# PX8000
## Precision Power Scope

# USER'S MANUAL

### Features Guide

YOKOGAWA
Yokogawa Test & Measurement Corporatio

IM PX8000-01EN
6th Edition

Thank you for purchasing the PX8000 Precision Power Scope (hereinafter, “PX8000” will refer to this products). This manual contains useful information about the features of the PX8000. To ensure correct use, please read this manual thoroughly before beginning operation.
Keep this manual in a safe place for quick reference in the event a question arises.

## List of Manuals

The following four manuals, including this one, are provided as manuals for the PX8000. Read them along with this manual.

| Manual Title | Manual No. | Description |
|---|---|---|
| PX8000 Precision Power Scope Features Guide | IM PX8000-01EN | This manual. This manual explains all the PX8000 features other than the communication interface features. |
| PX8000 Precision Power Scope User’s Manual | IM PX8000-02EN | The manual explains how to operate the PX8000. |
| PX8000 Precision Power Scope Getting Started Guide | IM PX8000-03EN | Provided as a printed manual.<br>The guide explains the handling precautions, basic operations, and specifications of the PX8000. |
| PX8000 Precision Power Scope Communication Interface User’s Manual | IM PX8000-17EN | The manual explains the PX8000 communication interface features and instructions on how to use them. |
| Model PX8000 Precision Power Scope | IM PX8000-92Z1 | Document for China |

The “EN” and “Z1” in the manual number is the language code.
PDF files of all the manuals above are included in the accompanying manual CD.

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

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

## Notes

- The contents of this manual are subject to change without prior notice as a result of continuing improvements to the instrument’s performance and functions. The figures given in this manual may differ from the actual screen.
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## Revisions

- 1st Edition: January 2014
- 2nd Edition: January 2014
- 3rd Edition: August 2014
- 4th Edition: December 2015
- 5th Edition: June 2017
- 6th Edition: October 2017

6th Edition: October 2017 (YMI)

# Contents

## 14 Zooming in on Waveforms



## 15 Cursor Measurement



## 16 Automated Measurement of Waveform Parameters



## 17 Waveform Computation

## 18 FFT



## 19 GO/NO-GO Determination



## 20 Action



## 21 Searching Waveforms



## 22 Displaying and Searching History Waveforms



## 23 Printing and Saving Screen Captures



## 24 Saving and Loading Data

# 1 Items That This Instrument Can Measure

The following tables show the items that this product can measure (measurement functions).
In the tables, “Element” and “Wiring Unit” indicate the following:

- Element: Element1, Element2, Element3, Element4
- Wiring unit: ΣA, ΣB

However, the elements and wiring units that you can measure vary depending on how many elements are installed in the PX8000.

- For details about how the values of the measurement functions are determined, see appendix 1 in the features guide, IM PX8000-01EN.
- For explanations of the terms measurement function, element, and wiring unit, see “What Is a Measurement Function?”

▶ See here.

In the tables, “Yes” and “No” indicate the following:

- Yes: Measured value available
- No: Measured value not available

## Measurement Functions Used in Normal Measurement

### Voltage

| Function | Description | 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 |
| U+pk | Maximum voltage | Yes | No |
| U−pk | Minimum voltage | Yes | No |
| CfU | Voltage crest factor | Yes | No |

### Current

| Function | Description | 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 |
| I+pk | Maximum current | Yes | No |
| I−pk | Minimum current | Yes | No |
| CfI | Current crest factor | Yes | No |

## Power

| Function | Description | 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 |
| Pc | Corrected Power | Yes | Yes |
| P+pk | Maximum power | Yes | No |
| P−pk | Minimum power | Yes | No |

## Frequency

| Function | Description | Element | Wiring Unit |
|---|---|---|---|
| fU | Voltage frequency | Yes | No |
| fI | Current frequency | Yes | No |
| fPLL | Frequency of PLL[1] | No | No |

1 On models with the harmonic measurement option.

## Efficiency

| Function | Description |
|---|---|
| η1 to η4 | Efficiency |

## User-Defined Functions

| Function | Description |
|---|---|
| F1 to F20 | User-defined functions |

# Harmonic Measurement Functions (Option)

| Function | Description | Element | Wiring Unit |
|---|---|---|---|
| U(k) | Rms voltage of harmonic order k | Yes | Yes |
| I(k) | Rms current of harmonic 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 |
| λ(k) | Power factor of harmonic order k | Yes | Yes |
| Φ(k) | Phase difference between the voltage and current of harmonic order k. | Yes | No |
| ΦU(k) | Phase difference between the fundamental signal, U(1), and harmonic voltage U(k) | Yes | No |
| ΦI(k) | Phase difference between the fundamental signal, I(1), and harmonic current I(k) | Yes | No |
| Z(k) | Impedance of the load circuit | Yes | No |
| Rs(k) | Series resistance of the load circuit | Yes | No |
| Xs(k) | Series reactance of the load circuit | Yes | No |
| Rp(k) | Parallel resistance of the load circuit | Yes | No |
| Xp(k) | Parallel reactance of the load circuit | Yes | No |
| Uhdf(k) | Harmonic voltage distortion factor | Yes | No |
| Ihdf(k) | Harmonic current distortion factor | Yes | No |
| Phdf(k) | Harmonic active power distortion factor | Yes | No |
| Uthd | Total harmonic voltage distortion | Yes | No |
| Ithd | Total harmonic current distortion | Yes | No |
| Pthd | Total harmonic active power distortion | Yes | No |
| Uthf | Telephone harmonic factor of the voltage | Yes | No |
| Ithf | Telephone harmonic factor of the current | Yes | No |
| Utif | Telephone influence factor of the voltage | Yes | No |
| Itif | Telephone influence factor of the current | Yes | No |
| hvf | Harmonic voltage factor | Yes | No |
| hcf | Harmonic current factor | Yes | No |
| K−factor | K factor | Yes | No |
| ΦUi−Uj[1] | Phase difference between the fundamental voltage of element i, Ui(1), and the fundamental voltage of element j, Uj(1). | No | Yes |
| ΦUi−Uk[1] | Phase difference between Ui(1) and the fundamental voltage of element k, Uk(1) | No | Yes |
| ΦUi−Ii[1] | Phase difference between Ui(1) and the fundamental current of element i, Ii(1) | Yes[2] | Yes |
| ΦUj−Ij[1] | Phase difference between Uj(1) and the fundamental current of element j, Ij(1) | No | Yes |
| ΦUk−Ik[1] | Phase difference between Uk(1) and the fundamental current of element k, Ik(1) | No | Yes |
| ΦIi−Ij[1] | Phase difference between Ii(1) and the fundamental current of element j, Ij(1) | No | Yes |
| ΦIj−Ik[1] | Phase difference between Ij(1) and the fundamental current of element k, Ik(1) | No | Yes |
| ΦIk−Ii[1] | Phase difference between Ik(1) and the fundamental current of element i, Ii(1) | No | Yes |

1 i, j, and k are element numbers. For example, when the number of elements in wiring unit ΣA is three and the wiring system of elements 1, 2, and 3 is three phase, four wire, i is 1, j is 2, and k is 3. ΦUi – Uj represents ΦU1 – U2, the difference between the fundamental voltage signal of element 1, U1(1), and the fundamental voltage signal of element 2, U2(1). In the same way ΦUi – Uk, ΦUi – Ii, ΦUj – Ij, and ΦUk−Ik represent to ΦU1 – U3, ΦU1 – I1, ΦU2 – I2, and ΦU3 – I3, respectively.
2 Setting i to an element, is the same as setting k to 1 in Φ(k).

## Harmonic Measurement Function Orders

The harmonic orders that you can specify are indicated below.

### Element Harmonic Measurement Functions

| Measurement Function | Characters or Numbers in Parentheses | | | |
|---|---|---|---|---|
| | **Total** | **0 (DC)** | **1** | **k** |
| U( ) | Yes | Yes | Yes | 2 to 500 |
| I( ) | Yes | Yes | Yes | 2 to 500 |
| P( ) | Yes | Yes | Yes | 2 to 500 |
| S( ) | Yes | Yes | Yes | 2 to 500 |
| Q( ) | Yes | Fixed at 0 | Yes | 2 to 500 |
| λ( ) | Yes | Yes | Yes | 2 to 500 |
| Φ( ) | Yes | No | Yes | 2 to 500 |
| ΦU( ) | No | No | No | 2 to 500 |
| ΦI( ) | No | No | No | 2 to 500 |
| Z( ) | No | Yes | Yes | 2 to 500 |
| Rs( ) | No | Yes | Yes | 2 to 500 |
| Xs( ) | No | Yes | Yes | 2 to 500 |
| Rp( ) | No | Yes | Yes | 2 to 500 |
| Xp( ) | No | Yes | Yes | 2 to 500 |
| Uhdf( ) | No | Yes | Yes | 2 to 500 |
| Ihdf( ) | No | Yes | Yes | 2 to 500 |
| Phdf( ) | No | Yes | Yes | 2 to 500 |
| Uthd | Yes | No | No | No |
| Ithd | Yes | No | No | No |
| Pthd | Yes | No | No | No |
| Uthf | Yes | No | No | No |
| Ithf | Yes | No | No | No |
| Utif | Yes | No | No | No |
| Itif | Yes | No | No | No |
| hvf | Yes | No | No | No |
| hcf | Yes | No | No | No |
| K-factor | Yes | No | No | No |

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

- Total: Total value (The total value of all harmonic components from the minimum order to N.*)
  For information about how the value is determined, see appendix 1 in the features guide, IM PX8000-01EN.
- 0(DC): DC value
- 1: Fundamental harmonic value
- k: The value of any order from 2 to N.*

* N is the maximum measurable order. The maximum measurable harmonic order is the smallest of the three orders listed below.
  - The specified maximum measurable harmonic order
  - The value determined automatically according to the PLL source frequency (see section 7.5 in the getting started guide, IM PX8000-03EN)

### Wiring Unit Harmonic Measurement Functions (Σ functions)

| Measurement Function | Characters or Numbers in Parentheses | |
|---|---|---|
| | Total | 1 |
| UΣ( ) | Yes | Yes |
| IΣ( ) | Yes | Yes |
| PΣ( ) | Yes | Yes |
| SΣ( ) | Yes | Yes |
| QΣ( ) | Yes | Yes |
| λΣ( ) | Yes | Yes |

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

- Total: Total value
- 1: Fundamental harmonic value

# Delta Computation Functions

| Function | Description |
|---|---|
| ΔU1 | The values returned by the delta computation functions vary depending on the specified delta computation type. |
| ΔU2 | |
| ΔU3 | |
| ΔUΣ | |
| ΔI | |
| ΔP1 | |
| ΔP2 | |
| ΔP3 | |
| ΔPΣ | |

For details about delta computation functions, see “Delta Computation (Δ Measure).”

▶ See here.

# Auxiliary Input Measurement Functions

When Motor Mode Is Disabled

| Function | Description |
|---|---|
| Aux | Auxiliary input |

When Motor Mode Is Enabled

| Function | Description |
|---|---|
| Aux(Speed) | Motor rotating speed |
| Aux(Torque) | Motor torque |
| Pm | Mechanical output of the motor (mechanical power) |

Synchronous speed and slip can be computed using the user-defined function (User Defined Function) of numeric computation. For details see “User-Defined Functions (User Defined Function)” of numeric computation.

▶ See here.

# What Is a Measurement Function?

## Measurement Function

The physical values (such as rms voltage, average current, power, and phase difference) that the PX8000 measures and displays are called measurement functions. Each measurement function is displayed using symbols that correspond to its physical value. For example, “Urms” corresponds to the true rms voltage.

## Input Module

Signal input devices that are installed in the side panel of the PX8000 are called input modules. There are four types of input modules: 760811 (voltage module), 760812/760813 (current modules), and 760851 (AUX module). The combination of the 760811 (voltage module) and the 760812 (current module), or the combination of the 760811 (voltage module) and the 760813 (current module) is called a power measurement element.

## Power Measurement Element (Element)

Power measurement element refers to a set of input modules that can receive a single phase of voltage and current to be measured. Power measurement element is called element for short. The PX8000 can contain up to four elements, numbered from 1 to 4. An element number is appended to the measurement function symbol for the measured data that the PX8000 displays, so that you can tell which data belongs to which element. For example, “Urms1” corresponds to the true rms voltage of element 1.

## Wiring System

You can specify five wiring systems on the PX8000 to measure the power of various single-phase and three-phase power transmission systems: single-phase, two-wire; single-phase, three-wire; three-phase, three-wire; three-phase, four-wire; and three-phase, three-wire with three-voltage, three-current method.

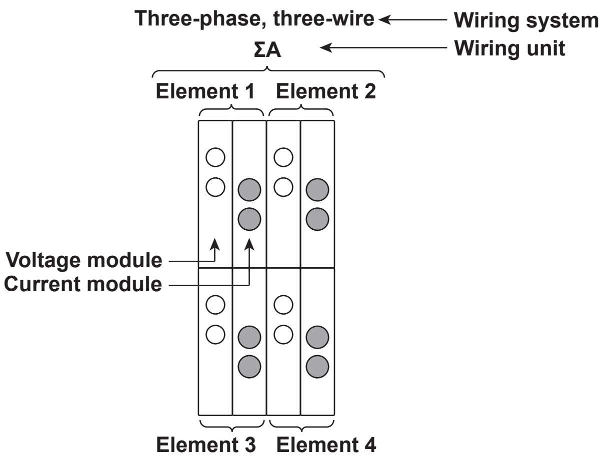
## Wiring Unit

The wiring unit is a set of two or three elements of the same wiring system that are grouped to measure three-phase power. There can be up to two wiring units: ΣA and ΣB.

## Σ Functions

The measurement function of a wiring unit is called a Σ function.
For example, “UrmsΣA” corresponds to the average of the voltages of the elements that are assigned to the wiring unit ΣA. The average value represents the true rms value.

**Illustration of modules installed in the PX8000 (right side panel)**




# Measurement Period

For information about the measurement period for computing measurement functions, see “Synchronization Source (Sync Source)” under “Fundamental Measurement Conditions.”

▶ See here.

# 2 Fundamental Measurement Conditions

## Wiring System Settings (WIRING)

The wiring system settings are listed below.

- Wiring Dystem (Wiring)
- Efficiency Equation (η Formula)
- Independent Element Configuration (Element Independent)
- Delta Computation (Δ Measure)
- External Current Sensor Range Display Ttype (Sensor Range Display Type)
- Deskewing the Transfer Time Difference between Input Signals (Deskew Setup)

## Wiring System (Wiring)

There are five wiring systems available on the PX8000. The selectable wiring systems vary depending on the number of installed 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-voltage, three-current method

### Wiring Unit

Wiring units are sets of two or three elements of the same wiring system that are grouped together. You can define up to two wiring units: ΣA and ΣB.

- When there is one wiring unit, that unit is ΣA. You cannot make ΣB the first wiring unit.
- When there are two wiring units, those units are ΣA and ΣB.
- When there are multiple wiring units, element numbers are assigned to them in ascending order. The element numbers are assigned to ΣA and then ΣB.
- Wiring units are composed of elements that are next to each other. Wiring units cannot consist of elements that are not next to each other.

### Σ Functions

The measurement function of a wiring unit is called a Σ function.
For example, “UrmsΣA” corresponds to the average of the voltages of the elements that are assigned to the wiring unit ΣA. The average value represents the true rms value.

### Wiring System Combinations

The following tables provide the wiring system combinations that you can use and the elements that you can assign to wiring system ΣA or ΣB depending on the number of installed elements.
For details about the relationship between wiring systems and how the values of the measurement functions are determined, see appendix 1 in the features guide, IM PX8000-01EN.

<table>
<tr><td>Element</td><td>1</td></tr>
<tr><td>Wiring system combination</td><td>1P2W</td></tr>
</table>

<table>
<tr><td>Element</td><td>1</td><td>2</td></tr>
<tr><td rowspan="2">Wiring system combination</td><td>1P2W</td><td>1P2W</td></tr>
<tr><td colspan="2">1P3W or 3P3W:ΣA</td></tr>
</table>

<table>
<tr><td>Element</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td rowspan="4">Wiring system combination</td><td>1P2W</td><td>1P2W</td><td>1P2W</td></tr>
<tr><td colspan="2">1P3W or 3P3W:ΣA</td><td>1P2W</td></tr>
<tr><td>1P2W</td><td colspan="2">1P3W or 3P3W:ΣA</td></tr>
<tr><td colspan="3">3P4W or 3P3W:ΣA</td></tr>
</table>

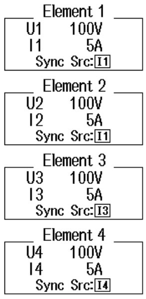
<table>
<tr><td>Element</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td rowspan="7">Wiring system combination</td><td>1P2W</td><td>1P2W</td><td>1P2W</td><td>1P2W</td></tr>
<tr><td colspan="2">1P3W or 3P3W:ΣA</td><td>1P2W</td><td>1P2W</td></tr>
<tr><td>1P2W</td><td colspan="2">1P3W or 3P3W:ΣA</td><td>1P2W</td></tr>
<tr><td>1P2W</td><td>1P2W</td><td colspan="2">1P3W or 3P3W:ΣA</td></tr>
<tr><td colspan="2">1P3W or 3P3W:ΣA</td><td colspan="2">1P3W or 3P3W:ΣB</td></tr>
<tr><td colspan="3">3P4W or 3P3W:ΣA</td><td>1P2W</td></tr>
<tr><td>1P2W</td><td colspan="3">3P4W or 3P3W:ΣA</td></tr>
</table>

Select the wiring system to match the actual wiring of the circuit under measurement. The method in which the Σ functions (wiring unit measurement functions) are determined varies depending on the wiring system. If the selected wiring system does not match the wiring of the actual circuit, measurements and computation will not be correct.

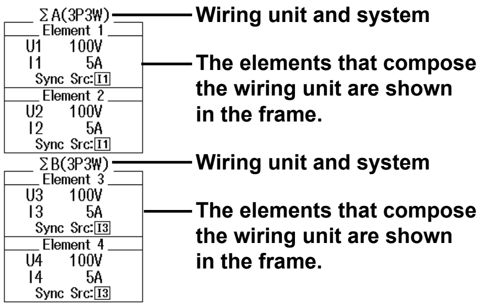
### Wiring System Display

The wiring system configuration is displayed on the right side of the screen. Because it is displayed behind the menu, to view it, you need to press the ESC key to hide the menu. The figure below shows wiring system display examples for a model with four elements installed.

**When the wiring systems of elements 1 to 4 are set to single-phase, two-wire**




**When the wiring system of elements 1 and 2 is set to three-phase, three-wire and the wiring system of elements 3 and 4 is set to three-phase, three-wire**



**Settings of Elements Grouped in a Wiring Unit**

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

- The measurement range is set to the greatest of the measurement ranges of the elements assigned to the same wiring unit. The external current sensor input range has precedence over the direct input current range.
- The auto range on/off settings are changed to match the setting of the element whose measurement range is highest. If multiple elements are set to a common highest measurement range, the setting of the element with the smallest element number takes precedence.
- The synchronization source for a wiring unit is set to the element whose number is the smallest of the elements in the unit.

# Efficiency Equation (η Formula)

You can create an efficiency equation by combining measurement function symbols. The PX8000 can determine the energy conversion efficiency of the device using the numeric values of the measurement functions.

### η1 to η4

You can create four efficiency equations (η1 to η4), using the following measurement functions as operands.

- The active powers of each element (P1 to P4)
- The active powers of the Σ functions (PΣA or PΣB)
- The motor output (Pm; on models with the AUX module)
- Udef1 and Udef2

### Udef1 and Udef2

To add active powers and motor output and use them in η1 to η4, use Udef1 and Udef2. You can add up to four operands consisting of the measurement functions listed above.

### Equation Examples

- **Efficiency of a Single-Phase, Two-Wire Input/Single-Phase, Two-Wire Output Device**
  Input: Power of element 1 (P1)
  Output: Power of element 2 (P2)
  Efficiency equation: P2/P1 × 100 (%)


- **Efficiency of a Single-Phase, Two-Wire Input/Three-Phase, Three-Wire Output Device**
  Input: Power of element 1 (P1)
  Output: Σ power of elements 2 and 3 (PΣA)
  Efficiency equation: PΣA/P1 × 100 (%)

- **Efficiency of a Three-Phase, Three-Wire Input/Three-Phase, Three-Wire Output Device**
  Input: Σ power of elements 1 and 2 (PΣA)
  Output: Σ power of elements 3 and 4 (PΣB)
  Efficiency equation: PΣB/PΣA × 100 (%)

- **Efficiency of a Motor with a Single-Phase, Two-Wire Input**
  Input: Power of element 1 (P1)
  Output: Motor output (Pm)
  Efficiency equation: Pm/P1 × 100 (%)

- **Efficiency of a Motor with a Three-Phase, Three-Wire Input**
  Input: Σ power of elements 1 and 2 (PΣA)
  Output: Motor output (Pm)
  Efficiency equation: Pm/PΣA × 100 (%)

To correctly compute the efficiency, set the power coefficients of all elements so that all power units used in the computation are the same. For example, the efficiency cannot be computed correctly if elements or wiring units used in the computation have different power units, such as W (watt) and J (joule).

## Independent Element Configuration (Element Independent)

In the wiring system settings, you can select whether to set the measurement range or sync source of elements in the same wiring unit collectively or independently.

**Turning Independent Element Configuration On or Off**

- If both types of current modules, the 760812 and 760813, are installed in the PX8000, independent element configuration is fixed to ON.
- If only a single type of current module, 760812 or 760813, is installed in the PX8000, you can set independent element configuration to ON or OFF.
  For example, assume that the wiring system on a model with three elements is set as follows:
  Elements 1 to 3: Three-phase, four-wire system (3P4W). Elements 1 to 3 are assigned to a single wiring unit ΣA.
  - ON
    The measurement range and sync source can be set independently for each element included in a wiring unit.
  - OFF
    The measurement range and sync source of elements 1 to 3 are set to the same setting. This is convenient because when you are measuring a three-phase device, you can set the range and sync source settings of all elements included in a wiring unit simultaneously.

**Settings That Are Shared between Elements When Independent Element Configuration Is Turned Off**

- Measurement range (including auto range on or off)
- Direct current input or external current sensor input
- Synchronization source

**Settings That Can Be Configured Independently Even When Independent Element Configuration Is Turned Off**

- External current sensor conversion ratio
- Scaling (turning scaling on and off, VT ratio, CT ratio, and power coefficient)
- Input filters (line filter and frequency filter)

These settings can be configured independently for each element regardless of whether independent element configuration is turned on or off.

**How Settings Are Aligned When You Turn Independent Element Configuration from On to Off**

When independent element configuration is switched from on to off, the measurement range and sync source settings of each element in a wiring unit (ΣA or ΣB) are changed as follows:

- The measurement range is set to the greatest of the measurement ranges of the elements assigned to the same wiring unit. The external current sensor input range has precedence over the direct input current range.
- The auto range on/off settings are changed to match the setting of the element whose measurement range is highest. If multiple elements are set to a common highest measurement range, the setting of the element with the smallest element number takes precedence.
- The synchronization source for a wiring unit is set to the element whose number is the smallest of the elements in the unit.

# Delta Computation (Δ Measure)

The sum or difference of the instantaneous voltage or current values (sampled data) between the elements in a wiring unit can be used to determine various types of data such as the differential voltage and phase voltage. This operation is called delta computation.

### Types of Delta Computation (ΔMeasure Type)

The following types of delta computation are available:

- Differential voltage and differential current (Difference)
- Line voltage and phase current (3P3W > 3V3A)
- Star-delta transformation (Star>Delta)
- Delta-star transformation (Delta>Star)

The delta computation types that you can select vary as indicated below according to the wiring system.

| Wiring System | Delta Computation Type |
|---|---|
| 1P3W | Difference, 3P3W>3V3A |
| 3P3W | Difference, 3P3W>3V3A |
| 3P4W | Star>Delta |
| 3P3W(3V3A) | Delta>Star |

- **Differential Voltage and Differential Current (Difference)**

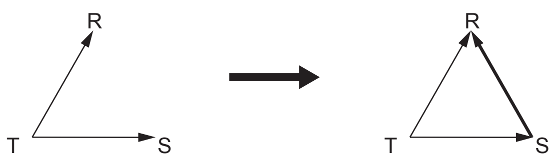
  The differential voltage and differential current between two elements can be computed on a single-phase, three-wire system or on a three-phase, three-wire system.

  When you perform delta computation on wiring unit ΣA, the available measurement functions are as follows.
  ΔU1rms[UdiffA], ΔU1mn[UdiffA], ΔU1dc[UdiffA], ΔU1rmn[UdiffA], ΔU1ac[UdiffA]
  ΔIrms[IdiffA], ΔImn[IdiffA], ΔIdc[IdiffA], ΔIrmn[IdiffA], ΔIac[IdiffA]

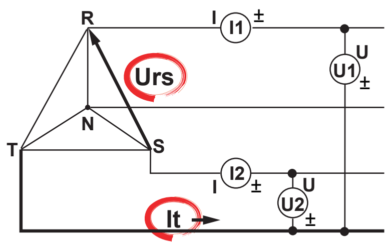
  * In the measurement functions, *rms*, *mn(mean)*, *dc*, *rmn(r-mean)*, and *ac* are the delta computation modes. *A* indicates the wiring unit.

- **Line Voltage and Phase Current (3P3W > 3V3A)**

  You can compute unmeasured line voltages and phase currents by converting the data of a three-phase, three-wire system to the data of the three-voltage, three-current method (3V3A).



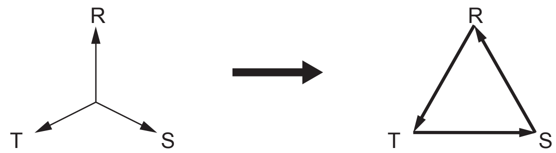

When you perform delta computation on wiring unit ΣA, the available measurement functions are as follows.
ΔU1rms[UrsA], ΔU1mn[UrsA], ΔU1dc[UrsA], ΔU1rmn[UrsA], ΔU1ac[UrsA]
ΔIrms[ItA], ΔImn[ItA], ΔIdc[ItA], ΔIrmn[ItA], ΔIac[ItA]



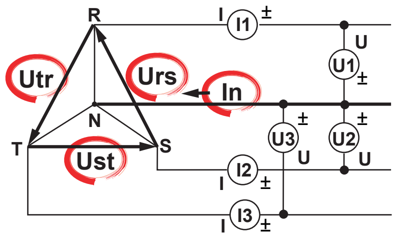

* In the measurement functions, *rms*, *mn(mean)*, *dc*, *rmn(r-mean)*, and *ac* are the delta computation modes. *A* indicates the wiring unit.

- **Star-delta transformation (Star>Delta)**

  You can use the data from a three-phase, four-wire system to compute the data of a delta connection from the data of a star connection.



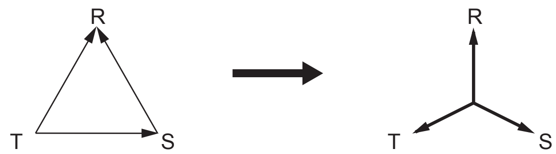

When you perform delta computation on wiring unit ΣA, the available measurement functions are as follows.
ΔU1rms[UrsA], ΔU1mn[UrsA], ΔU1dc[UrsA], ΔU1rmn[UrsA], ΔU1ac[UrsA]
ΔU2rms[UstA], ΔU2mn[UstA], ΔU2dc[UstA], ΔU2rmn[UstA], ΔU2ac[UstA]
ΔU3rms[UtrA], ΔU3mn[UtrA], ΔU3dc[UtrA], ΔU3rmn[UtrA], ΔU3ac[UtrA]
ΔUΣrms[UΣA], ΔUΣmn[UΣA], ΔUΣdc[UΣA], ΔUΣrmn[UΣA], ΔUΣac[UΣA]
ΔIrms[InA], ΔImn[InA], ΔIdc[InA], ΔIrmn[InA], ΔIac[InA]



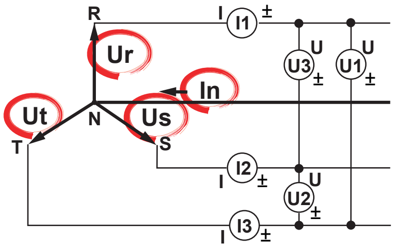

* In the measurement functions, *rms*, *mn(mean)*, *dc*, *rmn(r-mean)*, and *ac* are the delta computation modes. *A* indicates the wiring unit.

- **Delta-star transformation (Delta>Star)**

  Using the data from a three-phase, three-wire system that uses a three-voltage, three-current method, you can compute the data of a star connection from the data of a delta connection. This function is useful when you wish to observe the phase voltage of an object that has no neutral line, such as a motor. The center N of the star connection is computed as the center of the delta connection. If the actual center of the star connection does not match the center of the delta connection, an error results.




When you perform delta computation on wiring unit ΣA, the available measurement functions are as follows.
ΔU1rms[UrA], ΔU1mn[UrA], ΔU1dc[UrA], ΔU1rmn[UrA], ΔU1ac[UrA]
ΔU2rms[UsA], ΔU2mn[UsA], ΔU2dc[UsA], ΔU2rmn[UsA], ΔU2ac[UsA]
ΔU3rms[UtA], ΔU3mn[UtA], ΔU3dc[UtA], ΔU3rmn[UtA], ΔU3ac[UtA]
ΔUΣrms[UΣA], ΔUΣmn[UΣA], ΔUΣdc[UΣA], ΔUΣrmn[UΣA], ΔUΣac[UΣA]
ΔIrms[InA], ΔImn[InA], ΔIdc[InA], ΔIrmn[InA], ΔIac[InA]
ΔP1[PrA]
ΔP2[PsA]
ΔP3[PtA]
ΔPΣ[PΣA]




* In the measurement functions, *rms*, *mn(mean)*, *dc*, *rmn(r-mean)*, and *ac* are the delta computation modes. *A* indicates the wiring unit.

For information about equations, see appendix 1 in the features guide, IM PX8000-01EN.
For information about the measurement period, see “Synchronization Source.”

▶ See here.

**Delta Computation Modes (ΔMeasure Mode)**

You can select the voltage or current mode to be displayed as delta computation values from the following:
rms, mean, dc, r−mean, ac

- We recommend that you set the measurement range and scaling (VT/CT ratio and coefficients) of the elements that are undergoing delta computation as closely as possible. Using different measurement ranges or scaling causes the measurement resolutions of the sampled data to be different. This results in errors.
- The numbers (1, 2, and 3) that are attached to delta computation measurement function symbols have no relation to the element numbers. The computation of all delta measurement functions, from ΔU1 to ΔPΣ, varies depending on the wiring system and the delta computation type. For details, see appendix 1 in the features guide, IM PX8000-01EN.
- When only one element is installed in the PX8000, this feature cannot be used, and its settings do not appear.
- Delta computation cannot be performed on a single-phase, two-wire (1P2W) wiring system.

# External Current Sensor Range Display Type (Sensor Range Display Type)

- This menu appears when a 760812 (current module) is installed in the PX8000.
  You can select the external current sensor range display type from the following options.
  - DIRECT (direct input value display)
    Values are displayed within the external current sensor range (voltage). This setting is useful when you want to set the external current sensor range using the voltage received by the PX8000 from the external current sensor as a guide.
  - MEASURE (measurement range display)
    The external current sensor range is divided by the external current sensor conversion ratio, and the resulting (current) range is displayed. This setting is useful when you want to set the external current sensor range using the current measured by the external current sensor as a guide. For example, if you are using a current sensor that produces 10 mV when it receives 1 A (external current sensor conversion ratio: 10 mV/A) and you set the external current sensor range to 1 V, the displayed current range is 100 A.
- This menu does not appear when a 760812 (current module) is not installed in the PX8000.

# Deskewing the Transfer Time Difference between Input Signals (Deskew Setup)

To measure the power items correctly from the voltage and current of input signals, you must apply the voltage and current signals to the PX8000 signal input terminals with no transfer time difference between the signals. However, transfer time difference may occur between the two signals depending on the sensor or cable that you are using. The PX8000 allows you to deskew the transfer time difference between the two signals and then measure power items.

**Deskewing (Diff Time U, Diff Time I, and Diff Time Sen)**

Sets values for deskewing the transfer time difference between signals on each channel.

- Diff Time U: Correction value for voltage input
- Diff Time I: Correction value for direct current input
- Diff Time Sen: Correction value for external current sensor input*

* This can be set only on a 760812 (current module).

By selecting the Diff Time U, Diff Time I, and Diff Time Sen cells, you can collectively set the correction values for the transfer time differences of all channels.
Selectable range: −20000.000 ns to 20000.0 ns in 0.625−ns steps

When waveform data or numeric data is saved, the deskewed data is saved.

# Power Measurement Element Settings (ELEM1 to 4)

The element settings are listed below.

- Line Filter (Line Filter)
- Frequency Filter (Freq Filter)
- Turning Scaling On and Off (Scaling)
- VT Ratio (VT Scaling)
- CT Ratio (CT Scaling)
- Power Coefficient (SF Scaling; scaling factor)
- Synchronization Source (Sync Source)

# Line Filter (Line Filter)

There are two types of input filters, line filters and frequency filters.
Because the line filter is inserted into the voltage and current measurement input circuits, it directly affects voltage, current, and power measurements (see the block diagram in appendix 14 in the features guide, IM PX8000-01EN). When the line filter is turned on, measured values do not contain high frequency components. Thus, the voltage, current, and power of inverter waveforms, strain waveforms, etc., can be measured with their high frequency components eliminated.

Select the cutoff frequency from the options listed below.
OFF, 500 Hz, 2 kHz, 20 kHz, and 1 MHz

- If the filter of any of the elements is not set to OFF, the line filter setting is displayed as described below.
  - “On” appears to the right of Line Filter at the top of the screen.
  - Line F (Line Filter indicator) turns on in the element information area on the right side of the screen.
- Selecting OFF disables the line filter.

# Frequency Filter (Freq Filter)

The frequency filter is inserted into the frequency measurement input circuit and affects frequency measurements. It also affects the detection of the measurement period for voltage, current, and power measurements (see appendix 4 in the features guide, IM PX8000-01EN). In this case, the filter also acts as a filter for detecting the zero-crossing of the synchronization source signal more accurately. The frequency filter is not inserted into the voltage and current measurement input circuits. Therefore, the measured values include high frequency components even when the frequency filter is turned on.

Select the cutoff frequency from the options listed below.
OFF, 100 Hz, 500 Hz, 2 kHz, and 20 kHz

- The PX8000 detects the zero-crossing point with a hysteresis of approximately 3% of the measurement range.
- If the filter of any of the elements is not set to OFF, the frequency filter setting is displayed as described below.
  - “On” appears to the right of Freq Filter at the top of the screen.
  - Freq F (Freq Filter indicator) turns on in the element information area on the right side of the screen.
- If the line filter described above is on, it affects the frequency measurement even when the frequency filter is off.

# Turning Scaling On and Off (Scaling)

You can set coefficients for when you apply a voltage or current signal from an external VT (voltage transformer) or CT (current transformer).

You can select whether to apply the VT ratio, CT ratio, and power coefficient to applicable measurement functions.
When reading measured values directly by using a VT or CT (or current sensor), select ON.
If the scaling of an element is set to ON , the scaling setting is displayed as described below.

- “On” appears to the right of Scaling at the top of the screen.
- Scale (Scaling indicator) turns on in the element information area on the right side of the screen.

**Applicable Measurement Functions**

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

- ON: The measurement functions above are multiplied by the VT ratio, CT ratio, or power coefficient.
- OFF: The measurement functions above are not multiplied by the VT ratio, CT ratio, or power coefficient. The output values of the VT and CT are displayed directly as numeric data.

# VT Ratio (VT Scaling)

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.

Sset the VT ratio to a value within the following range.
0.0001 to 99999.9999

# CT Ratio (CT Scaling)

Set the CT ratio (or the conversion ratio of the current sensor that produces current) when applying the secondary output of a CT or clamp-type current sensor that produces current to the current input terminal. Then, set the current range according to the maximum CT or current sensor output.

Set the CT ratio to a value within the following range.
0.0001 to 99999.9999

# Power Coefficient (SF Scaling; scaling factor)

By setting the power coefficient (SF), you can display the measured active power, apparent power, and reactive power after they have been multiplied by a coefficient.

| Measurement Function | Data before Transformation | Transformation Result | |
|---|---|---|---|
| Voltage U | $U_2$ (secondary output of the VT) | $U_2 \times V$ | V: VT ratio |
| Current I | $I_2$ (secondary output of the CT) | $I_2 \times C$ | 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 | $Upk_2$ (secondary output of the VT) | $Upk_2 \times V$ | |
| Max./min. current Ipk | $Ipk_2$ (secondary output of the CT) | $Ipk_2 \times C$ | |

Set the power coefficient to a value within the following range.
0.0001 to 99999.9999

- If the value of the result of multiplying the measured value by the VT ratio, CT ratio, or power coefficient (scaling factor) exceeds 9999.99 M, “-OF-” will appear in the numeric data display frame.
- You can view the VT and CT ratios and the power coefficients of all elements by displaying the menu for configuring all channels (ALL CH).

  ▶ See here.
- To correctly compute the power and efficiency of Σ functions, set the power coefficients of all elements so that all power units used in the computation are the same. For example, the efficiency cannot be computed correctly if elements or wiring units used in the computation have different power units, such as W (watt) and J (joule). To compute the efficiency correctly, make all the power units the same (either all W or all J).

# Synchronization Source (Sync Source), Voltage and Current Module

Select the signal to use as the sync source from the options listed below. The available options vary depending on the installed elements. When independent element configuration is off, elements in the same wiring unit have the same sync source.
U1, I1, U2, I2, U3, I3, U4, I4, External,* and None

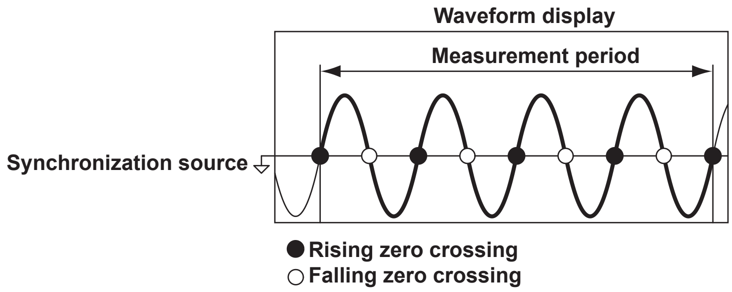
* When you select External, the external signal applied to the external trigger input connector (TRIGGER IN) on the side panel is used as the sync source. For the TRIGGER IN connector specifications, see section 5.1 in the getting started guide, IM PX8000-03EN.

### Synchronization Source Setting Status

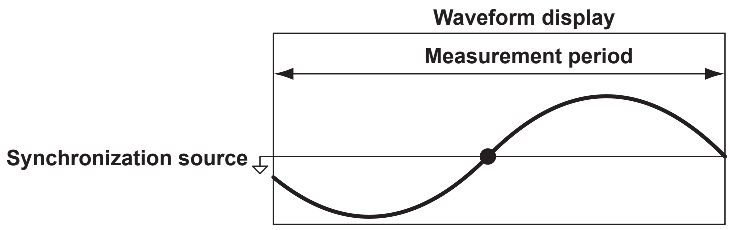
The synchronization source setting is shown in the element information area on the right side of the screen.

### Measurement Period for Measurement Functions Used in Normal Measurement

The measurement period is determined by the input signal that is used as the reference (synchronization source). The measurement period is set within the waveform display between the first point where the sync source crosses the level-zero point (center of the amplitude) on a rising slope (or falling slope) and the last point where the sync source crosses the level-zero point (center of the amplitude) on a rising slope (or falling slope).




If there is not more than one rising or falling slope within the waveform display, the entire waveform display is set as the measurement period.




The measurement period for determining the numeric data of the peak voltage or peak current is always the entire waveform display. Therefore, the measurement period for the measurement functions that are determined on the basis of the maximum voltage or current value (U+pk, U-pk, I+pk, I-pk, CfU, and CfI) is also the entire waveform display.
For details, see appendix 4 in the features guide, IM PX8000-01EN.

### Measurement Period for Measurement Functions Used in Harmonic Measurement (Option)

The measurement period is 8192 points from the start point of harmonic measurement.
The PX8000 determines the harmonic sampling frequency automatically based on the period of the signal that is set as the PLL source. The sampling data and measurement period that are used to determine the values of harmonic measurement functions may be different from those used to determine the values of normal measurement functions.

- If you specify no sync source by selecting "None," all of the sampled data within the the waveform display is used to determine the numeric data. When you are measuring DC signals, this method can be used to prevent noise from causing errors in the detection of the measurement period.
- If the sync source is not set correctly, the measured value may fluctuate or be incorrect. When you set the sync source, refer to appendix 4 in the features guide, IM PX8000-01EN.

# AUX Module Settings (ELEM2 to 4)

The AUX module settings are listed below.

- Turning Motor Mode On and Off (Motor Mode)
- Function Name (Name)
- Scaling (Scaling)
- Unit (Unit)
- Synchronization Source (Sync Source)

# Turning Motor Mode On and Off (Motor Mode)

The PX8000 can determine the motor rotating speed, torque, and output. It determines them using the revolution sensor signal, which is proportional to the motor rotating speed, and the torque meter signal, which is proportional to the motor torque.

If motor mode is set to OFF, the following items cannot be specified.

- Function Name (Name)
- Scaling (Scaling)
- Unit (Unit)

# Function Name (Name)

Set the function name of measurement function Pm.

# Scaling (Scaling)

You can specify the scaling factor for computing the motor output (mechanical power) from the rotating speed and torque. Set the factor to a value from 0.0001 to 99999.9999.

The equation is indicated below. The scaling factors of the rotating speed and torque are set so that the unit of the rotating speed is $\text{min}^{-1}$ (or rpm) and the unit of torque is N•m. When the scaling factor of the motor output specified here is 1, the unit of the motor output Pm is W. Because the efficiency computation uses W as the unit of Pm, we recommend that you set the scaling factor of each item so that the unit of Pm is W.

$$\text{Motor output Pm} = \frac{2\pi}{60} \times \text{Speed} \times \text{Torque} \times \text{S}$$

Speed: The rotating speed, determined from the number of pulses per revolution
Torque: The torque, determined from the torque signal pulse rating
S: The scaling factor

# Unit (Unit)

- Number of characters: Up to eight
- Usable characters: Spaces and all characters that are displayed on the keyboard

## Synchronization Source (Sync Source), AUX Module

- When you are measuring analog revolution and torque signals, you can select the element to use 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, Externa,* and None
  * When you select External, the external signal applied to the external trigger input connector (TRIGGER IN) on the side panel is used as the sync source. For the TRIGGER IN connector specifications, see section 5.1 in the getting started guide, IM PX8000-03EN.
- The measurement period is determined according to the zero-crossing point of the selected synchronization source. The PX8000 uses the measurement period to measure the analog revolution and torque signals. If you specify no synchronization source by selecting “None,” all the sampled data within the waveform display is used to determine the rotating speed and torque.
- When the revolution or torque signal is a pulse signal, its value is the pulse signal period averaged over the measurement period. The measurement period is determined according to the sync source. If the pulse signal period does not fit within the measurement period, the previous period is used to determine the measured value.
- To achieve stable motor efficiency measurements, we recommend that you set the sync source for motor efficiency measurement to the same sync source that is set in the fundamental measurement conditions. This ensures that the measurement period is in sync with the measurement functions, such as those for voltage, current, and active power.

# 3 Vertical Axis

This section explains how to configure the signal input settings and the amplitude-direction display settings. The items that can be set vary depending on the installed modules.

### Input Settings

**U1 to U4, I1 to I4, P1 to P4, CH3 to CH8 (When an AUX module is installed)**

The channel menu that corresponds to the key you pressed appears. You can set the various vertical axis settings for each channel.
The waveform display turns on and off each time that you press the key.

- Voltage Measurement (U)
- Current Measurement (I)
- Power Measurement (P)
- Sensor Input Voltage Measurement (AUX)

**ALL CH**

You can configure the settings of all channels while viewing the settings in a list. You can also copy the various vertical axis settings of one channel to another channel. There are some items that cannot be configured from the ALL CH menu.

▶ See here.

## Voltage Measurement (U)

For voltage measurement, the items that have to be set for each voltage input signal (U1 to U4) include measurement range (vertical scales), the vertical positions, the zoom method, the offset, and auto range.

- Waveform Display (Display)
- Labels (Label)
- Measurement Range (Vertical Scale, RANGE knob)
- Waveform Vertical Position (Vertical POSITION knob)
- Zoom Method (Vertical Scale)
- Zooming by Setting a Magnification (Vertical Zoom)
- Zooming by Setting Upper and Lower Display Limits (Upper/Lower)
- Offset (Offset)
- Auto Range (Auto Range)

### Waveform Display (Display)

Select whether to display each channel’s input signal waveform.

- ON: Displays the waveform
- OFF: Does not display the waveform

### Labels (Label)

You can specify a name of up to sixteen characters in length for each channel.
You can set whether to display labels using the WAVE SETTING menu.

▶ See here.

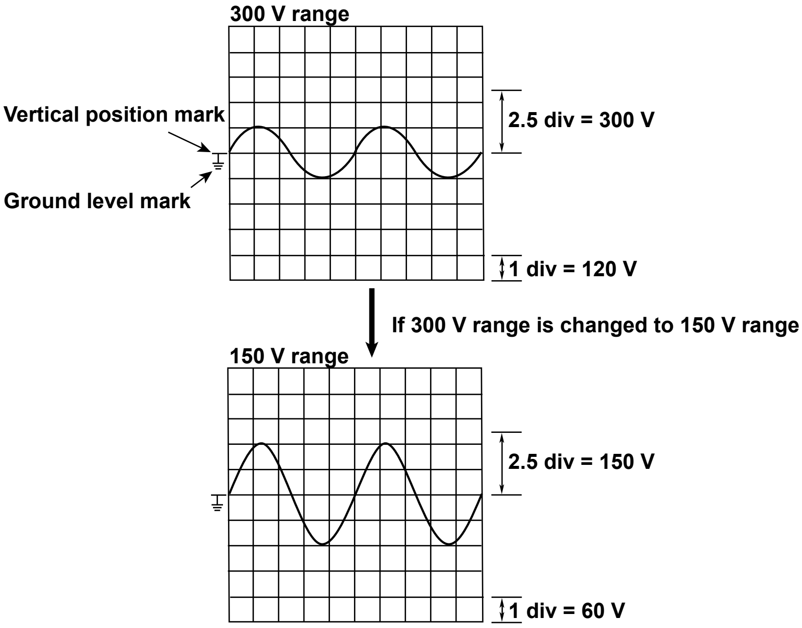
- The specified display label is used in labels, scale values, the numeric display, and cursor-measurement values.
- Depending on the display and zoom formats, label names may not appear when the waveform display is narrow.

