If there is no need to select an input element or similar item for the numeric data item to store (for example, efficiency: η , user-defined: F, Ev), select the numeric data item directly.

All ON (All ON)

Stores data for all measurement functions.

All OFF (All OFF)

Does not store data for any measurement functions.

Preset 1 (Preset 1)

Stores data for the following measurement functions for all elements and all wiring units.*

Urms, Irms, FreqU, FreqI, P, S, Q, λ , Φ

Preset 2 (Preset 2)

Stores data for the following measurement functions for all elements and all wiring units.*

WP, WP+, WP-, q, q+, q-, ITime, WS, WQ

* Depending on the wiring system (Wiring), wiring units may not exist. In that case, data for the functions of those wiring units is not stored.

Unit to configure (Selected Unit)

During multi-unit synchronization (option /SY1), the main unit can store power numeric data from subunits.

Specify the unit you want to operate from the following, and set the stored items and Element/ Σ for each unit.

Main, Sub 1, Sub 2, Sub 3, Sub 4

Element, motor, or auxiliary input numbers for the measurement functions to store

- **Element (Element/ Σ)**

Select the check boxes for the elements and wiring units whose data you want to store.

Element 1, Element 2, Element 3, Element 4, ΣA , ΣB

* Depending on the wiring system (Wiring), wiring units may not exist. In that case, data for the functions of those wiring units is not stored. For example, if ΣB does not exist, ΣB data is not stored.

- **Motor number (Motor)**

Select the check boxes for motor inputs 1 to 4 whose data you want to store.

- **Auxiliary input (Aux)**

Select the check boxes for auxiliary inputs 1 to 8 whose data you want to store.

If Selected Items is selected as the method for setting the numeric data items to store, the above settings are displayed in the upper part of the Select Stored Items menu.

If Selected Items (Element Select) is selected as the method for setting the numeric data items to store, the above settings are displayed under each measurement function in "Data to store," described later.

Data to store

Select one of the following measurement function groups to switch the displayed list of numeric data items to store. Select the check boxes for the data you want to store.

- Voltage, current, power (Voltage/Current/Power)
- Frequency, integration (Frequency/Integ)
- Efficiency, user-defined functions and events (Efficiency/User Func&Ev)
- Harmonic measurement (Harmonic)
- Motor evaluation, auxiliary input (Motor/Aux)
- Measurement range (Range)

The measurement function types that can be selected are the items listed in section 1.1, "Items That This Instrument Can Measure."

If Selected Items (Element Select) is selected as the method for setting the numeric data items to store, selecting data to store displays a selection box for the element number, motor number, or auxiliary input number. Selecting one or more items in this selection box will cause the data to be stored (check box selected). This selection box is not displayed for data that does not require specification of an element number or similar item. Use the check boxes to select the data you want to store.

When the update mode is Auto, the information items for timestamp and update status are saved at the end of the stored data. These items are saved automatically according to the selection status of each item in Element (Element/ Σ), Motor (Motor), and Auxiliary input (Aux) in the stored items. For the symbols and meanings of timestamp and update status, see page 1-7.

Note

- The settings on the Stored Items screen and those on the Stored Items (Element Select) screen are independent.
- For measurement functions that are restricted or disabled depending on the setup conditions, such as harmonic measurement, motor evaluation, and auxiliary input, data may not be stored even when the Data to Store check box is selected.

Example When the update mode is other than Auto and the data update interval is 10 ms, harmonic measurement is disabled. Therefore, measurement functions related to harmonics are not stored even if they are checked.

Selecting the storage timestamp (Store Time Stamp)

You can select from the following options for when the storage timestamp is captured for a binary stored data file (.WTS).

Store (Store)

Uses the time when the storage function saves the data to memory as the storage timestamp.

When converted to a CSV file (ASCII format), the time format is as follows:

Example: Date, Time

2026/01/01, 23:59:59

Measure (Measure)

Uses the timestamp at the beginning of the data update interval, which is added during measurement, as the storage timestamp.

The binary-format stored data file also contains fractional-second data.

When converted to a CSV file (ASCII format), the time information, including fractional seconds [μ s], is formatted as follows:

Example: TS Date, TS Time, TS Subsec [μ sec]

2026/01/01, 23:59:59, 123456

12.3 Setting the Data Storage Destination

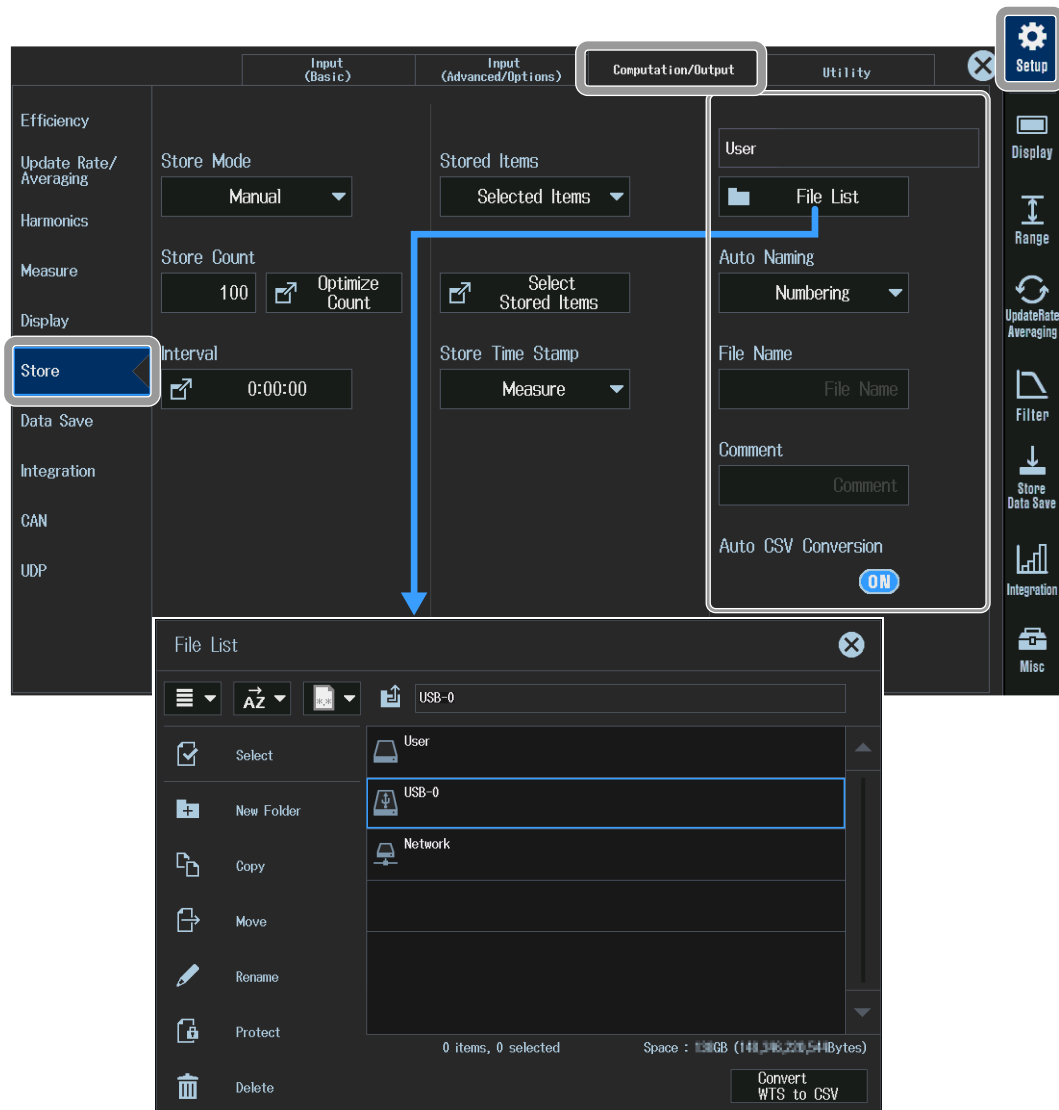
Set the save conditions for storing data.

- When data is stored, two types of binary files are created: *.WTS and *.HDS.
- The stored data file (*.WTS) stores the measured data in binary format.
- The store header file (*.HDS) stores the measurement conditions, settings, and storage information in binary format.
- The file name extension is added automatically.
- The stored data file (*.WTS) can store up to 1 GB.
- Stored data cannot be loaded into this instrument.

See section 13.1.

Procedure

Setup menu icon  > **Computation/Output** > **Data Save** > **Store**



Note

- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

File list (File List)

In the file list, set the storage destination for the stored data. Select the storage destination (drive) from the following:

- Internal memory (User)
- USB memory (USB-0/USB-1/USB-2)

Data cannot be stored on network drives.

See page 13-5.

Note

If USB memory is selected as the storage destination (drive) and then removed, the storage destination automatically switches to internal memory.

Manual CSV conversion (Convert WTS to CSV)

Converts the stored data selected in the file list to ASCII format (.CSV). This menu item appears when File List is selected and the file list is displayed.

A CSV file is created in the same folder as the stored data file being converted.

Auto naming (Auto Naming)

This is the same function as Auto Naming for saving a setup.

See page 3-25.

File name (File Name)

This is the same function as File Name for saving a setup.

See page 3-26.

Comment (Comment)

This is the same as Comment for saving a setup.

See page 3-26.

Automatic CSV conversion (Auto CSV Conversion)

ON

When a storage operation completes or is reset, an ASCII-format stored data file (.CSV) is automatically created from the stored data file (.WTS) and the storage header file (.HDS). The CSV file is created in the same folder as the stored data file.

OFF

Select OFF to disable automatic CSV conversion.

Note

- In the following cases, some data may not be stored. If this happens, an asterisk (*) appears in the storage status display. The storage count includes the data that was not stored.
 - When the setting menus are operated continuously
 - When communication commands are received continuously
 - When operations are performed via FTP
 - If the next storage point occurs before the current data has finished being saved, some data may not be stored. In this case as well, an asterisk (*) appears in the storage status display. The storage count includes the data that was not stored. You can avoid missing stored data in the following ways:
 - Increase the data update interval.
 - Reduce the number of stored items.
 - Use a faster USB memory device.
 - If writing to a USB memory device takes too long, storage may be aborted before all data is saved. In this case, the storage status display shows Error.
 - Conversion to ASCII format (.CSV) processes one pair of files with the same file name: a stored data file (.WTS) and a header file (.HDS). Do not rename a stored data file (.WTS) and a header file (.HDS) containing different stored data to the same file name. Doing so may cause this instrument to malfunction or may damage the USB memory device during conversion to ASCII format (.CSV).
 - CSV conversion can continue until the CSV file size reaches 2 GB. The conversion stops before the data that would exceed this limit is converted.
 - If the USB memory device is removed during storage or storage enters the Error state, the stored data file may be incomplete or corrupted. In such cases, it cannot be converted to ASCII format (.CSV). Always remove the USB memory device only when the storage status is reset or complete (Cmpl).
 - USB memory devices have a limited number of write cycles, so use them with care.
-

12.4 Starting (Rec), Pausing (Pause), and Ending (End) Storage

You can start, pause, or end storage.

CAUTION

During storage, the icon indicating access to the storage destination is not displayed, but the storage destination is still accessed as needed. Do not remove the USB memory device or turn off the power. The device may be damaged, or the data on it may be corrupted.

French

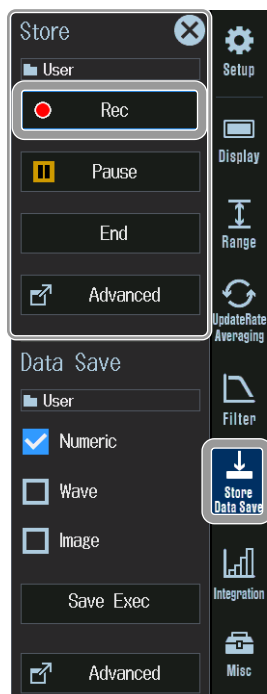
ATTENTION

Pendant la collecte, le système a constamment accès au support de stockage, même si l'icône qui l'indique n'est pas affichée. Ne retirez pas le support de stockage USB et ne coupez pas l'alimentation.

Vous risqueriez d'endommager le support de stockage ou les données qu'il contient.

Procedure

Store/Data Save menu icon  > Rec/Pause/End



Starting, pausing, and ending storage

Starting storage (Rec)

When **Rec** is selected, storage starts as follows depending on the storage mode.

Manual (Manual)

Storage starts.

Real-time control (Real Time)

Storage enters the Ready state. Storage starts when the scheduled storage start time is reached.

Integration synchronization (Integ Sync)

Storage enters the Ready state. Storage starts when integration starts.

Event synchronization (Event)

Storage enters the Ready state. Storage starts when the user-defined event condition is met.

Single shot (Single Shot)

Storage starts. Each time **Rec** is selected, the numeric data at that point is stored.

- When storage starts, the storage status Rec appears at the top of the screen.
- When storage enters the Ready state, the storage status Ready appears at the top of the screen.
- If the storage status is Reset, starting storage creates and opens a stored data file (.WTS) and a storage header file (.HDS).
- If the storage status is Pause, storage can be restarted. When storage is restarted, data continues to be written to the same stored data file that was in use before storage was paused.
- If the storage status is Cmpl, storage can be restarted after it is ended. If storage is started again after it has ended, a new stored data file is created, and data is written to it.

Pausing storage (Pause)

When **Pause** is selected, storage pauses.

- When storage is paused, the storage status Pause appears at the top of the screen.
- If **Pause** is selected when the storage count is 0 and storage is in the Ready state,* storage ends. The stored data file (.WTS) and the store header file (.HDS) are also deleted.

* Example: In real-time storage mode, this is the state after Rec is selected but before the scheduled storage start time is reached and storage has not yet started.

Note

When the update mode is Auto and the storage mode is integration synchronization (Integ Sync), set the storage interval to 00:00:00. With any setting other than 00:00:00, storage cannot be started.

Completion of storage

Depending on the storage mode, storage stops automatically and the storage status changes to Cmpl under the following conditions.

Manual (Manual)

Storage continues until the storage count is reached.

Real-time control (Real Time)

Storage continues until the specified storage count is reached or the scheduled storage stop time is reached.

Integration synchronization (Integ Sync)

Storage continues until the storage count is reached, and then storage is completed (Cmpl).

If integration stops, the following occurs:

- If integration cannot be restarted unless it is reset, the storage status changes to Pause.
- If integration can be restarted without being reset, the storage status changes to Ready.

Event synchronization (Event)

Storage continues until the storage count is reached.

Single shot (Single Shot)

Storage continues until the storage count is reached.

When storage is completed, the following processing is performed:

- The storage status Cmpl appears at the top of the screen.
- Writing to the stored data file (.WTS) and storage header file (.HDS) is completed, and the files are closed.
- If automatic CSV conversion (Auto CSV Conversion) is enabled, an ASCII-format storage data file (.csv) is created.

Note

If the free space in the storage destination runs out or the stored data size exceeds the maximum value (1 GB) before the specified storage count is reached, storage is completed.

Ending storage (End)

Selecting **End** ends storage. The storage status indication at the top of the screen disappears.

- If the storage status is Pause, ending storage completes writing to the stored data file (.WTS) and storage header file (.HDS), and closes the files. If automatic CSV conversion (Auto CSV Conversion) is enabled, an ASCII-format storage data file (.csv) is created.
- If the storage status is Cmpl, no file processing occurs when storage ends, because the stored data file (.WTS) and store header file (.HDS) are already closed.
- If the storage status is Rec, ending storage first pauses storage and then ends it.

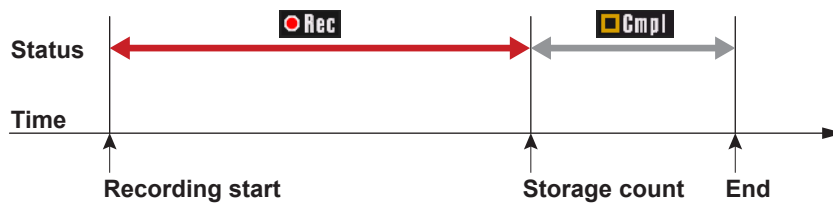
Advanced settings (Advanced)

Displays the storage settings screen.

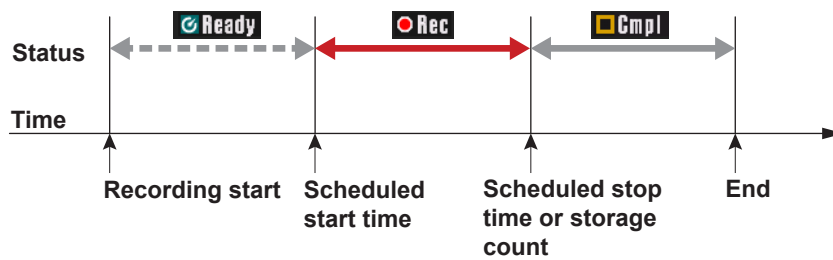
See sections 12.1 to 12.3.

Storage behavior in each storage mode

Manual (Manual)

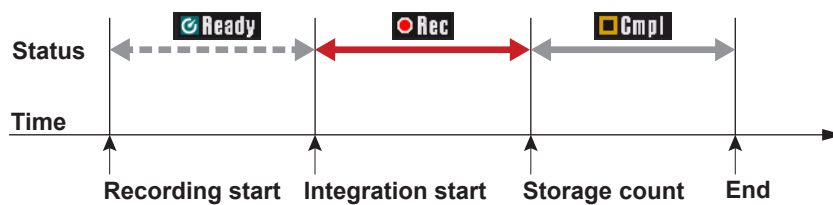


Real-time control (Real Time)

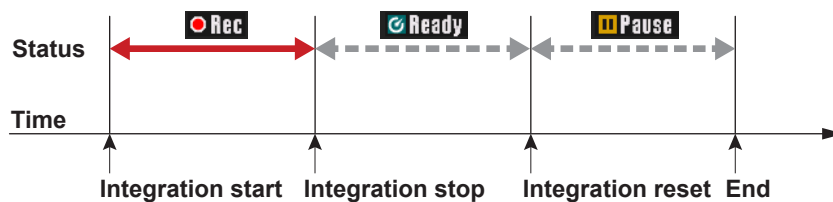


Integration synchronization (Integ Sync)

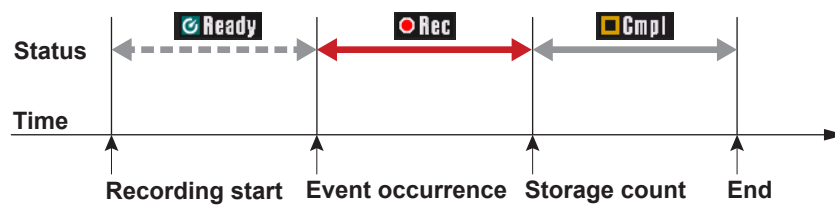
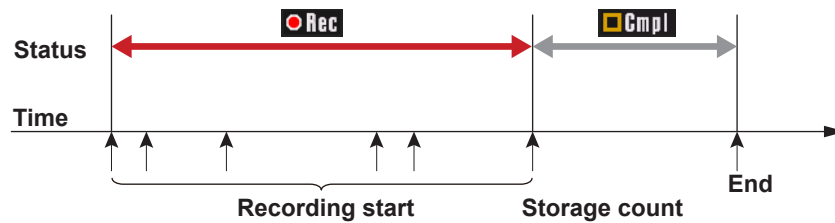
If the storage count is reached before integration stops



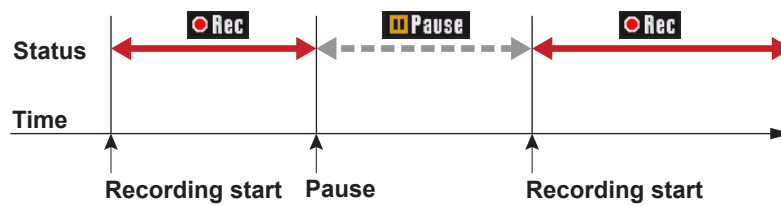
If integration stops before the storage count is reached (operation after integration starts)



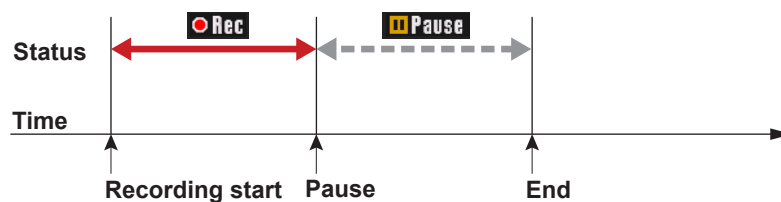
- If integration is reset while stopped, the storage status changes to Cmpl. Writing to the stored data file (.WTS) and the storage header file (.HDS) is completed, and the files are closed.
- If integration is restarted while stopped, the storage status changes to recording (Rec). Data continues to be written to the same stored data file that was being used before storage was paused.

Event synchronization (Event)**Single shot (Single Shot)****Storage behavior when storage is paused during recording****Restarting storage**

When Rec, Pause, and Rec are selected in that order

**Ending storage**

When Rec, Pause, and End are selected in that order

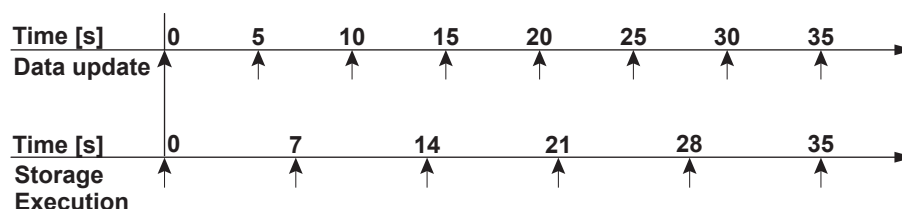


Storage behavior when the storage interval is not an integer multiple of the data update interval

The following example assumes a data update interval of 5 s and a storage interval of 7 s. The storage behavior depends on the storage mode, as follows:

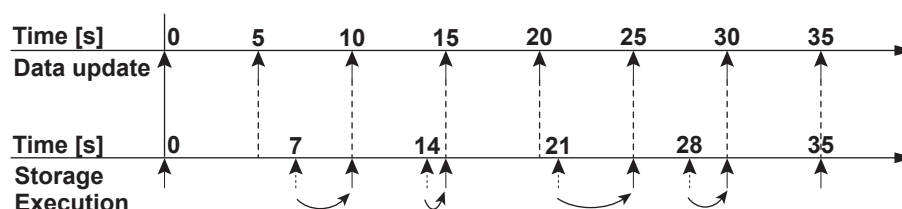
When the storage mode is other than integration synchronization

Data is stored at each storage interval.



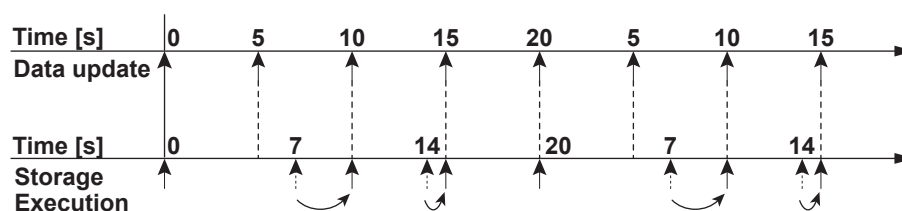
When the storage mode is integration synchronization and the integration mode is neither continuous nor real-time continuous

After the storage interval has elapsed, data is stored at the next data update.



When the storage mode is integration synchronization and the integration mode is continuous or real-time continuous

After the storage interval has elapsed, data is stored at the next data update. Data is also stored when integration is reset by the integration timer. In this case, both the integration timer and the storage interval timer are reset. The figure below shows an example in which the integration timer is set to 20 s.



Note

- When the storage of numeric data at store start (Store At Start) is enabled, data is stored at 0 s (storage start).
- In continuous integration mode and real-time continuous integration mode, data is stored when the integration timer expires and the integration values are reset. In the example above, if the integration timer is set to 20 s, the numeric data at 20 s is stored, and then the integration values are reset.

Behavior during hold

If you press HOLD during storage, the display is held, and storage operates as follows:

- When the storage mode is manual and the storage interval is set to 00:00:00, when the storage mode is real-time control and the storage interval is set to 00:00:00, or when the storage mode is event synchronization
Storage stops. However, it does not stop during integration.
- When the storage mode is single shot
The held display values are stored. The held display values are also stored during integration.
- In other cases
The held display values are stored. During integration, the measured values are stored.

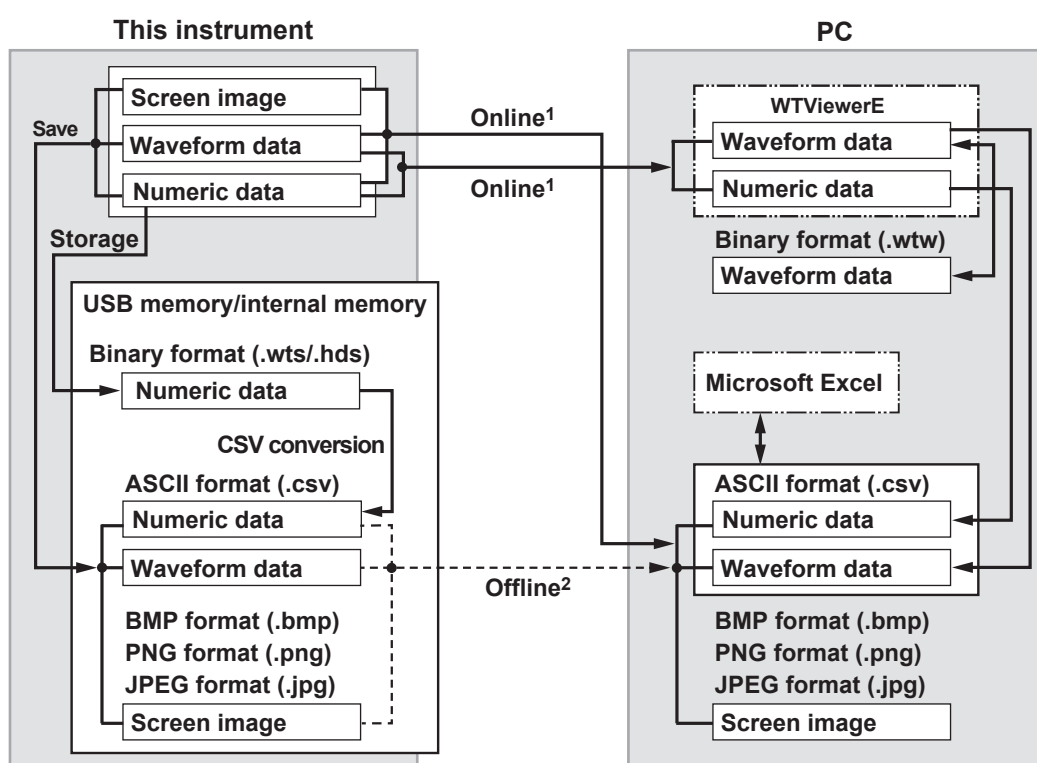
Note

- During storage, the icon indicating device access is displayed only while files are being opened when Rec is selected and while files are being closed when storage completes or ends. At other times during storage, the icon is not displayed even though the device is still accessed as needed. After the files are opened and before they are closed, do not remove the USB memory device or turn off the power. The device may be damaged, or the data on it may be corrupted.
 - Where there is no numeric data, NAN, OL, OF, ERROR, or a blank is stored. A blank is stored for measurement functions that are displayed as blank on the screen, such as the 0th-order (DC) and 1st-order values of ΦU and ΦI .
 - During storage, if auto range causes a range up or range down, the measurement data is not updated, so storage is interrupted and the measurement data is not stored. After the range is changed by auto range, storage resumes.
-

13.1 Saving Data

- Numeric data, waveform data, and screen images can be saved to a USB memory device, internal memory, or a network drive.
For saving setup information, see “Saving Setup Data.” (See page 3-25.)
- Setup data saved on the above storage devices can be loaded into this instrument.
See “Loading Setup Data.” (See page 3-27.)
- You can rename, copy, and delete saved data files.

Loading numeric data, waveform data, and screen images to a PC



1 Data loading via USB, Ethernet

2 Data loading via USB memory device

13.2 Connecting USB Memory Devices

This section explains how to connect a USB memory device for saving or loading data.

When using a storage device on a network (network drive), you need to connect this instrument to the network via Ethernet. For more details, see section 14.5.

CAUTION

- Do not remove the USB memory device or turn off the power while the USB memory device is being accessed. The device may be damaged, or the data on it may be corrupted.
- While the USB memory device is being accessed, an icon indicating access appears near the top center of the screen, or the indicator on the USB memory device blinks.

French

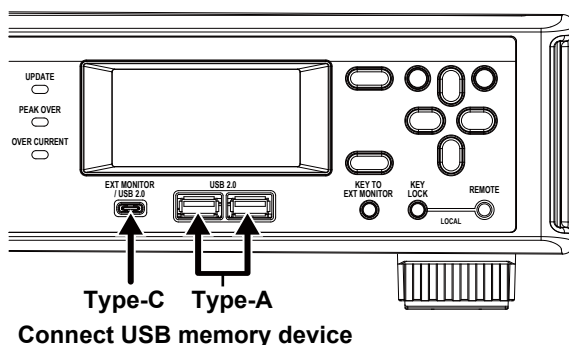
ATTENTION

- Ne retirez pas la clé USB et ne coupez pas l'alimentation pendant l'accès à la clé USB. L'appareil pourrait être endommagé ou les données qu'il contient pourraient être corrompues.
- Pendant l'accès à la clé USB, une icône indiquant l'accès apparaît près du centre supérieur de l'écran, ou le voyant de la clé USB clignote.

Supported USB memory devices and how to connect them

Use a portable USB memory device that supports USB Mass Storage Class Ver1.1. Connect it directly to the peripheral USB connector (Type-A or Type-C) on the front panel of this instrument. This instrument supports hot plugging, so USB devices can be connected and disconnected regardless of whether the power switch is on or off. When the power switch is on, the USB memory device is recognized automatically after it is connected.

This instrument has three USB ports: USB-0, USB-1, and USB-2. The port numbers are not fixed. The port to which the first detected USB memory device is connected becomes USB-0. The port to which the second recognized USB memory device is connected becomes USB-1, and the port to which the third recognized USB memory device is connected becomes USB-2.



Note

- Connect the USB memory device directly to the peripheral USB connector (Type-A or Type-C), not through a USB hub.
- Use a portable USB memory device that supports USB Mass Storage Class Ver1.1. Do not connect any unsupported USB memory device.
- USB memory devices with security functions (such as encryption) cannot be used.
- Do not connect and disconnect three USB devices in rapid succession. Wait at least 10 seconds between operations.

General precautions for handling USB memory devices

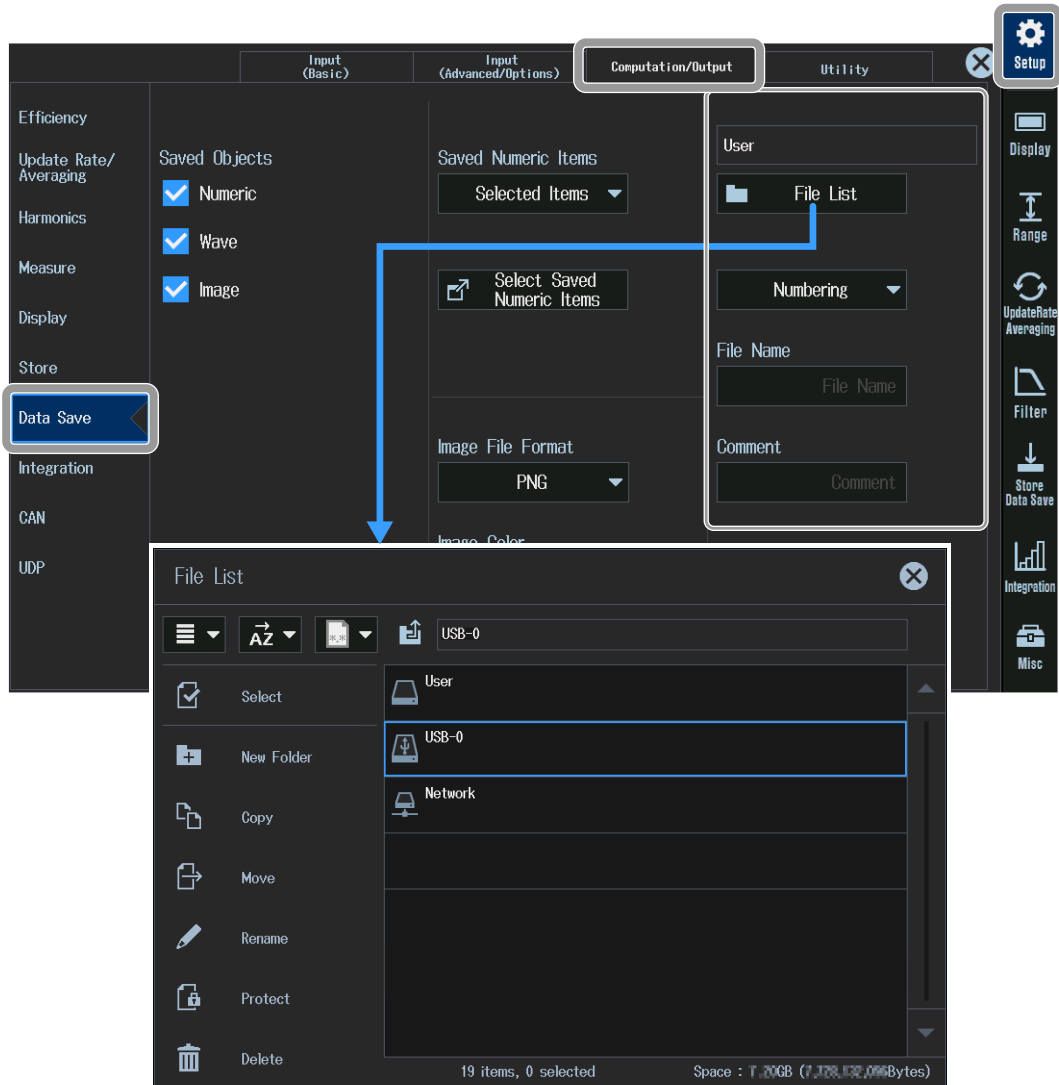
For general handling precautions, follow the instruction manual supplied with your USB memory device.

13.3 Setting the Save Destination for Numeric Data, Waveform Data, and Screen Images

Set the save destination for the data.

Procedure

Setup menu icon  > **Computation/Output** > **Data Save** menu > **File List**



Note

- For procedures using the setup menu, see chapter 3.
- Select the **Store/Data Save** menu icon . The Store/Data Save menu appears in the submenu area on the right side of the screen. (See page xiii and section 13.6.)
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Storage for saving and loading

This instrument can use the following three types of storage for saving and loading data.

Internal memory (User)

The memory built into this instrument.

USB memory (USB-0, USB-1, USB-2)

A USB memory device connected to a USB port on this instrument. You can connect a USB 2.0-compatible mass storage device compliant with USB Mass Storage Class Ver. 1.1.

Network drive (Network)

A storage device on the network. To use a network drive, connect this instrument to the network via Ethernet.

Note

Precautions for USB devices

- Connect the USB memory device directly to the peripheral USB connector (Type-A or Type-C), not through a USB hub.
 - You can use a portable USB memory device that supports USB Mass Storage Class Ver. 1.1.
 - USB memory devices with security functions (such as encryption) cannot be used.
 - Only connect supported external monitors, USB keyboards, USB memory devices, or wireless LAN adapters to the peripheral USB connector.
 - Do not connect and disconnect multiple USB devices in rapid succession. Wait at least 10 seconds between operations.
 - Do not connect or disconnect USB devices after turning on this instrument and before key operation becomes available (30 seconds or more).
 - This instrument can handle up to three USB memory devices.
-

Setting auto naming (Auto Naming)

OFF

Auto naming is disabled. The name that you specify using the File Name setting is used. If a file with the same name already exists in the save destination folder, the data cannot be saved.

Numbering

The file is saved with a four-digit number from 0000 to 0999 automatically appended to the common name entered in File Name.

Date

The file name is the date and time (to the second) when the file was saved. The file name specified for the File Name setting is ignored.

20260130_121530_0 (2026/01/30 12:15:30)

YYYY MM DD hh mm ss

Sequence number (0 to 9 then A to Z) for when
multiple files are saved at the same time (second)

If multiple files are saved at the same time (to the second), a serial number is added after the date and time. No serial number is added to the first file. After that, the serial number increases by one each time a file is added, starting from 1. After 9, the letters A, B, C, and so on are used.

Setting the file name (File Name)

You can set the file name used when Auto Naming is OFF, or the common name used when Auto Naming is set to Numbering. A file name or folder name can contain up to 32 characters from the beginning of the entered text. However, there are restrictions on the characters and character strings that can be used.

For how to enter text, see section 2.4.

Setting a comment (Comment)

You can add and save a comment of up to 30 characters. A comment is optional.

Any characters, including spaces, can be used.

For how to enter text, see section 2.4.

File list (File List)

Specify the data save destination in the file list. You can perform file operations such as creating folders on the storage device, deleting and copying files, and changing file names.

For how to use the file list, see section 13.7.

13.4 Setting the Numeric Data Items to Save

The numeric data measured by this instrument can be saved in ASCII format (.CSV).

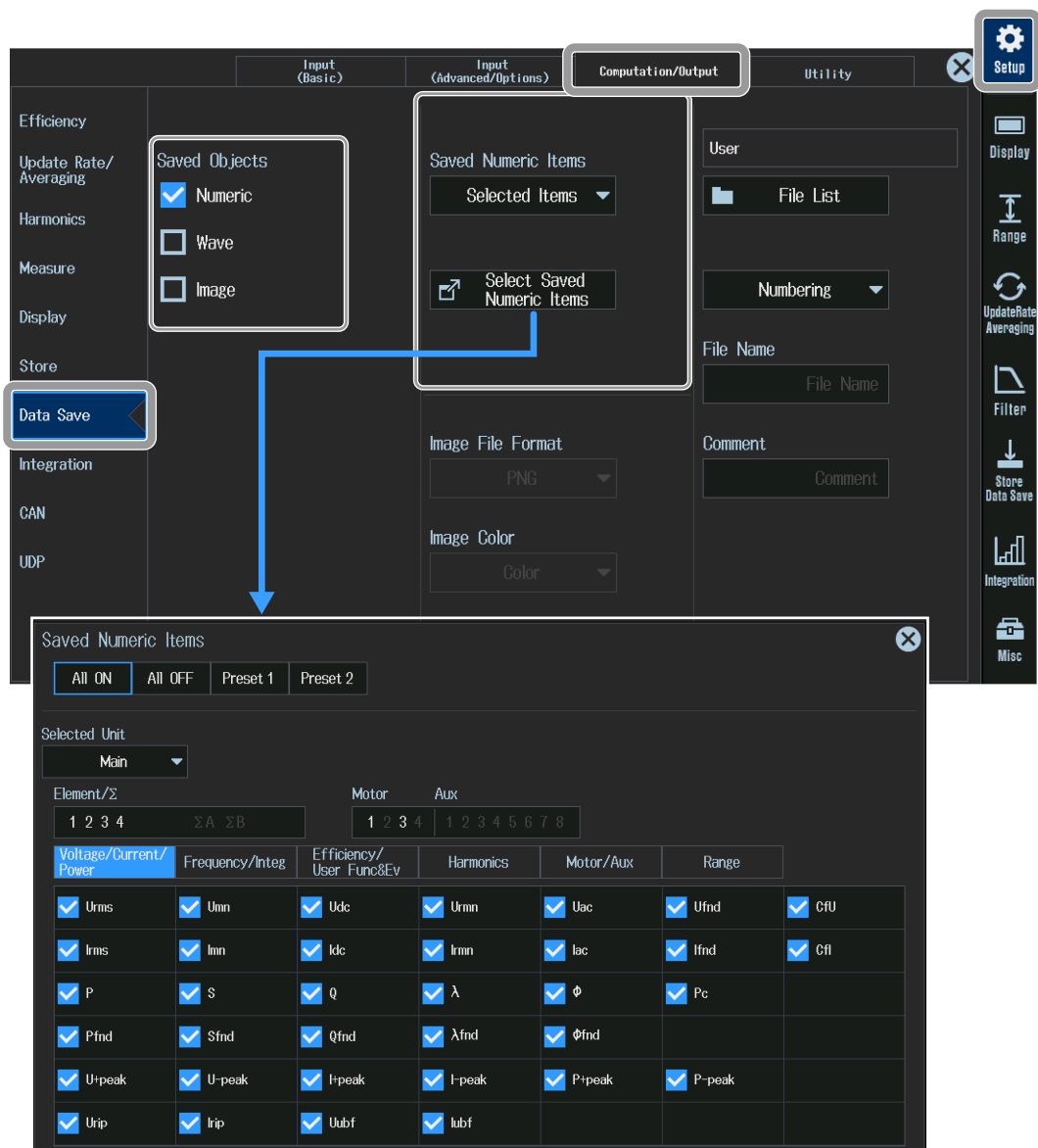
After selecting the method for setting the numeric data items to save, select the required numeric data items as necessary.

Procedure

Setup menu icon  > **Computation/Output** > **Data Save**

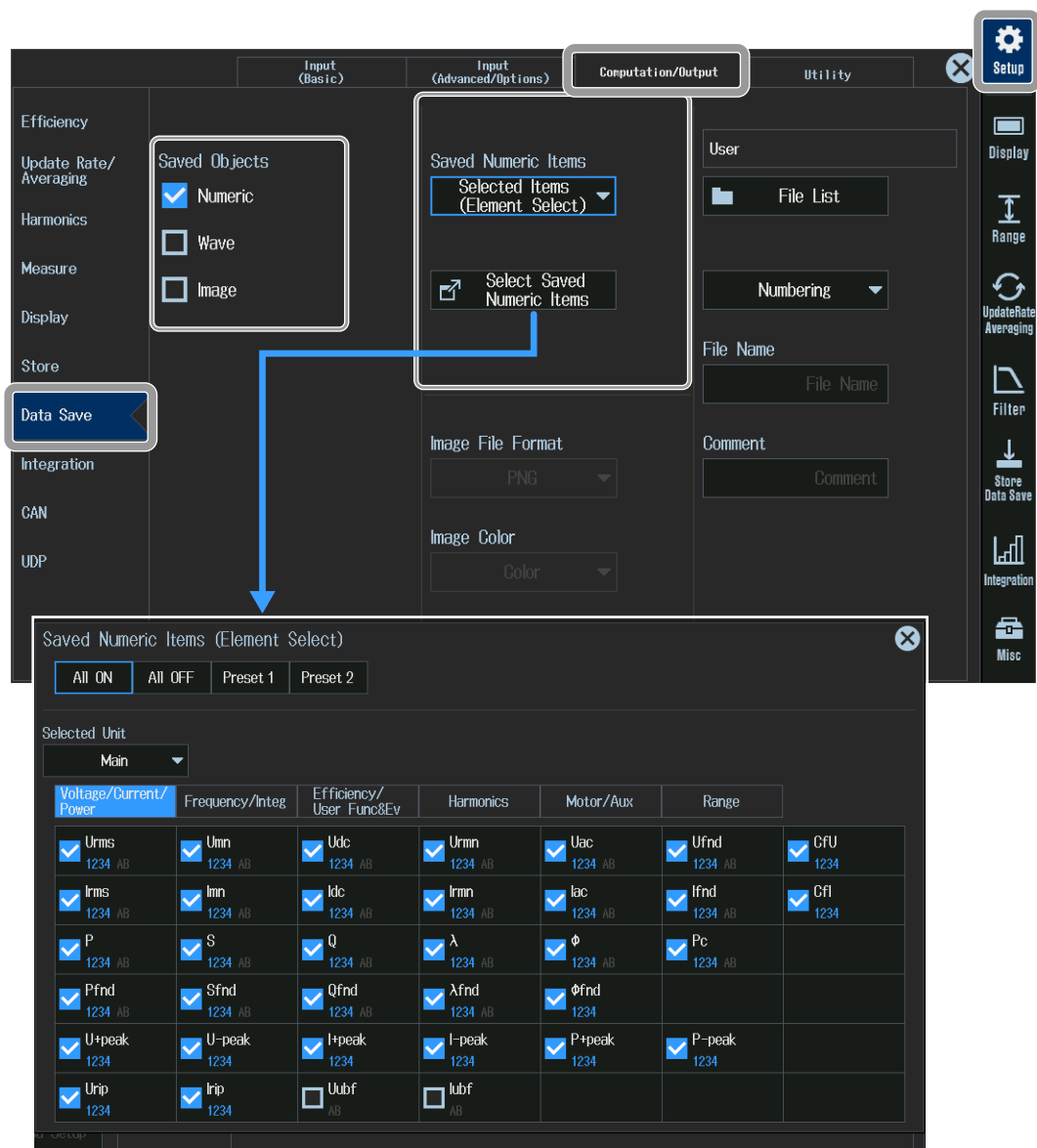
> set Saved Objects to **Numeric** > using Saved Numeric Items, select from the following three

- **Displayed Numeric Items**
- **Selected Items** > **Select Saved Numeric Items**



13.4 Setting the Numeric Data Items to Save

- Selected Items (Element Select) > Select Saved Numeric Items



Note

- For procedures using the setup menu, see chapter 3.
- Select the **Store/Data Save** menu icon . The Store/Data Save menu appears in the submenu area on the right side of the screen. (See page xiii and section 13.6.)
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Saved Numeric Items (Saved Numeric Items)

Select the items to save from the following:

- Displayed numeric items (Displayed Numeric Items)
- Selected items (Selected Items)
- Selected items (Element Select) (Selected Items (Element Select))

Displayed numeric items (Displayed Numeric Items)

The saved items vary as indicated below depending on the display.

- Numeric display: 4-, 8-, or 16-value display or matrix display
All measurement functions displayed on the page shown at the time saving is executed are saved in the order in which they are displayed.
- Numeric display: Harmonics list single or dual display
In addition to the above, data for harmonics that are not displayed on the screen are also saved, up to the maximum measurement order (Max Order).
- Numeric display: All items display
The data cannot be saved. If you try to save the data, an error message is displayed.
- Non-numeric displays (e.g., waveform display, bar display)
Numeric data is not saved.

Selected items (Selected Items)

Select the measurement functions to save, along with the element number, motor number, or auxiliary input number. The selected element number, motor number, or auxiliary input number is applied in common to all selected measurement functions. Measurement functions that do not require specification of element numbers and the like are saved by simply selecting the measurement function.

Selected items (Element Select) (Selected Items (Element Select))

Select the element number, motor number, or auxiliary input number for each measurement function to save.

Measurement functions that do not require specification of element numbers and the like are saved by simply selecting the measurement function.

Selecting numeric data items (Select Saved Numeric Items)

If Selected Items or Selected Items (Element Select) is selected, select the channels for the input elements, wiring units, motor evaluation, and auxiliary input for the numeric data items to save.

If a numeric data item to save does not require selection of an input element or similar item (for example, efficiency: η , user-defined: F, Ev), select the numeric data item directly.

All ON (All ON)

Data for all measurement functions is saved.

All OFF (All OFF)

Data for all measurement functions is not saved.

Preset 1 (Preset 1)

Saves data for the following measurement functions for all elements and all wiring units.*

Urms, Irms, FreqU, FreqI, P, S, Q, λ , Φ

Preset 2 (Preset 2)

Saves data for the following measurement functions for all elements and all wiring units.*

WP, WP+, WP-, q, q+, q-, ITime, WS, WQ

* Depending on the wiring system (Wiring), wiring units may not exist. In that case, data for the functions of those wiring units is not saved.

Unit to configure (Selected Unit)

During multi-unit synchronization (option /SY1), the main unit can save numeric data files containing power data from subunits.

Specify the unit you want to operate from the following, and set the items to save and Element/ Σ for each unit.

Main, Sub 1, Sub 2, Sub 3, Sub 4

Element, motor, or auxiliary input numbers for the measurement functions to save

- **Element (Element/ Σ)**

Select the check boxes for the following elements and wiring units whose data you want to save:

Element 1, Element 2, Element 3, Element 4, ΣA , ΣB

* Depending on the wiring system (Wiring), wiring units may not exist. In that case, data for the functions of those wiring units is not saved. For example, if ΣB does not exist, ΣB data is not saved.

- **Motor number (Motor)**

Select the check boxes for motor inputs 1 to 4 whose data you want to save.

- **Auxiliary input (Aux)**

Select the check boxes for auxiliary inputs 1 to 8 whose data you want to save.

If Selected Items is selected as the method for setting the numeric data items to save, the above settings are displayed in the upper part of the menu for selecting saved numeric data items.

If Selected Items (Element Select) is selected as the method for setting the numeric data items to save, the above settings are displayed under each measurement function in "Data to Save", described later.

Data to Save

Select one of the following measurement function groups to switch the displayed list of numeric data items to save. Select the check boxes for the data you want to save.

- Voltage, current, power (Voltage/Current/Power)
- Frequency, integration (Frequency/Integ)
- Efficiency, user-defined functions and events (Efficiency/User Func&Ev)
- Harmonic measurement (Harmonic)
- Motor evaluation, auxiliary input (Motor/Aux)
- Measurement range (Range)

The measurement function types that can be selected are the items listed in section 1.1, “Items That This Instrument Can Measure.”

If Selected Items (Element Select) is selected as the method for setting the numeric data items to save, selecting data to save displays a selection box for the element number, motor number, or auxiliary input number. Selecting one or more items in this selection box will cause the data to be saved (check box selected). This selection box is not displayed for data that does not require specification of an element number or similar item. Select the check boxes for the data you want to save.

Note

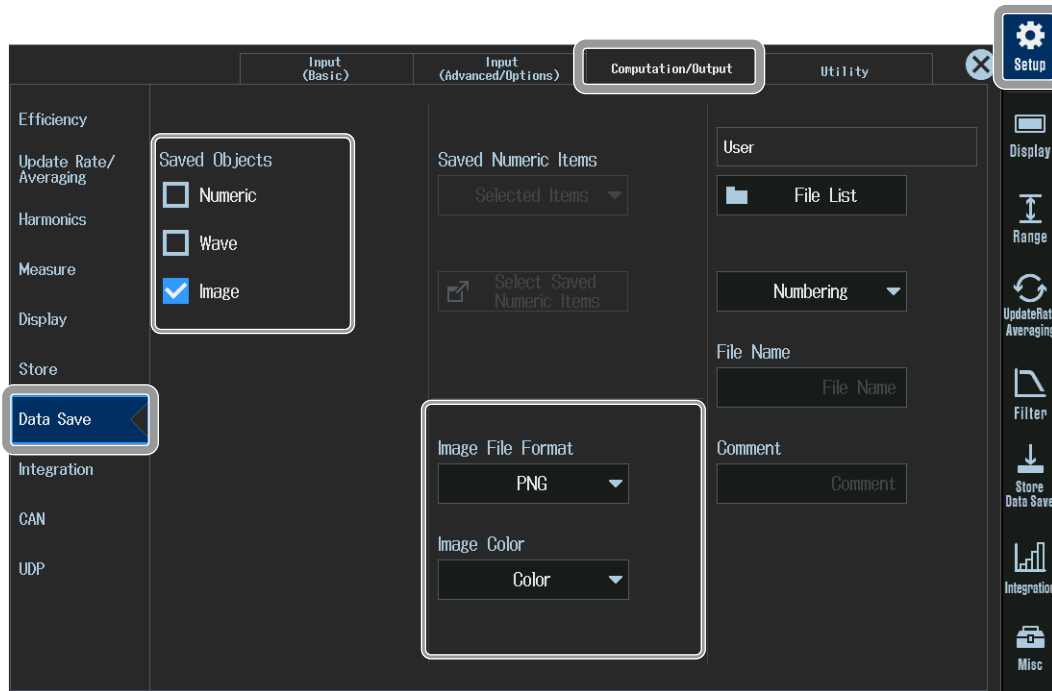
-
- The settings on the Saved Numeric Items screen and those on the Saved Numeric Items (Element Select) screen are independent.
 - When numeric data is saved, NAN, OL, OF, ERROR, or a blank is saved where no numeric data is available.
A blank is saved for measurement functions that are displayed as blank on the screen, such as the 0th-order (DC) and 1st-order values of Φ_U and Φ_I .
 - If sensor correction is configured, corrected data is saved.
 - Even when the update mode is Auto, unlike the storage function, the data update status and timestamp information items are not saved automatically.
-

13.5 Setting the Format of Saved Screen Images

You can save screen image data to files in BMP, PNG, and JPEG formats.

Procedure

Setup menu icon  > **Computation/Output** > **Data Save**
> set Saved Objects to **Image**



Note

- For procedures using the setup menu, see chapter 3.
- Select the **Store/Data Save** menu icon . The Store/Data Save menu appears in the submenu area on the right side of the screen. (See page xiii and section 13.6.)
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Screen image file format (Image File Format)

Select the save format from the following:

- **BMP**: The extension is .BMP.
The file size is about 130 KB in black and white and about 2 MB in color.
- **PNG**: The extension is .PNG.
The file size is about 30 KB in black and white and about 100 KB in color.
- **JPEG**: The extension is .JPG.
The file size is about 200 KB in color.

These file sizes are for typical images and vary depending on the image being saved.

Screen image color (Image Color)

Select the color format from the following:

- Black and white (Black & White): Saves the image in black and white.
- Color (Color): Saves the image in 65536 colors.
- Reverse (Reverse): Saves the image in 65536 colors. The screen background becomes white.
- Grayscale (Gray): Saves the image in 16 levels of gray.

13.6 Saving Numeric Data, Waveform Data, and Screen Images

You can select the data to save (numeric data, waveform data, or a screen image) and then save it.

CAUTION

During saving, the icon indicating access to the save destination is not displayed, but the save destination is still accessed as needed. Do not remove the USB memory device or turn off the power. The device may be damaged, or the data on it may be corrupted.

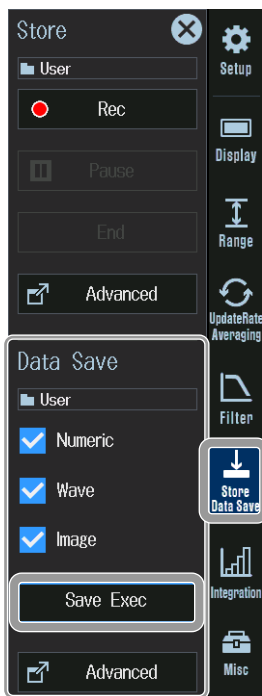
French

ATTENTION

Pendant le stockage, l'icône indiquant l'accès à la destination de stockage n'est pas affichée, mais la destination de stockage reste accessible selon les besoins. Ne retirez pas la clé USB et ne coupez pas l'alimentation. L'appareil pourrait être endommagé ou les données qu'il contient pourraient être corrompues.

Procedure

Store/Data Save menu icon  > Numeric/Wave/Image > Save Exec



Saving data (Save Exec, EXEC)

Saves the data to the specified save destination using the specified file name.

- Saving may take from several seconds to several tens of seconds, depending on the number of waveforms to save, the data update interval, and the transfer speed to the save destination. Saving takes longer when many waveforms are being saved or when the data update interval is long.
- Measurement stops during saving. Measurement resumes when saving is complete or is canceled.
- To save data when the data update interval is 20 s, turn HOLD on, perform a single measurement once, and then save the data after the data update from that single measurement is complete.
- When the data update interval is 10 ms, waveform data cannot be saved.

Note

The header of a saved file uses a format common to YOKOGAWA measuring instruments, so it also contains data that is not needed by this instrument.

Advanced settings (Advanced)

Displays the save settings screen.

See sections 13.3 to 13.5.

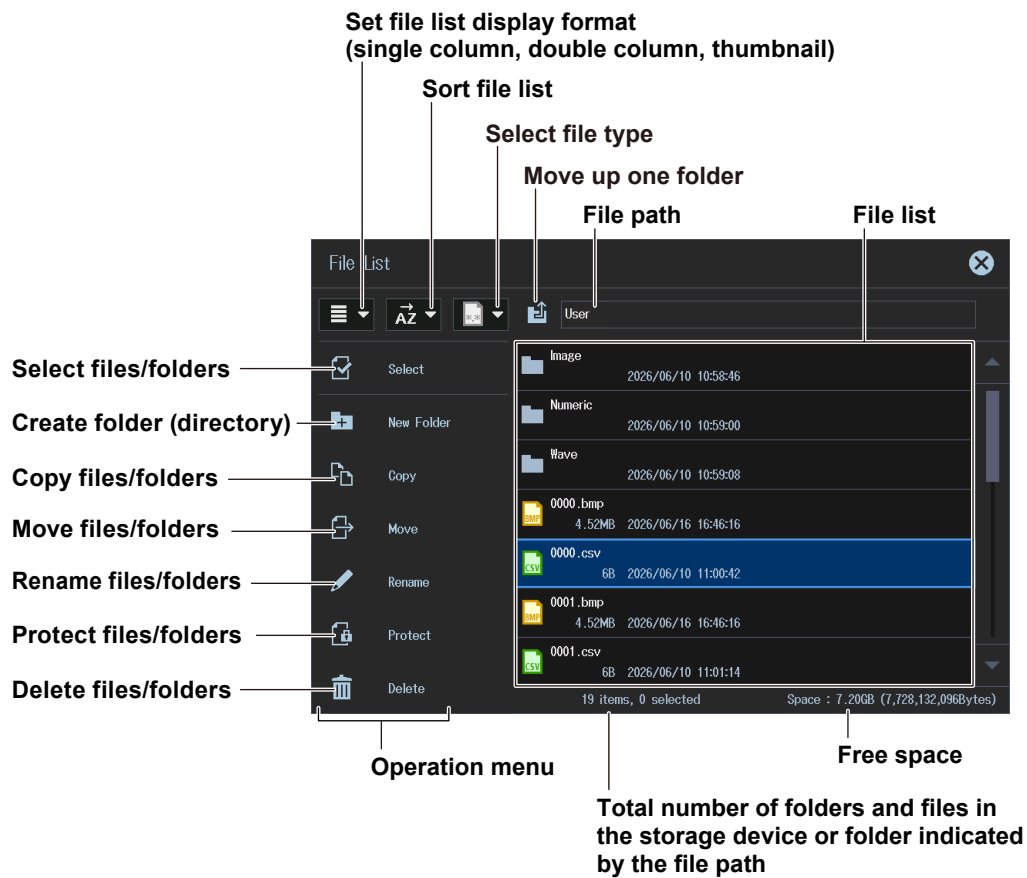
13.7 File Operations

This section explains how to use the file list.