# Measurement Range (Vertical Scale, RANGE knob), Voltage

### Voltage Measurement Range Setting

The measurement range is used to adjust the displayed waveform amplitude so that you can easily view signals. For the voltage measurement range, set the voltage that corresponds to 2.5 grid divisions on the waveform screen.

Example




### Selectable range of the voltage measurement range

You can select from 1.5 V, 3 V, 6 V, 10 V, 15 V, 30 V, 60 V, 100 V, 150 V, 300 V, 600 V, and 1000 V.

The measurement range can be fixed (when auto range is set to off) or determined automatically (when auto range is set to on).

### Fixed Ranges

When the measurement range is fixed, you can select a range from the available options. The selected measurement range does not change even if the amplitude of the input signal changes. Set the range in reference to the rms value of the input signal.

### Auto Range

For auto range, see the auto range explanation.

▶ See here.

- Set the range in reference to the rms value of the input signal. For example, if you are applying a 100-Vrms sinusoidal signal, set the range to 100 V.
- When measuring a signal other than a sine wave (such as a distorted wave), you can obtain accurate measurements by selecting the smallest measurement range that does not produce any of the conditions below.
  - The range status indicator at the top left of the screen illuminates in red.
  - The measured values of the voltage and current are indicated as being overload values (“-OL-”).

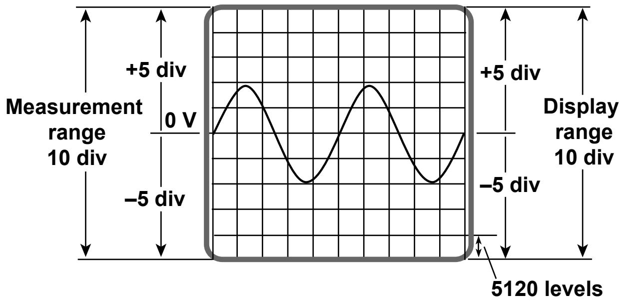
- The range status indicator may not illuminate or blink in the following cases.
  - If the pulse width is narrow, and the peak value of the waveform cannot be acquired at the sample rate of the PX8000.
  - If the high frequency components of the pulse waveform attenuate due to the bandwidth limitations of the PX8000 measurement circuit, causing the waveform peak value to be less than the peak over-range detection level.
- When a signal with the peak which becomes more than about 10 times of the range is input, it takes about 1 second to change the range.
- When the secondary output of a VT (voltage transformer) is being applied to the voltage input terminal, set the voltage range according to the maximum value of the VT output. Then, use the scaling feature to set the VT ratio.
- To display a list of the range settings of all elements, see displaying the menu for configuring all channels (ALL CH).

  ▶ See here.
- While waveform acquisition is stopped, turning the RANGE knob will not change the displayed waveform. The changed measurement range will be applied the next time that waveform acquisition is started.
- While waveform acquisition is stopped, turning the RANGE knob will not change the cursor-measurement values or the automated measurement values of waveform parameters, they will continue to be based on the measurement range at the time of measurement.

### Measurement Range and Display Range of Voltage and Current Signals

The measurement range and display range of the PX8000 is ±5 div with 0 V (voltage signal) or 0 A (current signal) at the center (absolute span of 10 div). You can use the following features to move displayed waveforms and zoom in or out of displayed waveforms.

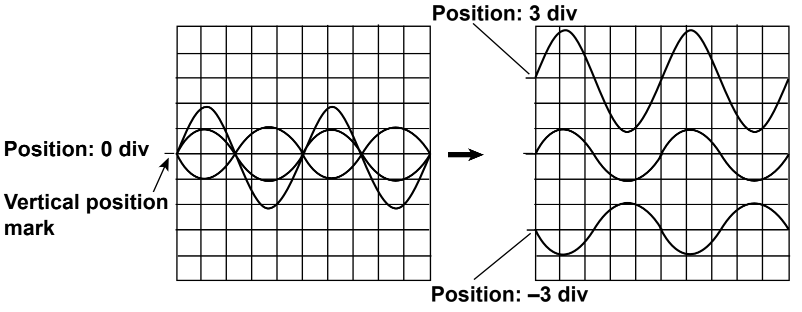
- Vertical position adjustment
- Offset voltage setting
- Vertical zoom



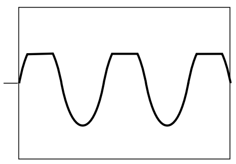

To display multiple waveforms so that they do not overlap without dividing the screen, you have to set the measurement range to a large value. This prevents you from taking advantage of the A/D converter's resolution. However, if you divide the screen  and arrange the waveforms  in the divided screens, they will not overlap, and you can down their measurement range.

# Waveform Vertical Position (Vertical POSITION knob)

The PX8000 can display the waveforms of the voltage, current, power, and computed waveforms. Because the PX8000 can display so many waveforms, the waveforms may overlap and be difficult to view. If this happens, you can adjust the vertical display position to make waveforms easier to view (vertical position).
The vertical position can be moved within the range of ±5 div.
When you changethe measurement range, the location of the vertical position mark does not change.
Use the POSITION knob to set the vertical position.
The same POSITION knob is used to adjust the position of each waveform display.
To change the position of a voltage, current, or power waveform, press the key from U1 to U4, I1 to I4, or P1 to P4 that corresponds to the waveform.
To change the position of a AUX input waveform, press the key from CH3 to CH8 that corresponds to the waveform.




- When the menu for configuring all channels (ALL CH) is displayed, you can use the job shuttle to change the vertical positions.
- When you change the vertical position, offset voltage, or upper or lower limit (when Vertical Scale is set to SPAN), data that is outside of the measurement range is handled as overflow data. As shown in the figure below, waveforms appear cut off when there is overflow data.



# Zoom Method (Vertical Scale)

You can choose the method for zooming the waveform vertically.

- DIV: The waveform is zoomed by a set magnification.
- SPAN: The waveform is zoomed to fit within specified upper and lower display limits.

## Zooming by Setting a Magnification (Vertical Zoom)

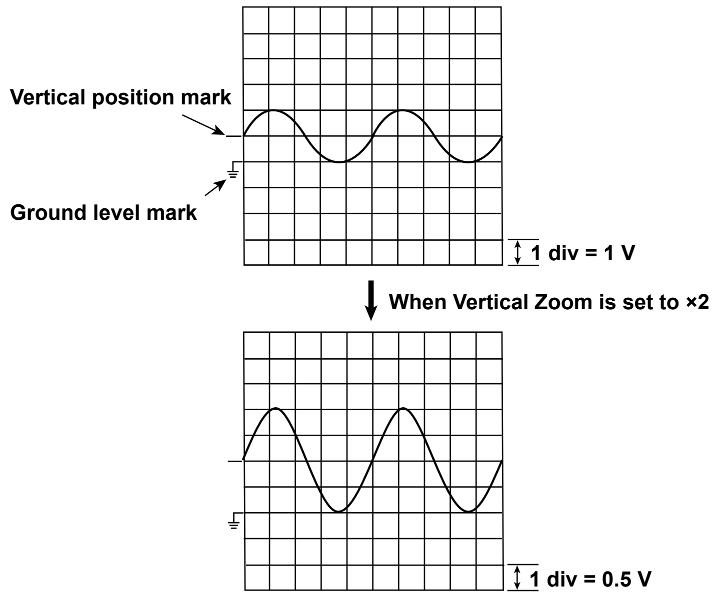
When Vertical Scale is set to DIV, you can set the vertical magnification and enlarge or reduce the waveform along the vertical axis. This method is useful when you want to change the vertical scale of the waveform after it has been displayed.

### Zoom Factor (Vertical Zoom)

The magnifications that you can choose from are listed below.
x0.1, x0.111, x0.125, x0.143, x0.167, x0.2, x0.25, x0.33, x0.4, x0.5, x0.556, x0.625, x0.667, x0.714, x0.8, x0.833, x1, x1.11, x1.25, x1.33, x1.43, x1.67, x2, x2.22, x2.5, x3.33, x4, x5, x6.67, x8, x10, x12.5, x16.7, x20, x25, x40, x50, x100

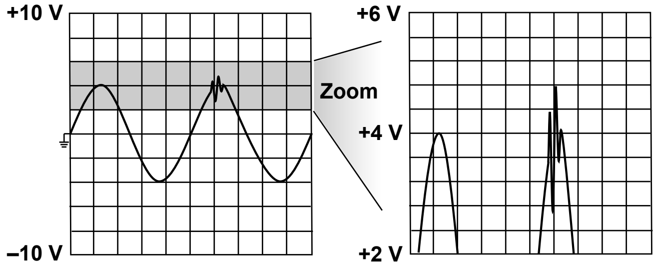
### Zoom Position

Zooming is centered on the vertical position.



## Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

When Vertical Scale is set to SPAN, you can set the upper and lower vertical limits and enlarge or reduce the waveform along the vertical axis. By setting the appropriate upper and lower limits for the displayed waveform, you can zoom in vertically on the area of the waveform that you want to observe. You can also increase the display range to view parts of the waveform that were outside the range. Zooming the waveform does not change its A/D conversion resolution or accuracy.




### Selectable Range of the Upper and Lower Limits

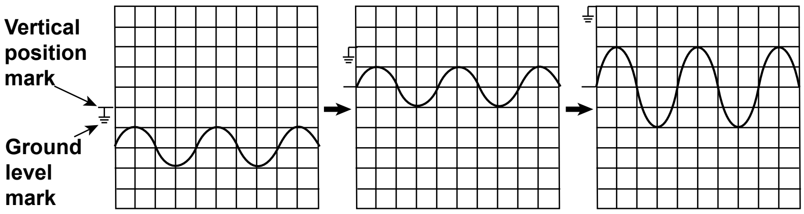
The upper and lower limits can be set within ±(20 × the specified measurement range). Set the limits so that the upper limit is greater than the lower limit.

The displayed V/div will not change if you turn the RANGE knob after you set the upper and lower limits, but the measurable range will change. If you change the measurable range so that it is narrower than the range of the set upper and lower limits, when you start waveform acquisition, the parts of the waveform that do not fit within the measurable range may not appear. The measurable range is approximately ±5 div (with 0 in the center) when Vertical Scale is set to DIV.

# Offset (Offset)

By adding an offset, you can move the waveform to a vertical position that is easier to see. For example, when measuring a signal with a fixed voltage component, you can use the offset to cancel out the fixed voltage and measure the signal changes at a higher voltage sensitivity.
You can set the offset for each input waveform.
The offset is useful when you are measuring voltage or current.

| | | | |
|---|---|---|---|
| **Voltage range:** | **60 V** | **60 V** | **30 V** |
| **Voltage sensitivity:** | **24 V/div** | **24 V/div** | **12 V/div** |
| **Vertical position:** | **0.00 div** | **1.00 div** | **1.00 div** |
| **Offset voltage:** | **0.0 V** | **–48.0 V** | **–48.0 V** |




### Selectable Range of the Offset

±5 div

### Notes about Setting the Offset

- When you are measuring voltage, changes to the offset are applied when acquisition is stopped.
- When you are measuring voltage, the offset will not change even if you change the voltage scale. However, if the offset goes outside the selectable range, the offset is set to the maximum or minimum value for the current voltage scale. If you set the vertical scale back to its original value without changing the offset, the offset returns to its original value.

- The offset does not affect cursor-measurement values, automated measurement values of waveform parameters, or computed values.
- You can change the position of the waveform relative to the vertical position (change the focus of the vertical zoom) by changing the offset.

# Auto Range (Auto Range)

When you set the auto range ON, the range is set automatically. The measurement range is switched automatically depending on the amplitude of the input signal as described below. The different ranges used in the auto range are the same as those available for the fixed range.

### Auto Range Setting Status

Setting auto range ON turns on AUTO (Auto range indicator) in the element information area on the right side of the screen.

## Range Increase

The measurement range is increased when any of the following conditions is met.

- The data of measurement function Urms or Irms exceeds 110% of the measurement range.
- The data of Upk or Ipk exceeds 200% of the current measurement range.

When a wiring unit is configured and independent element configuration is off, the measurement range is increased on all elements in the wiring unit when any of the elements in the unit meets the range-increase conditions .

## Range Decrease

The measurement range is decreased when all the following conditions are met.

- The data of Urms or Irms is less than 30% of the measurement range.
- The data of Upk or Ipk is less than or equal to 180% of the next lower range.

When a wiring unit is configured and independent element configuration is off,  and all the elements in the unit meet the range-increase conditions, all their measurement ranges are increased.

When non-periodic pulse waveforms are applied, the range may not remain constant. If this happens, use the fixed range setting.

## Conditions in Which Auto Range Is Disabled

If any of the conditions is met, auto range is disabled.

- Roll mode display (trigger mode is set to Auto, AutoLevel, Single, or On Start, and the time scale is set to 100 ms/div or higher)
- The acquisition mode is set to Average or Envelope.
- Numeric measurement is set to OFF.
- GO/NO-GO determination mode is set to Wave Zone or Parameter.
- Action mode is set to ON.
- The AUX input signal type is Pulse.

# Current Measurement (I)

For current measurement, the items that have to be set for each current input signal (I1 to I4) include measurement range (vertical scales), the vertical positions, the zoom method, the offset, and auto range.

- Waveform Display (Display)
- Labels (Label)
- Measurement Range (Vertical Scale, RANGE knob)
- Waveform Vertical Position (Vertical POSITION knob)
- Zoom Method (Vertical Scale)
- Offset (Offset)
- Auto Range (Auto Range)
- External Current Sensor Input (Ext Sensor)*
- External Current Sensor Conversion Ratio (Sensor Ratio)*

* This can be set only on a 760812 (current module).

## Waveform Display (Display)

Select whether to display each channel's input signal waveform.

- ON: Displays the waveform
- OFF: Does not display the waveform

## Labels (Label)

This item is the same as labels of the voltage measurement.

▶ See here.

# Measurement Range (Vertical Scale, RANGE knob), Current

**Selectable range of the current measurement range**

- **Direct input**

  You can select from 10 mA, 20 mA, 50 mA, 100 mA, 200 mA, 500 mA, 1 A, 2 A, and 5 A.

- **External current sensor input (/EX1, /EX2)**

  You can select from 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, and 10 V.

When the secondary output of a CT (current transformer) or a clamp-type current sensor that outputs current is being applied to the current input terminal, set the current range according to the maximum value of the CT or current sensor output. Then, use the scaling feature to set the CT ratio or the conversion ratio of the clamp-type current sensor that outputs current.

### Current Measurement Range Setting

This item is the same as range setting of the voltage measurement.

For the current measurement range, set the current that corresponds to 2.5 grid divisions on the waveform screen.

▶ See here.

## Waveform Vertical Position (Vertical POSITION knob)

This item is the same as waveform vertical position of the voltage measurement.

▶ See here.

### Zoom Method (Vertical Scale)

This item is the same as zoom method of the voltage measurement.

▶ See here.

### Offset (Offset)

This item is the same as offset of the voltage measurement.

▶ See here.

### Auto Range (Auto Range)

This item is the same as auto range of the voltage measurement.

▶ See here.

## External Current Sensor Input (Ext Sensor)

This function can be set only on a 760812 (current module).

The output of current sensors that produce voltage, such as shunts and clamps, can be applied to an element's external current sensor input connector (EXT) and measured.

Select whether to use each channel's external current sensor input.

- ON: Uses the external current sensor input
- OFF: Does not use the external current sensor input

## External Current Sensor Conversion Ratio (Sensor Ratio)

This function can be set only on a 760812 (current module).

Set the conversion ratio used to measure the signal received by the external current sensor input connector (EXT) from a current sensor that produces voltage. Set how many millivolts the current sensor transmits when 1 A of current is applied (conversion ratio). Then, the input signal can be made to correspond to the numeric data or waveform display data that is obtained when the current is directly applied to the input terminals. When using a current sensor that produces current, set the conversion ratio as the CT ratio.

| Measurement Function | Conversion Ratio | Data before Transformation | Transformation Result |
|---|---|---|---|
| Current I | E | $I_S$ (current sensor output) | $I_S/E$ |
| Active power P | E | $P_S$ | $P_S/E$ |
| Apparent power S | E | $S_S$ | $S_S/E$ |
| Reactive power Q | E | $Q_S$ | $Q_S/E$ |
| Max./min. current Ipk | E | $Ipk_S$ (current sensor output) | $Ipk_S/E$ |

### External Current Sensor Range and Conversion Ratio Configuration Example

When you measure a current with a maximum value of 100 A using a current sensor that produces 10 mV when 1 A of current is flowing, the maximum voltage that the current sensor produces is 10 mV/A × 100 A = 1 V. Therefore, configure the settings as indicated below.

- External current sensor range: 1 V
- External current sensor conversion ratio: 10 mV/A

- When you want to divide the external current sensor output by the conversion ratio and read the current of the circuit under measurement directly, turn the external VT/CT scaling feature off. If the feature is turned on, the value will be further multiplied by the CT ratio.
- When you are measuring a signal other than a sine wave (such as a distorted wave), you can obtain accurate measurements by selecting the smallest measurement range that does not produce any of the conditions below.
  - The range status indicator at the top left of the screen illuminates in red.
  - The measured values of the voltage and current are indicated as being overload values ("-OL-").

# Power Measurement (P)

For power measurement, the items that have to be set for each power input signal (P1 to P4) include the vertical positions, the zoom method, and the offset.

- Waveform Display (Display)
- Labels (Label)
- Measurement Range
- Waveform Vertical Position (Vertical POSITION knob)
- Zoom Method (Vertical Scale)
- Offset (Offset)

## Waveform Display (Display)

Select whether to display each channel's input signal waveform.

- ON: Displays the waveform
- OFF: Does not display the waveform

## Labels (Label)

This item is the same as labels of the voltage measurement.

▶ See here.

# Measurement Range, Power

**Power Range**

For the power range on the waveform display screen, "voltage range × current range" is set to +5 div by setting the default zoom value to ×2.

## Waveform Vertical Position (Vertical POSITION knob)

This item is the same as waveform vertical position of the voltage measurement.

▶ See here.

## Zoom Method (Vertical Scale)

This item is the same as zoom method of the voltage measurement.

▶ See here.

## Offset (Offset)

This item is the same as offset of the voltage measurement.

▶ See here.

# Sensor Input Voltage Measurement (AUX)

For sensor input voltage measurement, the items that have to be set for each AUX input signal (AUX3 to AUX8) include measurement range (vertical scales), the vertical positions, the zoom method, the offset, and auto range.

- Waveform Display (Display)
- Labels (Label)
- Measurement Range (Vertical Scale, RANGE knob)
- Waveform Vertical Position (Vertical POSITION knob)
- Zoom Method (Vertical Scale)
- Offset (Offset)
- Auto Range (Auto Range)
- AUX Settings (Aux Settings)
- Rotating Speed Settings (Speed Settings)
- Torque Settings (Torque Settings)
- Input Coupling (Coupling)
- Probe Attenuation and Current-to-Voltage Conversion Ratio (Probe)
- Bandwidth (Bandwidth)
- Pulse Reference Level (Pulse Level High/Pulse Level Low)

## Waveform Display (Display)

Select whether to display each channel's input signal waveform.

- ON: Displays the waveform
- OFF: Does not display the waveform

## Labels (Label)

This item is the same as labels of the voltage measurement.

▶ See here.

# Measurement Range (Vertical Scale, RANGE knob), AUX

### Measurement range

- **When Motor Mode Is Set to OFF and Aux Settings Is Set to Analog**
  - When the probe attenuation (Probe) is 1:1
    You can select from 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V, 5 V, 10 V, 25 V, 50 V, and 100 V.
  - When the probe attenuation (Probe) is 10:1
    You can select from 500 mV, 1 V, 2.5 V, 5 V, 10 V, 25 V, 50 V, 100 V, 250 V, 500 V, and 1 kV.
  - When the probe attenuation (Probe) is 100:1
    You can select from 5 V, 10 V, 25 V, 50 V, 100 V, 250 V, 500 V, 1 kV, 2.5 kV, 5 kV, and 10 kV.
  - When the probe attenuation (Probe) is 1000:1
    You can select from 50 V, 100 V, 250 V, 500 V, 1 kV, 2.5 kV, 5 kV, 10 kV, 25 kV, 50 kV, and 100 kV.

- **When Motor Mode Is Set to ON and Speed Settings or Torque Settings Is Set to Analog**
  You can select from 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V, 5 V, 10 V, 25 V, 50 V, and 100 V.

- **When Aux Settings, Speed Settings, or Torque Settings Is Set to Pulse**
  You can select from 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz, 50 Hz, 100 Hz, 200 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz, 20 kHz, 50 kHz, 100 kHz, 200 kHz, 500 kHz, and 1 MHz.

### Measurement Range Setting

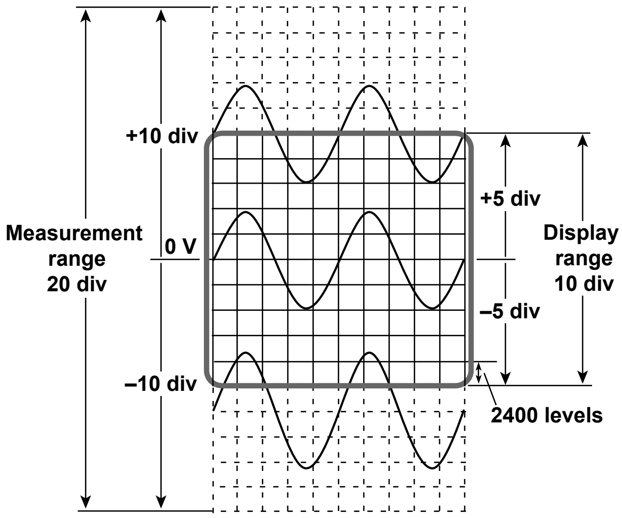
This item is the same as range setting of the voltage measurement.
However, set the voltage that corresponds to 5 grid divisions on the waveform screen for the measurement range.

▶ See here.

### Measurement Range and Display Range of AUX InputX

The measurement range of the PX8000 is ±10 div, with 0 V in the center (the absolute width, or span, is 20 div). The default display-range setting is ±5 div (the span is 10 div). Using the features listed below, you can move and scale the displayed waveform so that parts of it that were outside of the display range are displayed.

- Vertical position adjustment
- Offset voltage setting
- Vertical zoom



## Waveform Vertical Position (Vertical POSITION knob)

This item is the same as waveform vertical position of the voltage measurement.

▶ See here.

## Zoom Method (Vertical Scale)

This item is the same as zoom method of the voltage measurement.

▶ See here.

## Offset (Offset)

This item is the same as offset of the voltage measurement.

▶ See here.

## Auto Range (Auto Range)

### When the Input Signal Type Is Analog

When you set the auto range ON, the range is set automatically. The measurement range is switched automatically depending on the amplitude of the input signal as described below. The different ranges used in the auto range are the same as those available for the fixed range.

#### Range Increase

The measurement range is increased when any of the following conditions is met.

- The computed value DC based on AUX measurement exceeds 110% of the measurement range.
- The peak value of measured AUX data exceeds 200% of the measurement range (when motor mode is set to OFF).
- The peak value of measured AUX data exceeds 145 of the measurement range (when motor mode is set to ON).

#### Range Decrease

The measurement range is decreased when all the following conditions are met.

- The computed value DC based on AUX measurement is less than 30% of the measurement range.
- The peak value of measured AUX data is less than or equal to 180% of the next lower range (when motor mode is set to OFF).
- The peak value of measured AUX data is less than or equal to 140% of the next lower range (when motor mode is set to ON).

When non-periodic pulse waveforms are applied, the range may not remain constant. If this happens, use the fixed range setting.

### When the Input Signal Type Is Pulse

The auto range feature is disabled.

### Auto Range Setting Status

Setting auto range ON turns on AUTO (Auto range indicator) in the element information area on the right side of the screen.

### Conditions in Which Auto Range Is Disabled

The same conditions that auto range is disabled for voltage and current ranges.

▶ See here.

# AUX Settings (Aux Settings)

This menu display varies depending on whether the motor mode is on.

- When motor mode is off: AUX settings (Aux Settings)
- When motor mode is on:
  - Odd channels (AUX3, AUX5, AUX7): Rotating speed settings (Speed Settings)
  - Even channels (AUX4, AUX6, AUX8): Torque settings (Torque Settings)

Set the following items for sensor input voltage measurement.

- Input Signal Type (Sense Type)
- Linear Scaling (Scaling)
- Display Type (Display Type)

## Input Signal Type (Sense Type)

You can select which of the following two types of signals you want the PX8000 to receive from the sensor.

- Analog: Select this option when the PX8000 will receive analog signals.
- Pulse: Select this option when the PX8000 will receive pulse signals.

## Linear Scaling (Scaling)

Linear scaling is a function that converts measured values into physical values and reads them directly.

### Linear Scaling Modes (Scaling Mode)

- **OFF**

  Linear scaling is not performed.
  You can select this when Sense Type is set to Analog.

- **AX + B**

  Using specified scaling coefficient A and offset B, the PX8000 performs the following computation to scale cursor-measurement values and automated measurement values of waveform parameters. You can specify the unit of the linearly scaled results.
  Y = AX + B
  X: Value before scaling
  Y: Value after scaling

  Selectable range for A and B: −9.9999E+30 to +9.9999E+30
  Initial value of A: 1.0000
  Initial value of B: 0.0000

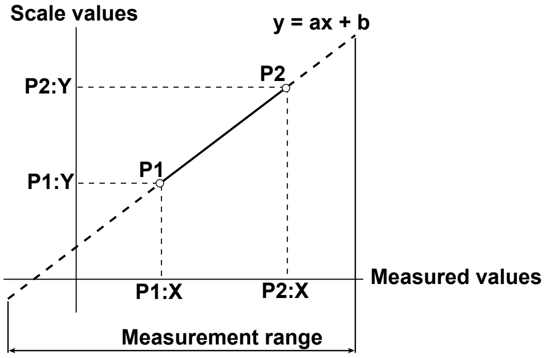
**• P1-P2**

You can specify two measured values (P1:X, P2:X) and specify a scale value (P1:Y, P2:Y) for each. The scale-conversion equation (y = ax + b) is determined by these four values.

- Measured value (P1:X, P2:X) range: Same as the measurement range
- Scale value (P1:Y, P2:Y) range: −9.9999E+30 to +9.9999E+30
- Initial scale values
  P1:X 1.0000, P1:Y 1.0000
  P2:X 5.0000, P2:Y 5.0000

**Get Value (Get Value)**

Sets P1:X and P2:X to the current values, regardless of whether waveform acquisition is in progress or stopped.




### Unit String (Unit String)

You can set the unit using up to eight alphanumeric characters.

## Display Type (Display Type)

You can set the display type when the linear scaling mode is not set to OFF.
You can display the linearly scaled results using one of the following two methods (Mode).
Exponent: Values are displayed in exponential notation.
Floating: Values are displayed as decimal numbers.

For Decimal Number, set the number of digits after the decimal point to Auto or a number from 0 to 3. For SubUnit, set the unit prefix to Auto, p, n, µ, m, None, k, M, G, or T.

- If you set Decimal Number to a number from 0 to 3, the specified number of digits after the decimal point are displayed. If you select Auto, all numbers will be displayed using five digits (for example: 1.0000, 250.00). The default setting is Auto.
- If you set SubUnit to a setting other than Auto, numbers will be displayed with the specified unit prefix. If you select Auto, the PX8000 will automatically select appropriate unit prefixes. The default setting is Auto. The PX8000 displays values in exponential notation if it is unable to display them as decimal numbers.

### Scale Value Display

You can display the linearly scaled values of the upper and lower vertical limits of each channel.
You can turn the scale value display on and off from the WAVE SETTING menu of the waveform display.

▶ See here.

- You can configure linear scaling for each channel.
- The specified scaling coefficient A and offset B are retained even after linear scaling is set to OFF.
- Computations are performed on the linearly scaled values.

# Rotating Speed Settings (Speed Settings)

This menu display varies depending on whether the motor mode is on.

- When motor mode is off: AUX settings (Aux Settings)
- When motor mode is on:
    - Odd channels (AUX3, AUX5, AUX7): Rotating speed settings (Speed Settings)
    - Even channels (AUX4, AUX6, AUX8): Torque settings (Torque Settings)

Set the following items for sensor input voltage measurement.

- Input Signal Type (Sense Type)
- Unit (Unit)
- Analog settings (Analog) or Pulse settings (Pulse)
- Display Type (Display Type)

## Input Signal Type (Sense Type)

You can select which of the following two types of signals you want the PX8000 to receive from the sensor.

- Analog: Select this option when the PX8000 will receive analog signals.
- Pulse: Select this option when the PX8000 will receive pulse signals.

## Unit (Unit)

You can select from rps, rpm, and rph.

## Analog settings (Analog)

Set the conversion ratio for converting input voltage signals into rotating speed.

This is the same feature as linear scaling of AUX settings.

▶ See here.

## Pulse Settings (Pulse)

**Revolution signal pulses per revolution (Pulse N)**

Set the number of pulses per revolution to a value from 1 to 9999.

## Display Type (Display Type)

This item is the same as display typee of the AUX settings.

▶ See here.

# Torque Settings (Torque Settings)

This menu display varies depending on whether the motor mode is on.

- When motor mode is off: AUX settings (Aux Settings)
- When motor mode is on:
  - Odd channels (AUX3, AUX5, AUX7): Rotating speed settings (Speed Settings)
  - Even channels (AUX4, AUX6, AUX8): Torque settings (Torque Settings)

Set the following items for sensor input voltage measurement.

- Input Signal Type (Sense Type)
- Unit (Unit)
- Analog settings (Analog) or Pulse settings (Pulse)
- Display Type (Display Type)

## Input Signal Type (Sense Type)

You can select which of the following two types of signals you want the PX8000 to receive from the sensor.

- Analog: Select this option when the PX8000 will receive analog signals.
- Pulse: Select this option when the PX8000 will receive pulse signals.

## Unit (Unit)

You can set the unit using up to eight alphanumeric characters.

## Analog settings (Analog)

Set the conversion ratio for converting input voltage signals into torque.
This is the same feature as linear scaling of AUX settings.

▶ See here.

## Pulse Settings (Pulse)

When the torque signal type is pulse, refer to the torque meter's specifications to set its rated positive and negative values.

**Positive and Negative Rated Torque Signal Values (Rated Upper, Rated Lower)**

Range: –10000.0000 to 10000.0000

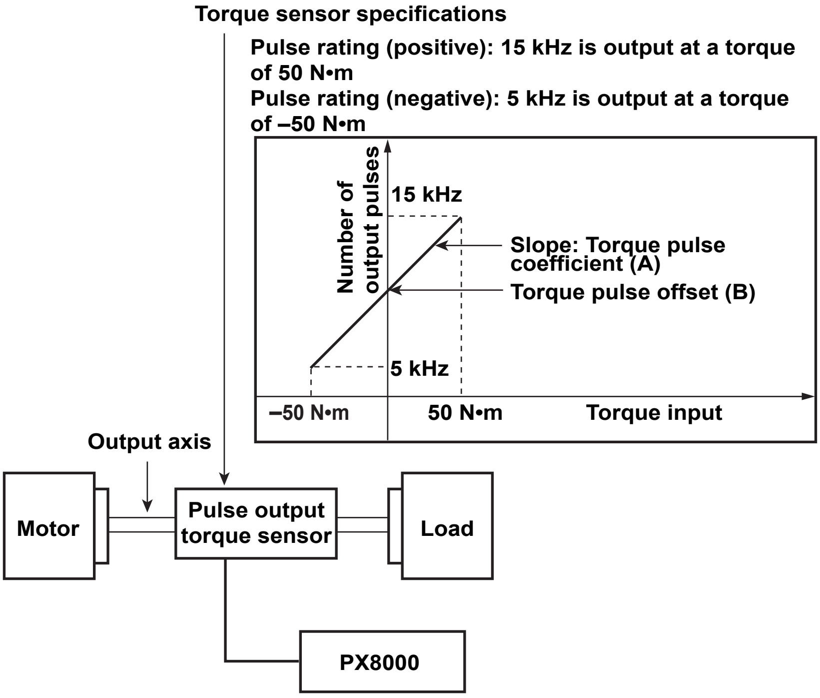
Set the positive and negative rated torque signal pulse frequencies to the right of the colon.
Range: 1 to 100000000 (Hz)

**The Torque Signal Pulse Rating**

When you use a torque meter with specifications in the figure below, configure the pulse rating settings as indicated below.

- Positive rated torque signal value (Rated Upper): 50.0000
- Negative rated torque signal value (Rated Lower): –50.0000
- Positive rated torque signal pulse frequency : 15000
- Negative rated torque signal pulse frequency : 5000

Also, set the unit to N•m




## Display Type (Display Type)

This item is the same as display typee of the AUX settings.

▶ See here.

## Input Coupling (Coupling)

It is easier to measure the amplitude of an AC signal if you remove its DC component. On the other hand, there are times when you want to measure the ground level or observe the entire signal, including both the DC and AC components. In these kinds of situations, you can change the input coupling setting. By changing the setting, you can choose how the vertical-axis (voltage-axis) control circuit is coupled to the input signal.

- This setting is valid when Sense Type is set to Analog.
- This setting is not valid when Sense Type is set to Pulse.

You can set the input coupling to one of the available settings below.

**AC (Only when measuring AC voltage)**

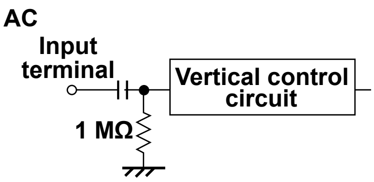
The input signal is coupled to the attenuator of the vertical control circuit through a capacitor. Set the input coupling to AC when you want to measure only the amplitude of the AC signal without the DC component.

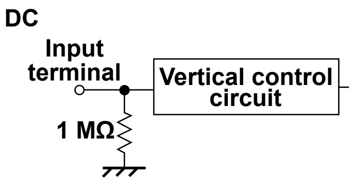
**DC**

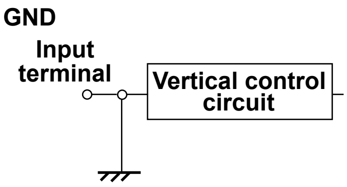
The input signal is coupled directly to the attenuator of the vertical control circuit. Set the input coupling to DC when you want to measure the entire signal, including both the DC and AC components.

**GND**

The input signal is coupled to the ground rather than to the attenuator of the vertical control circuit. Set the input coupling to GND to check the ground level on the screen.




## Probe Attenuation and Current-to-Voltage Conversion Ratio (Probe)

When you use a probe, to read the measurement voltage correctly, you must set the attenuation on the PX8000 to match the probe attenuation.
This setting is valid when Motor Mode is set to OFF and Sense Type is set to Analog.
You cannot specify this setting when Motor Mode is set to ON or when Sense Type is set to Pulse.

Set the attenuation ratio as indicated below for each probe. (The probes are optional accessories that are sold separately.)

| Probe Type | Attenuation |
|---|---|
| Isolated probe (700929) | 10:1 |
| Isolated probe (701947) | 100:1 |
| High voltage differential probe (701926) | 1000:1, 100:1 |

The attenuation settings available on the PX8000 are 1:1, 10:1, 100:1, and 1000:1. If you use a probe other than one of the separately sold optional accessories provided by Yokogawa, set the attenuation ratio in accordance with that probe.

Use a probe that is appropriate for the input capacitance of the AUX module. The capacitance cannot be adjusted for an inappropriate probe.

## Bandwidth (Bandwidth)

You can set bandwidth limitations on the analog signals by specifying a cutoff frequency.
You can view signals with frequency components above the specified frequency removed.
Set the cutoff frequency to one of the settings below.
Full (no bandwidth limit), 2 MHz, 1.28 MHz, 640 kHz, 320 kHz, 160 kHz, 80 kHz, 40 kHz, 20 kHz, or 10 kHz

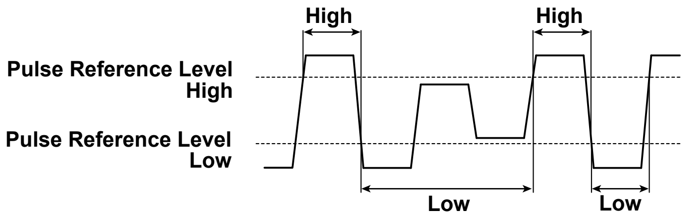
## Pulse Reference Level (Pulse Level High/Pulse Level Low)

- This setting is not valid when Sense Type is set to Analog.
- This setting is valid when Sense Type is set to Pulse.

You can set the voltage level for counting pulses. The range is –10.0V to 10.0V, and the resolution is 0.1 V.

- Judgment condition for high pulse level
  Between the point when the input waveform level changes from below the low pulse reference level to above the high pulse reference level to the point when the level changes from above the high pulse reference level to below the low pulse reference level
- Judgment condition for low pulse level
  Between the point when the input waveform level changes from above the high pulse reference level to below the low pulse reference level to the point when the level changes from below the low pulse reference level to above the high pulse reference level

For all other conditions, the pulse is not detected as high or low level conditions. They are handled as sections where pulse judgment condition is not met.



# Displaying the Menu for Configuring All Channels (ALL CH)

You can configure the settings of all channels while viewing the settings in a list. You can also copy the various settings of one channel to another channel. There are some items that cannot be configured from the ALL CH menu.

## Settings of All Elements (All Elements)

You can configure the settings of all elements while viewing the settings in a list. By selecting the left most cell, you can collectively set all elements.

### Sensor Conversio Ratio Preset (Sensor Preset)

When using the dedicated shunt box, preset the external current sensor conversion ratio. Select the preset name (shunt box) from one of the settings below.

| Preset Name | External Current Sensor Conversion Ratio (Sensor Ratio) |
|---|---|
| Shunt20 (20 Ω) | 20000.0000 mV/A (mΩ) |
| Shunt10 (10 Ω) | 10000.0000 mV/A (mΩ) |
| Shunt5 (5 Ω) | 5000.0000 mV/A (mΩ) |

If you set this item, the external current sensor input ON/OFF (Ext Sensor) is set to ON. If you change the external current sensor conversion ratio (Sensor Ratio) after setting this item, an asterisk will be added to the preset name. To use other sensors, select Others. If you select Others, the external current sensor input ON/OFF and external current sensor conversion ratio do not change.

### CT Ratio Preset (CT Preset)

When using the dedicated CT, preset the CT ratio. Select the preset name (CT) from one of the settings below.

| Preset Name | CT Ratio (CT Scaling) |
|---|---|
| CT2000A | 2000.0000 |
| CT1000 | 1500.0000 |
| CT200 | 1000.0000 |
| CT60 | 600.0000 |

If you set this item, the scaling ON/OFF (Scaling) is set to ON. If you change the CT ratio (CT Scaling) after setting this item, an asterisk will be added to the preset name. To use other sensors, select Others. If you select Others, the scaling ON/OFF and CT ratio do not change.

## Settings of All AUX Channels (All Auxiliaries)

You can configure the settings of all auxiliaries while viewing the settings in a list.

## Independent Element Configuration (Element Independent)

This item is the same as independent element configuration of the fundamental measurement conditions.

▶ See here.

## External Current Sensor Range Display Type (Sensor Range Display Type)

This item is the same as external current sensor range display type of the fundamental measurement conditions.

▶ See here.

## Copy (Elements Copy to, or Auxiliaries Copy to)

You can copy the various vertical axis and linear scaling settings from one element to other elements.
You can also copy the vertical and linear scaling settings of one AUX channel to other AUX channels.

### Source Channel (Source)

Select the copy source element or AUX channel.

### Destination Channels (Destination)

Select the copy destination element or AUX channel.

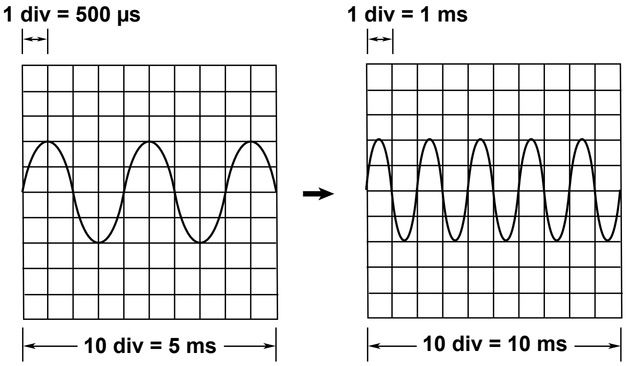
### Execute (Execute)

Select Execute to copy the settings.

# 4 Horizontal Axis

## Time Axis Setting (TIME/DIV)

When the internal clock is being used, the time axis scale is set as a length of time per grid division (1 div).
The time axis scale can be set within the following ranges: 100 ns/div to 30 s/div, 1 min/div, and 2 min/div. The transition from seconds to minutes occurs automatically.
The horizontal display range is 10 div. Therefore, the amount of time on the waveform that is displayed is equal to the time axis setting × 10.



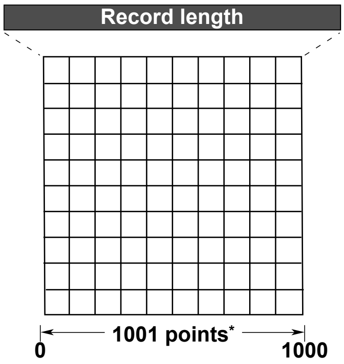

### Internal and External Clocks (Time base selection)

Under the initial settings, the PX8000 samples the waveform data using the clock signal produced by its internal time-base circuit (internal clock).
You can also use an external clock signal to control sampling. Apply the external clock signal to the external-clock input terminal (EXT CLK IN) on the left panel of the PX8000. This external clock input is useful for synchronizing to the clock signal of the waveform that is being measured.

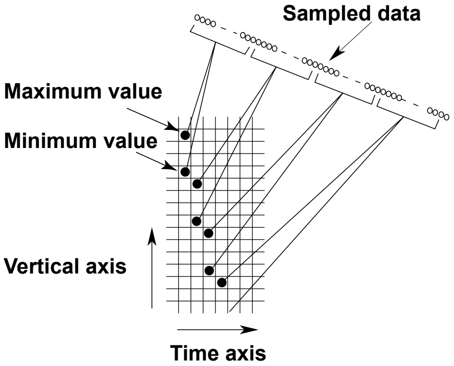
When you control sampling using an external clock, you cannot change the time axis setting. To change the time-axis display range, change the record length or zoom in on the time axis.
▶ See here.

## How the Time Axis Relates to the Display of the Waveform

There are 10 div along the time axis, and 1001 points (logical number of points, not the dots on the screen) are used to draw the waveforms. Therefore, if the display record length is exactly 1 kpoint (the number of acquired data points is 1001), the waveform is displayed using 1001 points. However, if the display record length is greater than or equal to 2 kpoint, as shown in the figure on the right, the PX8000 draws the waveform by determining the maximum and minimum values at each fixed interval (P-P compression) and aligning them vertically at the same time position (total number of points: 2002).




* 1001 is the logical number of points. On the screen, the data is compressed to 800 dots.




<P-P compression display>

### Zooming Horizontally and Drawing Waveforms

The PX8000 can expand (zoom) the waveform horizontally. When the zoom factor of the waveform is increased, the number of displayed points decreases. The PX8000 displays the waveform using P-P compressed until the number of displayed points falls to 2002, but it cannot display the waveform using continuous lines when the number of displayed points falls below 1001. When this happens, the PX8000 interpolates the display data so that the number of displayed points is 1001.

### Dot Display

Under the initial settings, display interpolation is performed automatically, but you can also disable display interpolation (set it to OFF) and display the waveform using dots. When interpolation is disabled, the waveform is displayed using 2002 P-P compressed dots.

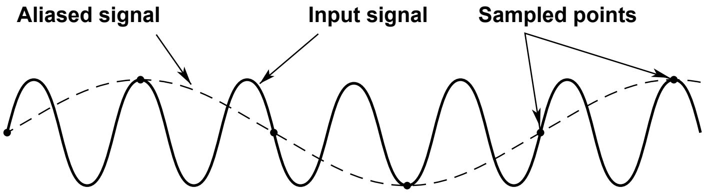
## Relationship between the Time Axis Setting, Record Length, and Sample Rate

If you change the time axis setting, the sample rate and the acquisition-memory record length also change. For details, see appendix 7, “Relationship between the Time Axis Setting, Record Length, and Sample Rate” in the features guide, IM PX8000-01EN.

## Sample Rate

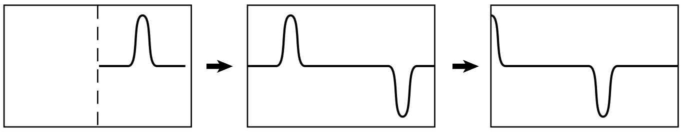
If you change the time axis setting, the sample rate also changes. The sample rate is the number of samples-per-second (S/s).

* If the sample rate is comparatively low with respect to the input signal frequency, the harmonics contained in the signal are lost. When this happens, some of the harmonics will be misread as low-frequency waves due to the effects described by the Nyquist sampling theorem. This phenomenon is called aliasing. You can avoid aliasing by acquiring waveforms with the acquisition mode set to Envelope.




## Time Axis Setting and Roll Mode Display

When the trigger mode is Auto, Auto Level, Single, or On Start and the time axis setting is 100 ms/div or longer, instead of updating waveforms through triggering (update mode), the PX8000 displays the waveforms in roll mode. In roll mode, waveforms scroll from right to left as new data is captured and the oldest values are deleted from the screen.



This allows waveforms to be observed in the same way as on a pen recorder. Roll mode is useful for observing signals with long repeating periods and signals that change slowly. It is also effective when you want to detect occasional glitches (pulse signals in the waveform).

# 5 Triggering

A trigger is a cue used to display the waveform on the screen. A trigger occurs when the specified trigger condition is met, and a waveform is displayed on the screen.

## Trigger Mode (MODE)

The trigger mode determines the conditions for updating the displayed waveforms. There are six trigger modes.

### Auto Mode (Auto)

If the trigger conditions are met before an approximately 50 ms timeout, the PX8000 updates the displayed waveforms on each trigger occurrence. If not, the PX8000 automatically updates the displayed waveforms. Even when Auto mode is specified, the PX8000 operates in Normal mode when the trigger source is set to Time and a simple trigger is used.
If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled.

### Auto Level Mode (AutoLevel)

If a trigger occurs before a timeout (which is approximately 1 second), the PX8000 updates the waveform in the same way that it does in Auto mode. If a trigger does not occur, the PX8000 detects the center value of the trigger source amplitude, automatically changes the trigger level to the center value, triggers on that value, and updates the displayed waveform. Auto-level mode is valid only if the trigger source is an analog waveform on a channel between U1 to U4, I1 to I4, P1 to P4, or AUX3 to AUX8. For all other cases, Auto Level mode operates in the same way as Auto mode.
If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled.

### Normal Mode (Normal)

The PX8000 updates the waveform display only when the trigger conditions are met. If no triggers occur, the display is not updated. If you want to view waveforms that the PX8000 cannot trigger on, or if you want to check the ground level, use Auto mode.

### Single Mode (Single)

When the trigger conditions are met, the PX8000 updates the displayed waveform once and stops waveform acquisition.
If the time axis is set to a range that causes the display to switch to roll mode, the roll mode display will be enabled. When the PX8000 triggers, it begins recording data. When data has been acquired up to the amount specified by the set record length, the waveform display stops.

### N Single Mode (SingleN)

The PX8000 acquires waveforms each time the trigger conditions are met until a specified number of waveforms have been acquired, and then displays all the acquired waveforms. If no triggers occur, the display is not updated.

### Instant Start Mode (On Start)

Regardless of the trigger settings, when you press the START key, the PX8000 updates the displayed waveforms once and stops signal acquisition.
If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled. When data has been acquired up to the amount specified by the set record length, the waveform display stops.

- The trigger mode setting applies to all trigger types.
- When waveforms are being acquired, the trigger condition appears in the center of the bottom of the screen.

# Basic Trigger Settings (SIMPLE/ENHANCED)

- Trigger types: The trigger types.
- Trigger source: The trigger source signal.
- Trigger slope: Specifies which edge, rising or falling, the PX8000 will trigger on.
- Trigger level: The trigger determination level.
- Trigger hysteresis: The trigger level margin (the PX8000 does not trigger on changes in the signal level within this margin).
- Trigger hold-off: The amount of time to wait before the next trigger detection (applies to all triggers except for the simple trigger when the trigger source is Time, the period trigger, and the manual trigger).
- Trigger position: The position where the trigger point will be displayed (applies to all trigger types).
- Trigger delay: The delay from the trigger point (applies to all trigger types).

# Trigger Types (Type)

The following trigger types are available.

## Simple (Simple)

- Simple trigger: Simply triggers on a trigger source edge.
  In addition to using the signals applied to the modules installed in the slots as trigger sources, you can also use the time, an external signal (the signal applied to the TRIGGER IN terminal), or the power line signal as a trigger source.

## Enhanced (Enhanced)

- A -> B(N) trigger: After state condition A is met, the PX8000 triggers when the state condition B is met N times.
- A Delay B trigger: After state condition A is met and the specified amount of time elapses, the PX8000 triggers when the state condition B is first met.
- Edge On A trigger: While state condition A is met, the PX8000 triggers on the OR of multiple trigger source edges.
- OR trigger: The PX8000 triggers on the OR of multiple trigger source edges.
- AND trigger: The PX8000 triggers on the AND of multiple trigger source conditions.
- Period trigger: The PX8000 triggers on a specified period of occurrence of state condition B.
- Pulse Width trigger: The PX8000 triggers after state condition B has been met for a specified duration (width).
- Wave Window trigger: The PX8000 creates real-time templates (Wave Window) using a number of cycles directly preceding the current waveforms. The PX8000 compares the current waveforms to the real-time templates and triggers if one of the current waveforms falls outside of its real-time template.

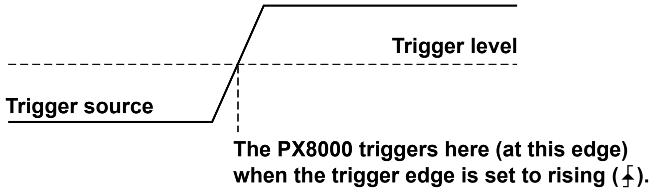
* A state condition is a condition that is met when the levels of specified trigger sources are High or Low relative to a specified trigger level. If you set a signal to X (Don’t Care), the state of the specified signal is not used to determine whether the state condition is met.

## Manual Trigger (MANUAL TRIG)

Regardless of the trigger settings, you can make the PX8000 trigger by pressing the MANUAL TRIG key on the front panel.

# Simple Trigger (Simple)

The PX8000 triggers on trigger source edges (rising or falling edges). *Edge* refers to a point where the trigger source passes through the trigger level.




# Trigger Source (Source)

The trigger source is the signal that is used to check for the trigger condition. You can set the source waveform to one of the waveforms below.

### Analog Signal (U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8)

Select an analog signal being applied to the terminal of each module as the trigger source. You can select the channel of an installed module.

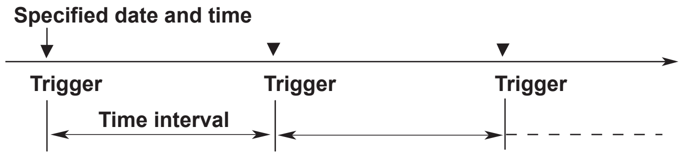
U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8*

* If Sense Type is set to Pulse and the trigger source is AUX3 to AUX8, waveform acquisition cannot be started.

### Time (Time)

Select Time to use the date and time as the trigger source. The trigger occurs at the specified date and time and at specified intervals afterwards.

- Specify the year, month, day, hour, minute, and second.
- You can select one of the time intervals listed below.
  10sec, 15sec, 20sec, 30sec, 40sec, 50sec, 1min, 2min, 3min, 4min, 5min, 6min, 7min, 8min, 9min, 10min, 15min, 20min, 25min, 30min, 40min, 45min, 50min, 1hour, 2hour, 3hour, 4hour, 5hour, 6hour, 7hour, 8hour, 9hour, 10hour, 11hour, 12hour, 18hour, 24hour




- Depending on the specified time interval, a trigger may occur while the waveform is being acquired or in the pre-trigger section (the section before the trigger that is acquired for observation). When this happens, the trigger is ignored.
- If the specified date and time fall within the pre-trigger section, a trigger occurs at the end of the pre-trigger section.
- If the specified date and time are in the past, triggers occur at the points in the present defined by the function (specified date and time) + (time interval × integer N).
- If you set the number of acquisitions, the specified number of waveforms are acquired. When the specified number of acquisitions is infinite, waveform acquisition continues until you press START/STOP.

### External Signal (External)

Select External to use the signal that is received through the left-panel TRIGGER IN input terminal as the trigger source.

### Power Line Signal (Line)

Select Line to use the power line signal received by the PX8000 as the trigger source. The PX8000 triggers only on the rising edge. This option enables you to observe waveforms in synchronization with the power supply frequency (50 Hz or 60 Hz).

## Trigger Slope (Slope)

*Slope* refers to the movement of the signal from a low level to a high level (rising edge) or from a high level to a low level (falling edge). When a slope is used as one of the trigger conditions, it is called a trigger slope.
The following trigger slope settings are available for triggering the PX8000.

| | |
|---|---|
| | The PX8000 triggers when the trigger source changes from a level below the trigger level to a level above the trigger level (rising). |
| | The PX8000 triggers when the trigger source changes from a level above the trigger level to a level below the trigger level (falling). |
| | The PX8000 triggers on both rising and falling edges. |

* can be selected only when a simple trigger is used with an analog trigger source.

## Trigger Level (Level)

*Trigger level* refers to the signal level used as a reference for detecting a signal's rising and falling edges or high and low states. With simple triggers such as the edge trigger, the PX8000 triggers when the trigger source level passes through the specified trigger level.
The range and resolutions that you can use to set the trigger level vary depending on the type of signal being measured.

### When Measuring Voltage, Current, or Power

Selectable range: ±5 div ( the display range)
Resolution: 0.01 div

You can normally set the trigger level using the jog shuttle and arrow keys. If you press the NUM LOCK key so that it illuminates, you can also enter numbers by pressing the CH key.

# Trigger Hysteresis (Hysteresis)

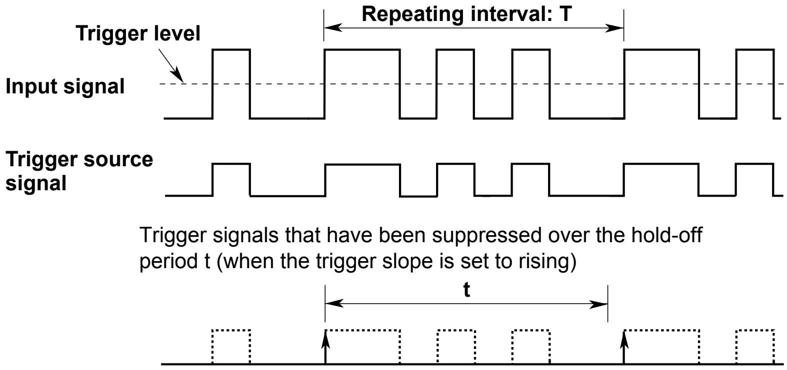
Noise rejection establishes a trigger level margin (hysteresis) so that the PX8000 does not trigger if the signal level change is within the margin.
For each type of measured signal, you can set the hysteresis around the trigger level to one of the options listed below. You cannot set hysteresis when the trigger source is set to Time, External, or Line.

| | | |
|---|---|---|
| Approx. ±0.1 div | Approx. ±0.5 div | Approx. ±1 div |

* The above values are approximate values. They are not strictly warranted.

# Trigger Hold-Off (Hold Off)

The trigger hold-off feature temporarily stops the detection of the next trigger once a trigger has occurred. This feature is useful in cases when you want to change the waveform acquisition interval, such as when you are observing a PCM (pulse code modulation) code or other pulse train signal or when you are using the history feature.




Selectable range: 0.00 μs to 10000000.00 μs (10 s). The default settings is 0.00 μs
Resolution: 0.01 μs

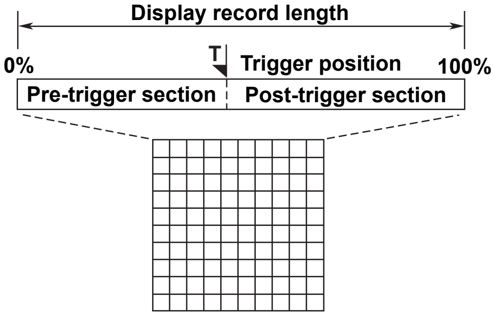
- To trigger with the hold-off time set to 50 ms or longer, set the trigger mode to Normal.
- For the A -> B(N) and A Delay B triggers, the hold-off time applies only to state condition B.
- The trigger hold-off time does not apply to the simple trigger when the trigger source is Time, to the period trigger, or to the manual trigger.

# Trigger Position and Trigger Delay (POSITION/DELAY)

- Trigger Position
- Trigger Delay

# Trigger Position (Position)

When you move the trigger position, the ratio of the displayed data before the trigger point (the pre-trigger section) to the data after the trigger point (the post-trigger point) changes. When the trigger delay is 0 s, the trigger point and trigger positions coincide.




Selectable range: 0.0 to 100% of the display record length.
Resolution: 0.1%

- When waveform acquisition is stopped, if you change the trigger position, the setting is not applied until you start waveform acquisition and update the waveforms.
- If you change the time axis setting (using the TIME/DIV knob), the location of the trigger position does not change.

### Time Reference Point

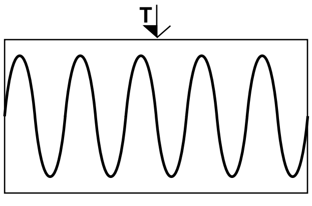
In addition to the trigger position, a time reference point is indicated. The times that appear in the lower left and right of the screen are the times from this time reference point. The cursor time-measurement values are also based on this reference point.
When waveform acquisition is stopped the displayed location of the time reference point varies as indicated below.

- **In Update Mode**

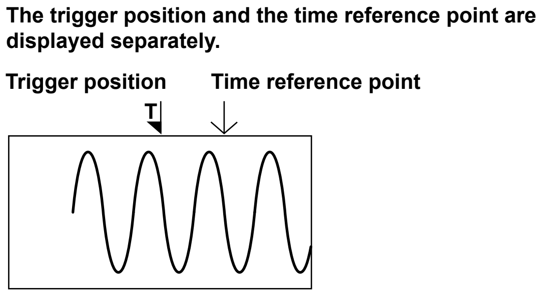
  When the displayed waveform is updated by the trigger, the time reference point is displayed as indicated below. The time reference point and the trigger point are the same.

  - Under Normal Waveform Update Conditions When All Pre-Trigger and Post-Trigger Data Has Been Acquired

**The trigger position and the time reference point are displayed at the same position.**



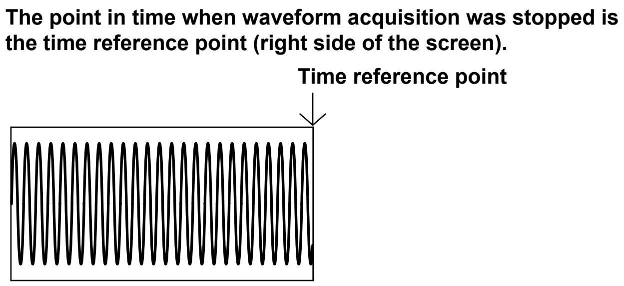
- When Waveform Acquisition Is Stopped before All Pre-Trigger and Post-Trigger Data Has Been Acquired



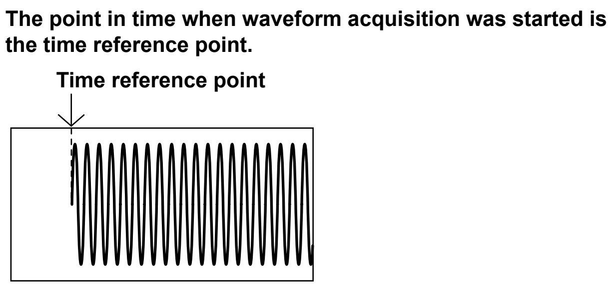

- **In Roll Mode**

  In roll mode, in which waveforms scroll from right to left, the time reference point is displayed as indicated below.

  - When the Trigger Mode Is Auto Mode or Auto Level Mode

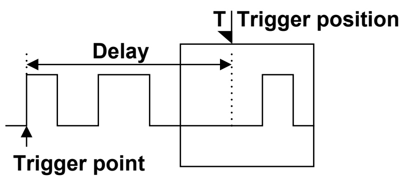



  - When the Trigger Mode Is Instant Start Mode (On Start)




## Trigger Delay (Delay)

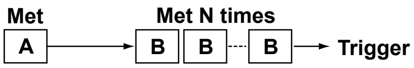
The PX8000 normally displays waveforms before and after the trigger point. You can set a trigger delay to display waveforms that the PX8000 has acquired a specified amount of time after the trigger occurrence.
Selectable range: 0.00 μs to 10000000.00 μs (10 s). The default settings is 0.00 μs
Resolution: 0.01 μs




- If you change the time axis setting (using the TIME/DIV knob) so that the unit becomes larger, because of display-digit limitations, the delay time that you set when the unit was small will not appear in the setup menu, but it is retained.
- You cannot specify a trigger delay when an external clock is being used as the time base.

# A -> B(N) Trigger (Enhanced)

After state condition A is met, the PX8000 triggers when state condition B is met N times.




## Trigger Source

You can use U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8 as the trigger sources.

## State Conditions (A State, B State)

To set state conditions A and B, select the states of the trigger sources in relation to the trigger level.

**Example**

| | State Condition A | State Condition B |
|---|---|---|
| U1 | H | H |
| I1 | L | L |
| P1 | L | L |
| U2 | L | H |
| I2 | H | X |
| …… | … | … |
| AUX8 | X | L |

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

## State Condition Achievement Condition (A Condition, B Condition)

Select how the result of comparing the trigger source states to their specified conditions must change for a state condition to be considered met.

| | |
|---|---|
| Enter | The result must change from not being met to being met. |
| Exit | The result must change from being met to not being met |

## Number of Times State Condition B Must Be Met

Set the number of times that state condition B must be met.

Selectable range: 1 to 10000. The default setting is 1.

## Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.

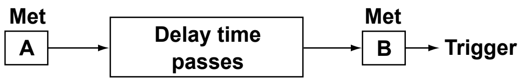
These items are the same as the trigger level and trigger hysteresis of the simple trigger.

## Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off, trigger position, and trigger delay of the simple trigger.

# A Delay B Trigger (Enhanced)

After state condition A is met and the specified amount of time elapses, the PX8000 triggers when state condition B is first met.




## Trigger Source

You can use U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8 as the trigger sources.

## State Conditions (A State, B State)

To set state conditions A and B, select the states of the trigger sources in relation to the trigger level.

**Example**

| | State Condition A | State Condition B |
|---|---|---|
| U1 | H | H |
| I1 | L | L |
| P1 | L | L |
| U2 | L | H |
| I2 | H | X |
| …… | … | … |
| AUX8 | X | L |

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

## State Condition Achievement Condition (A Condition, B Condition)

Select how the result of comparing the trigger source states to their specified conditions must change for a state condition to be considered met.

| | |
|---|---|
| Enter | The result must change from not being met to being met. |
| Exit | The result must change from being met to not being met |

## Delay Time

Set the amount of time that must pass after state condition A is met.

Selectable range: 0.0 μs to 10000000.0 μs (10 s). The default settings is 0.0 μs.

Resolution: 0.1 μs

## Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.

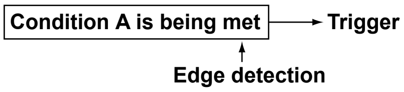
These items are the same as the trigger level and trigger hysteresis of the simple trigger.

## Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off, trigger position, and trigger delay of the simple trigger.

# Edge On A Trigger (Enhanced)

While state condition A is met, the PX8000 triggers on the OR of multiple trigger source edges.




## Trigger Source

You can use U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8 as the trigger sources.

## State Condition (A State)

To set state condition A, select the states of the trigger sources in relation to the trigger level.

**Example**

| | State Condition A |
|---|---|
| **U1** | **H** |
| **I1** | **L** |
| **P1** | **L** |
| **U2** | **L** |
| **I2** | **H** |
| **……** | **…** |
| **AUX8** | **X** |

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

## State Condition Achievement Condition (Condition)

Select whether the result of comparing the trigger source states to their specified conditions must be true or false for the state condition to be considered met.

| | |
|---|---|
| True | The result must be true. |
| False | The result must be false. |

## Edge Detection Condition (Edge)

Set the condition for detecting the trigger source edge.

| | |
|---|---|
| ↑ | An edge is detected when the trigger source changes from a level below the trigger level to a level above the trigger level (rising). |
| ↓ | An edge is detected when the trigger source changes from a level above the trigger level to a level below the trigger level (falling). |
| – | The signal is not used as a trigger condition. |

## Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.
These items are the same as the trigger level and trigger hysteresis of the simple trigger.

## Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off, trigger position, and trigger delay of the simple trigger.

# OR Trigger (Enhanced)

The PX8000 triggers on the OR of multiple trigger source edges.

## Trigger Source

You can use U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, and Ext* as the trigger sources.

* The signal that is received through the left-panel TRIGGER IN input terminal as the trigger source.

## Edge Detection Condition (Edge)

Set the conditions for detecting each trigger source edge.

| | |
|---|---|
| ↑ | An edge is detected when the trigger source changes from a level below the trigger level to a level above the trigger level (rising). |
| ↓ | An edge is detected when the trigger source changes from a level above the trigger level to a level below the trigger level (falling). |
| IN | An edge is detected when the trigger source enters the specified level range. |
| OUT | An edge is detected when the trigger source leaves the specified level range. |
| – | The signal is not used as a trigger condition. |

* IN and OUT are selectable only when the trigger source is an analog signal (U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8).

## Trigger Level (Level)

Set these items for each trigger source.

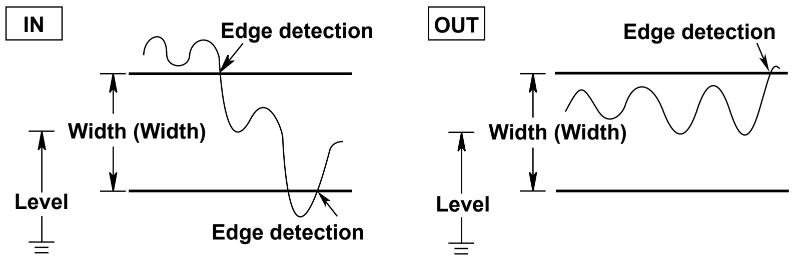
### When the Edge Detection Condition Is ↑ or ↓

Set the level used to detect the trigger source's rising or falling edge.

▶ See here.

### When the Edge Detection Condition Is IN or OUT

An edge is detected when the trigger source enters (IN) or leaves (OUT) the specified level range. You can specify the level range settings for each analog signal trigger source.




| Setting | Selectable Range | Resolution |
|---|---|---|
| Level (center value)<br>Width (Width) | Same as the trigger level | |

## Trigger Hysteresis (Hys)

Set these items for each trigger source.
This item is the same as the trigger hysteresis of the simple trigger.

## Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off, trigger position, and trigger delay of the simple trigger.

# AND Trigger (Enhanced)

The PX8000 triggers on the AND of multiple trigger source conditions. The PX8000 triggers when all the specified conditions are met at a single point.

## Trigger Source

You can use U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8 as the trigger sources.

## Achievement Condition (Condition)

Set the achievement condition for each trigger source.

| | |
|---|---|
| H | The signal level must be high. |
| L | The signal level must be low. |
| IN | The signal must be within the specified level range. |
| OUT | The signal must be outside of the specified level range. |
| − | The signal is not used as a trigger condition. |

* IN and OUT are selectable only when the trigger source is an analog signal (U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8).

## Trigger Level (Level)

Set this item for each trigger source.

### When the Achievement Condition Is H or L

Set the level for determining whether the trigger sources are high or low.

▶ See here.

### When the Achievement Condition Is IN or OUT

An edge is detected when the trigger source enters (IN) or leaves (OUT) the specified level range. You can specify the level range settings for each analog signal trigger source.

▶ See here.

## Trigger Hysteresis (Hys)

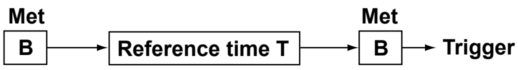
Set these items for each trigger source.
This item is the same as the trigger hysteresis of the simple trigger.

## Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off, trigger position, and trigger delay of the simple trigger.

# Period Trigger (Enhanced)

The PX8000 triggers on a specified period of occurrence of state condition B. The PX8000 triggers when state condition B occurs again.




## Trigger Source

You can use U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8 as the trigger sources.

## State Condition (B State)

To set state condition B, select the states of the trigger sources in relation to the trigger level.

**Example**

| | State Condition B |
|---|---|
| **U1** | **H** |
| **I1** | **L** |
| **P1** | **L** |
| **U2** | **L** |
| **I2** | **H** |
| **……** | **…** |
| **AUX8** | **X** |

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

## Determination Mode (Mode)

Set what kind of relationship must be established between period T and the specified reference times (Time or T1 and T2) for the PX8000 to trigger.

| | |
|---|---|
| T < Time | Period T must be shorter than the reference time (Time). |
| T > Time | Period T must be longer than the reference time (Time). |
| T1 < T < T2 | Period T must longer than reference time T1 and shorter than reference time T2. |
| T < T1, T2 <T | Period T must be shorter than reference time T1 or longer than reference time T2. |

## Reference Times (Time, T1, T2)

You can set the reference times (Time, T1, and T2) within the following ranges.

| Setting | Selectable Range | Default | Resolution |
|---|---|---|---|
| Time | 0.02 µs to 10000000.00 µs (10 s) | 0.02 µs | |
| T1 | 0.02 µs to 9999999.99 µs | 0.02 µs | 0.01 µs |
| T2 | 0.03 µs to 10000000.00 µs (10 s) | 0.03 µs | |

## Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.

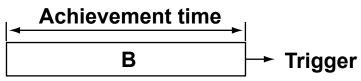
These items are the same as the trigger level and trigger hysteresis of the simple trigger.

## Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off, trigger position, and trigger delay of the simple trigger.

# Pulse Width Trigger (Enhanced)

The PX8000 triggers according to a specified duration (achievement time) for which state condition B has been met. The timing of the triggering varies depending on the determination mode.




## Trigger Source

You can use U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8 as the trigger sources.

## State Condition (B State)

To set state condition B, select the states of the trigger sources in relation to the trigger level.

**Example**

| | State Condition B |
|---|---|
| U1 | H |
| I1 | L |
| P1 | L |
| U2 | L |
| I2 | H |
| ...... | ... |
| AUX8 | X |

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

## Determination Mode (Mode)

Set what kind of relationship must be established between the state condition B achievement time and the specified reference times (Time or T1 and T2) for the PX8000 to trigger.

| | |
|---|---|
| B < Time | The PX8000 triggers when the achievement time is shorter than the reference time (Time), and the state condition changes to not met. |
| B > Time | The PX8000 triggers when the achievement time is longer than the reference time (Time), and the state condition changes to not met. |
| B TimeOut | The PX8000 triggers when the achievement time is longer than the reference time (Time). |
| B Between | The PX8000 triggers when the achievement time is longer than reference time T1 and shorter than reference time T2, and the state condition changes to not met. |

## Reference Times (Time, T1, T2)

You can set the reference times (Time, T1, and T2) within the following ranges.

| Setting | Selectable Range | Default | Resolution |
|---|---|---|---|
| Time | 0.02 μs to 10000000.00 μs (10 s) | 0.02 μs<br>0.01 μs for B TimeOut | 0.01μs |
| T1 | 0.01μs to 9999999.99μs | 0.01μs | |
| T2 | 0.02μs to 10000000.00μs(10 s) | 0.02 μs | |

Triggering may not function properly when the interval between achievement times is less than 0.01 μs or when the duration of the achievement time is less than 0.01 μs (Typical).

## Trigger Level (Level) and Trigger Hysteresis (Hys)

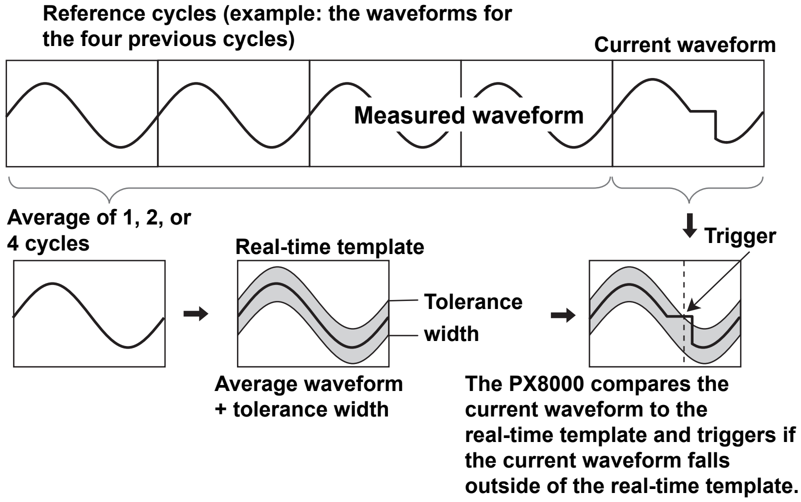
Set these items for each trigger source.
These items are the same as the trigger level and trigger hysteresis of the simple trigger.

### Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off, trigger position, and trigger delay of the simple trigger.

## Wave Window Trigger (Enhanced)

The PX8000 creates real-time templates (Wave Window) using a number of cycles directly preceding the current waveforms. The PX8000 compares the current waveforms to the real-time templates and triggers if one of the current waveforms falls outside of its real-time template.




### Trigger Source

You can use U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8 as the trigger sources.

### Template Channels (Condition)

Select which trigger sources to use to make real-time templates. The PX8000 triggers if the condition of even one of the channels is met.

| | |
|---|---|
| ON | Use |
| OFF | Don't use |

#### Tolerance Width (Width)

To create a real-time template for a channel, set the distance from the averaged waveform (of 1, 2, or 4 cycles before the current waveform) that will be tolerated.
Selectable range: 0.01 × the voltage scale to 10 × the voltage scale
Default: 0.01 div
Resolution: Same as the trigger level resolution

▶ See here.

For example, when Width is set to 2 V, the tolerance width is ±1 V around the averaged waveform.

### Cycle Frequency (Cycle Frequency)

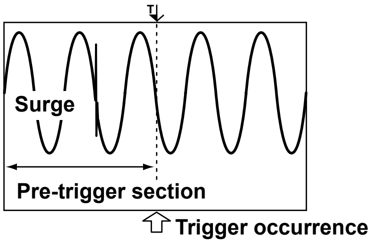
Set the trigger source frequency. If the actually frequency is within ±10% of the specified value, it is automatically tracked.
Selectable range: 40 to 1000 Hz. The default setting is 50 Hz.
Resolution: 1 Hz

## Reference Cycles (Reference Cycle)

Select how many waveforms before the current waveform are used to create the real-time templates.

| | |
|---|---|
| 1 | One previous waveform is used. |
| 2 | Two previous waveforms are used. |
| 4 | Four previous waveforms are used. |

If a surge or other abnormal waveform occurs in the reference cycle, the abnormal waveform will be included in the averaged waveform, so the PX8000 will trigger on the next normal waveform. This may make it appear is if the trigger has been delayed by a few cycles.




When you use the wave window trigger, we recommend that you set a pre-trigger length that is longer than the reference cycle so that you can observe waveform abnormalities that occur in the reference cycle.

## Sync Channel (Sync. Ch)

Select the channel used to detect the points at which waveform comparison for the wave window trigger starts and stops. Select the synchronization channel by selecting Auto or a channel from U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8 that has a module that the wave window trigger can be used with.

### Auto

Of the modules that the wave window trigger can be used with, the module with the smallest number is automatically selected.
Level for detecting the start and end points: The center of the amplitude of the sync-channel signal measured for 0.5 seconds after the start of waveform acquisition.
Detection hysteresis: Same as the edge trigger hysteresis

### U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8

Select a channel whose module can be used with the wave window trigger. If triggering does not function properly when you select Auto, you can specify an appropriate channel.
For the selected channel, you need to set the level for detecting the start and end points and set the detection hysteresis.

## Level for Detecting the Start and End Points (Level) and Detection Hysteresis (Hysteresis)

If you set the sync channel to a channel from U1 to U4, I1 to I4, P1 to P4, and AUX3 to AUX8, you need to set the level for detecting the start and end points and set the detection hysteresis.
These items are the same as the trigger level and trigger hysteresis of the simple trigger.

## Trigger Hold-Off (Hold Off), Trigger Position (Position), Trigger Delay (Delay)

These items are the same as trigger hold-off, trigger position, and trigger delay of the simple trigger.

### Operating Conditions of the Wave Window Trigger

You can use the wave window trigger with the following waveforms and settings. You cannot use the wave window trigger when the record length is 25 kpoint or less and the time axis setting is shorter than 10 ms/div.

| | |
|---|---|
| Waveforms | AC waveforms and triangular waveforms between 40 kHz and 1 kHz. (The trigger cannot be used with rectangular waveforms, such as inverter waveforms, or waveforms with fast rising edges.) |
| Sample rate | 10 kS/s to 500 kS/s |
| Acquisition mode | Normal |
| Trigger mode | Normal, Single, Single(N)<br>When the trigger mode is Auto or Auto Level, it is difficult for the wave window trigger to occur. |

# 6 Waveform Acquisition

### ACQUIRE

Based on the data that has been stored in the acquisition memory, the PX8000 performs various operations, such as displaying waveforms on the screen, computing, measuring cursors, and automatically measuring waveform parameters.
This chapter explains how to set the number of data points to store in the acquisition memory (the record length), how to enable or disable the sample data averaging feature, and so on.

## Record Length (Record Length)

*Record length* refers to the number of data points that are stored to the acquisition memory for each channel.
*Display record length* refers to the data points from the data stored in the acquisition memory that are displayed on the screen. Normally, the acquisition-memory record length and display record length are the same, but the time axis setting may cause them to differ. When you change the time axis setting, the sample rate and record length also change.
On the standard model of the PX8000, you can set the record length to a value between 100 kpoint and 10 Mpoint. On models with the /M1 option, you can set the record length to up to 50 Mpoint. On models with the /M2 option, you can set the record length to up to 100 Mpoint.
Use a long time axis setting when you want to observe a phenomenon over a long period of time. When you want to observe a phenomenon at a high time resolution, set a long record length, and raise the sample rate. When the record length is long, computation and measurement processing take longer than when the record length is short.
For example, the amounts of time for which you can record data to the acquisition memory when the record length is 100 Mpoint are listed below.

| Sample Rate | In Seconds |
|---|---|
| 100 MS/s | 1 |
| 10 MS/s | 10 |
| 5 MS/s | 120 |
| 2 MS/s | 50 |
| 1 MS/s | 100 |
| 500 kS/s | 200 |

The following limitations on waveform acquisition conditions and the number of waveforms that can be stored in the acquisition memory (the number of history waveforms) apply depending on the set record length.
▶ See here.

**Notes about Setting the Record Length**

- When the acquisition mode is set to Average, the maximum record length is 5 Mpoint on standard models, 10 Mpoint on models with the /M1 option, and 25 Mpoint on models with the /M2 option.
- When the trigger mode is Auto, Auto Level, Normal, or N Single and the display is not in roll mode, you can select only a record length that is less than 5 Mpoint on standard models, 10 Mpoint on models with the /M1 option, or 25 Mpoint on models with the /M2 option.
- On the PX8000, record lengths are expressed in units of points. There are some products, such as the DL750, for which record lengths are expressed in units of words.
- Numeric data is calculated on the basis of sampled data over the display record length.

# Acquisition Mode (Acquisition Mode)

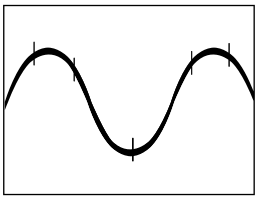
You can set the acquisition mode to one of the options below.

## Normal Mode (Normal)

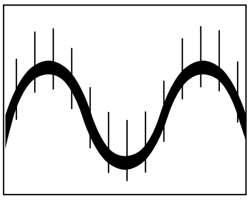
Displays waveforms without processing the sampled data.

## Envelope Mode (Envelope)

The PX8000 determines the maximum and minimum values among the data sampled at the maximum samp rate for each module at a time interval that is twice the sampling period (the inverse of the sample rate) of Normal mode, saves the values as pairs in the acquisition memory, and uses the saved value pairs to display the waveforms. This mode is effective when you want to avoid aliasing, because the sample rate is essentially kept high regardless of the time axis setting. It is also effective when you want to detect glitches (narrow pulse signals) or when you want to display the envelope of a modulated signal.



Normal mode



Envelope mode

Numeric data will be invalid.

## Averaging Mode (Average)

The PX8000 acquires waveforms multiple times, averages the same time points relative to the trigger point, saves them in the acquisition memory, and uses them to display averaged waveforms. Averaging mode is useful when you want to remove random noise from waveforms.

The averaging method varies depending on the acquisition count.

**When Acquisition Count Is Set to Infinity**

**Exponential average**

$$An = \frac{1}{N}\{(N - 1)An - 1 + Xn\}$$

An: $n^{th}$ averaged value
Xn: $n^{th}$ measured value
N: Attenuation constant (2 to 256 in $2^n$ steps)

**When Acquisition Count Is Set to a Value between 2 and 65536 (in $2^n$ steps)**

**Linear average**

$$A_N = \frac{\sum_{n=1}^{N} Xn}{N}$$

Xn: $n^{th}$ measured value
N: Average count = acquisition count

- When waveforms are acquired in averaging mode, they are saved to the acquisition memory as a single record. This means that the history feature cannot be used.
- You cannot select averaging mode when:
  - The display is in roll mode.
  - The trigger mode is Single, N Single, or On Start.
- To average waveforms that have been acquired in N Single mode, set the acquisition mode to Normal, and set the history feature's display mode to Averaging.
- Power measurement in averaging mode is computed from the zero-crossing data of the last acquired waveform data.
- In averaging mode, the waveforms of AUX channels whose input signal type is set to Pulse are not averaged. Such waveforms are displayed without processing the sampled data.

### Trigger Mode (Trigger Mode)

▶ See here.

## Acquisition Count (Acquisition Count)

The ranges within which you can set the waveform acquisition count are indicated below. If you select Infinite, the PX8000 continues waveform acquisition until you stop it using the START/STOP key. The default setting is Infinite. Changes to the number of acquisitions are not applied during waveform acquisition. They are applied after acquisition stops.

- When the acquisition mode is set to Normal or Envelope
  1 to 65536 (in steps of 1) or Infinite
- When the acquisition mode is set to Average.
  2 to 65536 (in $2^n$ steps) or Infinite

- The number of waveforms that have been stored to the acquisition memory appears in the lower left of the screen.
- If the trigger mode is set to Single or On Start, you can set the acquisition count only when the action mode is on.

# Time Base (Time Base)

Under the initial settings, the PX8000 samples the measured signals using the clock signal produced by its internal time-base circuit (internal clock). You can also use an external clock signal to control sampling. One data sample is stored to the acquisition memory at every pulse in the external clock signal. The external clock input is useful when you want to monitor the waveform using a clock signal that is in sync with the signal being measured.

Apply the external clock signal to the external-clock input terminal (EXT CLK IN) on the left panel. For the specifications of the external-clock input terminal, see section 5.3 in the getting started guide, IM PX8000-03EN.

| | |
|---|---|
| Int | The internal clock signal is used as the time base (the TIME/DIV time axis setting is valid). |
| Ext | An external clock signal is used as the time base (the TIME/DIV time axis setting is invalid). |

## Pulses per Rotation (Pulse/Rotate)

When the time base is an external clock, you can specify how many pulses of the external clock signal (how many sampled data acquisitions) correspond to one mechanical rotation (or period). For example, if you set Pulse/Rotate to 100 pulses, when the record length is 100 kpoint, 1000 rotations worth of sampled data will be acquired. When Pulse/Rotate is set to 1 pulse, each point of sampled data corresponds to a single rotation.
The Pulse/Rotate setting only affects the horizontal-cursor measurement values and how the time axis is displayed on the screen. For example, if you set Pulse/Rotate to 10000 pulses, when the record length is 100 kpoint, 1 div will correspond to 1 rotation. With these settings, if you move the cursor by 1 div, the measured horizontal value will increase or decrease by 1.

Selectable range for pulses: 1 to 24000

**Notes about Sampling Using an External Clock Signal**

- You cannot acquire waveforms when the acquisition mode is set to Envelope.
- You cannot display waveforms in roll mode.
- There is no function for dividing the frequency of the clock signal.
- The time axis cannot be changed. To change the time-axis display range, change the record length, or zoom in on the time axis.
- The measured time values in cursor measurements and automated measurements of waveform parameters indicate the number of clock signal pulses. For these measurements, units are not displayed.
- The trigger settings listed below are invalid.
  Hold-off, trigger delay, period trigger, pulse width trigger
- Harmonic measurement and frequency measurement cannot be performed.

**Maximum Sample Rates for Each Module**

If you set the sample rate of the PX8000 to a rate that is higher than a module's maximum sample rate, because the data is updated at the module's maximum sample rate, all the data within the module's data update interval will be the same. The maximum sample rates for each module are listed below.

| Module | Maximum Sample Rate | |
|---|---|---|
| | Internal Clock | External Clock |
| 760811, 760812, 760813, 760851 | 100 MHz | 9.5 MHz |

# Executing Logger Setup (Execute Logger Setup)

When you execute logger setup, the following features are turned off.

- Turning Numeric Measurement On and Off (Numeric Measure)
- Cursor Measurement
- Automated Measurement of Waveform Parameters
- Waveform Computation
- Auto Calibration

When these features are turned off, the computation time required on the PX8000 CPU is reduced, allowing data to be collected at high speeds (at short time intervals). This setting is effective when you want to use the PX8000 like a logger-acquire data at short time intervals and analyze on a PC the waveforms of input signals that change steeply. The time interval for acquiring data varies depending on the number of channels, time scale settings, record length, and the like. You can execute logger setup to turn off the above features and set them back on individually.

# Waveform Acquisition (START/STOP)

When you start waveform acquisition, the PX8000 stores waveform data to the acquisition memory and updates the displayed waveforms each time it triggers. The acquisition memory is divided into many areas based on the set record length, and the maximum number of acquirable waveforms are stored in the memory. You can recall past waveforms that are stored in the memory by using the history feature when waveform acquisition is stopped.

**PX8000 Operation When the Acquisition Mode Is Set to Averaging**

- Averaging stops when you stop acquisition.
- If you start acquisition again, averaging starts from the beginning.

**The START/STOP Key Is Disabled:**

- When the PX8000 is in remote mode.
- When the PX8000 is printing to a printer, or when it is accessing a storage medium.
- When the key lock type is ALL and key lock is set to ON

- If you change the waveform acquisition conditions and start waveform acquisition, the past data stored in the acquisition memory is cleared.
- You can use the snapshot feature to retain the displayed waveform on the screen. This feature allows you to update the display without having to stop waveform acquisition.
- Regardless of the trigger settings, you can make the PX8000 trigger by pressing the MANUAL TRIG key on the front panel.

# 7 Display Mode and Display Settings

## Display Mode (DISPLAY MODE)

Press DISPLAY MODE to select the display mode.

- Split displays with the numeric data display (Numeric+***)
- Split displays with the waveform display (Wave+***)
- Numeric Data Display
- Waveform Display
- Bar Graph Display*
- Vector Display*

* This item is available on models with the harmonic measurement option.

### Split Displays with the Numeric Data Display (Numeric+***)

Numeric data is displayed in the top half of the screen. Select the display to show in the bottom half of the screen from the following options.

- Wave: Waveform
- Bar: Bar graph*
- Vector: Vector*

* This item is available on models with the harmonic measurement option.

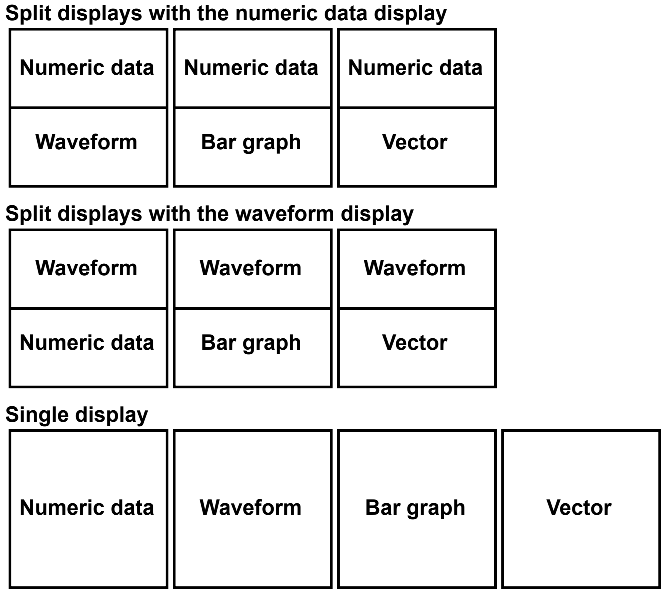
### Split Displays with the Waveform Display (Wave+***)

Waveforms are displayed in the top half of the screen. Select the display to show in the bottom half of the screen from the following options.

- Numeric: Numeric data
- Bar: Bar graph*
- Vector: Vector*

* This item is available on models with the harmonic measurement option.

The bottom half of the screen shows the zoom display, X-Y display, or FFT display when any of these displays are on.



### Waveform Display Types

The waveform display consists of the following windows.

- T-Y (Time axis) Waveform Display Window
- X-Y Window (Window 1 and Window 2)
- FFT Window (FFT1 window and FFT 2 window)
- Extra Window

For details, see “Waveform Display.”

▶ Click her

## Display Settings (DISPLAY SETTING)

Press DISPLAY SETTING to configure the display.

- Numeric Data Display Settings
- Waveform Display Settings
- Bar Graph Display Settings
- Vector Display Settings

#### Split Display Settings

Press DISPLAY SETTING to switch between the SETTING menus of the display that you assigned to the top half of the screen in the split display and the display that you assigned to the bottom half of the screen in the split display.

# 8 Numeric Data Display

When you select Numeric with the DISPLAY MODE key, numeric data is displayed.

## Numeric Data Display Settings

You can set the following items.

- Display Format (Format)
- Settings other than the display format vary depending on the display that is shown.
  - 4-, 8-, and 16-Value Displays (4 Items/8 Items/16 Items)
  - Matrix Display (Matrix)
  - All Items Display (All Items)
  - Single Harmonics and Dual Harmonics Lists (Hrm Single List/Hrm Dual List; option)
  - Custom Display (Custom)

### Display Format (Format)

You can select the number of numeric data items that are displayed simultaneously from the choices below or choose to display a list of items.

#### 4-Value Display (4 Items)

Four numeric data values are displayed in one column.

#### 8-Value Display (8 Items)

- When the display mode is Numeric, eight numeric data values are displayed in one column.
- When the display is split, eight numeric data values are displayed in two columns.

#### 16-Value Display (16 Items)

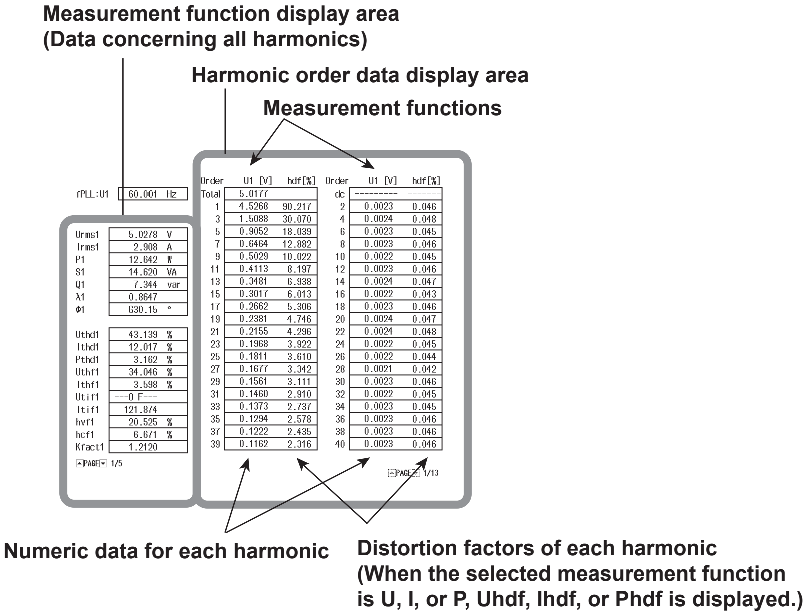
Sixteen numeric data values are displayed in two columns.

#### Matrix (Matrix) and All (All Items) Displays

A table of numeric data is displayed with measurement functions listed vertically and symbols indicating elements and wiring units listed horizontally. The number of displayed items varies depending on the number of elements that are installed in the PX8000.