The file list is a common function used to manage files, as in chapter 12, “Storing Numeric Data,” and section 13.3.

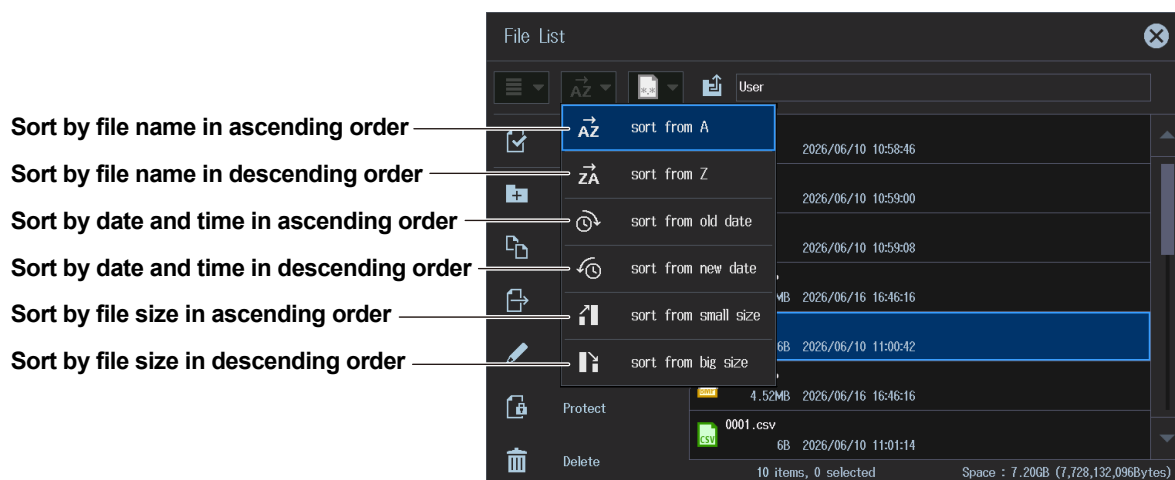
Procedure

File list (File List)



Sorting the file list (→A→Z)

Select →A→Z from the operation menu. The following screen appears.



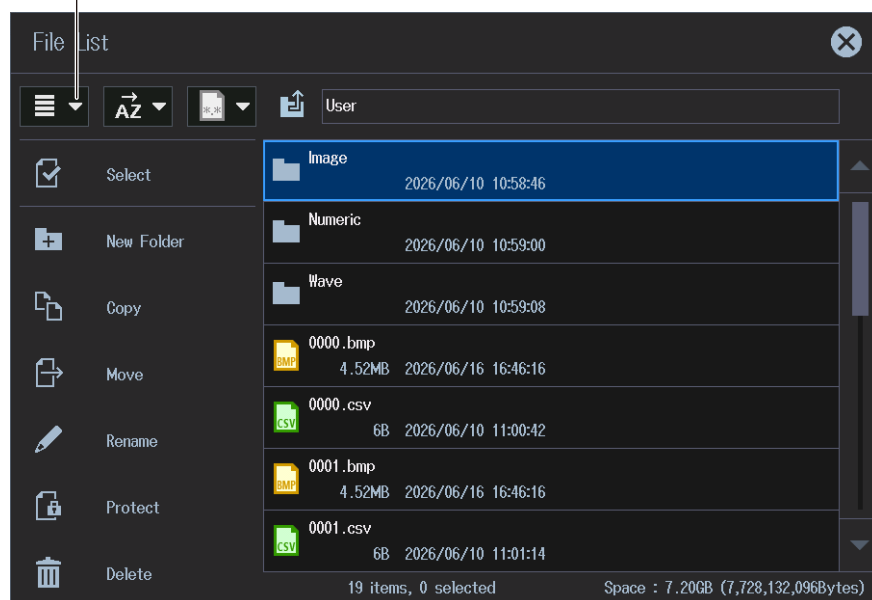
Setting the display format (≡, ≡≡, ≡≡≡)

Select ≡, ≡≡, or ≡≡≡ from the operation menu. The following screen appears.

single column display (≡)

Displays the file list in a single column.

Set file list display format
(≡, ≡≡, ≡≡≡)

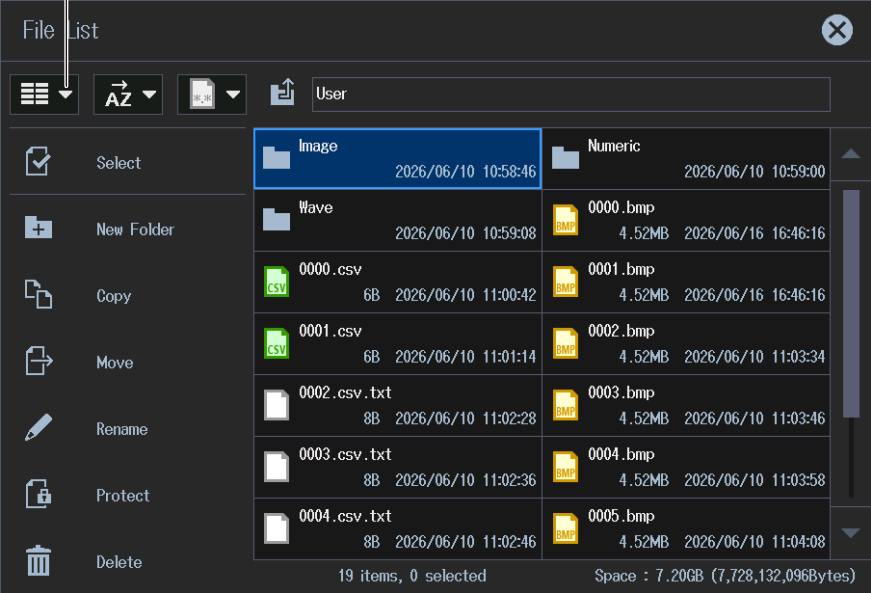


double column display (≡)

Displays the file list in two columns.

Set file list display format

(≡, ≡, ≡)

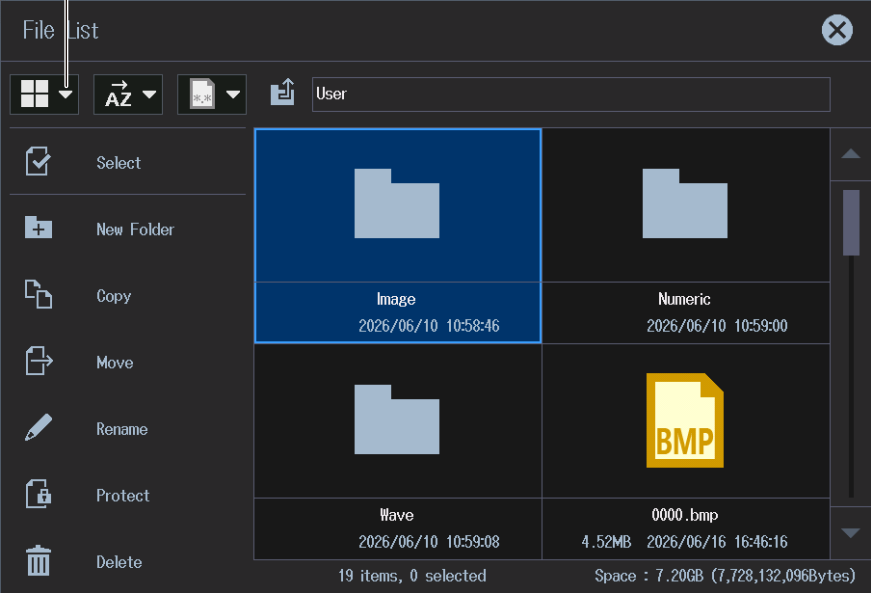


thumbnail display (≡)

Displays the file list as thumbnails.

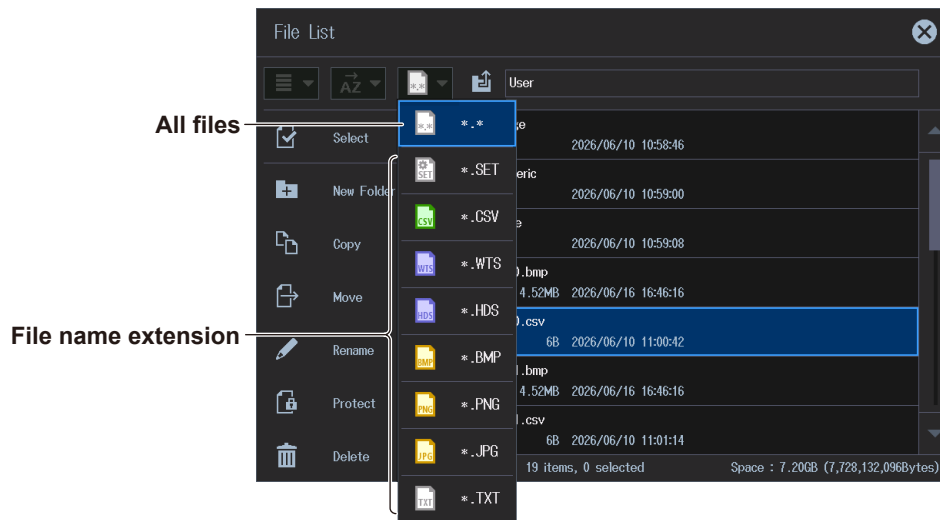
Set file list display format

(≡, ≡, ≡)



Selecting the file type

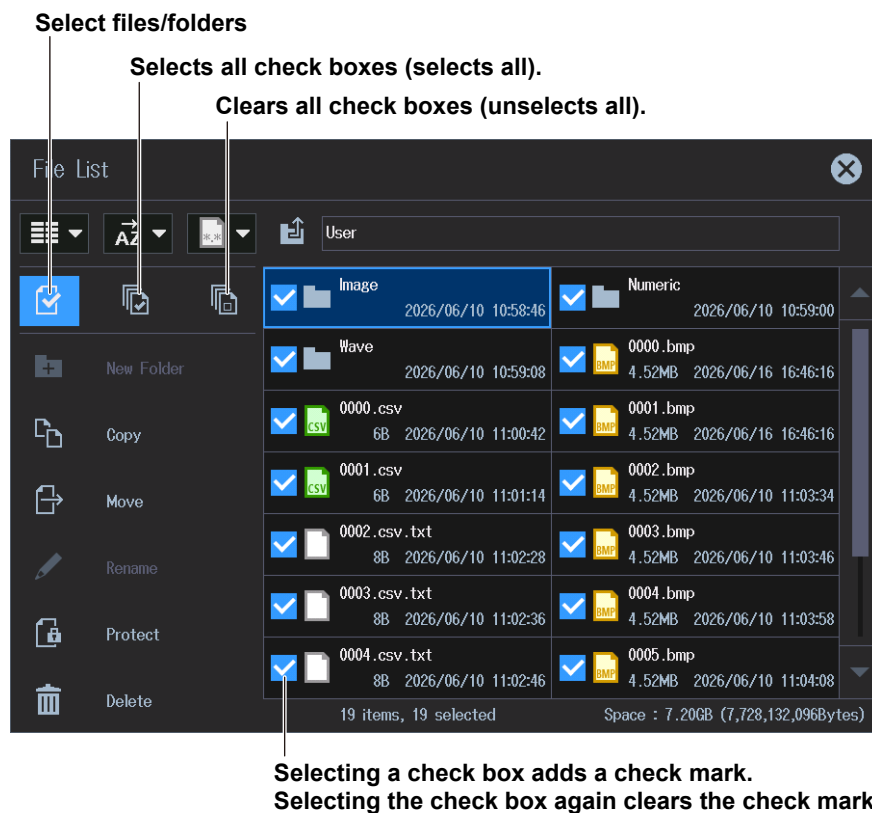
Select the file types to display in the file list.



Selecting files and folders (Select)

To select multiple files or folders, select **Select** from the operation menu. The following screen appears.

Select **Select** again to return to the previous screen.



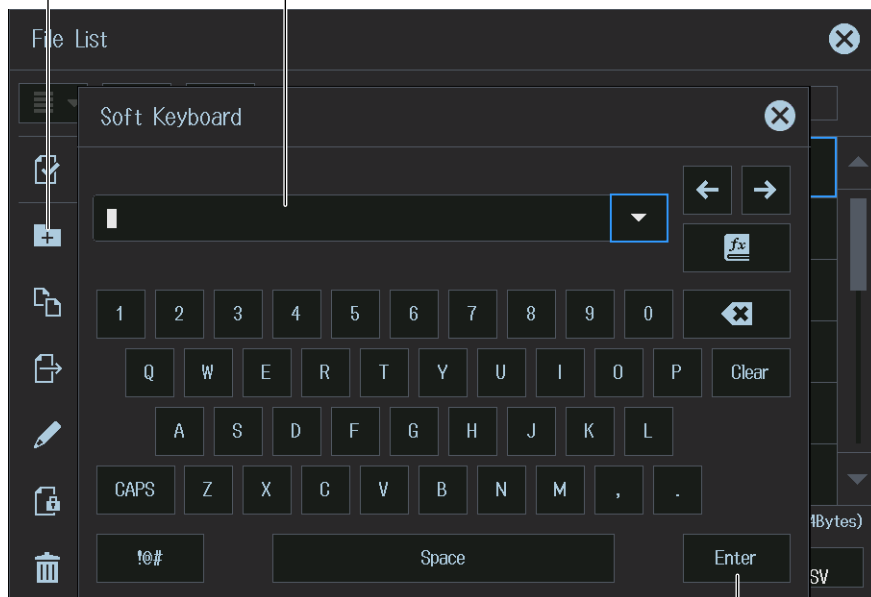
Creating folders (New folder)

Select **New folder** from the operation menu. The following screen appears.

To create a new folder within a folder, select the folder in the file list, and then select **New folder**.

Create folder (directory)

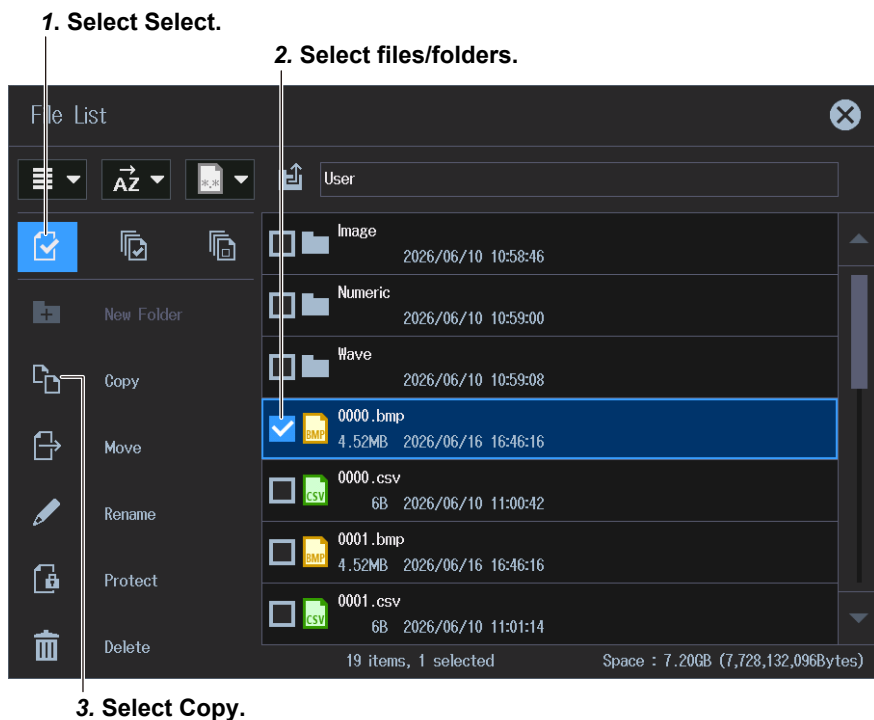
Use the keyboard to enter the name of the folder to create (up to 32 characters).



Confirm the entered folder name

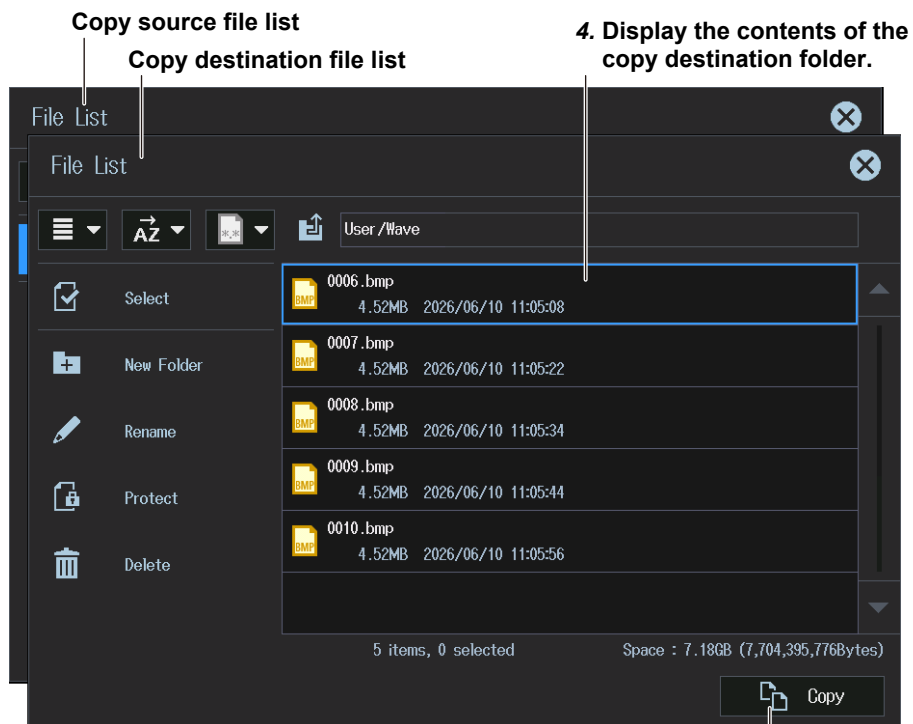
Copying files and folders (Copy)

1. Select **Select** from the operation menu.
Use this menu when copying multiple files or folders.
2. In the file list, select the source file or folder.
For how to select files and folders, see “Selecting files and folders (Select)” on page 13-19.
3. Select **Copy** from the operation menu. The destination file list appears.



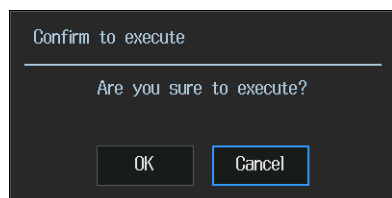
13.7 File Operations

4. In the destination file list, select the destination folder.
The contents of the folder are displayed.



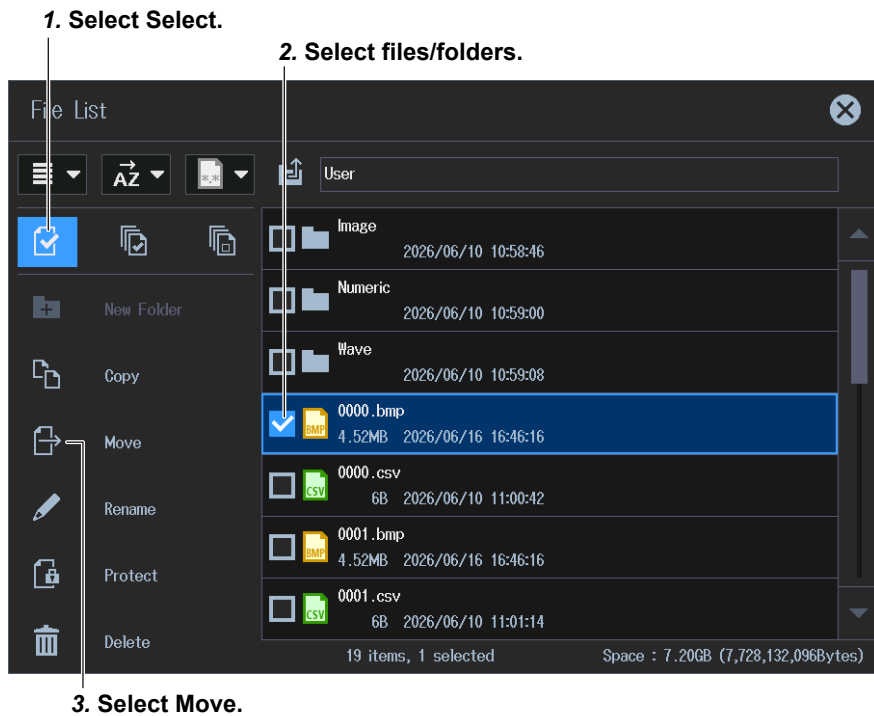
5. Execute file/folder copying.

5. Select **Copy** at the lower right of the screen. The following screen appears.
Select **OK** to copy the files or folders.

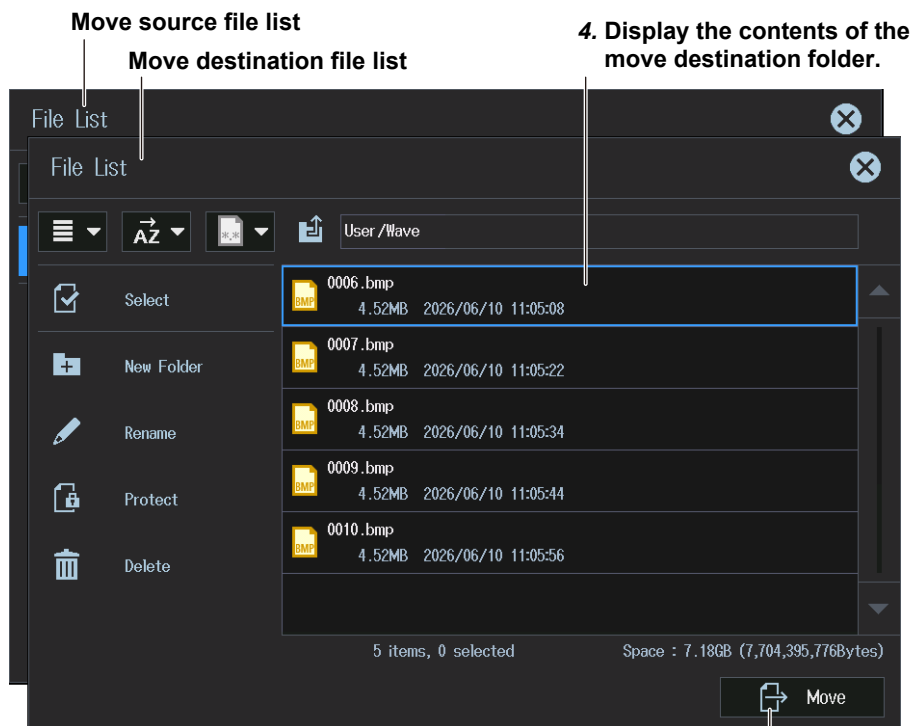


Moving files and folders (Move)

1. Select **Select** from the operation menu.
Use this menu when moving multiple files or folders.
2. In the file list, select the source file or folder.
For how to select files and folders, see “Selecting files and folders (Select)” on page 13-19.
3. Select **Move** from the operation menu. The destination file list appears.

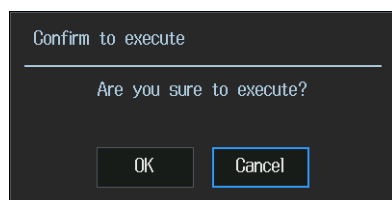


4. In the destination file list, select the destination folder.
The contents of the folder are displayed.



5. Execute file/folder moving.

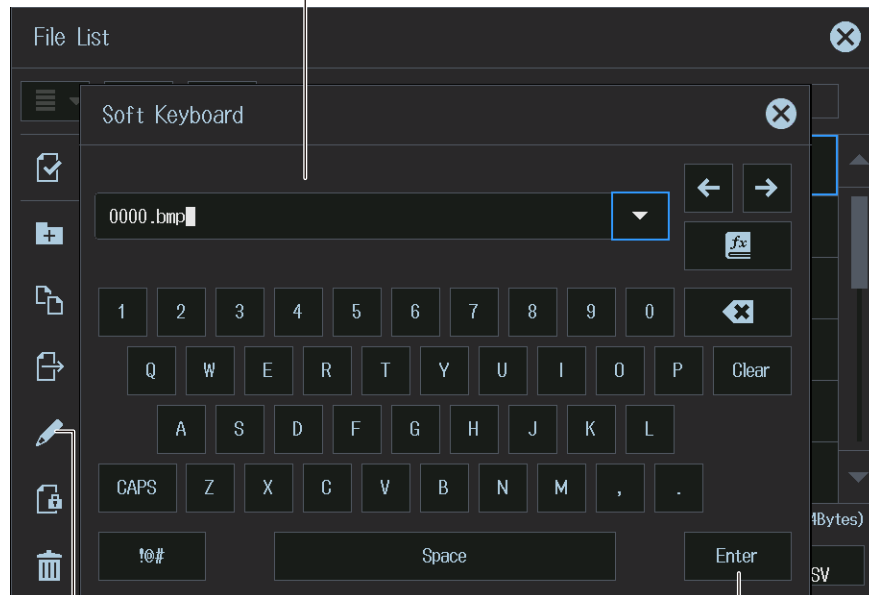
5. Select **Move** at the lower right of the screen. The following screen appears.
Select **OK** to move the files or folders.



Renaming files and folders (Rename)

1. In the file list, select the file or folder whose name you want to change.
2. Select **Rename** from the operation menu. The following screen appears.

Use the keyboard to enter the new folder name.

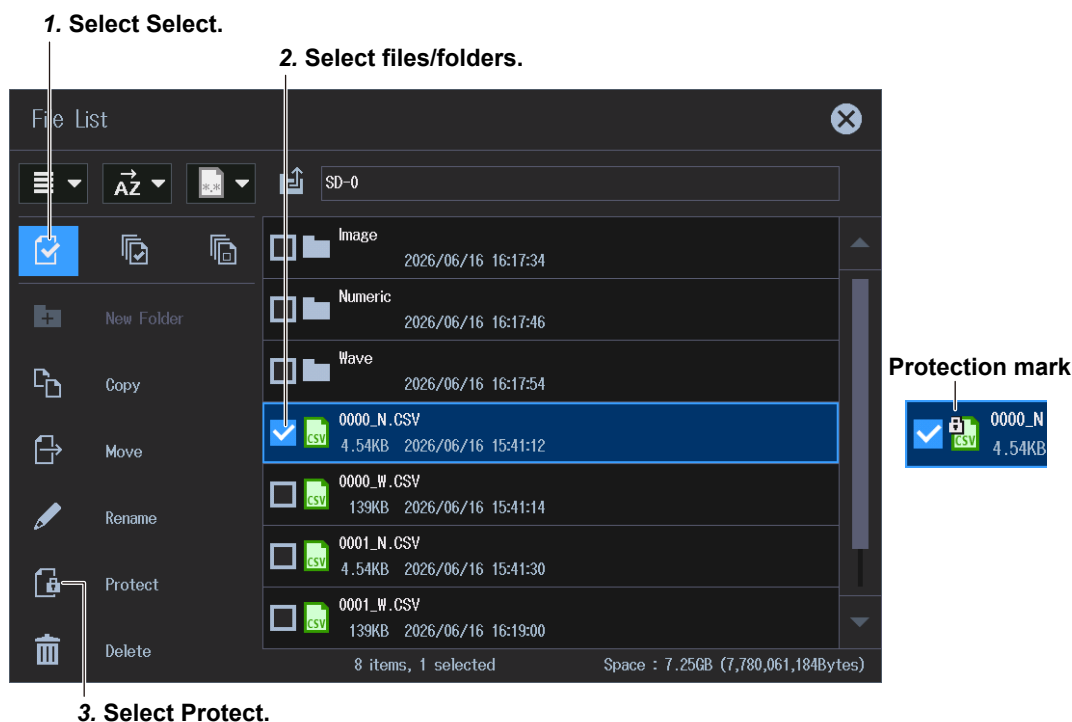


Rename files/folders

Confirm the entered file/folder name

Protecting files and folders (Protect)

1. Select **Select** from the operation menu.
Use this menu when protecting multiple files or folders.
2. In the file list, select the file or folder to protect.
For how to select files and folders, see “Selecting files and folders (Select)” on page 13-19.
3. Select **Protect** from the operation menu. A protection mark appears on the file or folder icon.



Protection	File attribute	Description
ON	r	Protects the selected file. The file can be read. The file cannot be written. The file cannot be deleted.
OFF	r/w	Does not protect the selected file. The file can be read and written.

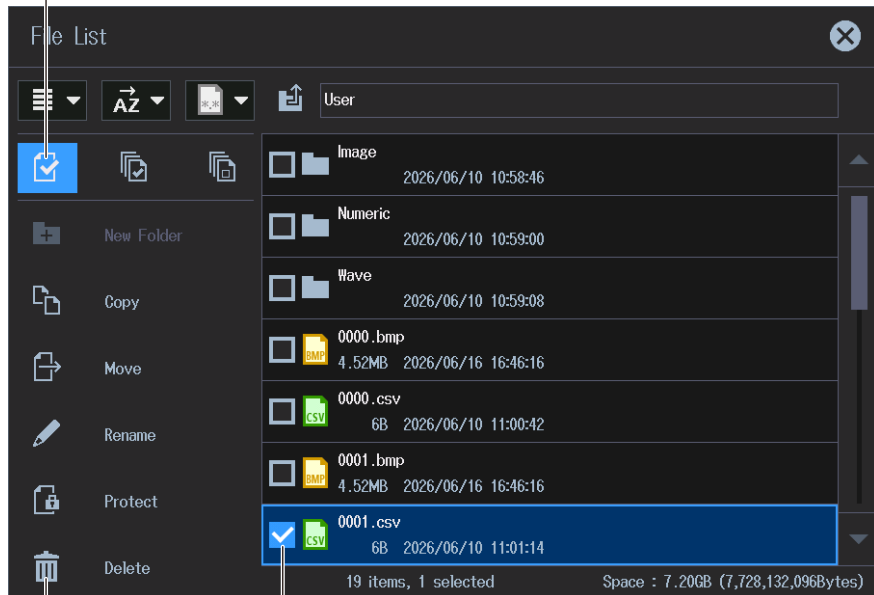
Clearing protection

1. In the file list, select the file for which you want to clear protection.
2. Select **Protect** from the operation menu. The protect mark disappears from the file or folder icon.

Deleting files and folders (Delete)

1. Select **Select** from the operation menu.
Use this menu when deleting multiple files or folders.
2. In the file list, select the file or folder to delete.
For how to select files and folders, see “Selecting files and folders (Select)” on the previous page.

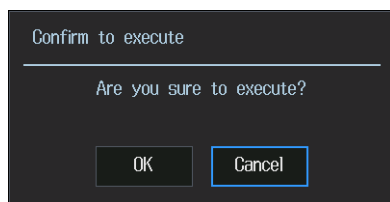
1. Select Select.



2. Select files/folders.

3. Select Delete.

3. Select **Delete** from the operation menu. The following screen appears.
Select **OK** to delete the files or folders.



14.1 Connecting This Instrument to a Network

Overview

By configuring TCP/IP settings, you can use Ethernet communication to do the following:

TCP/IP ▶ [section 14.2](#)

These are the TCP/IP settings for connecting to a network via Ethernet.
Set the IP address, subnet mask, and default gateway.

FTP server (FTP/Web Server) ▶ [section 14.3](#)

You can connect this instrument to a network as an FTP server.
A PC on the network can connect to this instrument and transfer the instrument's setup, numeric data, waveform display data, and screen image data to the PC.

Web server (FTP/Web Server) ▶ [section 14.4](#)

You can connect this instrument to a network as a Web server.
You can connect to this instrument from a PC on the network and monitor it from the Web server function screen displayed on the PC.

Network drive (Net Drive) ▶ [section 14.5](#)

You can save the instrument's setup, numeric data, waveform display data, and screen image data to a drive on the network. You can also load setup data saved on a drive on the network into this instrument.

SNTP ▶ [section 14.6](#)

Use SNTP to set the date and time of this instrument. When the instrument is turned on, the date and time are set automatically.
See section 14.6.

WLAN ▶ [section 14.7](#)

You can operate this instrument from a PC using a wireless LAN adapter.

UDP data output function ▶ [section 15.1](#)

You can continuously distribute the latest numeric data to multiple devices on the network.

Note

When connecting a PC to this instrument, connect it to the network through a hub or router. Do not connect a PC directly to the instrument.

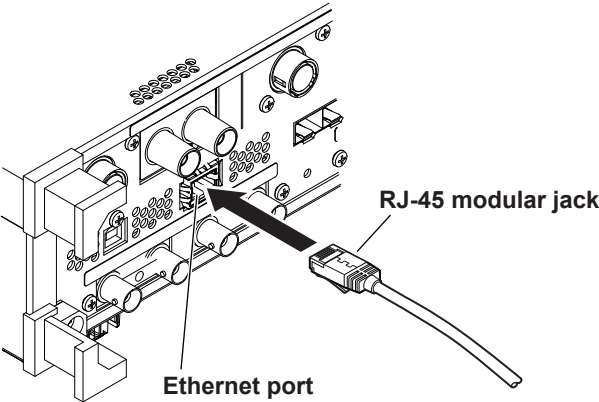
Procedure

This section explains how to connect this instrument to a network.

Ethernet interface specifications

A 1000BASE-T port is provided on the rear panel of the instrument.

Item	Specification
Number of ports	1
Electrical and mechanical specifications	IEEE 802.3 compliant, Auto-MDIX
Transmission system	Ethernet(1000BASE-T/100BASE-TX/10BASE-T)
Communication protocol	TCP/IP
Supported services	Server: FTP, remote control (VXI-11, HiSLIP, RawSocket), Modbus/TCP, Web Client: DHCP, DNS, SNTP, FTP (Net Drive)
Connector type	RJ-45



What you need for the connection

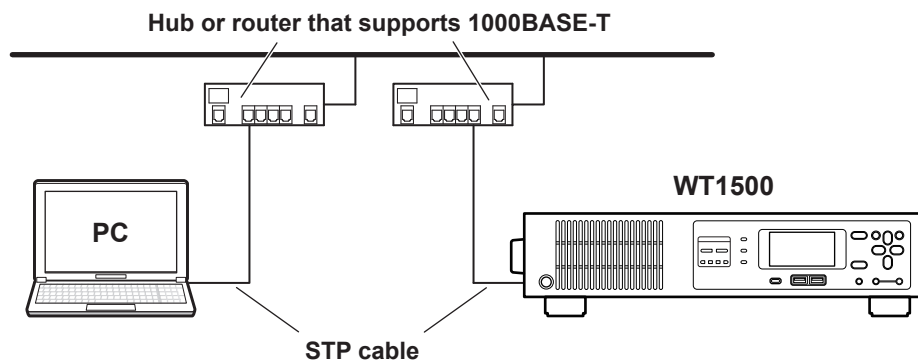
Connection cable

Use an STP (Shielded Twisted-Pair) cable that supports the transmission speed of your network environment.

Connection procedure

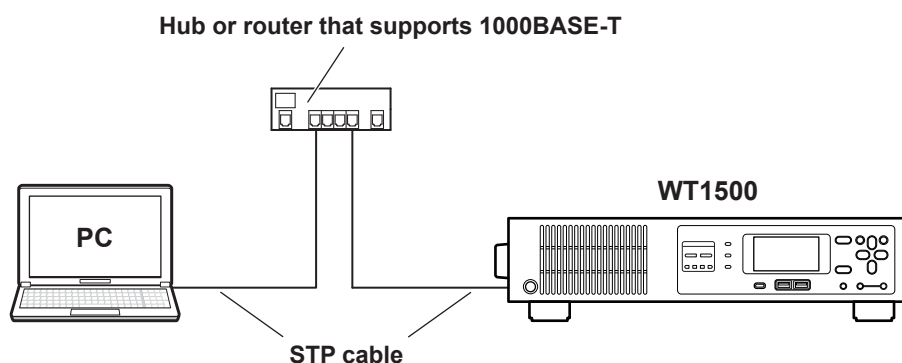
When connecting to a PC on the network

1. Turn off the power to the instrument.
2. Connect one connector of the STP cable to the ETHERNET 1000BASE-T port on the rear panel.
3. Connect the other connector of the STP cable to the hub or router.
4. Turn on the power to the instrument.



When connecting to a single PC

1. Turn off the power to the instrument and the PC.
2. Connect one connector of the STP cable to the ETHERNET 1000BASE-T port on the rear panel.
3. Connect the other connector of the STP cable to the hub or router.
4. Connect the PC to the hub or router in the same way.
5. Turn on the power to the instrument.



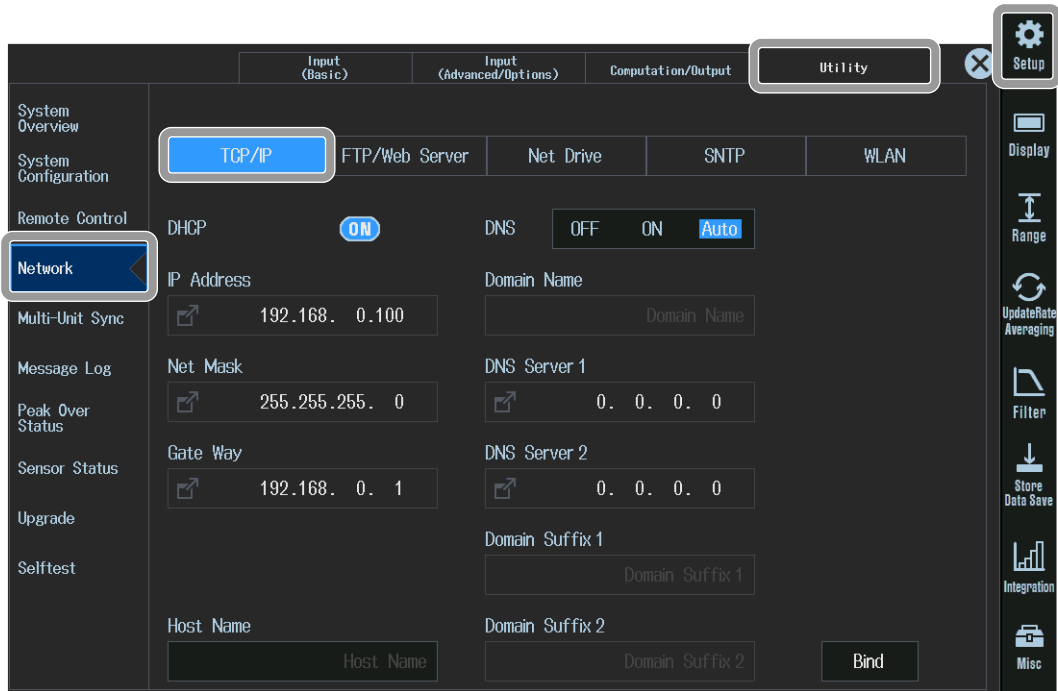
Note

- Use a hub or router that supports your network environment (transmission speed).
- When connecting to a single PC, the PC must have a network card that supports automatic switching between 1000BASE-T, 100BASE-TX, and 10BASE-T.
- Avoid connecting the instrument and the PC directly without using a hub or router. Communication in a direct connection is not guaranteed.

14.2 Setting TCP/IP

Procedure

Setup menu icon  > **Utility** > **Network** > **TCP/IP**



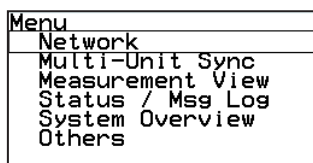
Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also move the cursor to **Utility** with the arrow keys and press **SET** to display the utility settings overview screen.
 - The utility settings overview screen is also displayed when you press the **KEY LOCK/LOCAL** key on the front panel.



Setting on the WT1500 LCD

You can also set TCP/IP on the WT1500 LCD using the operation keys as shown below.



Use the ▲ and ▼ arrow keys to select **Network** on the Menu screen, and then press **SET**.

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



←Network/Ethernet
DHCP ON
IP 192.168. 0.100
NM 255.255.255. 0
GW 192.168. 0. 1
Bind
SET>Select ESC:Back



DHCP
ON
OFF
SET>Select ESC:Back

The current IP address and serial number are displayed.

Select **IP xxx.xxx.xxx.xxx** under **TCP/IP**, and press **SET**.

The current setting for each item is displayed on the right.

Select **DHCP**, and press **SET**.

• DHCP setting (ON/OFF)

Use the ▲ and ▼ arrow keys to select ON or OFF.

Press **SET** to return to the previous screen.



←Network/Ethernet
DHCP OFF
IP 192.168. 0.100
NM 255.255.255. 0
GW 192.168. 0. 1
Bind
SET>Select ESC:Back



IP Address
192.168. 0.100
↔:SelectNumber
↔:Move Focus
SET:Enter

When DHCP is OFF, set the following items.

When DHCP is ON, these items are obtained automatically, so you do not need to set them.

IP: IP address

NM: subnet mask

GW: Default gateway

Use the ▲ and ▼ arrow keys to select the item to set, and press **SET**.

• Setting the IP address

Use the ◀ and ▶ arrow keys to move the cursor, and use the ▲ and ▼ arrow keys to select a value from 0 to 9.

Press **SET** to return to the previous screen.

• Setting the subnet mask and default gateway

The procedure is the same as for setting the IP address.



Bind
Execute
Cancel
SET:OK ESC:Back

After changing the settings for each item, select **Bind** and press **SET**.

• Select **Execute** and press **SET** to apply the settings.

• Select **Cancel** and press **SET** to return to the Network/Ethernet screen.

DHCP

A protocol that temporarily assigns the information required for a computer to connect to the Internet.

ON

When connecting to a network that supports a DHCP server, you can connect with DHCP set to ON. In this case, when the instrument is connected to the network, the IP address is obtained automatically, so you do not need to set the IP address.

OFF

When DHCP is OFF, set the IP address, subnet mask, and default gateway according to the network you are connecting to.

DNS

DNS is a system that associates Internet names, such as host names and domain names, with IP addresses. (In AAA.BBBBB.co.jp, AAA is the host name, and BBBBB.co.jp is the domain name.)

- You can access the network by specifying a host name or domain name instead of a numeric IP address.
- You can specify the destination host by name instead of by IP address. Set the domain name and DNS server addresses (default: 0.0.0.0). For details, consult your network administrator.

OFF

Disables DNS.

ON

Enables DNS. Set the domain name, DNS server IP addresses, and domain suffixes.

Auto

Enables DNS. Set the domain suffixes. The domain name and DNS server IP addresses are set automatically.

Auto is displayed only when DHCP is ON.

Domain name (Domain Name)

- Number of characters: Up to 30
- Allowed characters: 0 to 9, A to Z, a to z, -

DNS server (DNS Server1/DNS Server2)

You can set up to two DNS server addresses: primary (first priority) and secondary (second priority). If an inquiry to the primary DNS server fails, the secondary DNS server is automatically used to search for the association between the host name plus domain name and the IP address.

Server 1: primary, Server 2: secondary

Other domain names: Domain Suffix1/Domain Suffix2

This information is added automatically when an inquiry is sent to the DNS server using only part of a domain name. For example, if BBBBB.co.jp is set as a domain suffix, a search for AAA is performed as AAA.BBBBB.co.jp.

You can set two domain suffixes: Domain Suffix 1 (first priority) and Domain Suffix 2 (second priority).

- Number of characters: Up to 127
- Allowed characters: 0 to 9, A to Z, a to z, -

Host name (Host Name)

- Number of characters: Up to 32
- Allowed characters: 0 to 9, A to Z, a to z, -

Applying settings (Bind)

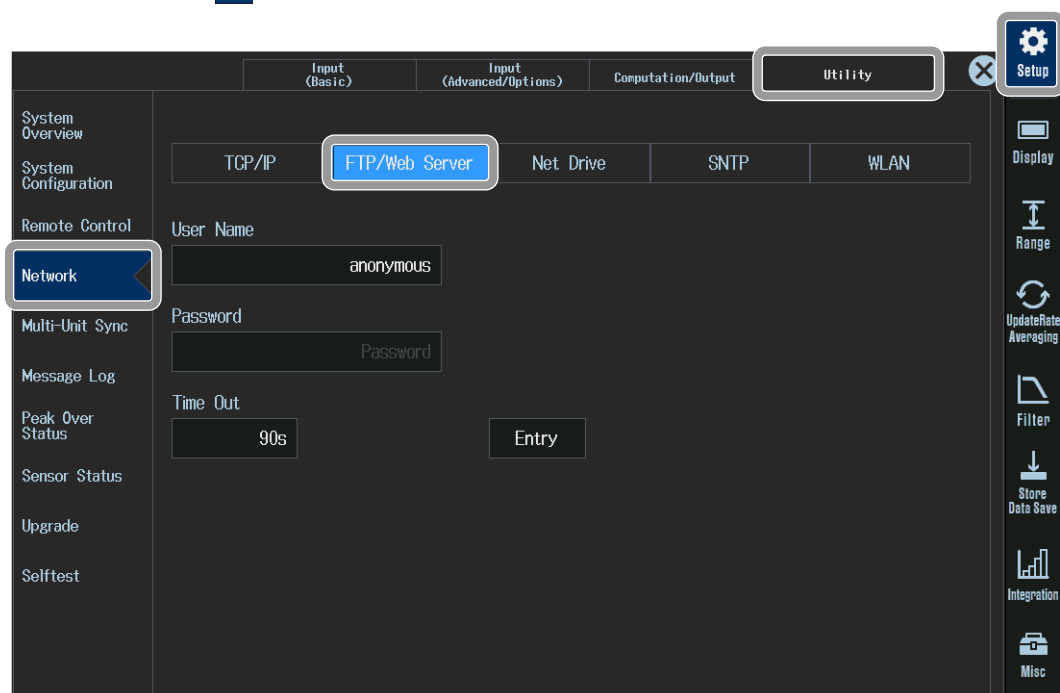
The TCP/IP settings take effect when Bind is selected in the dialog box or when the instrument is turned on again.

14.3 Accessing This Instrument from a PC (FTP Server)

When this instrument is connected to the network as an FTP server, you can browse the file list stored in the instrument's storage (internal memory and connected storage devices) and transfer files to a PC.

Procedure

Setup menu icon  > **Utility** > **Network** > **FTP/Web Server**



Set User Name, Password, and Time Out for access to this instrument from devices on the network.

Note

- If the user name is set to anonymous, you can access this instrument without entering a password.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
 - For operations using keys other than SET
See section 14.2.

Setting on the WT1500 LCD

You can also configure the FTP server settings on the WT1500 LCD using the operation keys as follows:

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



Use the ▲ and ▼ arrow keys to select **Network** on the Menu screen, and then press **SET**.

Select **FTP/Web Server**, and press **SET**.

14.3 Accessing This Instrument from a PC (FTP Server)

←FTP/Web Server	
User Name	anonymous
Password	
Time Out	90
Entry	
SET>Select ESC:Back	



User Name	
aonymous	
▲▼:SelectNumber	
◀▶:Move_Focus	
SET:Enter	

The current setting is displayed to the right of each item.

Use the ▲ and ▼ arrow keys to select **User Name**, **Password**, or **Time Out**, and press **SET**.

User Name: User name setting

Password: Password setting

Time Out: timeout period setting

- **Setting the user name**

Use the ◀ and ▶ arrow keys to select one character to enter.

Number of characters: Up to 15

Use the ▲ and ▼ arrow keys to select a character.

- When you press the ▲ arrow key: Space → 9 to 0 → ~}{['_^]¥[@?>=< ;/.,+*)('&%\$#! → z to a → Z to A → space → 9 to 0

- When you press the ▼ arrow key: Space → A to Z → a to z → !"#\$%&'()*+,-./:;<=>?@[¥]^_{'|}~ → 0 to 9 → space → A to Z

Press **SET** to confirm the displayed user name and return to the previous screen.

Password	
■	
▲▼:SelectNumber	
◀▶:Move_Focus	
SET:Enter	

- **Setting the password**

Use the ◀ and ▶ arrow keys to select one character to enter.

Use the ▲ and ▼ arrow keys to select a character.

Press **SET** to confirm the displayed password and return to the previous screen.

Time Out	
90	
▲▼:SelectNumber	
◀▶:Move_Focus	
SET:Enter	

- **Setting the timeout period**

Use the ◀ and ▶ arrow keys to select one digit to enter.

Use the ▲ and ▼ arrow keys to select a value from 0 to 9.

Input range: 1 to 120 (s)

Press **SET** to confirm the displayed timeout period and return to the previous screen.*

* If a value outside the range is entered, a value within the range is used.



←FTP/Web Server	
User Name	anonymous
Password	
Time Out	120
Entry	
SET>Select ESC:Back	



Entry	
Execute	
Cancel	
SET:OK ESC:Back	

After setting each item, use the ▼ arrow key to select **Entry**, and press **SET**.

- Select **Execute** and press **SET** to apply the entry.
- Select **Cancel** and press **SET** to return to the FTP/Web Server screen.

User name (User Name)

Set the user name required to access this instrument from a PC. If anonymous is specified, you can access this instrument without entering a password.

- Number of characters: Up to 32
- Allowed characters: 0 to 9, A to Z, a to z, -, _
 - * Numbers only are not allowed.

Password (Password)

Set the password required to access this instrument from a PC.

- Number of characters: Up to 32
- Allowed characters: All ASCII characters displayed on the keyboard

Timeout (Time Out)

If there is no access within a certain period after connection processing to this instrument starts, the connection processing is canceled.

The timeout period can be set from 1 s to 120 s.

Entry (Entry)

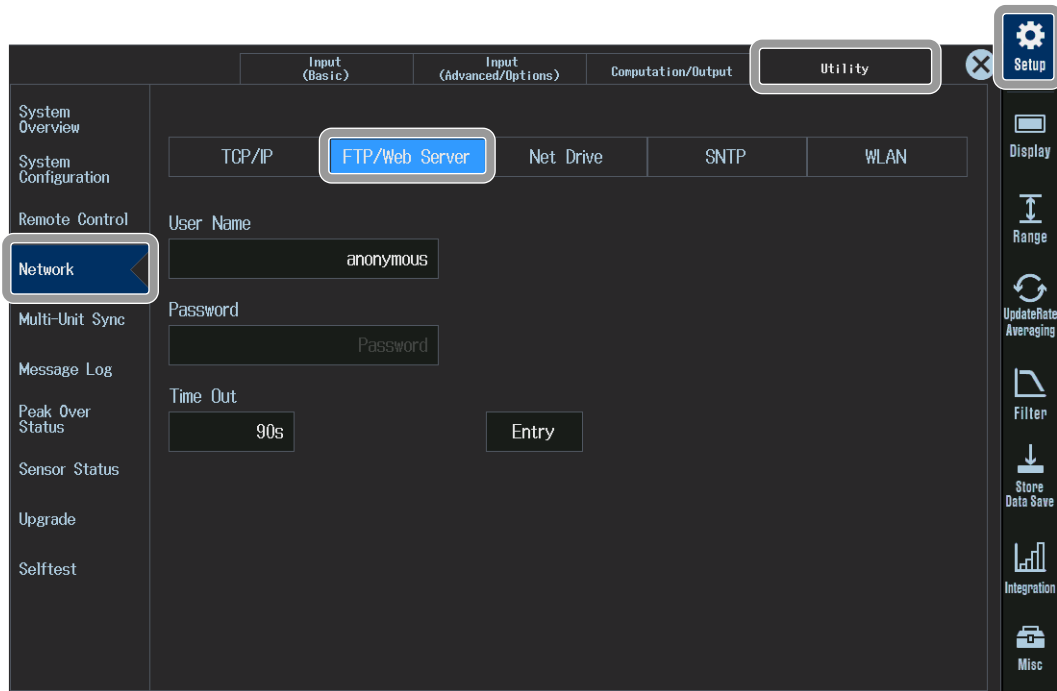
To apply the settings that you specified, select Entry.

14.4 Web Server Function

When this instrument is connected to the network as a Web server, you can display the Web server function screen on a PC on the network and operate the instrument via Ethernet.

Procedure

Setup menu icon  > Utility > Network > FTP/Web Server



Set User Name and Password for access to this instrument from devices on the network.
Time Out is used for the FTP server function. It does not need to be set for the Web server function.

Note

Procedures using front-panel keys

See section 1.2 of the Getting Started Guide (IM WT1501-02EN).

- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
- For operations using keys other than SET
See section 14.2.

Setting on the WT1500 LCD

You can also configure the Web server settings on the WT1500 LCD using the operation keys.

The setting procedure is the same as for the FTP server settings in section 14.3. However, the timeout period does not need to be set.

Operations on a PC

1. Start a browser on a PC connected to the network.
You can use a web browser such as Google Chrome or Microsoft Edge.
2. Enter the following address:
`http://xxx.xxx.xxx.xxx/`
 - For xxx.xxx.xxx.xxx, enter the IP address of this instrument.
 - If a host name has been set, you can also access the instrument by entering `http://` followed by the configured host name.
3. Enter the user name and password set on the previous page to access this instrument.
The home screen of this instrument appears.
 - If the user name is set to anonymous, you can access this instrument without entering a password.
 - The IP address of this instrument appears at the top of the screen. If you are connected using a host name, the host name appears.



4. Select an item from the side navigation on the left side of the screen. The corresponding screen appears.

Note

- The Web server function cannot be used while this instrument is performing file operations.
- When capturing the screen, disable the browser's pop-up blocker.
- While the Web server function is in use, response may be delayed or there may be no response, depending on the network environment.
- When the data update interval is 10 ms, the Web server cannot display the screen. If you try to connect through the Web server, "This site can't be reached" appears, and the screen cannot be updated.
 - To change the data update interval from 10 ms to another interval, operate from the external monitor screen or use communication commands.
 - If the data update interval is changed to 10 ms by another path, such as a communication command, while the Web server screen is displayed, the Web server screen is no longer displayed.
 - If the data update interval is changed to 10 ms while the Web server is in use, a message appears indicating that the Web server function has stopped. If the Web server screen is no longer displayed, you can recover by performing Initialize Settings on the WT1500 LCD (see section 2.8).

User name (User Name)

Set the user name required to access this instrument from a PC. If anonymous is specified, you can access this instrument without entering a password.

- Number of characters: Up to 32
- Allowed characters: 0 to 9, A to Z, a to z, -, _
 - * Numbers only are not allowed.

This instrument supports the MD5 algorithm (RSA Data Security, Inc. MD5 Message-Digest Algorithm).

Password (Password)

Set the password required to access this instrument from a PC.

- Number of characters: Up to 32
- Allowed characters: All ASCII characters displayed on the keyboard

Entry (Entry)

To apply the settings that you specified, select **Entry**.

Side navigation

The following items are available.

Home (Home)

Displays information about this instrument.

LAN configuration (LAN Configuration)

You can change the TCP/IP settings of this instrument.

Press **submit** to apply the settings.

- * Depending on the settings, the connection to this instrument may be disconnected.

Remote view (Remote View)

The Remote View screen* and key panel are displayed. (See the next page.)

In Remote View, you can view waveforms, numeric values, and the status of the settings.

- * The displayed screen is the same as the external monitor screen (page iii)), but when remote display (Remote View) is selected, you cannot remotely operate the instrument from this screen. Key panel operations are also disabled.

Select the items at the top of the screen to perform the following operations.

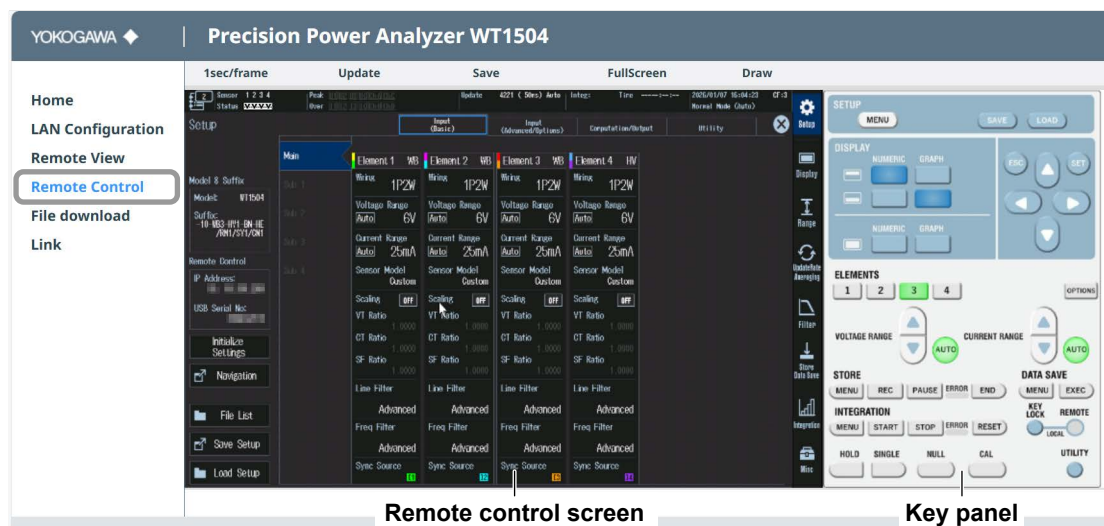
1sec/frame	Update	Save	FullScreen	Draw
------------	--------	------	------------	------

- **1sec/frame:** Sets the update interval of the displayed screen. Select off, 200msec, 500msec, 1sec, 3sec, or 5sec.
- **Update:** Updates the displayed screen.
- **Save:** Saves the displayed screen to the PC as a PNG image file (.png).
- **FullScreen:** Opens a full-screen image (1280 × 720) of the displayed screen in a tab.
- **Draw:** Opens an image of the displayed screen in a tab. You can paint on it or insert text.

Remote control (Remote Control)

The Remote Control screen* and key panel are displayed. You can remotely control this instrument using the screen, key panel, and mouse.

- * The displayed screen is the same as the external monitor screen (page iii).
Touch operation on the screen is limited to single taps. Other operations, such as pinch-out and zoom-in, are not supported.



- For details on the keypad, see the next page.
- You can select the items at the top of the screen (1sec/frame, Update, Save, FullScreen, and Draw) to perform operations. For details on each item, see “Remote view” in the previous section.

File download (File download)

You can save any file from the internal memory of this instrument to a PC.
See appendix 14.

Link (Link)

You can access the following linked pages.

- Power Analyzers Entrance: Power analyzer homepage
- Yokogawa Meters & Instruments Corporation: Home page of our website
- User’s Manual for This Instrument: WT1500 user’s manual page on our website

Recommended browsers

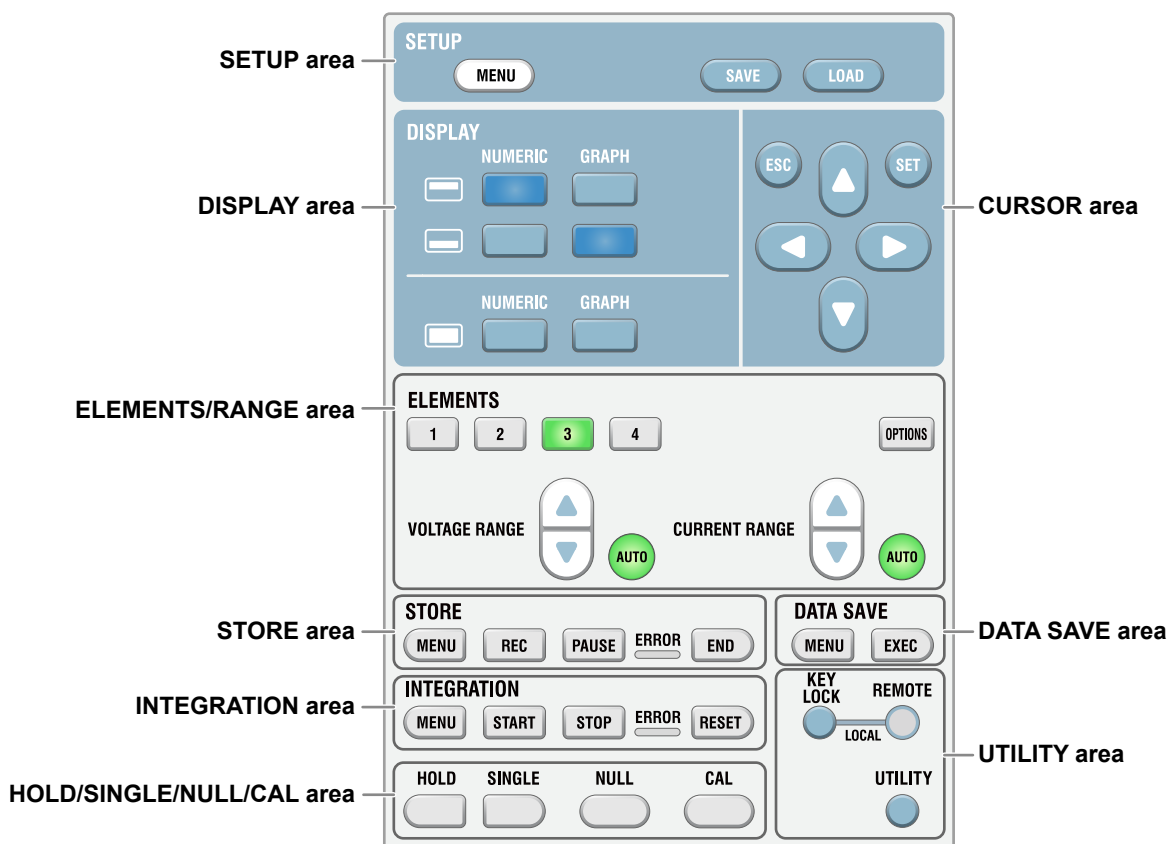
- Microsoft Edge
- Google Chrome (latest version)

Environment

Enable JavaScript.

Key panel (when Remote Control is selected)

When Remote Control is selected in the side navigation, the keys shown below are displayed on the right side of the screen. Use them to operate this instrument remotely.



SETUP area



MENU key

Displays the setup menu.

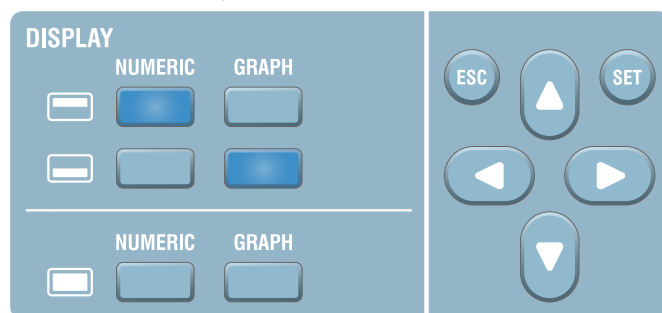
SAVE key

Displays the menu for saving setup data.

LOAD key

Displays the menu for loading setup data.

DISPLAY area, CURSOR area



NUMERIC key (upper half of split display)

Displays numeric data in the upper half of the split display.

GRAPH key (upper half of split display)

Displays graphs (waveforms, bar graphs, and vectors) in the upper half of the split display.

NUMERIC key (lower half of split display)

Displays numeric data in the lower half of the split display.

GRAPH key (lower half of split display)

Displays graphs (waveforms, bar graphs, and vectors) in the lower half of the split display.

NUMERIC key (full screen)

Displays numeric data on the full screen.

GRAPH key (full screen)

Displays graphs (waveforms, bar graphs, and vectors) on the full screen.

Common function of each key

When you select a key, it lights.

Common function of the NUMERIC key

Each time you select it, the numeric display format switches in the following order: full display → 4-item → 8-item → 16-item → matrix → harmonics list single → harmonics list dual → full display → ...

Common function of the GRAPH key

Each time you select it, the display switches in the following order: waveform → bar graph → vector → waveform → ...

ESC key

- Closes menus and dialog boxes.
- If a lower-level menu is displayed, it closes one level at a time.

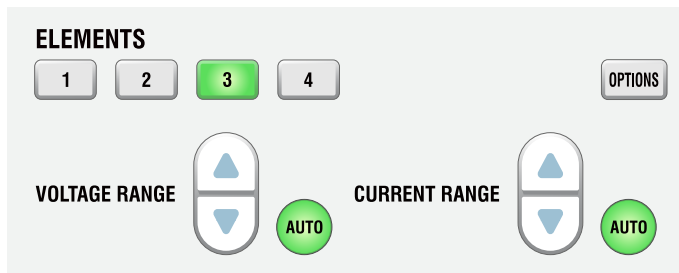
SET key

Confirms the item selected or the value set with the arrow keys.

Arrow keys (▲ ▼ ◀ ▶ keys)

- Use ▲ and ▼ to increase or decrease the numeric value being entered. You can also use ▲ and ▼ to select setting items.
- Use ◀ and ▶ to move the input digit (cursor) left or right.

ELEMENTS/RANGE Area



1 to 4 keys

- Select the input element for which to set the measurement range.
- The key for the selected element lights.
- Depending on the wiring system setting, input elements assigned to the same wiring unit are selected simultaneously.

OPTIONS key

- On models with the motor evaluation option, displays the menu for setting the motor evaluation and auxiliary input functions.
- Displays the motor evaluation function (optional) in the input information area of the screen.

▲ key, ▼ key

- Select the voltage range, current range, or external current sensor range.
- The selected range is enabled when the AUTO key below is off (fixed-range function).

AUTO key

- When this key is selected, it lights and the autoranging function is enabled. The voltage range, current range, external current sensor range, and current probe input range switch automatically according to the magnitude of the input electrical signal.
- When selected again, it turns off and the fixed-range function is enabled.

STORE area



MENU key

Displays the store menu.

REC key

Starts storage and creates a file. This key lights while storage is in progress.

PAUSE key

Pauses storage. This key blinks while storage is paused.

This key lights when storage is complete.

ERROR indicator

This indicator blinks when a storage-related error occurs.

END key

Ends storage and closes the file.

DATA SAVE area

DATA SAVE

MENU

EXEC

MENU key

Displays the data save menu.

EXEC key

Saves data.

INTEGRATION area

INTEGRATION

MENU

START

STOP

ERROR

RESET

MENU key

Displays the integration menu.

START key

Starts integration. This key lights while integration is in progress.

STOP key

Stops integration. This key blinks while integration is stopped.

This key lights when integration is complete.

ERROR indicator

This indicator blinks when an integration-related error occurs.

RESET key

Resets integration.

HOLD/SINGLE/NULL/CAL area

HOLD

SINGLE

NULL

CAL

HOLD key

- Interrupts the sequence of measurement and display operations for each data update interval and holds the numeric data display. This key lights when HOLD is ON.
- When selected again, hold is released and the numeric data display resumes updating.

SINGLE key

When selected during hold, this key performs measurement once at the configured data update interval, updates the data, and then returns to the hold state.

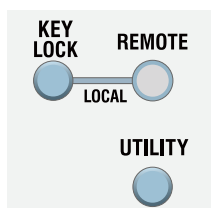
NULL key

- Executes the Null function. This key lights when the Null function is ON.
- When selected again, the Null function is canceled.

CAL key

Executes zero-level compensation. This instrument creates a zero-input state in its internal circuit and uses the level at that time as the zero level.

UTILITY area



REMOTE indicator

Lights green when the instrument is in remote mode.

KEY LOCK/LOCAL key

- Key lock: When this key is selected, it lights, and key operation on the front panel of this instrument is disabled. Select it again to exit this mode.
- Remote release: Switches the instrument from remote mode (REMOTE indicator lit) to local mode (front-panel key operation on the instrument is enabled). However, this function is disabled in local lockout mode.*

* For local lockout, see the Communication Interface User's Manual (IM WT1501-17EN).

UTILITY key

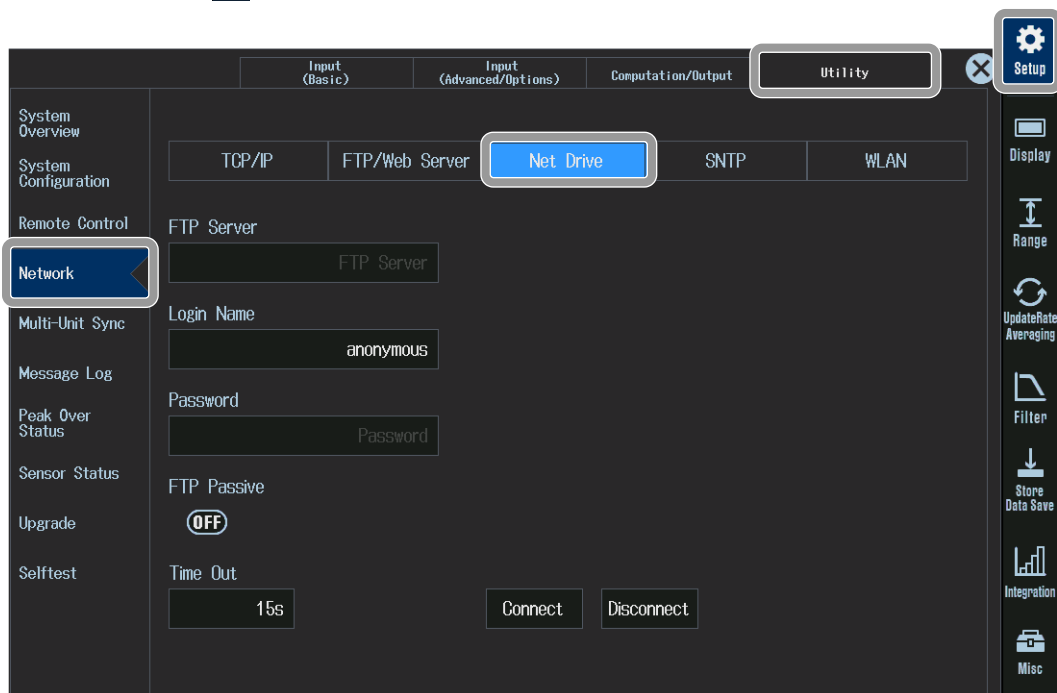
Displays the utility menu.

14.5 Connecting to a Network Drive

You can save the instrument's setup, numeric data, waveform display data, and screen image data to a drive on the network. You can also load setup data saved on a drive on the network into this instrument.

Procedure

Setup menu icon  > Utility > Network > Net Drive



Note

Procedures using front-panel keys

See section 1.2 of the Getting Started Guide (IM WT1501-02EN).

- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
- For operations using keys other than SET
See section 14.2.

FTP server (FTP Server)

Specify the FTP server on the network, by IP address, for saving numeric data, waveform display data, and screen image data, and for loading setup data.

In environments where DNS can be used, you can specify it by name (host name or domain name) instead of by IP address.

Host name or domain name

- Number of characters: Up to 32
- Character types: All ASCII characters displayed on the keyboard

Login name (Login Name)

Set the login name.

- Number of characters: Up to 32
- Character types: All ASCII characters displayed on the keyboard

Password (Password)

Set the password for the login name.

- Number of characters: Up to 32
- Character types: All ASCII characters displayed on the keyboard

FTP passive mode (FTP Passive)

Set FTP Passive to ON or OFF.

FTP passive mode is a mode in which the FTP client side specifies the port number used for data transfer. Set it to ON when accessing through a firewall, such as when an external FTP server is set for the network drive.

Timeout (Time Out)

If data cannot be sent or received within a certain period, the connection to the FTP server is disconnected.

The timeout can be set in the range from 1 s to 3600 s.

Connecting to the network drive (Connect/Disconnect)

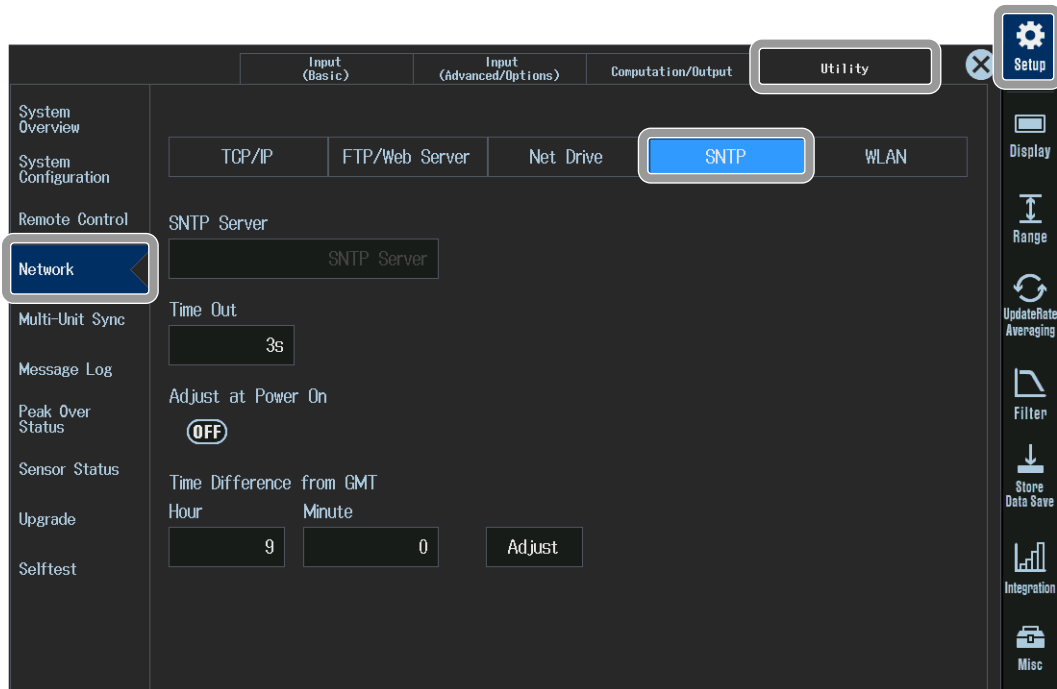
Selecting Connect connects to the configured network drive. Selecting Disconnect disconnects the network drive.

14.6 Setting the Date and Time Using SNTP

Use SNTP (Simple Network Time Protocol) to set the date and time of this instrument. When the instrument is turned on, the date and time are set automatically.

Procedure

Setup menu icon  > **Utility** > **Network** > **SNTP**



Note

Procedures using front-panel keys

See section 1.2 of the Getting Started Guide (IM WT1501-02EN).

- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
- For operations using keys other than SET
See section 14.2.

SNTP server (SNTP Server)

Specify the SNTP server to use by entering its IP address. In environments where DNS can be used, you can specify it by name (host name or domain name) instead of by IP address.

Host name or domain name

- Number of characters: Up to 32
- Character types: All ASCII characters displayed on the keyboard

Timeout (Time Out)

If the instrument cannot connect to the SNTP server within a certain period, the connection to the SNTP server is canceled.

The timeout can be set in the range from 1 s to 60 s.

Automatic adjustment at power-on (Adjust at Power ON)

ON

When the power to the instrument is turned on while it is connected to the network, the date and time of the instrument can be adjusted automatically to the date and time of the SNTP server.

OFF

Select OFF when you do not want to use the automatic adjustment function.

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

Set the time difference from Greenwich Mean Time (–12 hours 0 minutes to 13 hours 0 minutes). This is the same as the time difference from Greenwich Mean Time (Time Difference From GMT) for the date and time settings.

See section 2.7.

Note

The Time Difference from GMT setting is shared with the Time Difference from GMT setting for SNTP in Date/Time. If you change this setting in Network under Ethernet communication, the Time Difference from GMT setting in date and time (Date/Time) settings is also changed.

Adjusting the time (Adjust)

Adjusts the date and time of the instrument to the date and time of the SNTP server.

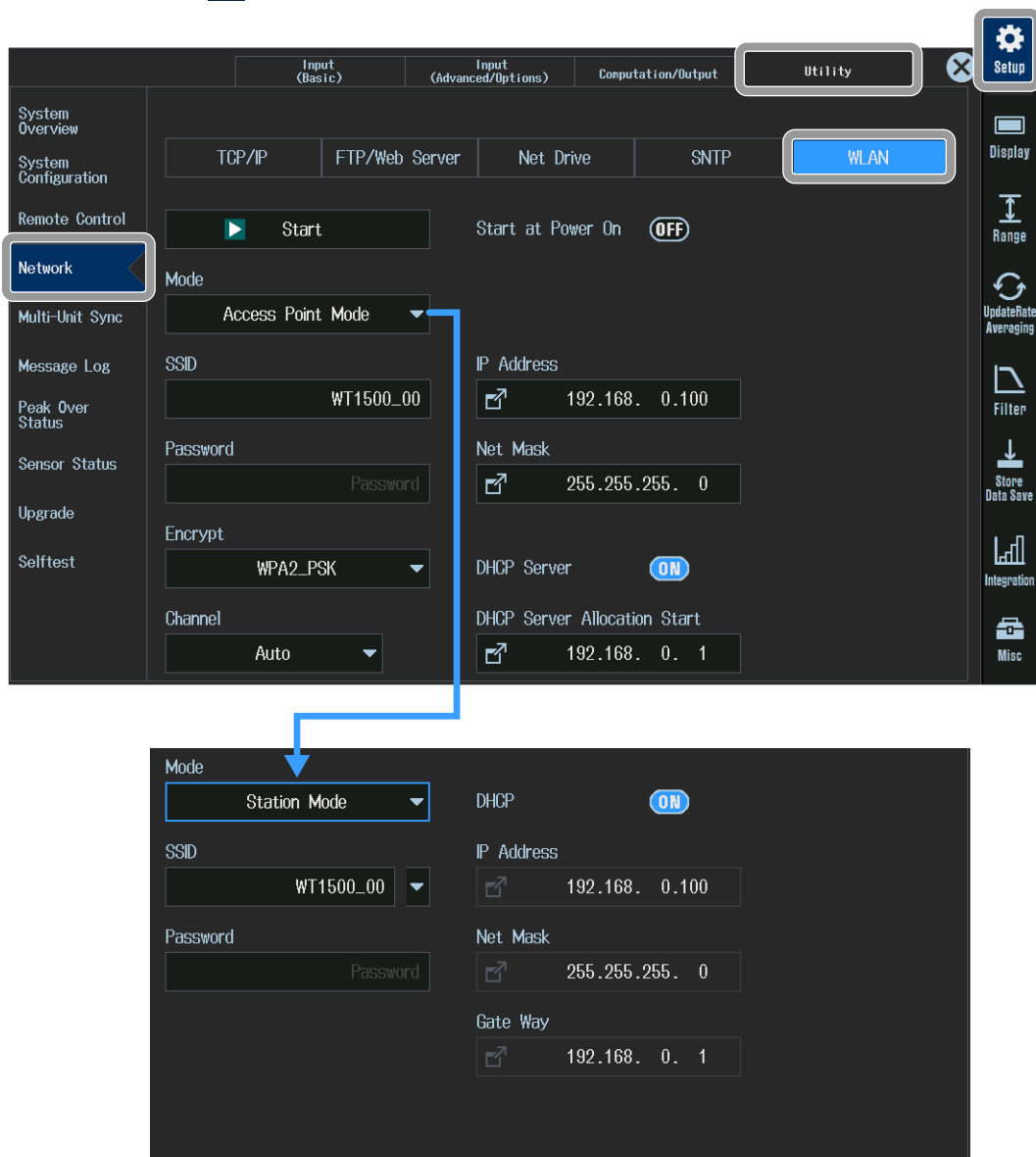
To apply the configured time adjustment, select **Adjust**.

14.7 Setting WLAN

You can operate this instrument from a PC using a wireless LAN adapter.

Procedure

Setup menu icon  > Utility > Network > WLAN



Note

Procedures using front-panel keys

See section 1.2 of the Getting Started Guide (IM WT1501-02EN).

- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
- For operations using keys other than SET
See section 14.2.

14.7 Setting WLAN

Setting on the WT1500 LCD

You can also set WLAN on the WT1500 LCD using the operation keys.

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



WLAN	
Mode	AccessPoint
Setup	Mode
SET>Select ESC:Back	



Mode	
AccessPointMode	
Station Mode	
SET>Select ESC:Back	

Use the ▲ and ▼ arrow keys to select **Network** on the Menu screen, and then press **SET**.

Select **WLAN**, and press **SET**.

The currently selected mode is displayed to the right of Mode.

To change the mode, select **Mode**, and press **SET**.

Selecting the mode

Use the ▲ and ▼ arrow keys to select **Access Point Mode** or **Station Mode**.

Press **SET** to return to the previous screen.



WLAN	
Mode	AccessPoint
Setup	Mode
SET>Select ESC:Back	



←AccessPointMode	
SSID	WT1500_0...
Password	*****
Encrypt	WPA2_PSK
Channel	Auto
IP	192.168.123.100
Start	

Setting the selected mode

Select **Setup**, and press **SET**.

The screen changes to the settings screen for the selected mode.

• Setting the access point mode

Use the ▲ and ▼ arrow keys to select the item to set, and press **SET**. The screen changes to the settings screen for each item.

Start (when the connection is stopped) or Stop (when connected) appears at the bottom of the screen. Select **Start** or **Stop**, and press **SET**.

←Station Mode	
SSID	WT1500_0...
Password	
DHCP	ON
IP	192.168. 0.100
Start	

• Setting the station mode

Use the ▲ and ▼ arrow keys to select the item to set, and press **SET**. The screen changes to the settings screen for each item.

Start (when the connection is stopped) or Stop (when connected) appears at the bottom of the screen. Select **Start** or **Stop**, and press **SET**.



Start	
Execute	
Cancel	
SET>Select ESC:Back	

Executing Start (start connection) or Stop (stop connection)

- Select **Execute** and press **SET** to start or stop.
- Select **Cancel** and press **SET** to return to the previous screen.

The figure on the left shows an example in which Start is selected. The procedure is the same when Stop is selected.

Setting the mode (Mode)

Access point mode

Select this mode when using this instrument as an access point.

Station mode

Select this mode when using this instrument by connecting it to an access point.

Access point

Set these items when using the instrument as an access point.

Setting the SSID

The text input screen appears. For how to enter text, see section 2.5.

Set the access point name displayed when a wireless terminal, such as a PC, searches for access points.

Setting the authentication password (Password)

The text input screen appears. For how to enter text, see section 2.5.

Set the authentication password used when a wireless terminal connects to the access point.

If Encrypt is set to None, no entry is required (no password).

Setting encryption (Encrypt)

Set the encryption key used for communication with the wireless terminal from the following:

- None: No encryption key is used.
- WPA2_PSK: Uses an encryption key based on the WPA2-PSK method.

Setting the channel (Channel)

Set the channel used to receive the beacon signal when a wireless terminal searches for the access point from the following:

- Auto: The channel is selected automatically during broadcast transmission.
- 1Ch to 11Ch: If interfering radio waves from nearby wireless communications are present, set the channel manually to avoid interference.

IP address

The numeric keypad screen appears.

Set the IP address assigned to the instrument. An IP address is an identification number assigned to each computer connected to the network.

Subnet mask (Net Mask)

The numeric keypad screen appears.

Set the mask value used to determine the subnet network address from the IP address. The subnet mask is the value that defines how many bits of the IP address are used as the network address to identify the network.

DHCP server on/off

- ON: Select this when using IP addresses and other network settings assigned automatically to each device.
- OFF: Select this when setting network settings such as IP addresses manually for each device.

DHCP server: Allocation start address (DHCP Server Allocation Start)

The numeric keypad screen appears.

Set the IP address assigned to a wireless terminal that accesses the access point (the instrument). Address values are assigned sequentially starting from the specified address.

Station

Set these items when using the instrument by connecting it to an access point.

Setting the SSID

See the previous page.

Setting the authentication password (Password)

See the previous page.

DHCP on/off

- ON: Select this when using an automatically assigned IP address.
- OFF: Select this when setting network information such as the IP address manually.

IP address

See the previous page.

Subnet mask (Net Mask)

See the previous page.

Default gateway (Gate Way)

The numeric keypad screen appears.

Start (Start)/Stop (Stop)

- Start (Start): Starts the connection.
- Stop (Stop): Stops the connection.

Start at power-on (Start at Power On)

- ON: Starts the connection automatically when the power is turned on.
- OFF: Does not start the connection automatically when the power is turned on.

15.1 Basic Connection Operation of UDP Data Output

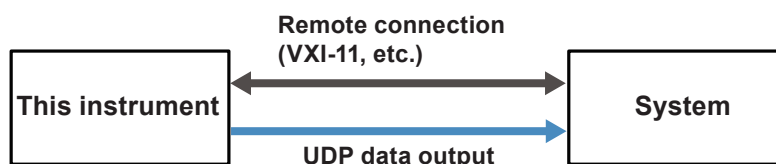
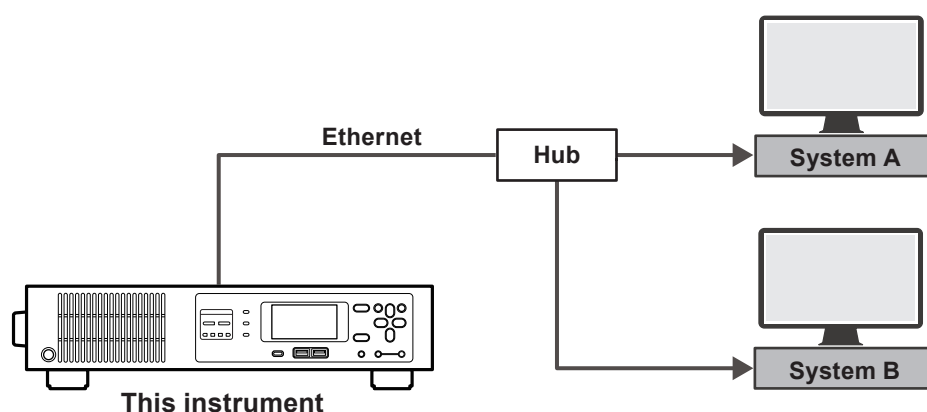
Overview

UDP data output function

UDP (User Datagram Protocol) data output is a function that uses the UDP protocol over Ethernet to continuously distribute the latest numeric data to multiple devices on the network.

With UDP, the latest data can be sent to multiple systems simultaneously.

- Set TCP/IP in Network in advance. (See section 14.2.)
- Before using UDP data output, set the numeric data output items via a remote connection. (See page 15-5.)



Communication settings

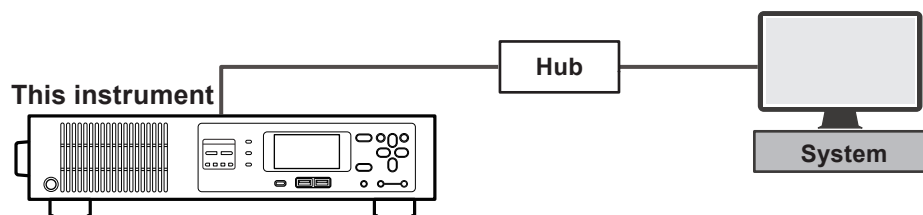
The destination of UDP packets output by this instrument is the specified IP address and port.

Because of the nature of UDP packets, packet loss is tolerated.

Ethernet frame size	Up to 1518 bytes (MTU = 1500)
Protocol	UDP/IPv4
Bit rate	1 Gbps, 100 Mbps, 10 Mbps
Destination IP address	Broadcast, multicast, unicast
Destination port	Specified port (default: 11000)
Adapter	Wired only

Procedure

1. Use a LAN cable to physically connect the instrument and the system on the same network.
(See section 14.1.)
2. Turn on the power to the instrument and the system.
3. On each device, set TCP/IP according to the connected network environment. (See section 14.2.)
4. Connect remotely from the system to the instrument, and configure UDP output.
For remote connections, see section 18.5.
 - Set the destination IP address and port number for UDP output. (See page 15-2.)
 - Set the output items (ITEM). (See page 15-5.)
 - Start UDP data output. (See page 15-5.)
 - On the system side, disconnect the remote connection to the instrument.UDP data reception starts on the system side.
.
.
.
UDP data reception ends on the system side.
5. Connect remotely from the system to the instrument, and stop UDP data output.



Packet Specifications

Data size per frame

Maximum 1472 bytes

- The size that can be sent at one time is limited to the size that fits in a single Ethernet frame.
- If the data exceeds the frame size, it is divided into multiple frames and sent.

UDP packet structure per frame

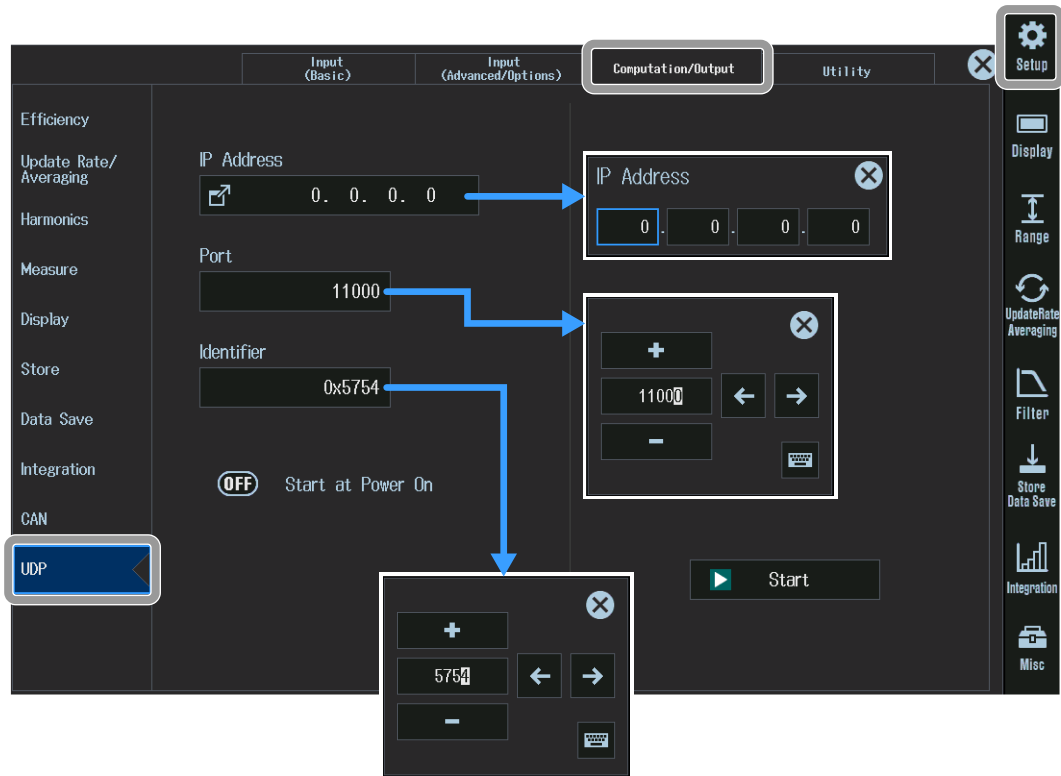
Item	Size	Overview
Identifier	2 bytes	0x5754 ("WT") or user-specified
Packet ID	1 byte	Multiple-packet identification ID [0–5]
Reserved1	1 byte	Fixed at 0
Size	2 bytes	Data size (timestamp (extended field) to data value N)
Timestamp (extended field)	2 bytes	* Reserved
Timestamp	4 bytes	UNIX time, 32-bit (local time)
Fractional seconds	4 bytes	Microseconds [0–999999]
Data ID 1	2 bytes	Data ID 1 [1–1000]
Reserved2 1	1 byte	Fixed at 0
Data size 1	1 byte	Data value size [4 = 4 bytes]
Data value 1	Variable length	Numeric data 1 (FLOAT)
...	...	...
Data ID N	2 bytes	Data header N
Reserved2 N	1 byte	Data header N
Data size N	1 byte	Data header N
Data value N	Variable length	Numeric data N

- Data in the packet uses big-endian representation. For numeric data, the setting specified with the **:NUM:BYTeorder** command is applied.
- The maximum number of items per frame is 170 ($170 \times 6 = 1020$).
- Time information is the measurement timestamp.
 - * The time corresponds to TS Date or TS Time in the function name, and the fractional-second part corresponds to TS Subsec.
- The data ID is linked to the number of the output item specified by the **:NUM:ITEM** command. The number of IDs depends on the count specified by the **:NUM:NUM** command, and IDs that are not specified are not output.
- For numeric data, the setting specified with the **:NUM:FORMAt** command is ignored, and the format is fixed to FLOAT.

15.2 Setting UDP Data Output Conditions and Starting and Stopping Output

Procedure

Setup menu icon  > Computation/Output > UDP



Note

- Set TCP/IP in Network in advance. (See section 14.2.)
- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing MENU on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

IP address (IP Address)

Set and check the destination IP address for UDP output.

If the destination is 0.0.0.0, no data is sent.

Port number (Port)

Set and check the destination port number for UDP output.

Identifier (Identifier)

Set and check the identifier used for the header.

Start at power-on (Start at Power On)

Select ON or OFF to specify whether UDP data output starts automatically when the power is turned on.

Start (Start)/Stop (Stop)

- Start (Start): Starts UDP data output in sync with numeric data updates.
- Stop (Stop): Stops UDP data output.

Note

-
- Do not start UDP data output while the storage function or CAN data output function is in use. If these functions are used at the same time, some output data may be lost.
 - Output items (ITEM) cannot be changed while UDP data output is in progress.
-

Setting output items

Uses the output items set with the communication command

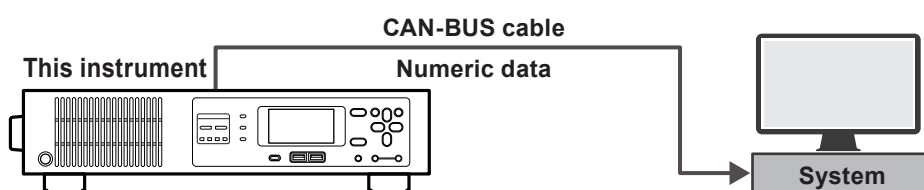
:NUMERIC[:NORMAl]:ITEM<x>[:FUNction].

For details, see the Communication Interface User's Manual (IM WT1501-17EN).

16.1 Basic Connection Operation for CAN Data Output

Overview

- Numeric data for CAN or CAN FD signals can be output to an external device through CAN data communication.
- The data is output at the configured communication speed.
- The output data is sent in a format compliant with the CAN protocol and can be analyzed and recorded in real time with an external device such as CANalyzer.*
- * CANalyzer is an analysis tool for in-vehicle ECUs and networks from Vector Informatik GmbH.
- Data output through CAN is not saved in the instrument.



Note

- Do not start CAN data output while using the storage function (see chapter 12) or the UDP data output function (see chapter 15). If these functions are used at the same time, some output data may be lost.
- CAN data output settings cannot be changed while CAN data output is in progress. An error message is displayed.
- The values for Bit Rate, Sample Point, Data Bit Rate, and Data Sample Point can only be specified by selecting from the available choices for each item. Arbitrary values cannot be entered.

CAN data output conditions

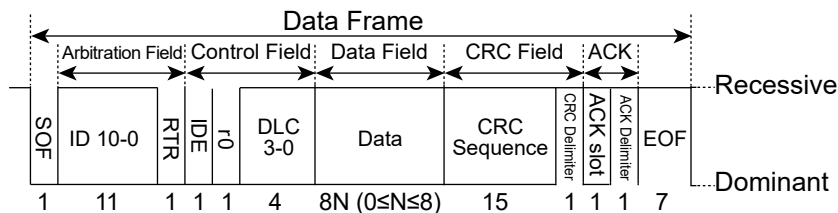
The CAN communication condition setting menu includes the following items:

- CAN data communication settings
- Setting CAN data output items
- Displaying the CAN data output item list and setting and saving the DBC file*
- * A DBC file is used to decode data fields and IDs.
- Starting (Start) and stopping (Stop) CAN data output

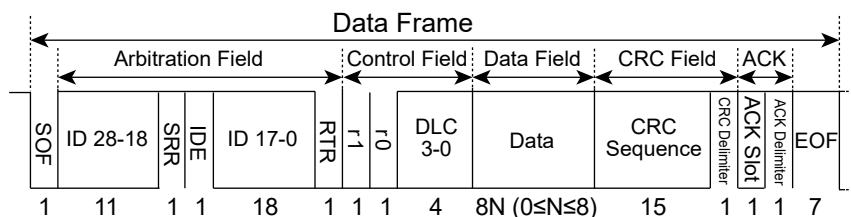
CAN frame format

Data frame

- Standard format

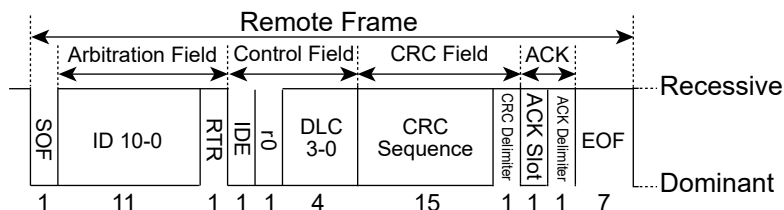


- Extended format

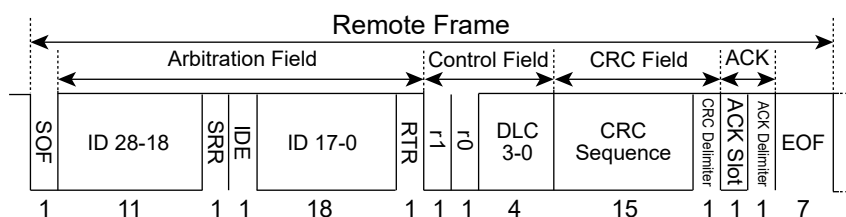


Remote frame

- Standard format



- Extended format

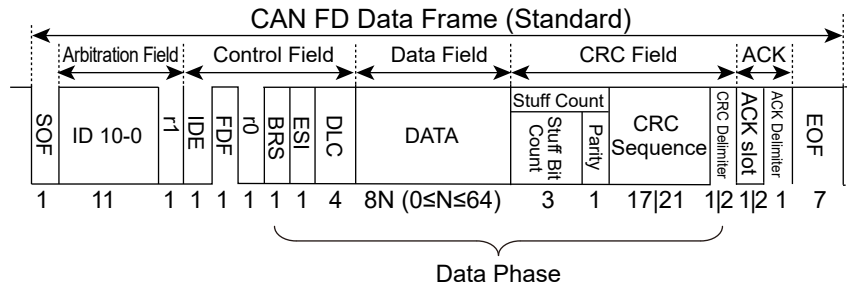


CAN FD frame format

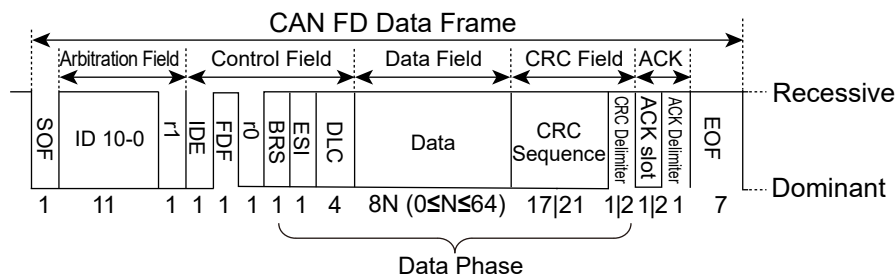
Data frame

- **Standard format**

- CAN FD (ISO 11898-1: 2015)

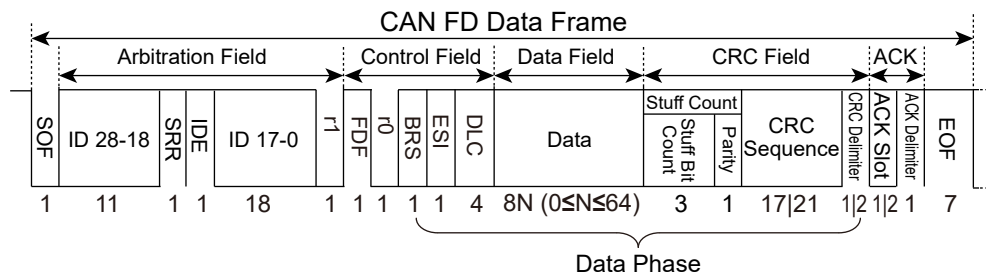


- CAN FD (non-ISO)

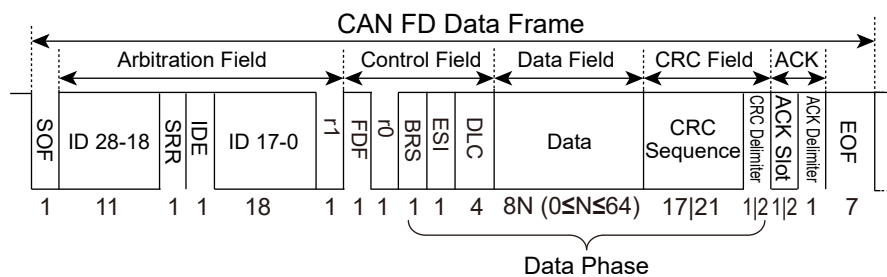


- **Extended format**

- CAN FD (ISO 11898-1: 2015)

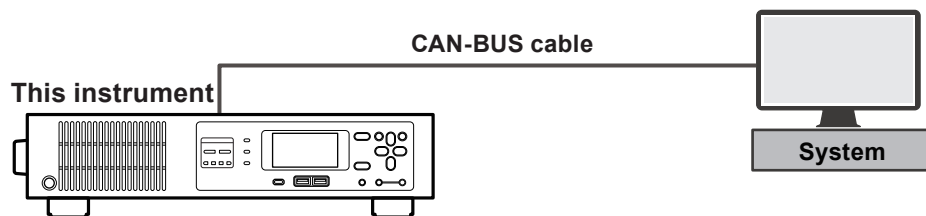


- CAN FD (non-ISO)



Procedure

1. Physically connect the instrument and the system with a CAN-BUS cable.
For how to connect them, see section 2.13 of the Getting Started Guide (IM WT1501-02EN).
2. Turn on the power to the instrument and the system.
3. Set the required items on each device.
 - On the instrument, set the CAN data communication settings. On the system, configure the communication settings to match those of the instrument. (See section 16.2.)On the instrument, set the CAN data output items and save the DBC file. (See section 16.3.)
On the connected system, load the DBC file.
 - On the instrument, set CAN data output and start output. (See section 16.3.)On the system, prepare for analysis and start it.



- | | |
|---|---|
| <ol style="list-style-type: none">2. WT power on3. WT operation<ul style="list-style-type: none">• CAN data communication settings• CAN data output item settings• Save DBC file• Set/Execute CAN data output | <ol style="list-style-type: none">2'. System power on3'. System operation<ul style="list-style-type: none">• CAN data communication settings• Load DBC file• Prepare/Execute analysis |
|---|---|

Note

- If there is an abnormality in the output CAN/CAN FD signal data, check the following:
- After creating the DBC file, do not change the instrument's CAN output item settings.
 - If CAN/CAN FD signals are transmitted from other devices, make sure their signals and ID numbers do not overlap.
-

16.2 Setting CAN Data Communication

Procedure

- Setup** menu icon  > **Computation/Output** > **CAN**
> set CAN Protocol to CAN/CAN FD (ISO)/CAN FD (non-ISO)
> **CAN Setup/CAN FD Setup, CAN Count**



Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - You can also select **Computation/Output** with the arrow keys and press **SET** to display the Computation/Output settings overview screen.

Setting the CAN protocol (CAN Protocol)

You can select the CAN protocol from the following:

CAN(CAN)

Data length: Up to 8 bytes

Communication speed: Up to 1 Mbps

CAN FD (ISO-compliant) (CAN FD (ISO))

Data length: Extended to up to 64 bytes; communication speed: up to 4 Mbps (data phase)

CAN FD based on ISO compliance (ISO 11898-1)

CAN FD (non-ISO-compliant) (CAN FD (non-ISO))

Data length: Extended to up to 64 bytes; communication speed: up to 4 Mbps (data phase)

Some error handling and frame structures are not ISO-compliant.

CAN setup (CAN Setup)

When CAN is selected in CAN Protocol, set the following items.

- **Bit rate (Bit Rate)**

Select the data communication speed from the following:

125 kbps, 250 kbps, 500 kbps, 1 Mbps

- **Sample point (Sample Point)**

The sample point is a parameter within the bit time that ensures accurate data reading. It is the timing at which the value of the data bit is sampled. Optimizing the sample point for CAN communication improves communication stability (fewer errors) and reliability (correct data transmission).

Select from the following:

50.0 % to 91.6 % (the setting resolution varies depending on the bit rate)

CAN FD setup (CAN FD Setup)

When CAN FD (ISO) or CAN FD (non-ISO) is selected in CAN Protocol, set the following items.

- **Bit rate (Bit Rate)**

Select the data communication speed (arbitration-phase communication speed) from the following:

500 kbps, 1 Mbps

- **Sample point (Sample Point)**

Same as for CAN Setup.

- **Data bit rate (Data Bit Rate)**

Select the data communication speed of the CAN FD bus signal from the following:

500 kbps*, 1 Mbps, 2 Mbps, 4 Mbps

* Can be selected only when 500 kbps is selected for Bit Rate.

Note

Operation of bit rate and data bit rate in CAN FD setup

- If the data bit rate is 500 kbps and the bit rate is changed from 500 kbps to 1 Mbps, the data bit rate also changes to 1 Mbps.
- When the bit rate is 1 Mbps, only 1 Mbps, 2 Mbps, and 4 Mbps can be selected for the data bit rate.

- Behavior of the data bit rate when the bit rate is changed from 500 kbps to 1 Mbps and then back to 500 kbps
 - If the data bit rate has never been changed from 1 Mbps
The data bit rate also returns to 500 kbps.
 - If the data bit rate has been changed from 1 Mbps at least once
(including setting it again to the same value, such as 1 Mbps → 1 Mbps)
The data bit rate remains at the current setting.

- **Data sample point (Data Sample Point)**

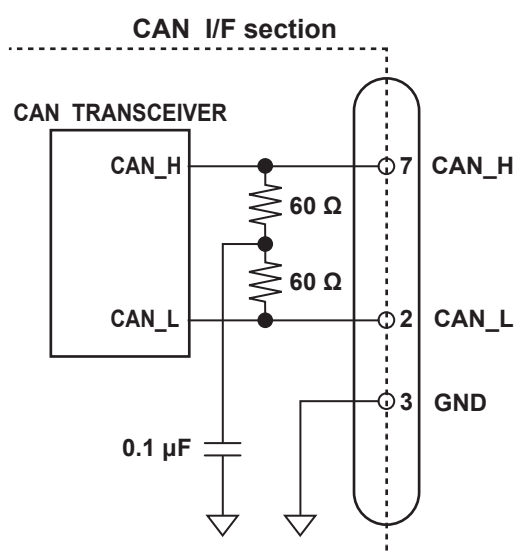
Select the sample point for each bit in the data phase of the CAN FD bus signal from the following:

50.0 % to 91.6 % (the setting resolution varies depending on the bit rate)

- **Terminator setting (Terminator)**

You can set the termination resistance for the CAN bus signal port.

- ON: A termination resistor (120 Ω) is inserted between CAN_H and CAN_L of the CAN bus line.
- OFF: No termination resistor is inserted between CAN_H and CAN_L of the CAN bus line.



Note

The bit rate and data bit rate must match those of the other CAN devices used for communication.
Communication is not possible with different bit rates.

CAN count (CAN Count)

Setting range: Infinite, 1 to 9999999

If Infinite is selected, the CAN data output count is set to 9999999.

16.3 Setting CAN Data Output Items and Starting and Stopping Output

Procedure

- Setup menu icon  > Computation/Output > CAN
 > Message Format, Message ID
 • Setting CAN data items
 > Select CAN Items



Note

- The CAN data output function cannot be used at the same time as the storage function (see chapter 12).
- CAN data output settings cannot be changed while CAN data output is in progress. An error message is displayed.
- The values for Bit Rate, Sample Point, Data Bit Rate, and Data Sample Point can only be specified by selecting from the available choices for each item. Arbitrary values cannot be entered.

- Displaying the CAN Data Output Item List and Setting and Saving the DBC File
 - > CAN Output Items
- Starting (Start) and stopping (Stop) CAN data output
 - > Start/Stop



Message format (Message Format)

Select the message format from the following:

- Standard (Standard): 11 bits
- Extended (Extend): 29 bits

Message ID (Message ID)

Set the message ID within the following range.

- When message format (Message Format) is set to Standard
0 to 7FF(Hex)
- When message format (Message Format) is set to Extend
0 to 1FFFFFFF(Hex)

Note

In the communication method used by CAN, priority is determined by a process called arbitration. In CAN, messages with smaller message ID values are given priority.

Setting CAN data items

CAN data items (CAN Items)

The method for setting CAN items to output is fixed to Selected Items (Element Select).

- In “Selecting CAN data items (Select CAN Items)” in the next section, select the element number, motor number, or auxiliary input number for each measurement function to output.
- For measurement functions that do not require an element number or similar specification, CAN data can be output simply by selecting the measurement function.

Selecting CAN data items (Select CAN Items)

Select the channels for the input elements, wiring units, motor evaluation, and auxiliary input of the numeric data items to output. If there is no need to select an input element or similar item for the numeric data item to output (for example, efficiency: η , user-defined: F, Ev), select the numeric data item directly.

All ON (All ON)

Outputs the CAN data of all measurement functions

All OFF (All OFF)

Does not output the CAN data of any measurement function

Preset 1 (Preset 1)

Outputs the CAN data of the following measurement functions for all elements and all wiring units.

Urms, Irms, FreqU, FreqL, P, S, Q, λ , Φ

Preset 2 (Preset 2)

Outputs the CAN data of the following measurement functions for all elements and all wiring units.

WP, WP+, WP-, q, q+, q-, ITime, WS, WQ

Remaining available items (Remaining Available Items)

The remaining number of selectable data items is displayed in real time at the upper right of the screen.

- Number of selectable data items**

The maximum number of data items that can be selected varies depending on the bit rate setting for CAN data output (see section 16.2) and the data update interval setting (see section 4.10).

CAN protocol	Bit rate	Number of selectable data items [items]	
		Data update interval	
		10 ms	Other than 10 ms
CAN	125 kbps	4	20
	250 kbps	8	40
	500 kbps	16	64
	1 Mbps	32	64
CANFD, CANFD (NON-ISO)	500 kbps	32	128
	1 Mbps	64	256
	2 Mbps	128	512
	4 Mbps	256	512

Copying from stored items (Copy from Store)

You can copy the stored item settings (pages 12-8 and 12-9) to the CAN data items.

Unit to configure (Selected Unit)

During multi-unit synchronization (option /SY1), the main unit can output power numeric data from subunits.

Specify the unit you want to operate from the following, and set the stored items and Element/ Σ .

Main, Sub 1, Sub 2, Sub 3, Sub 4

Data to output

Select the check boxes for the CAN data you want to output.

- Voltage, current, power, frequency (Voltage/Current/Power/Frequency)
- Integrated power, efficiency (Integ/Efficiency)
- User-defined function, user-defined event (User Func/User/Event)
- Harmonics (Harmonics)
 - Harmonics Setting (CAN)

For harmonic measurement data in groups Hrm ① and Hrm ②, you can set the CAN data output range by measured harmonic order (Min Order/Max Order).

For the groups of harmonic elements, see page 8-3.

- Motor, auxiliary input (Motor/Aux)
- Measurement range (Range)

The measurement function types that can be selected are the items listed in section 1.1, “Items That This Instrument Can Measure.”

When you select data to output, a selection box appears for the element number, motor number, or auxiliary input number. When one or more items are selected in this selection box, the data is selected for CAN data output (check box selected).

This selection box is not displayed for data that does not require specification of an element number or similar item. Select whether to output CAN data using the check box.

Displaying the CAN Data Output Item List and Setting and Saving the DBC File

CAN data output items (CAN Output Items)

Set the save conditions.

- You can review in a list the items selected in the previous section, “Selecting CAN data items (Select CAN Items).”
- You can also set and save the DBC file.

Setting the Conditions for Saving DBC Files (Save DBC File Setting)

Set the conditions for saving the DBC file.

The DBC file is created based on the current CAN data item settings.

- **File list (File List)**

In the file list, set the save destination for the DBC file. The save destination is USB memory (USB-0/USB-1/USB-2). See pages 3-25 and 13-5.

The contents of the folder set as the save destination are displayed, and you can review a list of saved DBC files.

- **Auto naming (Auto Naming)**

This is the same as Auto Naming for saving a setup (see page 3-25).

By default, a serial number (Numbering) is added automatically to the DBC file name to be saved. If the setting is changed to Date, the save date and time are added automatically to the file name.

(If the setting is changed to OFF, nothing is added.)

- **File name (File Name)**

This is the same as File Name for saving a setup (see page 3-26).

You can enter any file name manually.

- **Comment (Comment)**

This is the same as Comment for saving setup data (see page 3-26).

In addition to the file name, you can also add a comment to supplement the file contents or intended use.

Saving the DBC file (Save DBC File)

Saves the DBC file to the specified save destination using the specified file name.

Note

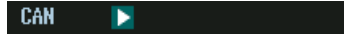
USB memory devices have a limited number of write cycles, so use them with care.

Starting (Start) and stopping (Stop) CAN data output

Start (Start)

When Start is selected, CAN data output starts according to the selected conditions.

When CAN data output starts, the icon shown below appears at the top of the screen.



Stop (Stop)

When Stop is selected, CAN data output stops.

The icon at the top of the screen disappears.

Completion of CAN data output

When the number of data outputs set in CAN Count is reached, CAN data output stops automatically.

17.1 Connecting Multiple Instruments

Overview

Multi-unit synchronization (Multi-Unit Synchronization) function

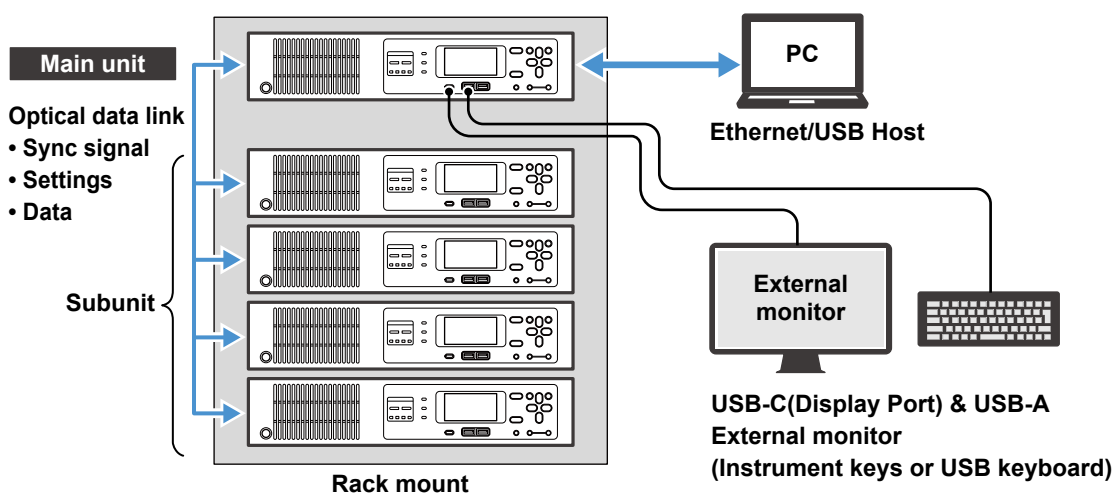
Up to five WT1500s can be operated in synchronization by connecting them with optical fiber cords. For multi-unit synchronization, set one of the connected WT1500s as the main unit and the others as subunits.

The input channels of the main unit are expanded to a maximum of 20 elements, 20 motor evaluations, or 40-channel auxiliary input.

- High-speed, noise-resistant communication between units over long distances (20 m/100 m/300 m)
- Synchronization of the measurement start position in the data update interval
- Synchronization of the integration start position
- Synchronization of hold, manual zero calibration, and Null operations
- Time synchronization of subunits to the main unit
- Synchronization of the measurement period (specifying a common signal as the synchronization source across units)
- Synchronization of PLL frequency measurement (specifying a common signal as the PLL source across units)
- Synchronization of trigger updating (specifying a common signal as the trigger source across units)
- Synchronization of the analysis start position (specifying a common signal as the Z phase for the electrical-angle harmonic analysis trigger across units)
- Collection and output by the main unit of power measurement values from subunits
- Setting of subunit measurement conditions from the main unit

Using and controlling this instrument during multi-unit synchronization

Configure the connection settings for multi-unit synchronization on the main unit and each subunit. During multi-unit synchronization, operations and data acquisition are performed on the main unit, and no operation on the subunits is required.