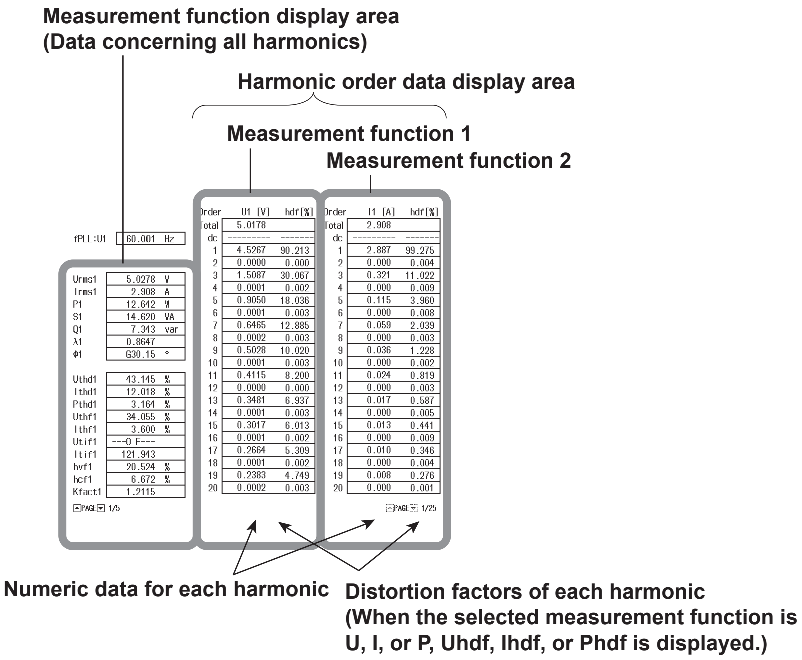
### Single Harmonics List Display (Hrm Single List; option)

- When the display mode is Numeric, up to 42 of the harmonic order data items of a single measurement function are displayed in two columns.
- When the display is split, up to 22 of the harmonic order data items of a single measurement function are displayed in two columns.



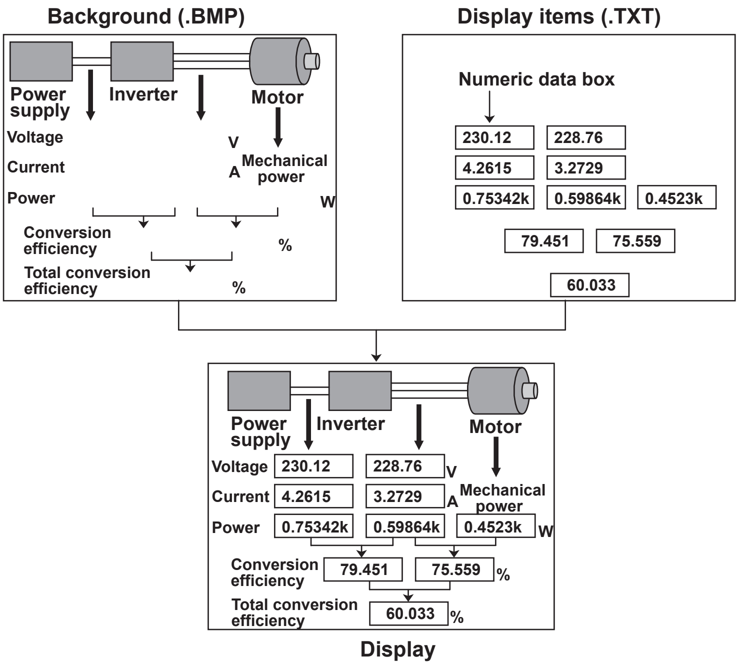

### Dual Harmonics List Display (Hrm Dual List; option)

- When the display mode is Numeric, the numeric values of two measurement functions are displayed in two separate columns, each containing up to 22 numeric values.
- When the display is split, the numeric values of two measurement function are displayed in two separate columns, each containing up to 12 numeric values.



### Custom Display (Custom)

You can use an illustration (.BMP) or picture (.BMP) from a PC or other device as the background of the display. You can arrange numeric data boxes on top of this background to create a custom display. Numeric data appears in this custom display.




## Switching the Displayed Page

You can switch the displayed page and display a new set of items.

- ▼ key: The next page is displayed.
- ▲ key: The previous page is displayed.

### In the 4-, 8-, and 16-Value Displays

You can switch between and display pages 1 to 12.

### In the Matrix Display

You can switch between and display pages 1 to 9.

### In the All Items Display

The first page is always displayed in the top half of the screen. You can switch between pages 2 and later pages in the bottom half of the screen. When the display is split and the All Items display is shown, you can switch between all pages, including page 1, in order.

### In the Single Harmonics List and Dual Harmonics List Displays

You can switch separately between the pages of the measurement function display (on the left side of the screen) and the harmonic order data display (on the right side of the screen). Use the left and right arrow keys to select the display whose pages you want to switch between.

### In the Custom Display

When you have configured the custom display to contain multiple pages, you can switch between each of the pages.

## Number of Displayed Digits (Display Resolution)

The number of displayed digits (display resolution) for voltage, current, active power, apparent power, reactive power, and so on is as follows:

- When the number of displayed digits is set to 5
  - If the value is less than or equal to 60000: Five digits.
  - If the value is greater than 60000: Four digits.
- When the number of displayed digits is set to 6
  - If the value is less than or equal to 600000: Six digits.
  - If the value is greater than 600000: Five digits.

For details, see appendix 3 in the features guide, IM PX8000-01EN. When the range rating (rated value of the specified measurement range) is specified, the Σ functions of the voltage, current, active power, apparent power, reactive power, and so on, are set to the decimal place and unit of the element with the lowest number of displayed digits (display resolution) in the wiring unit.

# Display Item

For a list of the measurement functions and their descriptions, see "Items That This Instrument Can Measure."

▶ See here.

## Example of How Measurement Functions Are Displayed in the Numeric Data Display

True rms voltage of element 1

Urms1

**Element 1**
**True rms value**
**Voltage**

Simple average of the currents of the elements in wiring unit ΣA

IdcΣA

**Σ function of wiring unit ΣA**
**Simple average**
**Current**

Voltage of the 20$^{th}$ order of element 2

**Voltage**
**Element 2**

U2
(20)

**Harmonic order 20**

Simple average of the fundamental currents of the elements in wiring unit ΣB

**Current**
**Σ function of wiring unit ΣB**

IΣB
(1)

**Order 1 (fundamental wave)**

### Notes about the Numeric Data Display

- “-------” is displayed if a measurement function is not selected or if there is no numeric data.
- If Urms, Umn, Udc, Urmn, Uac, Irms, Imn, Idc, Irmn, or Iac exceeds 140% of the measurement range, “-OL-” is displayed to indicate an overload value.
- If the voltage or current exceeds 140% of the measurement range, “-OL-” is displayed to indicate an overload value for P.
- If the measured or computed result cannot be displayed using the specified decimal place or unit, “-OF-” (for overflow) is displayed.
- When the measured voltage or current value is at or below the percentage of the measurement range indicated below, the values of Urms, Umn, Urmn, Uac, Irms, Imn, Irmn, Iac, and other measurement functions that are based on them are displayed as zero (suppression to zero). The λ and Φ functions will return errors (“Error” is displayed).
  - When Urms, Uac, Irms, or Iac is 0.3% or less
  - When Umn, Urmn, Imn, or Irmn is 2% or less
- If the number of sampled data points is less than 8192, harmonic data is not measured, and no data display [–———] appears.
- There is no overload value indication (“-OL-”) or zero indication (suppression to zero) for the numeric data of harmonic orders 0 (DC) to 500.
- If the measured frequency is outside the measurement range, the fU or fI function returns an error (“Error” is displayed).
- If the power factor λ is greater than 1 and less than or equal to 2, λ returns 1. Φ returns zero.
- If λ is greater than 2, λ and Φ return errors (“Error” is displayed).

# 4-, 8-, and 16-Value Displays (4 Items/8 Items/16Items)

## Item Number to Set (Item No.)

Select the number of the item that you want to configure.

## Function (Function)

You can select any of the measurement function types listed under “Items That This Instrument Can Measure.”

▶ See here.

If you select None, no measurement function is displayed for the selected item.

## Element (Element/Σ)

- You can select the element/wiring unit from the options below. The available options vary depending on the installed elements.
  Element1, Element2, Element3, Element4, ΣA, and ΣB
- If the selected wiring unit does not have any elements assigned to it, because there is no data, “-------” (no data) is displayed. For example, if elements are assigned to ΣA but not to ΣB, the measurement function for ΣB is displayed as “-------” (no data).

## Order (Order; option)

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 500

The numeric data corresponding to harmonic orders above the maximum measurable harmonic order is displayed as “-------” (no data). For information about the maximum measurable harmonic order, see “Maximum Harmonic Order to Be Measured (Max Order).”

▶ See here.

## Resetting the Display Items (Reset Items)

You can select the reset method from the following options.

- Reset Items Exec: The numeric data for each element is displayed on each page. The pattern that the data is arranged in varies depending on the number of installed elements.
- Clear Current Page: All the measurement functions on the current page are set to None.
- Clear All Pages: All the measurement functions on every page are set to None.

# Matrix Display (Matrix)

## Item Number to Set (Item No.)

This is the same as setting the item number in the 4-, 8-, and 16-value displays.

▶ See here.

## Function (Function)

This is the same as setting the function in the 4-, 8-, and 16-value displays.

▶ See here.

In the matrix display, if you choose a measurement function that does not require an element or wiring unit (such as η1 to η4, F1 to F20, etc.), data is displayed in the first column.

## Order (Order; option)

This is the same as setting the order in the 4-, 8-, and 16-value displays.

▶ See here.

## Columns (Column Settings)

### Number of Columns (Column Num)

You can set the number of columns to 4 or 6.

### Column Number (Column No.)

Select the number of the column that you want to configure.

### Element (Element/Σ)

- You can select the element/wiring unit from the options below. The available options vary depending on the installed elements.
  None, Element1, Element2, Element3, Element4, ΣA, and ΣB
- If you select None, no measurement data is displayed in the selected column.
- If the selected wiring unit does not have any elements assigned to it, because there is no data, "-------" (no data) is displayed. For example, if elements are assigned to ΣA but not to ΣB, the measurement function for ΣB is displayed as "-------" (no data).

### Resetting the Settings (Reset Columns)

Reset the column settings.

## Resetting the Display Items (Reset Items)

This is the same as resetting the display items in the 4-, 8-, and 16-value displays.

▶ See here.

# All Items Display (All Items)

You cannot change individual measurement functions. Change the display by pressing PAGE ▲ and PAGE ▼ soft keys or the up and down arrow keys.

The number of displayed pages varies as indicated below depending on the installed options.

| | | |
|---|---|---|
| Harmonic Measurement Option | Installed | 10 pages |
| | Not installed | 6 pages |

## Order (Order (k); option)

This setting is valid on the 7th or 8th page. On the 7th or 8th page, the order setting appears in the upper left of the screen. This is the same as setting the order in the 4-, 8-, and 16-value displays.

▶ See here.

# Single Harmonics and Dual Harmonics Lists (Hrm Single List/ Hrm Dual List; option)

For each measurement function, you can display the numeric data for a harmonic order from 0 (DC) to 500 or for all harmonic orders in two columns.

This item is available on models with the harmonic measurement option.

## Item Number to Set (List Item No.)

- You can specify two lists to show in the harmonic order data display area (the right side of the screen). Select the number—1 or 2—of the list that you want to select.
  - When Hrm Single Lis is selected, the data of List Item No1 is listed in two columns.
  - When Hrm Dual List is selected, the data of List Item No1 is listed in one column, and the data of List ItemNo2 is listed in another column.
- You cannot change individual items in the measurement function display area (the left side of the screen). Change the display by pressing the up and down arrow keys.

## Function (Function)

Select the measurement function to show in the harmonic order data display area from the following options.

U, I, P, S, Q, λ, Φ, ΦU, ΦI, Z, Rs, Xs, Rp, and Xp

## Element (Element/Σ)

You can select the element or wiring unit to display in the harmonic order data display area. This is the same as setting the element in the 4-, 8-, and 16-value displays.

▶ See here.

## Order

The Total value and 0 (DC) order numeric data is always displayed at the top of the harmonic order data display area. To switch between the displays of the numeric data for harmonic orders 1 to 500, use the up and down arrow keys.

The number of harmonic orders that switch when you change the page is indicated below.

| | Normal display (1 screen) | Split display |
|---|---|---|
| Hrm Single List | 40 orders | 20 orders |
| Hrm Dual List | 20 orders | 10 orders |

# Custom Display (Custom)

## Loading a Display Configuration File (Load Items)

On the file list, specify a file to load display configuration data from. The extension is .TXT.
For information about how to configure the file list display and how to operate files and folders, see "File Operations (FILE UTILITY)."

▶ See here.

## Loading a Background File (Load Bmp)

On the file list, specify a background file to load. The extension is .BMP.
If you use a commercial graphics program to create an image that meets the following specifications, you can load the image to the PX8000.

- File format: BMP
- Resolution: 800 × 654 pixels
- Color scale: 16-bit high color (R: 5 bits, G: 6 bits, B: 5 bits) or 24-bit true color (R: 8 bits, G: 8 bits, B: 8 bits)
- Size: Approx. 1 MB (16 bit) or approx. 1.6 MB (24 bit)

- If you attempt to load an image that does not meet the above specifications, the image will not be displayed properly, or an error message will appear and you will not be able to load the image.
- After you properly load a display configuration file and a background file, if you restart the PX8000 and the same background file is not in the same location, the background will return to its default.
- A background file cannot be loaded from a network drive.

## Simultaneously Loading a Display Configuration File and a Background File (Load Items & Bmp)

When you select a display configuration file (.TXT) from the file list and load it, if there is a background file with a .BMP extension and the same name as the display configuration file, that file is also loaded.

If there is no background file with the same name as the display configuration file in the same directory as the display configuration file, an error occurs.

## Display Configuration (Edit Items)

### Total Number of Items (Total Items)

You can set the total number of numeric data boxes to display to a number from 1 to 192.*

### Number of Items per Page (Items Per Page)

You can set the total number of numeric data boxes to display per page to a number from 1 to 192.*
The total number of pages is Total Items/Items Per Page.

* The ranges of Total Items and Items Per Page are related as indicated below.
- Total Items: Items Per Page to Items Per Page × 12
- Items Per Page: Total Items/12 to Total Items

### Customizing the Displayed Items (Custom Items)

- **Item Number to Set (Item No.)**

  Select the number of the item that you want to configure.

- **Function (Function)**

  This is the same as setting the function in the 4-, 8-, and 16-value displays.

  ▶ See here.

  If you select None, you can display a character string in the numeric data box. Select the String menu item to enter the string.

- **Element (Element/Σ)**

  This setting is valid when Function is not set to None. This is the same as setting the element in the 4-, 8-, and 16-value displays.

  ▶ See here.

- **Order (Order; option)**

  This is the same as setting the order in the 4-, 8-, and 16-value displays.

  ▶ See here.

  If you set Function to None, instead of the Order menu item, a menu item for entering a string (String) appears.

- **String (String)**

  This menu item appears when you set Function to None. Enter the character string to display in the numeric data box. You can enter a string of up to 15 characters in length.
  If you do not set Function to None, instead of the String menu item, the Order menu item appears.

- **X Display Position (X Pos)**

  Set the position where the left edge of the numeric data box will appear on the screen to a value from 0 (the left edge of the screen) to 800 (the right edge of the screen).

- **Y Display Position (Y Pos)**

  Set the position where the top edge of the numeric data box will appear on the screen to a value from 0 (the top of the screen) to 654 (the bottom of the screen).

- **Font Size (Font Size)**

  Select the font size from the options below.
  14, 16, 20, 24, 32, 48, 64, 96, and 128

- **Font Color (Font Color)**

  Select the font color from the options below.
  Yellow, Green, Magenta, Cyan, Red, Orange, Light Blue, Purple, Blue, Pink, Light Green, Dark Blue, Blue Green, Salmon Pink, Mid Green, Gray, White, Dark Gray, Blue Gray, and Black

### Saving the Display Configuration (Save Custom Items)

You can save the display configuration that you have created to the specified storage medium. The extension is .TXT.

- **Displaying a File List and Specifying the Save Destination (File List)**

  On the file list, specify the save destination. For information about how to configure the file list display and how to operate files and folders, see “File Operations (FILE UTILITY).”

  ▶ See here.

- **File Name (File Name)**

  **Automatic File Naming (Auto Naming)**

  This is the same as the auto naming feature for saving and loading data.

  ▶ See here.

  **File Name (File Name)**

  This is the same as file name setting for saving and loading data.

  ▶ See here.

- **Saving (Save Exec)**

  Saves the display configuration.

- Note that if there is a file with the same name in the save destination, it will be overwritten without warning.
- File names are not case sensitive.

# 9 Numeric Computation

## NUMERIC

You can set the following items.

- Turning Numeric Measurement On and Off (Numeric Measure)
- Calculation Period  (Period)
- Averaging (Averaging)
- User-Defined Functions (User Defined Function)
- Apparent Power, Reactive Power, and Corrected Power Equations (Formula)
- Phase Difference Display Format (Phase)
- Harmonic Measurement Conditions (Harmonics; option)

### Re-executing Computation

If you change the numeric computation settings when acquisition of sampled data is stopped, computation is re-executed. All computations including the data of measurement functions are re-executed with the exception of averaging. Averaging is cleared.

## Turning Numeric Measurement On and Off (Numeric Measure)

Turn the measurement of all measurement functions, such as voltage, current, and power, on and off.

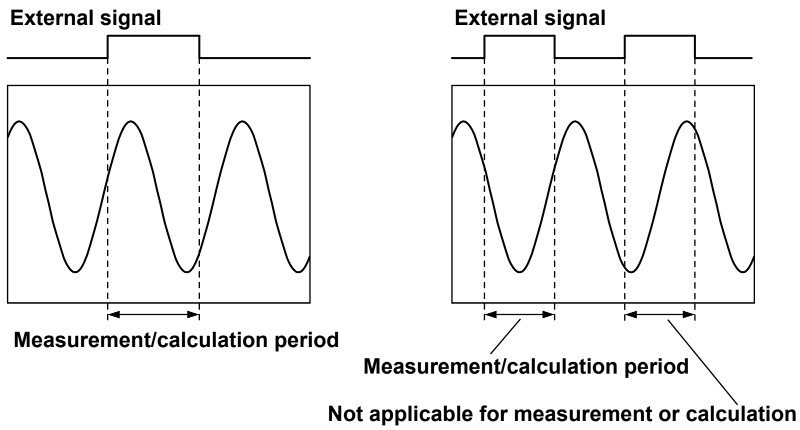
- ON
  The PX8000 measures measurement functions from the acquisition data and shows numeric data on the numeric data display.
- OFF
  The PX8000 does not measure measurement functions. All the numeric data on the numeric data display are set to no data display [————]. The computation time required on the PX8000 CPU is reduced, allowing data to be collected at high speeds (at short time intervals). This setting is effective when you want to use the PX8000 like a logger—acquire data at short time intervals and analyze on a PC the waveforms of input signals that change steeply.

# Calculation Period (Period)

Select the calculation period for the measurement functions of normal measurement, such as voltage, current, and power.

- Zero Cross
  The calculation period is set using the zero-crossings of the specified synchronization source input signal. For details on the synchronization source and zero-crossing, see “Synchronization Source (Sync Source)” in “Fundamental Measurement Conditions.”
  ▶ See here.
- Ext Gate
  The calculation period is set using the external signal received through the TRIGGER IN terminal.
  - : The measurement/calculation period is when the external signal is at low level.
  - : The measurement/calculation period is when the external signal is at high level.

The measurement/calculation period is only during the first period that meets the above condition.
For example, if Ext Gate is set to , the PX8000 operates as follows:




- Cursor
  Set the computation period using two cursors (start point and end point) that appear in the waveform display. The period between the start point (Start Position) and end point (End Position) becomes the measurement or calculation period. The default settings are −5 div and +5 div.
  Selectable range: −5 div to +5 div
  The start and end point settings are similar to the cursor position settings in cursor measurement.
  For details, see “Selectable Range of Cursor Positions” under “Cursor Measurement.”
  ▶ See here.

If you want the measurement period to cover the entire waveform display, select Zero Cross, and set the synchronization source to None.

## Search Zero Cross (Search Zero Cross)

If the calculation period (Period) is set to Cursor, the PX8000 searches for a zero-crossing position and moves the computation period’s start point (or end point) to the zero-crossing position.

Zero-Crossing Search Source (Source)
Select the signal to use as the zero-crossing search source from the options listed below. The available options vary depending on the installed elements.
U1, I1, U2, I2, U3, I3, U4, I4, and External*

* When you select External, the external signal applied to the external trigger input connector (TRIGGER IN) on the side panel is used as the zero-crossing search source. For the TRIGGER IN connector specifications, see section 5.1 in the getting started guide, IM PX8000-03EN.

**Edge (Edge)**

Select the polarity to detect zero crossing from the options listed below.

- ⨍: Rising
- ⨍: Falling
- ⨍⨍: Rising or falling

**Zero-Crossing Search**

You can move the Start Position or End Position to the zero-crossing position of the zero-crossing search source.

- Search Next Move Start: Moves to the nearest zero-crossing position after the Start Position
- Search Previous Move Start: Moves to the nearest zero-crossing position before the Start Position
- Search Next Move End: Moves to the nearest zero-crossing position after the End Position
- Search Previous Move End: Moves to the nearest zero-crossing position before the End Position
- Search Next Move Start Link: Moves to the nearest zero-crossing position after the Start Position (while maintaining the cursor span)
- Search Previous Move Start Link: Moves to the nearest zero-crossing position before the Start Position (while maintaining the cursor span)

Because the computation method and correction method differ, numeric computation data in the range selected with cursors and the computed result of automated measurement of waveform parameters may be different. Numeric computation performs computation more accurately on all items simultaneously. Automated measurement of waveform parameters performs high-speed computation on selected computation items.

# Averaging (Averaging)

You can take exponential or moving averages of the numeric data. The averaging function is effective when reading of the numeric display is difficult due to fluctuations. This occurs when the fluctuation of the power supply or the load is large or when the input signal frequency is low.

## Off

Averaging is not performed.

## Exponential Averaging (Exp)

With the specified attenuation constant, the numeric data is exponentially averaged according to the equation below.

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

$D_n$: Displayed value that has been exponentially averaged n times. (The first displayed value, $D_1$, is equal to $M_1$.)
$D_{n-1}$: Displayed value that has been exponentially averaged n – 1 times.
$M_n$: Measured data at the $n^{th}$ time.
K: Attenuation constant (select from 2 to 64)

**Attenuation Constant (Count)**

- Set the attenuation constant to a value within the following range.
  2 to 64

## Moving Average (Lin)

The specified average count is used to compute moving averages according to the equation below.

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

$D_n$: n–(m–1)th to the nth time

$M_{n-(m-1)}$: Measured data at the n–(m–1)th time

………………………………………………

………………………………………………

$M_{n-2}$: Measured data at the n – 2th time.

$M_{n-1}$: Measured data at the n – 1st time.

$M_n$: Measured data at the nth time.

m: Average count (select a number from 8 to 64)

## Average Count (Count)

- Set the average count to a value within the following range.
  8 to 64

## Averaging Status Display

The averaging status is shown at the top of the screen.

- When averaging is set to OFF: Averaging:Off is displayed.
- When averaging is set to Exp or Lin: Averaging:On is displayed.

## Measurement Functions That Are Averaged

The measurement functions that are directly averaged are indicated below. Other functions that use these functions in their computation are also affected by averaging. For details about how the values of the measurement functions are determined, see appendix 1 in the features guide, IM PX8000-01EN.

### Measurement Functions Used in Normal Measurement

The following measurement functions are averaged when averaging is set to Exp or Lin.

- Urms, Umn, Udc, Urmn, Uac, Irms, Imn, Idc, Irmn, Iac, P, S, and Q
- ΔU1 to ΔP3
- Aux3 to Aux8, Pm2 to Pm4
- λ, Φ, CfU, CfI, Pc, and η1 to η4 are computed using the averaged values of Urms, Irms, P, S, and Q.

### Measurement Functions Used in Harmonic Measurement (Option)

The following measurement functions are averaged when averaging is set to Exp. They are not averaged when averaging is set to Lin.

- U(k), I(k), P(k), S(k), and Q(k)
- λ(k), and Φ(k) are computed using the averaged values of 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 using the averaged values of U(k), I(k), and P(k).
  k: The harmonic order

## Measurement Functions That Do Not Perform Averaging

The following measurement functions do not perform averaging.

### Measurement Functions Used in Normal Measurement

fU, fI, U+pk, U–pk, I+pk, I–pk, P+pk, and P−pk

**Measurement Functions Used in Harmonic Measurement (Option)**

ΦU(k), ΦI(k), ΦUi–Uj, ΦUi–Uk, ΦUi–Ii, ΦUj–Ij, ΦUk–Ik, ΦIi–Ij, ΦIj–Ik, ΦIk–Ii, and fPLL

* k: The harmonic order

**Measurement Functions Used in Normal and Harmonic Measurement (Option)**

F1 to F20

- When averaging is turned on, the average value of multiple measurements is determined and displayed. If the input signal changes drastically, it will take longer for the change to be reflected in the measured values when averaging is used.
- A larger attenuation constant (for exponential averaging) or average count (for moving averages) will result in more stable (and less responsive) measured values.
- When history data is recalled or manipulated, averaging will be cleared.
- hen numeric computation settings are changed and recalculation is performed, averaging will be cleared.
- If you set the acquisition mode to averaging mode, waveforms are averaged but numeric data is not.

## Resetting of Averaging

Averaging is reset when measurement conditions are changed. Below are some of the main settings that are affected.

- Measurement range
- Independent element configuration
- Wiring system
- Scaling values, linear scaling values
- Line filter, frequency filter, bandwidth
- Averaging types (Exp, Lin), attenuation constant, average count
- Time axis
- Record length
- Sample rate
- Synchronization source
- Maximum and minimum harmonic order to be measured
- Apparent power and reactive power equations

# User-Defined Functions (User Defined Function)

You can combine function symbols to create equations and use the numeric data of the combined functions to determine the value of the equation. It is convenient to use a USB keyboard when entering multiple equations or particularly long equations.

User-defined functions allow you to determine physical values other than those of the measurement functions by combining operands. The measurement functions that you can specify for the efficiency equation are fixed at power and motor output. However, by using user-defined functions, you can create equations consisting of measurement functions other than power and motor output measurement functions to determine ratios other than efficiency.

## Selecting Which User-Defined Function to Configure

Select the number of the user-defined function that you want to configure from the options below.

- User Defined F01 to F05: User-defined functions F1 to F5
- User Defined F06 to F10: User-defined functions F6 to F10
- User Defined F11 to F15: User-defined functions F11 to F15
- User Defined F16 to F20: User-defined functions F16 to F20

## Turning the Computation of a User-Defined Function On or Off

Selecting Whether to Compute a User-Defined Function

## User-Defined Function Name (Name)

- Number of characters: Up to eight
- Usable characters: Spaces and all characters that are displayed on the keyboard

## Unit (Unit)

- Number of characters: Up to eight
- Usable characters: Spaces and all characters that are displayed on the keyboard

## Expression (Expression)

### Operation Type

You can use combinations of measurement functions and element numbers (e.g., Urms1) as operands to configure up to 20 equations (F1 to F20). There can be up to 16 operands in 1 equation.
The different types of operands are listed below (measurement function: operand).

- **Normal Measurement**

  Voltage, current, and power

| | | |
|---|---|---|
| Urms: URMS( ) | Irms: IRMS( ) | P: P( ) |
| Umn: UMN( ) | Imn: IMN( ) | S: S( ) |
| Udc: UDC( ) | Idc: IDC( ) | Q: Q( ) |
| Urmn: URMN( ) | Irmn: IRMN( ) | λ: LAMBDA( ) |
| Uac: UAC( ) | Iac: IAC( ) | Φ: PHI( ) |
| fU: FU( ) | fI: FI( ) | Pc: PC( ) |
| U+pk: UPPK( ) | I+pk: IPPK( ) | P+pk: PPPK( ) |
| U–pk: UMPK( ) | I–pk: IMPK( ) | P–pk: PMPK( ) |
| CfU: CFU( ) | CfI: CFI( ) | —— |

Efficiency

η1: ETA1( ) to η4: ETA4( )

User-defined functions

F1: F1( ) to F20: F20( )

- **Harmonic Measurement (Option)**

| | | |
|---|---|---|
| U(k): UK( , ) | I(k): IK( , ) | P(k): PK( , ) |
| S(k): SK( , ) | Q(k): QK( , ) | λ(k): LAMBDAK( , ) |
| 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( , ) | Ihdf(k): IHDF( , ) | Phdf(k): PHDF( , ) |
| Uthd: UTHD( ) | Ithd: ITHD( ) | Pthd: PTHD( ) |
| Uthf: UTHF( ) | Ithf: ITHF( ) | — |
| Utif: UTIF( ) | Itif: ITIF( ) | — |
| hvf: HVF( ) | hcf: HCF( ) | — |
| fPLL: PLLFRQ( ) | Kfactor: KFACT( ) | — |
| ΦU1–U2: PHIU1U2( ) | ΦU1–U3: PHIU1U3( ) | — |
| ΦU1–I1: PHIU1I1( ) | ΦU2–I2: PHIU2I2( ) | ΦU3–I3: PHIU3I3( ) |
| ΦI1–I2: PHII1I2( ) | ΦI2–I3: PHII2I3( ) | ΦI3–I1: PHII3I1( ) |

- **Delta Computation**

| | | |
|---|---|---|
| ΔU1( ): DELTAU1( ) | ΔI( ): DELTAI( ) | ΔP1( ): DELTAP1( ) |
| ΔU2( ): DELTAU2( ) | — | ΔP2( ): DELTAP2( ) |
| ΔU3( ): DELTAU3( ) | — | ΔP3( ): DELTAP3( ) |
| ΔUΣ( ): DELTAUSIG( ) | — | ΔPΣ( ): DELTAPSIG( ) |
| ΔU1rms( ): DELTAU1RMS( ) | ΔU1mean( ): DELTAU1MN( ) | ΔU1rmean( ): DELTAU1RMN( ) |
| ΔU2rms( ): DELTAU2RMS( ) | ΔU2mean( ): DELTAU2MN( ) | ΔU2rmean( ): DELTAU2RMN( ) |
| ΔU3rms( ): DELTAU3RMS( ) | ΔU3mean( ): DELTAU3MN( ) | ΔU3rmean( ): DELTAU3RMN( ) |
| ΔUΣrms( ): DELTAUSIGRMS( ) | ΔUΣmean( ): DELTAUSIGMN( ) | ΔUΣrmean( ): DELTAUSIGRMN( ) |
| ΔU1dc( ): DELTAU1DC( ) | ΔU1ac( ): DELTAU1AC( ) | ΔIrms( ): DELTALRMS( ) |
| ΔU2dc( ): DELTAU2DC( ) | ΔU2ac( ): DELTAU2AC( ) | ΔImean( ): DELTAIMN( ) |
| ΔU3dc( ): DELTAU3DC( ) | ΔU3ac( ): DELTAU3AC( ) | ΔIrmean( ): DELTAIRMN( ) |
| ΔUΣdc( ): DELTAUSIGDC( ) | ΔUΣac( ): DELTAUSIGAC( ) | ΔIdc( ): DELTAIDC( ) |
| — | — | ΔIac( ): DELTAIAC( ) |

- **Auxiliary Input**

Aux3: AUX3( ) to Aux8: AUX8( )

- **Output of the motor**

Pm2: PM2( ) to Pm4: PM4( )

### Setting Operand Parameters

The parameters that you need to enter depend on whether the function is followed by "( , )" or "( )".

- **Setting Parameters for Functions Followed by "( , )"**

  Specify the element to the left of the comma, and specify the harmonic order to the right of the comma. For example: (E1,OR2).

  - Symbols used to represent elements
    E1 to E4: Elements 1 to 4
    SA or SB: Wiring units ΣA or ΣB
  - Symbols that indicate the harmonic order (Order)*
    ORT: Total value
    OR0: dc
    OR1: Fundamental wave
    OR2 to OR500: Harmonic orders 2 to 500
    * On models with the harmonic measurement option

- **Setting Parameters for Functions Followed by "( )"**

  Specify the element. You do not need to specify a harmonic order. For example: (E1).

For information about the parameters that you can use with each operand, see appendix 6 in the features guide, IM PX8000-01EN.

### Values Substituted in Operands

- η1 to η4 are displayed as percentages. However, in this section ETA1 to ETA4 are described as ratios.
  Example When η1 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). For example, if elements 2, 3, and 4 are assigned to wiring unit ΣA, PHIU1U2 is the phase difference between the voltage signals of elements 2 and 3.
- User-defined equations can use other user-defined equations with smaller numbers as operands. For example, the equation for user-defined function F3 can be set to F1( ) + F2( ). This allows equations that would otherwise exceed 50 characters in length to be computed. This can be accomplished by for example setting equations in F1 and F2, and then adding or dividing those equations in F3. This feature is also convenient when defining multiple equations that include common operands. For example, you can set common operands in F1, and then set F4 as F3( ) divided by F1( ) and set F5 as F4( ) divided by F1( ). However, if you enter a user-defined equation with a number that is greater than or equal to its own number, correct results will not be obtained. For 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).
- In the following situations, computed results are set to no data display [————], overflow display [–OF–], or error display [Error].
  - When a division by zero occurs.
  - When a negative value is specified in SQRT.
  - When a value less than zero is specified in a LOG or LOG10 function.
  - An operand in an equation is undetermined
    - Example 1: An element that is not installed is specified.
    - Example 2: The equation contains a delta computation measurement function, but delta computation is set to OFF.
  - When any of the operands is set to no data display [————], overflow display [–OF–], or error display [Error].

### Operators

The following operators can be used in equations.

| 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 |

### Number and Type of Characters That Can Be Used in Equations

- Number of characters: Up to 50
- Usable characters: Spaces and all characters that are displayed on the keyboard

### Equation Examples

- An equation to determine the rms value of the harmonic components of the voltage signal of element 2.

$$\sqrt{(\text{Total rms voltage value})^2 - (\text{Rms value of the fundamental voltage signal})^2}$$

SQRT(SQR(U(E2,ORT))–SQR(U(E2,OR1)))

- Synchronous speed of the motor that the voltage signal (U2) of element 2 is being applied to (When the motor's number of poles is 4)

$$\frac{120 \cdot \text{the frequency of U2 [Hz]}}{\text{Number of motor poles}} \quad [\text{min}^{-1} \text{ or rpm}]$$

(120*FU(E2))/4

- Slip when the rotating speed of the motor above is being measured using AUX module AUX 5 (When the user-defined function of the above rotating speed is set using F4)

$$\frac{\text{SyncSp - Speed}}{\text{SyncSp}} \cdot 100 \quad [\%]$$

(F4()–AUX5())/F4()*100

# Apparent Power, Reactive Power, and Corrected Power Equations (Formula)

## Equation for Apparent Power (S Formula)

You can select the voltage and current to use to compute the apparent power (voltage × current) from the following options.

- Urms*Irms
  The product of the true rms values of the voltage and current
- Umean*Imean
  The product of the voltage's and current's rectified mean values calibrated to the rms values
- Udc*Idc
  The product of the simple averages of the voltage and current
- Umean*Irms
  The product of the voltage's rectified mean value calibrated to the rms value and the current's true rms value
- Urmean*Irmean
  The product of the voltage's and current's rectified mean values

## 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 equations.

Active power P = UIcosΦ (1)
Reactive power Q = UIsinΦ (2)
Apparent power S = UI (3)
U = rms voltage; I = rms current; Φ = Phase difference between voltage and current
The power values are related as follows:
(Apparent power S)$^2$ = (Active power P)$^2$ + (Reactive power S)$^2$ (4)
The three-phase power is the sum of the power of each phase.

These definitions only apply for sine waves. The measured values for apparent power and reactive power vary for distorted waveform measurement depending on which of the above definitions are combined for the computation. Because the equations for deriving the apparent and reactive power for distorted waveforms are not defined, none of the equations can be said to be more correct than the other. Therefore, the PX8000 provides three equations, Type 1 to Type 3, for determining the apparent power and reactive power.
Unlike apparent power and reactive power, active power is derived directly from the sampled data, so errors resulting from different definitions do not occur.

**Type 1 (The method used in the normal mode of conventional WT series power meters*)**

The PX8000 calculates the apparent power of each phase using equation 3, calculates the reactive power of each phase using equation 2, and sums the results to derive the power.

| | |
|---|---|
| Active power for a three-phase, four-wire system | PΣ = P1 + P2 + P3 |
| Apparent power for a three-phase, four-wire system | SΣ = S1 + S2 + S3 ( = U1 × I1 + U2 × I2 + U3 × I3) |
| Reactive power for a three-phase, four-wire system | QΣ = Q1 + Q2 + Q3 |

$$\left(=s1\times\sqrt{(U1\times I1)^2-P1^2}+s2\times\sqrt{(U2\times I2)^2-P2^2}+s3\times\sqrt{(U3\times I3)^2-P3^2}\right)$$

The signs for s1, s2, and s3 are negative when the current leads the voltage and positive when the current lags the voltage.

* WT210, WT230, WT1000 series, or WT2000 series, etc.

#### Type 2

The PX8000 calculates the apparent power of each phase using equation 3 and sums the results to derive the three-phase apparent power. The PX8000 calculates the three-phase reactive power from the three-phase apparent power and the three-phase active power using equation 4.

| | |
|---|---|
| Active power for a three-phase, four-wire system | $P\Sigma = P1 + P2 + P3$ |
| Apparent power for a three-phase, four-wire system | $S\Sigma = S1 + S2 + S3$ ( $= U1 \times I1 + U2 \times I2 + U3 \times I3$) |
| Reactive power for a three-phase, four-wire system | $Q\Sigma = \sqrt{S\Sigma^2 - P\Sigma^2}$ |

#### Type 3 (The method used in the harmonic measurement modes of the WT500, WT1600, WT1800, WT3000 and PZ4000)

The PX8000 calculates the reactive power of each phase using equation 2 and calculates the three-phase apparent power using equation 4. This equation is available on models with the harmonic measurement option.

| | |
|---|---|
| Active power for a three-phase, four-wire system | $P\Sigma = P1 + P2 + P3$ |
| Apparent power for a three-phase, four-wire system | $S\Sigma = \sqrt{P\Sigma^2 + Q\Sigma^2}$ |
| Reactive power for a three-phase, four-wire system | $Q\Sigma = Q1 + Q2 + Q3$ |

## Corrected Power Equation (Pc Formula)

Some standards require that a voltage transformer's active power be corrected when the load connected to the voltage transformer is very small. You can select an equation to use for this correction and specify the coefficient.

#### Applicable Standard (Select standard)

Select from the following.

- IEC76–1 (1976)
- IEC76–1 (1993)

Equations for each applicable standard

**IEC76-1(1976)**

$$P_C = \frac{P}{P_1 + P_2\left(\frac{Urms}{Umn}\right)^2}$$

**IEC76-1(1993)**

$$P_C = P\left(1 + \frac{Umn - Urms}{Umn}\right)$$

Pc: Corrected power
P: Active power
Urms: True rms voltage
Umn: Voltage's rectified mean calibrated to the rms value
P1, P2: Coefficients specified by the applicable standard

#### Coefficients (P1 and P2)

You can set coefficients P1 and P2 to values within the range of 0.0001 to 9.9999.

The IEEE C57.12.90-1993 equation is the same as IEC76-1(1976).

# Phase Difference Display Format (Phase)

The phase difference Φ between the voltage and current indicates the current phase relative to the voltage of each element. Set the display format to one of the options below.

- **180 degrees**
  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 expressed by an angle between 0 and 180° (see appendix 2 in the features guide, IM PX8000-01EN).

- **360 degrees**
  The phase difference is expressed as an angle between 0 and 360° in the clockwise direction.

- If the measured voltage or current value is zero, “Error” is displayed.
- When both the voltage and current signals are sinusoidal waves and the ratios of the voltage and current inputs with respect to the measurement range do not differ greatly, the phase difference Φ lead and lag are still detected and displayed correctly.
- If the computation result of power factor λ exceeds 1, Φ is displayed as follows:
  - If the power factor 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).
- On models with the harmonic measurement option, the phase differences ΦU and ΦI of harmonic orders 1 to 500 of the voltage and current are always displayed using an angle between 0 and 180° (no sign for lead and negative sign for lag).

# Harmonic Measurement Conditions (Harmonics; option)

Using harmonic measurement, you can measure functions that are based on the voltage, current, and power harmonics and their distortion factors; on the phase angle of each harmonic relative to the fundamental; etc. You can also compute the harmonic distortion factors for voltage and current.

For a list of the measurement functions that can be measured with harmonic measurement and their descriptions, see “Harmonic Measurement Functions” under “Items That This Instrument Can Measure.”

▶ See here.

## Turning the Harmonic Measurement On and Off (Harmonics Mode)

- ON: The harmonic measurement is turned on.
- OFF: The harmonic measurement is turned off.

## PLL Source (PLL Source)

For harmonics to be measured, the fundamental period (the period of the fundamental signal) that will be used to analyze the harmonics must be determined. The signal for determining the fundamental period is the PLL (phase locked loop) source.

Select the PLL source from the choices below. The available options vary depending on the installed elements.
U1, I1, U2, I2, U3, I3, U4, I4, and External*

* If you select External, the frequency of the signal applied to the external trigger input connector (TRIGGER IN) on the side panel is used as the fundamental frequency for harmonic measurement. For the TRIGGER IN connector specifications, see section 5.1 in the getting started guide, IM PX8000-03EN.

- Select a signal that has the same period as the signal that you want to measure the harmonics of. For stable harmonic measurement, choose an input signal for the PLL source that has as little distortion and fluctuation as possible. If the fundamental frequency of the PLL source fluctuates or if the fundamental frequency cannot be measured due to waveform distortion, correct measurements will not be obtained. When the measured item is a switching power supply and in other cases where the distortion of the voltage signal is smaller than that of the current signal, we recommend that the PLL source be set to the voltage.
- If all of the input signals are distorted or the amplitude is small compared to the measurement range, the specifications may not be met. To achieve stable, accurate measurements on high harmonics, set the PLL source to “External” and apply a signal with the same period as the input signal to the external trigger input connector.
- If the fundamental frequency contains high frequency components, we suggest that you turn on the frequency filter. This filter is only effective on the frequency measurement circuit.
- If the amplitude level of the signal applied to the element that is specified as the PLL source is small compared to the range, PLL synchronization may not be achieved. Set the measurement range so that the amplitude level of the PLL source is at least 50%.

## Measured Harmonic Orders (Min Order/Max Order)

The harmonic measurement range can be specified. The harmonic orders specified here are used to determine the numeric data of the distortion factor.

▶ See here.

### Minimum Harmonic Order to Be Measured (Min Order)

Select from the following.

- 0: The 0th order (DC) component is included when numeric harmonic waveform data is determined.
- 1: The 0th order (DC) component is not included when numeric harmonic waveform data is determined. The harmonic measurement data (the harmonic waveform data) is determined from the 1st order (the fundamental wave).

### Maximum Harmonic Order to Be Measured (Max Order)

You can select a value between 1 and 500.
However, the maximum measurable harmonic order is smaller of the two orders listed below.

- The specified maximum harmonic order to be measured
- The value determined automatically according to the PLL source frequency (see section 7.5 in the getting started guide, IM PX8000-03EN)

The numeric data corresponding to harmonic orders above the maximum measurable harmonic order is displayed as "-------" (no data).

- If the minimum harmonic order to be measured is set to 1, the data of the DC component is not included when the distortion factor is determined.
- There is no overload value indication ("-OL-") or zero indication (suppression to zero) for the numeric data of harmonic orders 0 (DC) to 500. For information about the overload value indication ("-OL-") and zero indication (suppression to zero) in normal measurement, see section 7.12 in the getting started guide, IM PX8000-03EN.

## Distortion Factor Equation (Thd Formula)

When determining the harmonic measurement functions Uhdf, Ihdf, Phdf, Uthd, Ithd, and Pthd, you can select to use one of the denominators described below as the denominator for the equation. For information about equations, see appendix 1 in the features guide, IM PX8000-01EN.

### 1/Total

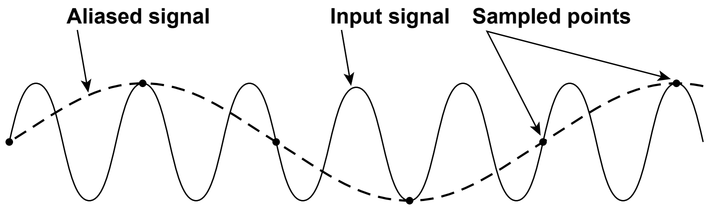
The denominator is the measured data of all orders from the minimum measured order (0 or $1^{st}$) to the maximum measured order (within the upper limit of harmonic analysis).

### 1/Fundamental

The denominator is the data of the fundamental signal component (1st order).

## Anti-Aliasing Filter

When an FFT is taken through the performance of A/D conversion on a repetitive waveform, a phenomenon occurs in which frequency components that exceed half the frequency of the sampling frequency are detected as low frequency components. This is called aliasing.




Aliasing causes problems such as increased errors in measured values and incorrect measurements of the phase angles on each harmonic. An anti-aliasing filter is used to prevent aliasing and eliminate high frequency components that are irrelevant to the harmonic measurement.
For example, when an input signal with a fundamental frequency of 50 Hz is measured up to the 50th order, the frequency of the 50th order is 2.5 kHz. Thus, a 20-kHz anti-aliasing filter is used to eliminate high frequency components that are greater than or equal to approximately 20 kHz, which are irrelevant to harmonic measurement.

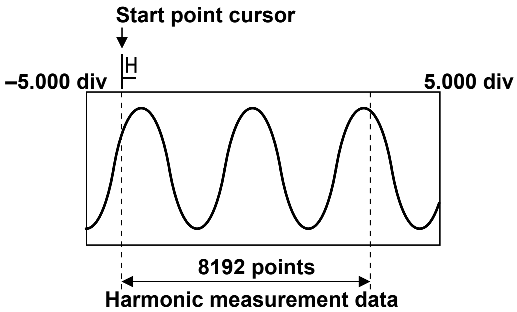
The PX8000 uses the line filter as an anti-aliasing filter for harmonic measurements. For information about how to configure the filter, see “Line Filter (LINE FILTER).”

▶ See here.

The accuracy and the upper limit of the measurement bandwidth change when the anti-aliasing filter (line filter) is turned ON. For details, see appendix 7.5 in the getting started guide, IM PX8000-03EN.

## Harmonic Measurement Start Point

When harmonic measurement is set to ON, set the start point of harmonic measurement using the start point cursor that is displayed. From the start point up to the 8192nd data point at the PLL sampling frequency are measured and computed.
If the number of sampled data points is less than 8192, no data display [————] appears.