Operation and measurement are performed through communication with the main unit or by using an external monitor.

For system measurement applications

Install the instrument in a rack mount, and control it from the system PC application. Operate and configure the main unit using communication commands or an external monitor.

When using the instrument as a standalone measuring instrument

- Connect an external monitor to the USB connector on the instrument, and operate or configure it using the operation keys on the instrument or a USB keyboard.
- You can also connect the PC and the instrument by Ethernet or USB communication and control the instrument using the Web server function.

Uses of the LCD screen on the instrument

You can check the settings for communication connection between the instrument and a PC, as well as information such as the IP address and serial number.

- Checking the instrument status on the peak over, current sensor status, and error message screens
- Quickly checking basic measurement values when starting up a system measurement bench or verifying the measurement wiring
- Setting the clock
- Checking the system overview
- Saving and loading setup files, and saving message logs
- Updating the instrument version and adding options

Procedure from connecting the instruments to measuring with multi-unit synchronization

Connecting multiple units

See the next page.

Install optical transceiver modules on up to five instruments and connect the optical fiber cords. For details, see section 2.14 of the Getting Started Guide (IM WT1501-02EN).

Configuring multi-unit connection settings on each instrument (unit)

See section 17.2.

Of the connected instruments, set one as the main unit for settings and data output operations. Set the other instruments (up to four) as subunits, and execute the multi-unit synchronization connection.

If the multi-unit synchronization mode of all connected instruments is set to main unit or subunit, the multi-unit synchronization connection process is performed automatically when the power is turned on again.

- **When controlling from a PC application or the Web server**
Connect the PC and the main unit by Ethernet or USB communication. A communication connection between the PC and the subunits is not required.
- **When connecting multiple units and operating with multi-unit synchronization without a PC**
Connect an external monitor to the USB connector on the main unit, and control the system using the menu displayed on the monitor. A connection between the USB connector on a subunit and an external monitor is not required.

Setting measurement conditions

See section 17.3.

- When the main unit is operated, the measurement conditions of the subunits are controlled so that they work in conjunction with the settings of the main unit.
- For unit-specific settings such as input range, specify the subunit from the main unit and configure it.

Measuring and outputting with multi-unit synchronization

Output the measurement data (communication, files, and screens) of the main unit and subunits from the main unit.

Procedure**Installing optical transceiver modules****CAUTION**

- When installing or removing optical transceiver modules, take sufficient precautions against static electricity. Installing or removing the modules while static electricity is present may cause failure.
- Do not install or remove optical transceiver modules while an optical fiber cord is connected. Doing so may cause failure.
- 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**

- Prenez des précautions suffisantes contre l'électricité statique lors de l'installation ou du retrait de modules émetteurs-récepteurs optiques. L'installation ou le retrait des modules en présence d'électricité statique peut provoquer une défaillance.
- N'installez pas et ne retirez pas de modules émetteurs-récepteurs optiques lorsqu'un cordon de fibre optique est connecté. Le non-respect de cette consigne peut entraîner une défaillance.
- N'installez pas et ne retirez pas de modules émetteurs-récepteurs optiques pendant une mesure. Le non-respect de cette consigne peut entraîner une défaillance. Mettez l'instrument hors tension avant d'installer ou de retirer des modules émetteurs-récepteurs optiques.

To connect multiple WT1500s, the separately sold optical transceiver module 720941 and optical fiber cords are required. For the optical fiber cords, use the separately sold 720942 or multimode optical fiber cords (LC type).

Note

Be sure to use the separately sold optical transceiver module 720941. If an optical transceiver module other than 720941 is used, the functions and performance of this instrument are not covered by the warranty. In addition, failures caused by the use of an optical transceiver module other than 720941 are not covered.

17.1 Connecting Multiple Instruments

Installing optical transceiver modules in the main unit

Install the optical transceiver modules in optical ports 1 to 4 of the main unit, starting from port 1 and filling the ports in order.

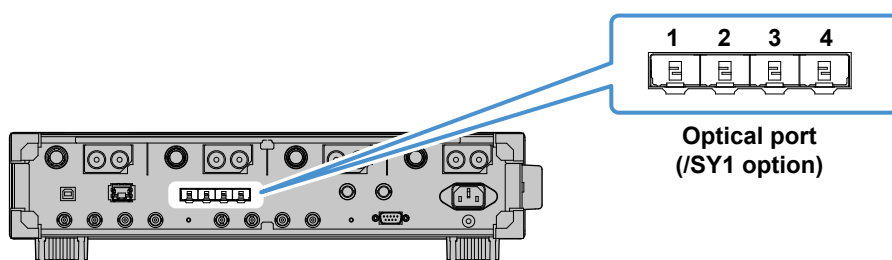
The subunits connected to optical ports 1 to 4 of the main unit are identified in multi-unit synchronization as Subunit 1 to Subunit 4.

Note

Do not install optical transceiver modules in unused optical ports. If optical transceiver modules are installed in unused ports, the multi-unit synchronization connection will not complete, and the standby state will continue.

Installing optical transceiver modules in each subunit

Install the optical transceiver module in optical port 1.



For details, see section 2.14 of the Getting Started Guide (IM WT1501-02EN).

Connecting optical fiber cords



WARNING

When the power is turned on with an optical transceiver module installed, light is emitted from the optical port. Do not disconnect the connected optical fiber cord. If the light enters your eyes, it may cause visual impairment and result in an accident.

French



AVERTISSEMENT

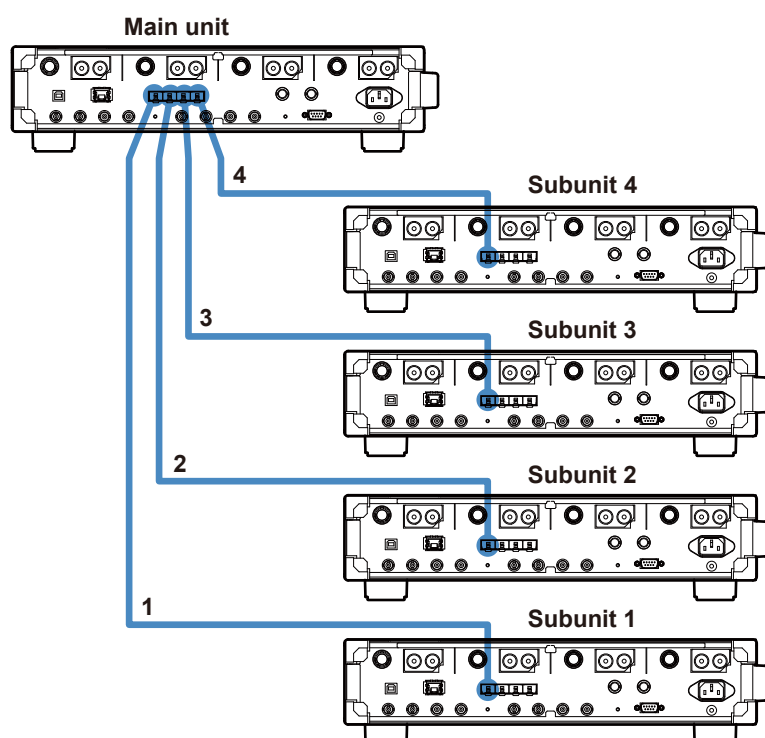
Lorsque l'appareil est mis sous tension avec un module émetteur-récepteur optique installé, de la lumière est émise par le port optique. Ne débranchez pas le cordon de fibre optique connecté. Si la lumière pénètre dans vos yeux, elle peut causer des troubles visuels et entraîner un accident.

Use the separately sold optical fiber cord 720942 to connect multiple WT1500s.

If you are preparing your own optical fiber cords, use multimode optical fiber cords (LC type).

Connect the main unit and subunits in a star configuration as shown below.

For details, see section 2.14 of the Getting Started Guide (IM WT1501-02EN).



Subunit numbers 1 to 4 are assigned from left to right according to the connector positions on the connected main unit.

17.2 Setting Up Multi-Unit Connection



CAUTION

For multi-unit synchronization, connect the main unit and all subunits to be synchronized using optical fiber cords before executing the connection command (Connect) in the multi-unit synchronization settings.

If optical transceiver modules or optical fiber cords are inserted or removed after the connection command (Connect) is executed, this instrument may malfunction.

French



ATTENTION

Pour la synchronisation multi-unités, connectez l'unité principale et toutes les sous-unités à synchroniser à l'aide de cordons de fibre optique avant d'exécuter la commande de connexion (Connect) dans les paramètres de synchronisation multi-unités.

Si des modules émetteurs-récepteurs optiques ou des cordons de fibre optique sont insérés ou retirés après l'exécution de la commande de connexion (Connect), cet instrument peut présenter un dysfonctionnement.

This section explains the following settings for connecting multiple WT1500s.

- Setting the main unit and subunits (setting the multi-unit synchronization mode)
- Connecting, canceling, and disconnecting
- Connection information (Information)
- Multi-unit synchronization LED
- Multi-unit synchronization information screen (LCD screen on the instrument)
- Connection procedure (LCD Screen on the Instrument)
- Connection errors

Procedure

Setup menu icon  > **Utility** > **Multi-Unit Sync** > set Mode to **Main/Sub/OFF** > **Connect/Disconnect/Cancel**

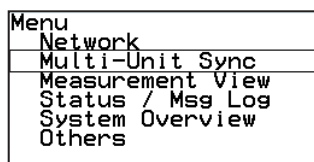


Note

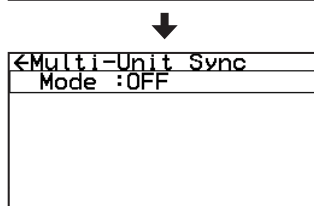
Setting on the WT1500 LCD

The main unit and subunit settings can also be configured on the WT1500 LCD using the operation keys as follows:

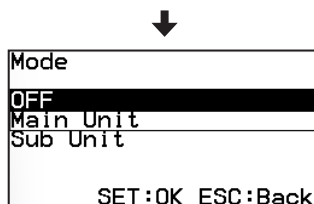
For details, see pages 17-13 and 17-14.



Use the ▲ and ▼ arrow keys to select **Multi-Unit Sync** on the Menu screen, and then press **SET**.



Use the ▲ and ▼ arrow keys to select Mode, and then press **SET**.



Use the ▲ and ▼ arrow keys to select OFF/Main Unit/Sub Unit, and then press **SET**.

17.2 Setting Up Multi-Unit Connection

<Multi-Unit Sync	
Mode	:Main Unit
Connect	
SyncStatus	:OFF
Sub1	:-----
Sub2	:-----
Sub3	:-----
Sub4	:-----



Connect	
Execute	
Cancel	
SET:OK ESC:Cancel	

Use the ▲ and ▼ arrow keys to select Connect, and then press **SET**.

Use the ▲ and ▼ arrow keys to select Execute/Cancel, and then press **SET**.

To return to the previous screen, press **ESC**.

Setting the main unit and subunits

Select the multi-unit synchronization role of each unit connected by optical fiber cord from the options below.

The default setting is OFF.

Multi-unit synchronization mode (Mode)

- Main Unit: Used as the main unit, and multi-unit synchronization mode is turned on.
- Sub Unit: Used as a subunit, and multi-unit synchronization mode is turned on.
- OFF: Multi-unit synchronization mode is turned off, and the unit operates independently.

Indications for multi-unit synchronization mode

The status of this instrument during multi-unit synchronization is shown in the icon display area at the upper right of the screen.



When this instrument is the main unit



Connection processing
in progress



Multi-unit synchronization
in progress



When this instrument is the subunit

Note

- In optical fiber cord connections, only a star configuration centered on the main unit is supported. Multi-unit synchronization cannot be performed if subunits are connected to one another.
- Set the multi-unit synchronization mode (Mode) appropriately for each WT1500 connected in the star configuration.
Only one unit, the main unit connected to each subunit, can be set to Main Unit.
Set the multi-unit synchronization mode of all subunits connected to the main unit to Sub Unit.
- Multi-unit synchronization cannot be performed if even one connected WT1500 has its multi-unit synchronization mode set to OFF.
- Connections in multi-unit synchronization mode are subject to version-based restrictions for each connected WT1500.

Connecting, canceling, and disconnecting

Connect

Starts connection between the main unit and subunits for multi-unit synchronization.

- When you select Connect in the menu on the main unit and all subunits, connection processing between the main unit and each subunit starts.
Connect in the menu changes to Cancel.
When connection processing is complete, Cancel changes to Disconnect.
- The Synchronous Status (Synchronized operation status) indication changes as follows:
Connection processing in progress: Standby
Connection processing complete: Operating

Cancel (Cancel)

If you select Cancel in the menu on the main unit or a subunit while connection processing is in progress, the connection processing is interrupted.

- Synchronous Status (Synchronized operation status): Changes to OFF when the connection is terminated.

Disconnect (Disconnect)

If you select Disconnect in the menu on the main unit or a subunit during multi-unit synchronization, the connections to all units are disconnected, and multi-unit synchronization turns OFF.

- If communication with a subunit is lost, the main unit returns the multi-unit synchronization status of all units to standby and attempts to reconnect to all units.
- Synchronous Status (Synchronized operation status): Changes to OFF when the connection is terminated.

Note

- For multi-unit synchronization, connect the main unit and all subunits to be synchronized using optical fiber cords, and then execute the connection command (Connect) in the multi-unit synchronization settings. If optical transceiver modules or optical fiber cords are inserted or removed after the connection command (Connect) is executed, this instrument may malfunction.
- If the main unit and all subunits are turned off while multi-unit synchronization mode is configured properly, the multi-unit synchronization connection process is performed automatically the next time the units are started.
However, if the configuration of the connected subunits differs from the previous configuration, or if any subunit does not have multi-unit synchronization mode configured properly, the settings are initialized after the multi-unit synchronization connection process is complete.
- The history function data is reset when multi-unit synchronization is connected or disconnected.
- If a power supply or connection error occurs during measurement with multi-unit synchronization, all WT1500s participating in the synchronized operation enter standby mode, and settings can no longer be changed and measurement can no longer be started. To resume multi-unit synchronization, execute Cancel on each WT1500, clear the abnormal condition, and then execute Connect again.
- As a result of the multi-unit synchronization connection process, the subunit settings for items common to all units are changed to match the settings of the main unit.
- To connect units for multi-unit synchronization, all connected units must have the same firmware version. Update the firmware version of the units as necessary.

17.2 Setting Up Multi-Unit Connection

- If any subunit has its multi-unit synchronization mode set to OFF, the multi-unit synchronization connection process does not complete, and the units remain in standby.
 - To exit standby, execute Cancel on each unit to stop the multi-unit synchronization connection process.
 - While the units are in standby during multi-unit synchronization, no operation other than Cancel can be performed on any unit.
 - Measurement cannot be performed while the units are in standby during multi-unit synchronization.
 - When the data update interval is 10 ms, multi-unit synchronization cannot be performed. An error message is displayed.
 - During multi-unit synchronization, the data update interval cannot be changed to 10 ms. An error message is displayed.
-

Connection information (Information)

Displays information about multi-unit synchronization connections on the screen.

Synchronous status (Synchronous Status)

Lets you check whether the main unit and all subunits are connected for multi-unit synchronization and whether synchronized measurement can be performed.

- OFF: Multi-unit synchronization OFF
- Standby: Standby state while waiting for connection processing
- Operating: Multi-unit synchronization in progress (all subunits are connected and measurement can be performed)

Unit connection state (Unit Connection State)

Displays the connection status between the main unit and subunits for multi-unit synchronization.

Main unit

Displays the connection status with each subunit, 1 to 4 (Sub1 to Sub4).

Display	Description
None(---)	No connection status when multi-unit synchronization is OFF
Not Used	Unused subunit (no optical transceiver module installed in the optical port)
Connecting	Connection processing with the subunit is in progress
OK	Connection complete
Error	Error

Subunit

Displays the connection status with the main unit.

Display	Description
None(---)	No connection status when multi-unit synchronization is OFF
Not Used	Unused subunit (no optical transceiver module installed in the optical port)
Connecting	Connection processing with the main unit is in progress
OK	Connection complete
Error	Error

Instrument information

Lets you check the following instrument information for the main unit and subunits.

- Model
- Suffix
- Serial number
- Firmware version

Note

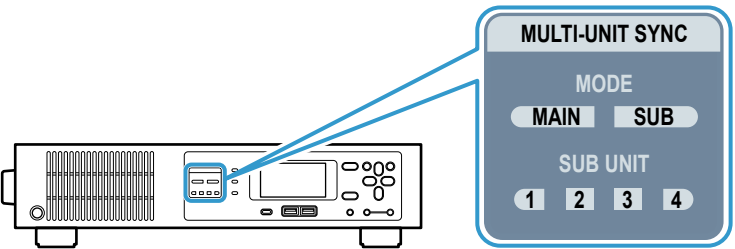
In addition to the multi-unit synchronization information screen displayed on the external monitor above, multi-unit synchronization connection information can also be checked on the multi-unit synchronization LED on the instrument and on the multi-unit synchronization information screen on the LCD screen of the instrument. The synchronous status and unit connection state for multi-unit synchronization can also be output using communication commands.

Multi-unit synchronization LED

Lets you quickly check the identification of the main unit and subunits and their connection status for multi-unit synchronization.

Displays the following information:

- Multi-unit synchronization mode: Main Unit, Sub Unit, or OFF
- For the main unit: Numbers of connected subunits
- For a subunit: the subunit number assigned to this instrument
- Connection status is indicated by color: multi-unit synchronization in progress, connection processing in progress (standby), or connection error



MODE (MAIN/SUB) LED

Displays whether the unit is set as the main unit or a subunit.

The indicator lights as follows according to the multi-unit synchronization mode setting.

Multi-unit synchronization mode	MAIN/SUB LED		
	Status	MAIN	SUB
OFF		Off	Off
Main Unit		On (green)	Off
Sub Unit		Off	On (green)

It blinks when the synchronous status (Synchronous Status) is Standby.

SUB UNIT LED

- When the multi-unit synchronization mode is Main Unit, it displays the connection status with the subunits.
- When the multi-unit synchronization mode is Sub Unit, it displays the subunit number assigned to this instrument and the connection status with the main unit.

Display example	Indicator color and state		Status
		— Off	Not used or OFF
		Green Lit	Connection normal
		Green Blinking	Connection processing in progress
		Red Blinking	Error (check the optical transceiver module)

Multi-unit synchronization information screen (LCD screen on the instrument)

This section describes the settings and displayed information shown on the multi-unit synchronization information screen on the LCD screen of the instrument when setting the multi-unit synchronization mode and performing connection operations.

Display examples on the LCD screen of the instrument

• Main unit screen

←Multi-unit Sync
Mode : Main Unit
⌂Disconnect
SyncStatus : Operating
Sub1 : TEMP0001
Sub2 : TEMP0002
Sub3 : TEMP0003
Sub4 : Not Used

• Subunit screen

←Multi-unit Sync
Mode : Sub Unit
⌂Disconnect Sub1
SyncStatus : Operating
Main : TEMP0000

From the second line onward, the screen displays the following items in order.

Item	Description	See
Multi-unit synchronization mode setting (Mode)	OFF, Main Unit, Sub Unit	See page 17-8.
Connection, cancellation, and disconnection for multi-unit synchronization	Connect, Cancel, Disconnect	See page 17-9.
Synchronous status (Sync Status)	OFF, Standby, Operating	See page 17-11.
Unit connection state	- Main or Sub1 to Sub4 (subunit number) - Not Used, OFF, Connecting, serial number of the connected unit (OK)	See page 17-11.

Connection procedure (LCD Screen on the Instrument)

This section explains the connection procedure for multi-unit synchronization, the instrument LCD screen, and the multi-unit synchronization LED, using a four-unit multi-unit connection (three subunits connected to the main unit) as an example.

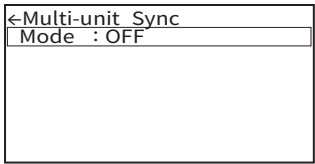
Initial state of this instrument

1. If the instrument is started with the default settings, opening the multi-unit synchronization menu results in the following states.

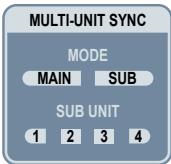
- **Main unit**

Multi-unit synchronization mode setting: **OFF**

LCD



Multi-unit synchronization LED



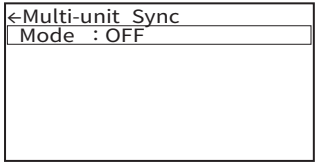
MODE: Off
SUB UNIT: Off

Status	Measurement update: Updating
Operation on the instrument	Possible
Synchronized operation status	OFF
Unit connection state	OFF

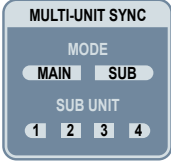
- **Subunit**

Multi-unit synchronization mode setting: **OFF**

LCD



Multi-unit synchronization LED



MODE: Off
SUB UNIT: Off

Status	Measurement update: Updating
Operation on the instrument	Possible
Synchronized operation status	OFF
Unit connection state	OFF

Setting the multi-unit synchronization mode on the main unit and subunits

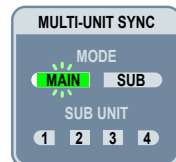
2. First, set the multi-unit synchronization mode. Set the main unit to Main Unit and the three subunits to Sub Unit.

- **Main unit**

Multi-unit synchronization mode setting: **Main Unit**

LCD

←Multi-unit_Sync
Mode : Main Unit
⌂Connect
SyncStatus : OFF
Sub1 : - - -
Sub2 : - - -
Sub3 : - - -
Sub4 : Not Used

Multi-unit synchronization LED

MODE: MAIN blinking (green)

SUB UNIT: Off

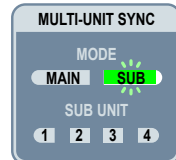
Status	Measurement update: Updating
Operation on the instrument	Possible
Synchronized operation status	OFF
Unit connection state	OFF

- **Subunit**

Multi-unit synchronization mode setting: **Sub Unit**

LCD

←Multi-unit_Sync
Mode : Sub Unit
⌂Connect
SyncStatus : OFF
Main : - - -

Multi-unit synchronization LED

MODE: SUB blinking (green)

SUB UNIT: Off

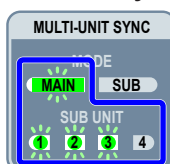
Status	Measurement update: Updating
Operation on the instrument	Possible
Synchronized operation status	OFF
Unit connection state	OFF

Executing connection (Connect) for multi-unit synchronization on the main unit

3. On the main unit's multi-unit synchronization screen, execute the connection command (Connect) to start the optical transceiver modules.
 - To connect to the other units, the synchronous status changes to the standby state while waiting for connection processing (Standby).
 - The MODE MAIN LED on the main unit blinks, and the synchronous status displays the standby state while waiting for connection processing (Standby).
 - At the same time, the SUB UNIT LEDs for the subunit numbers corresponding to the ports where optical transceiver modules are installed blink green, and the unit connection state displays connection processing in progress (Connecting).
 - The SUB UNIT LEDs for the subunit numbers corresponding to ports where no optical transceiver module is installed are off.
 - The main unit starts detecting subunits in the standby state while waiting for connection processing (Standby) and repeats the detection until connection to all subunits is complete.

• **Main unit**Multi-unit synchronization mode setting: **Main Unit****LCD**

←Multi-unit Sync
Mode : Main Unit
Cancel
SyncStatus : Standby
Sub1 : Connecting
Sub2 : Connecting
Sub3 : Connecting
Sub4 : Not Used

Multi-unit synchronization LED

MODE: MAIN blinking (green)

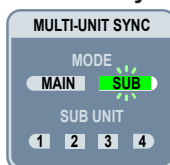
SUB UNIT: 1, 2, 3 blinking (green)

Status

Operation on the instrument	Cancel only*
Synchronized operation status	Standby
Unit connection state	Connecting

* To interrupt the process here, execute **Cancel**. The synchronous status returns to OFF, as in step 2.• **Subunit**Multi-unit synchronization mode setting: **Sub Unit****LCD**

—

Multi-unit synchronization LED

MODE: SUB blinking (green)

SUB UNIT: Off

Status

Operation on the instrument	Possible
Synchronized operation status	OFF
Unit connection state	OFF

Executing the connection command (Connect) for multi-unit synchronization on a subunit

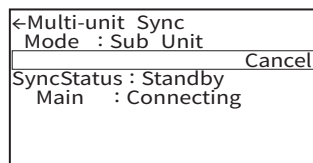
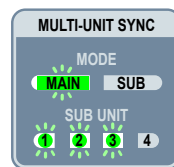
4. On the subunit's multi-unit synchronization screen, execute **Connect** to start the optical transceiver modules.
- The synchronous status changes to the standby state while waiting for connection processing (Standby).
 - The MODE SUB LED on the subunit blinks, and the synchronous status displays the standby state while waiting for connection processing (Standby).

At the same time, the SUB UNIT LEDs for all subunit numbers blink green, and the unit connection state displays the standby state while waiting for connection processing (Standby).

(The subunit number is assigned by the main unit, but because it is not yet known at this point, all SUB UNIT LEDs blink.) The subunit continues waiting for a connection request from the main unit.

- Main unit**

Multi-unit synchronization mode setting: **Main Unit**

LCD**Multi-unit synchronization LED**

MODE: MAIN blinking (green)

SUB UNIT: 1, 2, 3 blinking (green)

Status

Operation on the instrument	Cancel only*
Synchronized operation status	Standby
Unit connection state	Connecting

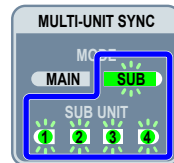
* To interrupt the process here, execute **Cancel**. The synchronous status returns to OFF, as in step 2.

- Subunit**

Multi-unit synchronization mode setting: **Sub Unit**

LCD

—

Multi-unit synchronization LED

MODE: SUB blinking (green)

SUB UNIT: 1, 2, 3, 4 blinking (green)

Status

Operation on the instrument	Cancel only*
Synchronized operation status	OFF
Unit connection state	OFF

* To interrupt the process here, execute **Cancel**. The synchronous status returns to OFF, as in step 2.

Connection between the main unit and subunits

The subunit receives a connection request from the main unit and starts the multi-unit synchronization connection process.

- The main unit exchanges instrument information, measures and compensates for the delay time between units, assigns a subunit number, and sends the common measurement conditions to the subunit.
- The main unit receives unit-specific measurement conditions, such as the range settings of the subunit, from the subunit.
- When the connection process between units is complete, the unit connection state of the subunit changes to OK, and the SUB UNIT LED for its own subunit number lights green. The synchronous status remains the standby state while waiting for connection processing (Standby), and the unit waits until connection between the main unit and all subunits is complete.
- On the main unit, only the SUB UNIT LEDs for subunit numbers whose unit connection state is OK light green. The main unit continues detecting subunits whose unit connection state is still Connecting.

Example: When the connection command (Connect) is executed on SUB1 Unit

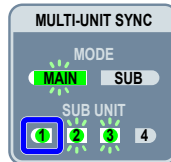
• **Main unit**

Multi-unit synchronization mode setting: **Main Unit**

LCD

←Multi-unit Sync
Mode : Main Unit
Cancel
SyncStatus : Standby
Sub1 : TEMP0001
Sub2 : Connecting
Sub3 : Connecting
Sub4 : Not Used

Multi-unit synchronization LED



MODE: MAIN blinking (green)

SUB UNIT: 1 lit (green), 2 and 3 blinking (green)

Status

Operation on the instrument Cancel only*

Synchronized operation status Standby

Unit connection state SUB1: OK
Others: Connecting

* To interrupt the process here, execute **Cancel**. The synchronous status returns to OFF, as in step 2.

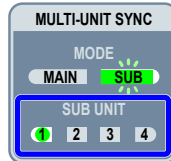
• **Subunit**

Multi-unit synchronization mode setting: **Sub Unit**

LCD

←Multi-unit Sync
Mode : Sub Unit
Cancel
SyncStatus : Standby
Main : TEMP0000

Multi-unit synchronization LED



MODE: SUB blinking (green)

SUB UNIT: 1 lit (green)

Status

Operation on the instrument Cancel only*

Synchronized operation status Standby

Unit connection state OK

* To interrupt the process here, execute **Cancel**. The synchronous status returns to OFF, as in step 2.

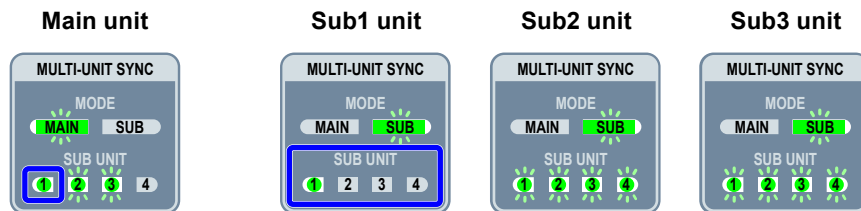
5. As in step 4, execute the connection command (**Connect**) on all subunits to connect them to the main unit.

As each connection is established, the unit connection state changes to OK, and the SUB UNIT LED changes to lit green.

Example: When the connection command (Connect) is executed on the subunits in the order Sub1, Sub3, and Sub2

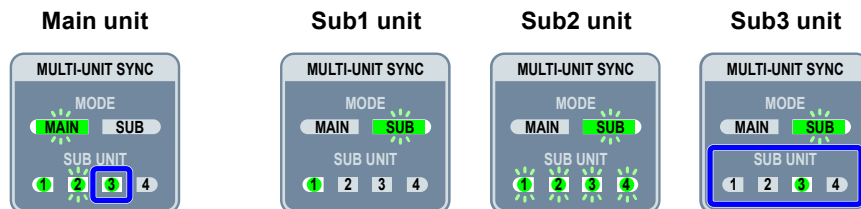
- 5-1. Execute the connection command (Connect) on Sub1 Unit.

SUB UNIT LED for Sub1: Blinking (green) → lit (green)



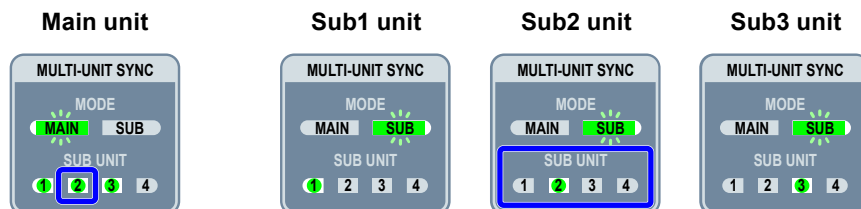
- 5-2. Execute the connection command (Connect) on Sub3 Unit.

SUB UNIT LED for Sub3: Blinking (green) → lit (green)



- 5-3. Execute the connection command (Connect) on Sub2 Unit.

SUB UNIT LED for Sub2: Blinking (green) → lit (green)



Status of each unit during multi-unit synchronization

Status/Unit	Main unit	Subunit
Synchronized operation status	Standby	Standby
Unit connection state	SUB1, 2, 3: OK	OK

Setting the multi-unit synchronization mode on all units

6. After the connection between the main unit and all subunits is complete, the system settings of all units are set for multi-unit synchronization mode. (See page 17-8.)

The time settings between the main unit and subunits are synchronized, the menus for multi-unit synchronization are rebuilt, and the synchronous status changes to Operating (multi-unit synchronization in progress).

Measurement can then be resumed in synchronized measurement.

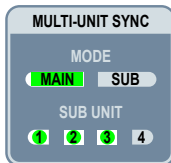
• Main unit

Multi-unit synchronization mode setting: **Main Unit**

LCD

←Multi-unit Sync
Mode : Main Unit
⌂Disconnect
SyncStatus : Operating
Sub1 : TEMP0001
Sub2 : TEMP0002
Sub3 : TEMP0003
Sub4 : Not Used

Multi-unit synchronization LED



MODE: MAIN lit (green)

SUB UNIT: 1, 2, 3 lit (green)

Status

Operation on the instrument Disconnect only*

Synchronized operation status Operating

Unit connection state SUB1, 2, 3: OK

* To interrupt the process here, execute the disconnection command (**Disconnect**). The synchronous status returns to OFF, as in step 2.

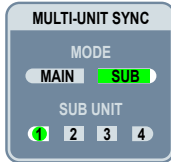
• Subunit

Multi-unit synchronization mode setting: **Sub Unit**

LCD

←Multi-unit Sync
Mode : Sub Unit
⌂Disconnect Sub1
SyncStatus : Operating
Main : TEMP0000

Multi-unit synchronization LED



MODE: SUB lit (green)

SUB UNIT: 1 lit (green)

Status

Operation on the instrument Disconnect only*

Synchronized operation status Operating

Unit connection state OK

* To interrupt the process here, execute the disconnection command (**Disconnect**). The synchronous status returns to OFF, as in step 2.

Note

To end Operating (multi-unit synchronization in progress), execute the disconnection command (Disconnect) on the multi-unit synchronization screen.

On the unit where Disconnect is executed, the optical transceiver modules turn off, the system settings return to normal mode, the normal menus are rebuilt, and the synchronous status changes to OFF, as in step 2.

On the other units whose multi-unit synchronization communication connection is disconnected, the synchronous status changes to Standby (standby while waiting for connection processing), and they wait for the disconnected unit to reconnect.

Connection errors

There are two main types of errors reported during multi-unit synchronization.

- Connection errors related to optical transceiver modules
- Connection errors caused by differences in firmware versions among connected units

Errors are detected at the following times.

- When the multi-unit synchronization mode is changed
- When connection or disconnection is executed for multi-unit synchronization
- During multi-unit synchronization connection processing

Note

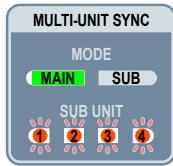
Insert and remove optical transceiver modules only when the power to the instrument is OFF.

Error number	Description	Action
Error 898	The firmware versions of the main unit and subunit differ.	Set the multi-unit synchronization mode to OFF, update the firmware, and make the versions the same.
Error 897	Optical transceiver module abnormality (light-emitting section)	• Replace the module.
Error 899	Optical transceiver modules are not installed in any of the ports on the main unit.	• Install or reinsert the required number of modules. • Replace the module.
Error 899	Optical transceiver modules are not installed in some ports on the main unit, leaving gaps.	• Install or reinsert the module in the port corresponding to the subunit number. • Replace the module.
Error 899	An optical transceiver module is not installed in port 1 of the subunit.	• Install or reinsert the module in port 1. Replace the module. • Replace the module.
Error 899	Optical transceiver modules are installed in ports 2 to 4 of the subunit, which cannot be used.	• Remove the modules from ports 2 to 4.
Error 817	Hot plug. The optical transceiver module installation configuration has changed since startup.	• Turn off the power to the instrument, install the required number of modules, and then turn the power back on. • Replace the module.

If the error continues to occur after performing the above actions, the optical port on the instrument may be faulty. Contact your nearest YOKOGAWA dealer for servicing.

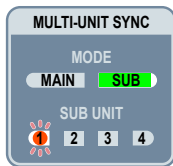
17.2 Setting Up Multi-Unit Connection

Examples of connection errors on the main unit



Subunit LED	LCD screen on the instrument Multi-Unit Sync screen	Status
1) Corresponding Sub1 to Sub4 LED blinking (red)	←Multi-unit Sync Mode : Main Unit ⌂Connect SyncStatus : OFF Sub1 : Diff Version Sub2 : ModuleFailure Sub3 : MissingModule Sub4 : Config Change	#1 Firmware version mismatch @Sub1 #2 Optical transceiver module abnormality @Sub2 #4 Optical transceiver module not installed @Sub3 #7 Optical transceiver module configuration change @Sub4
2) All Sub1 to Sub4 LEDs blinking (red)	←Multi-unit Sync Mode : Main Unit ⌂Connect SyncStatus : OFF Sub1 : MissingModule Sub2 : MissingModule Sub3 : MissingModule Sub4 : MissingModule	#3 No optical transceiver modules installed in any port

Examples of connection errors on the subunit



Subunit LED	LCD screen on the instrument Multi-Unit Sync screen	Status
Sub1 LED blinking (red)	←Multi-unit Sync Mode : Sub Unit ⌂Connect SyncStatus : OFF Main : Error Diff Version	#1 Firmware version mismatch
	←Multi-unit Sync Mode : Sub Unit ⌂Connect SyncStatus : OFF Main : Error ModuleFailure Port1	#2 Optical transceiver module abnormality @Port1
	←Multi-unit Sync Mode : Main Unit ⌂Connect SyncStatus : OFF Main : Error MissingModule Port1	#5 Optical transceiver module not installed @Port1

17.3 Setting Measurement Conditions and Performing Measurements

Setting measurement conditions

Use the main unit to configure settings and perform operations.

During measurement using multi-unit synchronization, the LCD screens on the main unit and subunits are not used. Settings and control are performed using communication commands from the main unit or from the menu on the external monitor display.

During multi-unit synchronization, settings on the subunits are restricted.

For details on restrictions, see the next page.

There are three types of settings.

Unit-specific settings

Example: Input range

For unit-specific settings, specify the unit first.

Settings common to all units

Example: Update interval

For settings common to all units, the main unit settings are also applied to all connected subunits.

For measurement conditions that are not configured on a per-unit basis, the settings of all units are linked as settings common to all units

Settings that apply only to the main unit

Examples: Efficiency computation, user-defined computation, user-defined events, output settings (screen display, store, files, CAN data, and so on), and communication and menu language settings

These settings are not applied to the subunits.

Restrictions

Connection restrictions

The restrictions on connections for multi-unit synchronization are as follows:

- When installing optical transceiver modules on the main unit, install them in order starting from port 1. If you skip port numbers, an error occurs when connecting for multi-unit synchronization.
- When installing an optical transceiver module on a subunit, install it in port 1.

Functional restrictions

The functional restrictions in multi-unit synchronization mode are as follows:

Functional restrictions common to the main unit and subunits

During multi-unit synchronization operation (or while the synchronous status is Standby), the following settings and operations are restricted.

- Maximum harmonic analysis order: Up to the 50th harmonic
- The Date/Time setting cannot be changed.
- Moving average is not supported for the averaging function. The setting is fixed to exponential averaging and cannot be changed.
- Synchronous measurement (Sync Measure) is disabled.
- The independent integration function is not supported. The setting is fixed to OFF and cannot be changed.
- The integration resume action function is not supported. The setting is fixed to Error and cannot be changed.
- Self-test cannot be executed.
- Firmware upgrades and option license additions cannot be executed.

Functional restrictions on the main unit

The following subunit settings cannot be set or operated from the main unit.

- Screen display format settings such as Numeric and Graph
- Storage settings
Settings such as storage mode, stored items, stored data file as well as storage Rec/Pause/End
- Settings related to data saving
- File list operations
- Settings related to setup files
- Secondary operation settings for efficiency computations, user-defined computations, and user-defined events
- CAN data output settings
- System configuration settings
Settings such as date and time, language, LCD screen, and USB keyboard
- Remote control settings
Settings such as USB (USB-TMC)
- Network settings
Settings such as TCP/IP, FTP/Web Server, Net Drive, SNTP, and WLAN
- Message log operations

Functional restrictions on subunits

- Communication commands are generally unavailable.
- During multi-unit synchronization, a dedicated screen is displayed, and the USB keyboard, touch panel, and web browser are disabled.
- The Key Control to Monitor key is fixed to OFF (cannot be changed).
- The HOLD key cannot be operated (measurement hold can be controlled only from the main unit).

Saving Data

During multi-unit synchronization, files cannot be saved to subunits.

Numeric data

On the main unit, you can save CSV files of the subunits' power numeric data.

A file containing data from the main unit and subunits is saved only on the main unit.

After specifying the unit, set the numeric data items and Element/ Σ , and then select the numeric data items to save for each unit.

See sections 13.1 and 13.6.

Waveform data

On the main unit, you can save CSV files of the subunits' waveform data.

See sections 13.3 and 13.6.

All input waveforms for all units are saved.

A file containing data from the main unit and subunits is saved only on the main unit.

Setup data

On the main unit, you can save the setup data for the main unit and each subunit in a single setup file.

The file is saved to the main unit's setup file save destination.

Setup data can also be restored (loaded) from the main unit.

If WT1500s are connected in the same configuration as when the setup data was saved, loading the setup data lets you perform measurements under the same conditions.

If the connection configuration differs from that in the setup data, the setup data cannot be loaded.

Saving and restoring setup files from the LCD screen on the instrument

You can also save and restore setup files in a simplified manner from the LCD screen.

Except for the following points, the contents are the same as those of a normal setup file.

Differences from a normal setup file

- Select the simple setup file name from Setup1 to Setup4.
- Select the save destination from either the root directory of the internal memory, "user," or the root directory of "usb1."

Note

If you save a setup file during multi-unit synchronization, measurement is temporarily paused.

Screen image data

You can save screen images of the main unit.

See sections 13.5 and 13.6.

Screen image data for subunits cannot be saved.

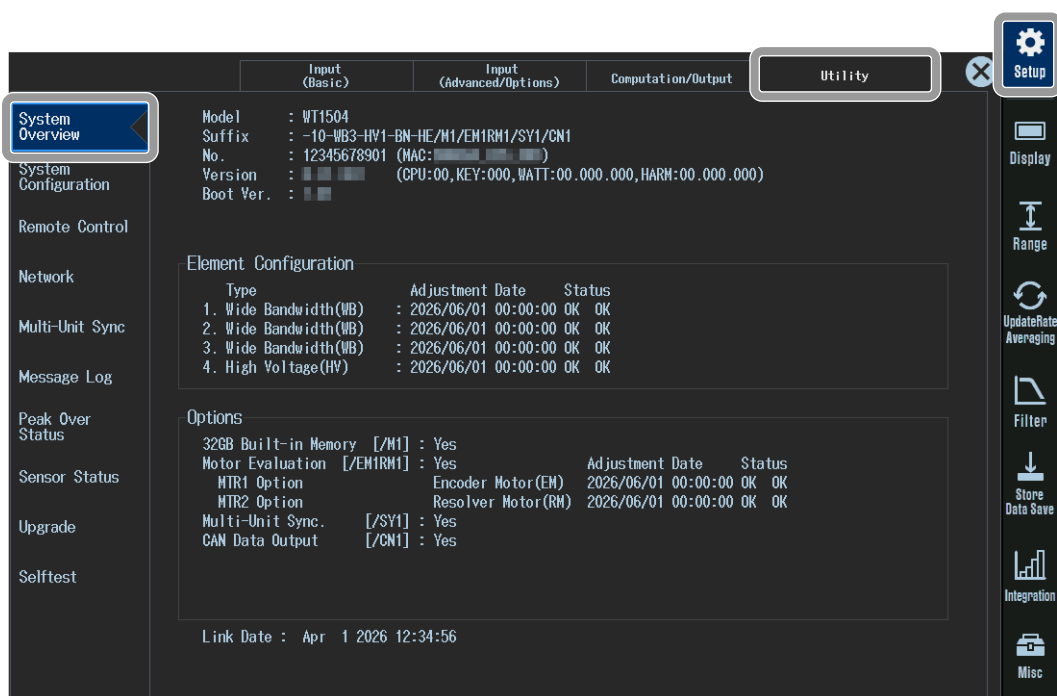
18.1 Viewing Instrument Information and Performing Upgrades

- You can view the system information and setup information for this instrument.
- You can upgrade the firmware of this instrument and add options.

Procedure

Setup menu icon  > Utility

- Viewing the instrument information (System Overview)
> System Overview

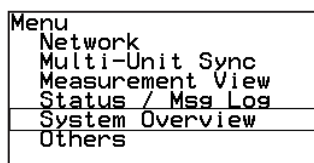


Note

- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing MENU on the front panel.
 - The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.

Viewing Instrument Information on the LCD Screen of the WT1500

You can also view instrument information on the LCD screen of the WT1500 using the operation keys.



Use the ▲ and ▼ arrow keys to select **System Overview** on the Menu screen, and then press **SET**.

18.1 Viewing Instrument Information and Performing Upgrades

```
←System Overview
Model:WT1504
Suffix:
-10-WB3-HV1-BN-HE
/M1/EM1RM1/SY1/CN1
Serial No:12345678901
MAC:00:00:77:77:77:77
      ▲ 1/2 ▼
```

The first page of the instrument information appears.

Use the ▲ and ▼ arrow keys to switch pages.

To return to the previous screen, press **ESC**.

Upgrade (Upgrade)

This section explains how to add an option license. For firmware upgrades, see the next page.

Perform this operation on the WT1500 LCD screen.

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

Use the ▲ and ▼ arrow keys to select **Others** on the Menu screen, and then press **SET**.



```
←Others
Upgrade
LCD Settings
Date/Time
Self Test
Initialize Settings
```

Use the ▲ and ▼ arrow keys to select **Upgrade**, and press **SET**.



```
←Upgrade
Firmware Version Up
Enter License Key
```

- Adding an option license

Use the ▲ and ▼ arrow keys to select **Enter License Key**, and press **SET**.



```
Enter License Key

A
▲▼:Select Letter
◀▶:Move Focus
SET:Enter
```

- Entering the license key

Use the ◀ and ▶ arrow keys to select one character to enter.

Number of characters: 9

Use the ▲ and ▼ arrow keys to select a character.

- Press ▲ to select characters in the following order: 9 to 0→z to a→Z to A→9 to 0

- Press ▼ to select characters in the following order: A to Z→0 to 9→a to z→A to Z

Press **SET** to confirm the displayed license key and return to the previous screen.

Viewing the instrument information (System Overview)

Item	Meaning
Model	Model
Suffix	Suffix code
No.	Instrument number, MAC address
Version	Firmware version
Boot Ver.	Boot program version
Element Configuration	Input element type
Options	Options
Link Date	Firmware creation date and time
Product ID	Unique number assigned to each instrument (required when adding paid options)

Upgrade (Upgrade)

Perform this operation on the Instrument's LCD screen. For the operating procedure, see the instructions included when upgrading the firmware or adding options.

Firmware upgrade (Firmware)

You can upgrade the firmware.

Access the firmware download page from our website (<https://tmi.yokogawa.com/library/>) and download the firmware. For the firmware upgrade procedure, see the instructions included with the downloaded file.

Option license (Option License)

By entering an option license key, you can add or remove options on this instrument. To order an option license, contact your nearest YOKOGAWA dealer.

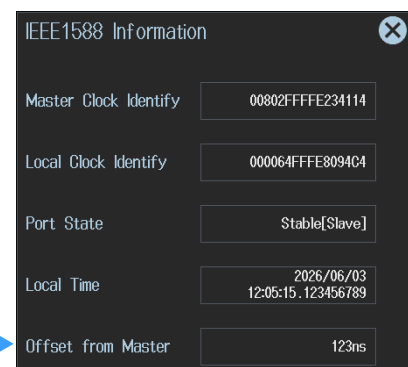
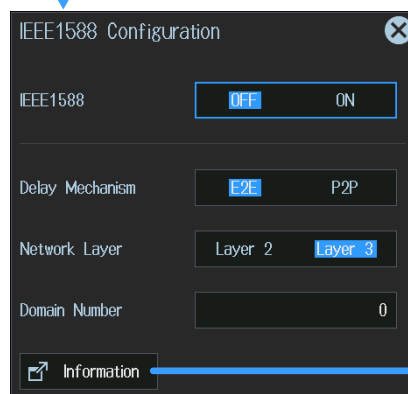
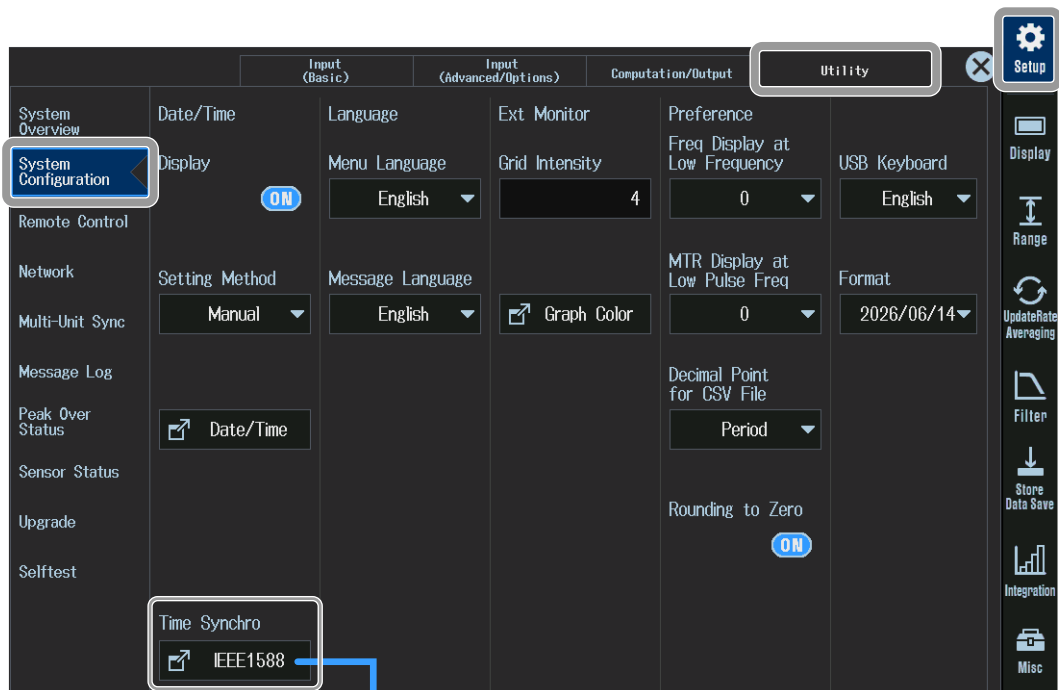
18.2 Setting IEEE 1588 Time Synchronization

You can set IEEE 1588 time synchronization.

IEEE 1588 is a standard for highly accurate time synchronization on a local area network (LAN). This instrument operates as an IEEE 1588 slave and can synchronize its time by receiving PTP (Precision Time Protocol) packets from the master.

Procedure

Setup menu icon  > **Utility** > **System Configuration** > Date/Time > Time Synchronization > **IEEE1588** > **Information**



Note

Procedures using front-panel keys

See section 1.2 of the Getting Started Guide (IM WT1501-02EN).

- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
- For operations using keys other than SET (see section 18.1)

Setting IEEE 1588 Time Synchronization

The IEEE 1588 setting screen appears.

Turning the IEEE 1588 time synchronization function (IEEE 1588) on and off

Sets whether to enable (ON) or disable (OFF) time synchronization using IEEE 1588 PTP packets.

Before turning on the IEEE 1588 time synchronization function, set the following items: Delay Mechanism, Network Layer, and Domain Number.

For the packet format and protocol, see the IEEE 1588 standard specifications.

Delay mechanism (Delay Mechanism)

Select the time difference calculation method from E2E (End-to-End) or P2P (Peer-to-Peer).

We recommend E2E because the deviation from the master is relatively small.

Network layer (Network Layer)

Set the type of packet to receive to Layer2 (Ethernet) or Layer3 (UDP/IPv4).

Domain number (Domain Number)

Sets the domain number of the device to be synchronized.

Setting range: 0 to 127

Information (Information)

Displays information related to IEEE 1588 time synchronization.

- **Master Clock Identity**

Displays the master clock ID (64-bit identifier).

Display format: 16 characters (hexadecimal)

- **Local Clock Identity**

Displays the local clock ID (64-bit identifier).

Display format: 16 characters (hexadecimal)

- **Port State**

Displays the port state [state defined in IEEE 1588-2008].

Off	The IEEE 1588 time synchronization function is OFF
Unlock	Communication with the master is not established
Lock	Communication with the master is established, and time is being adjusted
Stable	Time synchronization with the master is established
Unstable	After time synchronization with the master is established, the state has returned to time adjustment (Lock) one or more times
SyncErr	Time synchronization with the master has failed
Initializing	State defined in IEEE 1588-2008
Faulty	
Disabled	
Listening	
Uncalibrated	
Slave	

- **Local Time**
Displays the local time.
- **Offset from Master**
Displays the offset from the master.

Time synchronization states

The time synchronization function has the following four states.

	Unlock	Time is not synchronized.
	Lock	A time synchronization signal is being received normally. After the state changes to Lock, it changes to Stable in a few minutes.
	Stable	Time is synchronized within 10 μ s.
	Unstable	Time synchronization was once established, but then synchronization was lost.

Note

Start measurements that require high time accuracy only after the time synchronization state becomes Stable. If synchronization is lost even once, the state changes to Unstable, but this is not abnormal. If Port State in IEEE 1588 Information is Unstable [Slave], time synchronization is still established. To clear the Unstable state, turn IEEE 1588 time synchronization OFF once, and then turn it on again.

Note

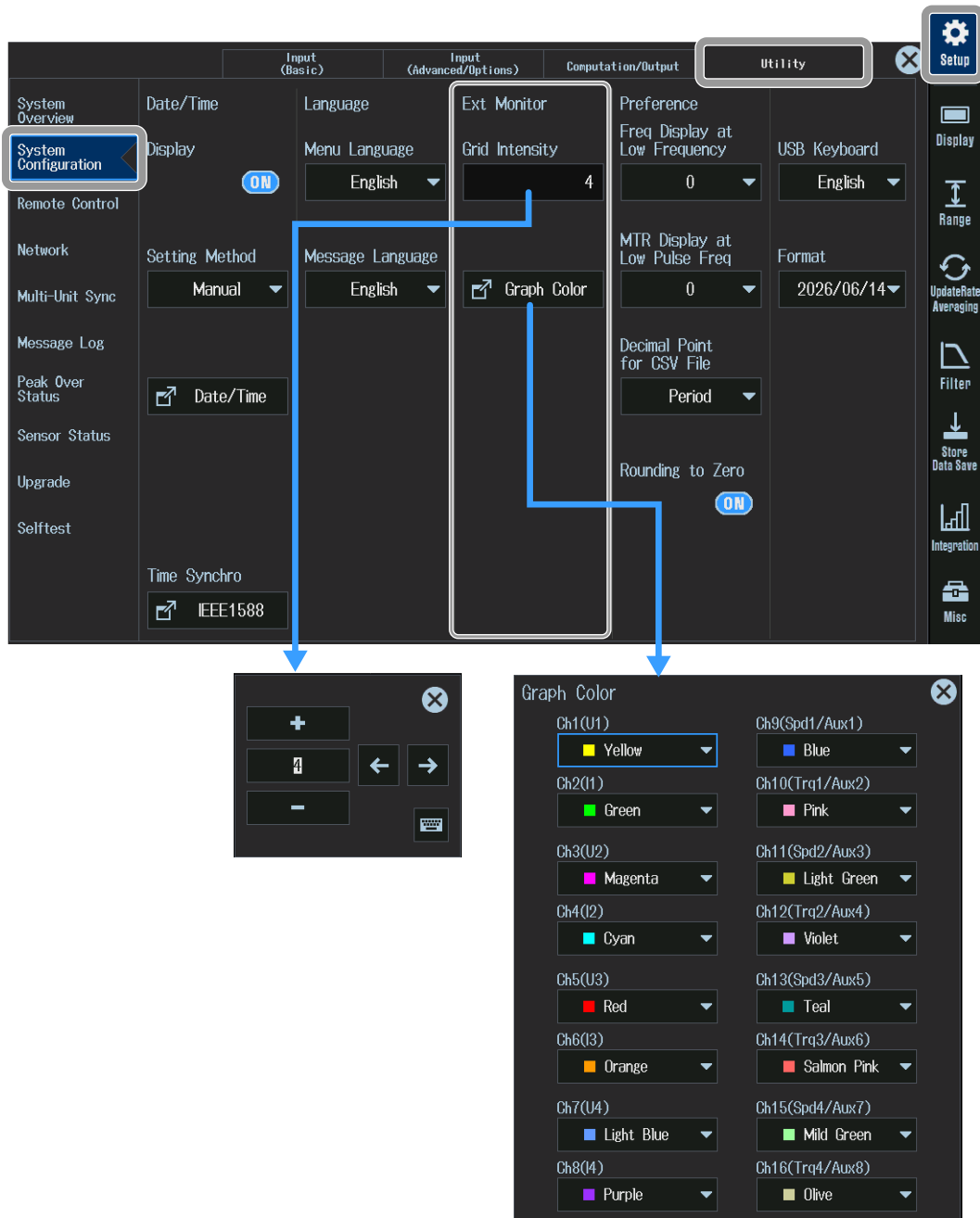
- The time displayed in Offset from Master is approximate because it is based on a value calculated from the packet timestamps.
- Start measurement only after time synchronization with the master becomes Stable.
- Once the state becomes Stable, the date and time are not synchronized during measurement.
- If you perform the following setting operations in the Stable or Unstable state, time synchronization with the master is performed again.
 - Measurement mode (Measurement Mode)
 - Computation method (Measurement Method)
 - Initialize settings (Initialize Settings)
 - Loading a setup (Load Setup)
- To reset the Stable, Unstable, or SY1cErr state, turn the IEEE 1588 time synchronization function off once, and then turn it on again.
- When the IEEE 1588 time synchronization function is on, the following operation cannot be performed until the state becomes Stable or Unstable.
 - Start integration

18.3 Adjusting the Screen

You can adjust the brightness of the screen grid and set graph colors.

Procedure

Setup menu icon  > Utility > System Configuration > Ext Monitor menu

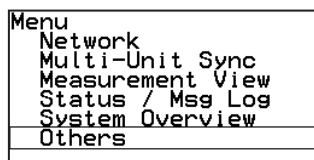


Note

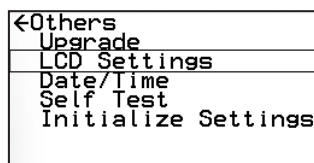
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
- For operations using keys other than SET (see section 18.1)

Adjusting the LCD screen of the WT1500

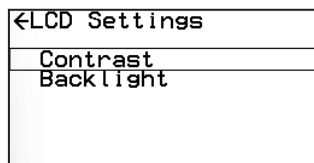
You can use the LCD screen and operation keys of the WT1500 to adjust the contrast of the LCD screen and turn the backlight on and off.



Use the ▲ and ▼ arrow keys to select **Others** on the Menu screen, and then press **SET**.



Use the ▲ and ▼ arrow keys to select **LCD Settings**, and press **SET**.



Use the ▲ and ▼ arrow keys to select **Contrast** or **Backlight**, and then press **SET**.

- Contrast**
Contrast: Use the ▲ and ▼ arrow keys to select a value from 1 to 10, and then press **SET**.
- Backlight ON/OFF**
Backlight: Use the ▲ and ▼ arrow keys to select ON or OFF, and then press **SET**.

To return to the previous screen, press **ESC**.

Grid intensity (Grid Intensity)

Select the grid (Grid) intensity from 1 (darkest) to 8 (brightest).

Graph color (Graph Color)

Displays the Graph Color setting screen.

You can select the display color for each item in the waveform display and vector display.

The display data corresponding to Ch1 to Ch16 in the waveform display and vector display are as follows:

Waveform display		Vector display	Waveform display		Vector display
Ch1	U1	U1	Ch9	Spd1/Aux1	---
Ch2	I1	I1	Ch10	Trq1/Aux2	---
Ch3	U2	U2	Ch11	Spd2/Aux3	---
Ch4	I2	I2	Ch12	Trq2/Aux4	---
Ch5	U3	U3	Ch13	Spd3/Aux5	---
Ch6	I3	I3	Ch14	Trq3/Aux6	---
Ch7	U4	U4	Ch15	Spd4/Aux7	---
Ch8	I4	I4	Ch16	Trq4/Aux8	---

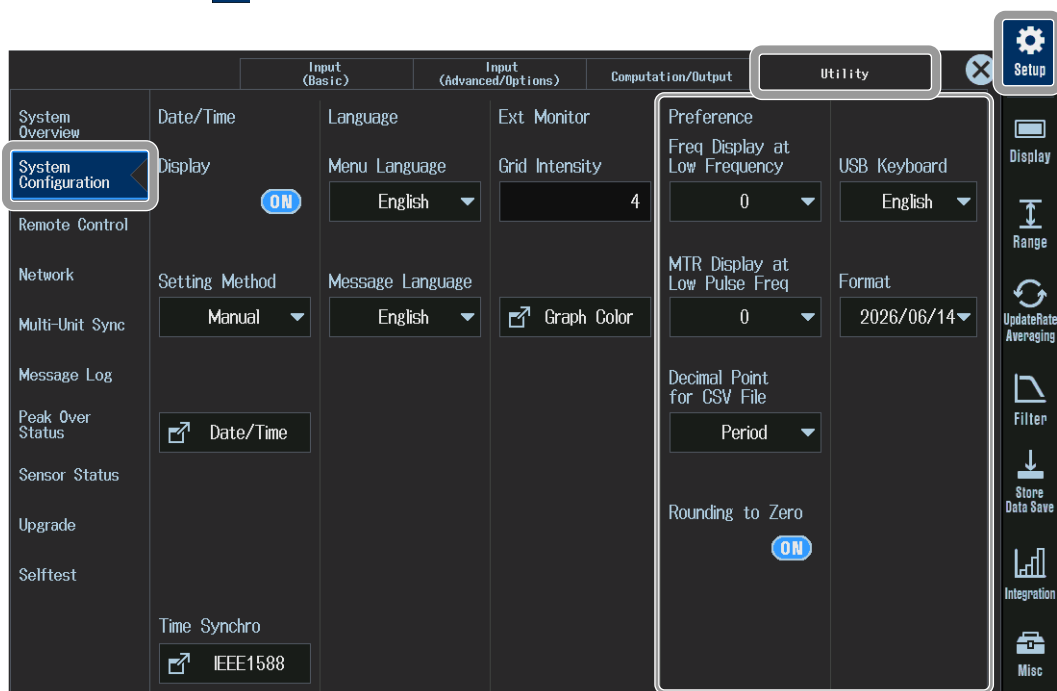
18.4 Setting the Preferences (Preference)

The following settings are available.

- Frequency display at low frequency
- Motor display at low pulse frequency
- Decimal point format for CSV files
- Rounding to zero
- USB keyboard language
- Date format

Procedure

Setup menu icon  > **Utility** > **System Configuration** > Preference menu

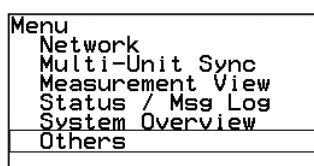


Note

- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
- For operations using keys other than SET (see section 18.1)

Displaying the date and time on the WT1500 display

You can display the current date and time using the WT1500 display and operation keys.



Use the ▲ and ▼ arrow keys to select **Others** on the Menu screen, and then press **SET**.



```
<Others
Upgrade
LCD Settings
Date/Time
Self Test
Initialize Settings
```

Use the ▲ and ▼ arrow keys to select **Date/Time**, and press **SET**.



```
<Date/Time
2026/06/19
15:16:53
```

The current date and time are displayed.

To return to the previous screen, press **ESC**.

Frequency Display at Low Frequency (Freq Display at Low Frequency)

When the frequency of the input signal is below the lower limit that this instrument can measure, you can select either 0 or Error for the displayed frequency.

* During multi-unit synchronized operation, this setting is linked across all units.

MTR Display at Low Pulse Frequency (MTR Display at Low Pulse Freq, option)

When the pulse frequency of the torque or speed input signal and the pulse frequency of the auxiliary input (Aux) are below the lower limit that this instrument can measure, you can select either 0 or Error for the display of measurement functions related to the motor evaluation function.

* During multi-unit synchronized operation, this setting is linked across all units.

Decimal point for CSV files (Decimal Point for CSV File)

When data is saved in ASCII format (.CSV), you can select the decimal point and separator for the data.

- Period (Period): The decimal point is a period, and the separator is a comma.
- Comma (Comma): The decimal point is a comma, and the separator is a semicolon.

Rounding to zero (Rounding to Zero)

* During multi-unit synchronized operation, this setting is linked across all units.

ON

When the measured voltage or current values are as follows relative to the measurement range, Urms, Umn, Urmn, Irms, Imn, Irmn, and other measurement functions derived from these measurement functions display and output zero.

For λ or Φ , [Error] is displayed and output.

- When the crest factor is set to CF3
Urms, Uac, Irms, or Iac is 0.3 % or less. Umn, Urmn, Imn, or Irmn is 2 % or less.
- When the crest factor setting is CF6 or CF6A
Urms, Uac, Irms, or Iac is 0.6 % or less. Umn, Urmn, Imn, or Irmn is 4 % or less.

OFF

Displays and outputs the measured values as they are.

USB keyboard language (USB Keyboard)

See page 2-9.

Date format (Format)

Select one of the following date display formats.

- YYYY/MM/DD
- DD/MM/YYYY
- DD-MMM-YY
- DD MMM YYYY

YYYY: Year (4 digits)

MM: month (2 digits)

DD: Day (2 digits)

YY: Year (last 2 digits)

MMM: month abbreviation in English

Applicable date displays

- Date display of the clock on the instrument screen
- Timestamp in numeric data communication output
- Date and timestamp in stored-data CSV files
- Date in numeric-data CSV files

Date displays not affected (fixed at YYYY/MM/DD)

- Date setup menu
- Date display in the file list
- Date display in instrument information
- Date display of the real-time integration mode start time on the screen of this instrument
- Date display in NULL notifications (startup time and notification time)
- Date display in the IEEE 1588 information dialog box
- Date display in the Message Log dialog box

Note

You cannot set the date format when this instrument is in any of the following states.

- When the integration status is not Reset
 - When the store state is other than Reset or Complete
 - While accessing storage
-

18.5 Remote Control

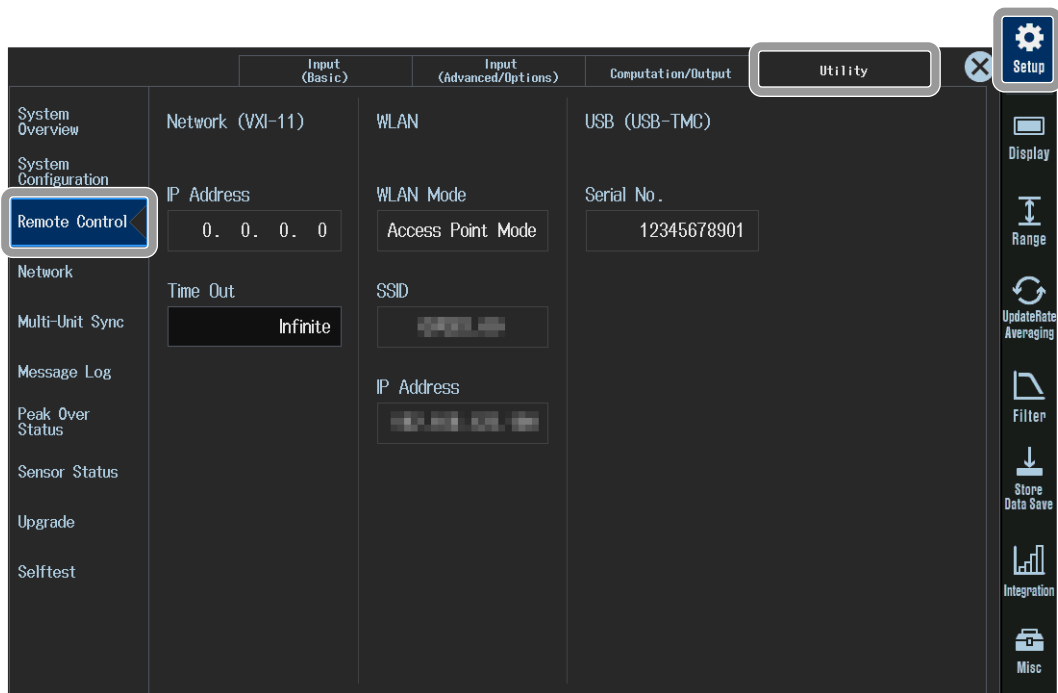
This section explains the communication interfaces used to control this instrument from a PC.

There are three types: Network, WLAN, and USB.

For details, see the Communication Interface User's Manual (IM WT1501-17EN).

Procedure

Setup menu icon  > **Utility** > **Remote Control** menu > Network(VXI-11)/WLAN/USB(USB-TMC)



Note

- Use only one communication interface: Network, WLAN, or USB. If commands are sent simultaneously using another communication interface, the commands will not execute properly.
- For procedures using the setup menu, see chapter 3.
- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
 - The setup menu can also be displayed by pressing **MENU** on the front panel.
 - The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
 - For operations using keys other than SET (see section 18.1)
- In remote mode, only the KEY LOCK/LOCAL key is active.



When this instrument is communicating with a PC, it enters remote mode, and the REMOTE LED on the front panel of the instrument lights green.

Network(VXI-11)

To use the Ethernet interface function, the following TCP/IP settings are required.

IP address (IP Address)

Displays the values set in Ethernet communication TCP/IP.

- IP address
- Subnet mask
- Default gateway

For details on how to set these items, see section 14.2.

Timeout (Time Out)

If there is no access within a certain period after the connection process to this instrument starts, the connection process is canceled.

The time-out can be set to Infinite or within a range from 1 s to 120 s.

Note

When connecting to a network through Ethernet, TCP/IP settings are required. See section 14.2.

Notes on connection

- To connect this instrument to a PC, always use a straight cable through a hub. Operation is not guaranteed for a one-to-one connection using a crossover cable.
- For the connection, use a cable that supports your network environment (transmission speed).
 - UTP (Unshielded Twisted-Pair) cable
 - STP (Shielded Twisted-Pair) cable

WLAN

To use the wireless LAN adapter (communication dongle), the following settings are required.

For details on how to set WLAN, see section 14.7.

WLAN Mode

- Access point mode
Select this mode when using this instrument as an access point.
- Station mode
Select this mode when using this instrument by connecting it to an access point.

ID name (SSID)

Sets the name of the access point displayed when the access point is searched for from a PC or other wireless device.

IP address (IP Address)

Displays the value set in Ethernet communication TCP/IP.

USB(USB-TMC)

Connect this instrument to a PC using USB.

Before connecting this instrument to a PC through the USB port, complete the following steps. Install our USB driver on the PC. For information on how to obtain our USB driver, contact your nearest YOKOGAWA dealer, or access the USB driver page from our website (<https://tmi.yokogawa.com/library/>) and download the USB driver. Do not use any USB driver or software provided by other companies.

Serial number (Serial No.)

Displays the serial number of the WT1500 instrument.

Clearing remote mode (KEY LOCK/LOCAL)

To switch this instrument from remote mode (the REMOTE LED lights green) to local mode (key operations on the front panel of the instrument are enabled), press the KEY LOCK/LOCAL key. However, this is disabled during local lockout.

If remote mode and key lock ON are set at the same time, clearing remote mode (LOCAL) takes precedence over key lock (KEY LOCK) operation.

- On the first KEY LOCK operation, remote mode is cleared, and the REMOTE LED turns off.
- On the second KEY LOCK operation, key lock turns OFF, and the KEY LOCK LED turns off.

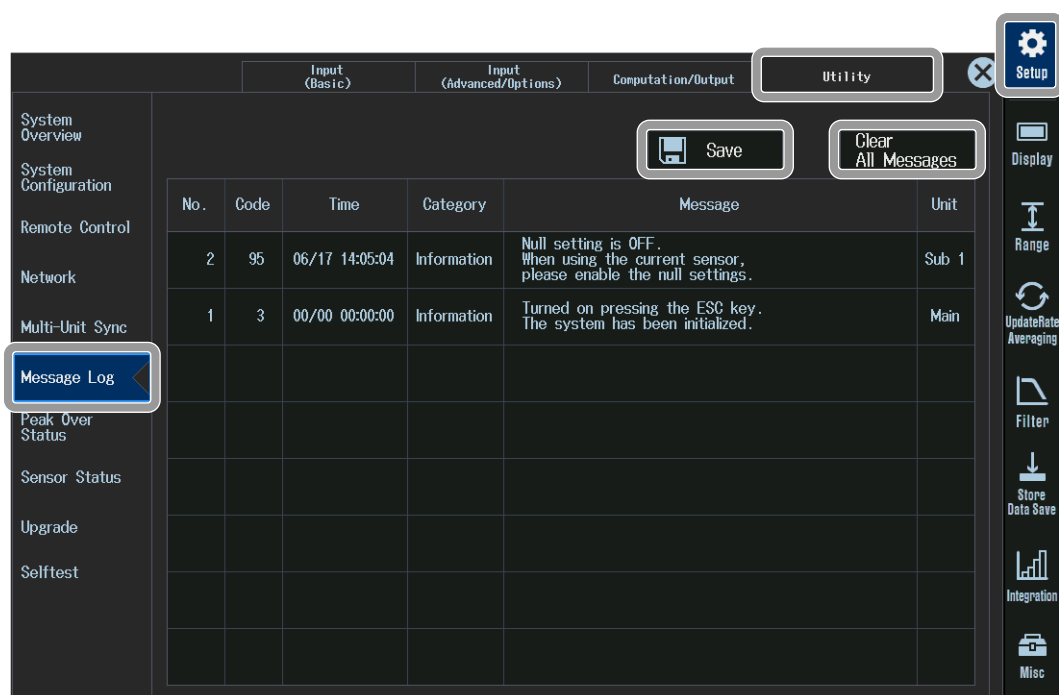
18.6 Displaying and Saving the Message Log

You can display a list of messages that occurred in the past and save the message log file. For error codes (Code), see the appendix.

During multi-unit synchronization (option /SY1), error messages that occur on a subunit are displayed on the main unit. There may be a delay of several seconds before an error that occurs on a subunit is displayed on the main unit.

Procedure

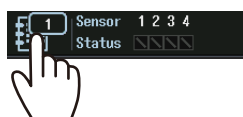
Setup menu icon  > **Utility** > **Message Log** menu > SAVE/Clear All Messages



Note

- Procedures using front-panel keys
See section 1.2 of the Getting Started Guide (IM WT1501-02EN).
- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
- For operations using keys other than SET (see section 18.1)

Message log icon



If there are unread messages, the number is displayed on the message log icon at the upper left of the screen.
When you touch the message log icon, the Message Log menu appears, and all messages, whether unread or read, are displayed.

18.6 Displaying and Saving the Message Log

Displaying it on the WT1500 display

You can also display the message log using the WT1500 display and operation keys as follows:

←Status / Msg Log
Peak Over
SensorPowerStatus
Message Log List
File Setup/Msg

Use the ▲ and ▼ arrow keys to select **Status/Msg Log** on the Menu screen > **Message Log List**, and then press **SET**.



←Message Log List
Clear all messages

The No., Error/Warning/Critical, Error No, and occurrence time are displayed.

Select **Clear All Messages** and press **SET** to move to the Clear All Messages screen.

Select a specific error and press the **SET** key to move to the error details screen.



Clear All Messages
Execute
Cancel
SET:OK ESC:Cancel

Select **Execute** and press the **SET** key to clear the contents of the Message Log.

Select **Cancel** and press **SET** to return to the Message Log screen.

Saving the message log file (Save)

Saves the error messages in the message log to a file.

- Save destination drive: Fixed to the root directory of the internal memory (User). The save destination cannot be changed.
- Save format: CSV

Note

The message log cannot be saved when this instrument is in either of the following states.

- While accessing storage
 - When the storage status is other than Reset or Complete
-

File name

The file name is automatically generated as MSGLOG“Date”.CSV.

The date and time when the file is saved are entered in “Date” as follows:

20260130_121530_0 (2026/01/30 12:15:30)

YYYY MMDD hh mmss

Sequence number (0 to 9 then A to Z) for when multiple files are saved at the same time (second)

If multiple files are saved at the same time (to the second), a serial number is added after the date and time. No serial number is added to the first file. After that, the serial number increases by one each time a file is added, starting from 1. After 9, the letters A, B, C, and so on are used.

File format

The message log file consists of the instrument configuration information and the message log items.

- **Instrument configuration information**

Model: model name

Version: Firmware version

Boot Ver.: Boot program version

Suffix: Suffix code

Element: Installed input element number

Module: Installed input element model name

An example of the instrument configuration information is shown below.

"Model", "WT1504"

"Version", "0.26.X01"

"Boot Ver.", "1.01"

"Suffix", "-10-WB3-HV1-BN-HE/M1/EM1RM1/SY1/CN1"

"Element", "Element1", "Element2", "Element3", "Element4"

"Module", "WB 2MHz", "WB 2MHz", "WB 2MHz", "HV 2kV"

"Message Log:"

"No.", "Code", "Date", "Time", "Category", "Message", "Extra Message", "Unit"

2, 95, "2026/01/07", "10:34:52", "Information", "Null setting is OFF...", "", "Main"

1, 3, "2000/00/00", "0:00:00", "Information", "Turned on pressing the ESC key...", "", "Main"

- **Message log items**

No.: message log number

Code: message code number

Date: message occurrence date

Time: message occurrence time

Category: message category (Information/Error)

Message: First line of the English message text

Extra Message: Additional message information on the last line

Clearing the message log (Clear All Messages)

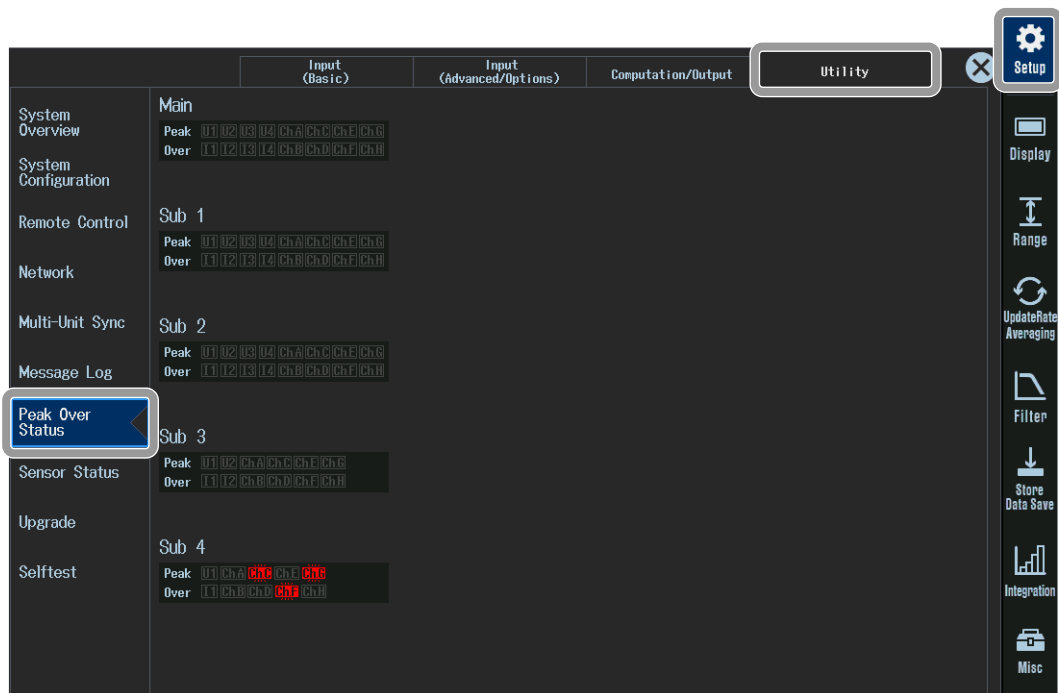
Clears the message log.

18.7 Displaying Peak Over Status

You can display a list of peak-over status information.

Procedure

Setup menu icon  > **Utility** > **Peak Over Status**



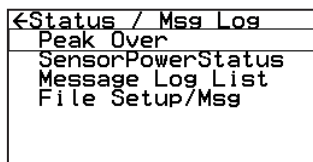
Note

- On the main unit during multi-unit synchronization (option /SY1), the peak over status of the subunits (Sub 1 to 4) is also displayed.

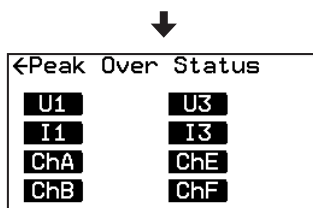
-  You can also display a list of peak-over status information by selecting the peak-over status indicator at the upper left of the screen.

Displaying it on the WT1500 display

You can also display peak-over status using the WT1500 display and operation keys.



Use the ▲ and ▼ arrow keys to select **Status/Msg Log** on the Menu screen > **Peak Over**, and then press **SET**.



Displays peak-over status for the voltage (U) and current (I) of each element and the speed (Speed) and torque (Torque) of each motor.

Input signals with peak-over status are displayed as icons with white text on a black background.

Displaying Peak Over Status

When a peak-over condition is detected on a voltage, current, or optional input channel, it is indicated as follows:

- If the allowable range is exceeded for Elements or Motor (/EM1, /RM1, /EM2, /RM2, or /EM1RM1), the PEAK OVER LED on the front panel of the instrument lights red.
- Peak-over information is displayed in the peak-over status indication on the LCD screen and on the external monitor screen.

Peak-over detection for elements is performed before the DLF.*

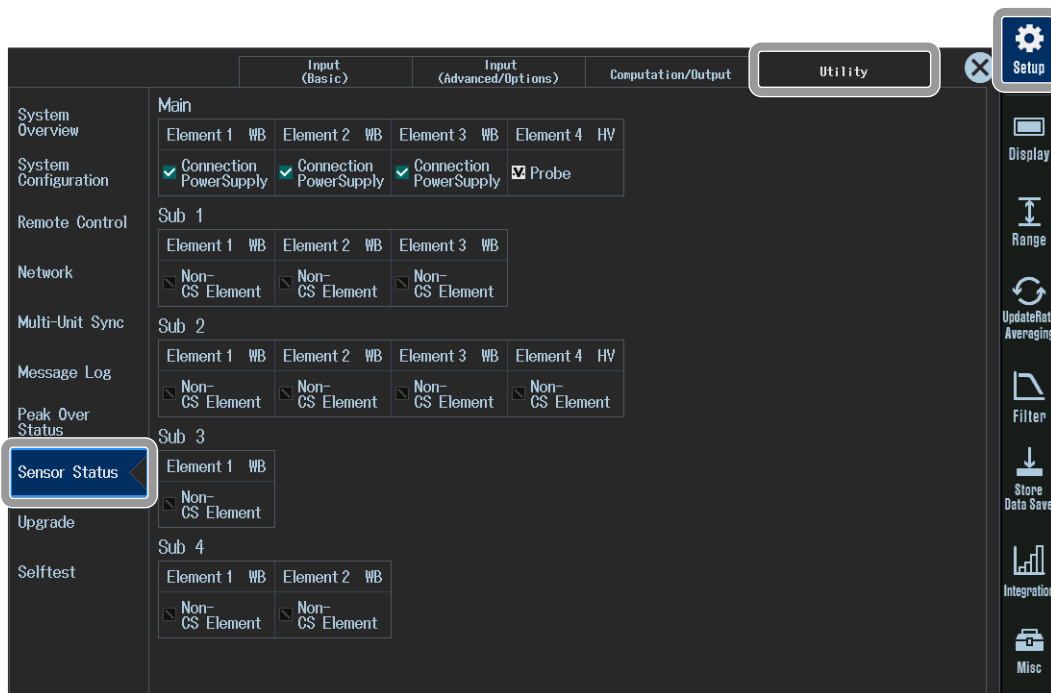
* For details on DLF, see section 4.6.

18.8 Displaying Current Sensor Status

You can display a list of current sensor status information.

Procedure

Setup menu icon  > **Utility** > **Sensor Status**

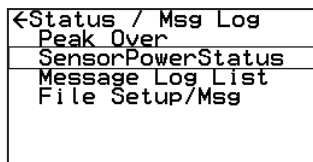


Note

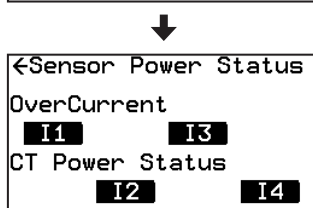
- On the main unit during multi-unit synchronization (option /SY1), the status of the subunits (Sub 1 to 4) is also displayed.
-  **Sensor Status**  You can also display a list of current sensor status information by selecting the sensor status indicator at the upper left of the screen.

Displaying it on the WT1500 display

You can also display current sensor status using the WT1500 display and operation keys.



Use the ▲ and ▼ arrow keys to select **Status/Msg Log** on the Menu screen > **SensorPowerStatus**, and then press **SET**.



The overcurrent status (Over Current) and current sensor power supply status (CT Power Status) of each current sensor are displayed.

The following elements are displayed as icons with white text on a black background.

- Elements for which power supply has been stopped because of overcurrent
- Elements receiving power

Displaying Current Sensor Status

Current sensor status	Description
 (Non-CS Element)	An element other than a current sensor is installed.
 (Non-Connection)	The sensor output type is set to Current, and no current sensor (CT series) is connected.
 (Connection Power Supply)	The sensor output type is set to Current, a current sensor (CT series) is connected, and power is being supplied to the current sensor (CT series).
 (Over Current)	Overcurrent was detected.
 (Probe)	The sensor output type is set to Voltage.

For the sensor output type (Sensor Output Type) setting, see pages 4-6 and 4-12.

18.9 Self-Test

You can test whether the memory, keyboard, and other components are operating normally.

Procedure

Setup menu icon  > **Utility** > **Selftest** menu

- **Memory test**
 - > In Test Item, select **Memory > Test Exec**



Note

When the update mode is Auto, the Memory self-test item cannot be executed.

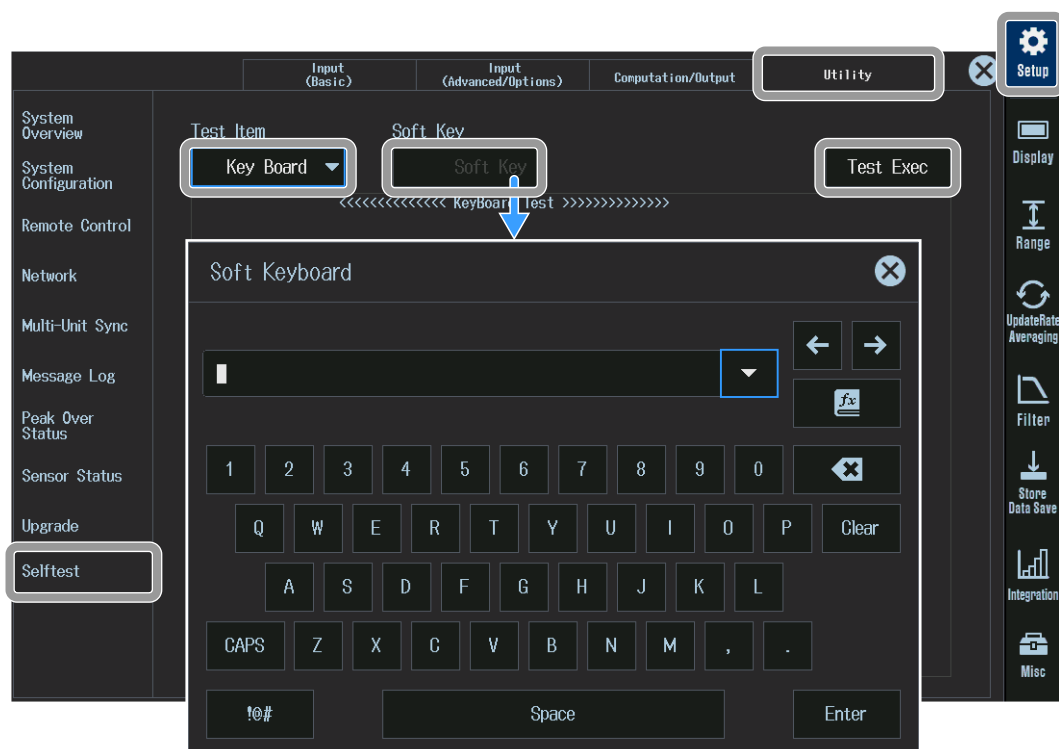
- **Keyboard test**

Front panel key test

> In Test Item, select **Key Board** > **Test Exec**

Onscreen soft keyboard test

> In Test Item, select **Key Board** > **Soft Key** > **Test Exec**


Note

Procedures using front-panel keys

See section 1.2 of the Getting Started Guide (IM WT1501-02EN).

- The utility settings overview screen can also be displayed by selecting **Utility** with the arrow keys and pressing **SET**.
- For operations using keys other than SET (see section 18.1)

Test items (Test Item)

You can test the following items.

Memory (Memory)

Tests whether the internal memory is operating normally. If “Pass” is displayed, operation is normal. If an error occurs, “Failed” is displayed. When the test is complete, “Test Completed” is displayed.

Key test (Key Board)

- Tests whether the operation keys on the front panel of the instrument are operating normally. If the name of the pressed key is displayed, operation is normal.
- Press the left and right cursor keys. If the LEDs on the front panel of the instrument light or turn off in sequence, operation is normal.
- To exit the key test, press ESC twice in succession.

Keyboard (Soft Key)

This is displayed when Key Board is selected as the test item. Tests whether the keyboard function on the screen is operating normally. If the entered characters are displayed correctly in the keyboard input field, operation is normal.

Test execution (Test Exec)

Starts the self-test for the selected item.

When the update mode is Auto, Memory cannot be executed as a test item.

If an error occurs during self-test

If an error still occurs after running the self-test several times, contact your nearest YOKOGAWA dealer.

18.10 Locking Front Panel Operation

You can lock operation of this instrument to prevent accidentally pressing keys on the front panel of the instrument during use from affecting measurement operation.

Procedure

KEY LOCK/LOCAL key on the front panel



Note

- In remote mode (when the REMOTE LED is lit), the front panel of the instrument cannot be operated. To clear remote mode, press **KEY LOCK/LOCAL**. For details on remote mode, see the Communication Interface User's Manual (IM WT1501-17EN).
- If remote mode and key lock ON are set at the same time, clearing remote mode (LOCAL) takes precedence over key lock (KEY LOCK) operation.
 - On the first KEY LOCK operation, remote mode is cleared, and the REMOTE LED turns off.
 - On the second KEY LOCK operation, key lock turns OFF, and the KEY LOCK LED turns off.

Key lock (KEY LOCK)

When key lock is turned ON, the following conditions apply. You can prevent accidental operation.

- Key operations other than the power switch and KEY LOCK are disabled.
- The KEY LOCK/LOCAL key lights.

Press the key again to clear the above conditions.

Note

The key lock ON/OFF setting is retained even when the power is turned off.

18.11 Other

History function

Using communication commands, you can import to a PC the history of the latest 20 sets of numeric data.

For details, see the Communication Interface User's Manual (IM WT1501-17EN).

Appendix 1 Symbols and Formulas for Measurement Functions

Normal measurement functions

(Table 1/8)

Measurement function								
Voltage U [V]	True RMS value	Urms	Urms	Umn	Udc	Urmn	Uac	Ufnd*
	Rectified mean value calibrated to the RMS value	Umn	$\sqrt{\text{AVG}[u(n)^2]}$	$\frac{\pi}{2\sqrt{2}} \text{AVG}[u(n)]$	AVG[u(n)]	AVG[u(n)]	$\sqrt{\text{RMS}^2 - \text{DC}^2}$	U(1)
	Simple average	Udc						
	Current rectified mean value	Urmn						
	AC component	Uac						
	Fundamental component	Ufnd						
Current I [A]	True RMS value	Irms	Irms	Imn	Idc	Irmn	Iac	Ifnd*
	Rectified mean value calibrated to the RMS value	Imn	$\sqrt{\text{AVG}[i(n)^2]}$	$\frac{\pi}{2\sqrt{2}} \text{AVG}[i(n)]$	AVG[i(n)]	AVG[i(n)]	$\sqrt{\text{RMS}^2 - \text{DC}^2}$	I(1)
	Simple average	Idc						
	Current rectified mean value	Irmn						
	AC component	Iac						
	Fundamental component	Ifnd						
Active power P [W]		AVG[u(n) · i(n)]						
Fundamental active power component Pfnd [W]		P(1)*						
Apparent power S [VA]	TYPE1, TYPE2	Select from Urms · Irms, Umn · Imn, Udc · Idc, Umn · Irms, Urmn · Irmn.						
	TYPE3	$\sqrt{P^2 + Q^2}$						
Fundamental apparent power component Sfnd [VA]		S(1)*						
Reactive power Q [var]	TYPE1, TYPE2	$s \cdot \sqrt{S^2 - P^2}$ s is -1 for leading and 1 for lagging.						
	TYPE3	$\sum_{k = \min}^{\max} Q(k)$ Q(k) = Ur(k) · Ij(k) –Uj(k) · Ir(k) Ur(k) and Ir(k) are the real number components of U(k) and I(k). Uj(k) and Ij(k) are the imaginary components of U(k) and I(k). Valid only when harmonics are measured correctly.						
Fundamental reactive power component Qfnd [var]		Q(1)*						
Power factor λ		$\frac{P}{S}$						
Fundamental power factor component λfnd		λ(1)*						
Phase difference Φ [°]		$s \cdot \cos^{-1}\left(\frac{P}{S}\right)$ The phase angle can be switched between lead (D)/lag (G) display and 360° display. s, which determines the signs for lead and lag, varies depending on the phase difference polarity setting as follows. • When phase difference polarity is set to Lead(-)/Lag(+): Leading: -1, lagging: 1 • When phase difference polarity is set to Lead(+)/Lag(-): Leading: 1, lagging: -1						
Fundamental phase difference component Φfnd [°]		Φ(1)*						
Voltage frequency fU(FreqU) [Hz] Current frequency fI(FreqI) [Hz]		The voltage frequency (fU) and current frequency (fI) are measured by detecting the cross points. The fU and fI of all elements can be measured simultaneously.						

* Valid only when harmonics are measured correctly.

Appendix 1 Symbols and Formulas for Measurement Functions

(Table 2/8)

Measurement function		Formula	
		For details on the symbols used in the formulas, see the notes provided on page App-6.	
		TYPE1:IEC76-1(1976), IEEE C57.12.90-2010	TYPE2:IEC76-1(2011)
Corrected Power Pc [W]		$\frac{P}{P1 + P2 \left(\frac{U_{rms}}{U_{mn}} \right)^2}$ P1, P2: coefficients defined in the applicable standards	$P \left(1 + \frac{U_{mn} - U_{rms}}{U_{mn}} \right)$
Maximum voltage: U + pk [V]		Maximum value of u(n) for each data update	
Minimum voltage: U – pk [V]		Minimum value of u(n) for each data update	
Maximum current: I + pk [A]		Maximum value of i(n) for each data update	
Minimum current: I – pk [A]		Minimum value of i(n) for each data update	
Maximum power: P + pk [W]		Maximum value of u(n) · i(n) for each data update	
Minimum power: P – pk [W]		Minimum value of u(n) · i(n) for each data update	
Voltage crest factor CfU Current crest factor Cfl		Voltage crest factor CfU = $\frac{U_{pk}}{U_{rms}}$ $U_{pk} = U + pk \text{ or } U - pk $ whichever is larger	Current crest factor Cfl = $\frac{I_{pk}}{I_{rms}}$ $I_{pk} = I + pk \text{ or } I - pk $ whichever is larger
Integration	Integration time ITime [h:m:s]	Elapsed time from the start of integration until it stops	
	Watt hours [Wh] WP WP+ WP–	When the watt-hour integration method for each polarity is Charge/Discharge ¹ $\left[\frac{1}{N} \sum_{n=1}^N \{u(n) \cdot i(n)\} \right] \cdot ITime$ N is the integration time sampling count. The unit of ITime is hours. WP is the sum of positive and negative watt hours. WP+ is the sum of only the positive values of u(n)·i(n) in the above formula. WP– is the sum of only the negative values of u(n)·i(n) in the above formula.	
		When the watt-hour integration method for each polarity is Sold/Bought ¹ $\left[\frac{1}{N} \sum_{n=1}^N \{u(n) \cdot i(n)\} \right] \cdot ITime$ N is the integration time sampling count. The unit of ITime is hours. WP is the sum of positive and negative watt hours. WP+ is the sum of only the positive power values for each data update. WP– is the sum of only the negative power values for each data update.	
	Ampere hours [Ah] rms, mean, ac q q+ q– dc	$\frac{1}{N} \sum_{n=1}^N I(n) \cdot ITime$ I(n) is the nth current measured value. N is the number of data updates. The unit of ITime is h.	
		$\frac{1}{N} \sum_{n=1}^N i(n) \cdot ITime$ i(n) is the nth sampled data of the current signal. N is the number of data samples. The unit of ITime is h. q is the sum of positive and negative ampere hours for i(n). q+ is the sum of only the positive values of i(n) in the above formula. q– is the sum of only the negative values of i(n) in the above formula.	
	Volt-ampere hour WS ² [VAh]	$\frac{1}{N} \sum_{n=1}^N S(n) \cdot ITime$ S(n) is the nth apparent power measured value, N is the number of data updates, and the unit of ITime is h.	
	Var hours WQ ² [varh]	$\frac{1}{N} \sum_{n=1}^N Q(n) \cdot ITime$ Q(n) is the nth reactive power measured value, N is the number of data updates, and the unit of ITime is h.	

1 When the update mode is Auto, the watt hour integration method for each polarity will only compute the charge or discharge.

2 When the update mode is set to Auto, WS and WQ are not computed.

Appendix 1 Symbols and Formulas for Measurement Functions

(Table 3/8)

Measurement function	Formula
	For symbols in the formulas, see the notes on page App-6.
Voltage ripple rate Urip [%]	$(U+pk - U-pk) / (2 \cdot U_{dc}) \cdot 100$
Current ripple rate Irip [%]	$(I+pk - I-pk) / (2 \cdot I_{dc}) \cdot 100$

(Table 4/8)

Measurement function	Formula
	For symbols in the formulas, see the notes on page App-6.
Voltage measurement range RngU [V]	Present voltage range
Current measurement range RngI [A]	Present current range

(Table 5/8)

Measurement function		Formula				
		For details on the symbols used in the formulas, see the notes provided on page App-6.				
Wiring system		Single-phase three-wire	Three-phase three-wire	Three-phase three-wire with three-voltage three-current method		Three-phase four-wire
		1P3W	3P3W	3V3A	3V3AR	3P4W 3P3W(3V3A)→3P4W 3P3W(3V3AR)→3P4W
UΣ [V]	Not Udc	(U1+U2)/2		(U1+U2+U3)/3		
	Udc			(U1+U2+U3)/3	(-U1+U2+U3)/3	(U1+U2+U3)/3
IΣ [A]		(I1+I2)/2		(I1+I2+I3)/3		
PΣ [W]		P1+P2			-P1+P2	P1+P2+P3
SΣ [VA]	TYPE1, TYPE2	S1+S2	$\frac{\sqrt{3}}{2}(S1+S2)$	$\frac{\sqrt{3}}{3}(S1+S2+S3)$		S1+S2+S3
	TYPE3	$\sqrt{P\Sigma^2+Q\Sigma^2}$				
	TYPE1 ¹	Q1+Q2		-Q1+Q2		Q1+Q2+Q3
QΣ [var]	TYPE2	$\sqrt{S\Sigma^2-P\Sigma^2}$				
	TYPE3	Q1+Q2		-Q1+Q2		Q1+Q2+Q3
PcΣ [W]		Pc1+Pc2		-Pc1+Pc2		Pc1+Pc2+Pc3
Σ functions	WPΣ	WP1+WP2		-WP1+WP2		WP1+WP2+WP3
	WP+Σ	When the watt-hour integration method for each polarity is Charge/Discharge ²				WP+1+WP+2+WP+3
		WP+1+WP+2		-WP-1+WP+2		
		When the watt-hour integration method for each polarity is Sold/Bought ² WP+Σ is the sum of only the positive values of active power WPΣ for each data update.				
	WP-Σ	When the watt-hour integration method for each polarity is Charge/Discharge ²				WP-1+WP-2+WP-3
		WP-1+WP-2		-WP+1+WP-2		
		When the watt-hour integration method for each polarity is Sold/Bought ² WP-Σ is the sum of only the negative values of active power WPΣ for each data update.				
qΣ [Ah]	qΣ	q1+q2		q1+q2+q3		
	q+Σ	q+1+q+2		q+1+q+2+q+3		
	q-Σ	q-1+q-2		q-1+q-2+q-3		
WQΣ ³ [varh]		$\frac{1}{N}\sum_{n=1}^N Q\Sigma(n) \cdot ITime$ QΣ(n) is the nth Σ function for reactive power, N is the number of data updates, and the unit of ITime is h.				
WSΣ ³ [VAh]		$\frac{1}{N}\sum_{n=1}^NS\Sigma(n)\cdot ITime$ SΣ(n) is the nth Σ function for apparent power, N is the number of data updates, and the unit of ITime is h.				
λΣ		$\frac{P\Sigma}{S\Sigma}$				
ΦΣ [°]		$\cos^{-1}\left(\frac{P\Sigma}{S\Sigma}\right)$				

(Continued on next page)

(Table 6/7)

Measurement function		Formula For details on the symbols used in the formulas, see the notes provided on page App-6.			
Σ functions	Wiring system	Single-phase three-wire	Three-phase three-wire	Three-phase three-wire with three-voltage three-current method	
		1P3W	3P3W	3V3A	3V3AR
	Three-phase voltage unbalance factor UubfΣ [%]				
Σ functions	Three-phase voltage unbalance factor UubfΣ [%]				
	Three-phase current unbalance factor IubfΣ [%]				

(Continued on next page)

- When the update mode is Auto, QΣ that includes elements with the synchronization source rectifier set to ON will be computed with TYPE2.
- When the update mode is Auto, the watt hour integration method for each polarity will only compute the charge or discharge.
- When the update mode is Auto, WSΣ and WQΣ will not be computed.

(Table 7/8)

Measurement function		Formula
		For details on the symbols used in the formulas, see the Note on the next page.
Σ functions	Wiring system	Three-phase three-wire with three-voltage three-current method 3P4W→3P3W(3V3AS)
	UΣ [V]	(U1+U2+U3)/3
	Not Udc	(U1-U2+U3)/3
	Udc	(U1-U2+U3)/3
	IΣ [A]	(I1+I2+I3)/3
	PΣ [W]	P1+P2+P3
	SΣ [VA]	TYPE1, TYPE2 TYPE3 -
	QΣ [var]	TYPE1 ¹ TYPE2 TYPE3 -
	PcΣ [W]	-
	WPΣ	-
	WP+Σ	When the watt-hour integration method for each polarity is Charge/Discharge ² -
	WPΣ [Wh]	When the watt-hour integration method for each polarity is Sold/Bought ² -
	WP-Σ	When the watt-hour integration method for each polarity is Charge/Discharge ² -
	WPΣ [Wh]	When the watt-hour integration method for each polarity is Sold/Bought ² -
	qΣ	q1+q2+q3
	qΣ [Ah]	q+1+q+2+q+3
	q-Σ	q-1+q-2+q-3
	WQΣ ³ [varh]	-
	WSΣ ³ [VAh]	-
	λΣ	-
	ΦΣ [°]	-
	Three-phase voltage unbalance factor UubfΣ [%]	$K = \frac{\sqrt{1 - \sqrt{3 - 6 \cdot \beta}}}{\sqrt{1 + \sqrt{3 - 6 \cdot \beta}}} \cdot 100$ $\beta = \frac{U_{rs}^4 + U_{st}^4 + U_{tr}^4}{(U_{rs}^2 + U_{st}^2 + U_{tr}^2)^2}$ Urs: line-to-line voltage between phases R and S Ust: line-to-line voltage between phases S and T Utr: line-to-line voltage between phases T and R Select whether to calculate the unbalance factor using the rms value or the fundamental harmonic value.
	Three-phase current unbalance factor IubfΣ [%]	$K = \frac{\sqrt{1 - \sqrt{3 - 6 \cdot \beta}}}{\sqrt{1 + \sqrt{3 - 6 \cdot \beta}}} \cdot 100$ $\beta = \frac{I_{rs}^4 + I_{st}^4 + I_{tr}^4}{(I_{rs}^2 + I_{st}^2 + I_{tr}^2)^2}$ Irs: line current between phases R and S Ist: line current between phases S and T Itr: line current between phases T and R The line-to-line currents are obtained, and the unbalance factor is calculated. Select whether to calculate the unbalance factor using the rms value or the fundamental harmonic value.

- When the update mode is Auto, QΣ that includes elements with the synchronization source rectifier set to ON will be computed with TYPE2.
- When the update mode is Auto, the watt hour integration method for each polarity will only compute the charge or discharge.
- When the update mode is Auto, WSΣ and WQΣ will not be computed.

Note

- $u(n)$ indicates the instantaneous voltage value.
- $i(n)$ indicates the instantaneous current value.
- n indicates the n th sampling data point within the measurement period determined by the sync source setting.
- $AVG[]$ indicates the arithmetic mean over the measurement interval determined by the sync source setting for the quantity in $[]$.
- $P\Sigma$ indicates the active power of wiring unit Σ . Which input elements are assigned to wiring unit Σ depends on the number of input elements installed in this instrument and the pattern of the selected wiring system.
- The numbers 1, 2, and 3 in the formulas for $Urms\Sigma$, $Umn\Sigma$, $Urmn\Sigma$, $Udc\Sigma$, $Uac\Sigma$, $Irms\Sigma$, $Imn\Sigma$, $Irmn\Sigma$, $Idc\Sigma$, $Iac\Sigma$, $P\Sigma$, $S\Sigma$, $Q\Sigma$, $Pc\Sigma$, $WP\Sigma$, and $q\Sigma$ indicate the case where input elements 1, 2, and 3 are set to the wiring system shown in the table.
- This instrument computes S , Q , λ , and ϕ from the measured values of voltage, current, and active power. (However, if TYPE3 is selected for Q , it is calculated directly from the sampling data.) Therefore, for distorted-wave input, differences may occur compared with other instruments that use different measurement principles.
- In the computation of Q [var], when the current leads the voltage, the Q value is displayed as a negative value ($-$). When the current lags the voltage, the Q value is displayed as a positive value ($+$). Because $Q\Sigma$ is computed from the Q of each element with its sign, it may become negative ($-$).
- When a wiring system with the delta transformation function is selected, delta-transformed data, not sampling data, is substituted for $u(n)$ and $i(n)$.
- When the wiring system is $3P4W \rightarrow 3P3W(3V3AS)$, the value before delta transformation is displayed for $P\Sigma$.

In this case, $S\Sigma$, $Q\Sigma$, $\lambda\Sigma$, $\Phi\Sigma$, $WP\Sigma$, $WQ\Sigma$, and $WS\Sigma$ are not computed.

The instantaneous value is calculated using the following formula.

$$u(n) = \{VT \text{ scaling value} \times \text{sample value [V]} - (\text{NULL value})\}$$

For wiring systems with the delta transformation function [$3P3W(3V3A) \rightarrow 3P4W$, $3P3W(3V3AR) \rightarrow 3P4W$, $3P4W \rightarrow 3P3W(3V3AS)$], substitute each sampling data item in the following table into the computation formula for voltage U to obtain the computation result. Here, u_1 , u_2 , u_3 , u'_1 , u'_2 , and u'_3 are instantaneous voltage values and indicate the case where input elements 1, 2, and 3 are set to the wiring system shown in the table.

(Table 8/8)

Wiring system	Symbol	Formula
3P3W(3V3A) $\rightarrow$ 3P4W	u_1	$u'_1 - (u'_1 + u'_2) / 3$
	u_2	$u'_2 - (u'_1 + u'_2) / 3$
	u_3	$-(u'_1 + u'_2) / 3$
	$u\Sigma$	$-$
3P3W(3V3AR) $\rightarrow$ 3P4W	u_1	$-u'_1 - (-u'_1 + u'_2) / 3$
	u_2	$u'_2 - (-u'_1 + u'_2) / 3$
	u_3	$-(-u'_1 + u'_2) / 3$
	$u\Sigma$	$-$
3P4W $\rightarrow$ 3P3W(3V3AS)	u_1	$u'_1 - u'_2$
	u_2	$u'_2 - u'_3$
	u_3	$u'_3 - u'_1$
	$u\Sigma$	$-$

Note

For wiring systems with the delta transformation function, the measurement data after delta transformation is displayed as the normal measurement result.

Harmonic measurement functions

(Table 1/6)

Measurement function	Formula			Total value (Total) {no () }
	Characters/numeric values in () of the measurement function			
	dc (when k = 0)	1 (when k = 1)	k (k = 1 to max)	
Voltage U() [V]	U(dc) = Ur(0)	$U(k) = \sqrt{U_r(k)^2 + U_j(k)^2}$		$U = \sqrt{\sum_{k = \min}^{\max} U(k)^2}$
Current I() [A]	I(dc) = Ir(0)	$I(k) = \sqrt{I_r(k)^2 + I_j(k)^2}$		$I = \sqrt{\sum_{k = \min}^{\max} I(k)^2}$
Active power P [W]	P(dc) = Ur(0) • Ir(0)	P(k) = Ur(k) • Ir(k) + Uj(k) • Ij(k)		$P = \sum_{k = \min}^{\max} P(k)$
Apparent power S() [VA] (TYPE3) ¹	S(dc) = P(dc)	$S(k) = \sqrt{P(k)^2 + Q(k)^2}$		$S = \sqrt{P^2 + Q^2}$
Reactive power Q() [var] (TYPE3) ¹	Q(dc) = 0	Q(k) = Ur(k) • Ij(k) – Uj(k) • Ir(k)		$Q = \sum_{k = \min}^{\max} Q(k)$
Power factor λ()	$\lambda(dc) = \frac{P(dc)}{S(dc)}$	$\lambda(k) = \frac{P(k)}{S(k)}$		$\lambda = \frac{P}{S}$
Phase difference Φ() [°]	–	$\Phi(k) = \tan^{-1} \frac{Q(k)}{P(k)} \cdot \text{pol}^2$		$\Phi = \tan^{-1} \left(\frac{Q}{P} \right) \cdot \text{pol}^2$
Phase difference with respect to U(1) ³ ΦU() [°]	–	–	ΦU(k) = phase difference of U(k) with respect to U(1)	–
Phase difference with respect to I(1) ³ ΦI() [°]	–	–	ΦI(k) = phase difference of I(k) with respect to I(1)	–
Load circuit impedance Z() [Ω]	$Z(dc) = \left \frac{U(dc)}{I(dc)} \right $	$Z(k) = \left \frac{U(k)}{I(k)} \right $		–
Series resistance of the load circuit Rs() [Ω]	$Rs(dc) = \frac{P(dc)}{I(dc)^2}$	$Rs(k) = \frac{P(k)}{I(k)^2}$		–
Series reactance of the load circuit Xs() [Ω]	Xs(dc) = 0	$Xs(k) = \frac{Q(k)}{I(k)^2}$		–
Parallel resistance of the load circuit Rp() [Ω] (= 1/G)	$Rp(dc) = \frac{U(dc)^2}{P(dc)}$	$Rp(k) = \frac{U(k)^2}{P(k)}$		–
Parallel reactance of the load circuit Xp() [Ω] (= 1/B)	Xp(dc) = Error	$Xp(k) = \frac{U(k)^2}{Q(k)}$		–

(Continued on next page)

- For details on the types of S and Q formulas, see “Apparent power, reactive power, and corrected power formulas (formula)” in section 5.4.
- Depending on the phase difference polarity setting, pol is as follows:
 - If the phase difference polarity setting is Lead(–)/Lag(+): 1
 - If the phase difference polarity setting is Lead(+)/Lag(–): -1
- The lead/lag signs of phase differences ΦU() and ΦI() are fixed at positive (+) and negative (–), respectively.

Note

- k indicates the harmonic order, r indicates the real part, and j indicates the imaginary part.
- U(k), Ur(k), Uj(k), I(k), Ir(k), and Ij(k) are expressed as RMS values.
- min can be selected as the minimum order (Min Order) from 0 (DC component) or 1 (fundamental component).
- max is the upper limit of the measurement order. The upper limit of the measurement order is the smaller of the automatically determined value and the set maximum measurement order.

(Table 2/6)

Measurement function	Formula	
	The characters/numeric values in () of the measurement function are dc (when k = 0) or k (when k = 1 to max).	
	When the denominator in the distortion factor formula is the Total value (Total)	When the denominator in the distortion factor formula is the fundamental wave (Fundamental)
Voltage harmonic distortion factor Udhf() [%]	$\frac{U(k)}{U(\text{Total})^2} \cdot 100$	$\frac{U(k)}{U(1)} \cdot 100$
Current harmonic distortion factor Ihdf() [%]	$\frac{I(k)}{I(\text{Total})^2} \cdot 100$	$\frac{I(k)}{I(1)} \cdot 100$
Active power harmonic distortion factor Phdf() [%]	$\frac{P(k)}{P(\text{Total})^2} \cdot 100$	$\frac{P(k)}{P(1)} \cdot 100$
Voltage total harmonic distortion Uthd [%]	$\frac{\sqrt{\sum_{k=2}^{\max} U(k)^2}}{U(\text{Total})^2} \cdot 100$	$\frac{\sqrt{\sum_{k=2}^{\max} U(k)^2}}{U(1)} \cdot 100$
Total harmonic distortion of current Ithd [%]	$\frac{\sqrt{\sum_{k=2}^{\max} I(k)^2}}{I(\text{Total})^2} \cdot 100$	$\frac{\sqrt{\sum_{k=2}^{\max} I(k)^2}}{I(1)} \cdot 100$
Total harmonic distortion of active power Pthd [%]	$\left \frac{\sqrt{\sum_{k=2}^{\max} P(k)}}{P(\text{Total})^2} \right \cdot 100$	$\left \frac{\sqrt{\sum_{k=2}^{\max} P(k)}}{P(1)} \right \cdot 100$
Telephone harmonic factor of voltage Uthf [%] Telephone harmonic factor of current Ithf [%]	$U_{thf} = \frac{1}{U(\text{Total})^2} \sqrt{\sum_{k=1}^{\max} \{\lambda(k) \cdot U(k)\}^2} \cdot 100 \quad I_{thf} = \frac{1}{I(\text{Total})^2} \sqrt{\sum_{k=1}^{\max} \{\lambda(k) \cdot I(k)\}^2} \cdot 100$ $\lambda(k)$: coefficient defined in the applicable standard (IEC34-1 (1996))	
Telephone influence factor of voltage Utif Telephone influence factor of current Itif	$U_{tif} = \frac{1}{U(\text{Total})^2} \sqrt{\sum_{k=1}^{\max} \{T(k) \cdot U(k)\}^2} \quad I_{tif} = \frac{1}{I(\text{Total})^2} \sqrt{\sum_{k=1}^{\max} \{T(k) \cdot I(k)\}^2}$ $T(k)$: coefficient defined in the applicable standard (IEEE Std 100 (1992))	
Harmonic voltage factor hvf [%] ¹ Harmonic current factor hcf [%] ¹	$hvf = \frac{1}{U(\text{Total})^2} \sqrt{\sum_{k=2}^{\max} \frac{U(k)^2}{k}} \cdot 100 \quad hcf = \frac{1}{I(\text{Total})^2} \sqrt{\sum_{k=2}^{\max} \frac{I(k)^2}{k}} \cdot 100$	
K-factor	$K\text{-factor} = \frac{\sum_{k=1}^{\max} \{I(k)^2 \cdot k^2\}}{\sum_{k=1}^{\max} I(k)^2}$	

(Continued on next page)

- 1 The formula may differ depending on the definitions in the applicable standard. For details, see the standard document (IEC34-1:1996).

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

Note

- k indicates the harmonic order, r indicates the real part, and j indicates the imaginary part.
- U(k), Ur(k), Uj(k), I(k), Ir(k), and Ij(k) indicate RMS values.
- min is the minimum measurement order.
- max is the upper limit of the measurement order. The upper limit of the measurement order is the smaller of the automatically determined value and the set maximum measurement order.