## Copying the Numeric Cursor Start Position Settings to Start Position (Copy Numeric Cursor Start Pos to Start Position)

Copies the Start Position settings of the computation period of the numeric computation’s Cursor calculation period to Start Position.
This is useful when you want to align the start point of the computation period of the numeric computation’s Cursor calculation period to the start point of harmonic measurement.

## Harmonic Measurement Display

The PX8000 provides the following three displays for harmonic measurement.

- Harmonics enable indicator
- Harmonic setting status
- Harmonics status

### Harmonics Enable Indicator

Located at the bottom center of the PX8000 LCD.

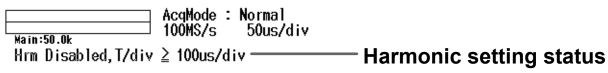

Harmonic measurement becomes possible when all the following conditions are met. When they are met, the harmonic enable indicator turns on.

- Acquisition mode (Acquisition Mode): Normal or Average
- Time base (Time Base): Int
- Time scale (TIME/DIV): 100 μs/div or higher
- Sample rate: 2 MS/s or higher.
  Sample rate varies depending on the record length and time scale settings. For details, see appendix 7, “Relationship between the Time Axis Setting, Record Length, and Sample Rate” in the features guide, IM PX8000-01EN.

### Harmonic Setting Status

Displayed in the upper right of the screen.

**Display Example**




Harmonic setting status does not appear when harmonic measurement is possible with the current settings. When harmonic measurement is not possible with the current settings, the causal condition (setting) is displayed.

- Display when the acquisition mode is set to Envelope
  Hrm Disabled,ACQ Mode:Nrm/Avg
  Solution: Set the acquisition mode to Normal or Average.
- Display when the time base is Ext
  Hrm Disabled,ACQ Time Base:[Int]
  Solution: Set the time base to Int.
- Display when the time scale (TIME/DIV) is less than 100 μs/div
  Hrm Disabled,T/div ≥ 100 μs/div
  Solution: Set the time scale to 100 μs/div or higher.
- Display when the sample rate is less than 2 MS/s
  Hrm Disabled,T/div or Rec Len (Smp ≥ 2MS/s)
  Solution: Change the record length and time scale to set the sample rate to 2 MS/s or higher.

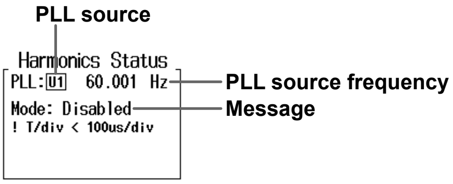
In either of the following conditions, harmonic setting status does not appear even if the above conditions are met.

- Numeric measurement ON/OFF (Numeric Measure) setting: OFF
- Harmonic measurement ON/OFF (Harmonics Mode) setting: OFF

### Harmonics Status

Displayed on the right side of the screen.

#### Display Example




- **PLL Source Frequency**

  The PLL source frequency appears when harmonic measurement completes successfully.

- **Messages**

- No messages appear if you execute a harmonic measurement, and it completes successfully.
- If harmonic measurement cannot be executed, Mode: Disabled appears. The reason also appears.
  For a description of the reasons, see “Harmonic Setting Status” described earlier.
- If harmonic measurement is executed and an error occurs, it is displayed as follows:
  - PLL Err: Freq Over: The PLL source frequency exceeds the upper limit.
  - PLL Err: Freq Under: The PLL source frequency is less than the lower limit.
  - PLL Err: Undetected: The frequency cannot be computed because the PLL cycles are not detected.
    This error may have occurred because the PLL source signal is a DC signal or the PLL source input level is too small.
  - PLL Err: Lack Cycle: Computation is not possible because the number of PLL cycles is insufficient within computation range.
  - PLL Err: Cursor Out: The start point of harmonic measurement is outside the numeric data computation range.
    This error may have occurred because the calculation period (Period) of numeric computation is set to Ext Gate and the start point of harmonic measurement is outside the numeric data computation range that is defined by the Ext Gate signal.
  - PLL Err: Invalid Ch: There is no sampled data of the PLL source.
    This error may have occurred because the appropriate file has not been loaded.
  - PLL Err: Low S.Rate: Computation is not possible because the sample rate* is insufficient for the PLL source frequency.

    * See the conditions listed under “Lower limit of sample rate” under “Harmonic Measurement (Option)” in section 7.5, “Features,” in the Getting Started Guide, IM PX8000-03EN.

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It may also be that the PLL source frequency could not be computed because the distortion in the PLL source waveform was too large. Set the appropriate frequency filter according to the fundamental frequency of the PLL source.

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In either of the following conditions, harmonic status does not appear.
- Numeric measurement ON/OFF (Numeric Measure) setting: OFF
- Harmonic measurement ON/OFF (Harmonics Mode) setting: OFF

# 10 Waveform Display

## Waveform Window Types

The PX8000 has the following types of windows.

**T-Y (Time axis) Waveform Display Window**

- Main window
  Displays normal waveforms, which are not magnified
- Zoom window (Zoom1 and Zoom2)
  Displays zoomed waveforms according to the settings specified using the ZOOM key

**X-Y Window** (Window 1 and Window 2)

Displays X-Y waveforms according to the settings specified using the X-Y key

**FFT Window** (FFT1 window and FFT 2 window)

Displays FFT waveforms according to the settings specified using the FFT key

**Extra Window**

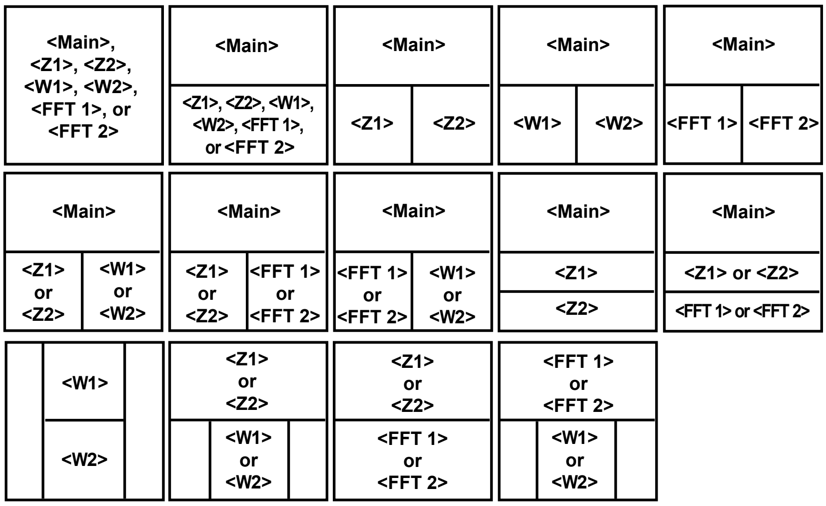
This window displays cursor-measurement values, automated measurement values of waveform parameters, and so on. It can be used when values overlap with waveforms and are difficult to see.

**Switching the Menu Area Display**

You can switch between the full-screen waveform display, the channel information display, and the waveform numeric-monitor display.

**Display Pattern Examples**

The main display patterns are shown in the figure below.

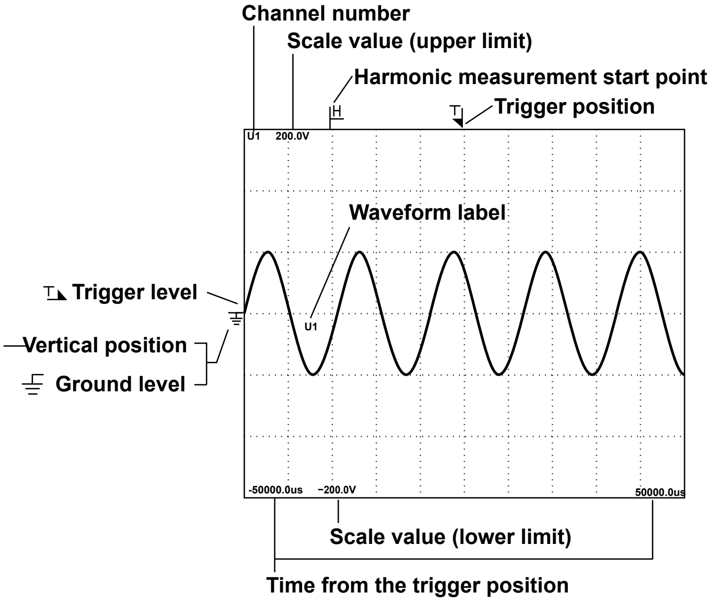



- Zoom1 and Zoom2 are abbreviated to Z1 and Z2.
- You can create patterns in which the main window is not displayed.

Under the following conditions, a total of 64 waveforms can be displayed on the main, Zoom1, and Zoom2 windows.

Trigger mode: Auto
TIME/DIV: 100 ms/div or 200 ms/div

## Waveform Display Example




# Waveform Display Settings

Press DISPLAY SETTING to configure the display.

- Display Format (Format)
- Advanced Waveform Display Settings (Wave Setup)
- Interpolation Method (Dot Connect)
- Grid (Graticule)
- Turning the Scale Value Display On and Off (Scale Value)
- Trace Label Display (Trace Label)
- Extra Window (Extra Window)

# Display Format (Format)

You can evenly divide the T-Y waveform display window so that you can easily view input waveforms and computed waveforms. You can set the number of divisions to one of the values listed below.

1, 2, 3, 4, 6, 8, 12, or 16

The number of displayed points in each division varies depending on the number of divisions. Even if the number of displayed points changes, the vertical resolution does not change. The number of displayed points when only the Main window is displayed is as follows:

| Divisions | Displayed Points | Divisions | Displayed Points | Divisions | Displayed Points |
|---|---|---|---|---|---|
| 1 | 656 points | 2 | 328 points | 3 | 218 points |
| 4 | 164 points | 6 | 109 points | 8 | 82 points |
| 12 | 54 points | 16 | 41 points | | |

# Advanced Waveform Display Settings (Wave Setup)

The channels of the installed modules and Math1 to Math8 are displayed.
If FFT1 is set to ON, Math7 at the left edge is displayed as FFT1.
If FFT2 is set to ON, Math8 at the left edge is displayed as FFT2.
You can set the following items.

## Turning the Display of Waveform On and Off (Disp)

Select whether to display waveform labels.
If the computation mode of waveform computation is set to OFF or if the operator of each waveform computation is set to OFF, the waveform display ON/OFF areas of Math1 to Math8 are blank.
Waveform display ON/OFF areas of FFT1 and FFT2 are blank.

## Display Color (Color)

You can set the display color of each of the waveforms to one of 16 colors.
You can assign all waveforms regardless of whether their displays are turned on.

## Mapping Mode (Map)

Set how to map channels to the divided screens on the mapping list.

- **Auto**

  The waveforms whose displays are turned on are arranged by number from the top of the window.

- **User**

  You can set how to map each waveform to the divided screens. You can assign all waveforms regardless of whether their displays are turned on.

## Waveform Labels (Label)

You can set waveform labels using up to 16 characters.
Waveform labels of FFT1 and FFT2 are blank.

## Zoom Method (V Scale)

This item is the same as zoom method of the vertical axis.

▶ See here.

### • When the Zoom Method Is Set to SPAN

**Zooming by Setting Upper and Lower Display Limits (Upper/Lower)**

This item is the same as zooming by setting upper and lower display limits of the vertical axis.

▶ See here.

### • When the Zoom Method Is Set to DIV

**Offset (Offset)**

This item is the same as offset of the vertical axis.

▶ See here.

**Waveform Vertical Position (Position)**

This item is the same as waveform vertical position of the vertical axis.

▶ See here.

**Zooming by Setting a Magnification (V Zoom)**

This item is the same as zooming by setting a aagnification of the vertical axis.

▶ See here.

# Interpolation Method (Dot Connect)

When the number of data points is within the interpolation zone of the T-Y waveform display,* the PX8000 displays waveforms by interpolating between sampled data points.

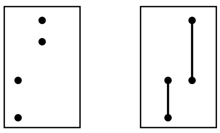
* Interpolation zone refers to the condition in which a given number of data points are not contained in the 10 div along the time axis. The number of data points that define the interpolation zone varies depending on the display record length and zoom ratio.

You can set the interpolation method to one of the options below.

- **OFF**
  Displays the data using dots without interpolation.
- **Sine Interpolation (Sine)**
  Interpolates a sine curve between two points using the (sinx)/x function. This method is suitable for the observation of sine waves.
- **Linear Interpolation (Line)**
  Linearly interpolates between two points.
- **Pulse Interpolation (Pulse)**
  Interpolates between two points in a staircase pattern.

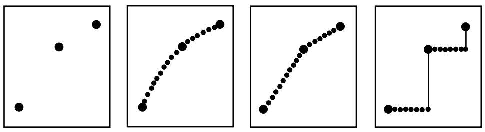
### Outside of the Interpolation Zone

If the interpolation method is set to Sine, Line, or Pulse, the dots are connected vertically.
If the number of data points is 2002 or greater, the PX8000 determines the P-P compression values (the maximum and minimum sampled-data values in a given interval), and displays vertical lines (rasters) connecting each pair of maximum and minimum P-P compression values.



OFF　Sine/Line/Pulse

### In the Interpolation Zone



OFF　Sine　Line　Pulse

The interpolation method is set to Pulse when:
- The acquisition mode is Envelope.

# Grid (Graticule)

You can set the window grid to one of the following options.

- : Displays the grid using broken lines
- : Displays the grid using crosshairs
- : Displays a frame

# Turning the Scale Value Display On and Off (Scale Value)

You can display the upper and lower limits (scale values) of each waveform's vertical or horizontal axes.

- ON: Displays the scale values
- OFF: Does not display the scale values

# Trace Label Display (Trace Label)

You can display waveform labels next to the displayed waveforms. If the waveform display is narrow because of the display format settings, labels may not be displayed.

- ON: Displays labels
- OFF: Does not display labels

# Extra Window (Extra Window)

When waveforms and measured values overlap and are difficult to see, you can use the extra window to display them separately. The extra window appears below the T-Y waveform display window. The following values appear in the extra window.

- Cursor-measurement values
- Automated measurement values of waveform parameters

## Height of the Extra Window

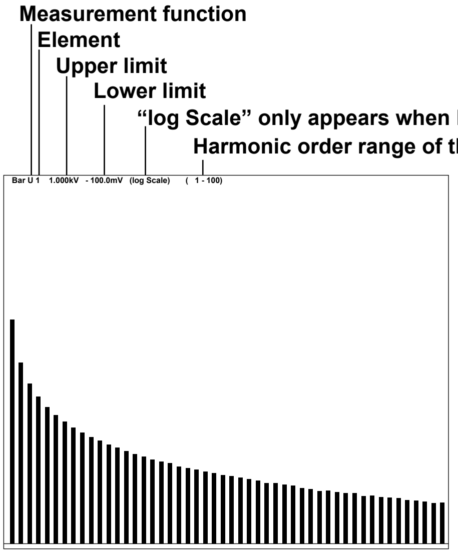
Set the height of the extra window.
OFF: The extra window is not displayed.
1 to 8: The extra window is set to the selected height.
Auto: The extra window appears automatically when you perform cursor measurements and automated measurements of waveform parameters.

- The number of displayed points on the T-Y waveform display window varies depending on the height of the extra window. Even if the number of displayed points changes, the vertical resolution does not change.
- When the extra window is displayed, depending on the Zoom Format, the scale values may overlap and be difficult to read.

# 11 Bar Graph Display (Option)

On models with the harmonic measurement option, you can display harmonics using bar graphs. The harmonic orders are lined up on the horizontal axis, and the vertical axis represents the amplitude of each harmonic.
You can configure three different bar graphs.

### Bar Graph Display Example




- When logarithmic coordinates are used (Log Scale), if a value is negative, its absolute value is displayed with a red bar graph.
- If the number of sampled data points is less than 8192, harmonic data is not measured, and the bar graph does not appear.
- The bar graphs of harmonic orders that exceed the maximum measurable order are not displayed. For information about the maximum measurable harmonic order, see “Maximum Harmonic Order to Be Measured (Max Order).”

▶ See here.

## Bar Graph Display Vertical Scale

- When the function is U, I, P, S, or Q, the scaling is logarithmic (Log).
- When the function is λ, Φ, ΦU, ΦI, Z, Rs, Xs, Rp, or Xp, the scaling is linear (Linear).
- The upper and lower limits of the bar graph window are automatically determined based on the maximum and minimum displayed trend data values. The lower and upper limits for λ are –1 and 1. For Φ, ΦU, and ΦI, the minimum and maximum values are –180 to 180°. Negative values correspond to phase lagging and positive values correspond to phase leading.

# Bar Graph Display Settings

Press DISPLAY SETTING to configure the display.


- Display Format (Format)
- Bar Graph Number (Item No.)
- Function (Function)
- Element (Element)
- Bar Graph Display Range (Start Order/End Order)
- Turning the Display of Numeric Data On and Off (Numeric)
- Position of Marker (x Order/+ Order)


# Display Format (Format)

You can choose the number of windows from one of the following options:

- 1: No windows. The data of bar graph (Item No.) 1 is displayed.
- 2: Two windows. The data of bar graphs (Item No.) 1 and 2 is displayed.
- 3: Three windows. The data of bar graphs (Item No.) 1 to 3 is displayed.

# Bar Graph Number (Item No.)

Select the number, from 1 to 3, of the bar graph that you want to select.

# Function (Function)

You can select the measurement function to display from the following options.

U, I, P, S, Q, λ, Φ, ΦU, ΦI, Z, Rs, Xs, Rp, and Xp

# Element (Element)

You can select the element from the following options. The available options vary depending on the installed elements.

Element1, Element2, Element3, and Element4

# Bar Graph Display Range (Start Order/End Order)

- You can configure the range of harmonic orders to show in a bar graph.
- The range is the same for bar graphs 1 to 3.

### Starting Harmonic Order (Start Order)

- You can select a value between 0 and 490. However, the starting harmonic order cannot be more than 10 orders less than the ending 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.

### Ending Harmonic Order (End Order)

You can select a value between 10 and 500. However, the ending harmonic order cannot be more than 10 orders greater than the starting order. You cannot display bar graphs containing harmonic orders that are greater than the maximum measurable order (see section 7.5 in the getting started guide, IM PX8000-03EN).

# Turning the Display of Numeric Data On and Off (Numeric)

You can select whether to show (ON) or hide (OFF) numeric data.

## Measured Items

| | |
|---|---|
| Y1x | The vertical-axis (Y-axis) value of marker x of bar graph 1 |
| Y1+ | The vertical-axis (Y-axis) value of marker + of bar graph 1 |
| ΔY1 | The difference between the vertical-axis (Y-axis) values of marker x and marker + of bar graph 1 |
| Y2x | The vertical-axis (Y-axis) value of marker x of bar graph 2 |
| Y2+ | The vertical-axis (Y-axis) value of marker + of bar graph 2 |
| ΔY2 | The difference between the vertical-axis (Y-axis) values of marker x and marker + of bar graph 2 |
| Y3x | The vertical-axis (Y-axis) value of marker x of bar graph 3 |
| Y3+ | The vertical-axis (Y-axis) value of marker + of bar graph 3 |
| ΔY3 | The difference between the vertical-axis (Y-axis) values of marker x and marker + of bar graph 3 |

# Position of Marker (x Order/+ Order)

## Position of Marker x (x Order)

Set the position of marker x to a value within one of the following ranges.

0 (DC) to 500 (the 500th order)

## Position of Marker + (+ Order)

Set the position of marker +. The ranges within which you can set the position are the same as those for marker x (x Order).

## Marker Movement

- Two markers (x and +) are displayed in each graph (Graph1 to Graph3).
- You can set the marker positions as orders.
- The bar graph display indicates what harmonic order each marker is located in. For example:
  - The location of marker x is indicated in this format: “Orderx:2.”
  - The location of marker + is indicated in this format: “Order+:55.”
- The orders indicating the locations of markers x and + are the same for each bar graph, from 1 to 3.

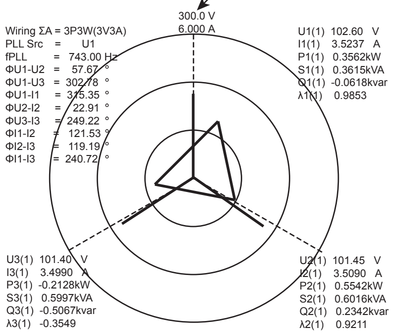
If immeasurable data exists, “***” is displayed in the measured value display area.

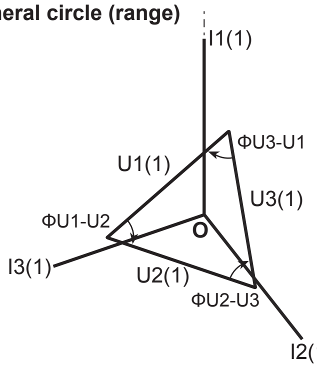
# 12 Vector Display (Option)

On models with the harmonic measurement option, you can select a wiring unit to display vectors of the phase differences and amplitudes (rms values) of the fundamental signals, U(1) and I(1), in each element in the unit. The positive vertical axis is set to zero (angle zero), and the vector of each input signal is displayed.

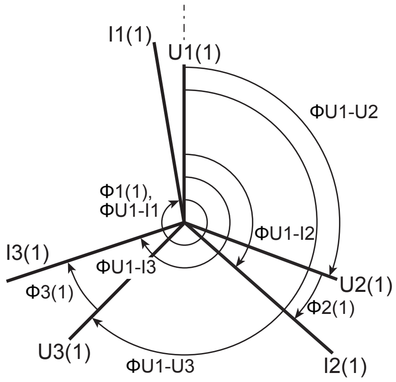
### Vector Display Example

**For a 3P3W 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.**



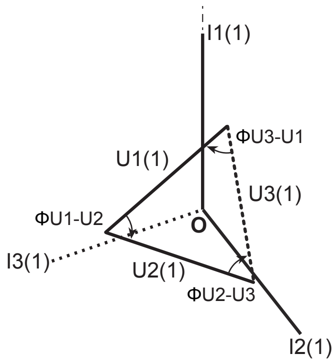




**For a 3P4W (three-phase, four-wire system)**
- **U1(1), U2(1), and U3(1) are line voltages.**
- **I1(1), I2(1), and I3(1) are line currents.**




**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 c urrents.**

**However, U3(1) and I3(1) are not actually measured for the 3P3W system. The vectors are displayed through computation.**




If the number of sampled data points is less than 8192, harmonic data is not measured, and the vectors do not appear.

# Vector Display Settings

Press DISPLAY SETTING to configure the display.

- Display Format (Format)
- Vector Number (Item No.)
- Element or Wiring Unit (Vector Object)
- Setting Vector Zoom Factors (U Mag/I Mag)
- Turning the Display of Numeric Data On and Off (Numeric)

# Display Format (Format)

You can choose the number of windows from one of the following options:

- 1: No windows. The data of vector (Item No.) 1 is displayed.
- 2: 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.

# Vector Number (Item No.)

Select the vector you want to set: 1 or 2.

# Element or Wiring Unit (Vector Object)

You can select the element or wiring unit to display from the options below. The available options vary depending on the installed elements.

Element1, Element2, Element3, Element4, ΣA, and ΣB

# Setting Vector Zoom Factors (U Mag/I Mag)

You can change the sizes of the vectors. You can specify separate zoom factors for the fundamental waves U(1) and I(1). When you zoom a vector, the value for the size of the peripheral circle of the vector changes according to the zoom factor.

**Setting the Zoom Factor of the Vector of Fundamental Waveform U (1) (U Mag)**

You can set the zoom factor to a value between 0.100 and 100.000.

**Setting the Zoom Factor of the Vector of Fundamental Waveform I (1) (I Mag)**

You can set the zoom factor to a value between 0.100 and 100.000.

If the zoom factor is too large, the vector will exceed the display range and will not be displayed properly. Reduce the zoom factor so that the vector is displayed within the display range.

# Turning the Display of Numeric Data On and Off (Numeric)

You can select whether to show (ON) or hide (OFF) numeric data. You can display the size of each signal and the phase differences between signals. For information about phase difference display formats, see “Phase Difference Display Format.”

▶ See here.

# 13 Displaying X-Y Waveforms

### X-Y

You can view the correlation between two waveform levels by assigning the level of one waveform to the X-axis (horizontal axis) and the level of the other waveform to the Y-axis (vertical axis). There are two X-Y waveform windows, and you can display four pairs of waveforms in each window (for a total of eight pairs).
You can perform cursor measurements on the displayed X-Y waveforms. You can also observe T-Y (time axis) waveforms and X-Y waveforms simultaneously.

## X-Y Waveform Display Settings


- Turning the X-Y Window Display On and Off (Display)
- Eight Pairs of X-Y Waveforms (Setup)
- Start Point and End Point (Start Point and End Point)
- Clearing Waveforms at Acquisition Start (Trace clear on Start)
- Display Ratio of the Main Window (Main Ratio)
- Window Layout (Window Layout)
- Combine Display (Combine Display)
- Interpolation Method (Dot Connect)
- Setting the Number of Data Points to Use for Waveform Display (Decimation)


## Turning the X-Y Window Display On and Off (Display)

You can select whether to display each X-Y window.

- ON: Displays the X-Y window
- OFF: Does not display the X-Y window

## Eight Pairs of X-Y Waveforms (Setup)

You can display XY1 to XY4 in window 1 and XY5 to XY8 in window 2. You can configure the display settings of a total of 8 X-Y waveforms. You can configure the following settings for each X-Y waveform.

### Display (DISPLAY)

You can select whether to display each X-Y waveform.

- ON: Displays the X-Y waveform
- OFF: Does not display the X-Y waveform

### X Trace and Y Trace (X Trace and Y Trace)

For XY1 to XY4 and XY5 to XY8, you can select which waveforms to assign to the X and Y axes from the following options. You can select the channel of an installed module.
U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8

- X-Y waveforms can be created from normal T-Y waveforms. They cannot be created from zoomed waveforms.
- You cannot create an X-Y waveform using one trace whose horizontal-axis unit is time and another trace whose horizontal-axis unit is frequency.

## Start Point and End Point (Start Point and End Point)

You can set the start and end points of the X-Y waveforms on the T-Y waveforms. You can set different start and end points for each X-Y window.
Selectable range: ±5 div from the center of the T-Y waveform window

## Clearing Waveforms at Acquisition Start (Trace Clear on Start)

Choose whether to clear the current X-Y waveforms when waveform acquisition is started through the pressing of the START/STOP key.

- ON: X-Y waveforms are cleared.
- OFF: X-Y waveforms are not cleared.

## Display Ratio of the Main Window (Main Ratio)

This item is the same as display ratio of the main window of the zooming in on waveforms.

▶ See here.

## Window Layout (Window Layout)

Set the display position of the X-Y window.

- Side: Horizontal
- Vertical: Vertical

## Combine Display (Combine Display)

Choose whether to combine the two X-Y windows into one window.

- ON: The windows are combined.
- OFF: The windows are not combined.

## Interpolation Method (Dot Connect)

When the number of data points is within the interpolation zone of the X-Y waveform display,* the PX8000 displays waveforms by interpolating between sampled data points.

* Interpolation zone refers to the condition in which a given number of data points are not contained in the X-Y waveform display. The number of data points that define the interpolation zone varies depending on the display record length.

You can set the interpolation method to one of the options below.

- OFF: Displays the data using dots without interpolation.
- Linear Interpolation (Line): Linearly interpolates between two points.

For details, see “Interpolation Method” of the waveform display.

▶ See here.

## Setting the Number of Data Points to Use for Waveform Display (Decimation)

In the X-Y waveform display, the PX8000 displays the acquired data by removing the data between fixed intervals. You can set the number of points to use to display waveforms to one of the options listed below.

**2k**

When the record length exceeds 2 kpoint, the PX8000 removes data until there are only 2 kpoint and displays two points on each vertical line. When the record length is less than 2 kpoint, all the points are displayed.

**100k**

When the record length exceeds 100 kpoint, the PX8000 removes data until there are only 100 kpoint and displays 100 points on each vertical line. When the record length is less than 100 kpoint, all the points are displayed.

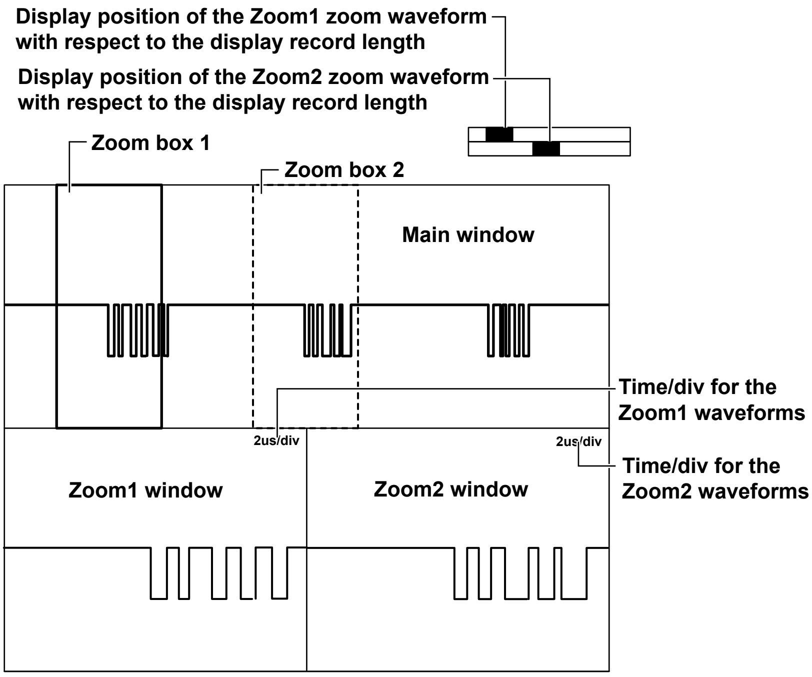
- To zoom in or out on an X-Y waveform, change the upper and lower limits (Upper and Lower) of the channel that you want to zoom, or change the vertical zoom (V Zoom).
- To change the displayed position of an X-Y waveform, change the positions of the channels that it is based on.

# 14 Zooming in on Waveforms

## ZOOM

You can magnify displayed waveforms along the time axis. The zoomed waveforms of two locations can be displayed simultaneously (the dual zoom feature). You can also specify which channel you want to zoom in on. You cannot zoom if the number of displayed points on the screen is less than or equal to 100.

**Example of the Dual Zoom Display**




If the Zoom1 or Zoom2 waveform window and the main waveform window (Main) are displayed at the same time, a zoom box appears in the Main window so that you can check the zoom position.

### Vertical Zoom

You can magnify displayed waveforms along the vertical axis by using the menu that appears when you press a U1 to U4, I1 to I4, or P1 to P4 key.

▶ See here.

## Zoom Window Display (Display)

You can set whether to display each of the zoom windows, Zoom1 and Zoom2. When a zoom window is displayed, a zoom bar appears at the top of the screen. This bar indicates what part of Main window is being zoomed in on.

- ON: Displays the zoom windows
- OFF: Does not display the zoom windows

## Zoom Source Window (Zoom2 Source)

Select the waveforms that you want to enlarge in the Zoom2 window.

- Main (Main): Main window waveforms
- Zoom1: Zoom1 window waveforms

# Zoom Factor (MAG knob)

Use the Mag knob to set the zoom factor. You can set separate horizontal zoom factors for Zoom1 and Zoom2. The zoom-window time-axis setting changes automatically based on the specified zoom factor.

### Selectable Range

Two times the time axis setting (TIME/DIV) of the Main window to the point where the number of data points in the zoom window reaches 10 points per div.

When an external clock signal is being used as the time base, you can select one of the following magnifications. You can select any magnification up to the point where the number of data points in the zoom window reaches 10 points per div.
Up to 1000000 in 1-2.5-5 steps (×2, ×2.5, ×5, ×10, ×25, ×50, ×100, ×250, ×500, ×1000, ×2500, and so on)

# Position (Zoom POSITION knob, Zoom1 Position, Zoom2 Position)

You can set the zoom position (position) using the zoom POSITION knob or the jog shuttle. Taking the horizontal center of the main window to be 0 div, set the center position of the zoom boxes in the range of −5 to 5 div. In the Main window, the box with solid lines is for Zoom1, and the box with dashed lines is for Zoom2. Waveforms are magnified around the centers of the zoom boxes.

The Z1 or Z2 indicator on the front panel illuminates to show when the Zoom1 or Zoom2 window can be moved by the Mag or zoom POSITION knob.

### Zoom Link

If you press the Mag knob or zoom POSITION knob so that the Z1 and Z2 indicators both light, you can move the zoom boxes while maintaining the spatial relationship between them. The relationship between the zoom factors is also maintained.

# Display Format (Format Zoom1 and Format Zoom2)

Select how to display the zoom windows from one of the options listed below. If you select a number, the zoom windows are divided evenly, and waveforms are displayed within the divisions.

- Main: Same as the display format of the main window of each display group.
- 1, 2, 3, 4, 6, 8, 12, 16: The window is broken up into the specified number of divisions.

# Moving the Zoom Position to the Latest Position (Move Zoom1 to Front and Move Zoom2 to Front)

You can move the position of one of the zoom boxes to the right side of the screen (where the most recent data is). When the waveform flows from the right to the left of the screen, as in roll mode, you can zoom in on the waveform where it starts from, on the right side of the screen. These menu items do not appear when the source waveform of the Zoom2 window is set to Zoom1.

# Display Ratio of the Main Window (Main Ratio)

Set the size of the main window in relation to the overall waveform display area.

- 50%: The main window appears in the upper half of the screen.
- 0%: The main window is not displayed.

# Window Layout (Window Layout)

You can select the layout of the two zoom windows.

- Side: Horizontal
- Vertical: Vertical

# Auto Scroll (Auto Scroll)

This feature automatically moves the zoom position in the specified direction. You can view the waveform and stop scrolling at the appropriate position.

| | |
|---|---|
| ⏮ | Zooms in on the left edge of the Main window |
| ⏭ | Zooms in on the right edge of the Main window |
| ◀ | Starts scrolling to the left |
| ▶ | Starts scrolling to the right |
| ■ | Stops scrolling |

## Speed (Speed)

You can select the auto scrolling speed.

Selectable range: 1 to 10. The default setting is 4.

# Waveforms That Are Zoomed (Allocation)

The waveforms of the channels whose check boxes are selected in the allocation window and whose displays are turned on are displayed.

# Changing the Range of the Automated Measurement of Waveform Parameters (Fit Measure Range)

Sets the range of the automated measurement of waveform parameters to the zoom range of Zoom1 or Zoom2. This is valid even if the automated measurement of waveform parameters is turned OFF.

# 15 Cursor Measurement

### CURSOR

You can move cursors on the waveforms displayed on the screen to view the measured values at the points where the cursors intersect the waveforms. You can select whether to measure the P-P compressed data values on the screen or the data values that have been acquired in the acquisition memory by cursor read mode.

▶ See here.

## Window Selection (Select Window)

Select the window to perform cursor measurement in. This option appears when X-Y or FFT waveforms are being displayed.

- T-Y: Displays T-Y waveform cursor-measurement values.
- X-Y: Displays the cursor-measurement values for the waveform in an X-Y window.
- FFT: Displays the cursor-measurement values for the waveform in an FFT window.

## T-Y Waveforms

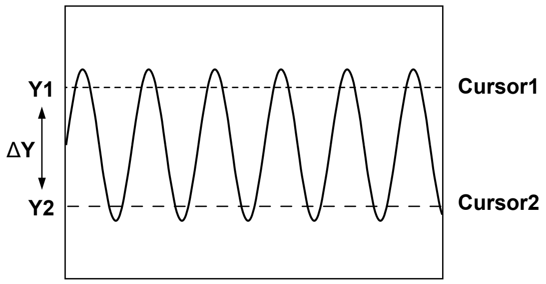
### Cursor Types (Type)

The following types of T-Y waveform cursors are available.

- OFF: Cursor measurement is not performed.
- Horizontal cursors (Horizontal): Two horizontal cursors are used to measure vertical values.
- Vertical cursors (Vertical): Two vertical cursors are used to measure time values.
- Horizontal and vertical cursors (H & V): Two horizontal cursors and two vertical cursors are used to measure vertical and time values.
- Marker cursors (Marker): Four marker cursors that move on the waveform are used to measure waveform values.
- Angle cursors (Degree): Two angle cursors are used to measure angles.

# Horizontal Cursors (Horizontal) - T-Y waveforms

Two dashed lines (horizontal cursors) appear on the horizontal axis. You can measure the vertical value at the position of each horizontal cursor and measure the level difference between the horizontal cursors.




### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below. You can select the channel of an installed module.
U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8

### Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in 0.01 div steps.

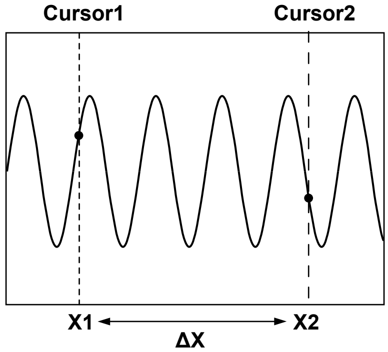
### Measurement Items (Item Setup)

You can measure the following vertical values at the cursor positions.

| | |
|---|---|
| Y1 | Vertical value at Cursor1 |
| Y2 | Vertical value at Cursor2 |
| ΔY | Difference between the vertical values of Cursor1 and Cursor2 |

# Vertical Cursors (Vertical) - T-Y waveforms

Two straight dashed lines appear on the vertical axis (these are the vertical cursors). You can measure the time between the trigger position and each cursor, the time difference between the two cursors, and the reciprocal of the time difference between the two cursors. You can also measure the vertical signal value at each cursor position and the level difference between the two cursors.




### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below. You can select the channel of an installed module.
U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8, All*

* Cursor measurement is performed on all channels. However, measured values that do not fit on the screen are not displayed.

### Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in steps of the following size: Time/div × 10 ÷ display record length.

### Cursor Jumping (Cursor Jump)

You can make Cursor1 and Cursor2 jump to the center of the specified zoom window.
Cursor1 to Zoom1: Cursor1 jumps to the Zoom1 window.
Cursor1 to Zoom2: Cursor1 jumps to the Zoom2 window.
Cursor2 to Zoom1: Cursor2 jumps to the Zoom1 window.
Cursor2 to Zoom2: Cursor2 jumps to the Zoom2 window.

### Measurement Items (Item Setup)

You can measure the following horizontal values at the cursor positions.

| | |
|---|---|
| X1 | Time value at Cursor1 |
| X2 | Time value at Cursor2 |
| ΔX | Difference between the time values of Cursor1 and Cursor2 |
| 1/ΔX | Reciprocal of the difference between the time values of Cursor1 and Cursor2 |
| Y1 | Vertical value at the intersection of Cursor1 and the waveform[1] |
| Y2 | Vertical value at the intersection of Cursor2 and the waveform[2] |
| ΔY | Difference between the vertical values at the intersections of the waveform with Cursor1 and Cursor2[2] |

1 When Trace is set to All, the values for the channels of all installed modules and the Math channel are measured.
2 This option does not appear when Trace is set to All.

# Horizontal and Vertical Cursors (H & V) - T-Y waveforms

Displays the horizontal and vertical cursors simultaneously.

### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below. You can select the channel of an installed module.
U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8

### Moving the Cursors (V Cursor1/V Cursor2, H Cursor1/H Cursor2)

Use V-Cursor1, V-Cursor2, H-Cursor1, and H-Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in steps of the following sizes: for horizontal cursors, 0.01 div; for vertical cursors, Time/div × 10 ÷ display record length.

### Cursor Jumping (Cursor Jump)

You can make V-Cursor1 and V-Cursor2 jump to the center of the specified zoom window.
Cursor1 to Zoom1: Cursor1 jumps to the Zoom1 window.
Cursor1 to Zoom2: Cursor1 jumps to the Zoom2 window.
Cursor2 to Zoom1: Cursor2 jumps to the Zoom1 window.
Cursor2 to Zoom2: Cursor2 jumps to the Zoom2 window.

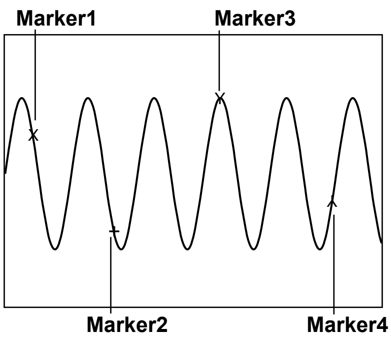
### Measurement Items (Item Setup)

You can measure the following horizontal and vertical values at the cursor positions.

| | |
|---|---|
| **Horizontal Axis** | |
| X1 | Time value at V-Cursor1 |
| X2 | Time value at V-Cursor2 |
| ΔX | Difference between the time values of V-Cursor1 and V-Cursor2 |
| 1/ΔX | Reciprocal of the difference between the time values of V-Cursor1 and V-Cursor2 |
| **Vertical Axis** | |
| Y1 | Vertical value of H-Cursor1 |
| Y2 | Vertical value of H-Cursor2 |
| ΔY | Difference between the vertical values of H-Cursor1 and H-Cursor2 |

# Marker Cursors (Marker) - T-Y waveforms

Four markers are displayed on the selected waveform. You can measure the level at each marker, the amount of time from the trigger position to each marker, and the level and time differences between markers.



### Markers (Marker1 through 4)

Select the markers, from Marker1 to 4, that you want to display. You can assign each marker to a different waveform.

### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below. You can select the channel of an installed module.

- OFF: Disables the marker
- U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8

### Position (Position)

Set the position of the selected marker.
Taking the center of the waveform display window to be 0 div, you can move the markers within the range of −5 to 5 div in steps of the following size: Time/div × 10 ÷ display record length.

### Cursor Jumping (Cursor Jump)

You can make Marker1 to Marker4 jump to the center of the specified zoom window.
To Zoom1: The selected marker jumps to the Zoom1 window.
To Zoom2: The selected marker jumps to the Zoom2 window.

### Marker Shape (Marker Form)

Set the shape of the displayed marker to one of the options below.

- Mark: A dot
- Line: A crosshair

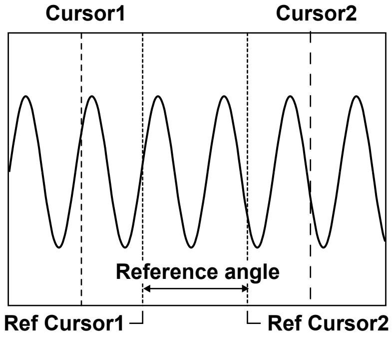
### Measurement Items (Display Item)

Marker cursors move on the waveform data. You can measure the following values at the markers.

| | |
|---|---|
| X1 | Time value at Marker1 |
| X2 | Time value at Marker2 |
| X3 | Time value at Marker3 |
| X4 | Time value at Marker4 |
| Δ(X2-X1) | Difference between the time values of Marker1 and Marker2 |
| Δ(X3-X1) | Difference between the time values of Marker1 and Marker3 |
| Δ(X4-X1) | Difference between the time values of Marker1 and Marker4 |
| Δ(X3-X2) | Difference between the time values of Marker2 and Marker3 |
| Δ(X4-X2) | Difference between the time values of Marker2 and Marker4 |
| Δ(X4-X3) | Difference between the time values of Marker3 and Marker4 |
| Y1 | Vertical value at Marker1 |
| Y2 | Vertical value at Marker2 |
| Y3 | Vertical value at Marker3 |
| Y4 | Vertical value at Marker4 |
| Δ(Y2-Y1) | Difference between the vertical values of Marker1 and Marker2 |
| Δ(Y3-Y1) | Difference between the vertical values of Marker1 and Marker3 |
| Δ(Y4-Y1) | Difference between the vertical values of Marker1 and Marker4 |
| Δ(Y3-Y2) | Difference between the vertical values of Marker2 and Marker3 |
| Δ(Y4-Y2) | Difference between the vertical values of Marker2 and Marker4 |
| Δ(Y4-Y3) | Difference between the vertical values of Marker3 and Marker4 |

# Angle Cursors (Degree) - T-Y waveforms

You can measure time values and convert them to angles. On the time axis, set the zero point (Ref Cursor1 position), which will be the measurement reference, the end point (Ref Cursor2 position), and the reference angle that you want to assign to the difference between Ref Cursor1 and Ref Cursor2. Based on this reference angle, you can measure the angle between two angle cursors (Cursor1 and Cursor2).




### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below. You can select the channel of an installed module.

U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8, All*

* Cursor measurement is performed on all channels.

### Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.

Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in steps of the following size: Time/div × 10 ÷ display record length.

### Cursor Jumping (Cursor Jump)

You can make Cursor1 and Cursor2 jump to the center of the specified zoom window.

Cursor1 to Zoom1: Cursor1 jumps to the Zoom1 window.

Cursor1 to Zoom2: Cursor1 jumps to the Zoom2 window.

Cursor2 to Zoom1: Cursor2 jumps to the Zoom1 window.

Cursor2 to Zoom2: Cursor2 jumps to the Zoom2 window.

### Reference Angle (Ref Value)

Set the reference angle you want to assign to the range defined by Ref Cursor1 and Ref Cursor2.

Selectable range: 1 to 720

### References (Ref1/Ref2)

Set the zero point (Ref Cursor1) and the end point (Ref Cursor2).

Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in steps of the following size: Time/div × 10 ÷ display record length.

#### Measurement Items (Item Setup)

The PX8000 measures the angle cursor (Cursor1 and Cursor2) positions as angles.

| | |
|---|---|
| X1 | Angle of Cursor1 from Ref Cursor1 |
| X2 | Angle of Cursor2 from Ref Cursor1 |
| ΔX | Angle difference between Cursor1 and Cursor2 |
| Y1 | Vertical value at the intersection of Cursor1 and the waveform[1] |
| Y2 | Vertical value at the intersection of Cursor2 and the waveform[2] |
| ΔY | Difference in the vertical values at the points where Cursor1 and Cursor2 intersect the waveforms[2] |

1 When Trace is set to All, the values for the channels of all installed modules and the Math channel are measured.

2 This option does not appear when Trace is set to All.

# X-Y Waveforms

## Cursor Types (Type)

The following types of X-Y waveform cursors are available.

- OFF: Cursor measurement is not performed.
- Horizontal cursors (Horizontal): Two horizontal cursors are used to measure vertical (Y axis) values.
- Vertical cursors (Vertical): Two vertical cursors are used to measure horizontal (X axis) values.
- Horizontal and vertical cursors (H & V): Two horizontal cursors and two vertical cursors are used to measure vertical (Y axis) and horizontal (X axis) values.
- Marker cursors (Marker): Four marker cursors that move on the waveform are used to measure waveform values.

## Horizontal Cursors (Horizontal)

Two dashed lines (horizontal cursors) appear on the horizontal axis. You can measure the vertical (Y axis) value at the position of each horizontal cursor and measure the level difference between the horizontal cursors.

#### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1 to XY8

#### Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in 0.01 div steps.

#### Measurement Items (Item Setup)

You can measure the following vertical (Y axis) values at the cursor positions.

| | |
|---|---|
| Y1 | Vertical (Y axis) value at Cursor1 |
| Y2 | Vertical (Y axis) value at Cursor2 |
| ΔY | Difference between the vertical (Y axis) values of Cursor1 and Cursor2 |

## Vertical Cursors (Vertical)

Two dashed lines (vertical cursors) appear on the vertical axis. You can measure the horizontal (X axis) value at the position of each vertical cursor and measure the level difference between the vertical cursors.

#### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1 to XY8

#### Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in 0.01 div steps.

#### Measurement Items (Item Setup)

You can measure the following horizontal (X axis) values at the cursor positions.

| | |
|---|---|
| X1 | Horizontal (X axis) value at Cursor1 |
| X2 | Horizontal (X axis) value at Cursor2 |
| ΔX | Difference between the horizontal (X axis) values of Cursor1 and Cursor2 |

### Horizontal and Vertical Cursors (H & V)

You can display the horizontal and vertical cursors simultaneously and measure vertical (Y axis) and horizontal (X axis) values.

#### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1 to XY8

#### Moving the Cursors (V Cursor1/V Cursor2, H Cursor1/H Cursor2)

Use V-Cursor1, V-Cursor2, H-Cursor1, and H-Cursor2 to move the cursors.
Taking the center of the waveform display window to be 0 div, you can move the cursors within the range of −5 to 5 div in 0.01 div steps.

#### Measurement Items (Item Setup)

You can measure the following horizontal (X axis) and vertical (Y axis) values at the cursor positions.

| | |
|---|---|
| **Horizontal Axis (X axis)** | |
| X1 | Horizontal (X axis) value at V-Cursor1 |
| X2 | Horizontal (X axis) value at V-Cursor2 |
| ΔX | Difference between the horizontal (X axis) values of V-Cursor1 and V-Cursor2 |
| **Vertical Axis (Y axis)** | |
| Y1 | Vertical (Y axis) value at H-Cursor1 |
| Y2 | Vertical (Y axis) value at H-Cursor2 |
| ΔY | Difference between the vertical (Y axis) values of H-Cursor1 and H-Cursor2 |

### Marker Cursors (Marker)

Four markers are displayed on the selected waveform. You can measure the level at each marker, the amount of time from the trigger position to each marker, and the level and time differences between markers.

#### Markers (Marker1 through 4)

Select the markers, from Marker1 to 4, that you want to display. You can assign each marker to a different waveform.

#### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1 to XY8

#### Position (Position)

Set the position of the selected marker.
Taking the center of the waveform display window to be 0 div, you can move the markers within the range of −5 to 5 div in steps of the following size: Time/div × 10 ÷ display record length.

#### Marker Shape (Marker Form)

Set the shape of the displayed marker to one of the options below.
- Mark: A dot
- Line: A crosshair

#### Measurement Items (Item Setup)

Marker cursors move on the waveform data. You can measure the following values at the markers.

| | |
|---|---|
| X1 | Horizontal (X axis) value at Marker1 |
| X2 | Horizontal (X axis) value at Marker2 |
| X3 | Horizontal (X axis) value at Marker3 |
| X4 | Horizontal (X axis) value at Marker4 |
| Y1 | Vertical (Y axis) value at Marker1 |
| Y2 | Vertical (Y axis) value at Marker2 |
| Y3 | Vertical (Y axis) value at Marker3 |
| Y4 | Vertical (Y axis) value at Marker4 |
| T1 | Time from the trigger position at Marker1 |
| T2 | Time from the trigger position at Marker2 |
| T3 | Time from the trigger position at Marker3 |
| T4 | Time from the trigger position at Marker4 |
| Δ(T2-T1) | Time difference between Marker1 and Marker2 |
| Δ(T3-T1) | Time difference between Marker1 and Marker3 |
| Δ(T4-T1) | Time difference between Marker1 and Marker4 |

# FFT Waveforms

## Cursor Types (Type)

The following types of FFT waveform cursors are available.
- OFF: Cursor measurement is not performed.
- Marker cursors (Marker): You can use four marker cursors to measure frequencies, levels, and the distances between markers.
- Peak cursors (Peak): You can use peak cursors to measure peak frequency and level values.

## Marker Cursors (Marker)

You can measure the frequency and level at each marker and the frequency and level differences between markers. You can select a measurement source waveform for each cursor.

#### Markers (Marker#)

The selected markers appear on the measurement source waveforms.

#### Measurement Source Waveform (Trace)

Set the measurement source waveform for each marker to one of the waveforms below.
- OFF: Disables measurement.
- FFT1: The waveform in the FFT1 window is measured.
- FFT2: The waveform in the FFT2 window is measured.

### Position (Position)

Set the position of the selected marker.
You can move the markers within the range of −5 to 5 div of the frequency axis in 0.01 div steps.

### Marker Shape (Marker Form)

Set the shape of the displayed marker to one of the options below.
- Mark: A dot
- Line: A crosshair

### Measurement Items (Item Setup)

Marker cursors move on the waveform data. You can measure the following values at the markers.

| | |
|---|---|
| X1 | Frequency at Marker1 |
| X2 | Frequency at Marker2 |
| X3 | Frequency at Marker3 |
| X4 | Frequency at Marker4 |
| Δ(X2-X1) | Frequency difference between Marker1 and Marker2 |
| Δ(X3-X1) | Frequency difference between Marker1 and Marker3 |
| Δ(X4-X1) | Frequency difference between Marker1 and Marker4 |
| Δ(X3-X2) | Frequency difference between Marker2 and Marker3 |
| Δ(X4-X2) | Frequency difference between Marker2 and Marker4 |
| Δ(X4-X3) | Frequency difference between Marker3 and Marker4 |
| Y1 | Level at Marker1 |
| Y2 | Level at Marker2 |
| Y3 | Level at Marker3 |
| Y4 | Level at Marker4 |
| Δ(Y2-Y1) | Level difference between Marker1 and Marker2 |
| Δ(Y3-Y1) | Level difference between Marker1 and Marker3 |
| Δ(Y4-Y1) | Level difference between Marker1 and Marker4 |
| Δ(Y3-Y2) | Level difference between Marker2 and Marker3 |
| Δ(Y4-Y2) | Level difference between Marker2 and Marker4 |
| Δ(Y4-Y3) | Level difference between Marker3 and Marker4 |

## Peak Cursors (Peak)

In the frequency range defined by FFT1 Range1 and Range2 and the frequency range defined by FFT2 Range1 and Range 2, the PX8000 detects peaks (Peak1 and Peak2) and measures their frequencies and levels. You can set the two frequency ranges in the range of −5 to 5 div.

### Measurement Items (Item Setup)

The following values at the peaks are measured.

| | |
|---|---|
| F1 | Frequency at Peak1 |
| F2 | Frequency at Peak2 |
| Y1 | Level at Peak1 |
| Y2 | Level at Peak2 |

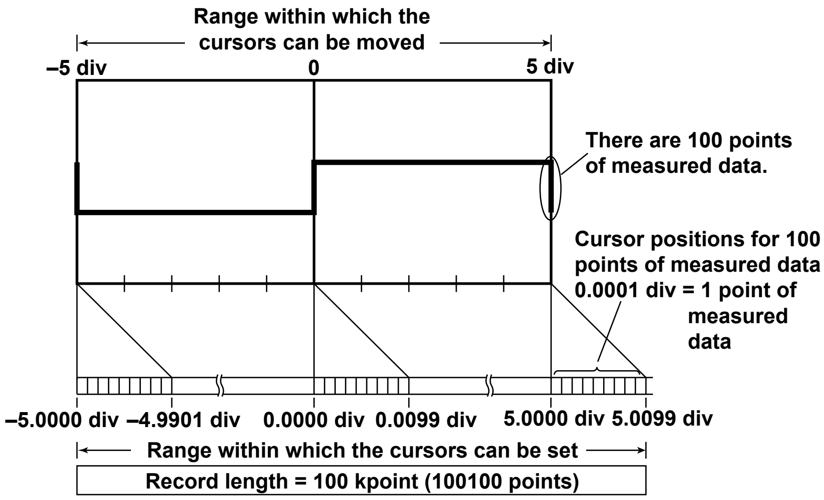
# Notes about Cursor Measurement

## Cursor Measurement

- You cannot perform cursor measurement on snapshot waveforms.
- For history waveforms, cursor measurement is performed on the waveform whose record number is selected.
- The measured time values are based on the trigger position.
- The measured value for data that cannot be measured appears as "***."
- The pulse/rotate setting affects only the X-axis (horizontal) cursor measurement values.

## Selectable Range of Cursor Positions

When Cursor Read Mode is set to ACQ, in cursor measurements, measurement is performed on the data stored in the acquisition memory, not on the displayed data. Because 1001 points along the time axis are used to display the waveform, the number of acquired data points is equal to the set record length × 1.001. If the record length is set to 100 kpoint, the number of acquired data points is 100100. Therefore, if the record length is set to 100 kpoint, there will be 100 points of measured data at the same position on the screen. The cursor display position is normally within ±5 div of the center of the waveform display window. In this case, if the cursor display position is set to 5 div from the center of the window, only 1 point out of 100 points can be measured even if there are 100 points of measured data at the same time axis position. For these kinds of situations, the cursor position can be set in the range of −5 div to 5.0099 div (if the record length is set to 100 kpoint) from the center of the window. In other words, you can measure the data at the right end of the waveform display window by setting the cursor position to a value in the range of 5.0000 to 5.0099 div from the center of the window. Because the number of points at the same time axis position increases as the record length gets larger, the range varies depending on the record length (5.00000 to 5.00999 div for 1 Mpoint).



# 16 Automated Measurement of Waveform Parameters

### MEASURE

The PX8000 can automatically measure various parameters of the displayed waveform, such as the maximum and minimum values. It can also compute statistics for the automatically measured data.

## Mode Settings (Mode)

The following types of statistical processing are available for the automatically measured values of waveform parameters.

- OFF: Automated measurement is not performed.
- Automated measurement of waveform parameters (ON): Automated measurement is performed.
- Normal statistical processing (Statistics): Normal statistical processing is performed.
- Cyclic statistical processing (Cycle Statistics): Statistical processing is performed for each period (cyclic statistical processing).

## Automated Measurement of Waveform Parameters (ON)

The PX8000 automatically measures the specified measurement items on the source waveform.

## Measurement Items (Measure Setup)

### Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below. You can select the channel of an installed module.

U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8, XY1 to XY8

When the AUX input signal type is set to Pulse, "*****" is displayed.

### Measurement Item (Item)

You can choose from the 26 measurement items and delay measurement items listed below. The PX8000 can store a total of up to 64000 data values for all waveforms (U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, and Math1 to Math8). A total of up to 24 measurement items can be displayed on the screen.

- **Vertical Axis Measurement Items**

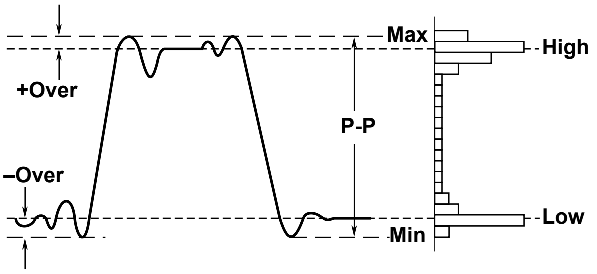
Voltage input signal measurement example

| | |
|---|---|
| Peak to Peak(P-P) | P-P value (Max − Min) [V] |
| Amplitude(Amp) | Amplitude (High − Low) [V] |
| Maximum(Max) | Maximum voltage [V] |
| Minimum(Min) | Minimum voltage [V] |
| High | High voltage [V] |
| Low | Low voltage [V] |
| Average(Avg) | Average voltage ((1/n)Σxi) [V] |
| Middle(Mid) | (Max + Min)/2 [V] |
| RMS[1] | Rms voltage $((1/(\sqrt{n}))(\Sigma(xN^2))^{1/2})$ [V] |
| Std.Deviation(SDev) | Standard deviation $(1/n(\Sigma xi^2 - (\Sigma xi)^2/n)^{1/2})$ [V] |
| +Overshoot(+Over) | Overshoot ((Max − High)/(High − Low) × 100) [%] |
| −Overshoot(−Over) | Undershoot ((Low − Min)/(High − Low) × 100) [%] |

1 On a channel that has been set to power spectrum computation (PS or PSD), if RMS is set to ON, “Rms = overall value” appears on the screen. For details about the overall value, see appendix 9 in the features guide, IM PX8000-01EN.

* The names in parentheses are the measurement item names that appear when the measured values are displayed.

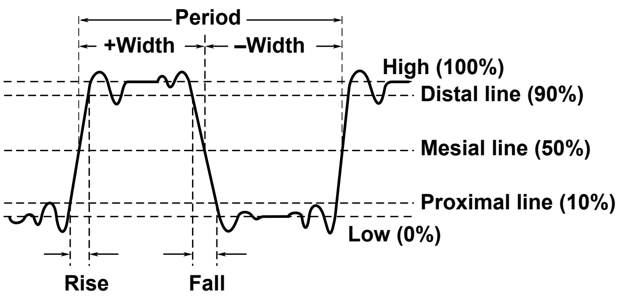
* The units are V for voltage, A for current, and W for power. The unit for AUX varies depending on the settings.




- **Time Measurement Items**

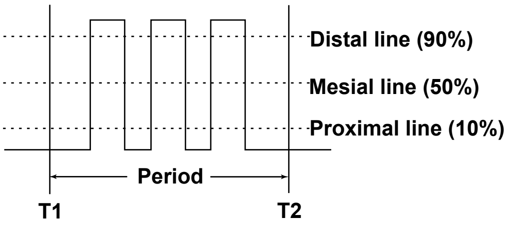
| | |
|---|---|
| Rise | Rise time [s] |
| Fall | Fall time [s] |
| Frequency(Freq) | Frequency [Hz] |
| Period | Period [s] |
| +Width | Time width of the portion that is greater than the mesial value [s] |
| −Width | Time width of the portion that is less than the mesial value [s] |
| Duty | Duty cycle (+Width/Period × 100) [%] |
| Avg.Frequency(Avg.F) | Average frequency in the measurement time period [Hz] |
| Avg.Period(Avg.P) | Average period in the measurement time period [s] |

* The names in parentheses are the measurement item names that appear when the measured values are displayed.

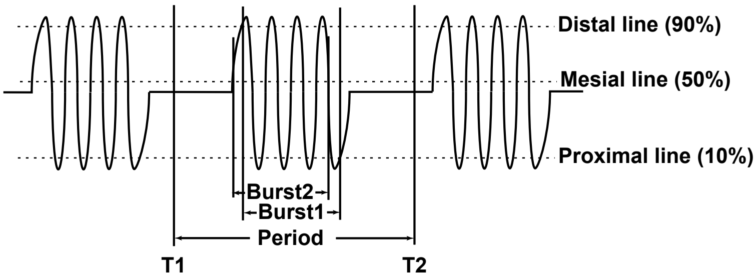


| | |
|---|---|
| Pulse | Pulse count<br>Set the measurement time period (Time Range) to a value appropriate for the pulse that you want to measure. |

**When Pulse = 3**




| | |
|---|---|
| Burst1 and Burst2 | Burst period [s]<br>Set the measurement time period (Time Range) to a value appropriate for the burst period that you want to measure. |




- **Other Measurement Items**

| | |
|---|---|
| **When Trace Is Set to U, I, P, AUX, or Math** | |
| Integ1TY(Integ1) | Area of the positive amplitude |
| Integ2TY(Integ2) | Area of the positive amplitude − area of the negative amplitude |
| **When Trace Is Set to XY** | |
| Integ1XY(Integ1) | Total triangular area of the X-Y waveform |
| Integ2XY(Integ2) | Total trapezoidal area of the X-Y waveform |

* The names in parentheses are the measurement item names that appear when the measured values are displayed.

For detailed information about how the area of the X-Y waveform is computed, see appendix 8 in the features guide, IM PX8000-01EN.

## All Clear (All Clear)

You can turn off all the items for the waveform selected for Trace at once.

## Copy (Copy to)

You can copy the settings of the waveform selected for Trace to other traces.

- You can turn the following channels on and off separately: U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8. You can select the channel of an installed module.
- All ON: All traces are turned on.
- All OFF: All traces are turned off.
- Execute: Select Execute to copy the settings.

When Trace is set to XY, All Clear and Copy to are not available.

# Detail Parameter (Detail Parameter)

Set the reference level that is used to measure various parameter values, such as the rise and fall times, for each measurement source waveform.

- **Distal, Mesial, and Proximal Unit Setting Method (Mode)**

  Set the method for setting the three levels that are used as references in the measurement of various parameter values, such as the rise and fall times.
  - %
    You can set the distal, mesial, and proximal values as percentages of the specified trace (U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, or Math1 to Math8). The high value of the specified trace is equal to 100%, and the low value is equal to 0%.
  - Unit
    You can set the distal, mesial, and proximal values of the specified trace (U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, or Math1 to Math8) by specifying physical values, such as voltages or currents.

  You can select the channel of an installed module.

- **Distal, Mesial, and Proximal (Distal, Mesial, Proximal)**

  You can set the distal, mesial, and proximal values.
  Selectable range: 0.0 to 100.0% (in 0.1% steps) or voltage, current, power or AUX input values that correspond to ±10 div.

- **High/Low Specification Method (High/Low)**

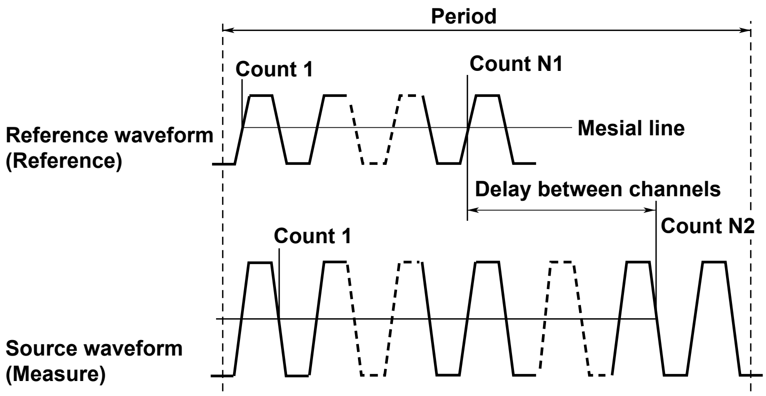
  The high and low levels are the 100% and 0% levels used to measure various parameter values, such as the rise and fall times. You can choose one of the following methods for setting the high and low levels.
  - Auto
    The PX8000 sets the high value to the high amplitude level and the low value to the low amplitude level based on the voltage level frequency of the waveform in the measurement time period while taking into account the effects of ringing, spikes, etc. This method is suitable for measuring square waves and pulse waves.
  - Max-Min
    The PX8000 sets the high and low values to the maximum and minimum values in the measurement time period. This method is suitable for measuring sinusoidal and saw waves. It is not suitable for waveforms that have ringing and spikes.

- **Integration Mode (Integ Mode)**

  Select the measurement mode of Integ1TY(Integ1) and Integ2TY(Integ2) from the following two options. This setting is valid when measurement source waveform (Trace) is set to I or P.
  - Normal
    The area is measured.
  - Hour
    Integrated current (Ah) and integrated power (Wh) are measured.

# Setting the Delay (Delay Setup)

The time difference between traces or the time difference from the trigger point to a rising or falling edge is called the delay between channels.




Reference waveform settings
- Polarity: (rising)
- Edge Count: N1 (an integer between 1 and 9)

Source waveform settings
- Polarity: (falling)
- Edge Count: N1 (an integer between 1 and 9)

- **Mode**

  Select a delay measurement mode.
  - OFF: Delay measurement is not performed.
  - Time: The delay between channels is displayed as a time.
  - Degree: The delay between channels is displayed as an angle.

- **Polarity**

  Select the slope of the edge you want to detect.
  - : Rising
  - : Falling

- **Edge Count**

  Sets which edge counted from the start point (T Range1) of the measurement time period to use as a detected point (measured point).
  Selectable range: 1 to 9

- **Reference**

  Select whether to use a trace or trigger as the reference for the reference waveform.
  - Trace: A trace is used.
  - Trigger: A trigger is used.

- **Reference Waveform (Reference Trace)**

  When Reference is set to Trace, set the reference waveform.
  - Trace: Select a reference waveform. U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8. You can select the channel of an installed module.
  - Polarity: Select the slope of the edge you want to detect (: rising, : falling).
  - Edge Count: Sets which edge counted from the start point (T Range1) of the measurement time period to use as a detected point (reference point). Selectable range: 1 to 9

- The voltage level of the detected point is the mesial line.
- The measurement item name that appears when the measured values are displayed is (Delay).
- If Mode is set to Degree and Reference is set to Trigger, the measured value is displayed as '*****'.
- If you set the delay measurement's Reference to Trace, measurements will not be performed when the sample rates of the base waveform and the measurement source waveform are different. The measured value is displayed as '*****'.

# Measurement Time Period (Time Range1/Time Range2)

Set the measurement time period using two vertical cursors. The position of the thin dashed line (Time Range1) is the measurement start point. The position of the thick dashed line (Time Range2) is the measurement end point. The default settings are −5 div and +5 div. The number of data points in the measured waveform can be up to 100 Mpoint from the measurement start point.
Selectable range: −5 div to +5 div

The Time Range1 and Time Range2 settings are similar to the cursor position settings in cursor measurement.

For details, see "Selectable Range of Cursor Positions" under "Cursor Measurement."
▶ See here.

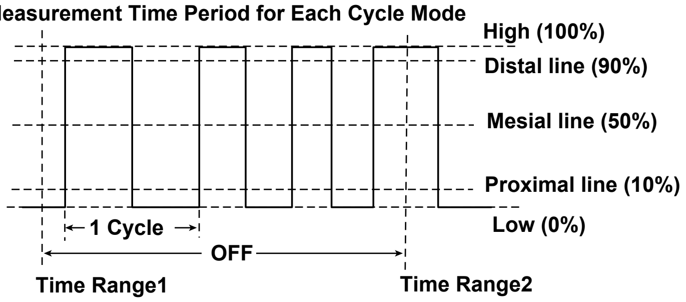
# 1-Cycle Mode (1-Cycle Mode)

Instead of automatically measuring the measurement time period specified by Time Range1 and Time Range2, you can automatically measure the first period after Time Range1.
The method of determining the period is the same as the method for determining the Period measurement item.

In this mode, after the period is determined, the values of the measurement items related to voltage and area are computed. This mode is effective for measurement items, such as Rms or Avg, that may result in errors depending on the measurement time period setting.
The measurements of time axis items and X-Y areas are not affected.

- OFF: 1-cycle mode is disabled.
- ON: 1-cycle mode is enabled.

**Measurement Time Period for Each Cycle Mode**




If the space between Time Range1 and Time Range2 is less than one period, "*****" is displayed for the measured value.

# Notes about Automated Measurement of Waveform Parameters

- Measurements cannot be made on a snapshot waveform.
- Automated measurement is not possible when the measurement source waveform is AUX3 to AUX8 and Sense Type is set to Pulse.
- When an item is impossible to measure, its measured value is displayed as '*****'.
- The PX8000 may not measure correctly if the waveform amplitude is small.
- If there are two or more waveform periods within the measurement time period, the time-axis parameters are measured on the first period.
- Automated measurement may require additional time depending on settings such as the memory length, the number of measurement items, and the input waveform. During automated measurement, appears in the center of the screen.
- To cancel automated measurement, set Mode to OFF. Measurement stops immediately.
- Only the Max and Min items can be measured for FFT waveforms. Only the overall rms power spectrum value can be measured.

# Normal Statistical Processing (Statistics)

While acquiring waveforms, the PX8000 calculates the statistics of the waveforms that it has acquired so far. If you stop waveform acquisition and then restart it, the PX8000 will continue statistical processing and include the data from before waveform acquisition was stopped. The PX8000 also performs statistical processing for selected automatically measured items that are not displayed. The number of measured values used to calculate statistics (Count) is equal to the number of waveforms that have been acquired up to that point.
If you add an additional automatically measured item to apply statistical processing to, the number of measured values used to calculate the statistics (Cnt) is reset to 1 regardless of whether the PX8000 is acquiring waveforms.

## Measurement Items (Measure Setup)

Statistical processing is performed on the same measurement items that the automated measurement of waveform parameters is performed on. The following five statistics are computed for the measurement items whose measurement has been turned on. The maximum number of measurement items that can be displayed on the screen is 3.

- Maximum: Maximum value
- Minimum: Minimum value
- Average: Average value
- SDev: Standard deviation
- Count: Number of measured values used to calculate statistics

The measurement items are the same as those for the automated measurement of waveform parameters.

▶ See here.

If you select U1 P-P as the automatically measured item, the number of measured values used to calculate the maximum, minimum, mean, and standard deviation values for U1 P-P appear at the bottom of the screen.
The PX8000 can display the statistical results of three automatically measured items. If four or more automatically measured items are selected, the PX8000 displays the first three items ordered by ascending channel number and the order that the items appear in the Item Setup automated-measurement-item selection menu (P-P, Amp, Max, Min, ..., Init1XY, and Init2XY).

Example 1:

When U1: P-P, Amp; I1: Min; P1: Max, Min are selected, the following items are displayed: U1: P-P; I1: Min; P1:Max.

Example 2:

When U1: Max, Min; I1: P-P, Amp are selected, the following items are displayed: U1: Max, Min; I1: P-P.

You can view the statistics of other items in the following way.

- Load the items into a PC using the communication feature.
- Save the statistical items as automated measurement values of waveform parameters, and load the data into a PC.
- Scroll through the list of calculated statistics using the arrow keys.

## Measurement Time Period (Time Range1/Time Range2)

This setting is the same as the measurement time period setting for the automated measurement of waveform parameters.

▶ See here.

## 1-Cycle Mode (1-Cycle Mode)

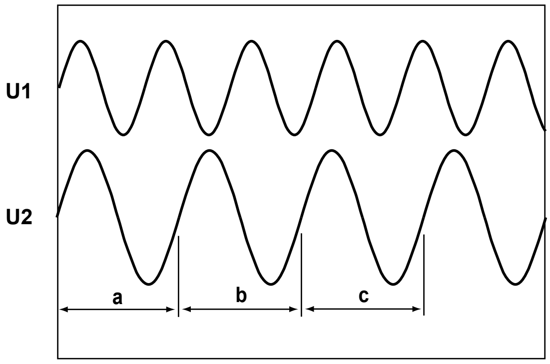
This setting is the same as the 1-cycle mode setting for the automated measurement of waveform parameters.

▶ See here.

# Cyclic Statistical Processing (Cycle Statistics)

The PX8000 determines periods in order from the oldest data of the displayed waveform, measures the selected automatically measured items within each period, and performs statistical processing on the results of automated measurement. The method used to determine the period in cyclic statistical processing is the same as the method used to determine the Period waveform parameter. You can choose whether to determine the period for the selected waveform and use it on all source waveforms or to determine individual periods for each waveform.

**Example in Which Cycle Trace Is Set to U2**




Measures the items in ranges a, b, and c, and calculates statistics on the items in the order a, b, and c.
The items of other channels are also measured in ranges a, b, and c.
If you select Own, the items are measured over each waveform's period.

## Measurement Items (Measure Setup)

These items are the same as those for the normal statistical processing.

▶ See here.

The following items are not measured:

- For waveforms that are used in period determination
  Avg.Frequency, Avg.Period, Pulse (pulse count), Integ1XY (area), Integ2XY (area), Delay
- For other waveforms
  Integ1XY (area), Integ2XY (area), Delay

## Measurement Time Period (Time Range1/Time Range2)

This setting is the same as the measurement time period setting for the automated measurement of waveform parameters.

▶ See here.

## Cycle Trace (Cycle Trace)

Selects the source waveform used to determine the period. You can select the channel of an installed module.

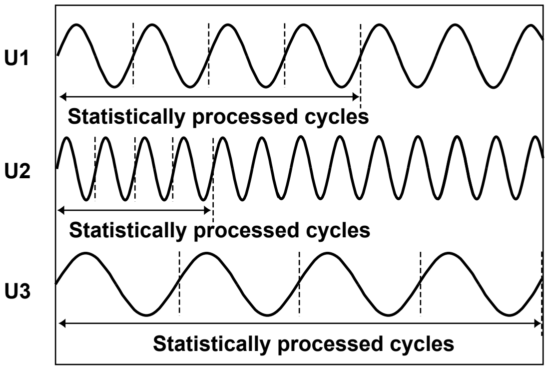
- **U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8, XY1 to XY8**

  The period of the specified waveform is applied to all waveforms.

- **Own**

  A period is determined for each source waveform. However, if signals that have different periods are applied to multiple channels, the number of iterations of automated measurement and statistical processing for each signal is equal to the number of periods in the slowest signal.

**When Cycle Trace Is Set to Own**




The number of cycles in the channel with the slowest cycle (U3) is four, so statistical processing is performed on the four oldest cycles of the data for U1 and U2. The remaining data is not used for statistical processing.

Statistical processing is performed in periods that are determined in order from the oldest data of the displayed waveform. It cannot be used at the same time as 1-cycle mode.

## Execution of Measurement (Execute Measure)

Executes statistical processing. You can select Execute Measure when Mode is set to Cycle Statistics.
Press Abort to stop statistical processing.

- The number of cycles being used for the cyclic statistical processing is displayed in the statistical display's Count column.
- The number of cycles that can be used in cyclic statistical processing varies depending on the number of measured items that the PX8000 is calculating the statistics of.
  64000/(the number of measured items that the PX8000 is calculating the statistics of)
- If the sample rates of the cycle trace and the displayed waveform are different, the displayed waveform will not be measured. The measured value and statistical processing value are both displayed as '*****.'

## Result Display (Display Result)

Displays a list of calculated statistics. You can display the list of statistics when Mode is set to Cycle Statistics.
Numbers are assigned to the data in order from the oldest cycle data or history data, and the automated measurement results for each number are displayed.
The maximum and minimum values for each parameter are indicated on the list by ↑ (maximum value) and ↓ (minimum value). If the same value appears in multiple locations, the oldest occurrence of the value is marked as the maximum or minimum value.
The number of data points that can be listed is 64000. If the number of data points exceeds 64000, the most recent data points in the history waveform or automatically measured item data are displayed. If the number of data points exceeds 64000, the maximum and minimum values may be outside of range of the displayed list. When this happens, ↑ (maximum value) and ↓ (minimum value) will not appear.

- **Sort**

  Sorts the list in the specified order.
  Forward (from the oldest) or Reverse (from the latest)

- **Statistics Max**

  Moves to the maximum value (↑) for the selected measurement item.

- **Statistics Min**

  Moves to the minimum value (↓) for the selected measurement item.

In cyclic statistical processing, you can select a waveform number (one period) with the jog shuttle and press the SET key to zoom in on it. Statistical processing is performed only on the number of data points that can be displayed in the list.

# 17 Waveform Computation

### MATH

You can perform various computations on up to 4 Mpoint of data. (When more than 4 Mpoint of waveform data is displayed, computation is performed on the first 4 Mpoint of data from the computation start point.)
The results of computation are displayed in Math1 to Math8.

## Turning Computation On and Off (Mode)

Select whether to use computation.

- ON: Computation is used.
- OFF: Computation is not used.

## Computation Settings (Math Setup)

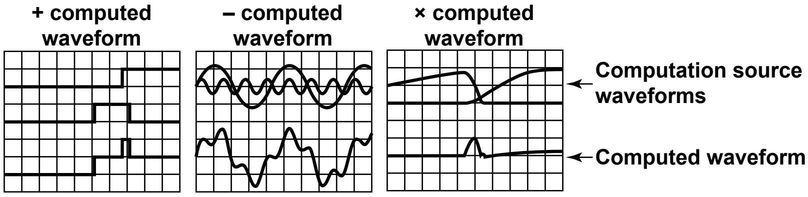
### Operators and Functions (Operation)

Select an operator or function (operation definition) from the options below.

- OFF: Computation is not performed.
- S1+S2: Adds the waveforms assigned to Source1 and Source2
- S1−S2: Subtracts the waveform assigned to Source2 from the waveform assigned to Source1
- S1*S2: Multiplies the waveforms assigned to Source1 and Source2
- S1/S2: Divides the waveform assigned to Source1 by waveform assigned to Source2
- Bin(S1): Converts the waveform assigned to Source to binary
- PS(S1): Computes the power spectrum of the waveform assigned to Source
- Shift(S1): Shows the waveform assigned to Source with its phase shifted
- User Define: Performs user-defined computation.

## Basic Arithmetic (S1+S2, S1−S2, S1*S2, and S1/S2)

Performs addition, subtraction, multiplication, or division on the two waveforms assigned to Source1 and Source2.




### Computation Source Waveforms (Source1 and Source2)

Select from the following. You can select the channel of an installed module.

U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math7[1]

1 You can use other computed waveforms as computation source waveforms. If the waveform that you are configuring is MathX, you can use a computation waveform up to MathX − 1 as the computation source waveform. You cannot use another computation waveform as the computation source waveform for Math1.

In the equation shown on the Setup menu, computation source waveforms are expressed as follows.

| Voltage | Current | Power | AUX | Math |
|---|---|---|---|---|
| U1:C1 | I1:C2 | P1:P1 | AUX3:C3 | Math1:M1 |
| U2:C3 | I2:C4 | P2:P2 | AUX4:C4 | Math2:M2 |
| U3:C5 | I3:C6 | P3:P3 | AUX5:C5 | Math3:M3 |
| U4:C7 | I4:C8 | P4:P4 | AUX6:C6 | Math4:M4 |
| | | | AUX7:C7 | Math5:M5 |
| | | | AUX8:C8 | Math6:M6 |
| | | | | Math7:M7 |

For example, if the equation of S1+S2 is set as U1+I1, the equation on the Setup menu will show C1+C2.

When computation is performed on a linearly scaled channel, the scaled values are used.

### Unit (Unit)

You can assign a unit of up to eight characters in length to the computed results. The specified unit is reflected in the scale values.

### Label (Label)

You can create a label of up to 16 characters in length. The first eight characters of the specified label appears on the screen.

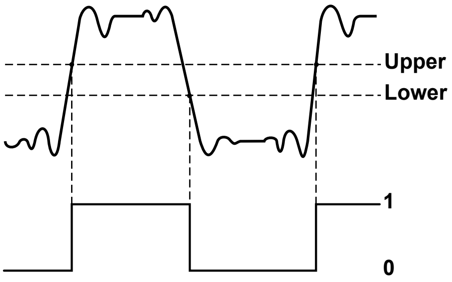
### Turning the Display On and Off (Display)

Select whether to display the computed waveform.

- ON: Displays the computed waveform
- OFF: Does not display the computed waveform

## Binary Conversion (Bin (S1))

Using the specified threshold levels, you can convert the waveform assigned to Source to a digital waveform.




**Computation Source Waveform (Source), Unit (Unit), Label (Label), and Turning the Display On and Off (Display)**

These settings are the same as those for basic arithmetic.

▶ See here.

**Upper and Lower Thresholds (Thr. Upper/Thr. Lower)**

Set the upper and lower threshold values. All values above the upper threshold on the computation source waveform are converted to ones, and all values below the threshold are converted to zeros.

## Power Spectrum (PS (S1))

Performs an FFT (fast Fourier transform) on the waveform assigned to Source, and displays a power spectrum. You can use this function to view the frequency distribution of an input signal.

**Computation Source Waveform (Source), Unit (Unit), Label (Label), and Turning the Display On and Off (Display)**

These settings are the same as those for basic arithmetic.

▶ See here.

### Phase Shift (Shift (S1))

You can shift the phase of the waveform assigned to Source, display the resulting waveform, and use the phase-shifted data in computations.

#### Computation Source Waveform (Source), Unit (Unit), Label (Label), and Turning the Display On and Off (Display)

These settings are the same as those for basic arithmetic.

▶ See here.

#### Shift (Shift)

You can shift waveforms within the following ranges.

- **When an Internal Clock Is Being Used as the Time Base**
  Selectable range: The time values between −(record length/2) points to (record length/2 points)
  Step: 1 ÷ sample rate
  The sample rate varies depending on how the record length and Time/div settings are configured. For details, see appendix 2, “Relationship between the Time Axis Setting, Record Length, and Sample Rate” in the *Getting Started Guide*, IM PX8000-03EN.

- **When an External Clock Is Being Used as the Time Base**
  Selectable range: −(record length/2) points to (record length/2 points)
  Step: 1

## Computation Waveform Selection (Select Math Trace)

Select the computed waveform to set the scaling mode.
Math1 to Math8

## Scaling Mode (Scaling Mode)

Set the method used to set the vertical display range of computed waveforms to one of the following options.

- Auto: The upper and lower limits are set automatically.
- Manual: The upper and lower limits must be set manually.

## Upper and Lower Limits (Upper/Lower)

Set the upper and lower limits when Scaling Mode is set to Manual.
The selectable range is −9.9999E+30 to 9.9999E+30.

# Start Point and End Point (Start Point/End Point)

Set the range of computation by specifying a computation start and end point. The default settings are −5 div and +5 div.

Selectable range: −5 div to +5 div

The maximum range from the computation start point to the computation end point varies as indicated below depending on the number of computations.

- One computation: Up to 4 Mpoint
- Two computations: Up to 2 Mpoint
- Three or four computations: Up to 1 Mpoint
- Five to eight computations: Up to 500 kpoint

The start and end point settings are similar to the cursor position settings in cursor measurement.

For details, see “Selectable Range of Cursor Positions” under “Cursor Measurement.”

▶ See here.

An icon ( ) appears in the center of the top of the screen when computations are being executed.

# User-Defined Computation

You can perform user-defined computation.

## Operators and Functions (Operation)

Select User Define.

# Expression (Expression) - user-defined

Create an expression by combining computation source waveforms, variables, constants, functions, and operators.

You can create an expression using up to 80 characters.

### Computation Source Waveforms and Variables

You can use the following waveforms and variables.

| Menu Item | Description |
|---|---|
| C1, C3, C5, C7 | Voltage waveforms C1:U1, C3:U2, C5:U3, C7:U4<br>AUX waveforms C3:AUX3, C5:AUX5, C7:AUX7 |
| C2, C4, C6, C8 | Current waveforms C2:I1, C4:I2, C6:I3, C8:I4<br>AUX waveforms C4:AUX4, C6:AUX6, C8:AUX8 |
| P1 to P4 | Power waveforms |
| M1 to M7 | Math waveforms |
| T | Total number of data points in the time direction |

When computation is performed on a linearly scaled channel, the scaled values are used.

### Operators and Functions

You can use the following operators and functions.

| Menu Item | Example | Description |
|---|---|---|
| +, −, *, / | C1+C2 | Displays the result of performing basic arithmetic on two specified waveforms |
| SHIFT | SHIFT(C1, TIME) | Displays the result of shifting the specified waveform's phase |
| ABS | ABS(M1) | Displays the absolute values of the specified waveform |
| SQRT | SQRT(C2) | Displays the square root of the specified waveform |
| LOG | LOG(C1) | Displays the log of the specified waveform |
| EXP | EXP(C1) | Displays the exponent of the specified waveform |
| NEG | NEG(C1) | Displays the specified waveform inverted around 0 |
| SIN | SIN(T) | Displays the sine of the specified waveform |
| COS | COS(C1) | Displays the cosine of the specified waveform |
| TAN | TAN(C1) | Displays the tangent of the specified waveform |
| ATAN | ATAN(C1) | Displays the arc tangent of the specified waveform (a value within ±π) |
| PH | PH(C1, C2) | Displays the phase difference between the two specified waveforms |
| TREND | TREND(C1) | Displays the RMS value for each cycle of the specified waveform[2] |
| TREND_HH | TREND_HH(C1) | Displays the RMS value for each cycle of the specified waveform (rising edge)[2] |
| TREND_LL | TREND_LL(C1) | Displays the RMS value for each cycle of the specified waveform (falling edge)[2] |
| TREND_XX | TREND_XX(C1) | Displays the RMS value for each half cycle of the specified waveform[2] |
| TRENDM | TRENDM(C1) | Displays the MEAN value for each cycle of the specified waveform[2] |
| TRENDM_HH | TRENDM_HH(C1) | Displays the MEAN value for each cycle of the specified waveform (rising edge)[2] |
| TRENDM_LL | TRENDM_LL(C1) | Displays the MEAN value for each cycle of the specified waveform (falling edge)[2] |
| TRENDM_XX | TRENDM_XX(C1) | Displays the MEAN value for each half cycle of the specified waveform[2] |
| TREMDD | TREMDD(C1) | Displays the DC value for each cycle of the specified waveform[2] |
| TRENDD_HH | TRENDD_HH(C1) | Displays the DC value for each cycle of the specified waveform (rising edge)[2] |
| TRENDD_LL | TRENDD_LL(C1) | Displays the DC value for each cycle of the specified waveform (falling edge)[2] |
| TRENDD_XX | TRENDD_XX(C1) | Displays the DC value for each half cycle of the specified waveform[2] |
| TRENDF | TRENDF(C1) | Displays the frequency for each cycle of the specified waveform[2] |
| TRENDF_HH | TRENDF_HH(C1) | Displays the frequency for each cycle of the specified waveform (rising edge)[2] |
| TRENDF_LL | TRENDF_LL(C1) | Displays the frequency for each cycle of the specified waveform (falling edge)[2] |
| ZC | ZC(C1) | Displays the zero-crossing of the specified waveform[2] |
| ZC | ZC(EXT) | Displays the zero-crossing of the TRIGGER IN terminal input[2] |
| DIF | DIF(C1) | Displays the derivative of the specified waveform |
| DDIF | DDIF(C1) | Displays the 2nd order derivative of the specified waveform |
| INTG | INTG(C1) | Displays the integral of the specified waveform |
| IINTEG | IINTEG(C1) | Displays the double integral of the specified waveform |
| BIN | BIN(C1, Up, Lo) | Displays the result of converting specified waveform to binary[3] |
| SQR | SQR(C1) | Displays the square of the specified waveform |
| CUBE | CUBE(C1) | Displays the cube of the specified waveform |
| F1 | F1(C1, C2) | Displays the result of computing $\sqrt{\lvert C1^2+C2^2 \rvert}$ for the specified waveforms |
| F2 | F2(C1, C2) | Displays the result of computing $\sqrt{\lvert C1^2-C2^2 \rvert}$ for the specified waveforms |
| FV | FV(C1, Up, Lo) | Displays the inverse of the PWHH of the pulse width[3] |
| PWHH | PWHH(M1, Up, Lo) | Displays the computation of the pulse widths between a rising edge and the next rising edge[3] |
| PWHL | PWHL(C2, Up, Lo) | Displays the computation of the pulses width between a rising edge and the next falling edge[3] |
| PWLH | PWLH(C1, Up, Lo) | Displays the computation of the pulse widths between a falling edge and the next rising edge[3] |
| PWLL | PWLL(C1, Up, Lo) | Displays the computation of the pulse widths between a falling edge and the next falling edge[3] |
| PWXX | PWXX(C2, Up, Lo) | Displays the computation of the pulse widths from a rising or falling edge to the next rising or falling edge[3] |
| DUTYH | DUTYH(C1, Up, Lo) | Positive (high) duty cycle within each cycle of the specified waveform[3] |
| DUTYL | DUTYL(C1, Up, Lo) | Negative (low) duty cycle within each cycle of the specified waveform[3] |
| FILT1 | FILT1(C1) | Displays the result of applying a filter to the specified waveform |
| FILT2 | FILT2(C1) | Displays the result of applying a filter to the specified waveform |
| HLBT | HLBT(C1) | Displays the Hilbert transform of the specified waveform |
| MEAN | MEAN(C1) | Displays the 10th-order moving average of the specified waveform |
| LS- | LS-MAG(C1) | Displays the magnitude of the specified waveform's linear spectrum |
| | LS-LOGMAG(C1) | Displays the logarithmic magnitude of the specified waveform's linear spectrum |
| | LS-PHASE(C1) | Displays the phase of the specified waveform's linear spectrum |
| | LS-REAL(C1) | Displays the real part of the specified waveform's linear spectrum |
| | LS-IMAG(C1) | Displays the imaginary part of the specified waveform's linear spectrum |
| RS- | RS-MAG(C1) | Displays the magnitude of the specified waveform's RMS spectrum |
| | RS-LOGMAG(C1) | Displays the logarithmic magnitude of the specified waveform's RMS spectrum |

| Menu Item | Example | Description |
|---|---|---|
| PS- | PS-MAG(C1) | Displays the magnitude of the specified waveform's power spectrum |
| | PS-LOGMAG(C1) | Displays the logarithmic magnitude of the specified waveform's power spectrum |
| PSD- | PSD-MAG(C1) | Displays the magnitude of the specified waveform's power spectrum density |
| | PSD-LOGMAG(C1) | Displays the logarithmic magnitude of the specified waveform's power spectrum density |
| CS- | CS-MAG(C1, C2) | Displays the magnitude of the cross spectrum of the two specified waveforms |
| | CS-LOGMAG(C1, C2) | Displays the logarithmic magnitude of the cross spectrum of the two specified waveforms |
| | CS-PHASE(C1, C2) | Displays the phase of the cross spectrum of the two specified waveforms |
| | CS-REAL(C1, C2) | Displays the real part of the cross spectrum of the two specified waveforms |
| | CS-IMAG(C1, C2) | Displays the imaginary part of the cross spectrum of the two specified waveforms |
| TF- | TF-MAG(C1, C2) | Displays the magnitude of the transfer function of the two specified waveforms |
| | TF-LOGMAG(C1, C2) | Displays the logarithmic magnitude of the transfer function of the two specified waveforms |
| | TF-PHASE(C1, C2) | Displays the phase of the transfer function of the two specified waveforms |
| | TF-REAL(C1, C2) | Displays the real part of the transfer function of the two specified waveforms |
| | TF-IMAG(C1, C2) | Displays the imaginary part of the transfer function of the two specified waveforms |
| CH- | CH-MAG(C1, C2) | Displays the magnitude of the coherence function of the two specified waveforms |

1 The unit of time is seconds. The number of clocks is used when the time base is an external clock signal (Ext).
2 For details, see appendix 9 in the features guide, IM PX8000-01EN.
3 Set the source waveform and the upper and lower threshold levels (Up and Lo).

### Constants

| Menu Item | Description |
|---|---|
| K1 to K8 | ▶ See here. |
| 0 to 9 | – |
| Exp | E notation. Selectable range: −30 to +30<br>Use this constant to enter values in E notation (1E+3 = 1000, 2.5E−3 = 0.0025).<br>It is displayed as “E” in expressions to distinguish it from the “EXP” operator. |

### Automated Measurement Values of Waveform Parameters (Measure)

You can use the automated measurement values of waveform parameters in expressions. The PX8000 cannot retrieve waveform parameter values when the display of the measurement source waveform is off.