(Table 3/6)

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

(Table 4/6)

Measurement function ⁴		Formula				
Σ functions	Wiring system	Single-phase three-wire Three-phase three-wire	Three-phase three-wire with three-voltage three-current method Three-phase four-wire			
		1P3W, 3P3W	3V3A	3V3AR	3P4W 3P3W(3V3A)→3P4W 3P3W(3V3AR)→ 3P4W	3P4W→ 3P3W(3V3AS)
	UΣ ¹ [V]	(U1+U2)/2	(U1+U2+U3) / 3			
	UfndΣ ² [V]	(Ufnd1+Ufnd2)/2	(Ufnd1+Ufnd2+Ufnd3) / 3			
	IΣ ¹ [A]	(I1+I2)/2	(I1+I2+I3) / 3			
	IfndΣ ² [A]	(Ifnd1+Ifnd2)/2	(Ifnd1+Ifnd2+Ifnd3) / 3			
	PΣ ¹ [W]	P1+P2	−P1+P2	P1+P2+P3	−	
	PfndΣ ² [W]	Pfnd1+Pfnd2	−Pfnd1+Pfnd2	Pfnd1+Pfnd2 +Pfnd3	−	
	SΣ ¹ [VA] (TYPE3) ³	$\sqrt{P\Sigma^2 + Q\Sigma^2}$				−
	SfndΣ ² [VA] (TYPE3) ³	$\sqrt{Pfnd\Sigma^2 + Qfnd\Sigma^2}$				−
	QΣ ¹ [var] (TYPE3) ³	Q1+Q2	−Q1+Q2	Q1+Q2+Q3	−	
	QfndΣ ² [var] (TYPE3) ³	Qfnd1+Qfnd2	−Qfnd1+Qfnd2	Qfnd1+Qfnd2 +Qfnd3	−	
	λΣ ¹	$\frac{P\Sigma}{S\Sigma}$				−
	λfndΣ ²	$\frac{Pfnd\Sigma}{Sfnd\Sigma}$				−

1 Only the Total value and the fundamental component (1st order) are computed.

2 Only the fundamental component (1st order) is computed.

3 For details on the types of SΣ and QΣ formulas, see “Apparent power, reactive power, and corrected power formulas (formula)” in section 5.4.

4 When the wiring system is 3P4W→3P3W(3V3AS), PΣ, PfndΣ, SΣ, SfndΣ, QΣ, QfndΣ, λΣ, and λfndΣ are not computed.

Note

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

(Table 5/6)

Measurement function	Formula
$\Phi U1-U2(^{\circ})$	Phase angle of the fundamental voltage component of element 2 (U2(1)) with respect to U1(1)
$\Phi U1-U3(^{\circ})$	Phase angle of the fundamental voltage component of element 3 (U3(1)) with respect to U1(1)
$\Phi U1-I1(^{\circ})$	Phase angle of the fundamental current component of element 1 (I1(1)) with respect to U1(1)
$\Phi U2-I2(^{\circ})$	Phase angle of the fundamental current component of element 2 (I2(1)) with respect to U2(1)
$\Phi U3-I3(^{\circ})$	Phase angle of the fundamental current component of element 3 (I3(1)) with respect to U3(1)

Note

- The numbers 1, 2, and 3 in the formulas indicate the case where input elements 1, 2, and 3 are set to the wiring system shown in the table.
- The lead/lag sign of the phase difference can be selected by the phase difference polarity setting.
 - When the phase difference polarity setting is Lead(-)/Lag(+):
Lead: negative (-), lag: positive (+) (output value: 0 to 360°)
 - When the phase difference polarity setting is Lead(+)/Lag(-):
Lead: positive (+), lag: negative (-) (output value: $\pm 180^{\circ}$)

(Table 6/6)

Measurement function	Formula
EaU1 to EaU4 (°) Eal1 to Eal4 (°)	For the encoder motor evaluation function Phase angle of the fundamental wave of U1 to I4 with respect to the falling edge of the Z-terminal input For the resolver motor evaluation function Phase angles of the fundamental waves of U1 to I4 with respect to the zero-degree pulse signal of the mechanical angle generated from the resolver rotation angle $EaU^* = \tan^{-1} \frac{Ur(1)}{Uj(1)} - B \qquad Eal^* = \tan^{-1} \frac{Ir(1)}{Ij(1)} - B$ Ur(1): real part of the fundamental voltage Ir(1): real part of the fundamental current Uj(1): imaginary part of the fundamental voltage Ij(1): imaginary part of the fundamental current B: electrical angle correction value B: electrical angle correction value

Note

- The lead/lag signs of the electrical angle are positive and negative, respectively. The signs do not change according to the phase difference polarity setting. The lead/lag signs of the electrical angle are fixed at positive (+) and negative (-), respectively.
- When using Motor evaluation for resolver, the electrical angle is uniquely determined only when the motor pole-pair count divided by the resolver pole-pair count is an integer.

Measurement functions for the encoder/resolver motor evaluation function (option)

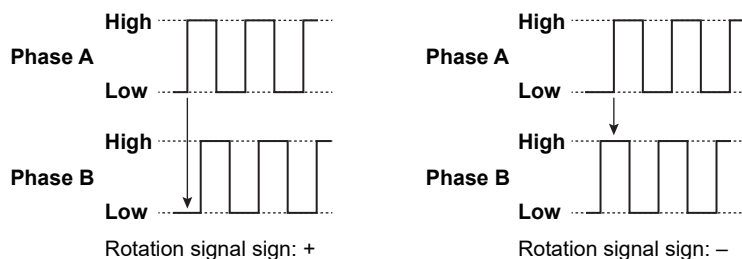
Measurement function	Input type	Method/formula
Rotation speed Speed	Analog	$S(AX + B - \text{NULL})$ S: scaling factor A: input signal slope X: input voltage from the rotation sensor B: offset value NULL: null value
	Pulse	$S\left(\frac{X}{N} - \text{NULL}\right)$ S: scaling factor X: number of input pulses from the rotation sensor per minute N: number of pulses per revolution NULL: null value • $X = f \times 60$. Here, f is the input frequency in Hz.
	Resolver	$S\left(\frac{X}{N}\right)$ S: scaling factor X: Number of resolver signal cycles per minute N: Resolver pole-pair count (number of resolver signal cycles per revolution) NULL: null value • $X = f \times 60$. Here, f is the input frequency in Hz.
Torque Torque	Analog	$S(AX + B - \text{NULL})$ S: scaling factor A: input signal slope X: input voltage from the torque meter B: offset value NULL: null value
	Pulse	$S(AX + B - \text{NULL})$ S: scaling factor A: torque pulse coefficient X: pulse frequency B: torque pulse offset NULL: null value The torque pulse coefficient and torque pulse offset are calculated internally by the instrument from two torque values [N·m] corresponding to the upper-limit and lower-limit frequencies. Normally, use 1 for the scaling factor. When using a unit other than N·m, set the unit conversion ratio.
Sync speed SyncSp	$\frac{120 \cdot \text{frequency of the frequency measurement source (Hz)}}{\text{Number of motor poles}}$ - The unit of sync speed is fixed at min^{-1} (or rpm). - Normally, use the voltage or current supplied to the motor as the frequency measurement source. If another signal is used, sync speed may not be determined correctly.	
Slip Slip [%]	$\frac{\text{SyncSp} - \text{Speed}}{\text{Speed}} \cdot 100$	
Motor output Pm	$\frac{2\pi \cdot \text{Speed} \cdot \text{Torque}}{60} \cdot \text{Scaling factor}$ When the Speed unit is min^{-1} (or rpm), the Torque unit is N·m, and the scaling factor is 1, the motor output Pm unit is W.	

Set motor efficiency and total efficiency using the efficiency formulas or user-defined functions.

Note

The sign of the rotational speed is as follows:

- When the MTR configuration is Single Motor (rotation signal: Pulse), the sign of the rotational speed is determined by the relationship between the A-phase pulse applied to Ch B/Ch F and the B-phase pulse applied to Ch C/Ch G. At the rising edge of the A-phase pulse, the sign is positive when the B-phase pulse is Low and negative when it is High.



- When the MTR configuration is Single Motor (rotation signal: Analog), the sign of the rotational speed is determined by the signal applied to Ch C/Ch G.
- When the MTR configuration is Double Motor, the sign of the rotational speed is always positive.

Measurement functions for auxiliary input (option)

Measurement function	Input type	Method/formula
AUX1 to 8	Analog	$S(AX + B - \text{NULL})$ S: scaling factor A: auxiliary signal slope X: average value of the input voltage of the auxiliary signal B: offset value NULL: null value
	Pulse	$S(AX + B - \text{NULL})$ S: scaling factor A: pulse coefficient X: pulse frequency B: offset value NULL: null value

Measurement range

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

Timestamp

Measurement function	Meaning of timestamp ¹
TS Date²	Date of the data update cycle, YYYY/MM/DD
TS Time²	Time of the data update cycle, hh:mm:ss
TS Subsec²	Fractional second of the data update cycle [μsec]
TS Date NrmPwr1 to 4³	Normal measurement: Date of the measurement interval for power elements 1 to 4, YYYY/MM/DD
TS Time NrmPwr1 to 4³	Normal measurement: Time of the measurement period for power elements 1 to 4, hh:mm:ss
TS Subsec NrmPwr1 to 4³	Normal measurement: Fractional second of the measurement period for power elements 1 to 4 [μsec]
TS Date NrmMtr1 to 4³	Normal measurement: Date of the measurement period for motor evaluation 1 to 4, YYYY/MM/DD
TS Time NrmMtr1 to 4³	Normal measurement: Time of the measurement period for motor evaluation 1 to 4, hh:mm:ss
TS Subsec NrmMtr1 to 4³	Normal measurement: Fractional second of the measurement period for motor evaluation 1 to 4 [μsec]
TS Date NrmAux1 to 8³	Normal measurement: Date of the measurement period for auxiliary input 1 to 8, YYYY/MM/DD
TS Time NrmAux1 to 8³	Normal measurement: Time of the measurement period for auxiliary input 1 to 8, hh:mm:ss
TS Subsec NrmAux1 to 8³	Normal measurement: Fractional second of the measurement period for auxiliary input 1 to 8 [μsec]
TS Date HrmPwr1 to 4³	Harmonic measurement: Date of the measurement period for power elements 1 to 4, YYYY/MM/DD
TS Time HrmPwr1 to 4³	Harmonic measurement: Time of the measurement period for power elements 1 to 4, hh:mm:ss
TS Subsec HrmPwr1 to 4³	Harmonic measurement: Fractional second of the measurement period for power elements 1 to 4 [μsec]

- 1 Timestamp is a measurement function that is valid when the measurement mode is Normal.
The data update interval's timestamp is the start position of the data update interval. The timestamp for the measurement period is the first sample of the measurement period.
- 2 Timestamp valid in all update modes (Constant/Trigger/Auto).
- 3 Timestamps valid when the update mode is Auto.

Update status

Measurement function	Meaning
UpdateStsPwr⁴	Update status of power element measurement values in normal measurement
UpdateStsMtr⁴	Update status of motor evaluation data in normal measurement
UpdateStsAux⁴	Update status of auxiliary input data in normal measurement
UpdateStsHrm⁴	Update status of power element data in harmonic measurement

- 4 Valid when the update mode is Auto.

Appendix 2 Basics of Power (Power, Harmonics, and RLC in AC Circuits)

This section explains basic matters such as power, harmonics, and the three constants of AC circuits (RLC).

Power

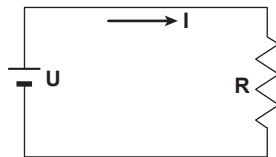
Electrical energy is used after being converted into various forms of energy, such as the heat of electric heaters and electric furnaces, the rotational force of motors, and the light of fluorescent lamps and mercury lamps. The amount of work done by electricity on such loads (electrical energy) per unit time is called electric power. The unit is W (watt). When 1 joule of work is done in 1 second, the electric power is 1 W.

DC Power

DC power P [W] is obtained from the product of the applied voltage U [V] and the current I [A] flowing through the circuit.

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

In the example below, this amount of electrical energy is drawn from the power supply every second and consumed by the resistor R [Ω] (load).

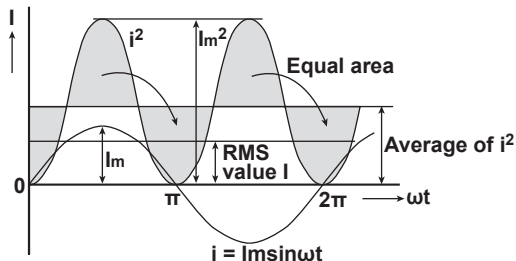


AC

Normally, the electricity supplied by electric power companies is AC, and its waveform is a sine wave. AC magnitude can be expressed in various ways, such as instantaneous value, maximum value, RMS value, and average value, but it is usually expressed as an RMS value.

The instantaneous current value i of sinusoidal AC is expressed as $I_m \sin \omega t$ (I_m : current amplitude, ω : angular velocity, where $\omega = 2\pi f$, and f : frequency of the sinusoidal AC). The heating effect* of this AC current is proportional to i^2 and changes as shown in the figure below.

* This means that electrical energy is converted into heat energy when current flows through a resistor.



The RMS value is the DC value that produces the same heating effect as the AC current. If the DC value that produces the same heating effect is I , then:

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

Since it corresponds to the square root of the mean of the squares of the instantaneous values i over one cycle (root mean square, abbreviated as RMS), the symbol “rms” is normally used to indicate the RMS value.

For the mean value, if the average over one cycle of a sine wave is taken as is, it becomes zero, so the absolute value is taken and then averaged over one cycle. As in the case of the RMS value, if the average value of the current whose instantaneous value is $i = I_m \sin \omega t$ is I_{mn} , then:

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

These relationships also apply to the voltage of a sinusoidal wave.

The maximum value, RMS value, and mean value of sinusoidal AC have the following relationships. To indicate the characteristics of the AC waveform, the crest factor and form factor are used.

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

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

Phasor representation of AC

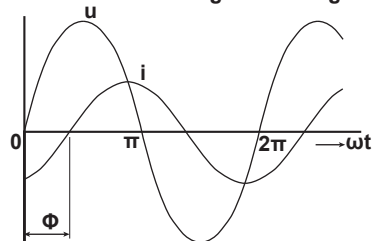
The instantaneous values of voltage and current are generally expressed by the following formulas:

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

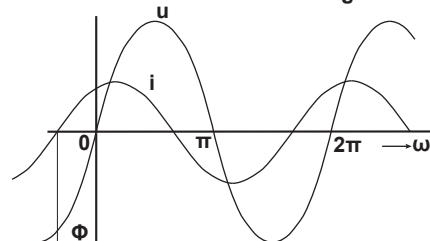
$$\text{Current: } i = I_m \sin(\omega t - \Phi)$$

The time difference between the voltage and current is called the phase difference, and Φ is called the phase angle. This time difference is caused mainly by the load to which power is supplied. In general, when the load has only resistance, the phase difference is zero. When the load has inductance (a coil), the current lags behind the voltage. When the load has capacitance, the current leads the voltage.

When the current lags the voltage



When the current leads the voltage



To make the magnitudes of voltage and current and their phase relationship easier to understand, phasor representation is used.

In phasor representation, voltage and current are expressed by the following formulas:

Voltage: Ue^{j0}

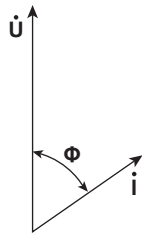
Current: $Ie^{-j\Phi}$

(Euler's formula: $e^{j\Phi} = \cos\Phi + j \sin\Phi$, where j is an imaginary number)

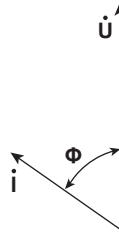
In this manual, the phasor magnitudes U and I represent RMS values.

The upward direction of the vertical axis is taken as the reference, and the counterclockwise angle is taken as the positive phase angle.

When the current lags the voltage



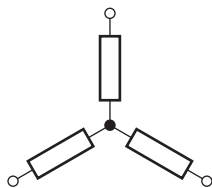
When the current leads the voltage



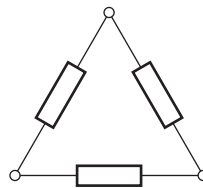
Three-phase AC connections

In general, in three-phase AC power supplies or loads, the power lines are connected in a star connection or a delta connection.

Star wiring

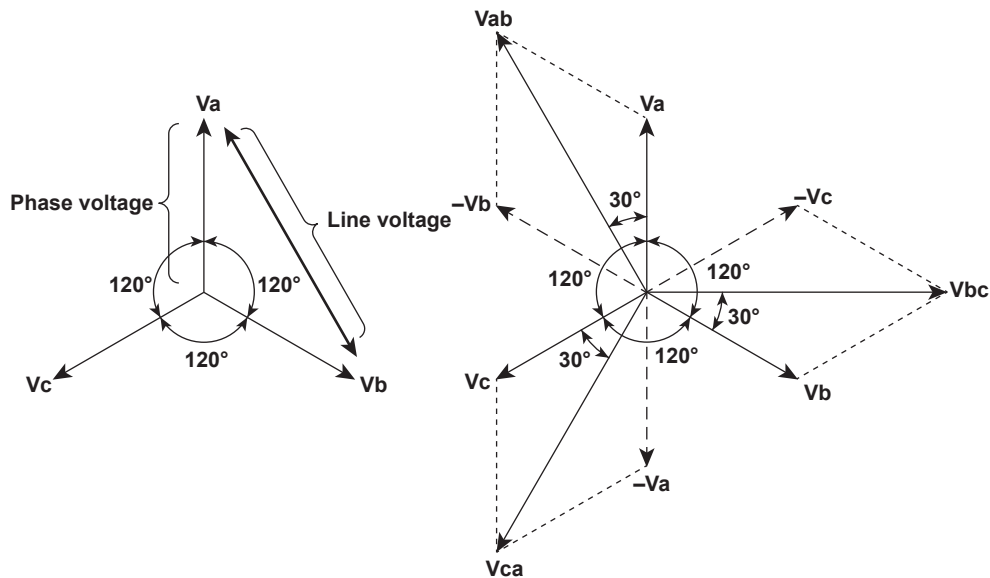


Delta wiring



Phasor representation of three-phase AC

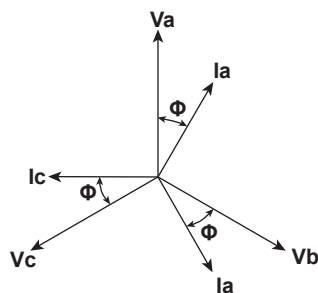
In general three-phase AC, the phase of each phase voltage is shifted by 120° . When this is displayed as a phasor diagram, it looks like the figure on the left below. The voltage of each phase is called the phase voltage, and the voltage between phases is called the line-to-line voltage.



When the power supply or load is delta-connected and there is no neutral line, the phase voltage cannot be measured. In that case, the line-to-line voltage is measured. The line-to-line voltage may also be measured to measure three-phase AC power with two single-phase wattmeters (this is called the two-wattmeter method).

When the phase voltages of each phase are equal in magnitude and shifted by 120° , the line-to-line voltage is $\sqrt{3}$ times the phase voltage in magnitude and shifted by 30° in phase (see the figure on the upper right).

When the current phase lags the voltage phase by Φ° , the phase relationship between the phase voltages and line currents of three-phase AC is shown in the following phasor diagram.



AC power

AC power cannot be obtained as simply as DC power because there is a phase difference between voltage and current, depending on the load.

Instantaneous power

When the instantaneous voltage value is $u = U_m \sin \omega t$ and the instantaneous current value is $i = I_m \sin(\omega t - \Phi)$, the instantaneous AC power value p is:

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

U and I represent the RMS values of voltage and current, respectively.

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

Active power P

The true power consumed by equipment is called active power P (active power or effective power). For the instantaneous power described above, this is the average power over one cycle.

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

Active power is the power consumed by equipment.

Apparent power S

In AC electricity, not all of the product of voltage and current, UI , is consumed power. The product UI is called apparent power S and represents the apparent power.

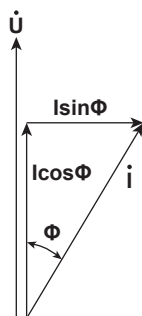
$$S = UI \text{ [VA]}$$

The unit is VA (volt-ampere). Apparent power is used to represent the electrical capacity of equipment operated by AC electricity.

Reactive power Q

Of the apparent power, the power that is not consumed by equipment and moves back and forth between the power supply and the load is called reactive power Q . When the current I lags the voltage U by Φ , if the current I is resolved into the component $I \cos \Phi$ in the same direction as the voltage U and the component $I \sin \Phi$ in the perpendicular direction, active power $P = UI \cos \Phi$ is the product of the voltage U and the current component $I \cos \Phi$. In contrast, reactive power is the product of the voltage U and the current component $I \sin \Phi$, and its unit is var.

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



Power factor λ

In the active power formula, $\cos\Phi$ indicates the proportion of apparent power that becomes active power. This is called power factor λ (power factor).

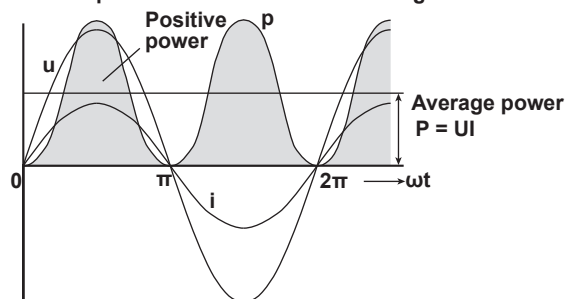
The following relationship exists among apparent power S , active power P , and reactive power Q .

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

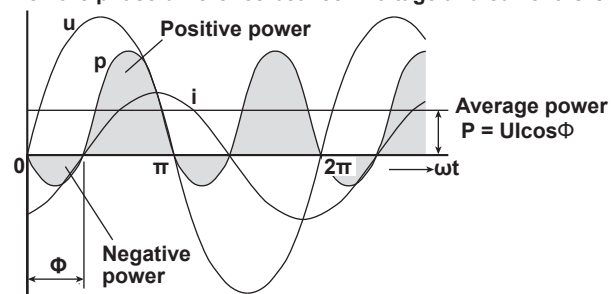
Effect of phase difference Φ

Even with the same voltage and current, the active power differs depending on the phase difference Φ . In the figure below, the area above the horizontal axis is positive power (power supplied to the load), and the area below the horizontal axis is negative power (power fed back from the load). The difference between the positive and negative power is the active power consumed by the load. As the phase difference between voltage and current increases, the negative power increases. When $\Phi = \pi/2$, the positive and negative power become equal, and no power is consumed.

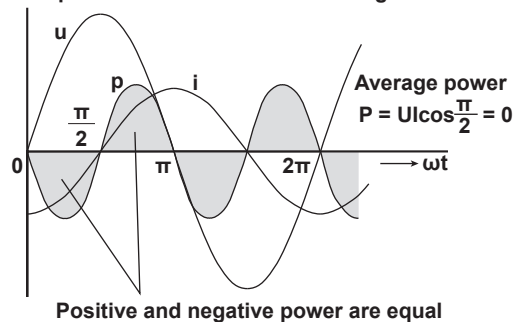
When the phase difference between voltage and current is 0



When the phase difference between voltage and current is Φ



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



Harmonics

Harmonics are sine waves with frequencies that are integer multiples of the fundamental wave (normally a 50/60 Hz power-frequency sine wave), excluding the fundamental wave itself. The input current flowing through power rectifier circuits, phase control circuits, and similar circuits used in various electrical and electronic equipment generates harmonic currents and voltages on the power line. When the fundamental wave and harmonics are combined, the waveform becomes distorted, which may cause problems in equipment connected to the power line.

Terminology

The following terms are used in relation to harmonics.

- **Fundamental wave (fundamental component)**
In a periodic composite wave, the sine wave with the longest period into which the wave can be divided. Or, among the components of a composite wave, the sine wave having the fundamental frequency.
- **Fundamental frequency**
In a periodic composite wave, the frequency corresponding to its period. The frequency of the fundamental wave.
- **Distorted wave**
A wave whose waveform differs from that of the fundamental wave.
- **Higher harmonic**
A sine wave having a frequency that is an integer multiple of 2 or greater of the fundamental frequency.
- **Harmonic component**
A waveform component having a frequency that is an integer multiple of 2 or greater of the fundamental frequency.
- **Harmonic distortion factor**
The ratio of the RMS value of a specified nth harmonic contained in a distorted wave to the RMS value of the fundamental wave (or full wave).
- **Harmonic order**
The ratio of the harmonic frequency to the fundamental frequency, expressed as an integer.
- **Total harmonic distortion**
The ratio of the RMS value of all harmonics to the RMS value of the fundamental wave (or full wave).

Interference caused by Harmonics

The following are examples of the effects of harmonics on electrical equipment and facilities.

- **Power-factor correction capacitors and series reactors**

A decrease in circuit impedance due to harmonic current causes excessive current to flow, resulting in vibration, humming, overheating, or burnout.

- **Cables**

Overheating of the neutral line caused by harmonic current flowing through the neutral line of a three-phase four-wire system.

- **Transformers**

Generation of magnetostrictive noise in the iron core, and increases in iron loss and copper loss.

- **Circuit breakers and fuses**

Malfunction or fuse blowing caused by excessive harmonic current.

- **Communication lines**

Generation of noise voltage due to electromagnetic induction.

- **Control equipment**

Malfunction due to disturbance of control signals.

- **AV equipment**

Degradation of performance or service life, screen flicker caused by noise, and component failure.

RLC in AC circuits

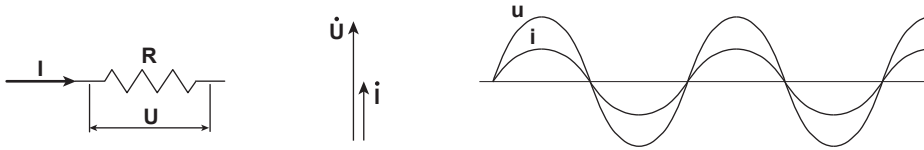
Resistance

When an AC voltage whose instantaneous value is $u = U_m \sin \omega t$ is applied to a resistive load with resistance $R [\Omega]$, the current i is expressed by the following formula. I_m indicates the current amplitude.

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

In terms of RMS values, $I = U/R$.

The current flowing through a resistive circuit has no phase difference with respect to the voltage.



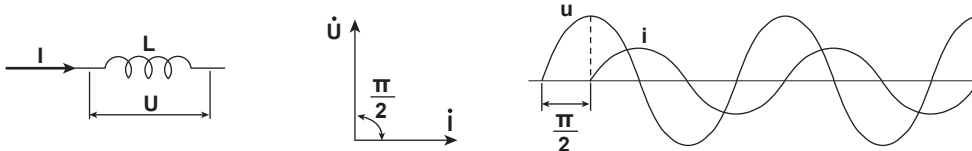
Inductance

When an AC voltage whose instantaneous value is $u = U_m \sin \omega t$ is applied to a coil load with inductance $L [H]$, the current i is expressed by the following formula.

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

In terms of RMS values, $I = U/X_L$. $X_L = \omega L$, where X_L is called the inductive reactance, and its unit is Ω .

Inductance acts to oppose changes in current (increase or decrease), so the phase of the current lags behind the voltage.



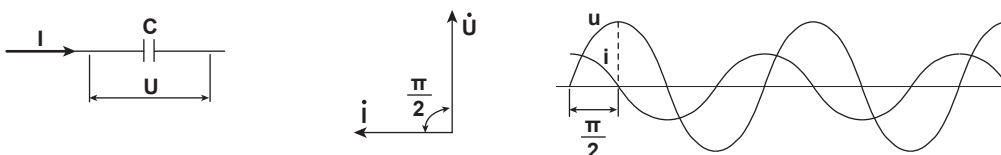
Capacitance

When an AC voltage whose instantaneous value is $u = U_m \sin \omega t$ is applied to a capacitive load with capacitance $C [F]$, the current i is expressed by the following formula.

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

In terms of RMS values, $I = U/X_C$. $X_C = 1/\omega C$, where X_C is called the capacitive reactance, and its unit is Ω .

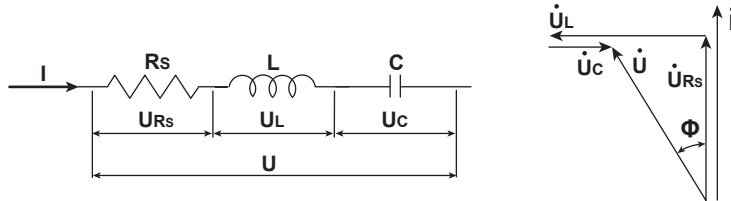
In a capacitor, when the voltage polarity changes, the largest charging current with the same polarity as the voltage flows. When the voltage decreases, a discharge current with the opposite polarity to the voltage flows. For this reason, the phase of the current leads the voltage.



Series RLC circuit

When a resistive load R_S [Ω], an inductive load L [H], and a capacitive load C [F] are connected in series, the relationship among the voltages is expressed by the following formula.

$$\begin{aligned} U &= \sqrt{(U_{R_S})^2 + (U_L - U_C)^2} = \sqrt{(IR_S)^2 + (IX_L - IX_C)^2} \\ &= I\sqrt{(R_S)^2 + (X_L - X_C)^2} = I\sqrt{R_S^2 + X_S^2} \\ I &= \frac{U}{\sqrt{R_S^2 + X_S^2}}, \quad \Phi = \tan^{-1} \frac{X_S}{R_S} \end{aligned}$$



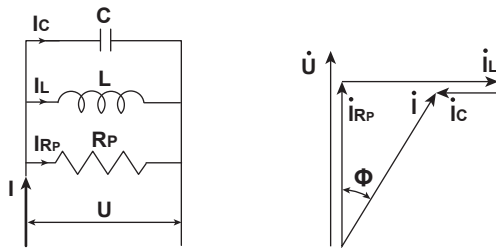
The relationship among the resistance R_S , reactance X_S , and impedance Z is as follows

$$\begin{aligned} X_S &= X_L - X_C \\ Z &= \sqrt{R_S^2 + X_S^2} \end{aligned}$$

Parallel RLC circuits

When a resistive load R_P [Ω], an inductive load L [H], and a capacitive load C [F] are connected in parallel, the relationship among the currents is expressed by the following formula.

$$\begin{aligned} I &= \sqrt{(IR_P)^2 + (I_L - I_C)^2} = \sqrt{\left(\frac{U}{R_P}\right)^2 + \left(\frac{U}{X_L} - \frac{U}{X_C}\right)^2} \\ &= U\sqrt{\left(\frac{1}{R_P}\right)^2 + \left(\frac{1}{X_L} - \frac{1}{X_C}\right)^2} = U\sqrt{\left(\frac{1}{R_P}\right)^2 + \left(\frac{1}{X_P}\right)^2} \\ U &= \frac{IR_P X_P}{\sqrt{R_P^2 + X_P^2}}, \quad \Phi = \tan^{-1} \frac{R_P}{X_P} \end{aligned}$$



The relationship among the resistance R_P , reactance X_P , and impedance Z is as follows

$$\begin{aligned} X_P &= \frac{X_L X_C}{X_C - X_L} \\ Z &= \frac{R_P X_P}{\sqrt{R_P^2 + X_P^2}} \end{aligned}$$

Appendix 3 Power Range

When the voltage range and current range are the same for each element that makes up a wiring unit, the active power range (unit: W) is as shown in the following table. The apparent power range (unit: VA) and reactive power range (unit: var) have the same range values as the active power range. Read the units as VA or var, respectively.

The number of displayed digits (display resolution) is five digits for values of 60000 or less and four digits for values greater than 60000.

When the crest factor setting is CF3

Active power range of the specified element

Sensor model: CT2000A

CT ratio: 2000

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	50.000	300.00 W	0.7500k W	1.5000k W	3.0000k W	7.500k W	15.000k W	30.000k W	50.000k W	100.00k W
50m	100.00	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.00k W	200.00k W
100m	200.00	1.2000k W	3.0000k W	6.0000k W	12.000k W	30.000k W	60.000k W	120.00k W	200.00k W	400.00k W
250m	500.00	3.0000k W	7.500k W	15.000k W	30.000k W	75.00k W	150.00k W	300.00k W	500.00k W	1.0000M W
500m	1.0000k	6.0000k W	15.000k W	30.000k W	60.000k W	150.00k W	300.00k W	600.00k W	1.0000M W	2.0000M W
1	2.0000k	12.000k W	30.000k W	60.000k W	120.00k W	300.00k W	600.00k W	1.2000M W	2.0000M W	4.0000M W

Sensor model: CT1000S

Output voltage rate: 2 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
50m	25.000	150.00 W	375.00 W	0.7500k W	1.5000k W	3.7500k W	7.500k W	15.000k W	25.000k W	50.000k W
100m	50.000	300.00 W	0.7500k W	1.5000k W	3.0000k W	7.500k W	15.000k W	30.000k W	50.000k W	100.00k W
200m	100.00	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.00k W	200.00k W
500m	250.00	1.5000k W	3.7500k W	7.500k W	15.000k W	37.500k W	75.00k W	150.00k W	250.00k W	500.00k W
1	500.00	3.0000k W	7.500k W	15.000k W	30.000k W	75.00k W	150.00k W	300.00k W	500.00k W	1.0000M W
2	1.0000k	6.0000k W	15.000k W	30.000k W	60.000k W	150.00k W	300.00k W	600.00k W	1.0000M W	2.0000M W
5	2.5000k	15.000k W	37.500k W	75.00k W	150.00k W	375.00k W	750.0k W	1.5000M W	2.5000M W	5.0000M W

Sensor model: CT1000A/CT1000

CT ratio: 1500

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	37.500	225.00 W	562.50 W	1.1250k W	2.2500k W	5.6250k W	11.250k W	22.500k W	37.500k W	75.00k W
50m	75.00	450.00 W	1.1250k W	2.2500k W	4.5000k W	11.250k W	22.500k W	45.000k W	75.00k W	150.00k W
100m	150.00	0.9000k W	2.2500k W	4.5000k W	9.000k W	22.500k W	25.000k W	90.00k W	150.00k W	300.00k W
250m	375.00	2.2500k W	5.6250k W	11.250k W	22.500k W	56.250k W	112.50k W	225.00k W	375.00k W	0.7500M W
500m	0.7500k	4.5000k W	11.250k W	22.500k W	45.000k W	112.50k W	225.00k W	450.00k W	0.7500M W	1.5000M W
1	1.5000k	9.000k W	22.500k W	45.000k W	90.00k W	225.00k W	450.00k W	0.9000M W	1.5000M W	3.0000M W

Sensor model: CT200

CT ratio: 1000

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	25.000	150.00 W	375.00 W	0.7500k W	1.5000k W	3.7500k W	7.500k W	15.000k W	25.000k W	50.000k W
50m	50.000	300.00 W	0.7500k W	1.5000k W	3.0000k W	7.500k W	15.000k W	30.000k W	50.000k W	100.00k W
100m	100.00	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.00k W	200.00k W
250m	250.00	1.5000k W	3.7500k W	7.500k W	15.000k W	37.500k W	75.00k W	150.00k W	250.00k W	500.00k W
500m	500.00	3.0000k W	7.500k W	15.000k W	30.000k W	75.00k W	150.00k W	300.00k W	500.00k W	1.0000M W
1	1.0000k	6.0000k W	15.000k W	30.000k W	60.000k W	150.00k W	300.00k W	600.00k W	1.0000M W	2.0000M W

Sensor model: CT60

CT ratio: 600

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	15.000	90.00 W	225.00 W	450.00 W	0.9000k W	2.2500k W	4.5000k W	9.000k W	15.000k W	30.000k W
50m	30.000	180.00 W	450.00 W	0.9000k W	1.8000k W	4.5000k W	9.000k W	18.000k W	30.000k W	60.000k W
100m	60.000	360.00 W	0.9000k W	1.8000k W	3.6000k W	9.000k W	18.000k W	36.000k W	60.000k W	120.00k W
250m	150.000	0.9000k W	2.2500k W	4.5000k W	9.000k W	22.500k W	45.000k W	90.00k W	150.00k W	300.00k W
500m	300.000	1.8000k W	4.5000k W	9.000k W	18.000k W	45.000k W	90.00k W	180.00k W	300.00k W	600.00k W
1	600.000	3.6000k W	9.000k W	18.000k W	36.000k W	90.00k W	180.00k W	360.00k W	600.00k W	1.2000M W

Sensor model: 720930

Output voltage rate: 10 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
50m	5.0000	30.000 W	75.00 W	150.00 W	300.00 W	0.7500k W	1.5000k W	3.0000k W	5.0000k W	10.000k W
100m	10.000	60.000 W	150.00 W	300.00 W	600.00 W	1.5000k W	3.0000k W	6.0000k W	10.000k W	20.000k W
200m	20.000	120.00 W	300.00 W	600.00 W	1.2000k W	3.0000k W	6.0000k W	12.000k W	20.000k W	40.000k W
500m	50.000	300.00 W	0.7500k W	1.5000k W	3.0000k W	7.500k W	15.000k W	30.000k W	50.000k W	100.00k W
1	100.00	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.00k W	200.00k W
2	200.00	1.2000k W	3.0000k W	6.0000k W	12.000k W	30.000k W	60.000k W	120.00k W	200.00k W	400.00k W
5	500.00	3.0000k W	7.500k W	15.000k W	30.000k W	75.00k W	150.00k W	300.00k W	500.00k W	1.0000M W

Sensor model: 720931

Output voltage rate: 2.5 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
50m	20.000	120.00 W	300.00 W	600.00 W	1.2000k W	3.0000k W	6.0000k W	12.000k W	20.000k W	40.000k W
100m	40.000	240.00 W	600.00 W	1.2000k W	2.4000k W	6.0000k W	12.000k W	24.000k W	40.000k W	80.00k W
200m	80.00	480.00 W	1.2000k W	2.4000k W	4.8000k W	12.000k W	24.000k W	48.000k W	80.00k W	160.00k W
500m	200.00	1.2000k W	3.0000k W	6.0000k W	12.000k W	30.000k W	60.000k W	120.00k W	200.00k W	400.00k W
1	400.00	2.4000k W	6.0000k W	12.000k W	24.000k W	60.000k W	120.00k W	240.00k W	400.00k W	0.8000M W
2	800.0	4.8000k W	12.000k W	24.000k W	48.000k W	120.00k W	240.00k W	480.00k W	0.8000M W	1.6000M W
5	2.0000k	12.000k W	30.000k W	60.000k W	120.00k W	300.00k W	600.00k W	1.2000M W	2.0000M W	4.0000M W

Active power range for wiring units using the 1P3W, 3P3W, 3P3W(3V3A), and 3P3W(3V3AR) wiring systems

Sensor model: CT2000A

CT ratio: 2000

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	50.000	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.00k W	200.00k W
50m	100.00	1200.00 W	3.0000k W	6.0000k W	12.0000k W	30.000k W	60.000k W	120.000k W	200.00k W	400.00k W
100m	200.00	2.4000k W	6.0000k W	12.0000k W	24.000k W	60.000k W	120.000k W	240.00k W	400.00k W	800.00k W
250m	500.00	6.0000k W	15.000k W	30.000k W	60.000k W	150.00k W	300.00k W	600.00k W	1.0000M W	2.0000M W
500m	1.0000k	12.0000k W	30.000k W	60.000k W	120.000k W	300.00k W	600.00k W	1200.00k W	2.0000M W	4.0000M W
1	2.0000k	24.000k W	60.000k W	120.000k W	240.00k W	600.00k W	1200.00k W	2.4000M W	4.0000M W	8.0000M W

Sensor model: CT1000S

Output voltage rate: 2 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
50m	25.000	300.00 W	750.00k W	1.5000k W	3.0000k W	7.5000k W	15.000k W	30.000k W	50.000k W	100.000k W
100m	50.000	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	20.000k W	60.000k W	100.000k W	200.00k W
200m	100.00	1200.00 W	3.0000k W	6.0000k W	12.0000k W	30.000k W	60.000k W	120.000k W	200.00k W	400.00k W
500m	250.00	3.0000k W	7.5000k W	15.000k W	30.000k W	75.000k W	150.00k W	300.00k W	500.00k W	1000.00k W
1	500.00	6.0000k W	15.000k W	30.000k W	60.000k W	150.00k W	300.00k W	600.00k W	1000.00k W	2.0000M W
2	1.0000k	12.0000k W	30.000k W	40.000k W	120.000k W	300.00k W	600.00k W	1200.00k W	2.0000M W	4.0000M W
5	2.5000k	30.000k W	75.000k W	150.00k W	300.00k W	750.00k W	1500.0k W	3.0000M W	5.0000M W	10.0000M W

Sensor model: CT1000A/CT1000

CT ratio: 1500

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	37.500	450.00 W	1125.00 W	2.2500k W	4.5000k W	11.2500k W	22.500k W	45.000k W	75.000k W	150.00k W
50m	75.00	900.00 W	2.2500k W	4.5000k W	9.0000k W	22.500k W	45.000k W	90.000k W	150.00k W	300.00k W
100m	150.00	1.8000k W	4.5000k W	9.0000k W	18.000k W	45.000k W	90.000k W	180.00k W	300.00k W	600.00k W
250m	375.00	4.5000k W	11.2500k W	22.500k W	45.000k W	112.500k W	225.00k W	450.00k W	750.00k W	1.5000M W
500m	0.7500k	9.0000k W	22.500k W	45.000k W	90.000k W	225.00k W	450.00k W	900.00k W	1.5000M W	3.0000M W
1	1.5000k	18.000k W	45.000k W	90.000k W	180.00k W	450.00k W	900.00k W	1.8000M W	3.0000M W	6.0000M W

Sensor model: CT200

CT ratio: 1000

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	25.000	300.00 W	750.00 W	1.5000k W	3.0000k W	7.5000k W	15.000k W	30.000k W	50.000k W	100.000k W
50m	50.000	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.000k W	200.00k W
100m	100.00	1200.00 W	3.0000k W	6.0000k W	12.0000k W	30.000k W	60.000k W	120.000k W	200.00k W	400.00k W
250m	250.00	3.0000k W	7.5000k W	15.000k W	30.000k W	75.000k W	150.00k W	300.00k W	500.00k W	1000.00k W
500m	500.00	6.0000k W	15.000k W	30.000k W	60.000k W	150.00k W	300.00k W	600.00k W	1000.00k W	2.0000M W
1	1.0000k	12.0000k W	30.000k W	60.000k W	120.000k W	300.00k W	600.00k W	1200.00k W	2.0000M W	4.0000M W

Sensor model: CT60

CT ratio: 600

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	15.000	180.00 W	450.00 W	900.00 W	1.8000k W	4.5000k W	9.0000k W	18.000k W	30.000k W	60.000k W
50m	30.000	360.00 W	900.00 W	1.8000k W	3.6000k W	9.0000k W	18.000k W	36.000k W	60.000k W	120.000k W
100m	60.000	720.00 W	1.8000k W	3.6000k W	7.2000k W	18.000k W	36.000k W	72.000k W	120.000k W	240.00k W
250m	150.000	1.8000k W	4.5000k W	9.0000k W	18.000k W	45.000k W	90.000k W	180.00k W	300.00k W	600.00k W
500m	300.000	3.6000k W	9.0000k W	18.000k W	36.000k W	90.000k W	180.00k W	360.00k W	600.00k W	1200.00k W
1	600.000	7.2000k W	18.000k W	36.000k W	72.000k W	180.00k W	360.00k W	720.00k W	1200.00k W	2.4000M W

Sensor model: 720930

Output voltage rate: 10 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
50m	5.0000	60.000 W	150.00 W	300.00 W	600.00 W	1.5000k W	3.0000k W	6.0000k W	10.0000k W	20.000k W
100m	10.000	120.000 W	300.00 W	600.00 W	1200.00 W	3.0000k W	6.0000k W	12.0000k W	20.000k W	40.000k W
200m	20.000	240.00 W	600.00 W	1200.00 W	2.4000k W	6.0000k W	12.0000k W	24.000k W	40.000k W	80.000k W
500m	50.000	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.000k W	200.00k W
1	100.00	1200.00 W	3.0000k W	6.0000k W	12.0000k W	30.000k W	60.000k W	120.000k W	200.00k W	400.00k W
2	200.00	2.4000k W	6.0000k W	12.0000k W	24.000k W	60.000k W	120.000k W	240.00k W	400.00k W	800.00k W
5	500.00	6.0000k W	15.000k W	30.000k W	60.000k W	150.00k W	300.00k W	600.00k W	1000.00k W	2.0000M W

Sensor model: 720931

Output voltage rate: 2.5 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
50m	20.000	240.00 W	600.00 W	1200.00 W	2.4000k W	6.0000k W	12.0000k W	24.000k W	40.000k W	80.000k W
100m	40.000	480.00 W	1200.00 W	2.4000k W	4.8000k W	12.0000k W	24.000k W	48.000k W	80.000k W	160.00k W
200m	80.00	960.00 W	2.4000k W	4.8000k W	9.6000k W	24.000k W	48.000k W	96.000k W	160.00k W	320.00k W
500m	200.00	2.4000k W	6.0000k W	12.0000k W	24.000k W	60.000k W	120.000k W	240.00k W	400.00k W	800.00k W
1	400.00	4.8000k W	12.0000k W	24.000k W	48.000k W	120.000k W	240.00k W	480.00k W	800.00k W	1.6000M W
2	800.0	9.6000k W	24.000k W	48.000k W	96.000k W	240.00k W	480.00k W	960.00k W	1.6000M W	3.2000M W
5	2.0000k	24.000k W	60.000k W	120.000k W	240.00k W	600.00k W	1200.00k W	2.4000M W	4.0000M W	8.0000M W

Active power range for wiring units using the 3P4W wiring system**Sensor model: CT2000A****CT ratio: 2000**

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	50.000	900.00 W	2.2500k W	4.5000k W	9.0000k W	22.500k W	45.000k W	90.000k W	150.000k W	300.00k W
50m	100.00	1800.00 W	4.5000k W	9.0000k W	18.0000k W	45.000k W	90.000k W	180.000k W	300.00k W	600.00k W
100m	200.00	3.6000k W	9.0000k W	18.0000k W	36.000k W	90.000k W	180.000k W	360.00k W	600.00k W	1200.00k W
250m	500.00	9.0000k W	22.500k W	45.000k W	90.000k W	225.00k W	450.00k W	900.00k W	1500.00k W	3.0000M W
500m	1.0000k	18.0000k W	45.000k W	90.000k W	180.000k W	450.00k W	900.00k W	1800.00k W	3.0000M W	6.0000M W
1	2.0000k	36.000k W	90.000k W	180.000k W	360.00k W	900.00k W	1800.00k W	3.6000M W	6.0000M W	12.0000M W

Sensor model: CT1000S**Output voltage rate: 2 [mV/A]**

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
50m	25.000	450.00 W	1125.00 W	2.2500k W	4.5000k W	11.2500k W	22.500k W	45.000k W	75.000k W	150.000k W
100m	50.000	900.00 W	2.2500k W	4.5000k W	9.0000k W	22.500k W	45.000k W	90.000k W	150.000k W	300.00k W
200m	100.00	1800.00 W	4.5000k W	9.0000k W	18.0000k W	45.000k W	90.000k W	180.000k W	300.00k W	600.00k W
500m	250.00	4.5000k W	11.2500k W	22.500k W	45.000k W	112.500k W	225.00k W	450.00k W	750.00k W	1500.00k W
1	500.00	9.0000k W	22.500k W	45.000k W	90.000k W	225.00k W	450.00k W	900.00k W	1500.00k W	3.0000M W
2	1.0000k	18.0000k W	45.000k W	90.000k W	180.000k W	450.00k W	900.00k W	1800.00k W	3.0000M W	4.0000M W
5	2.5000k	45.000k W	112.500k W	225.00k W	450.00k W	1125.00k W	2250.0k W	4.5000M W	7.5000M W	10.0000M W

Sensor model: CT1000A/CT1000**CT ratio: 1500**

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	37.500	675.00 W	1687.50 W	3.3750k W	6.7500k W	16.8750k W	33.750k W	67.500k W	112.500k W	225.00k W
50m	75.00	1350.00 W	3.3750k W	6.7500k W	13.5000k W	33.750k W	67.500k W	135.000k W	225.00k W	450.00k W
100m	150.00	2.7000k W	6.7500k W	13.5000k W	27.000k W	67.500k W	135.000k W	270.00k W	450.00k W	900.00k W
250m	375.00	6.7500k W	16.8750k W	33.750k W	67.500k W	168.750k W	337.50k W	675.00k W	1125.00k W	2.2500M W
500m	0.7500k	13.5000k W	33.750k W	67.500k W	135.000k W	337.50k W	675.00k W	1350.00k W	2.2500M W	4.5000M W
1	1.5000k	27.000k W	67.500k W	135.000k W	270.00k W	675.00k W	1350.00k W	2.7000M W	4.5000M W	9.0000M W

Sensor model: CT200**CT ratio: 1000**

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	25.000	450.00 W	1125.00 W	2.2500k W	4.5000k W	11.2500k W	22.500k W	45.000k W	75.000k W	150.000k W
50m	50.000	900.00 W	2.2500k W	4.5000k W	9.0000k W	22.500k W	45.000k W	90.000k W	150.000k W	300.00k W
100m	100.00	1800.00 W	4.5000k W	9.0000k W	18.0000k W	45.000k W	90.000k W	180.000k W	300.00k W	600.00k W
250m	250.00	4.5000k W	11.2500k W	22.500k W	45.000k W	112.500k W	225.00k W	450.00k W	750.00k W	1500.00k W
500m	500.00	9.0000k W	22.500k W	45.000k W	90.000k W	225.00k W	450.00k W	900.00k W	1500.00k W	3.0000M W
1	1.0000k	18.0000k W	45.000k W	90.000k W	180.000k W	450.00k W	900.00k W	1800.00k W	3.0000M W	6.0000M W

Sensor model: CT60**CT ratio: 600**

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
25m	15.000	270.00 W	675.00 W	1.35000k W	2.7000k W	6.7500k W	13.5000k W	27.000k W	45.000k W	90.000k W
50m	30.000	540.00 W	1350.00 W	2.7000k W	5.4000k W	13.5000k W	27.000k W	54.000k W	90.000k W	180.000k W
100m	60.000	1080.00 W	2.7000k W	5.4000k W	10.8000k W	27.000k W	54.000k W	108.000k W	180.000k W	360.00k W
250m	150.000	2.7000k W	6.7500k W	13.5000k W	27.000k W	67.500k W	135.000k W	270.00k W	450.00k W	900.00k W
500m	300.000	5.4000k W	13.5000k W	27.000k W	54.000k W	135.000k W	270.00k W	540.00k W	900.00k W	1800.00k W
1	600.000	10.8000k W	27.000k W	54.000k W	108.000k W	270.00k W	540.00k W	1080.00k W	1800.00k W	3.6000M W

Sensor model: 720930

Output voltage rate: 10 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
50m	5.0000	90.000 W	225.00 W	450.00 W	900.00 W	2.2500k W	4.5000k W	9.0000k W	15.0000k W	30.000k W
100m	10.000	180.000 W	450.00 W	900.00 W	1800.00 W	4.5000k W	9.0000k W	18.0000k W	30.000k W	60.000k W
200m	20.000	360.00 W	900.00 W	1800.00 W	3.6000k W	9.0000k W	18.0000k W	36.000k W	60.000k W	120.000k W
500m	50.000	900.00 W	2.2500k W	4.5000k W	9.0000k W	22.500k W	45.000k W	90.000k W	150.000k W	300.00k W
1	100.00	1800.00 W	4.5000k W	9.0000k W	18.0000k W	45.000k W	90.000k W	180.000k W	300.00k W	600.00k W
2	200.00	3.6000k W	9.0000k W	18.0000k W	36.000k W	90.000k W	180.000k W	360.00k W	600.00k W	1200.00k W
5	500.00	9.0000k W	22.500k W	45.000k W	90.000k W	225.00k W	450.00k W	900.00k W	1500.00k W	3.0000M W

Sensor model: 720931

Output voltage rate: 2.5 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	6.0000	15.000	30.000	60.000	150.00	300.00	600.00	1.0000k	2.0000k
50m	20.000	360.00 W	900.00 W	1800.00 W	3.6000k W	9.0000k W	18.0000k W	36.000k W	60.000k W	120.000k W
100m	40.000	720.00 W	1800.00 W	3.6000k W	7.2000k W	18.0000k W	36.000k W	72.000k W	120.000k W	240.00k W
200m	80.00	1440.00 W	3.6000k W	7.2000k W	14.4000k W	36.000k W	72.000k W	144.000k W	240.00k W	480.00k W
500m	200.00	3.6000k W	9.0000k W	18.0000k W	36.000k W	90.000k W	180.000k W	360.00k W	600.00k W	1200.00k W
1	400.00	7.2000k W	18.0000k W	36.000k W	72.000k W	180.000k W	360.00k W	720.00k W	1200.00k W	2.4000M W
2	800.0	14.4000k W	36.000k W	72.000k W	144.000k W	360.00k W	720.00k W	1440.00k W	2.4000M W	4.8000M W
5	2.0000k	36.000k W	90.000k W	180.000k W	360.00k W	900.00k W	1800.00k W	3.6000M W	6.0000M W	12.0000M W

When the crest factor is set to CF6 or CF6A

Active power range of the specified element

Sensor model: CT2000A

CT ratio: 2000

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	25.000	75.00 W	187.50 W	375.00 W	0.7500k W	1.8750k W	3.7500k W	7.500k W	12.500k W	25.000k W
25m	50.000	150.00 W	375.00 W	0.7500k W	1.5000k W	3.7500k W	7.500k W	15.000k W	25.000k W	50.000k W
50m	100.00	300.00 W	0.7500k W	1.5000k W	3.0000k W	7.500k W	15.000k W	30.000k W	50.000k W	100.00k W
125m	250.00	0.7500k W	1.8750k W	3.7500k W	7.500k W	18.750k W	37.500k W	75.00k W	125.00k W	250.00k W
250m	500.00	1.5000k W	3.7500k W	7.500k W	15.000k W	37.500k W	75.00k W	150.00k W	250.00k W	500.00k W
500m	1.0000k	3.0000k W	7.500k W	15.000k W	30.000k W	75.00k W	150.00k W	300.00k W	500.00k W	1.0000M W

Sensor model: CT1000S

Output voltage rate: 2 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
25m	12.500	37.500 W	93.75 W	187.50 W	375.00 W	0.9375k W	1.8750k W	3.7500k W	6.250k W	12.500k W
50m	25.000	75.00 W	187.50 W	375.00 W	0.7500k W	1.8750k W	3.7500k W	7.500k W	12.500k W	25.000k W
100m	50.000	150.00 W	375.00 W	0.7500k W	1.5000k W	3.7500k W	7.500k W	15.000k W	25.000k W	50.000k W
250m	125.00	375.00 W	0.9375k W	1.8750k W	3.7500k W	9.375k W	18.750k W	37.500k W	62.50k W	125.00k W
500m	250.00	0.7500k W	1.8750k W	3.7500k W	7.500k W	18.750k W	37.500k W	75.00k W	125.00k W	250.00k W
1	500.00	1.5000k W	3.7500k W	7.500k W	15.000k W	37.500k W	75.00k W	150.00k W	250.00k W	500.00k W
2.5	1.2500k	3.7500k W	9.375k W	18.750k W	37.500k W	93.75k W	187.50k W	375.00k W	0.6250M W	1.2500M W

Sensor model: CT1000A/CT1000

CT ratio: 1500

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	18.750	56.250 W	140.63 W	281.25 W	562.50 W	1.4063k W	2.8125k W	5.6250k W	9.375k W	18.750k W
25m	37.500	112.50 W	281.25 W	562.50 W	1.1250k W	2.8125k W	5.6250k W	11.250k W	18.750k W	37.500k W
50m	75.00	225.00 W	562.50 W	1.1250k W	2.2500k W	5.6250k W	11.250k W	22.500k W	37.500k W	75.00k W
125m	187.50	562.50 W	1.4063k W	2.8125k W	5.6250k W	14.063k W	28.125k W	56.250k W	93.75k W	187.50k W
250m	375.00	1.1250k W	2.8125k W	5.6250k W	11.250k W	28.125k W	56.250k W	112.50k W	187.50k W	375.00k W
500m	0.7500k	2.2500k W	5.6250k W	11.250k W	22.500k W	56.250k W	112.50k W	225.00k W	375.00k W	0.7500M W

Sensor model: CT200

CT ratio: 1000

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	12.500	37.500 W	93.75 W	187.50 W	375.00 W	0.9375k W	1.8750k W	3.7500k W	6.250k W	12.500k W
25m	25.000	75.00 W	187.50 W	375.00 W	0.7500k W	1.8750k W	3.7500k W	7.500k W	12.500k W	25.000k W
50m	50.000	150.00 W	375.00 W	0.7500k W	1.5000k W	3.7500k W	7.500k W	15.000k W	25.000k W	50.000k W
125m	125.00	375.00 W	0.9375k W	1.8750k W	3.7500k W	9.375k W	18.750k W	37.500k W	62.50k W	125.00k W
250m	250.00	0.7500k W	1.8750k W	3.7500k W	7.500k W	18.750k W	37.500k W	75.00k W	125.00k W	250.00k W
500m	500.00	1.5000k W	3.7500k W	7.500k W	15.000k W	37.500k W	75.00k W	150.00k W	250.00k W	500.00k W

Sensor model: CT60

CT ratio: 600

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	7.500	22.500 W	56.250 W	112.50 W	225.00 W	562.50 W	1.1250k W	2.2500k W	3.7500k W	7.500k W
25m	15.000	45.000 W	112.50 W	225.00 W	450.00 W	1.1250k W	2.2500k W	4.5000k W	7.500k W	15.000k W
50m	30.000	90.00 W	225.00 W	450.00 W	0.9000k W	2.2500k W	4.5000k W	9.000k W	15.000k W	30.000k W
125m	75.00	225.00 W	562.50 W	1.1250k W	2.2500k W	5.6250k W	11.250k W	22.500k W	37.500k W	75.00k W
250m	150.00	450.00 W	1.1250k W	2.2500k W	4.5000k W	11.250k W	22.500k W	45.000k W	75.00k W	150.00k W
500m	300.00	0.9000k W	2.2500k W	4.5000k W	9.000k W	22.500k W	45.000k W	90.00k W	150.00k W	300.00k W

Sensor model: 720930

Output voltage rate: 10 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
25m	5.0000	15.000 W	37.500 W	75.00 W	150.00 W	375.00 W	0.7500k W	1.5000k W	2.5000k W	5.0000k W
50m	10.000	30.000 W	75.00 W	150.00 W	300.00 W	0.7500k W	1.5000k W	3.0000k W	5.0000k W	10.000k W
100m	20.000	60.000 W	150.00 W	300.00 W	600.00 W	1.5000k W	3.0000k W	6.0000k W	10.000k W	20.000k W
250m	50.000	150.00 W	375.00 W	0.7500k W	1.5000k W	3.7500k W	7.500k W	15.000k W	25.000k W	50.000k W
500m	100.00	300.00 W	0.7500k W	1.5000k W	3.0000k W	7.500k W	15.000k W	30.000k W	50.000k W	100.00k W
1	200.00	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.00k W	200.00k W
2.5	500.00	1.5000k W	3.7500k W	7.500k W	15.000k W	37.500k W	75.00k W	150.00k W	250.00k W	500.00k W