### Combinations of Operators That Are Not Allowed

- An expression cannot be used in another expression with a smaller number.
  Example: Math5 = M6 + M3
- Expressions containing only constants (K1 to K8) are not allowed.
  Example: Math5 = K1 + K8
- An expression can contain only up to two FILT1 or FILT2 functions.
  Example: FILT1(C1)+FILT1(C2)+FILT1(C3)
- A single FFT expression can contain only one operator.
  Example: PS−MAG(C1+C2)
- Additional computations cannot be performed on FFT results.
  Example: PS−MAG(C1)+C2
- Additional computations cannot be performed on pulse width computations.
  Example: PWHH(C1)+C2
- Additional computations cannot be performed on cyclic computation (trend computation).
  Example: TREND(C1)+C2
- Only one operator can be used in a single phase-shift computation, pulse-width computation, binary-conversion, or cyclic computation (trend computation) expression.
  Example: SHIFT(C1+C2), BIN(C1−C2), PWHH(C1*C1), TREND(C1*C2)

If you want to perform an FFT, phase-shift, pulse-width, binary-conversion, or cyclic computation (trend computation) computation on the computed results of an expression such as C1+C2, create expressions like these: M1=C1+C2, M2=PS−MAG(M1).

### Unit (Unit), Label (Label), and Turning the Display On and Off (Display)

These settings are the same as those for basic arithmetic.

▶ See here.

### Scaling Mode (Scaling Mode)

▶ See here.

### Upper and Lower Limits (Upper/Lower)

▶ See here.

### Start and End Points (Start Point/End Point)

▶ See here.

## FFT Settings (FFT Setup) - user-defined

FFT computation is performed when you specify an operator that uses FFT computation (LS, PS, PSD, CS, TF, or CH). Set the number of FFT points, the window function, the damping rate, and Force1 and Force2.

- **Number of FFT Points (FFT Points)**

  You can set the number of points from the start of computation on the T-Y waveform to one of the options below.
  1k, 2k, 5k, 10k, 20k, 50k, or 100k

- **Window Function (Window)**

  You can select the window function from the following options.
  Rect, Hanning, Flat Top, Hamming, Exponential
  ▶ See here.

- **Damping Rate (Damping Rate)**

  You can configure this setting when Window is set to Exponential.
  You can set the value in the range of 1 to 100% (1% resolution).
  ▶ See here.

- **Force1**

  You can configure this setting when Window is set to Exponential.
  You can set the area to a value from 1 to 100% (in 1% steps).
  ▶ See here.

- **Force2**

  You can configure this setting when Window is set to Exponential.
  You can set the area to a value from 1 to 100% (in 1% steps).
  ▶ See here.

The results of the FFT appear in the selected computation waveform. Other than the fact that no FFT window is displayed, this is the same as the FFT computation that can be performed from the FFT menu.

▶ See here.

# Filter Settings (Filter Setup) - user-defined

When using FILT1 and FILT2 in user-defined computation, set the digital filter type, filter band, and cutoff frequency for each of the two filters (Filter1 and Filter2).

### Filter Type (Filter Type)

The following filter types are available: Gauss, Sharp, and IIR. MEAN (moving average) can also function as a filter. The features of each filter are listed below.

| Filter Type | Features | Operation Type |
|---|---|---|
| Gauss | • Frequency characteristics with a smooth attenuation slope<br>• Linear phase and constant group delay<br>• No ripples present in the passband<br>• No overshoot in the step response<br>• Low order and short delay | FIR |
| Sharp | • Frequency characteristics with a sharp attenuation slope (−40 dB at 1 oct)<br>• Linear phase and constant group delay<br>• Ripples present in the passband<br>• Comb-shaped stopband | FIR |
| IIR | • Attenuation slope steepness between those of the SHARP and GAUSS filters<br>• Non-linear phase and non-constant group delay<br>• No ripples present in the passband and stopband<br>• Characteristics similar to those of analog filters<br>• Compared to Sharp and Gauss filters, lower cutoff frequency possible | IIR |
| Mean | • Comb-shaped frequency characteristics<br>• Linear phase and constant group delay<br>• No overshoot in the step response | FIR |

### Filter Band (Filter Band)

| Filter Type (Filter Type) | Filter Band (Filter Band) |
|---|---|
| Gauss | Low-Pass |
| Sharp | Low-Pass, High-Pass, Band-Pass |
| IIR (Butterworth) | Low-Pass, High-Pass, Band-Pass |

### CutOff1 and CutOff2 (CutOff1/CutOff2)

Set the cutoff frequency. When Filter Band is set to Low-Pass or High-Pass, set CutOff1; when Filter Band is set to Band-Pass, set CutOff1 and CutOff2.
Selectable range: 2.0 to 30.0% of the sample rate
Resolution: Steps of 0.2% of the sample rate

# Constant Settings (Constant Setup) - user-defined

Set values for K1 to K8.
The selectable range is −9.9999E+30 to 9.9999E+30.

# Notes about Computation

- FFT computation can be performed through the configuration of settings in the Math menu or the FFT menu (▶ See here.). In the FFT menu, you can set the display format and choose a linear or logarithmic frequency domain (horizontal axis) scale. The data point, window function and unit settings are shared for the Math and FFT menus. When you change the settings in one menu, the settings in the other menu are also changed.
- When you perform FFT computation on 50 kpoint or more of data using the FFT menu, you cannot use computed waveforms.
- An icon ( ) appears in the center of the top of the screen when user-defined computation is being executed.

# 18 FFT

### FFT

You can display the power spectrum of an input waveform in the FFT window. You can display up to two FFT waveforms.

You can analyze the following spectrums in addition to the power spectrum.

Linear spectrums, RMS spectrum, power spectrum densities, cross spectrums, transfer functions, and coherence functions

## Turning FFT On and Off (Display)

Set whether to perform FFT analysis. If you set this to ON, the FFT windows appear. You can display separate FFT analysis results in the FFT 1 and FFT 2 windows.

- ON: FFT analysis is performed.
- OFF: FFT analysis is not performed.

## FFT Settings (FFT Setup)

Set the spectrum type and the window function.

### Spectrum Type (Type/Sub Type)

Set the spectrum type.

| Type | Sub Type | Description |
|---|---|---|
| LS | MAG | Magnitude of the specified waveform’s linear spectrum |
| LS | LOGMAG | Logarithmic magnitude of the specified waveform’s linear spectrum |
| LS | PHASE | Phase of the specified waveform’s linear spectrum |
| LS | REAL | Real part of the specified waveform’s linear spectrum |
| LS | IMAG | Imaginary part of the specified waveform’s linear spectrum |
| RS | MAG | Magnitude of the specified waveform’s RMS spectrum |
| RS | LOGMAG | Logarithmic magnitude of the specified waveform’s RMS spectrum |
| PS | MAG | Magnitude of the specified waveform’s power spectrum |
| PS | LOGMAG | Logarithmic magnitude of the specified waveform’s power spectrum |
| PSD | MAG | Magnitude of the specified waveform’s power spectrum density |
| PSD | LOGMAG | Logarithmic magnitude of the specified waveform’s power spectrum density |
| CS | MAG | Magnitude of the cross spectrum of the specified two waveforms |
| CS | LOGMAG | Logarithmic magnitude of the cross spectrum of the specified two waveforms |
| CS | PHASE | Phase of the cross spectrum of the specified two waveforms |
| CS | REAL | Real part of the cross spectrum of the specified two waveforms |
| CS | IMAG | Imaginary part of the cross spectrum of the specified two waveforms |
| TF | MAG | Magnitude of the transfer function of the specified two waveforms |
| TF | LOGMAG | Logarithmic magnitude of the transfer function of the specified two waveforms |
| TF | PHASE | Phase of the transfer function of the specified two waveforms |
| TF | REAL | Real part of the transfer function of the specified two waveforms |
| TF | IMAG | Imaginary part of the transfer function of the specified two waveforms |
| CH | MAG | Magnitude of the coherence function of the specified two waveforms |

### Analysis Source Waveforms (Source1 and Source2)[1]

Set the analysis source waveform to one of the waveforms below. You can select the channel of an installed module.

U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math6[2]

1 You can set Trace2 when Type is set to CS, TF, or CH.

2 You cannot select Math7 or Math8.

- When analysis is performed on a linearly scaled channel, the scaled values are used.
- When the PX8000 performs FFT to determine active power (P1 to P4), FFT is performed on the waveform of active power (P). On the other hand, when the conventional PZ4000 performs FFT to determine active power, it computes the real part of the cross spectrum (CS) of the voltage (U) and current (I) waveforms.
  If you want to perform FFT of active power using the same computation method as the PZ4000, set the items in the FFT Setup dialog box as shown below so that the real part (REAL) of the cross spectrum (CS) of the voltage (U) and current (I) is calculated..
  - Type: CS
  - Sub Type: REAL
  - Source1: U1 to U4
  - Source2: I1 to I4 (same element number as U)

## Window Function (Window)

You can select the window function from the following options.

### Rect (Rectangular window)

The rectangular window is suited to transient signals, such as impulse waves, which attenuate completely within the time window.

### Hanning (Hanning window)

The Hanning window encourages continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, it is suited to continuous signals. The Hanning window has a higher frequency resolution than the flattop window.

### FlatTop (Flattop window)

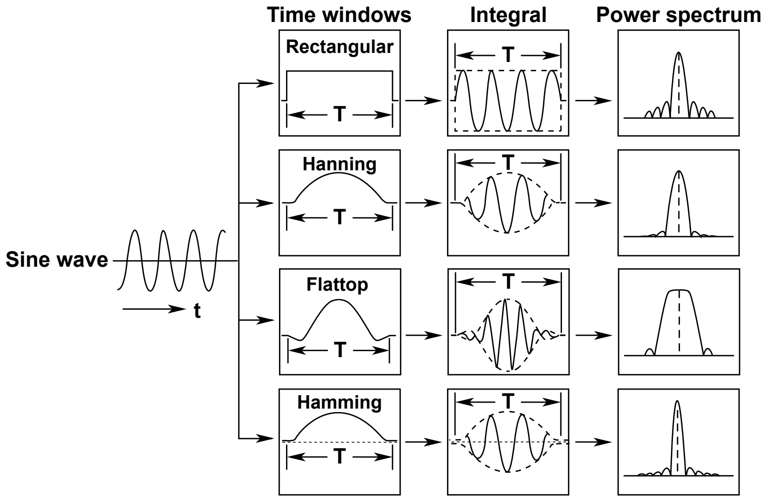
The flattop window encourages continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, it is suited to continuous signals. The flattop window has a higher spectral level accuracy than the flattop window.

### Hamming (Hamming window)

In the Hanning window, the values at the ends become 0 and the signal components there do not affect the spectrum. The Hamming window is a corrected Hanning window. Its characteristics are similar to those of the Hanning window, but the frequency resolution of its main beam is greater than that of the Hanning window. The Hamming window is suited for dividing close signals.

### Exponential (Exponential)

The exponential window removes noise from the signal. It can be selected only on models with the user-defined computation option. The exponential window is suited for the signals of impulse-excitation frequency-response tests and other similar signals.




**Rectangular** : $W(t) = u(t) - u(t - T)$    u(t): Step function

**Hanning** : $W(t) = 0.5 - 0.5\cos\left(2\pi \frac{t}{T}\right)$

**Flattop** : $W(t) = \left\{0.54 - 0.46\cos\left(2\pi \frac{t}{T}\right)\right\} \frac{\sin\{2\pi(1 - 2t/T)\}}{2\pi(1 - 2t/T)}$

**Hamming** : $W(t) = 0.54 - 0.46\cos\left(2\pi \frac{t}{T}\right)$

For details about the exponential window, see appendix 9 in the features guide, IM PX8000-01EN.

- **Damping Rate (Damping Rate)**

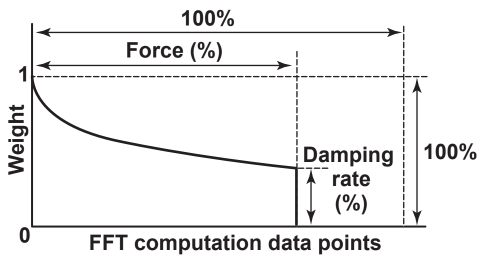
  You can configure this setting when Window is set to Exponential. You can set the value in the range of 1 to 100% (1% resolution). The weight of the last data point is used as a damping rate, with the weight of the first data point of the FFT computation taken to be 100% (= 1). When the damping rate is set to 100%, the window functions like a rectangular window. This setting applies to the input and output (response) signals.

- **Force1**

  You can configure this setting when Window is set to Exponential. Set the area over which computation is performed in terms of a percentage from the first FFT point, taking the number of FFT points to be 100%. You can set the area to a value from 1 to 100% (in 1% steps). When the area is set to 100%, the window functions like a rectangular window. The outer area is the average of the results of the window function for the data outside the area. This setting applies to the input signals (first parameter) of one-waveform and two-waveform FFTs.

- **Force2**

  You can configure this setting when Window is set to Exponential. This setting applies to the output (response) signal (second parameter) of a two-waveform FFT. It can be set in the same manner as Force1.



# Vertical Scale (Vert. Scale Mode)

You can select the method for setting the vertical scale from the following options.

- Auto: The center and scale of the vertical axis are set automatically.
- Manual: The center and scale of the vertical axis must be set manually.

# Center/Scale (Center/Sensitive)

When Vert. Scale Mode is set to Manual, set the center and scale of the vertical axis.

# Start Point and Number of FFT Points (Start Point and FFT Points)

## Start Point (Start Point)

Set the computation start point. The default setting is −5 div.

Selectable range: −5 div to +5 div

The start point setting is similar to the cursor position settings in cursor measurement.

For details, see “Selectable Range of Cursor Positions” under “Cursor Measurement.”

▶ See here.

## Number of FFT Points (FFT Points)

You can set the number of points from the start of computation on the T-Y waveform to one of the options below.

1k, 2k, 5k, 10k, 20k, 50k, or 100k

# Display Ratio of the Main Window (Main Ratio)

Set the size of the main window in relation to the overall waveform display area.

- 50%: The main window appears in the upper half of the screen.
- 0%: The main window is not displayed.

# Window Layout (Window Layout)

Set the display position of the FFT window.

- Side: Horizontal
- Vertical: Vertical

# Horizontal Scale (Horiz. Axis)

Select one of the following horizontal scale types.

- Hz: A normal (linear) scale is used.
- Log Hz: A logarithmic scale is used.

# Unit (Unit)

You can set the unit using up to eight characters. The specified unit is reflected in the vertical scale values.

# Horizontal Zoom (Horiz. Scale)

Select one of the following horizontal display ranges.

- Auto: The horizontal center point and span are set automatically (the entire range is displayed).
- Left/Right: You must set the left and right ends of the display range manually.
- Center/Span: You must set the horizontal center point and span manually. You can select this only when the horizontal scale is set to Hz.

# Horizontal Range (Left/Right, Center/Span)

## Horizontal Range (Left/Right)

When the horizontal zoom is set to Left/Right, set the left and right ends of the horizontal display range.
Selectable range: 0.00 kHz (DC) to the maximum frequency

## Horizontal Range (Center/Span)

When the horizontal zoom is set to Center/Span, set the center point and span of the horizontal display range.
Selectable range of the center: 0.00 kHz (DC) to the maximum frequency
Selectable range of the span: the frequency resolution x10 to the maximum frequency

# Notes about FFT Computation

## Notes about Displaying Power Spectrums

- You cannot display a power spectrum if the display record length is less than the number of computed data points.
- The following settings are shared for all computation channel: FFT Points, Window, and Start Point.
- When using the commands in the menu that appears when you press the ZOOM key to zoom FFT waveforms horizontally, you cannot set the number of displayed waveform points to 50 or less.

## Notes about Computation

- Computation is normally performed on the sampled data in the acquisition memory. For waveforms that are acquired in Envelope mode, computation is performed on the maximum and minimum values at each acquisition interval.
- FFT computation can be performed through the configuration of settings in the Math menu or the FFT menu. The data point, window function and unit settings are shared for the Math and FFT menus. When you change the settings in one menu, the settings in the other menu are also changed.
- When you perform FFT computation on 50 kpoint or more of data using the FFT menu, you cannot use computed waveforms.
- An icon () appears in the center of the top of the screen when FFT computation is being executed.

# 19 GO/NO-GO Determination

### GO/NO-GO

The PX8000 determines whether the acquired waveform meets the reference condition (GO result) or not (NO-GO result). When the PX8000 produces a GO or NO-GO result, it executes the specified actions.

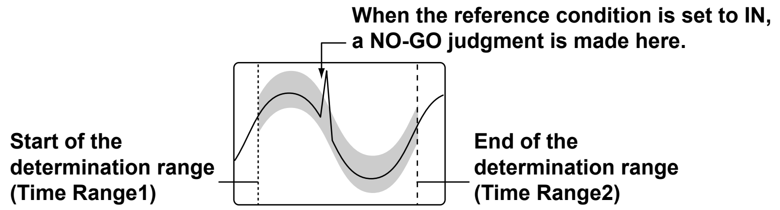
## Mode (Mode)

Set the method for GO/NO-GO determination.

- OFF: GO/NO-GO determination is not performed.
- Waveform zone (Wave Zone): GO/NO-GO determination is performed using a waveform zone configured on the screen.
- Waveform parameter (Parameter): GO/NO-GO determination is performed through the use of the specified waveform parameters.

## Waveform Zone (Wave Zone)

The PX8000 returns GO/NO-GO results based on whether waveforms leave or enter the zone that you create using a base waveform.




### Editing a Waveform Zone (Edit Zone)

Select the number of the waveform zone you want to edit from the range indicated below. If a zone has already been created for that number, the zone will be displayed. If no zone has been created for a number, select a base waveform from the base waveform editing menu (New), and then edit the zone.
Zone 1 to Zone 6 (Zone1 to Zone6)

#### Editing a Base Waveform (New)

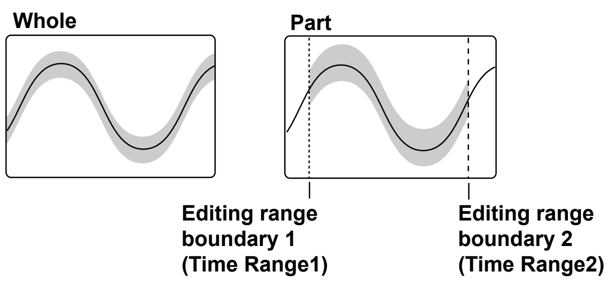
When you create a new waveform zone, you need to select the waveform that you will base it on (the base waveform). You can select the channel of an installed module. Select a waveform whose display is on.
U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8, Cancel (Cancel)*

* The selected menu closes.

#### Specifying the Editing Range (Edit)

Select the part of the base waveform that you want to edit.

- Whole (Whole): The whole waveform is within the editing range.
- Part (Part): A portion of the waveform is within the editing range.



### Zone Settings

When Edit is set to Whole, you can set the upper, lower, left, and right boundaries of the waveform zone. When Edit is set to Part, you can set the upper and lower boundaries of the zone.

- Upper and lower boundaries (Upper and Lower)
  Selectable range: ±10 div vertically from the base waveform
  When Edit is set to Part, you can set the upper and lower boundaries of the area between Time Range1 and Time Range2.
- Left and right sides (Left and Right): These settings can be configured only when Edit is set to Whole.
  Selectable range: ±5 div from the center of the screen
- Time range 1 and time range 2 (Time Range1 and Time Range2): These settings can be configured only when Edit is set to Part.
  Selectable range: ±5 div on the time axis

### Save Destination (Store as)

You can select one of the following save destinations for the waveform zone.

Zone 1 to zone 6 (Zone1 to Zone6): The save destination is changed to the selected zone number.

### Saving a Waveform Zone (Execute Store)

Save the waveform zone.

## Judgment Conditions (Judgement Setup)

For each of 16 judgment conditions, you can set the source waveform, zone number, and judgment criterion. You can also set the judgment logic, action condition, sequence, and acquisition count and enable or disable synchronization with a remote signal.

### Judgment Criterion (Mode)

Select the judgment criterion from the following options.

- X: The condition is not used for GO/NO-GO determination.
- IN: The PX8000 returns a GO result when the source waveform is within the GO/NO-GO determination zone. If even part of the source waveform is outside of the determination zone, the PX8000 returns a NO-GO result.
- OUT: The PX8000 returns a GO result when the entire source waveform is outside the GO/NO-GO determination zone. If even part of the source waveform is inside the determination zone, the PX8000 returns a NO-GO result.

### Source Waveform (Trace)

Set the waveform to use for GO/NO-GO determination to one of the waveforms below. You can select the channel of an installed module.

U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8

### Zone Number (Zone No.)

Select the number of the waveform zone you want to use for GO/NO-GO determination from the range indicated below.

Zone 1 to zone 6 (Zone1 to Zone6)

### Determination Logic (Logic)

You can select the determination logic from the following options.

- AND: The actions are performed when all the conditions from 1 to 16 are met.
- OR: The actions are performed when a condition from 1 to 16 is met.

### Action Condition (ActCondition)

Set the action condition to one of the settings below.

- Always (Always): The actions are always performed. The actions will be executed each time that the PX8000 triggers.
- At failure (Fail): The actions are executed when the specified GO conditions are not met.
- At success (Success): The actions are executed when the specified GO conditions are met.

### Sequence (Sequence)

Select the sequence for executing actions.

- Single (Single): Execution stops after the actions are performed once.
- Continue (Continue): Actions are executed repeatedly. However, the actions stop repeating after the number of specified waveform acquisitions (the Acquisition Count setting). If Acquisition Count is set to Infinite, the actions continue until waveform acquisition is stopped by the pressing of the START/STOP key.

### Acquisition Count (Acquisition Count)

Set the number of waveform acquisitions.

- Infinite: Waveform acquisition continues until it is stopped by the pressing of the START/STOP key.
- 1 to 65536: The PX8000 stops waveform acquisition after it acquires the specified number of waveforms.

### External Start (Remote)

You can perform GO/NO-GO determination and output the results in sync with an external signal applied to the GO/NO-GO I/O terminal (EXT I/O) of the PX8000.

- OFF: GO/NO-GO determination is not performed through the use of an external signal.
- ON: GO/NO-GO determination is performed through the use of an external signal.

## Action (Action)

▶ See here.

## Determination Period (Time Range1 and Time Range2)

You can set the determination period by setting Time Range1 and Time Range2. The default settings are −5 div and +5 div.

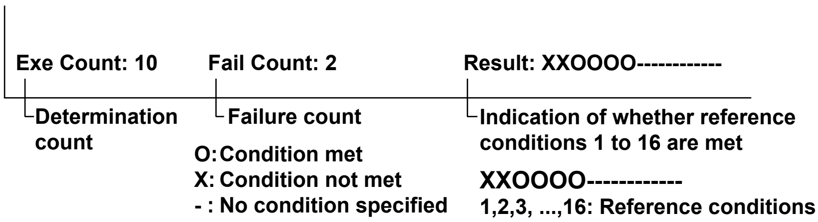
Selectable range: −5 div to +5 div

The Time Range1 and Time Range2 settings are similar to the cursor position settings in cursor measurement. For details, see “Selectable Range of Cursor Positions” under “Cursor Measurement.”

▶ See here.

## GO/NO-GO Determination Results

The results of GO/NO-GO determination (and the numbers of determinations and failures) appear at the bottom of the screen.




In this example, reference conditions 1 and 2 are not met while the conditions defined by base waveforms 3 to 6 are met.

# Waveform Parameters (Parameter)

Set the upper and lower limits for automated measurement values of waveform parameters, and perform GO/NO-GO determination based on whether the values are within or outside of the limits.

## Judgment Conditions (Judgement Setup)

For each of 16 judgment conditions, you can set the source waveform, waveform parameter, and upper and lower waveform parameter limits. You can also set the judgment logic, action condition, sequence, and acquisition count and enable or disable synchronization with an external start signal.

### Judgment Criterion (Mode)

Select the judgment criterion from the following options.

- X: The condition is not used for GO/NO-GO determination.
- IN: The PX8000 returns a GO result when the parameter is within the specified limits. The PX8000 returns a NO-GO result when the parameter is outside the specified limits.
- OUT: The PX8000 returns a GO result when the parameter is outside the specified limits. The PX8000 returns a NO-GO result when the parameter is inside the specified limits.

### Source Waveform (Trace)

Set the waveform to use for GO/NO-GO determination to one of the waveforms below. You can select the channel of an installed module.
U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, Math1 to Math8

### Waveform Parameter (Item)

You can use all automatically measured waveform parameters as reference conditions. You can perform GO/NO-GO determination on up to 16 parameters at the same time.

▶ See here.

### Upper and Lower Parameter Limit Settings (Upper/Lower)

Selectable range: −9.9999E+30 to 9.9999E+30.

### Judgment Logic (Logic), Action Condition (ActCondition), Sequence (Sequence), Acquisition Count (Acquisition Count), and External Start (Remote)

These items are the same as those for the judgment conditions of waveform zone.

▶ See here.

## Action (Action)

▶ See here.

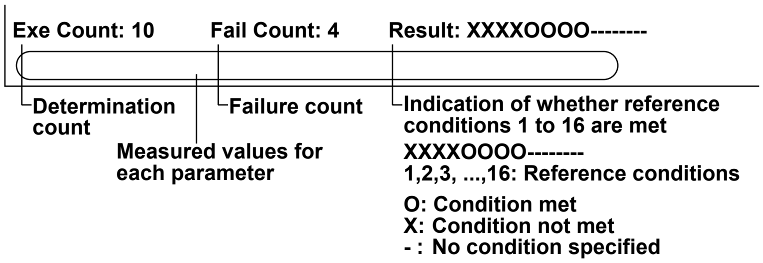
## Determination Period (Time Range1 and Time Range2)

The determination period is the same as that of waveform zones.

▶ See here.

## GO/NO-GO Determination Results

The results of GO/NO-GO determination (number of determinations, number of failures) appear at the bottom of the screen.




In this example, reference conditions 1 and 4 are not met while reference conditions 5 to 8 are met.

# Notes about GO/NO-GO Determination

- During determination, all keys other than START/STOP are invalid.
- The determination interval is synchronized to the trigger. However, while actions are being performed after determination, the PX8000 will not trigger.
- While you are accessing the PX8000 through the FTP server, if one of the following operations is performed, actions cannot be executed until you finish accessing the PX8000.
  Printing and saving of screen capture data and saving of waveform data

## Notes about the “Save Data” and “Save Image” Actions

▶ See here.

# 20 Action

### ACTION

If Mode is set to ON, the specified action (operation) is performed in the following situations. However, if the trigger mode is set to N Single, the PX8000 cannot start waveform acquisition when Mode has been set to ON.

- When the PX8000 triggers, and the corresponding waveform acquisition stops
- When the action condition of GO/NO-GO determination is met
- When waveform acquisition stops

## Mode (Mode)

Select whether to use the actions.

- OFF: The actions are not used.
- ON: The actions are executed.

## Action (Action Setup)

You can select the actions from the options below.

### Beep (Beep)

The PX8000 sounds an alarm.

### Screen Capture Printing (Print Image)

The PX8000 prints a screen capture to the specified printer. You can specify a printer in the PRINT menu by setting “Print to” to BuiltIn (built-in printer).

▶ See here.

### Waveform Data Saving (Save Waveform), Numeric Data Saving (Save Numeric)

The PX8000 saves the waveform data to the specified destination (SD card, USB storage device, or network drive).

#### File Path (File Path)

Specify where to save the file.

▶ See here.

#### Auto Naming (Auto Naming), File Name (File Name), Data Format (Data Type)

These settings are the same as the auto-naming, file-name, and data-format settings for saving waveform data.

▶ See here.

Changing the auto-naming, file-name, and data-format settings for saving waveform or numeric data will change the auto-naming, file-name, and data-format settings under Waveform(SAVE), Numeric(SAVE), and Setup(SAVE) in the FILE menu.

### Screen Capture Saving (Save Image)

The PX8000 saves the screen capture data to the specified destination (SD card, USB storage device, or network drive).

#### File Path (File Path), Auto Naming (Auto Naming), File Name (File Name)

These settings are the same as the file path, auto-naming, and file-name settings for saving waveform data.

▶ See here.

Changing the auto-naming and file-name settings for saving image data will change the auto-naming and file-name settings under Others(SAVE) in the FILE menu.

## Notes about Action

- You cannot change settings while the action feature is active.
- The actions may be slow if there is network access while the following operations are being performed.
  Printing and saving of screen capture data and saving of waveform data

### Notes about the “Save Data” and “Save Image” Actions

- Do not set the storage medium’s root folder as the save destination. The PX8000 can store only 512 files to the root folder of a storage medium that the PX8000 has formatted. A file whose name is longer than eight characters will be counted as two files. If such files exist, the number of files that can be stored will decrease.
- The maximum number of files that can be created in a single folder is 1000. Make sure that there are no files in the destination folder before you start the action feature.
- If you select waveform data saving (Save Waveform) and screen capture saving (Save Image) at the same time, use the FILE menu to specify separate folders to save to.
- In the FILE menu, if you set Auto Naming to Numbering, as the number of saved files increases, the amount of time required to save a file will also increase.
- Save Destination during Action Execution
  In the specified drive, a folder is automatically created with the date (year, month, and day) as its name, and data is saved to that folder using file names specified by the auto naming feature. If the number of files in the save destination folder exceeds 1000, a new folder is automatically created with the date and an incremented sequence number (000 to 999) as its name, and the data continues to be saved in the new folder.

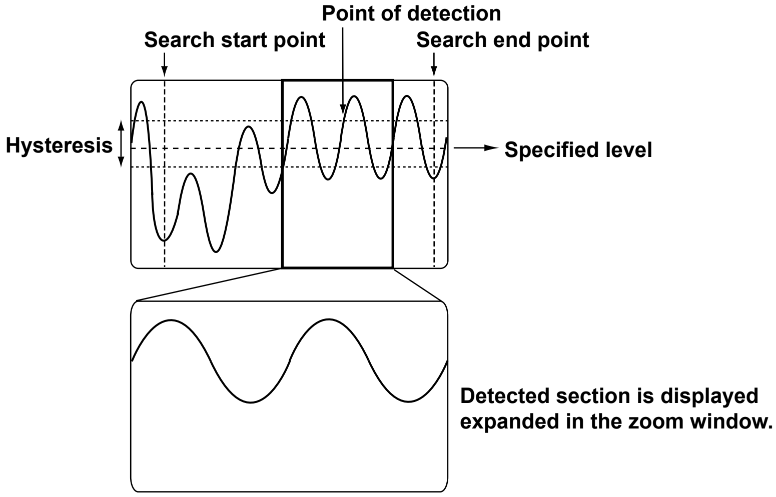
Select whether to enable the action feature when the power is turned on.

▶ See here.

# 21 Searching Waveforms

## SEARCH

You can search the displayed waveforms for locations that match the specified conditions. You can zoom-in on the detected locations.




Search condition: Two rising edges

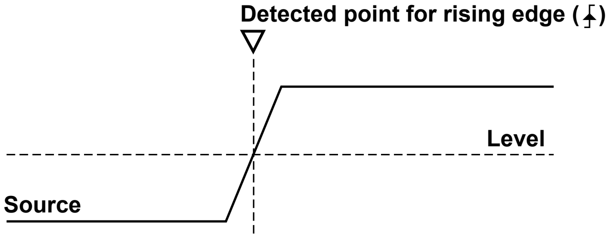
## Search Type (Type)

Set the search type to one of the options below.

- Edge: The PX8000 searches for edges.
- Time: The PX8000 searches for a time.

# Edge Search (Edge)

Search for positions where the rising or falling slope of the specified waveform passes through the specified level.




## Search Conditions (Setup)

Set the search conditions, such as the waveforms to search, judgment level, polarity, hysteresis, and count.

### Source Waveform (Trace)

Select the waveforms to search from the options listed below. You can select the channel of an installed module.
U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8

### Judgment Level (Level)

Set the level used to detect the rising or falling edges of the waveforms. You can set the level to a value within the 10 div of the screen. The resolution at which you can set the level varies depending on the module.

### Polarity (Polarity)

Select which type of edge to detect from the options listed below.

- : Rising
- : Falling
- : Rising or falling

### Hysteresis (Hysteresis)

You can set a range (hysteresis) within which level changes are not treated as edges. You can set the hysteresis to one of the settings below. The hysteresis widths vary depending on the input module.

- : Low hysteresis
- : Medium hysteresis
- : High hysteresis

### Count (Count)

Set the number of times the specified edge ( , , or ) must repeat. You can select a number from 1 to 1000000.

## Searched Waveform Display (Result Window)

The waveform that includes the search point specified by the detected point number (Pattern No.) described later is displayed expanded in the zoom windows. If both the Zoom1 and Zoom2 windows are displayed, select the zoom window that you want to control the zoom factor, position, and detected point number (Pattern No.) of.

- If only one of the two zoom windows is displayed, you do not have to select the window.
- If both Zoom1 and Zoom2 are not displayed, Zoom1 will be displayed when you press SHIFT+ZOOM (SEARCH) to display the SEARCH menu.

## Detected Point Number (Pattern No.)

Specify the number of the detected point to display in the zoom window. The maximum detected point number is 1000.

If the search does not yield any results, “No Match” appears.

## Search Range (Start Point and End Point)

Set the search start and end points (Start Point and End Point). The default settings are −5 div and +5 div.

Selectable range: −5 div to +5 div

The start and end point settings are similar to the cursor position settings in cursor measurement.

For details, see “Selectable Range of Cursor Positions” under “Cursor Measurement.”

▶ See here.

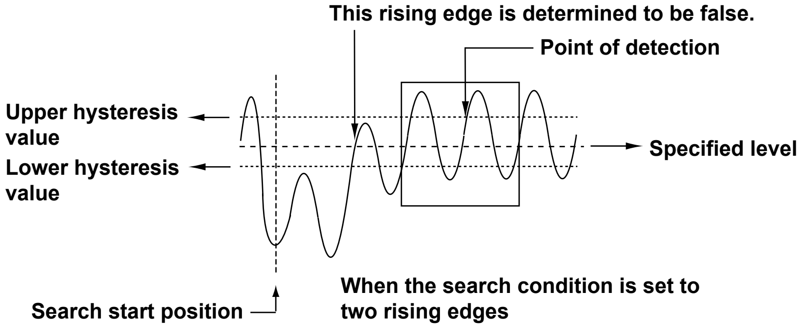
## Executing a Search (Execute)

The PX8000 searches for positions where the specified search conditions are met. Then, the PX8000 displays the waveforms expanded in the zoom window with the detected point that corresponds to the number you specify at the center.

Up to 1000 points can be detected.

## Edge Search Determination

If the peak is below the upper limit of the hysteresis immediately after a rising edge or above the lower limit of the hysteresis immediately after a falling edge, the PX8000 will not count the edge.



# Time Search (Time)

Search for a specific year, month, day, and time.

## Search Conditions (Setup)

Specify the time that you want to search for.

Set the year (Year), month (Month), day (Day), hour (Hour), minute (Minute), second (Second), and microsecond (µSecond).

## Searched Waveform Display (Result Window)

This setting is the same as the searched waveform display for edge search.

▶ See here.

## Executing a Search (Execute)

The PX8000 displays the waveforms of the area around the specified time expanded in the zoom window.

This feature is the same as the executing a search for edge search.

▶ See here.

# Notes about Searching Waveforms

- You cannot search during data acquisition.
- The search results are invalid after you:
  - Start data acquisition.
  - Change the settings.
- If you invert or change the offset voltage of a waveform that has been selected as a waveform to search, the search is performed on the new waveform.

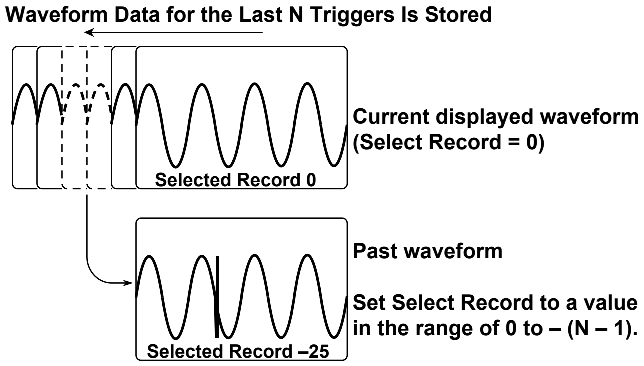
# 22 Displaying and Searching History Waveforms

## HISTORY

Acquisition memory stores waveforms that are displayed on the screen and waveform data that have been acquired in the past. The history feature allows you to display or search past waveforms (history waveforms). You can perform the following operations on history waveforms:

### Display

You can display any single waveform or display all waveforms (and highlight only the specified waveform). You can also list the timestamps (the times at the time references) of all history waveforms.

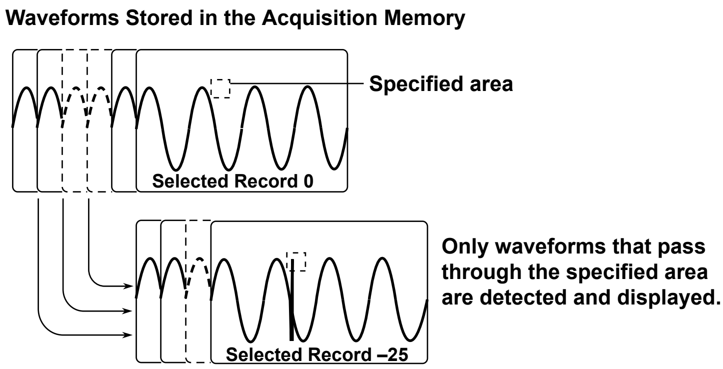



### Search

You can search for waveforms that meet the specified conditions, display the detected history waveforms, and list the timestamps of the waveforms.

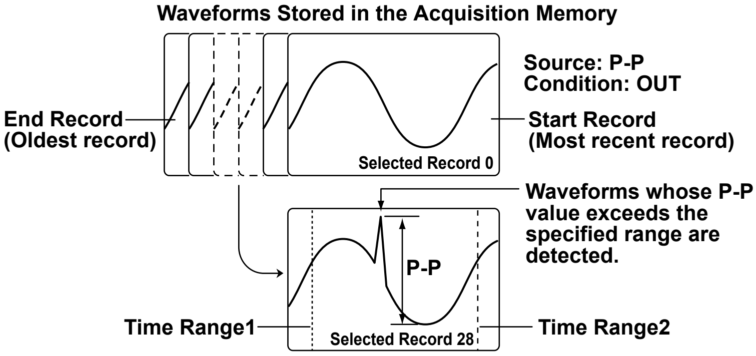
#### Zone Search

You can search for history waveforms that did or did not pass through a specified search zone.



### Parameter Search

You can search for history waveforms that do or do not meet specified search parameter conditions.




## History Waveform Search Range

The search range is from Start Record to End Record.

## Search Method

The PX8000 starts searching in order from the newest waveform.

## Calculation, Cursor Measurement, Automated Measurement, Statistical Processing, and FFT

You can perform calculations, cursor measurement, automated measurement of waveform parameters, or FFT analysis on the history waveform that you specified with Selected Record. You can also calculate statistics of automatically measured values on all history waveforms.

## Displaying and Analyzing XY Waveforms

You can display XY waveforms and perform analysis on the history waveform you specified with Selected Record. If the display mode is set to All, XY waveforms of all history waveforms are displayed.

# Display Mode (Display Mode)

Selects how history waveforms are displayed.

- One waveform (1 Record): Only the waveform that corresponds to the selected record number is displayed.
- All waveforms (All Record): Waveforms other than the highlighted waveform are displayed with normal intensity. All history waveforms between the specified start number (Start Record) and the end number (End Record) are displayed overlapped.
- Averaged waveform (Average Record): Linear averaging is performed on all history waveforms from the specified start (Start Record) to stop (End Record) number, and the results are displayed as a single waveform.

- An averaged waveform cannot be displayed for the following history waveforms.
  Waveforms with record lengths of 250 kpoint or greater on the standard model, 1 Mpoint or greater on models with the /M1 option, or 2.5 Mpoint or greater on models with the /M2 option.
- The waveforms of AUX channels whose input signal type is set to Pulse are not averaged. For such waveforms, history waveforms at the start number (Start Record) are displayed.

# Highlighting (Selected Record)

The latest history waveform is assigned the record number zero, and older waveforms are assigned numbers in descending order (−1, −2, −3, and so on).
The waveform and timestamp that correspond to the record number you specify here are highlighted.
Selectable range: 0 to −(the number of waveform acquisitions − 1)

### Maximum Number of Waveform Acquisitions

**(Maximum number of history waveforms that can be stored in the acquisition memory)**

The number of history waveforms that can be stored varies depending on the selected record length and the installed memory options as follows:

| Record Length | Number of Waveforms | | |
|---|---|---|---|
| | No options (10 Mpoint) | /M1 Option (50 Mpoint) | /M2 Option (100 Mpoint) |
| 100 kpoint | 100 | 400 | 1000 |
| 250 kpoint | 40 | 200 | 400 |
| 500 kpoint | 20 | 100 | 200 |
| 1 Mpoint | 10 | 40 | 100 |
| 2.5 Mpoint | 4 | 20 | 40 |
| 5 Mpoint | 1 | 10 | 20 |
| 10 Mpoint | 1 | 4 | 10 |
| 25 Mpoint | −* | 1 | 3 |
| 50 Mpoint | −* | 1 | 1 |
| 100 Mpoint | −* | −* | 1 |

* −: This record length cannot be set.

# Display Range (Start and End Record)

Using record numbers, set the range of history waveforms to display when the display mode is set to All or Average.
Selectable range: 0 to −(the number of waveform acquisitions −1)

# List of History Waveforms (List)

The history waveform record numbers and the timestamps when the waveforms were acquired are listed.

# History Waveform Search Mode (Search Mode)

When waveform acquisition is stopped, you can search for history waveforms that meet the specified conditions.

- OFF: Searching is not performed. All history waveforms are displayed.
- Zone: The PX8000 searches for history waveforms that did or did not pass through a specified search zone.
- Parameter: The PX8000 searches for history waveforms that do or do not meet specified search parameter conditions.

# Search Condition Settings for Zone Searching (Search Setup)

## Search Zone (Select Zone)

You can register four search zones to Zone1 to Zone4. For each search zone, set the channels to search, the search condition, and the search range.

## Search Condition (Condition)

- IN: The PX8000 searches for waveforms that pass through the specified search window.
- OUT: The PX8000 searches for waveforms that do not pass through the specified search window.
- OFF: The PX8000 does not search for waveforms.

## Source Waveforms (Source)

Set the search source waveform to one of the waveforms below. You can select the channel of an installed module.

U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8

The waveforms of channels that have not been specified as search source channels are also displayed.

## Search Window Upper and Lower Limits (Upper and Lower)

You can set the limits within ±5 div. You can set them in 0.01 div steps.

You cannot set the upper limit to a value that is less than the lower limit.

## Left and Right Sides of the Search Window (Left and Right)

You can set the left and right sides within the range of ±5 div. The resolution is 10 div/display record length.

You cannot set the left side to a value that is greater than the right side.

## Search Logic (Logic)

- AND: The PX8000 searches for waveforms that meet all the search conditions specified for Zone1 to Zone4.
- OR: The PX8000 searches for waveforms that meet at least one of the search conditions specified for Zone1 to Zone4.

# Search Condition Settings for Waveform Parameter Searching (Search Setup)

### Search Parameter (Select Param)

You can register four search conditions to Param1 to Param4. For each search condition, you can change the channels to search, the search condition, and the search range.

### Search Condition (Condition)

- IN: The PX8000 searches for waveforms in which the specified parameter is within the specified range.
- OUT: The PX8000 searches for waveforms in which the specified parameter is outside the specified range.
- OFF: The PX8000 does not search for waveforms.

### Source Waveforms and Parameters (Source)

The PX8000 searches through the specified parameter of the specified trace (Trace). You can specify one type of automatically measured waveform parameter.

### Search Condition Upper and Lower Limits (Upper and Lower)

Specify the range used to determine the condition of the specified parameter.

### Search Logic (Logic)

- AND: The PX8000 searches for waveforms that meet all the search conditions specified for Param1 to Param4.
- OR: The PX8000 searches for waveforms that meet at least one of the search conditions specified for Param1 to Param4.

### Parameter Measurement Time Period (Time Range1/Time Range2)

You can set the measurement time period for the specified parameter by setting Time Range1 and Time Range2. The default settings are −5 div and +5 div. The number of data points in the measured waveform can be up to 100 Mpoint from the start of the measurement time period.
Selectable range: −5 div to +5 div
The Time Range1 and Time Range2 settings are similar to the cursor position settings in cursor measurement.

For details, see “Selectable Range of Cursor Positions” under “Cursor Measurement.”
▶ See here.

# Search Execution (Execute Search)

Searches for waveforms that meet the specified search conditions and displays only the waveforms and timestamps that are detected.

# Notes about Using the History Feature

- You can start waveform acquisition when the HISTORY menu is displayed. However, you cannot change the history feature settings while waveform acquisition is in progress.
- When the acquisition mode is set to Average, you cannot use the history feature.
- If you stop waveform acquisition, even if one complete screen's worth of waveform data has not been acquired, the waveform at which the trigger occurred is displayed as a single history waveform.
- If you stop waveform acquisition and then start it again without changing the waveform acquisition conditions, the waveform data continues to be stored in the acquisition memory.
- If you change the waveform acquisition conditions and start waveform acquisition, the past data stored in the acquisition memory is cleared.
- An averaged waveform cannot be displayed for the following waveforms.
  Waveforms with record lengths of 250 kpoint or greater on the standard model, 1 Mpoint or greater on models with the /M1 option, or 2.5 Mpoint or greater on models with the /M2 option.
- The settings are restricted so that the following relationship is retained: Last record (End Record) ≤ Selected Record ≤ first record (Start Record).
- When you load waveform data from the specified storage medium, history waveforms up to that point are cleared. The loaded waveform data is placed in record number zero. If you load a file containing multiple history waveforms, the latest waveform is placed in zero, and earlier waveforms are placed in order to record numbers −1, −2, and so on.
- Computation and automated measurement of waveform parameters are performed on the waveform of the record number specified by Selected Record. You can analyze old data as long as you do not overwrite the acquisition memory contents by restarting waveform acquisition. If Display Mode is set to Average Record, analysis is performed on the averaged waveform.
- The times that are listed are the times at the time references. When the waveform display is in update mode, the time references are the trigger times. Furthermore, these times vary as indicated below depending on the trigger mode.

| Trigger Mode | Condition | Time Displayed in the List |
|---|---|---|
| Auto/Auto Level | Roll mode | Stop time |
| Single | Roll mode, no trigger | Stop time |
| On Start | − | Start time |

- When all the waveforms or averaged waveform are displayed, if a large number of records are selected, it may take time for them to be displayed completely. When the display is not complete, appears in the center of the screen. If you want to stop the operation, set Display Mode to 1 Record.
- History waveforms are cleared when you turn the power off.