Sensor model: 720931

Output voltage rate: 2.5 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
25m	20.000	60.000 W	150.00 W	300.00 W	600.00 W	1.5000k W	3.0000k W	6.0000k W	10.000k W	20.000k W
50m	40.000	120.00 W	300.00 W	600.00 W	1.2000k W	3.0000k W	6.0000k W	12.000k W	20.000k W	40.000k W
100m	80.00	240.00 W	600.00 W	1.2000k W	2.4000k W	6.0000k W	12.000k W	24.000k W	40.000k W	80.00k W
250m	200.00	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.00k W	200.00k W
500m	400.00	1.2000k W	3.0000k W	6.0000k W	12.000k W	30.000k W	60.000k W	120.00k W	200.00k W	400.00k W
1	0.8000k	2.4000k W	6.0000k W	12.000k W	24.000k W	60.000k W	120.00k W	240.00k W	400.00k W	0.8000M W
2.5	2.0000k	6.0000k W	15.000k W	30.000k W	60.000k W	150.00k W	300.00k W	600.00k W	1.0000M W	2.0000M W

Active power range for wiring units using the 1P3W, 3P3W, 3P3W(3V3A), and 3P3W(3V3AR) wiring systems

Sensor model: CT2000A

CT ratio: 2000

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	25.000	150.00 W	375.00 W	750.00 W	1.5000k W	3.7500k W	7.5000k W	15.000k W	25.000k W	50.000k W
25m	50.000	300.00 W	750.00 W	1.5000k W	3.0000k W	7.5000k W	15.000k W	30.000k W	50.000k W	100.000k W
50m	100.00	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.000k W	200.00k W
125m	250.00	1.5000k W	3.7500k W	7.5000k W	15.000k W	37.500k W	75.000k W	150.00k W	250.00k W	500.00k W
250m	500.00	3.0000k W	7.5000k W	15.000k W	30.000k W	75.000k W	150.00k W	300.00k W	500.00k W	1000.00k W
500m	1.0000k	6.0000k W	15.000k W	30.000k W	60.000k W	150.00k W	300.00k W	600.00k W	1000.00k W	2.0000M W

Sensor model: CT1000S

Output voltage rate: 2 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
25m	12.500	75.000 W	187.50 W	375.00 W	750.00 W	1.8750k W	3.7500k W	7.5000k W	12.500k W	25.000k W
50m	25.000	150.00 W	375.00 W	750.00 W	1.5000k W	3.7500k W	7.5000k W	15.000k W	25.000k W	50.000k W
100m	50.000	300.00 W	750.00 W	1.5000k W	3.0000k W	7.5000k W	15.000k W	30.000k W	50.000k W	100.000k W
250m	125.00	750.00 W	1.8750k W	3.7500k W	7.5000k W	18.750k W	37.500k W	75.000k W	125.00k W	250.00k W
500m	250.00	1.5000k W	3.7500k W	7.5000k W	15.000k W	37.500k W	75.000k W	150.00k W	250.00k W	500.00k W
1	500.00	3.0000k W	7.5000k W	15.000k W	30.000k W	75.000k W	150.00k W	300.00k W	500.00k W	1000.00k W
2.5	1.2500k	7.5000k W	18.750k W	37.500k W	75.000k W	187.50k W	375.00k W	750.00k W	1.2500M W	2.5000M W

Sensor model: CT1000A/CT1000

CT ratio: 1500

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	18.750	112.500 W	281.25 W	562.50 W	1125.00 W	2.8125k W	5.6250k W	11.2500k W	18.750k W	37.500k W
25m	37.500	225.00 W	562.50 W	1125.00 W	2.2500k W	5.6250k W	11.2500k W	22.500k W	37.500k W	75.000k W
50m	75.00	450.00 W	1125.00 W	2.2500k W	4.5000k W	11.2500k W	22.500k W	45.000k W	75.000k W	150.00k W
125m	187.50	1125.00 W	2.8125k W	5.6250k W	11.2500k W	28.125k W	56.250k W	112.500k W	187.50k W	375.00k W
250m	375.00	2.2500k W	5.6250k W	11.2500k W	22.500k W	56.250k W	112.500k W	225.00k W	375.00k W	750.00k W
500m	0.7500k	4.5000k W	11.2500k W	22.500k W	45.000k W	112.500k W	225.00k W	450.00k W	750.00k W	1.5000M W

Sensor model: CT200

CT ratio: 1000

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	12.500	75.000 W	187.50 W	375.00 W	750.00 W	1.8750k W	3.7500k W	7.5000k W	12.500k W	25.000k W
25m	25.000	150.00 W	375.00 W	750.00 W	1.5000k W	3.7500k W	7.5000k W	15.000k W	25.000k W	50.000k W
50m	50.000	300.00 W	750.00 W	1.5000k W	3.0000k W	7.5000k W	15.000k W	30.000k W	50.000k W	100.00k W
125m	125.00	750.00 W	1.8750k W	3.7500k W	7.5000k W	18.750k W	37.500k W	75.000k W	125.00k W	250.00k W
250m	250.00	1.5000k W	3.7500k W	7.5000k W	15.000k W	37.500k W	75.000k W	150.00k W	250.00k W	500.00k W
500m	500.00	3.0000k W	7.5000k W	15.000k W	30.000k W	75.000k W	150.00k W	300.00k W	500.00k W	1000.00k W

Sensor model: CT60

CT ratio: 600

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	7.500	45.000 W	112.500 W	225.00 W	450.00 W	1125.00 W	2.2500k W	4.5000k W	7.5000k W	15.000k W
25m	15.000	90.000 W	225.00 W	450.00 W	900.00 W	2.2500k W	4.5000k W	9.0000k W	15.000k W	30.000k W
50m	30.000	180.00 W	450.00 W	900.00 W	1.8000k W	4.5000k W	9.0000k W	18.000k W	30.000k W	60.000k W
125m	75.00	450.00 W	1125.00 W	2.2500k W	4.5000k W	11.2500k W	22.500k W	45.000k W	75.000k W	150.00k W
250m	150.00	900.00 W	2.2500k W	4.5000k W	9.0000k W	22.500k W	45.000k W	90.000k W	150.00k W	300.00k W
500m	300.00	1.8000k W	4.5000k W	9.0000k W	18.000k W	45.000k W	90.000k W	180.00k W	300.00k W	600.00k W

Sensor model: 720930

Output voltage rate: 10 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
25m	5.0000	30.000 W	75.000 W	150.00 W	300.00 W	750.00 W	1.5000k W	3.0000k W	5.0000k W	10.0000k W
50m	10.000	60.000 W	150.00 W	300.00 W	600.00 W	1.5000k W	3.0000k W	6.0000k W	10.0000k W	20.000k W
100m	20.000	120.000 W	300.00 W	600.00 W	1200.00 W	3.0000k W	6.0000k W	12.0000k W	20.000k W	40.000k W
250m	50.000	300.00 W	750.00 W	1.5000k W	3.0000k W	7.5000k W	15.000k W	30.000k W	50.000k W	100.000k W
500m	100.00	600.00 W	1.5000k W	3.0000k W	6.0000k W	15.000k W	30.000k W	60.000k W	100.000k W	200.00k W
1	200.00	1200.00 W	3.0000k W	6.0000k W	12.0000k W	30.000k W	60.000k W	120.000k W	200.00k W	400.00k W
2.5	500.00	3.0000k W	7.5000k W	15.000k W	30.000k W	75.000k W	150.00k W	300.00k W	500.00k W	1000.00k W

Sensor model: 720931

Output voltage rate: 2.5 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
25m	20.000	120.000 W	300.00 W	600.00 W	1200.00 W	3.0000k W	6.0000k W	12.0000k W	20.000k W	40.000k W
50m	40.000	240.00 W	600.00 W	1200.00 W	2.4000k W	6.0000k W	12.0000k W	24.000k W	40.000k W	80.000k W
100m	80.00	480.00 W	1200.00 W	2.4000k W	4.8000k W	12.0000k W	24.000k W	48.000k W	80.000k W	160.00k W
250m	200.00	1200.00 W	3.0000k W	6.0000k W	12.0000k W	30.000k W	60.000k W	120.000k W	200.00k W	400.00k W
500m	400.00	2.4000k W	6.0000k W	12.0000k W	24.000k W	60.000k W	120.000k W	240.00k W	400.00k W	800.00k W
1	0.8000k	4.8000k W	12.0000k W	24.000k W	48.000k W	120.000k W	240.00k W	480.00k W	800.00k W	1.6000M W
2.5	2.0000k	12.0000k W	30.000k W	60.000k W	120.000k W	300.00k W	600.00k W	1.2000k W	2.0000M W	4.0000M W

Active power range for wiring units using the 3P4W wiring system**Sensor model: CT2000A****CT ratio: 2000**

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	25.000	225.00 W	562.50 W	1125.00 W	2.2500k W	5.6250k W	11.2500k W	22.500k W	37.500k W	75.000k W
25m	50.000	450.00 W	1125.00 W	2.2500k W	4.5000k W	11.2500k W	22.500k W	45.000k W	75.000k W	150.000k W
50m	100.00	900.00 W	2.2500k W	4.5000k W	9.0000k W	22.500k W	45.000k W	90.000k W	150.000k W	300.00k W
125m	250.00	2.2500k W	5.6250k W	11.2500k W	22.500k W	56.250k W	112.500k W	225.00k W	375.00k W	750.00k W
250m	500.00	4.5000k W	11.2500k W	22.500k W	45.000k W	112.500k W	225.00k W	450.00k W	750.00k W	1500.00k W
500m	1.0000k	9.0000k W	22.500k W	45.000k W	90.000k W	225.00k W	450.00k W	900.00k W	1500.00k W	3.0000M W

Sensor model: CT1000S**Output voltage rate: 2 [mV/A]**

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
25m	12.500	112.500 W	281.25 W	562.50 W	1125.00 W	2.8125k W	5.6250k W	11.2500k W	18.750k W	37.500k W
50m	25.000	225.00 W	562.50 W	1125.00 W	2.2500k W	5.6250k W	11.2500k W	22.500k W	37.500k W	75.000k W
100m	50.000	450.00 W	1125.00 W	2.2500k W	4.5000k W	11.2500k W	22.500k W	45.000k W	75.000k W	150.000k W
250m	125.00	1125.00 W	2.8125k W	5.6250k W	11.2500k W	28.125k W	56.250k W	112.500k W	187.50k W	375.00k W
500m	250.00	2.2500k W	5.6250k W	11.2500k W	22.500k W	56.250k W	112.500k W	225.00k W	375.00k W	750.00k W
1	500.00	4.5000k W	11.2500k W	22.500k W	45.000k W	112.500k W	225.00k W	450.00k W	750.00k W	1500.00 W
2.5	1.2500k	11.2500k W	28.125k W	56.250k W	112.500k W	281.25k W	562.50k W	1125.00k W	1.8750M W	3.7500M W

Sensor model: CT1000A/CT1000**CT ratio: 1500**

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	18.750	168.750 W	421.88 W	843.75 W	1687.50 W	4.2188k W	8.4375k W	16.8750k W	28.125k W	56.250k W
25m	37.500	337.50 W	843.75 W	1687.50 W	3.3750k W	8.4375k W	16.8750k W	33.750k W	56.250k W	112.500k W
50m	75.00	675.00 W	1687.50 W	3.3750k W	6.7500k W	16.8750k W	33.750k W	67.500k W	112.500k W	225.00k W
125m	187.50	1687.50 W	4.2188k W	8.4375k W	16.8750k W	42.188k W	84.375k W	168.750k W	281.25k W	562.50k W
250m	375.00	3.3750k W	8.4375k W	16.8750k W	33.750k W	84.375k W	168.750k W	337.50k W	562.50k W	1125.00k W
500m	0.7500k	6.7500k W	16.8750k W	33.750k W	67.500k W	168.750k W	337.50k W	675.00k W	1125.00k W	2.2500M W

Sensor model: CT200**CT ratio: 1000**

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	12.500	112.500 W	281.25 W	562.50 W	1125.00 W	2.8125k W	5.6250k W	11.2500k W	18.750k W	37.500k W
25m	25.000	225.00 W	562.50 W	1125.00 W	2.2500k W	5.6250k W	11.2500k W	22.500k W	37.500k W	75.000k W
50m	50.000	450.00 W	1125.00 W	2.2500k W	4.5000k W	11.2500k W	22.500k W	45.000k W	75.000k W	150.000k W
125m	125.00	1125.00 W	2.8125k W	5.6250k W	11.2500k W	28.125k W	56.250k W	112.500k W	187.50k W	375.00k W
250m	250.00	2.2500k W	5.6250k W	11.2500k W	22.500k W	56.250k W	112.500k W	225.00k W	375.00k W	750.00k W
500m	500.00	4.5000k W	11.2500k W	22.500k W	45.000k W	112.500k W	225.00k W	450.00k W	750.00k W	1500.00 W

Sensor model: CT60**CT ratio: 600**

Current range		Voltage range [V]								
Setting [A]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
12.5m	7.500	67.500 W	168.750 W	337.50 W	675.00 W	1687.50 W	3.3750k W	6.7500k W	11.2500k W	22.500k W
25m	15.000	135.000 W	337.50 W	675.00 W	1350.00 W	3.3750k W	6.7500k W	13.5000k W	22.500k W	45.000k W
50m	30.000	270.00 W	675.00 W	1350.00 W	2.7000k W	6.7500k W	13.5000k W	27.000k W	45.000k W	90.000k W
125m	75.00	675.00 W	1687.50 W	3.3750k W	6.7500k W	16.8750k W	33.750k W	67.500k W	112.500k W	225.00k W
250m	150.00	1350.00 W	3.3750k W	6.7500k W	13.5000k W	33.750k W	67.500k W	135.000k W	225.00k W	450.00k W
500m	300.00	2.7000k W	6.7500k W	13.5000k W	27.000k W	67.500k W	135.000k W	270.00k W	450.00k W	900.00k W

Sensor model: 720930

Output voltage rate: 10 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
25m	5.0000	45.000 W	112.500 W	225.00 W	450.00 W	1125.00 W	2.2500k W	4.5000k W	7.5000k W	15.0000k W
50m	10.000	90.000 W	225.00 W	450.00 W	900.00 W	2.2500k W	4.5000k W	9.0000k W	15.0000k W	30.000k W
100m	20.000	180.000 W	450.00 W	900.00 W	1800.00 W	4.5000k W	9.0000k W	18.0000k W	30.000k W	60.000k W
250m	50.000	450.00 W	1125.00 W	2.2500k W	4.5000k W	11.2500k W	22.500k W	45.000k W	75.000k W	150.000k W
500m	100.00	900.00 W	2.2500k W	4.5000k W	9.0000k W	22.500k W	45.000k W	90.000k W	150.000k W	300.00k W
1	200.00	1800.00 W	4.5000k W	9.0000k W	18.0000k W	45.000k W	90.000k W	180.000k W	300.00k W	600.00k W
2.5	500.00	4.5000k W	11.2500k W	22.500k W	45.000k W	112.500k W	225.00k W	450.00k W	750.00k W	1500.00k W

Sensor model: 720931

Output voltage rate: 2.5 [mV/A]

Current range		Voltage range [V]								
Setting [V]	Measurement range [A]	3.0000	7.500	15.000	30.000	75.00	150.00	300.00	500.00	1.0000k
25m	20.000	180.000 W	450.00 W	900.00 W	1800.00 W	4.5000k W	9.0000k W	18.0000k W	30.000k W	60.000k W
50m	40.000	360.00 W	900.00 W	1800.00 W	3.6000k W	9.0000k W	18.0000k W	36.000k W	60.000k W	120.000k W
100m	80.00	720.00 W	1800.00 W	3.6000k W	7.2000k W	18.0000k W	36.000k W	72.000k W	120.000k W	240.00k W
250m	200.00	1800.00 W	4.5000k W	9.0000k W	18.0000k W	45.000k W	90.000k W	180.000k W	300.00k W	600.00k W
500m	400.00	3.6000k W	9.0000k W	18.0000k W	36.000k W	90.000k W	180.000k W	360.00k W	600.00k W	1200.00k W
1	0.8000k	7.2000k W	18.0000 W	36.000k W	72.000k W	180.000k W	360.00k W	720.00k W	1200.00k W	2.4000M W
2.5	2.0000k	18.0000k W	45.000k W	90.000k W	180.000k W	450.00k W	900.00k W	1800.00k W	3.0000M W	6.0000M W

Appendix 4 Setting the Measurement Period

To perform measurements correctly with this instrument, you need to set the measurement period appropriately.

This instrument detects the period of the input signal selected in the measurement period setting. An interval that is an integer multiple of this period becomes the measurement period. This instrument obtains measurement values by averaging the sampling data in this measurement period. The input signal selected to determine the measurement period is called the sync source. Therefore, by setting the sync source, the measurement period is automatically determined within this instrument.

This measurement method is called the sync source period average method (see page 4-48). This method is effective when the data update period is short or when low-frequency signals are measured efficiently.

You can select the sync source signal from the following:

U1, I1, U2, I2, U3, I3, U4, I4, Ext Clk (external clock), ZPhase 1 (Ch D), ZPhase 3 (Ch H), CommZC, None

* The available options vary depending on the installed elements.

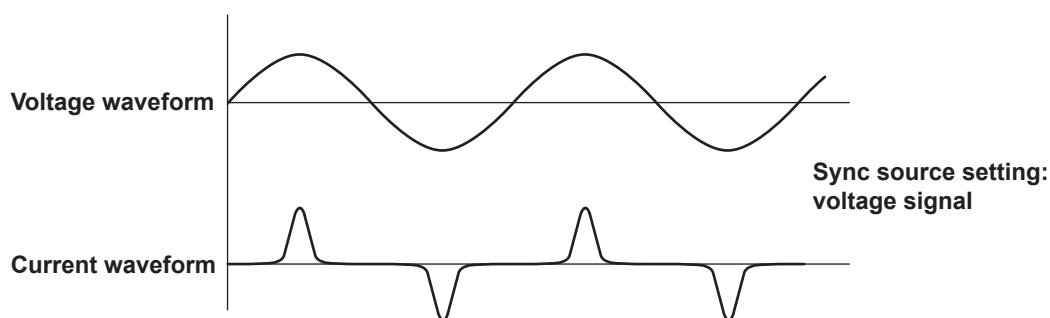
For example, if I1 is set as the sync source for input element 1, an interval that is an integer multiple of the I1 period becomes the measurement period. By averaging the sampling data in this measurement period, measurement values related to input element 1, such as U1, I1, and P1, are computed.

When the update mode is Auto, the timing of data updates differs for elements whose reference signal (sync source) is different (the minimum time resolution is 10 ms or 50 ms). In addition, the timeout time can be selected from 1 s, 5 s, 10 s, and 20 s. If the sync source does not enter for one or more cycles within the timeout time, the entire interval up to the timeout becomes the measurement period.

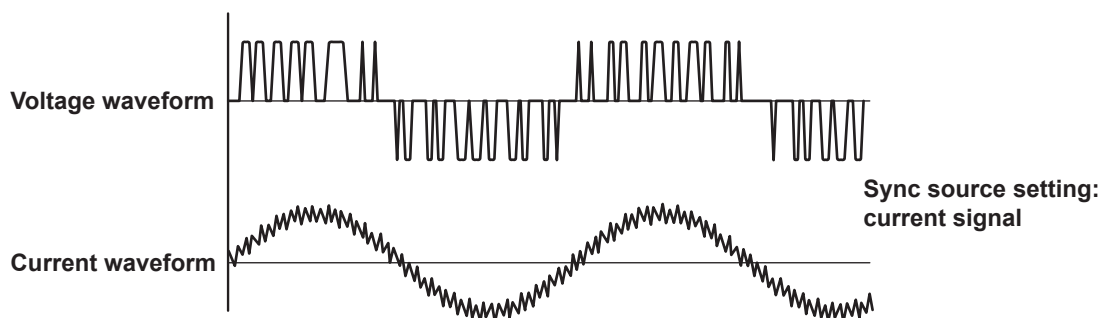
Selecting voltage or current input as the sync source

For the sync source, select an input signal with low distortion and stable input level and frequency. If the period of the sync source signal is not detected accurately, the measured values will not be correct. Display on this instrument the frequency of the input signal selected as the sync source, and check whether the frequency of the sync source signal is being measured correctly. The input signal that produces accurate and more stable measurement results is the better choice for the sync source.

For example, if the measurement target is a switching power supply and the voltage waveform has less distortion than the current waveform, set the sync source to the voltage signal.

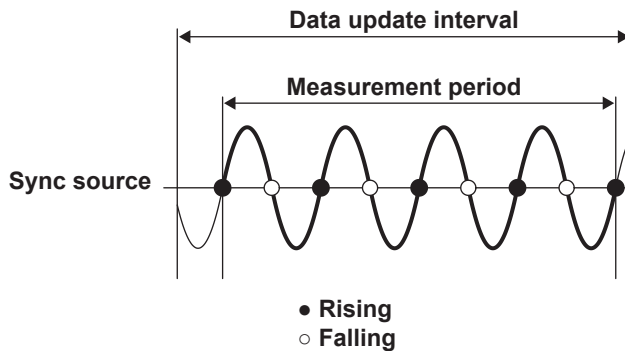


If the measurement target is an inverter and the current waveform has less distortion than the voltage waveform, set the sync source to the current signal.



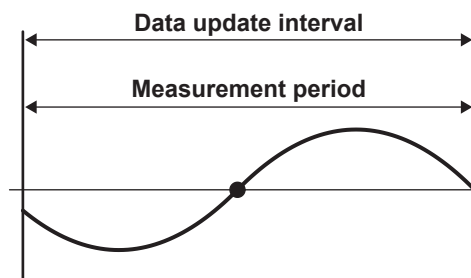
Measurement period detection

- The timing at which the sync source crosses the set level (the initial value is the midpoint of the amplitude) on a rising slope (or falling slope) is called a rising-edge (or falling-edge) cross point. In this instrument, the measurement period extends from the first rising-edge (or falling-edge) cross point within the data update period to the last rising-edge (or falling-edge) cross point within the data update period.
- Whether the period is bounded by rising-edge cross points or falling-edge cross points is selected automatically so that the longer period is used.



When the sync source period cannot be detected

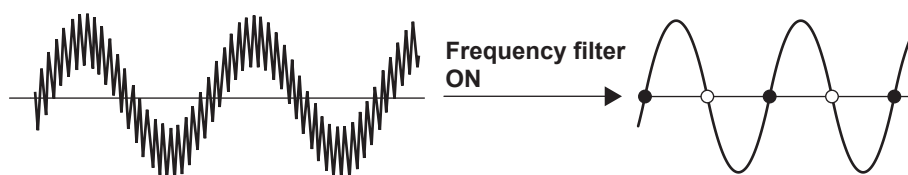
If the input signal set as the sync source has one or fewer rising or falling edges within the data update period, the period cannot be detected. Also, if the AC amplitude is small, period detection is not possible. (For the detection level of the frequency measurement circuit, see the conditions described under “Frequency measurement function” in section 5.9 of the Getting Started Guide IM WT1501-02EN.) In this case, the entire data update period becomes the measurement period, and the sampling data over the entire period is averaged.



For this reason, measurement values such as voltage and current may become unstable. In this case, increase the data update period so that it includes more cycles of the input signal.

When the sync source waveform is distorted

Change the sync source setting from voltage to current, or from current to voltage, and set the sync source to the signal whose period can be detected more stably. Also, turn the frequency filter on. This instrument reduces the effects of noise by applying hysteresis to cross point detection. If the sync source waveform is distorted enough to exceed this hysteresis, or if harmonics or noise are superimposed on it, many cross points caused by high-frequency components occur, and the cross points of the fundamental frequency cannot be detected stably. As a result, measurement values such as voltage and current may become unstable. As in the inverter example described above, if high-frequency components are superimposed on the current waveform, turn the frequency filter on so that cross points can be detected stably. If the frequency measurement results are accurate and more stable, the filter setting can be considered appropriate. In this way, the frequency filter also functions as a filter for sync source cross point detection.



When measuring a signal with a DC offset superimposed on the AC signal and no cross points

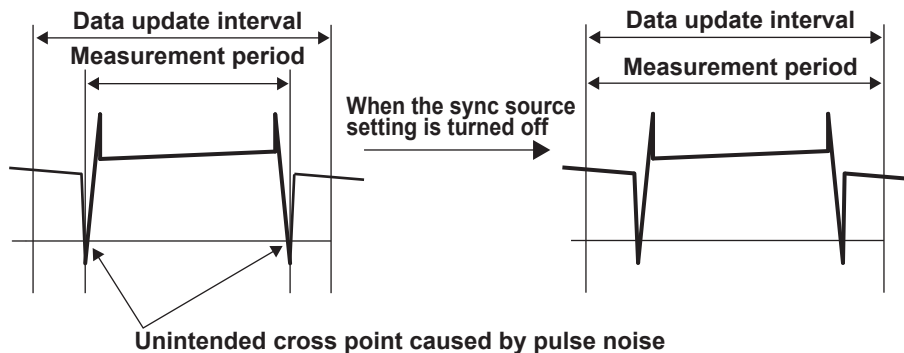
If the period of the AC signal is not detected accurately, the measured values may become unstable. Change the sync source setting from voltage to current, or from current to voltage, and set the sync source to the signal whose period can be detected more stably.

When measuring DC signals

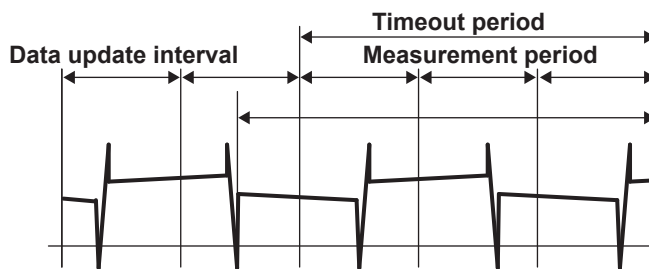
If ripple is present in the DC signal, and if the ripple level is at or above the detection level of the frequency measurement circuit (see the conditions described under “Accuracy” in “Frequency Measurement” in section 5.9 of the Getting Started Guide IM WT1501-02EN), more stable DC measurement is possible as long as the period is detected accurately and stably. For a signal in which a large AC component is superimposed on the DC signal, measurement is more stable if the period is detected and the data is averaged over that period.

Also, if pulse noise on a slightly varying DC signal crosses the set level, it is detected as a cross point. As a result, sampling data over an unintended range is averaged, and measurement values such as voltage and current may become unstable. Setting the sync source to None prevents this kind of false detection.

- When the update mode is other than Auto, the sampling data over the entire data update period is used to obtain the measured values.



- When the update mode is Auto, the sampling data over the entire timeout period is used to obtain the measured values.



Set the sync source according to the measurement signal and the purpose of the measurement.

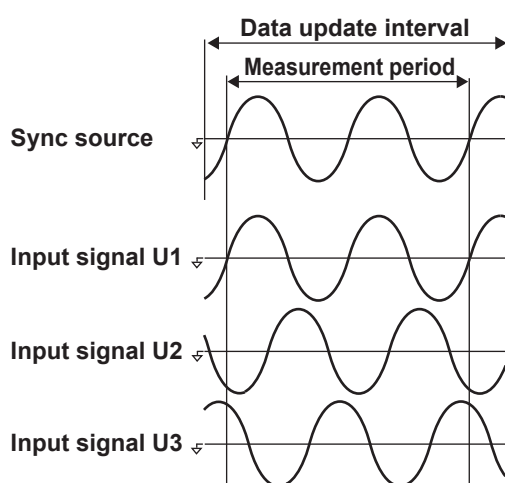
Setting the synchronization period when measuring three-phase equipment

When measuring three-phase equipment in a three-phase three-wire wiring system using input elements 1 and 2, set the sync source of input elements 1 and 2 to the same signal. For example, set the sync source of both input elements 1 and 2 to U1 (or I1, the same sync source). This makes the measurement periods of input elements 1 and 2 match, so that the Σ voltage, Σ current, and Σ power of the three-phase equipment can be measured with higher accuracy.

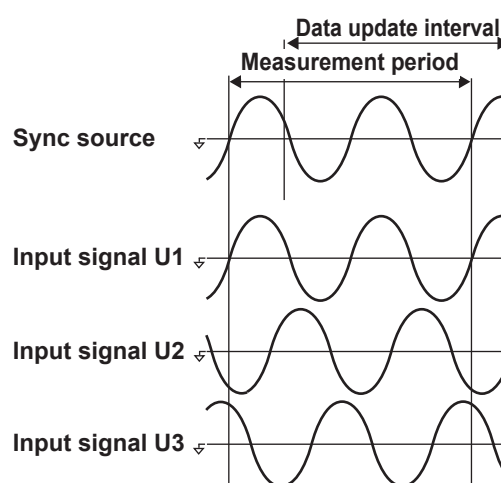
Similarly, when measuring three-phase equipment in a three-phase, four-wire wiring system using input elements 1, 2, and 3, set the sync source of input elements 1, 2, and 3 to the same signal.

In this instrument, to make this setting easier, the sync source setting is linked to the Σ wiring unit of the wiring system (when independent element configuration is OFF). When independent element configuration is ON, you can set the sync source of each input element in the Σ wiring unit individually.

When the update mode is not Auto



When the update mode is Auto



Example of sync source settings

Example of sync source settings	
Element 1	U1 (or I1)
Element 2	
Element 3	

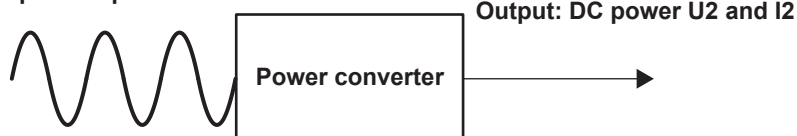
Setting the synchronization period when measuring the efficiency of power conversion equipment

Power converter with single-phase input and single-phase output

When measuring equipment that converts single-phase AC power to single-phase DC power using input elements 1 and 2, set the sync source of input elements 1 and 2 to the voltage (or current) on the AC power side. For example, in the figure below, set the sync source of both input elements 1 and 2 to U1 (or I1).

As a result, the measurement periods of input element 1 (input side) and input element 2 (output side) match, so you can measure the power conversion efficiency between the input side and output side of the power conversion equipment with higher accuracy.

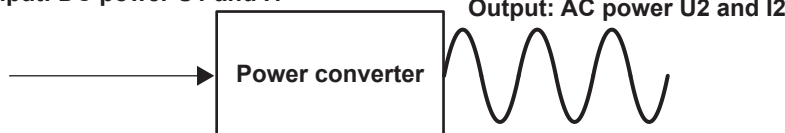
Input: AC power U1 and I1



Example of sync source settings	
Input element 1	U1 (or I1)
Input element 2	

Similarly, when measuring equipment that converts single-phase DC power to single-phase AC power using input element 1 (DC side) and input element 2 (AC side), set the sync source of input elements 1 and 2 to the voltage (or current) on the AC power side (input element 2). For example, in the figure below, set the sync source of input elements 1 and 2 to U2 (or I2).

Input: DC power U1 and I1



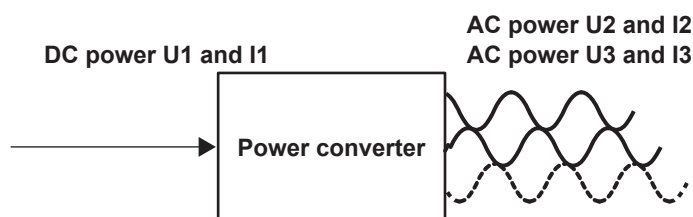
Example of sync source settings	
Input element 1	U2 (or I2)
Input element 2	

Power converter with single-phase DC input and three-phase AC output

When measuring equipment that converts single-phase DC power to three-phase AC power with the connection shown on the next page, set the sync source of all input elements to the same signal selected from the voltage and current of elements 2 and 3 on the AC power side.

In this example, set the sync source of input elements 1, 2, and 3 to the same signal: U2 (or I2, U3, or I3). As a result, the measurement periods of the input-side signal and all output-side signals match, so you can measure the power conversion efficiency of the power conversion equipment with higher accuracy.

- Single-phase DC power: Connect to input element 1
- Three-phase AC power: Connect to input elements 2 and 3 in the three-phase, three-wire wiring system



Example of sync source settings	
Input element 1	U2 (or I2, U3, or I3)
Input element 2	
Input element 3	

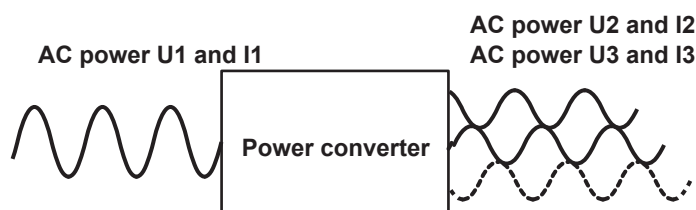
Power converter with single-phase AC input and three-phase AC output

When measuring equipment that converts single-phase AC power to three-phase AC power with the connection shown in the figure below, set the sync source of the input-side input elements to the same signal, and set the sync source of the output-side input elements to the same signal.

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

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

- Single-phase AC power: Connect to input element 1
- Three-phase AC power: Connect to input elements 2 and 3 in the three-phase, three-wire wiring system



Example of sync source settings	
Input element 1	U1 (or I1)
Input element 2	U2 (or I2, U3, or I3)
Input element 3	

Note

- When the update mode is other than Auto, the numeric data for the peak values of voltage and current uses the data update period as the measurement period, regardless of the measurement period set above. Therefore, the measurement period for the measurement functions U+pk, U-pk, I+pk, I-pk, CfU, and CfI, which are obtained from the peak values of voltage and current, is also the data update period.
- When the update mode is Auto, the numeric data for the peak values of voltage and current also uses the measurement period set above.
- For the measurement period of measurement functions related to harmonic measurement, see section 4.8, "Measurement Period (Sync Source)."

Appendix 5 Arguments for Operands in User-Defined Functions

The following arguments can be set as operands in user-defined functions.

Normal measurement functions

Measurement function	User-defined function		Inside ()	
			Element E1 to E4	Wiring unit SA, SB
Urms	URMS()	URMS(E1)	Yes	Yes
Umn	UMN()	UMN(E1)	Yes	Yes
Udc	UDC()	UDC(E1)	Yes	Yes
Urmn	URMN()	URMN(E1)	Yes	Yes
Uac	UAC()	UAC(E1)	Yes	Yes
Ufnd	UFND()	UFND(E1)	Yes	Yes
Irms	IRMS()	IRMS(E1)	Yes	Yes
Imn	IMN()	IMN(E1)	Yes	Yes
Idc	IDC()	IDC(E1)	Yes	Yes
Irmn	IRMN()	IRMN(E1)	Yes	Yes
Iac	IAC()	IAC(E1)	Yes	Yes
Ifnd	IFND()	IFND(E1)	Yes	Yes
P	P()	P(E1)	Yes	Yes
S	S()	S(E1)	Yes	Yes
Q	Q()	Q(E1)	Yes	Yes
λ	LAMBDA()	LAMBDA(E1)	Yes	Yes
Φ	PHI()	PHI(E1)	Yes	Yes
Pfnd	PFND()	PFND(E1)	Yes	Yes
Sfnd	SFND()	SFND(E1)	Yes	Yes
Qfnd	QFND()	QFND(E1)	Yes	Yes
λ fnd	LAMBDAFND()	LAMBDAFND(E1)	Yes	Yes
Φ fnd	PHIFND()	PHIFND(E1)	Yes	No
fU	FU()	FU(E1)	Yes	No
fI	FI()	FI(E1)	Yes	No
f2U	F2U()	F2U(E1)	Yes	No
f2I	F2I()	F2I(E1)	Yes	No
U+pk	UPPK()	UPPK(E1)	Yes	No
U-pk	UMPK()	UMPK(E1)	Yes	No
I+pk	IPPK()	IPPK(E1)	Yes	No
I-pk	IMPK()	IMPK(E1)	Yes	No
P+pk	PPPK()	PPPK(E1)	Yes	No
P-pk	PMPK()	PMPK(E1)	Yes	No
CfU	CFU()	CFU(E1)	Yes	No
CfI	CFI()	CFI(E1)	Yes	No
Pc	PC()	PC(E1)	Yes	Yes
Urip	URIP()	URIP(E1)	Yes	No
Irip	IRIP()	IRIP(E1)	Yes	No

Integrated power (watt hours)

Measurement function	User-defined function		Inside ()	
			Element	Wiring unit
		Example	E1 to E4	SA, SB
WP	WH()	WH(E1)	Yes	Yes
WP+	WHP()	WHP(E1)	Yes	Yes
WP–	WHM()	WHM(E1)	Yes	Yes
q	AH()	AH(E1)	Yes	Yes
q+	AHP()	AHP(E1)	Yes	Yes
q–	AHM()	AHM(E1)	Yes	Yes
WS	SH()	SH(E1)	Yes	Yes
WQ	QH()	QH(E1)	Yes	Yes
ITime	ITIME()	ITIME(E1)	Yes	No
Ewt	EWT()	EWT(E1)	Yes	Yes
Eeut	EEUT()	EEUT()	None or space*	
Err(abs)	ERRABS()	ERRABS(E1)	Yes	Yes
Err(rel)	ERRREL()	ERRREL(E1)	Yes	Yes

* You cannot omit the parentheses.

Three-Phase Unbalance Factor

Measurement function	User-defined function		Inside ()	
			Element	Wiring unit
		Example	E1 to E4	SA, SB
Uubf	UUBF()	UUBF(SA)	No	Yes
Iubf	IUBF()	IUBF(SA)	No	Yes

* You cannot omit the parentheses.

Efficiency

Measurement function	User-defined function		Inside ()
		Example	
η1	ETA1()	ETA1()	None or space*
η2	ETA2()	ETA2()	None or space*
η3	ETA3()	ETA3()	None or space*
η4	ETA4()	ETA4()	None or space*

* You cannot omit the parentheses.

User-defined function

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

* You cannot omit the parentheses.

A user-defined formula cannot use another user-defined formula with a larger number as an operand.

Maximum hold

Measurement function	User-defined function		Inside ()	
		Example	Element E1 to E4	Wiring unit SA, SB
Rms voltage	MAXURMS()	MAXURMS(E1)	Yes	Yes
Voltage mean	MAXUMN()	MAXUMN(E1)	Yes	Yes
Voltage simple average	MAXUDC()	MAXUDC(E1)	Yes	Yes
Voltage rectified mean value	MAXURMN()	MAXURMN(E1)	Yes	Yes
Voltage AC component	MAXUAC()	MAXUAC(E1)	Yes	Yes
Rms current	MAXIRMS()	MAXIRMS(E1)	Yes	Yes
Current mean	MAXIMN()	MAXIMN(E1)	Yes	Yes
Current simple average	MAXIDC()	MAXIDC(E1)	Yes	Yes
Current rectified mean value	MAXIRMN()	MAXIRMN(E1)	Yes	Yes
Current AC component	MAXIAC()	MAXIAC(E1)	Yes	Yes
Active power	MAXP()	MAXP(E1)	Yes	Yes
Apparent power	MAXS()	MAXS(E1)	Yes	Yes
Reactive power	MAXQ()	MAXQ(E1)	Yes	Yes
Positive peak voltage	MAXUPPK()	MAXUPPK(E1)	Yes	No
Negative peak voltage	MINUMPK()	MINUMPK(E1)	Yes	No
Positive peak current	MAXIPPK()	MAXIPPK(E1)	Yes	No
Negative peak current	MINIMPK()	MINIMPK(E1)	Yes	No
Positive peak power	MAXPPPK()	MAXPPPK(E1)	Yes	No
Negative peak power	MINMPPK()	MINMPPK(E1)	Yes	No

Motor evaluation option

Measurement function	User-defined function		Inside ()
			Motor
	Example	M1 to M4	
Speed	SPEED()	SPEED(M1)	Yes
Torque	TORQUE()	TORQUE(M1)	Yes
Pm	PM()	PM(M1)	Yes
Slip	SLIP()	SLIP(M1)	Yes
SyncSp	SYNC()	SYNC(M1)	Yes

Auxiliary input option

Measurement function	User-defined function		Inside ()
		Example	
Aux1	AUX1()	AUX1()	None or space*
Aux2	AUX2()	AUX2()	None or space*
Aux3	AUX3()	AUX3()	None or space*
Aux4	AUX4()	AUX4()	None or space*
Aux5	AUX5()	AUX5()	None or space*
Aux6	AUX6()	AUX6()	None or space*
Aux7	AUX7()	AUX7()	None or space*
Aux8	AUX8()	AUX8()	None or space*

* You cannot omit the parentheses.

Harmonic measurement

Measurement function	User-defined function		Left of (,), or inside ()		Right of (,)			
			Element	Wiring Unit	Harmonic order			
					Total	DC	Fundamental wave	Harmonics
		Example	E1 to E4	SA, SB	ORT	OR0	OR1	OR2 to OR100(500)
U_k	UK(,)	UK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR500
I_k	IK(,)	IK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR500
P_k	PK(,)	PK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR500
S_k	SK(,)	SK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR100
Q_k	QK(,)	QK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR100
λ_k	LAMBDAK(,)	LAMBDAK(E1,OR3)	Yes	Yes	Yes	Yes	Yes	Up to OR100
Φ_k	PHIK(,)	PHIK(E1,OR3)	Yes	No	Yes	No	Yes	Up to OR500
ΦU	UPHI(,)	UPHI(E1,OR3)	Yes	No	No	No	No	Up to OR500
ΦI	IPHI(,)	IPHI(E1,OR3)	Yes	No	No	No	No	Up to OR500
Z	ZK(,)	ZK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Rs	RSK(,)	RSK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Xs	XSK(,)	XSK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Rp	RPK(,)	RPK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Xp	XPK(,)	XPK(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR100
Uhdf	UHDF(,)	UHDF(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR500
Ihdf	IHDF(,)	IHDF(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR500
Phdf	PHDF(,)	PHDF(E1,OR3)	Yes	No	No	Yes	Yes	Up to OR500
Uthd	UTHD()	UTHD(E1)	Yes	No				
Ithd	ITHD()	ITHD(E1)	Yes	No				
Pthd	PTHD()	PTHD(E1)	Yes	No				
Uthf	UTHF()	UTHF(E1)	Yes	No				
Ithf	ITHF()	ITHF(E1)	Yes	No				
Utif	UTIF()	UTIF(E1)	Yes	No				
Itif	ITIF()	ITIF(E1)	Yes	No				
hvf	HVF()	HVF(E1)	Yes	No				
hcf	HCF()	HCF(E1)	Yes	No				
K-factor	KFACT()	KFACT(E1)	Yes	No				
EaU*	EAU()	EAU(E1)	Yes	No				
EaI*	EAI()	EAI(E1)	Yes	No				
FreqPLL1	PLLFRQ1()	PLLFRQ1()	No	No				
FreqPLL2	PLLFRQ2()	PLLFRQ2()	No	No				
ΦU1-U2	PHIU1U2()	PHIU1U2(SA)	No	Yes				
ΦU1-U3	PHIU1U3()	PHIU1U3(SA)	No	Yes				
ΦU1-I1	PHIU1I1()	PHIU1I1(SA)	Yes	Yes				
ΦU2-I2	PHIU2I2()	PHIU2I2(SA)	No	Yes				
ΦU3-I3	PHIU3I3()	PHIU3I3(SA)	No	Yes				
FreqU	FREQU()	FREQU()	Yes	No				
FreqI	FREQI()	FREQI()	Yes	No				

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

Measurement range

Measurement function	User-defined function		Inside ()
		Example	
RngU	RNGU()	RNGU(E1)	E1 to E7 (element)
RngI	RNGI()	RNGI(E1)	E1 to E7 (element)
RngSpd ¹	RNGSPD()	RNGSPD(M1)	M1 to M4 (motor)
RngTrq ¹	RNGTRQ()	RNGTRQ(M1)	M1 to M4 (motor)
RngAux ¹	RNGAUX1() to RNGAUX8()	RNGAUX1() to RNGAUX8()	None or space ²

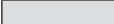
1 Available on models with the motor evaluation function (option)

2 You cannot omit the parentheses.

Appendix 6 USB Keyboard Key Assignments

104-key keyboard (US)

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

 : No function is assigned.

Appendix 6 USB Keyboard Key Assignments

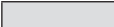
Key	When pressed together with Ctrl on the USB keyboard	When the Soft key keyboard is displayed on the screen		Other
			When Shift is pressed on the USB keyboard	
/		/	?	
Caps Lock		Caps Lock	Same as left	
F1	Execute VOLTAGE RANGE UP			ELEMENTS 1
F2	Execute VOLTAGE RANGE DOWN	Move cursor to the left	Same as left	ELEMENTS 2
F3		Move cursor to the right	Same as left	ELEMENTS 3
F4	Execute VOLTAGE RANGE AUTO	Back Space	Same as left	ELEMENTS 4
F5	Execute CURRENT RANGE UP	All Clear	Same as left	
F6	Execute CURRENT RANGE DOWN	Enter	Same as left	
F7		History	Same as left	
F8	Execute CURRENT RANGE AUTO			OPTIONS
F9				
F10				
F11		μ	Same as left	
F12		Ω	Same as left	
Print Screen	Execute DATA SAVE EXEC			
Scroll Lock				
Pause				
Insert				
Home				
Page Up				
Delete				
End				
Page Down				
→	Move cursor to the right	Move cursor to the right	Same as left	Move cursor to the right
←	Move cursor to the left	Move cursor to the left	Same as left	Move cursor to the left
↓	Move cursor down			Move cursor down
↑	Move cursor up			Move cursor up

Numeric keypad	When pressed together with Ctrl on the USB keyboard	When the Soft key keyboard is displayed on the screen		Other	
			When Shift is pressed on the USB keyboard		When Shift is pressed on the USB keyboard
Num Lock					
/		/	Same as left		
*		*	Same as left		
-		-	Same as left		
+		+	Same as left		
Enter	Execute SET	Enter	Same as left		Execute SET
1		1			
2	Move cursor down	2			Move cursor down
3		3			
4	Move cursor to the left	4	Move cursor to the left		Move cursor to the left
5		5			
6	Move cursor to the right	6	Move cursor to the right		Move cursor to the right
7		7			
8	Move cursor up	8			Move cursor up
9		9			
0		0			
.		.			

 : No function is assigned.

109-key keyboard (Japanese)

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

 : No function is assigned.

Appendix 6 USB Keyboard Key Assignments

Key	When pressed together with Ctrl on the USB keyboard	When the Soft key keyboard is displayed on the screen		Other
			When Shift is pressed on the USB keyboard	
Caps Lock		Caps Lock	Same as left	
F1	Execute VOLTAGE RANGE UP			ELEMENTS 1
F2	Execute VOLTAGE RANGE DOWN	Move cursor to the left	Same as left	ELEMENTS 2
F3		Move cursor to the right	Same as left	ELEMENTS 3
F4	Execute VOLTAGE RANGE AUTO	Back Space	Same as left	ELEMENTS 4
F5	Execute CURRENT RANGE UP	All Clear	Same as left	
F6	Execute CURRENT RANGE DOWN	Enter	Same as left	
F7		History	Same as left	
F8	Execute CURRENT RANGE AUTO			OPTIONS
F9				
F10				
F11		μ	Same as left	
F12		Ω	Same as left	
Print Screen	Execute DATA SAVE EXEC			
Scroll Lock				
Pause				
Insert				
Home				
Page Up				
Delete				
End				
Page Down				
→	Move cursor to the right	Move cursor to the right	Same as left	Move cursor to the right
←	Move cursor to the left	Move cursor to the left	Same as left	Move cursor to the left
↓	Move cursor down			Move cursor down
↑	Move cursor up			Move cursor up

Numeric keypad	When pressed together with Ctrl on the USB keyboard	When the Soft key keyboard is displayed on the screen		Other	
			When Shift is pressed on the USB keyboard		When Shift is pressed on the USB keyboard
Num Lock					
/		/	Same as left		
*		*	Same as left		
-		-	Same as left		
+		+	Same as left		
Enter	Execute SET	Enter	Same as left		Execute SET
1		1			
2	Move cursor down	2			Move cursor down
3		3			
4	Move cursor to the left	4	Move cursor to the left		Move cursor to the left
5		5			
6	Move cursor to the right	6	Move cursor to the right		Move cursor to the right
7		7			
8	Move cursor up	8			Move cursor up
9		9			
0		0			
.		.			

 : No function is assigned.

Appendix 7 List of Initial Settings and Numeric Data Display Order

Initial settings (factory default example for a product equipped with four input elements)

These settings vary depending on the number of input elements installed and whether options are provided.

Measurement Mode

Item	Setting
Measurement Mode	Normal

Input (Basic)

Item	Setting
Selected Unit	Main
Wiring	1P2W
Voltage Range	1000V (WB)/2000V (HV)
Auto	ON

WB element, HV element

Item	Setting
Current Range	1A
Auto	ON
Sensor Model	Custom
Sensor Output Type	Current
Scaling	OFF
VT Ratio	1.0000
CT Ratio	1.0000
SF Ratio	1.0000

Item	Setting
Line Filter	Advanced
Freq Filter	Advanced
Sync Source	Element 1: I1 Element 2: I2 Element 3: I3 Element 4: I4

Input (Advanced/Options)**Wiring**

Item	Setting
Selected Unit	Main
Wiring	1P2W
Sensor Output Type	Current

Range

Item	Setting
Crest Factor	CF3
Range Σ Link	ON
Current Range Display Format	Direct

Range Config

Item	Setting
Selected Unit	Main
Valid Measurement Range	All measurement ranges: Check box selected
Peak Over Jump	OFF

Line Filter

Item	Setting
Line Filter Advanced Settings	ON
Selected Unit	Main
AAF	
Anti-Aliasing Filter (300kHz/Bessel)	OFF
DLF(N)	
Digital Line Filter (Normal)	OFF
Cutoff	0.5kHz
DLF(H)	
Digital Line Filter (Harmonics)	ON
Auto	ON
Cutoff	0.1kHz

Freq Filter/Rectifier/Level

Item	Setting
Freq Filter Advanced Settings	ON
Selected Unit	Main
Rectifier	
Voltage	OFF
Current	OFF
LPF	
Freq Filter	OFF
Auto	ON
Cutoff	125Hz
Level	
Voltage	0.0%
Current	0.0%

Null

Item	Setting
Selected Unit	Main
Null	OFF

Appendix 7 List of Initial Settings and Numeric Data Display Order

Item	Setting
Control Target	All items: Check box selected U1 to U4, I1 to I4, Speed1 ¹ and 2 ² , Torque1 and 2 ² , Speed3 ¹ and 4 ³ , Torque3 and 4 ³ , Aux1 to Aux4 ² , Aux5 to Aux8 ³
Null Value Update	New

- 1 Speed check box not selected for models with the EM1, /RM1, or /EM1RM1 option
2 Applies to models with the /EM1, /RM1, or /EM1RM1 option
3 Applies to models with the /EM2, /RM2, or /EM1RM1 option

Motor/Aux

Item	Setting					
Selected Unit	Main					
MTR Configuration	Single Motor (Speed: Pulse) ⁴			Single Motor (Speed: Resolver) ⁵		
Ch Settings	Torque	Speed	Pm	Torque	Speed	Pm
Scaling	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Unit	Nm	rpm	W	Nm	rpm	W
Sense Type	Analog	Pulse		Analog	Resolver	
Analog Auto Range	ON	—		ON	ON	
Analog Range	20V	—		20V		
Linkage					OFF	
Carrier					20V	
Sine					20V	
Cosine					20V	
Linear Scale A	1.000	—		1.000	—	
Linear Scale B	0.000	—		0.000	—	
Calculation		—			—	
Point1X	1.000 [V]	—		1.000 [V]	—	
Point1Y	1.000 [Nm]	—		1.000 [Nm]	—	
Point2X	-1.000 [V]	—		-1.000 [V]	—	
Point2Y	-1.000 [Nm]	—		-1.000 [Nm]	—	
Line Filter (Butterworth)	OFF	—		OFF	—	
Pulse Noise Filter	—	OFF		—	—	
Sync Source	None	None		None	None	
Pulse Range Upper	—	10000.0000		—	5000.0000	
Pulse Range Lower	—	0.0000		—	-5000.0000	
Rated Upper	—			—		
Rated Freq Upper	—			—		
Rated Lower	—			—		
Rated Freq Lower	—			—		
Pulse N(Speed)		60				
Sync Speed						
Pole	2				2	
Source	I1				I1	
Hysteresis					Low	
Line Filter					OFF	
Tracking Filter					2kHz	
Resolver Pole Pair					1	
Electrical Angle Averaging					ON	
Electrical Angle Measurement	OFF					
Harmonics Trigger	Hrm1, Hrm2: None					
Electrical Angle Correction	0.00					
Auto Enter Correction Target	U1					

- 4 Applies to models with the /EM1, /EM2, or /EM1RM1 option
5 Applies to models with the /RM1, /RM2, or /EM1RM1 option

Sensor Correction

Item	Setting
Selected Unit	Main
Current Amplitude Correction	OFF
Correction Ratio	1.000000
Current DC Correction	OFF
DC Offset	0.00000A
Current Phase Correction	OFF
Frequency	60Hz
Phase Difference Between I/O	0.000°
Time Difference Between I/O	0.000s

Computation/Output

Efficiency

Item	Setting
η_1	Main P Σ B/Main P Σ A
η_2	Main P Σ A/Main P Σ B
η_3	Main OFF/Main OFF
η_4	Main OFF/Main OFF
Udef1	Main P1+Main None+Main None+Main None
Udef2	Main P1+Main None+Main None+Main None

Update Rate/Averaging

Item	Setting
Update Rate	
Update Mode	Auto
Update Rate	500ms
Update Rate for Auto Update Mode	50ms
Time Out	1 s
Trigger	
Trigger Mode	Auto
Trigger Source Unit	Main
Trigger Source	U1
Slope	Rise
Trigger Level	0.0%
Averaging	
Averaging	OFF
Averaging Type	Exp.
Averaging Count	2

Harmonics

Item	Setting
Selected Unit	Main
Elements	Element 1 to Element 4: Hrm1
PLL Source	U1
Min Order	1
Max Order	100
Thd Formula	1/Total

Appendix 7 List of Initial Settings and Numeric Data Display Order

Measure

Item	Setting				
User Defined Functions	ON/OFF	Name	Expression		Unit
Function1	OFF	Avg-W	WH(E1)/(ITIME(E1)/3600)		W
Function2	OFF	P-loss	P(E1)-P(E2)		W
Function3	OFF	U-ripple	URIP(E1)		%
Function4	OFF	I-ripple	IRIP(E1)		%
Function5	OFF	U-ubf	UUBF(SA)		%
Function6	OFF	I-ubf	IUBF(SA)		%
Function7	OFF	PhiU3-U2	360-PHIU1U3(SA)+PHIU1U2(SA)		degree
Function8	OFF	Phi1-I2	PHIU1I2(SA)-PHIU1I1(SA)		degree
Function9	OFF	Phi2-I3	PHIU3I3(SA)-PHIU2I2(SA)-F7()		degree
Function10	OFF	Phi3-I1	(360-PHIU3I3(SA))+PHIU1I1(SA)+(360-PHIU1U3(SA))		degree
Function11	OFF	Pp-p	PPPK(E1)-PMPK(E1)		W
Function12	OFF	F12	URMS(E1)		V
Function13	OFF	F13	UMN(E1)		V
Function14	OFF	F14	UDC(E1)		V
Function15	OFF	F15	URMN(E1)		V
Function16	OFF	F16	UAC(E1)		V
Function17	OFF	F17	IRMS(E1)		A
Function18	OFF	F18	IMN(E1)		A
Function19	OFF	F19	IDC(E1)		A
Function20	OFF	F20	IRMN(E1)		A
Max Hold	OFF				
User Defined Events	ON/OFF	Name	TRUE	FALSE	Expression
Event No.1	OFF	Ev1	True	False	URMS(E1) > 0.0000E+00
Event No.2	OFF	Ev2	True	False	IRMS(E1) > 0.0000E+00
Event No.3	OFF	Ev3	True	False	EV1() AND EV2()
Event No.4	OFF	Ev4	True	False	No Expression
Event No.5	OFF	Ev5	True	False	No Expression
Event No.6	OFF	Ev6	True	False	No Expression
Event No.7	OFF	Ev7	True	False	No Expression
Event No.8	OFF	Ev8	True	False	No Expression
S Formula	Urms*Irms				
S,Q Formula	Type 1				
Pc Formula	Type 1				
	P1 = 0.5000, P2 = 0.5000				
Unbalance Factor Formula	Fundamental				
Phase Polarity	Lead(-)/Lag(+)				
Phase Angle	180°				
Sync Measure	Master				

Appendix 7 List of Initial Settings and Numeric Data Display Order

Display

Item	Setting		
Display	Numeric+Graph(Wave)		
Numeric	All Items		
View Unit	Main		
Page	Page 1		
ITEM (Numeric)			
Order(k)	1		
Graph	Wave		
• Wave			
View Unit	Main		
Group	Group 1		
ITEM (Wave)			
Display On	U1 to U4, Speed1 and 2 ¹ , Torque1 and 2 ¹ , Speed3 and 4 ² , Torque3 and 4 ² ,		
Vertical Zoom	×1		
Vertical Position	0.000 %		
Form (Wave)			
Format	Single		
Time/div	5ms		
Advanced			
Interpolate	Line		
Graticule	Grid (■)		
Scale Value	ON		
Wave Label	OFF		
Cursor (Wave Cursor)			
Cursor	OFF		
C1+ Trace	U1		
C1+ Position	160		
C2x Trace	I1		
C2x Position	640		
Cursor Path	Max		
Linkage	OFF		
• Bar			
View Unit	Main		
Group	Group 1		
ITEM (Bar)			
Bar Item No.	1	2	3
Function	U	I	P
Element	Element 1	Element 1	Element 1
Scale Mode	Fixed	Fixed	Fixed
Form (Bar)			
Format	Single		
Start Order	1		
End Order	100		
Cursor (Bar Cursor)			
Cursor	OFF		
C1+ Order	1		
C2x Order	15		
Linkage	OFF		

1 Applies to models with the /EM1, /RM1, or /EM1RM1 option

2 Applies to models with the /EM2, /RM2, or /EM1RM1 option

Appendix 7 List of Initial Settings and Numeric Data Display Order

Item	Setting	
• Vector		
View Unit	Main	
Group	Group 1	
ITEM (Vector)		
Vector Item No	1	2
Object	ΣA	Element 1
U Mag	1.000	1.000
I Mag	1.000	1.000
Form (Vector)		
Format	Single	
Numeric	ON	

Store

Item	Setting
Store Mode	Manual
Store Count	100
Interval	00:00:00
Stored Items	Selected Items
Select Stored Items	Main, Element 1
	Urms, Irms, P, S, Q, λ , Φ , FreqU, FreqI
Store Time Stamp	Measure
Auto Naming	Numbering
Auto CSV Conversion	ON

Data Save

Item	Setting
Saved Objects	Numeric
Saved Numeric Items	Selected Items
Select Saved Numeric Items	Main, Element 1
	Urms, Irms, P, S, Q, λ , Φ , FreqU, FreqI
Image File Format	PNG
Image Color	Color
Auto Naming	Numbering

Integration

Item	Setting
Integration Mode	Normal
Integration Timer	0:00:00
Independent Control	OFF
Auto Cal	OFF
WP $\pm$ Type	
Selected Unit	Main
Setting	Each
Element 1 to 4	Charge/Discharge
q mode	
Selected Unit	Main
Setting	Each
Element 1 to 4	dc
Resume Action	Error

Appendix 7 List of Initial Settings and Numeric Data Display Order

CAN

Item	Setting
CAN Protocol	CAN
CAN Setup	
Bit Rate	125kbps
Sample Point	50.0%
Terminator	OFF
CAN Count	100
Message Format	Standard
Message ID	0x7e0
CAN Items	Selected Items (Element Select)
Select CAN Items	(All OFF)
CAN Output Items	
Save DCB File Setting	
Auto Naming	Numbering

UDP

Item	Setting
IP Address	0.0.0.0
Port	11000
Identifier	0x5754
Start at Power On	OFF

Utility

System Configuration

Item	Setting
Date/Time	
Display ^{1, 2}	ON
Setting Method ^{1, 2}	Manual
Time Zone ^{1, 2}	UTC+ 09:00
Time Synchro	
IEEE 1588 ^{1, 2}	OFF
Delay Mechanism ^{1, 2}	E2E
Network Layer ^{1, 2}	Layer 3
Domain Number ^{1, 2}	0
Language	
Menu Language ¹	English
Message Language ¹	English
Ext Monitor	
Grid Intensity	4
Graph Color	Ch1(U1): Yellow Ch9(Spd1/Aux1): Blue Ch2(I1): Green Ch10(Trq1/Aux2): Pink Ch3(U2): Magenta Ch11(Spd2/Aux3): Light Green Ch4(I2): Cyan Ch12(Trq2/Aux4): Violet Ch5(U3): Red Ch13(Spd3/Aux5): Teal Ch6(I3): Orange Ch14(Trq3/Aux6): Salmon Pink Ch7(U4): Light Blue Ch15(Spd4/Aux7): Mild Green Ch8(I4): Purpule Ch16(Trq4/Aux8): Olive
Preference	
Freq Display at Low Frequency ^{1, 2}	0
MTR Display at Low Pulse Freq ^{1, 2}	0
Decimal Point for CSV File ^{1, 2}	Period
Rounding to Zero	ON
USB Keyboard ^{1, 2}	English
Format ^{1, 2}	YYYY/MM/DD

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

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

Remote Control

Item	Setting
Network (VXI-11)	
Time Out ^{1, 2}	Infinite
WLAN	
WLAN Mode	Access Point Mode
SSID	WT1500_00

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

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

Appendix 7 List of Initial Settings and Numeric Data Display Order

Network

Item	Setting
TCP/IP	
DHCP ^{1, 2}	ON
DNS ^{1, 2}	Auto
FTP/Web Server	
User Name ^{1, 2}	anonymous
Time Out ^{1, 2}	90s
Net Drive	
Login Name ^{1, 2}	anonymous
FTP Passive ^{1, 2}	OFF
Time Out ^{1, 2}	15s
SNTP	
Time Out ^{1, 2}	3s
Adjust at Power On ^{1, 2}	OFF
Time Difference from GMT ^{1, 2}	Hour: 9, Minute: 0
WLAN^{1, 2}	
Start at Power On	OFF
Mode	Access Point Mode
SSID	WT1500_00
Password	12345678
Encrypt	WPA2_PSK
Channel	Auto
IP Address	192.168.123.100
Net Mask	255.255.255.0
DHCP Server	ON
DHCP Server Allocation Start	192.168.123.110

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

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

Multi-Unit Sync

Item	Setting
Mode	OFF

Upgrade

Item	Setting
Item	Option License

Selftest

Item	Setting
Test Item	Memory

Other

Item	Setting
Hold	OFF
DEMAG	
Selected Unit	Main
Control Target	I1, I2, I3, I4: OFF
KEY LOCK ^{1, 2}	OFF

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

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

Example of numeric data display order (example for a product equipped with four input elements)

If you reset the numeric data order with the reset pattern for Element Origin, the data for each measurement function is displayed in the order shown in the following table.

All items display

Page										
1	2	3	4	5	6	7 ³	8	9	10	11
Urms	Urms	Irms	lTime	Avg-W	Ev1	Speed ¹	U(k)	Uhdf(k)	Uthd	ΦUi-Uj
rmsl	Umn	lmn	WP	P-loss	Ev2	Torque ¹	I(k)	lhdf(k)	lthd	ΦUi-Uk
P	Udc	Idc	WP+	U-ripple	Ev3	SyncSp ¹	P(k)	Phdf(k)	Pthd	ΦUi-li
S	Urmn	lrmn	WP-	I-ripple	Ev4	Slip ¹	S(k)	Z(k)	Uthf	ΦUj-lj
Q	Uac	lac	q	D-UrmsR	Ev5	Pm ¹	Q(k)	Rs(k)	lthf	ΦUk-lk
λ	Ufnd	lfnd	q+	D-UrmsS	Ev6	Speed ²	λ(k)	Xs(k)	Utif	
Φ	U+pk	I+pk	q-	D-UrmsT	Ev7	Torque ²	Φ(k)	Rp(k)	Itif	
fU	U-pk	I-pk	WS	D-UmnR	Ev8	SyncSp ²	ΦU(k)	Xp(k)	hvf	
fl	CfU	Cfl	WQ	D-UmnS	η1	Slip ²	ΦI(k)	K-factor	hcf	
	Pc ⁴			D-UmnT	η2	Pm ²				
	P+pk ⁴			PhiU3-U2	η3	EaU ¹				
	P-pk ⁴			Phil1-l2	η4	Eal ¹				
				Phil2-l3						
				Phil3-l1						
				Pp-p						
				F16						
				F17						
				F18						
				F19						
				F20						

1 Displayed on models with the motor evaluation (/EM1, /RM1, /EM2, /RM2, or /EM1RM1) option.

2 Displayed on models with the motor evaluation (/EM2, /RM2, or /EM1RM1) option.

3 Not displayed on models without the motor evaluation option.

4 Not displayed when the split display is in use.

4 Items display

Page											
1	2	3	4	5	6	7	8	9	10	11	12
Urms1	Urms2	Urms3	Urms4	UrmsΣA	UrmsΣB	WP1	WPΣA	η1	Avg-W	D-UrmsR	D-UmnS
Irms1	Irms2	Irms3	Irms4	IrmsΣA	IrmsΣB	WP2	WPΣB	η2	P-loss	D-UrmsS	D-UmnT
P1	P2	P3	P4	PΣA	PΣB	WP3	-----	η3	U-ripple	D-UrmsT	PhiU3-U2
λ1	λ2	λ3	λ4	λΣA	λΣB	WP4	-----	η4	I-ripple	D-UmnR	Phil1-l2

8 items display:

Page											
1	2	3	4	5	6	7	8	9	10	11	12
Urms1	Urms2	Urms3	Urms4	UrmsΣA	UrmsΣB	WP1	WPΣA	P1	Avg-W	D-UmnS	F17
Irms1	Irms2	Irms3	Irms4	IrmsΣA	IrmsΣB	q1	qΣA	P2	P-loss	D-UmnT	F18
P1	P2	P3	P4	PΣA	PΣB	WP2	WPΣB	P3	U-ripple	PhiU3-U2	F19
S1	S2	S3	S4	SΣA	SΣB	q2	qΣB	P4	I-ripple	Phil1-l2	F20
Q1	Q2	Q3	Q4	QΣA	QΣB	WP3	-----	η1	D-UrmsR	Phil2-l3	-----
λ1	λ2	λ3	λ4	λΣA	λΣB	q3	-----	η2	D-UrmsS	Phil3-l1	-----
Φ1	Φ2	Φ3	Φ4	ΦΣA	ΦΣB	WP4	-----	η3	D-UrmsT	Pp-p	-----
fU1	fU2	fU3	fU4	-----	-----	q4	-----	η4	D-UmnR	F16	-----

Appendix 7 List of Initial Settings and Numeric Data Display Order

16 items display:

Page											
1	2	3	4	5	6	7	8	9	10	11	12
Urms1	Urms2	Urms3	Urms4	UrmsΣA	P1	PΣA	P1	Avg-W	F17	-----	-----
Irms1	Irms2	Irms3	Irms4	IrmsΣA	WP1	WPΣA	P2	P-loss	F18	-----	-----
P1	P2	P3	P4	PΣA	Irms1	IrmsΣA	P3	U-ripple	F19	-----	-----
S1	S2	S3	S4	SΣA	q1	qΣA	P4	I-ripple	F20	-----	-----
Q1	Q2	Q3	Q4	QΣA	P2	PΣB	PΣA	D-UrmsR	-----	-----	-----
λ1	λ2	λ3	λ4	λΣA	WP2	WPΣB	PΣB	D-UrmsS	-----	-----	-----
Φ1	Φ2	Φ3	Φ4	ΦΣA	Irms2	IrmsΣB	-----	D-UrmsT	-----	-----	-----
Pc1	Pc2	Pc3	Pc4	PcΣA	q2	qΣB	-----	D-UmnR	-----	-----	-----
fU1	fU2	fU3	fU4	UrmsΣB	P3	-----	η1	D-UmnS	-----	-----	-----
fl1	fl2	fl3	fl4	IrmsΣB	WP3	-----	η2	D-UmnT	-----	-----	-----
U+pk1	U+pk2	U+pk3	U+pk4	PΣB	Irms3	-----	η3	PhiU3-U2	-----	-----	-----
U-pk1	U-pk2	U-pk3	U-pk4	SΣB	q3	-----	η4	Phil1-I2	-----	-----	-----
I+pk1	I+pk2	I+pk3	I+pk4	QΣB	P4	-----	-----	Phil2-I3	-----	-----	-----
I-pk1	I-pk2	I-pk3	I-pk4	λΣB	WP4	-----	-----	Phil3-I1	-----	-----	-----
CfU1	CfU2	CfU3	CfU4	φΣB	Irms4	-----	-----	Pp-p	-----	-----	-----
Cfl1	Cfl2	Cfl3	Cfl4	PcΣB	q4	-----	-----	F16	-----	-----	-----

Matrix display

Page								
1	2	3	4	5	6	7	8	9
Urms	Urms	Irms	lTime	-----	-----	-----	-----	-----
Irms	Umn	lmn	WP	-----	-----	-----	-----	-----
P	Udc	Idc	WP+	-----	-----	-----	-----	-----
S	Urmn	lrmn	WP-	-----	-----	-----	-----	-----
Q	Uac	Iac	q	-----	-----	-----	-----	-----
λ	U+pk	I+pk	q+	-----	-----	-----	-----	-----
Φ	U-pk	I-pk	q-	-----	-----	-----	-----	-----
fU	CfU	Cfl	WS	-----	-----	-----	-----	-----
fl	fU	fl	WQ	-----	-----	-----	-----	-----

Left side of the harmonics list single/dual display (in single display mode)

Page						
1	2	3	4	5	6	7
Urms1	Urms2	Urms3	Urms4	UrmsΣA	UrmsΣB	F1
Irms1	Irms2	Irms3	Irms4	IrmsΣA	IrmsΣB	F2
P1	P2	P3	P4	PΣA	PΣB	F3
S1	S2	S3	S4	SΣA	SΣB	F4
Q1	Q2	Q3	Q4	QΣA	QΣB	F5
λ1	λ2	λ3	λ4	λΣA	λΣB	F6
Φ1	Φ2	Φ3	Φ4	ΦUi-Uj	ΦUi-Uj	F7
Uthd1	Uthd2	Uthd3	Uthd4	ΦUi-Uk	ΦUi-Uk	F8
lthd1	lthd2	lthd3	lthd4	ΦUi-li	ΦUi-li	F9
Pthd1	Pthd2	Pthd3	Pthd4	ΦUj-lj	ΦUj-lj	F10
Uthf1	Uthf2	Uthf3	Uthf4	ΦUi-Uj	ΦUi-Uj	F11
lthf1	lthf2	lthf3	lthf4			F12
Utif1	Utif2	Utif3	Utif4			F13
ltif1	ltif2	ltif3	ltif4			F14
hvf1	hvf2	hvf3	hvf4			F15
hcf1	hcf2	hcf3	hcf4			F16
Kfact1	Kfact2	Kfact3	Kfact4			F17
						F18
						F19
						F20

Left side of the harmonics list single/dual display (in split display mode)

Page						
1	2	3	4	5	6	7
Urms1	Urms2	Urms3	Urms4	UrmsΣA	UrmsΣB	F1
Irms1	Irms2	Irms3	Irms4	IrmsΣA	IrmsΣB	F2
P1	P2	P3	P4	PΣA	PΣB	F3
S1	S2	S3	S4	SΣA	SΣB	F4
Q1	Q2	Q3	Q4	QΣA	QΣB	F5
λ1	λ2	λ3	λ4	λΣA	λΣB	F6
Φ1	Φ2	Φ3	Φ4			F7
						F8
						F9
						F10
Page						
8	9	10	11	12	13	14
Uthd1	Uthd2	Uthd3	Uthd4	ΦUi-Uj	ΦUi-Uj	F11
lthd1	lthd2	lthd3	lthd4	ΦUi-Uk	ΦUi-Uk	F12
Pthd1	Pthd2	Pthd3	Pthd4	ΦUi-li	ΦUi-li	F13
Uthf1	Uthf2	Uthf3	Uthf4	ΦUj-lj	ΦUj-lj	F14
lthf1	lthf2	lthf3	lthf4	ΦUi-Uj	ΦUi-Uj	F15
Utif1	Utif2	Utif3	Utif4			F16
ltif1	ltif2	ltif3	ltif4			F17
hvf1	hvf2	hvf3	hvf4			F18
hcf1	hcf2	hcf3	hcf4			F19
Kfact1	Kfact2	Kfact3	Kfact4			F20

Appendix 8 Restrictions on Changing Settings

During integration, storage, or CAN data output, some measurement conditions and computation settings cannot be changed, and some functions cannot be executed.

Operation (changing settings or executing functions)		Integration status		Storage state			CAN status
		Start/Ready	Stop/Timeup/Error	Rec/Ready	Pause	Cmpl/Error	Start
Fundamental measurement conditions	Measurement Mode	No	No	No	No	No	No
	Wiring	No	No	No	No	No	No
	η Formula	No	Yes	No	No	No	No
	Range Σ Link	No	No	No	No	No	No
	Voltage or current range	No	No	Yes	Yes	Yes	Yes
	Voltage or current Auto Range	No	No	Yes	Yes	Yes	Yes
	Sensor Model	No	No	No	No	No	No
	Sensor Output Type/Output Voltage Rate	No	No	No	No	No	No
	VT/CT/SF Scaling	No	No	No	No	No	No
	Valid Measurement Range	No	No	No	No	No	No
	Crest Factor	No	No	No	No	No	No
	Sync Source	No	No	No	No	No	No
	Line Filter Settings	No	No	No	No	No	No
	Freq Filter Settings	No	No	No	No	No	No
	Rectifier	No	No	No	No	No	No
	Level	No	No	No	No	No	No
	Sensor Correction	No	No	No	No	No	No
	Update Rate	No	No	No	No	No	No
	Timeout at Update Rate	No	No	No	No	No	No
	Average	No	No	No	No	No	No
Harmonics	PLL Source	No	No	No	No	No	No
	Min/Max Order	No	No	No	No	No	No
	Thd Formula	No	No	No	No	No	No
	Element Settings	No	No	No	No	No	No
Motor	MTR Configuration	No	No	No	No	No	No
	Scaling	No	No	No	No	No	No
	Sense Type	No	No	No	No	No	No
	Auto Range	No	No	Yes	Yes	Yes	Yes
	Range	No	No	Yes	Yes	Yes	Yes
	Linear Scale A/B	No	No	No	No	No	No
	Linear Scale Calculate Execute	No	No	No	No	No	No
	Line Filter	No	No	No	No	No	No
	Pulse Noise Filter	No	No	No	No	No	No
	Sync Source	No	No	No	No	No	No
	Pulse Range Upper/Lower	No	No	No	No	No	No
	Torque Pulse	No	No	No	No	No	No
	Torque Pulse Rated Freq	No	No	No	No	No	No
	Pulse N	No	No	No	No	No	No
	Pole	No	No	No	No	No	No
	Sync Speed Source	No	No	No	No	No	No
	Analog Range Linkage	No	No	No	No	No	No
	Resolver Hysteresis	No	No	No	No	No	No
	Resolver Line Filter	No	No	No	No	No	No
	Tracking Filter	No	No	No	No	No	No
	Resolver Pole Pair	No	No	No	No	No	No
	Electrical Angle Average	No	No	No	No	No	No
	Electrical Angle Measurement ON/OFF	No	No	No	No	No	No
	Electrical Angle Correction	No	No	No	No	No	No

Yes: The setting can be changed, or the function can be executed.

No: The setting cannot be changed, or the function cannot be executed.

* Store Rec can be executed in Single Shot Mode.

Appendix 8 Restrictions on Changing Settings

Operation (changing settings or executing functions)		Integration status		Storage state			CAN status
		Start/Ready	Stop/Timeup/Error	Rec/Ready	Pause	Cmpl/Error	Start
Auxiliary signal	Scaling	No	No	No	No	No	No
	Auto Range	No	No	Yes	Yes	Yes	Yes
	Range	No	No	Yes	Yes	Yes	Yes
	Linear Scale A/B	No	No	No	No	No	No
	Linear Scale Calculate Execute	No	No	No	No	No	No
	Line Filter	No	No	No	No	No	No
	Pulse Noise Filter	No	No	No	No	No	No
	Pulse Range Upper/Lower	No	No	No	No	No	No
computation	User-Defined Function conditions	No	Yes	No	No	No	No
	Max Hold ON/OFF	No	No	Yes	Yes	Yes	Yes
	User-Defined Event conditions	No	Yes	No	No	No	No
	S Formula	No	No	No	No	No	No
	S, Q Formula	No	No	No	No	No	No
	Pc Formula	No	No	No	No	No	No
	Unbalance Factor Formula	No	No	No	No	No	No
hold	Phase	No	No	No	No	No	No
	Sync Measure	No	No	No	No	No	No
Single measurement	Hold	Yes	Yes	Yes	Yes	Yes	Yes
	Single	Yes	Yes	Yes	Yes	Yes	Yes
integration	Independent Control	No	No	Yes	Yes	Yes	Yes
Waveform display	Time/Div	No	No	No	No	No	No
	Trigger Mode	No	No	Yes	Yes	Yes	Yes
	Trigger Source	No	No	No	No	No	No
	Trigger Slope	No	No	No	No	No	No
	Trigger Level	No	No	No	No	No	No
storage	Store CSV Conversion	Yes	Yes	No	No	Yes	Yes
	Store Rec	Yes	Yes	No*	Yes	No	No
	Store Pause	Yes	Yes	Yes	Yes	Yes	No
	Store End	Yes	Yes	Yes	Yes	Yes	No
CAN	Start			No	No	No	No
	Stop			No	No	No	Yes
File	File Auto Naming	Yes	Yes	No	No	Yes	Yes
	File Name	Yes	Yes	No	No	Yes	Yes
	Comment	Yes	Yes	No	No	Yes	Yes
	Setup File Save	No	No	No	No	No	No
	Setup File Load	No	No	No	No	No	No
	Numeric Save	Yes	Yes	No	No	Yes	Yes
	Numeric Save Item Settings	Yes	Yes	No	No	Yes	Yes
	Wave Save	Yes	Yes	No	No	Yes	Yes
	Execute Image Save	Yes	Yes	No	No	Yes	Yes
	Change Drive	Yes	Yes	No	No	No	Yes
	Change Folder	Yes	Yes	No	No	No	Yes
	Delete	No	No	No	No	No	No
	Rename	No	No	No	No	No	No
	New Folder	No	No	No	No	No	No
	Copy	No	No	No	No	No	No
	Move	No	No	No	No	No	No
Utility	Initialize Settings	Yes	Yes	No	No	No	No
	Date/Time	No	No	No	No	No	No
	Setting Method	No	No	No	No	No	No
	Menu Language	No	No	Yes	Yes	Yes	Yes
	Message Language	No	No	Yes	Yes	Yes	Yes
	Freq Display at Low Frequency	No	No	No	No	No	No
	Motor Display at Low Pulse Freq	No	No	No	No	No	No
	SelfTest	No	No	No	No	No	No

Yes: The setting can be changed, or the function can be executed.

No: The setting cannot be changed, or the function cannot be executed.

* Store Rec can be executed in Single Shot Mode.

Appendix 8 Restrictions on Changing Settings

Operation (changing settings or executing functions)		Integration status		Storage state			CAN status
		Start/Ready	Stop/Timeup/Error	Rec/Ready	Pause	Cmpl/Error	Start
Other	Manual Cal	No	No	Yes	Yes	Yes	Yes
	DEMAG	No	No	No	No	No	No
	Null	No	No	No	No	No	No

Yes: The setting can be changed, or the function can be executed.

No: The setting cannot be changed, or the function cannot be executed.

* Store Rec can be executed in Single Shot Mode.

Appendix 9 Available Measurement Functions

The available measurement functions are as follows:

Measurement item ¹		Measurement mode
		Normal measurement
Voltage	Urms	Yes
	Umn	Yes
	Udc	Yes
	Urmn	Yes
	Uac	Yes
	Ufnd	Yes
	U(k)	Yes
	Urip	Yes
	Uubf	Yes
Current	Irms	Yes
	Imn	Yes
	Idc	Yes
	Irmn	Yes
	Iac	Yes
	Ifnd	Yes
	I(k)	Yes
	Irip	Yes
	Iubf	Yes
Power	P	Yes
	Pfnd	Yes
	P(k)	Yes
	S	Yes
	Sfnd	Yes
	S(k)	Yes
	Q	Yes
	Qfnd	Yes
	Q(k)	Yes
	λ	Yes
	λ fnd	Yes
	λ (k)	Yes
	Φ	Yes
	Φ fnd	Yes
	Φ (k)	Yes
	Pc	Yes
Frequency	fU	Yes
	fI	Yes
	fPLL1	Yes
	fPLL2	Yes
Peak	U+pk	Yes
	U-pk	Yes
	I+pk	Yes
	I-pk	Yes
	P+pk	Yes
	P-pk	Yes
	CfU	Yes
	CfI	Yes

Appendix 9 Available Measurement Functions

Measurement item ¹		Measurement mode
		Normal measurement
Integration	ITime	Yes
	WP	Yes
	WP+	Yes
	WP-	Yes
	q	Yes
	q+	Yes
	q-	Yes
	WS	Yes
	WQ	Yes
Pulse integration	Ewt	Yes
	Eeut	Yes
	Err(abs)	Yes
	Err(rel)	Yes
Efficiency	$\eta 1$ to $\eta 4$	Yes
User-defined function	F1 to F20	Yes
user-defined events	Event1 to Event8	Yes
Harmonics	$\Phi U(k)$	Yes
	$\Phi I(k)$	Yes
	$Z(k)$	Yes
	$R_s(k)$	Yes
	$X_s(k)$	Yes
	$R_p(k)$	Yes
	$X_p(k)$	Yes
	$U_{hdf}(k)$	Yes
	$I_{hdf}(k)$	Yes
	$P_{hdf}(k)$	Yes
	U_{thd}	Yes
	I_{thd}	Yes
	P_{thd}	Yes
	U_{thf}	Yes
	I_{thf}	Yes
	U_{tif}	Yes
	I_{tif}	Yes
	hvf	Yes
	hcf	Yes
	K-factor	Yes
	ΦU_i-U_j	Yes
	ΦU_i-U_k	Yes
	ΦU_i-I_i	Yes
	ΦU_j-I_j	Yes
	ΦU_k-I_k	Yes
Motor evaluation function ^{2, 3}	Speed	Yes
	Torque	Yes
	SyncSp	Yes
	Slip	Yes
	Pm	Yes
	EaU	Yes
	EaI	Yes
Auxiliary input ²	Aux1 to Aux4	Yes
Auxiliary input ³	Aux5 to Aux8	Yes
Measurement range ⁴	RngU	Yes
	RngI	Yes
Measurement range ^{2, 4}	RngSpd	Yes
	RngTrq	Yes
	RngAux	Yes

Measurement item ¹		Measurement mode
		Normal measurement
Timestamp ⁵	TS Date	Yes
	TS Time	Yes
	TS Subsec	Yes
	TS Date NrmPwr1 to 4	Yes
	TS Time NrmPwr1 to 4	Yes
	TS Subsec NrmPwr1 to 4	Yes
	TS Date NrmMtr1 to 4	Yes
	TS Time NrmMtr1 to 4	Yes
	TS Subsec NrmMtr1 to 4	Yes
	TS Date NrmAux1 to 8	Yes
	TS Time NrmAux1 to 8	Yes
	TS Subsec NrmAux1 to 8	Yes
	TS Date HrmPwr1 to 4	Yes
	TS Time HrmPwr1 to 4	Yes
	TS Subsec HrmPwr1 to 4	Yes

Yes: Available

No: Not available

- 1 k indicates the harmonic order and the total value. The maximum order of the measured harmonic data is the maximum measurement order set in the harmonic measurement menu. For harmonic orders with no data, [-----] (no data) is shown.
- 2 The motor evaluation function for encoders (option, /EM1, /EM2, or /EM1RM1) is required.
- 3 The motor evaluation function for resolvers (option, /RM1, /RM2, or /EM1RM1) is required.
- 4 For measurement range functions, data can be acquired using the following methods.
 - By setting a user-defined function
 - By storing or by saving numeric data
 - By outputting through communication
- 5 For timestamp functions, data can be acquired using the following methods.
 - By outputting through communication
 - By storing timestamps for storage times

Appendix 10 Restrictions on Functions When the Update Mode Is Auto

When the update mode is Auto, some functions do not allow you to change the measurement conditions or computation settings, and some functions cannot be executed.

Setting	Restriction
Single measurement	Not available.
Independent integration	Integration cannot be started while independent integration is ON.
Integration mode	Fixed at "Normal"
Watt-hour integration method for each polarity (WP ± Type)	Fixed at "Charge/Discharge"
Integration auto calibration	Fixed at OFF
Auto range during integration	Fixed at OFF Fixed range is selected when integration is started.
Integration resume operation at power failure recovery	Recovery occurs in the integration Error state. Integration cannot continue.
Storage mode	When the storage mode is integration-synchronized mode and the storage interval is other than 00:00:00, storage (Rec) cannot be started.
Self-Test	The test item "memory test (Memory)" not available
averaging	Averaging type fixed at Exp

Measurement function

When the update mode is Auto, the following measurement functions are not measured and are shown as [-----] (no data). When the data is stored, saved, or output through communication, the data is NAN.

- WS, WQ: Integrated values of apparent power and reactive power

Data update status

When the update mode is Auto, the following data update status information is also stored along with the data.

The data update status information uses a 16-bit or 32-bit hexadecimal value to indicate when the measurement values for the detected measurement period were updated within each 10 ms or 50 ms data update cycle.

- If a bit is 1, a new measurement value has been updated.
- If a bit is 0, no new measurement value has been updated, and the previous measurement value is output.

However, when averaging is ON, the measurement values are averaged for each 10 ms or 50 ms data update cycle.

This information can be output using the :NUMeric:VALue? communication command and the storage function.

UpdateStsPwr

Data update status for the input elements in normal measurement (16-bit)

The bit is set to 1 when the measurement value for a new measurement period is updated by “cycle detection of the synchronization source” or “timeout.”

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

EL1 to 4: Input elements 1 to 4

UpdateStsMtr

Data update status for the motor evaluation inputs in normal measurement (16-bit)

The bit is set to 1 when the measurement value for a new measurement period is updated by “cycle detection of the synchronization source” or “timeout.”

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
								Trq4	Spd4	Trq3	Spd3	Trq2	Spd2	Trq1	Spd1

Spd1 to 4: Speed inputs for motors 1 to 4

Trq1 to 4: torque inputs for motors 1 to 4

UpdateStsAux

Data update status for the auxiliary inputs in normal measurement (16-bit)

The bit is set to 1 when the measurement value for a new measurement period is updated by “timeout.”

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
								Aux8	Aux7	Aux6	Aux5	Aux4	Aux3	Aux2	Aux1

Aux1 to 8: Auxiliary inputs 1 to 8

UpdateStsHrm

Data update status for the power elements in harmonic measurement (16-bit)

- The bit is set to 1 when a new measurement value is updated by PLL source cycle count detection.
- The bit is also set to 1 when the harmonic measurement no-data indication [-----] is updated because of a timeout.

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

EL1 to 4: Input elements 1 to 4

Communication commands and data update status

In communication commands, the data update statuses described above correspond to the following functions.

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

When the update mode is other than Auto, if any of the above functions is set for **<Function>** in the following communication command, the return value of :NUMeric[:NORMal]:VALue? is 0x0: "No update."

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


Appendix 11 Firmware Version

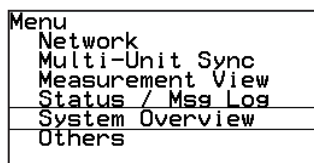
This manual applies to this instrument with firmware versions 1.01 and later.

Viewing the firmware version

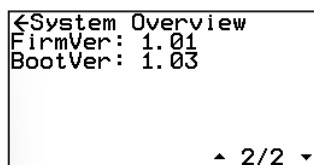
Select **Setup** menu icon  > **Utility** > **System Overview**. Check the version on the overview screen displayed (see section 18.1).

- **Viewing the firmware version on the WT1500 LCD**

Use the WT1500 LCD and operation keys.



Use the ▲ and ▼ arrow keys to select **SystemOverview** on the Menu screen, and then press **SET**.



Use the ▲ and ▼ arrow keys to check FirmVer on page 2/2.

To return to the previous screen, press **ESC**.

Appendix 12 Messages and Corrective Actions

Messages

Messages may appear on the screen while you are using this instrument. This section explains their meanings and the corrective actions to take. The messages can be displayed in the language set by the procedure in section 2.5. If servicing is required as a corrective action, contact your nearest YOKOGAWA dealer.

In addition to the messages below, there are also communication-related messages. These are described in the separate Communication Interface User's Manual (IM WT1501-17EN).

Warning messages (1 to 99)

Code	Message	Chapter or section
3	Turned on pressing the ESC key. The system has been initialized.	3.7 ¹
11	Cannot measure PLL frequency. Check input level.	8.1
12	File access slow. Too many files in directory or medium read/write speed slow.	13.7
64	File access is aborted.	—
73	Web server is not available at 10ms data update rate.	14.4
75	Wiring is now set to 3P4W→3P3W(3V3AS). PΣ is calculated by before translated 3P4W formula, which is sum of each phase power.	5.7 ¹
78	The system has started in service mode.	—
79	The system has detected the power status of current sensors.	—
80	System Configuration was changed. The system has been initialized.	—
81	Input element configuration was changed. The system has been initialized.	—
84	Key lock is enabled. To release the lock, press the KEY LOCK key.	1.2 ¹
85	In remote control mode, all keys are locked except LOCAL (KEY LOCK) key. Please hit LOCAL (KEY LOCK) key to exit the remote control mode.	Chapters 1 to 3 ²
86	In Local Lockout mode, all keys are locked. Please cancel the local lockout.	Chapters 1 to 3 ²
87	Firmware was changed. The system has been initialized.	—
88	Integration has started with a fixed range and fixed cutoff frequency.	4.2
89	Processing system settings change. Please wait for a moment.	—
93	This model has neither motor evaluation function or auxiliary input. Check the specifications to see whether or not the optional motor evaluation function and the optional auxiliary input are provided.	18.1
95	Null setting is OFF. When using the current sensor, please enable the null settings.	4.14
96	If the S or Q computation is set to type 1 or 2, the following is applied to elements with the rectifier set to on. - Φ is fixed to lag (G). Displayed in the range of 0 to 180°(360 degrees format). - The sign of Q is fixed to positive. For QΣ that includes elements with the rectifier set to on, type 2 is used.	Appendix 1, 3.1

1 Getting Started Guide, IM WT1501-02EN

2 Communication Interface User's Manual (IM WT1501-17EN)

Setup error messages (500 to 899)

Code	Message	Chapter or section
600	File access failure.	—
601	Invalid file name. Check the file name.	13.3
602, 603	No USB device or no storage media inserted. Check the USB device connection, and the existence of a storage medium in the drive.	13.2
604	Media failure. Check the storage medium.	13.2
605	File not found. Check the filename and the storage medium.	—
606	Media is protected. Set the disk's(media's) write protect switch to OFF.	—
607	Media was removed while accessing. Check the storage medium.	13.2
608, 609	File already exists.	—
610	Contains invalid characters.	13.3
611, 612	Media full. Delete unnecessary file(s) or use another disk.	13.7
613	Cannot delete a directory if there are files in the directory.	13.7
614	File is protected.	—
615	Physical format error. Reformat the medium. If the same error occurs, the instrument is probably unable to execute a format on this medium.	—
616 to 620, 622 to 641	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	—
621	File is damaged. Check the file.	—
643 to 653, 659, 660	Media failure. Check the medium.	—
656	Cannot save more than 256 item to the root directory. Change save destination or delete files/directories from the root directory.	13.3
662	File operation is interrupted.	—
663	File unknown format. Check the file format.	3.4
665	Cannot load this file format. File was stored on other models or other versions.	—
666	File is now being accessed. Execute after access is made.	—
669	Cannot load this text file. Confirm the contents of file.	3.4
675	Cannot load this file. Model/options/Multi-unit-Configuration do not conform.	—
676	Writing prohibited in this file.	—
677	An error occurred while network access. Confirm network conditions.	Chapter 14
690	Cannot execute for the directory depth is 10 or more.	—
691	Cannot execute because of source and destination are over lapped.	—
692	Cannot execute for the media itself.	—
693	Cannot store at Network Drive.	12.3
694	Trigger Event is Off.	5.6
695	File version is new. Update firmware.	—
696	The file may be damaged or an unsuccessful file close could have occurred.	—
697	Abnormal data file. Unsuccessful finish of file save is detected.	—

Appendix 12 Messages and Corrective Actions

Code	Message	Chapter or section
701	System initialization in progress. Operation cannot be initiated. Wait until the process is completed and retry.	–
705	Can not operate while accessing medium. Wait until access has completed.	–
706	Can not operate during hard copy. Wait until output has completed.	–
707	Can not operate while processing multi-unit synchronous connection. Cancel connection or wait until the connection is completed.	17.2
713	Cannot execute for All or User display mode.	–
714	Cannot execute for All display mode.	–
720	Over Run had occurred.	–
721	Can not set or execute because store is processing. Try Again.	–
722	No target Element for integration execution.	7.1
723	Can not set or execute when Integ Independent Control is on.	7.1
724	Can not set or execute because recording is processing. Try again.	–
725	File creation stopped. File size exceeded 2G bytes.	–
728	Settings and execution are allowed only when multi-unit synchronization is operating. To set or execute, execute multi-unit synchronization connect first.	17.1
729	Can not set or execute while multi-unit synchronaization is operating. To set or execute, disconnect multi-unit synchronization.	17.1
730	Can not operate at 10ms data update rate. To operate, set update rate to 50ms or slower.	4.10
731	A multiple unit synchronous communication error occurred.	Chapter 17
732	Can not set or execute while multi-unit synchronaization mode is setting. Use setting or execution with multi-unit synchronization mode turned OFF.	17.2
733	Can not set or execute while WLAN is running. To set WLAN to a disconnected state.	14.7
750, 751	Unable to connect to the server. Check the network settings and configuration.	Chapter 14
752	This ftp function in not supported.	–
753	FTP Error: Client Handle Confirm the network settings and connection.	Chapter 14
758	Failed to acquire time from SNTP server. Confirm the network settings and connection.	14.6
759	Failed to initialize network. Confirm the network settings.	Chapter 14
760	Cannot execute or set when IEEE 1588 is on. To execute or change this setting, turn off IEEE 1588.	18.2
761	Cannot execute or set when SNTPs "Adjust at Power On" is on. To execute or change the setting, turn off "Adjust at Power On".	14.6
762	Cannot execute when IEEE 1588 is not in the "Stable" state. To execute, wait until the state becomes "Stable" or turn off IEEE 1588.	18.2
800	Illegal date-time. Set the correct date and time.	2.7
801	Illegal file name. The file name contains characters which are not allowed or the file name is not a valid MS-DOS file name. Enter another file name.	13.3
802	Cannot be set or executed in the Normal measurement mode.	–
812	Cannot be set or executed while storing data.	–
813	Cannot be set while integration is running. Reset Integration.	7.2
814	Cannot be set or executed when Null is on. Please turn Null off.	4.14
815	Cannot be set or executed when the Update Mode is Auto. Change to a different Update Mode to execute.	4.10
816	Failed during multi-unit synchronous connection process.	Chapter 17

Code	Message	Chapter or section
817	Settings and execution are allowed only when multi-unit synchronaization mode is setting. To set or execute, execute multi-unit synchronization mode set first.	17.2
818	This unit is not connected. Please check the target unit.	Chapter 17
819	Cannot be set or executed during sending UDP message. To set or execute, stop the transmission UDP messages."	15.2
823	Cannot change during CAL. Wait until CAL is completed.	4.15
827	Illegal math expression. Input a correct computing equation.	4.6
831	Processing now. Retry setting or execution again.	–
832	Set the password with at least 8 characters.	14.7
833	The SSID field cannot be left blank.	14.7
834	Could not connect to the access point.	14.7
835	This WLAN dongle does not support Access Point mode.	2.3 ²
836	The WLAN dongle is not connected.	14.7
840	Communication with the SubUnit is not possible during multi-unit synchronous operation. Please disable multi-unit synchronous operation or set the multi-unit sync mode to something other than SubUnit.	Chapter 17
841	Attempted to start integration after integration time has reached its preset value.	7.2
842	Attempted to start integration while integration is in progress.	7.2
843	Measurement stopped due to overflow during integration or due to a power failure.	7.2
844	Attempted to stop integration even though integration was not in progress.	7.2
845	Attempted to reset integration even though integration was in progress or integration mode was not selected.	7.2
846	Attempted to start integration while measurement of peak overflow was in progress.	–
847	Attempted to start integration in continuous integration mode when integration preset time was set to "0".	7.2
848	Attempted made to start integration in real time counting integration mode when the end time had already passed.	7.2
849	Attempted made to start storing in real time counting storing mode when the end time had already passed.	12.1
850	Cannot be set or executed at current store state. To set or execute, reset store.	12.4
851	Cannot start integration. Turn off the multi-unit synchronization mode or connect multiple units synchronously, and then execute during synchronous operation.	7.3, 17.2
852	No CAN items selected.	16.3
853	Too many CAN items selected.	16.3
854	Waveform display data not found.	–
855	Data destination memory is full. Saving has been stopped.	–
856	An error has occurred while storing. Storing has been stopped.	–
857	Cannot be set while Master/Slave Synchronized Measurement is set to Slave.	4.16
858	Store process is in progress now. Execute or set setting again.	–
859	Cannot convert selected file. Select a file with an extension of WTS or HDS.	12.3
860	Cannot be set or executed during sending CAN message. To set or execute, stop the transmission CAN messages.	Chapter 16
861	Can message could not be sent.	Chapter 16
862	Numeric data not found.	–
863	Cannot be set or executed when different types of elements are installed.	–

Appendix 12 Messages and Corrective Actions

Code	Message	Chapter or section
864	This wiring cannot be set as the first selected element.	4.7
865	Cannot be set while integration is running. Stop or reset Integration.	7.2
874	Sync source, PLL source or trigger source cannot be set to Ext Clk, while Master/Slave Synchronization Measurement is set to Slave.	4.16
875	Master/Slave Synchronization Measurement cannot be set to Slave, while sync source, PLL source or trigger source is set to Ext Clk.	4.16
876	Can not calculate from present point value.	11.1
877	Can not set 0 to count.	12.1
878	Can not set 0. Set to a value other than 0.	—
880	Cannot be set or executed while initialization. Wait until status changes to "Ready".	—
881	Cannot be set or executed while measurement is in progress. To set or execute, "Stop" measurement.	—
882	Stopped measurement. Detection error of measuring interval signal. Check External Sync (MEAS START) input.	2.16 ¹
888	Cannot start integration. Disable independent integration or change update mode to "Constant".	4.6, 4.1
889	Setting and execution is not. available when auto-ranging is set to ON.	—
890	Cannot start store. Change store mode to a mode other than "integration synchronization" or set store interval to zero. Otherwise, change update mode to a mode other than "Auto".	12.1, 4.1
894	Cannot be executed/set in current condition. All element must have the same element type to set wiring or range sigma link.	4.1, 4.2
895	Can not set wiring with delta conversion in current condition.	—
896	Can not set or execute this settings for wiring with delta conversion.	—
897	"Abnormality in the optical transceiver module was detected."	2.14 ¹
898	Firmware version mismatch between main unit and sub unit. Please match the versions.	18.1
899	Optical transceiver module insersion manner is incorrect. Please install them sequentially from Port 1 with no gaps.	17.1

1 Getting Started Guide, IM WT1501-02EN

2 Communication Interface User's Manual (IM WT1501-17EN)

System error messages (900 to 999)

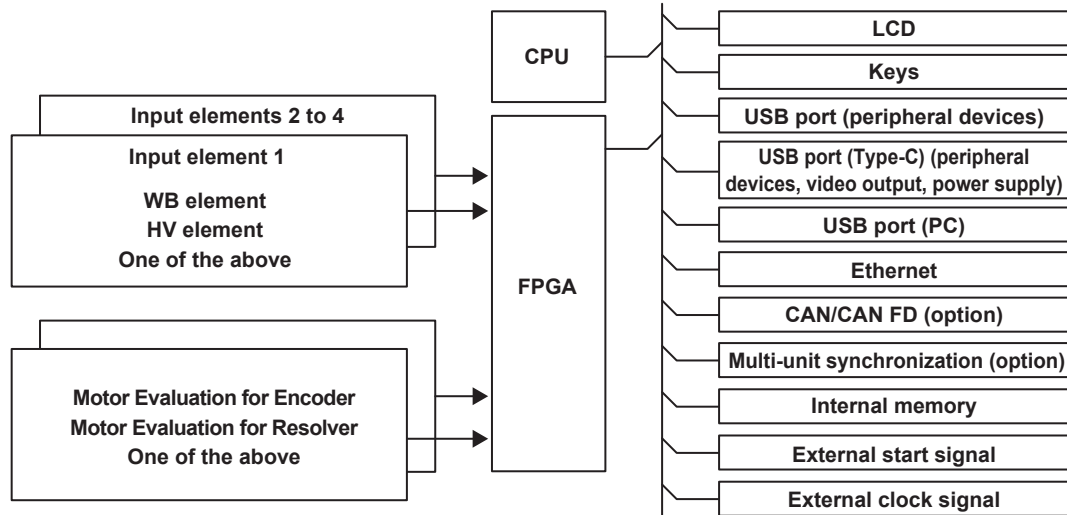
Code	Message	Chapter or section
901	Failed to backup setup data. The system has been initialized. Maintenance service is required.	—
902	System RAM failure. Maintenance service is required.	—
903	System ROM failure. Maintenance service is required.	—
904	Internal temperature is too high. Maintenance service is required. It will shutdown automatically.	—
906	Fan stopped. Power off immediately. Maintenance service is required.	—
907	Backup battery is flat. Maintenance service is required to replace the back-up battery.	—
909	Illegal SUM value. Maintenance service is required.	—
911	Software exception has occurred. A firmware update may be required. Notify maintenance service the Service No. below.	—
915	EEPROM error. EEPROM may be damaged. Maintenance service is required.	—
918	Input element1 is not installed. Turn Off the instrument and insert an input element to element1.	—
919	Option board cannot be detected. Maintenance service is required.	—
921	Failed to communicate with measure component. Reboot the instrument and try again. If this error persists after rebooting, please consult with service.	—
922	Failed to communicate with measure component. Reboot the instrument and try again. If this error persists after rebooting, please consult with service.	—
923	Transmit data abnormality from devices. Maintenance service is required.	—
925	Error while synchronizing to IEEE 1588. Please turn IEEE 1588 off once to reset state.	18.2
926	The USB device's power consumption exceeded the capacity of the USB hub.	—
927	An overcurrent has occurred in the USB device port. Remove the USB device and wait at least 10 seconds before reconnecting it. If the issue persists, use a different device.	—
929	A USB mass storage device that is greater than 137 GB in capacity has been connected. Be careful in using this device. If an area exceeding 137 GB is accessed, the storage device may break.	—
931	Hardware configuration error occurred. Restart this machine. If it occurred again, maintenance service is required.	—
932	Error occurred while ImageFile process.	—
942	Hardware mismatch error occurred. Maintenance service is required.	—
944	An overcurrent of the CT sensors or the current probes has been detected. The power of devices has been shutdown. Power off immediately.	—
946	The sensor model settings and detected current sensor are different. Please confirm current input setup.	4.2
947	Detected changes in insertion and removal with the CT sensors. Please confirm them.	—

Appendix 12 Messages and Corrective Actions

Code	Message	Chapter or section
948	An Error of the sensor power supply was detected. The power to the device has been shutdown. Power off immediately. Maintenance service is required.	—
950	An abnormal power status in the current sensor was detected.	—
951	A memory access error in the current sensor was detected.	—

Appendix 13 Block Diagram

WT1500

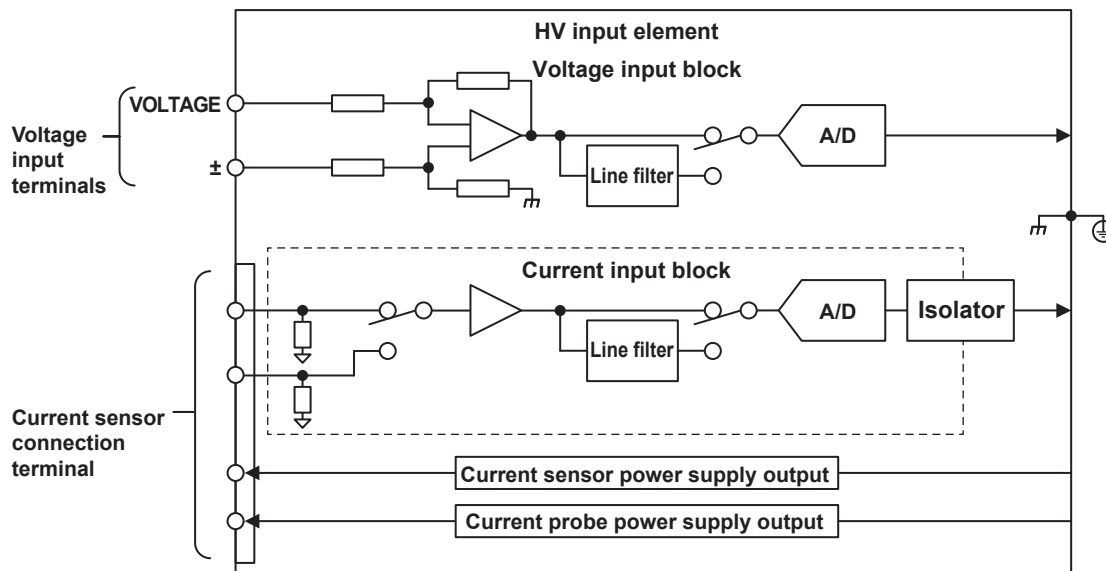


Input signal flow and processing

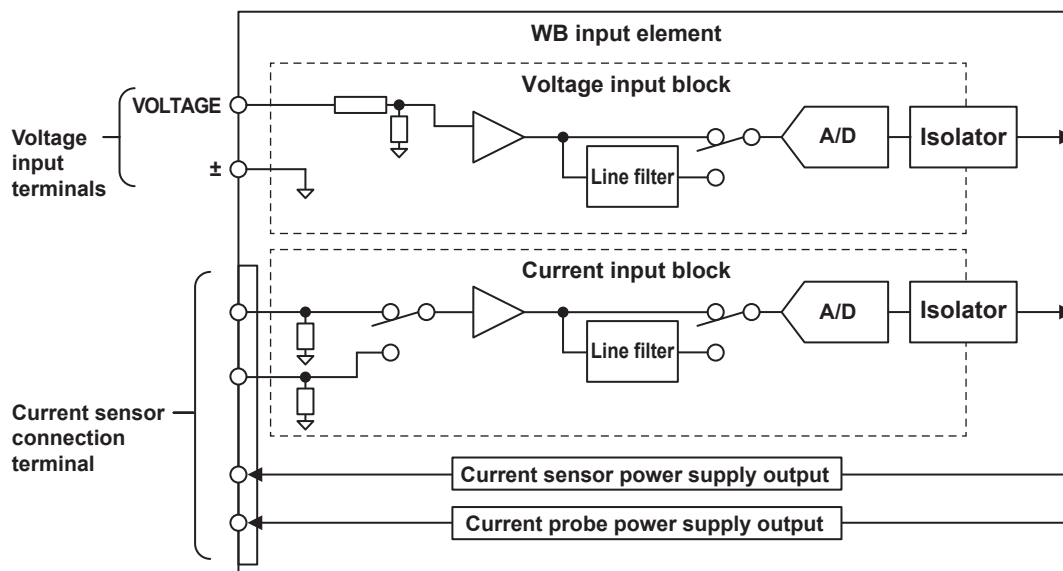
- Input elements 1 to 4 consist of a voltage input circuit and a current input circuit.
- In WB elements, the voltage input circuit and current input circuit are isolated from the instrument case and from each other.
In HV elements, the voltage input circuit has a non-isolated differential input configuration, and only the current input circuit is isolated from the instrument case.
- In WB elements, voltage signals applied to the voltage input terminals (U, $\pm$) are normalized by the voltage divider and op amp of the voltage input circuit and then sent to the voltage A/D converter.
In HV elements, voltage signals applied to the voltage input terminals (U, $\pm$) are normalized as the potential difference between the two terminals by the differential voltage divider circuit and op amp of the voltage input circuit and then sent to the voltage A/D converter.
- The current input circuit has two types of input terminals: one for current sensors with current output and one for current sensors with voltage output. You can use either type.
Voltage signals applied to the terminals for current sensors with voltage output are normalized by a voltage divider and an op amp, and then sent to the current A/D converter.
Current signals applied to the terminals for current sensors with current output are converted into voltage signals by a shunt and then sent to the current A/D converter in the same manner as the voltage signals from the current sensors.
- Voltage signals sent to the voltage A/D converter and current A/D converter are converted to digital values at intervals of approximately 400 ns.
- The current digital values are isolated by the isolator and sent to the FPGA.
In WB elements, the voltage digital values are isolated by the isolator and sent to the FPGA.
In HV elements, the voltage digital values are sent to the FPGA.

- The FPGA determines measured values based on the digital values. The measured values are sent to the CPU. The CPU performs various computations on the measured values to determine computed values, and these measured values and computed values are displayed, output through CAN, and output through the communication interface as normal measurement functions and harmonic measurement functions.

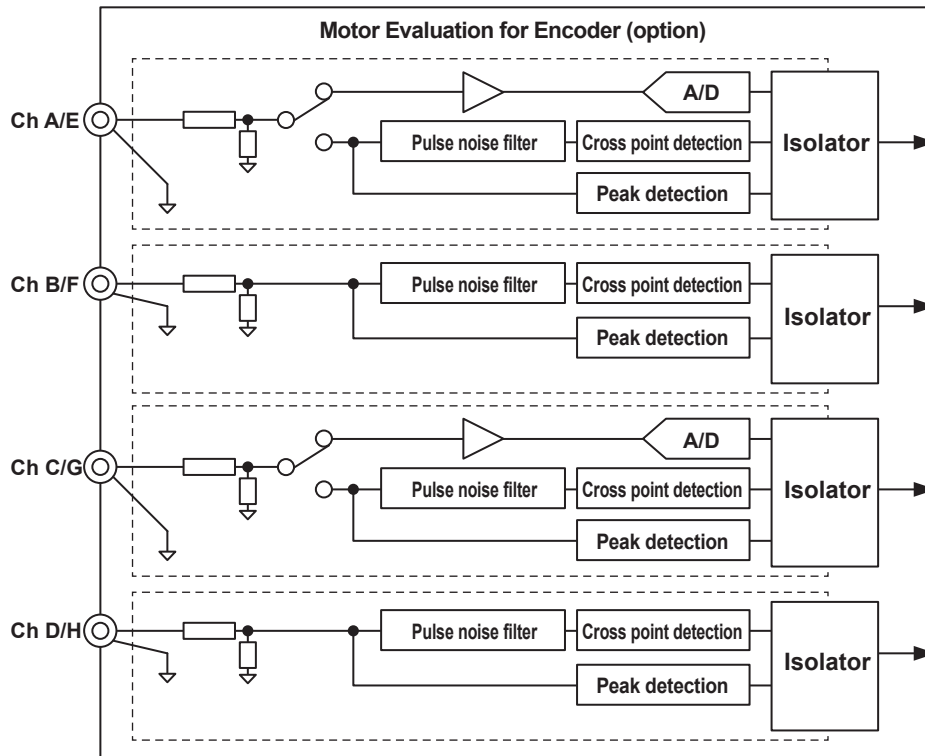
HV element



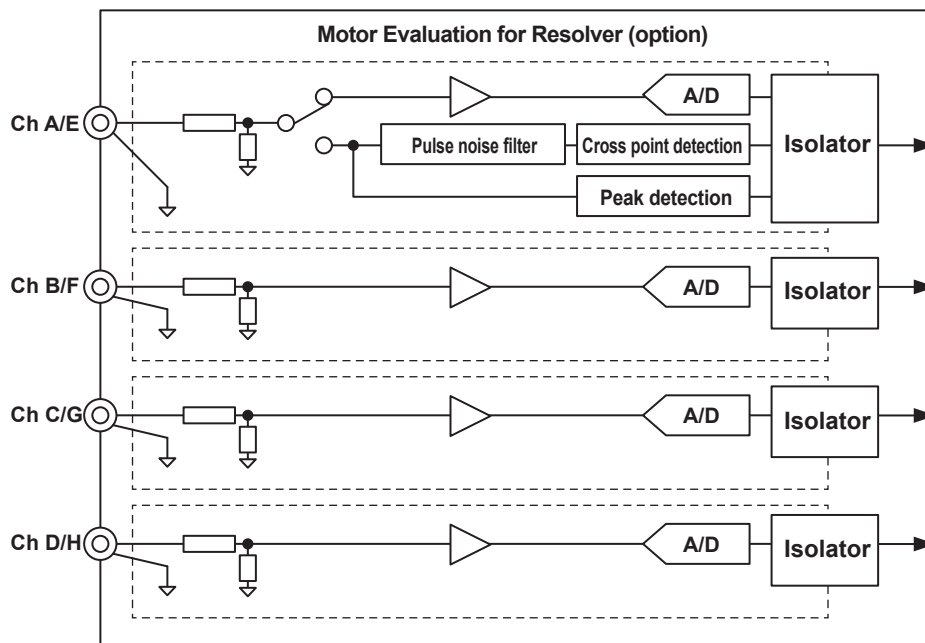
WB element



Motor Evaluation for Encoder



Motor Evaluation for Resolver



Appendix 14 Using Open Source Software

This product includes open-source software.

For the license of each open-source software program, see TermsAndConditions_OpenSourceSoftware.pdf in the OSS Licenses folder on the instrument.

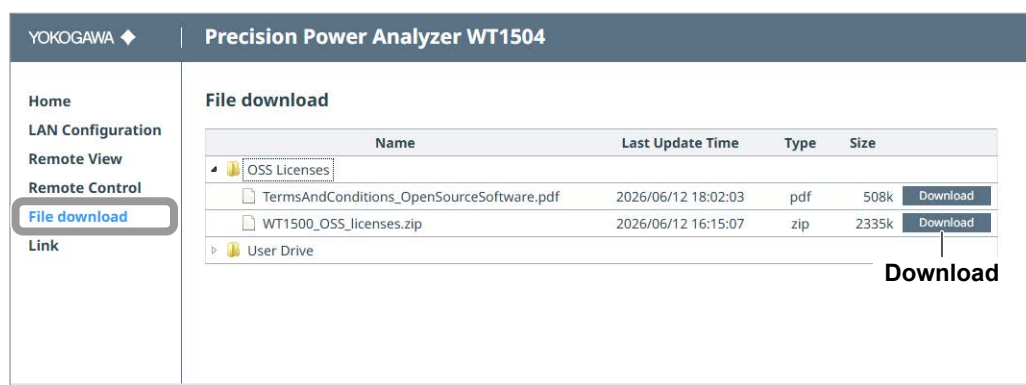
How to view licenses for the open-source software

The following files are stored in User/OSS_Licenses in the internal memory of this instrument.

- TermsAndConditions_OpenSourceSoftware.pdf
- WT1500_OSS_licenses.zip

The above files can be downloaded to a PC via the Web server.

1. Connect the instrument to a network as a Web server, and access the instrument from the PC.
For details, see section 14.4.
2. In the side navigation on the left side of the screen, select **File download**.
The File download screen appears.
3. Open the OSS Licenses folder, and select **Download** to the right of the file you want to download.



To view the downloaded PDF data, you need software capable of viewing PDF files, such as Adobe Acrobat Reader.

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