# 23 Printing and Saving Screen Captures

### PRINT MENU

You can print screen captures from a built-in printer (option), save images to files, and so on.

## Destination Type (Print To)

Select the screen capture output destination.

- Built-in printer (BuiltIn): You can select this option when the optional built-in printer is installed.
- File (File): You can save screen captures to files in PNG, BMP, and JPEG formats.

## Printing from the Built-In Printer (BuiltIn; option)

Models that have the optional built-in printer installed can print from it. Images printed from the built-in printer are printed just as they are displayed on the PX8000.

### Comment (Comment)

You can enter a comment of up to 26 characters in length. The comment that you create is displayed in the bottom of the screen.
Changing this comment also changes the file comments.

## Saving Screen Captures (File)

You can save screen captures to files in PNG, BMP, and JPEG formats.

### Data Format (Format)

You can select the format to save to from the options listed below.

- PNG: The extension is .PNG. The file size is approximately 50 KB for black and white mode and approximately 100 KB for color mode.
- BMP: The extension is .BMP. The file size is approximately 150 KB for black and white mode and approximately 2 MB for color mode.
- JPEG: The extension is .JPG. The file size is approximately 250 KB for color mode.

The file sizes listed here are for reference. Actual file sizes will vary depending on the image that is saved.

### Color (Color)

You can select the color format to save to from the options below.

- ON: Saves data using 65536 colors.
- ON (Gray): Saves data using 16 grayscale levels.
- ON (Reverse): Saves data using 65536 colors. The screen background is not produced in color.
- OFF: Saves data in black and white.

### Background Transparent or Opaque (Background)

For PNG format, you can save the waveform display area with a transparent background. This feature is convenient when you want to compare waveforms by overlaying screen captures on the PC.

- Normal (Normal): Saves data without changing the background (not made transparent).
- Transparent (Transparent): Saves data by making the background transparent.

### Frame On or Off (Frame)

For JPEG format, you can add a white frame to the image to prevent the surrounding area from dropping out when the capture is printed.

- ON: The capture is saved with a frame.
- OFF: The capture is saved without a frame.

### File Name Setting (File Setup)

You can set file names, comments, and so on. This is the same as the file feature.
However, the file name and comment are not the same as those when the following types of data are saved.

- Waveform data
- Numeric data
- Setup data
- Snapshot waveform data
- The results of the automated measurement of waveform parameters
- FFT analysis results

Changing the comment also changes the built-in printer comments.

▶ See here.

In addition to using the PRINT key, you can set save conditions and execute a save operation in the following manner.

- **Save Conditions (SAVE MENU)**

  Press SHIFT and then SAVE to display the SAVE menu. On this menu, you can configure the waveform-data, numeric-data, and screen-capture-data save operations. On the menu for configuring the save operation (the SAVE menu), you cannot turn off all of the waveform-data, numeric-data, and screen-capture-data save operations.

- **Saving (SAVE)**

  Press SAVE (without SHIFT) to save items whose save operation is set to ON.

## Printing or Saving a Screen Capture (PRINT)

The screen capture is printed from the built-in printer or saved to the specified file.

# 24 Saving and Loading Data

## FILE

You can save the following kinds of data to an SD memory card, USB storage device, or network drive.
Waveform data, numeric data, setup data, screen capture data, snapshot waveform data, automated measurement data, FFT analysis results of waveform parameters

You can load the following types of data from a storage medium into the PX8000.
Waveform data, setup data, snapshot waveform data

You can also rename and copy files and set or clear protection on files.

## Storage Media You Can Save and Load From

The PX8000 can access the following three types of storage media for saving and loading data.

**SD Memory Card (SD-1)**

The SD memory card inserted into the SD memory card slot of the PX8000.

**USB Storage Medium (USB-0 or USB-1)**

A USB storage device that is connected to the PX8000 USB port. USB2.0 mass storage devices compatible with USB Mass Storage Class Ver. 1.1 can be connected to the PX8000.

**Network Drive (Network)**

A storage device on the network. You can use a network storage device by connecting the PX8000 to an Ethernet network.

**Notes about Using the USB Memory**

- Connect USB storage media directly, not through a USB hub.
- Only connect a compatible USB keyboard, mouse, or storage device to the USB connector for peripherals.
- Do not connect and disconnect multiple USB devices repetitively. Provide a 10-second interval between removal and connection.
- Do not connect or remove USB cables from the time when the PX8000 is turned on until key operation becomes available (approximately 20 to 30 seconds).
- You can use USB storage media that are compatible with USB Mass Storage Class Ver. 1.1.
- The PX8000 can handle up to four storage media. If the connected medium is partitioned, the PX8000 treats each partition as a separate storage medium. As such, the PX8000 can handle up to four partitions.

# Saving Data (Save)

The PX8000 saves data to the specified storage medium.

In addition to using the FILE key, you can set save conditions and execute a save operation in the following manner.

- **Save Conditions (SAVE MENU)**

  Press SHIFT and then SAVE to display the SAVE menu. On this menu, you can configure the waveform-data, numeric-data, and screen-capture-data save operations. On the menu for configuring the save operation (the SAVE menu), you cannot turn off all of the waveform-data, numeric-data, and screen-capture-data save operations.

- **Saving (SAVE)**

  Press SAVE (without SHIFT) to save items whose save operation is set to ON.

## Saving Waveform Data (Waveform)

You can save the waveform data that the PX8000 has measured to a file in binary, ASCII, floating-point, or WDF binary format.

**Save Destination (File List)**

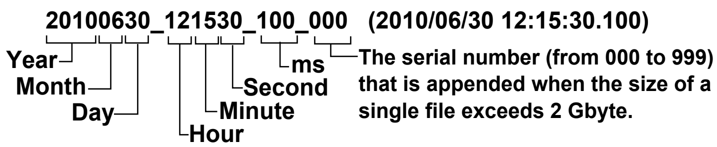
Specify the file to save to.

**File Name (File Name)**

Set the file name.

- You can use the auto naming feature to automatically assign file names.
- Whether Auto Naming is set to Numbering, Date, or OFF, when the size of a single file exceeds 2 Gbyte, an underscore and a three-digit serial number (000 to 999) are appended to the file names.

**File Name Example for When Auto Naming Is Set to Date**




- The underscore and three-digit serial number are not appended to the file name when the file size is 2 Gbyte or less.

- **Auto Naming (Auto Naming)**
  - Numbering (Numbering)

    The PX8000 automatically adds a four-digit number from 0000 to 9999 after the common name specified using the File Name setting (up to four characters) and saves files.
  - Date (Date)

    The file name is the date and time (down to ms) when the file is saved. The file name specified using the File Name setting is not used.
  - OFF

    Disables the auto naming feature. The name that you specify using the File Name setting is used. If there is a file with the same name in the save destination folder, you cannot save the data.
  - Save Destination during Action Execution

    In the specified drive, a folder is automatically created with the date (year, month, and day) as its name, and data is saved to that folder using file names specified by the auto naming feature. If the number of files in the save destination folder exceeds 1000, a new folder is automatically created with the date and an incremented sequence number (000 to 999) as its name, and the data continues to be saved in the new folder.

- **File Name (File Name)**

  You can set the common file name that is used when the auto naming feature is turned off or when the auto naming feature is set to Numbering. The maximum number of characters that you can use for file names and folder names is 32 characters. The following restrictions apply.
  - The following types of characters can be used: 0 to 9, A to Z, _, −, =, (, ), {, }, [, ], #, $, %, &, ~, !, `,and @. @ cannot be entered consecutively.
  - The following character 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, or COM9
  - Make sure that the full file path (absolute path from the root directory) is less than or equal to 260 characters in length. If it exceeds 260 characters, an error occurs when you perform a file operation (such as save, copy, rename, or create folder). 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 restrictions apply when you use the file name auto naming feature.
  - If you set auto naming to Numbering, file names will be eight characters long. A file name will consist of the four characters that you entered for the file name and a four-character sequence number.
  - If you set auto naming to Date (date and time), the characters that you entered for the file name will not be used. File names will consist of only the date information.

- **Comment (Comment)**

  You can add a comment that consists of up to 120 characters when saving files. You do not have to enter a comment. All characters, including spaces, can be used in a comment.

### Data Type (Data Type)

Set the data type to binary, ASCII, floating-point, or WDF binary.

- **Binary (Binary)**
  - The sampled data stored to the acquisition memory is saved to a file in binary format. The extension is .WPF. A thumbnail file is also saved at the same time. The thumbnail file can be viewed in the File Property screen.
  - You can load the saved binary format data into the PX8000, display the waveform of the data, and view the values that it contains.

- **ASCII (ASCII)**
  - The sampled data stored in the acquisition memory is converted using the specified range and saved to a file in ASCII format. The extension is .CSV. You can use the file to analyze waveforms on your PC. When you save data for MATLAB (numeric analysis software), the extension will be .TXT.
  - You cannot load the file into the PX8000.
  - If you configure the record length and the number of channels so that the size of a file would exceed 2 Gbyte, the file cannot be created.

- **Floating Point (Float)**
  - The sampled data stored in the acquisition memory is converted using the specified range and saved to a file in 32-bit IEEE floating format. The extension is .FLD. You can use the file to analyze waveforms on your PC. The data notation is little-endian (Intel format).
  - You cannot load the file into the PX8000.
  - If you configure the record length and the number of channels so that the size of a file would exceed 2 Gbyte, the file cannot be created.

- **WDF Binary (WDF Binary)**
  - The sampled data stored to the acquisition memory is saved to a file in binary format. The extension is .WDF. This file is used to analyze waveforms using NI DIAdem. Thumbnails are also saved when the sampled data is saved. You can view the thumbnails on the File Property (File Property) screen.
  - You cannot load the file into the PX8000.
  - If you configure the record length and the number of channels so that the size of a file would exceed 2 Gbyte, the file cannot be created.

### Data Size

The data sizes indicated below are for when the record length is 100 kpoint and you save the measured data of U1, I1, and P1 with all computed waveforms turned off and one history waveform.

| Data Type | Extension | Size (In bytes) |
|---|---|---|
| Binary | .WPF | Approx. 900 K: (100 kpoint) × 3 channels × the number of history waveforms × 2 |
| ASCII | .CSV | Approx. 4 M |
| Float | .FLD | Approx. 1.6 M: (100 kpoint) × 3 channels × the number of history waveforms × 4 |
| WDF Binary | .WDF | Approx. 900 k |

### Save Range (Range)

When you save data in ASCII or floating point format, you can select the waveform save range (area) from one of the choices below.

- Main window (Main): Saves the data displayed in the main window
- Zoom 1 or Zoom2 (Zoom1 or Zoom2): Saves the data displayed in the specified zoom window
- Cursor range (Cursor Range): Saves the data in the area between the cursors

### Save Conditions (Waveform Save Setup)

- **Waveform to Save (Select Save Trace)**
  - You can select All ON, U1 to U4, I1 to I4, P1 to P4, AUX3 to AUX8, and Math1 to Math8*. The waveforms you select that are displayed are saved. You can select the channel of an installed module. Even if you select All ON, only the waveforms that are displayed are saved.
    * You can select Math1 to Math8 to save data in ASCII or floating-point format.
      - If the computation mode on the MATH menu is set to OFF, Math1 to Math8 cannot be selected.
      - Any math channel (Math1 to Math8) on the MATH menu whose equation definition is set to OFF cannot be selected.
      - Any computation channels (Math1 to Math8) whose display is set to OFF on the MATH menu will not be displayed. Therefore, they will not be saved.
    - If the data type is set to binary, source waveforms for waveform computation on the MATH menu are saved even if they are not displayed. Therefore, even though Math1 to Math8 are cannot be specified to be saved when the data type is set to binary, when binary data is loaded, Math1 to Math8 may appear depending on the setup data of the MATH menu.
    - If the data type is set to ASCII or floating point and you select to save all history waveforms, math waveforms will not be saved. If you want to save math waveforms, set History to One.
  - The vertical-axis, horizontal-axis, and trigger settings are also saved along with the waveforms.

- **Saving History Waveforms (History)**
  You can set the source waveform to one of the waveforms below.
  - One waveform (One): Only the waveform with the record number specified in the history menu is saved.
    To save an averaged history waveform, set the display mode in the history menu to Average Record, and set History to One.
  - All waveforms (All): All history waveforms between the start and end numbers specified in the history menu are saved.
    If you search for history waveforms, and then select All, only the detected waveforms will be saved.
    All waveforms (All) cannot be used when data is saved to WDF binary format.

- **Data Removal Interval (Interval)**

  When you save data in ASCII format, you can thin out the data before you convert it to ASCII format. Set the data removal interval.

  OFF (no data is removed), 5 points (Per 5), 10 points (Per 10), 20 points (Per 20), 50 points (Per 50), 100 points (Per 100), 200 points (Per 200), 500 points (Per 500), 1000 points (Per 1000), 2000 points (Per 2000), 5000 points (Per 5000)

  For example, if you select Per 5, the data will be removed as indicated below.

  First data point, +5, +10, +15...

- **Time Information (Time Info.)**

  When you save data in ASCII format, you can choose whether to save time information.
  - ON: Time information is saved.
  - OFF: Time information is not saved.

- **Extension (Extension)**

  When you save data in ASCII format, you can set the extension of the files that you save to .csv or .MATLAB (.txt).

- **Decimal Point (Decimal Point)**

  When you save data in ASCII format, you can choose how to separate the data.
  - Point (Point): 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.

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- If you change the extension of the saved data file, by using a PC or some other device, the PX8000 will no longer be able to load it.
- Up to 1000 files and folders can be displayed in the file list. If there are more than a total of 1000 files and folders in a given folder, the file list for that folder will display only 1000 files and folders. There is no way to set which files and folders are displayed.
- Math waveforms are not saved if they are shorter than 10 div or if the computation start point is not −5 div.
- If deskewing the transfer time difference between inputs is configured, deskewed data is saved.

---

### Data Format for Saving Multiple Records

The PX8000 saves data that contains multiple records, such as history waveforms, in the following data format.

**ASCII format: CR+LF is inserted between records.**

<Header><br>
U1 data 1-1, P1 data 1-1, I1 data 1-1, ..., [CR+LF]<br>
U1 data 1-2, P1 data 1-2, I1 data 1-2, ..., [CR+LF]<br>
⋮<br>
U1 data 1-m, P1 data 1-m, I1 data 1-m, ..., [CR+LF]<br>
[CR+LF]<br>
U1 data 2-1, P1 data 2-1, I1 data 2-1, ..., [CR+LF]<br>
U1 data 2-2, P1 data 2-2, I1 data 2-2, ..., [CR+LF]<br>
⋮<br>
U1 data 2-n, P1 data 2-n, I1 data 2-n, ..., [CR+LF]<br>
[CR+LF]<br>
⋮

**One history record**

**Float format: Data is saved separately by channel.**

| |
|---|
| Measured data for U1 on record 1 |
| Measured data for U1 on record 2 |
| ⋮ |
| Measured data for U1 on record N |
| Measured data for P1 on record 1 |
| Measured data for P1 on record 2 |
| ⋮ |
| Measured data for P1 on record N |
| Measured data for I1 on record 1 |
| Measured data for I1 on record 2 |
| ⋮ |
| Measured data for I1 on record N |
| ⋮ |

## Saving Numeric Data (Numeric)

You can save the numeric data that the PX8000 has measured to a file in ASCII format.

### Save Destination (File List), Auto Naming (Auto Naming), File Name (File Name), Comment (Comment)

These settings are the same as those for saving waveform data.
However, when saving numeric data, “N” is automatically appended to the name of the numeric data file.

▶ See here.

### Items That Are Saved (Target)

- **Displayed Numeric Items (Displayed)**

  The saved items vary as indicated below depending on the display.

  - When Numeric Values Are Displayed in the 4-, 8-, or 16-Value Display or the Matrix Display
    All the measurement functions on the page that is displayed when saving starts are saved in the order that they are displayed.
  - When Numeric Values Are Displayed in the Single or Dual Harmonics List
    In addition to the data described above, the data of harmonics that are not displayed on the screen is saved up to the maximum measurable order (Max Order).
  - When Numeric Values Are Displayed in the All Items Display
    The measurement functions belonging to the highlighted page number on the right side of the screen are saved.
    - When the entire screen is numeric display
      The top half of the screen shows the measurement functions of the first page. The bottom half of the screen shows the measurement functions of the second and subsequent pages. Therefore, if page number 1 is highlighted, the measurement function in the top half of the screen are saved. Therefore, if page number 2 or higher is highlighted, the measurement function in the bottom half of the screen are saved.
    - When a split display that includes the numeric display is shown
      All measurement functions of pages shown when the save operation is executed are saved.
  - When Numeric Values Are Displayed in the Custom Display
    All measurement functions of pages shown when the save operation is executed are saved.
  - In Non-Numeric Displays (Waveform display, X-Y waveform display, etc.)
    The PX8000 saves data according to the numeric display settings. For example, when waveforms are displayed, if switching the display to numeric display would cause a 16-value display to appear, the measurement functions of the pages that would appear on the 16-value display are saved.

- **Selected Items (Selected)**

  You can select the types of numeric data to save.

#### Selecting Items (Select Items)

If you selected Selected, select which numeric data to save.

- Element (Element)
  To select an element or wiring unit that you want to save the data of, select or clear its check box. You can select from the following options.
  Element1, Element2, Element3, Element4, ΣA, and ΣB
- Function (Function)
  Select whether to store the data of a function by selecting or clearing its check box.
- Selecting All Functions (All ON)
  The data of all measurement functions is saved.
- Deselecting All Functions (All OFF)
  None of the data for any of the measurement functions is saved.
- Preset (Preset)
  The data of the following measurement functions is saved for all elements and wiring units.*
  Urms, Irms, FreqU, FreqI, P, S, Q, λ, and Φ

* If the wiring system setting (Wiring) is configured so that a wiring unit does not exist, the data for the functions of that wiring unit is not saved. For example, if ΣB does not exist, the data for ΣB is not saved.

#### Separator and Decimal Point When Data Is Saved in ASCII Format (.csv; Decimal Point for CSV File)

This settings is the same as that for saving waveform data.

▶ See here.

If deskewing the transfer time difference between inputs is configured, deskewed data is saved.

### Saving Setup Data (Setup)

You can save the PX8000 setup information to the specified storage medium. The extension is .SET.
However, the date, time, and communication setup parameters are not saved.

#### Save Destination (File List), Auto Naming (Auto Naming), File Name (File Name), Comment (Comment)

These settings are the same as those for saving waveform data.

▶ See here.

#### Saving to Internal Memory

You can save setup data to internal memory from the storing and recalling setup data menu.

▶ See here.

### Saving Other Types of Data (Others)

You can save the screen capture, snapshot waveforms, results of the automated measurement of waveform parameters, FFT analysis results.

#### Save Destination (File List), Auto Naming (Auto Naming), File Name (File Name), Comment (Comment)

These settings are the same as those for saving waveform data.

▶ See here.

#### Data Type (Data Type)

- Screen capture (Screen Image): You can save the displayed screen image to a file in PNG, BMP, or JPEG format. You can also save the screen image from the menu that appears when you press the PRINT MENU key.
- Snapshot waveforms (Snap): You can save the waveform data captured in a snapshot. The extension is .SNP.
- Measure (Measure): You can save the results of the automated measurement of waveform parameters to a file in CSV format.
- FFT (FFT): You can save FFT analysis results to a file in CSV format.

### Screen capture (Screen Image)

You can save the displayed screen image to a file.

#### Data Format (Format), Color (Color), Background Transparent or Opaque (Background), Frame On or Off (Frame)

These settings are the same as those for saving screen captures.

▶ See here.

### Automated Measurement Values of Waveform Parameters (Measure)

Save the results of automatic waveform parameter measurement to a file in CSV format. The extension is .CSV. CSV files are text files that contain data separated by commas. They are used to convert data between spreadsheet and database applications.

The maximum number of previous values that you can save is equal to 100000 ÷ number of items that are turned on.

Data size in bytes = Number of measured items × 15 × number of history waveforms

#### Save Conditions (Measure Save Setup)

**• Unit (Unit)**

You can select whether to save the units of measure along with the measured results.

- ON: Units are saved.
- OFF: Units are not saved.

**• Time information (Time Info.), Decimal Point (Decimal Point)**

These settings are the same as those for saving waveform data.

▶ See here.

### FFT Analysis Results (FFT)

You can save the analysis results of FFT1 or FFT2 to a file in CSV format. The extension is .CSV.

#### Save Conditions (FFT Save Setup)

**• Frequency Information (Frequency Info.)**

You can select whether to save frequency information along with computed results.

- ON: Frequency information is saved.
- OFF: Frequency information is not saved.

**• Decimal Point (Decimal Point)**

This setting is the same as that for saving waveform data.

▶ See here.

## Saving (Execute Save)

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

You cannot save the following types of data while waveform acquisition is in progress. Press START/STOP to stop the waveform acquisition.

- Waveform data
- Numeric data
- Setup data
- The results of the automated measurement of waveform parameters
- FFT analysis results

# Loading Data (Load)

You can load waveform data, setup data, and snapshot waveforms that have been saved by the PX8000. Numeric data cannot be loaded.

## Loading Waveform Data (Waveform)

Waveform data in binary format (files with .WPF extensions) can be loaded.
You can load a specified waveform data file with the setup data. You can load the entirety of the specified waveform data file. Waveforms of computed data appear when computation is turned on. Because setup data is also loaded, the PX8000 settings change when you load waveform data. If you start waveform acquisition by pressing the START/STOP key, the loaded data is cleared.

- If the modules that are currently installed in the PX8000 are different from the modules that were installed when the waveform data was saved, you cannot load the waveform data.
- You cannot load waveform data saved by a module with a larger amount of memory on a module with a smaller amount of memory.
- You can load only waveform data that you saved with the save range set to the main window.

## Loading Setup Data (Setup)

The setup data of the specified file is loaded. The extension is .SET.

* The following settings are not loaded.
Date and time, Time synchronization feature (option), Storage media format, USB keyboard language, USB communication feature, Menu font size, Menu background color, Click sound on/off, Key lock, Network

### Recalling Data from the Internal Memory

You can recall setup data from the internal memory from the storing and recalling setup data menu.
▶ See here.

The PX8000 cannot load setup parameters that were saved by an instrument with a different module configuration, different options, etc.

## Loading Other Types of Data (Others)

The snapshot waveforms of the specified file or the contents of a symbol definition file are loaded.

### Snapshot Waveforms (Snap)

The extension is .SNP. The snapshot waveforms that you load are displayed in white on the screen.

## Loading (Execute Load)

Loads the data of the specified file.

# File Operations (FILE UTILITY)

You can perform file operations such as creating folders on the storage medium, deleting and copying files, and changing file names.

### Sorting the List (Sort To)

You can sort the file list by file name, data size, date, etc.

### Display Format

Select whether to display a list of files or to display thumbnails.

### Selecting the Type of File to List (File Filter)

You can limit the type of files that appear in the list by selecting an extension.

### Changing the Storage Medium (Change Drive)

You can select the storage medium that you want to access. The PX8000 displays various storage media as follows:

- SD-1: The SD memory card inserted into the SD memory card slot of the PX8000
- USB-0: The USB storage device that is connected to a PX8000's USB port (type A) for connecting peripheral devices (the first connected device)
- USB-1: The USB storage device that is connected to a PX8000's USB port (type A) for connecting peripheral devices (the second connected device).
- Network: A storage device on the network

### Deleting Files and Folders (Delete)

You can delete the selected files and folders.

### Renaming Files and Folders (Rename)

You can rename a selected file or folder.

### Making Folders (Make Dir)

Make a folder.
You can use the same characters in folder names that you can in file names.

▶ See here.

### Copying and Moving Files (Copy and Move)

You can copy or move the selected files and folders to other storage media or folders. You can copy or move multiple files at the same time.

### File Property (File Property)

You can view information about the selected file, such as its name (File Name), file size (File Size), the date and time when it was saved (Date/Time), and its attributes (Attribute).

### Turning File Protection On and Off (Protect ON and OFF)

You can turn protection on and off for the selected file. The change is reflected in the file attributes, displayed under the Attr column in the file list.

| Protection | File Attribute | Description |
|---|---|---|
| ON | r | File protection is on for the selected file.<br>The file can only be read. The file cannot be written to or deleted. |
| OFF | r/w | File protection is off for the selected file.<br>The file can be read and written to. |

### Selecting Files (ALL SET, ALL RESET, and SET/RESET)

Selects or deselects all the files in the list.
You can also select or deselect only the highlighted files.

- To format the storage medium, press the UTILITY key to display the System Config menu, and then select Storage Manager.
  ▶ See here.
- You can abort the file copy and delete operations, except for the file that is being processed at the time.

# 25 Ethernet Communication (Network)

You can configure TCP/IP parameters and use the optional Ethernet interface to perform the following tasks.

**TCP/IP**

TCP/IP settings for connecting to an Ethernet network.
Set the IP address, subnet mask, and default gateway.

▶ See here.

**FTP Server (FTP Server)**

You can connect the PX8000 as an FTP server to a network.
You can connect to the PX8000 from a PC on the same network and retrieve waveform data.
You can connect to the PX8000 from a PC on the same network and retrieve setup data, numeric data, waveform data, and screen image data.

▶ See here.

**Network Drive (Net Drive)**

You can save the PX8000’s setup data, numeric data, waveform data, and screen image data to a network drive.
You can also load the setup data from a network drive into the PX8000.

▶ See here.

**SNTP**

The PX8000 clock can be set using SNTP. The PX8000 can be configured to automatically adjust its clock when it is turned on.

▶ See here.

To connect a PC to the PX8000, use a hub or router, and connect to a network. Do not connect a PC directly to the PX8000.

# TCP/IP (TCP/IP)

Configure the settings that the PX8000 needs to connect to a network.

## DHCP

DHCP is a protocol that temporarily allocates settings that a PC needs to connect to the Internet.
To connect to a network that has a DHCP server, turn the DHCP setting on. When DHCP is turned on, the IP address can be automatically obtained when the PX8000 is connected to a network. (You do not have to set it manually.)
When DHCP is turned off, you must set the appropriate IP address, subnet mask, and default gateway for the network.

## DNS

DNS is a system used to associate Internet host names and domain names with IP addresses. Given AAA.BBBBB.com, AAA is the host name and BBBBB.com is the domain name. You can use host names and domain names to access the network instead of using IP addresses, which are just numbers. The PX8000 allows you to specify the host by name, instead of by IP address. Set the domain name and the DNS server address (0.0.0.0 by default). For details, consult your network administrator.

### DNS Servers (DNS Server1/DNS Server2)

You can specify up to two DNS server addresses: primary and secondary. If querying fails with the primary DNS server, the secondary DNS server is automatically used to find the mapping of the host name and domain name to the IP address.

### Domain Suffixes (Domain Suffix1/Domain Suffix2)

The domain suffix is a piece of information that is automatically added when a query is made to a DNS server using only a portion of the domain name. For example, if BBBBB.co.jp is registered as a domain suffix and a query is made using “AAA,” the name “AAA.BBBBB.co.jp” is searched.
You can specify up to two domain suffixes: Domain Suffix1 and Domain Suffix 2.
You can use up to 127 characters. The characters that you can use are 0 to 9, A−Z, a−z, and dashes.

TCP/IP settings are applied when you press Bind and then SET or when you turn on the PX8000 the next time.

# FTP Server (FTP Server)

You can connect the PX8000 as an FTP server to a network.
Set the user name and password that will be used by devices on the network to access the PX8000. Also, set the access timeout value.

### User Name (User Name)

Set the user name that will be used to access the PX8000 from a PC. If you set the user name to “anonymous,” you can connect to the PX8000 without entering a password.

- Number of characters: Up to 15
- Usable characters: All ASCII characters that are displayed on the keyboard

### Password (Password)

Set the password that will be used to access the PX8000 from a PC.

- Number of characters: Up to 15
- Usable characters: All ASCII characters that are displayed on the keyboard

### Timeout (Time Out)

If an FTP connection cannot be established between the PX8000 and the PC within the amount of time specified here, the PX8000 aborts the connection process.
You can set the timeout time to a value between 30 and 3600 seconds.

To apply the settings that you specified, press Entry.

## FTP Server Overview

When the PX8000 is connected to the network as an FTP server, the following features become available.

### FTP Server

From a PC, you can view a list of files that are stored in the PX8000 storage medium (the internal memory or a storage medium that is connected to it) and retrieve files.

## PC System Requirements

### PC

A PC running Microsoft Windows 7 Professional or Mac OS X.

### OS

Microsoft Windows 7 Professional or Mac OS X (10.9)

### Internal memory

512 MB or more recommended.

### Communication ports

100BASE-TX or 1000BASE-T Ethernet port. Use this port to connect the PC to the network.

### Display

A display compatible with any of the above operating systems and with a resolution of 1024×768 or higher.

### Mouse or pointing device

Mouse or pointing device compatible with any of the above operating systems

### Web browser

Internet Explorer 8.0, Firefox 25.0, Safari (for Windows, 5.1.7), Safari (for Snow Leopard, 5.1.10)

## Network Drive (Net Drive)

You can save the PX8000's setup data, numeric data, waveform display data, and screen image data to a network drive. You can also load the setup data from a network drive into the PX8000.

### FTP Server (FTP Server)

Specify the IP address of an FTP server on the network. You can save numeric data, waveform display data, and screen image data to the server and load setup data from it. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

### Login Name (Login Name)

Specify the login name.

- Number of characters: Up to 15
- Usable characters: All ASCII characters that are displayed on the keyboard

### Password (Password)

Specify the password that corresponds to the login name.

- Number of characters: Up to 15
- Usable characters: All ASCII characters that are displayed on the keyboard

### Passive Mode (Passive)

Turn passive FTP on or off.
In passive mode, the FTP client sets the port number for data transfer. Enable passive mode when you have set an external FTP server as a network drive or when you are accessing an FTP server through a firewall.

### Timeout (Time Out)

If the PX8000 cannot transfer files for a certain amount of time, it disconnects from the FTP server.
You can set the timeout time to a value between 1 and 3600 seconds.

### Connecting to the Network Drive(Connect/Disconnect)

When you press Connect, the PX8000 connects to the specified network drive. When you press Disconnect, the network drive is disconnected.

# SNTP (SNTP)

The PX8000 clock can be set using Simple Network Time Protocol (SNTP). The PX8000 can be configured to automatically adjust its clock when it is turned on.

### SNTP Server (SNTP Server)

Specify the IP address of the SNTP server that the PX8000 will use. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

### Timeout (Timeout)

If the PX8000 cannot connect to the SNTP server for a certain amount of time, it aborts the operation.
You can set the timeout time to a value between 1 and 60 seconds.

### Executing Time Adjustment (Adjust)

The PX8000 clock is synchronized to the SNTP server clock.

### Automatic Adjustment (Adjust at Power On)

You can configure the PX8000 so that its clock is automatically synchronized to the SNTP server clock when the PX8000 is turned on when it is connected to the network.

- If the time difference from GMT (Greenwich Mean Time) is set in the date/time setting, the PX8000 will make appropriate adjustments to the time information received from the SNTP server.
  ▶ See here.
- If you do not want the PX8000 to synchronize with an SNTP server, do not set the SNTP server IP address.

# 26 Other Features

## Calibration (Zero-level compensation, CAL)

### Executing Calibration (Execute Calibration)

The following items are calibrated on all input modules. Execute calibration when you want to make accurate measurements.

- Vertical-axis ground level

Calibration is performed automatically when the power switch is turned on.

### Notes about Calibration

- Allow the PX8000 to warm up for at least 30 minutes before you execute calibration. If you execute calibration immediately after power-on, the calibrated values may drift due to temperature changes or other environmental changes.
- Execute calibration in a stable temperature environment ranging from 5 to 40°C* (23 ± 5°C recommended).
  * 35°C when the PX8000 is installed facing up.
- If the measurement range and input filter remain the same for a long period of time, the zero level may change due to the changes in the environment surrounding the PX8000. If this happens, we recommend that you execute calibration.

### Auto Calibration

- **Voltage Modules (760811) and Current Modules (760812/760813)**

  Calibration is performed automatically at the following two instances.
  - Immediately after a measurement is started before triggers start operating
  - Immediately after the completion of a measurement if measurement is performed continuously Calibration values take effect in the subsequent measurement.

  **Calibration That Is Performed When a Measurement Is Completed on an Input Element (Cal at End for Elements)**

  Select whether to execute calibration when a measurement is completed for voltage and current modules.
  - OFF: Auto calibration is not executed.
  - ON: Auto calibration is executed.

- **AUX Modules (760851)**

  **Calibration That Is Performed When AUX Modules Start (Cal on Start for Auxiliaries)**

  Select whether to execute calibration when signal acquisition is first started when the following time periods elapse after the power is turned on.
  - Approx. 3 minutes
  - Approx. 10 minutes
  - Approx. 30 minutes and every 30 minutes thereafter

  - OFF: Auto calibration is not executed.
  - ON: Auto calibration is executed.

# NULL Feature (NULL SET)

You can use the NULL feature to subtract the DC offset while a measurement cable or external sensor is connected.

## Turning NULL Value Subtraction On and Off (Affect NULL)

Select whether to subtract the NULL value from measured data of input signals for each module when the NULL feature is turned on. You can set this separately for each channel of installed modules.
You can use the Affect NULL box to collectively select whether to subtract the NULL value from measured data of input signals for all modules.

## Updating the NULL Value (Update Value)

Select whether to update the NULL value of input signals for each module when the NULL feature is turned on. You can set this separately for each channel of installed modules.
You can use the Update Value box to collectively select whether to update the NULL value of input signals for all modules.

## NULL Values

The following displayed measured values that are measured when the NULL feature is turned on are used as NULL values.

- Udc1 to Udc4, Idc1 to Idc4 (the voltage and current simple averages)
- AUX3 to AUX8

# Enabling and Disabling the NULL Feature (NULL)

Press NULL to enable or disables the NULL feature.

- When the NULL feature is enabled, the NULL values are set to the Udc, Idc, and AUX data values that are displayed. The NULL values are applied in the next set of measurement data. In the element information on the right side of the screen, NULL (NULL indicator) illuminates for channels whose Affect NULL check boxes are selected.
- If you press NULL while the NULL feature is enabled, the NULL indicators turn off, and the NULL feature is disabled.

- To make accurate measurements, we recommend that you execute calibration before enabling the NULL feature.
- The NULL feature is not enabled if there are no displayed Udc, Idc, and AUX data values (data is NAN, OL, ERROR, etc.). For example, this would occur if you turn on the NULL feature immediately after turning the power on when no measurements have taken place.

### Disabling the NULL Feature

The NULL feature is disabled in the following situations.

- The NULL feature on all channels is disabled when the power is turned on.
- The NULL feature on all channels is disabled when the settings are initialized.
- The NULL feature on all channels is disabled when a setup data file is loaded.
- If you change a current input from direct input to external current sensor input or cause it to change such as when the wiring system is changed, the NULL feature on the relevant current input channel is disabled. The stored NULL value is also cleared.
- If you change the input signal type (Sense Type) of an AUX module, the NULL feature on the relevant input channel is disabled. The stored NULL value is also cleared.

### Influence of Measurement Range Change

If the NULL feature is ON, the NULL value is retained even when the measurement range is changed. However, if the NULL value falls outside ±14% of the new range, it is set to ±14% of the new range. This also holds true when the range is changed by the auto range feature.

### Measurement Functions Affected by the NULL Feature

All measurement functions are affected by the NULL values.

- NULL values are subtracted from the acquisition data of voltage, current, and AUX inputs.
- NULL values cannot be applied to waveforms that have already been acquired.
- If the following settings that existed when the currently displayed data was acquired are different from the current settings, an error will occur when you turn NULL on.
  - Direct input or external current sensor input of a current input
  - Input signal type (Sense Type) of AUX modules

  For example, an error will occur if you turn NULL on and acquire data, change the above settings, and then turn NULL on again.
- The NULL feature is not disabled even if you load a saved waveform data file.

## Snapshot (SNAPSHOT)

Retains the currently displayed waveforms on the screen. This feature allows you to update the display without having to stop waveform acquisition. It is a useful feature when you want to compare waveforms.
Snapshot waveforms are displayed in white.
You cannot perform the following operations on snapshot waveforms.
  Cursor measurement, automated measurement of waveform parameters, zoom, or computation
You can save and load snapshot waveforms.

## Clear Trace (CLEAR TRACE)

Clears all the waveforms that are displayed on the screen.
If you change the display format or perform other similar operations, the PX8000 redisplays the channel waveforms, computed waveforms, and loaded waveforms that were displayed before you executed the clear trace operation.
Snapshot and clear trace features are disabled:
- When the PX8000 is in remote mode.
- When the PX8000 is printing, when it is executing auto setup, or when it is accessing a storage medium.
- When go/no-go determination is in progress, when action is in progress, or when searching is in progress.

# Utility (UTILITY)

You can specify the following settings.

### System Configuration (System Config)

You can set the date and time, time synchronization, the menu and message languages, the LCD intensity, whether the backlight is on or off, the and USB keyboard language, and you can format storage media or initialize settings.

▶ See here.

### Remote Control (Remote Ctrl)

You can select the method for connecting a PC to the PX8000 to control it.

▶ See here.

### Ethernet Communication (Network)

You can configure TCP/IP, FTP server, network drive, and SNTP settings.

▶ See here.

### Environment Settings (Preference)

You can set the action performed at power on, terminal setup, display setup, key and knob setup, frequency display when the frequency measurement is less than lower limit, and AUX display when the pulse frequency measurement is less than the lower limit.

▶ See here.

### Self-Test (Self Test)

You can test the keyboard and memory operations.

▶ See here.

### Storing and Recalling Setup Data (Setup Data Store and Recall)

You can save up to 16 sets of setup data to specific internal memory areas.

▶ See here.

### Overview (Overview)

You can view the PX8000 system information.

▶ See here.

# System Configuration (System Config)

You can specify the following settings.

- PX8000 date and time
- Language
- LCD adjustment
- Formatting Storage Media
- USB Keyboard Language

## Date and Time Settings (Date/Time)

The PX8000 date and time.

### Turning the Display On and Off (Display)

Set whether to display the date and time on the PX8000 screen.

### Display Format (Format)

You can display the date in one of the following formats.

2013/06/30 (year/numeric month/day)
30/06/2013 (day/numeric month/year)
30-JUN-13 (day-English abbreviation of the month-last two digits of the year)
30 JUN 2013 (day month (English abbreviation) year)

### Date and Time Settings (Date/Time)

Sets the date and time.

### Time Difference from Greenwich Mean Time (Time Diff. GMT)

Set the time difference between the region where you are using the PX8000 and Greenwich Mean Time.

Selectable range: Set the time difference in the range of −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 Time Hour to 9 and Minute to 00.

#### Checking the Standard Time

Using one of the methods below, check the standard time of the region where you are using the PX8000.

- Check the Date, Time, Language, Regional Options on your PC.
- Check the standard time at the URL on the right. http://www.worldtimeserver.com/

- The PX8000 does not support Daylight Savings Time. To set the Daylight Savings Time, reset the time difference from Greenwich Mean Time.
- Date and time settings are backed up using the internal lithium battery. They are retained even if the power is turned off.
- The PX8000 has leap-year information.

## Time Synchronization Feature (Time Synchro; optional)

You can use this feature to use an IRIG (Inter Range Instrumentation Group) signal to synchronize the time on the PX8000 with the GPS (Global Positioning System). This feature has three conditions: Unlock, Lock, and Stable. When an IRIG signal is properly received, the PX8000 enters into the Lock condition and acquires time information.

### Turning the Time Synchronization Feature On and Off (Time Synchro)

You can select whether to use an IRIG (Inter Range Instrumentation Group) signal for time synchronization (IRIG) or not (OFF).

### IRIG Code Format (IRIG Format)

You can set the IRIG code format to A or B.

### IRIG Code Modulation Type (Modulation)

You can set the IRIG code modulation type to AM or Pulse-width Code (PWCode).

### Input Impedance (Impedance)

You can set the input impedance to 50 Ω or 5 kΩ.

The time synchronization feature has three conditions: Unlock, Lock, and Stable. When an IRIG signal is properly received, the PX8000 enters into the Lock condition. Time acquisition and synchronization are possible after 1 s. A few minutes after the PX8000 enters the Lock condition, it enters into the Stable condition. In the Stable condition, the internal clock of the PX8000 is synchronized to within 10 ppm of the GPS.

## Language (Language)

Sets the language that is used in the setup menu and messages.

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

## Adjusting the LCD (LCD)

You can turn off the LCD and adjust its brightness.

### Turning Off the LCD (LCD Turn OFF)

You can turn off the LCD. When the LCD is off, you can turn it back on by pressing a key.

### Automatically Turning Off the LCD (Auto OFF)

The LCD turns off automatically when there are no key operations for a given time period. The LCD turns back on when you press a key.

### Auto Off Time (Auto OFF Time)

You can set the time after which the LCD turns off automatically to a value within the following range.
1 min to 60 min

### Adjusting the Brightness (Brightness)

You can adjust the brightness in the range of 1 (darkest) to 9 (brightest). You can prolong the LCD service life by decreasing the LCD brightness or by turning off the LCD when you do not need to view it.

### Formatting Storage Media (Storage Manager)

You can format storage media.

If you format a storage medium, all saved data is erased.

### USB Keyboard Language (USB Keyboard)

Sets the USB keyboard language to English or Japanese. The USB keyboard can be used to enter file names, comments, etc.

## All Setup (All Setup)

### Initializing Settings (Initialize)

You can reset the PX8000 settings to their factory default values. This feature is useful when you want to cancel all the settings that you have entered or when you want to redo measurement from scratch. Default reset refers to the act of resetting the PX8000 settings to their factory default values.

#### Items That Cannot Be Reset

The following settings cannot be reset.

Date and time settings, communication settings, the language setting (Japanese or English), and environment settings

#### Undoing Default Reset (Undo)

If you perform default reset by mistake, you can undo it by pressing the Undo soft key.

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

While holding down the RESET key, turn the power switch on. All settings except the date and time settings (display on/off setting will be reset) and the setup data stored in internal memory will be reset to their factory default values. If you reset the settings using this method, the changes cannot be undone.

# Remote Control (Remote Ctrl)

Communication interface for controlling the PX8000 from a PC. GP-IB, USB, and Network are the available communication interfaces.
For details, see the communication interface user's manual, IM PX8000-17EN.

- Only use one communication interface: GP-IB, USB, or Network. If you send commands simultaneously from more than one communication interface, the PX8000 will not execute the commands properly.
- The REMOTE indicator at the bottom center of the PX8000 screen illuminates when the PX8000 is communicating with a PC in remote mode. All keys except SHIFT + CLEAR TRACE are disabled in Remote mode.

## USB

Connects the PX8000 to a PC using USB.
To remotely control the PX8000 using communication commands through the USB port, select USBTMC and then carry out the following procedure.

- Install YOKOGAWA USB TMC (Test and Measurement Class) driver on your PC. For information about how to obtain the YOKOGAWA USB TMC driver, contact your nearest YOKOGAWA dealer. You can also access the YOKOGAWA USB driver download website and download the driver (http://www.yokogawa.com/ymi/).
- Do not use USB TMC drivers (or software) supplied by other companies.

## GP-IB

Connects the PX8000 to a PC using GP-IB.

### Address (Address)

- You can set the address to a value from 0 to 30.
- Each device that is connected by GP-IB has its own unique address in the GP-IB system. This address is used to distinguish one device from other devices. Therefore, you must assign a unique address to the PX8000 when connecting it to a PC or other device.

- Several cables can be used to connect multiple devices. However, no more than 15 devices, including the controller, can be connected on a single bus.
- When connecting multiple devices, you must assign a unique address to each device.
- When the controller is communicating with the PX8000 or with other devices through GP-IB, do not change the address.
- Use cables that are 2 m or shorter in length to connect devices.
- Keep the total length of the cables under 20 m.
- When devices are communicating, have at least two-thirds of the devices on the bus turned on.
- To connect multiple devices, use a star or daisy-chain configuration. Loop and parallel configurations are not allowed.

## Network

Connects the PX8000 to a PC using Ethernet.

### IP Address (IP Address)

Displays the TCP/IP setting that you specified in the Ethernet communication settings.

▶ See here.

### Timeout (Time Out)

If a connection cannot be established between the PX8000 and the PC within the amount of time specified here, the PX8000 aborts the connection process.
You can set the timeout time to infinity or a value between 1 and 3600 seconds.

- You must set TCP/IP parameters to connect the PX8000 to an Ethernet network.

▶ See here.

- To connect the PX8000 to a PC, be sure to use straight cables through a hub. Correct operation is not guaranteed for a one-to-one connection using a cross cable.
- Use one of the following types of network cable that conforms to the transfer speed of your network.
  A UTP (Unshielded Twisted-Pair) cable
  An STP (Shielded Twisted-Pair) cable

## Clearing Remote Mode (LOCAL)

To clear remote mode, press SHIFT key and CLEAR TRACE key.

# Environment Settings (Preference)

## Action Performed at Power On (Power On Action)

### Setting Whether to Start Waveform Acquisition (Start)

Select whether to start waveform acquisition at power on (ON) or not (OFF).

### Setting Whether to Turn the Action Function On or Off (Action)

Select whether to enable the action function at power on (ON) or not (OFF).

- ON: When the power is turned on, the action mode setting is the same as it was when the power was turned off.
- OFF: When the power is turned on, the action mode is off.

## Terminal Setup (Terminal Setup)

### Enabling or Disabling the Remote High Edge (STOP) Signal (Remote Stop)

Select whether to enable (ON) the high edge (STOP) in the external start/stop remote signal or disable (OFF).

### Trigger Output Signal (Trigger Out)

You can set the type of signal that is generated from the trigger output terminal to Normal or Pulse.

### Trigger Output Signal Pulse Width (Pulse Width)

When you set the trigger output signal type to Pulse, you can set the pulse width to 1 ms, 50 ms, 100 ms, or 500 ms.

## Configuring the Display (Display Setup)

### Menu Font Size (Menu Font Size)

You can set the font size of the menu to Small or Large.

### Menu Background Color (Base Color)

You can set the background color of the menu to Blue or Gray.

### Scale Value Display Font Size (Scale Font Size)

You can set the font size of the scale value display to small or large.

### Items Whose Scale Values Are Displayed (Scale On Item)

Set the items that you want to display when Scale Value is set to ON.

- ALL: The scale value of the vertical axis and horizontal axis are displayed.
- Time Scale: The scale value of the horizontal axis is displayed.

### Turning the Numeric Display Frame On and Off (Numeric Frame)

Set whether to show the numeric display frame.

### Display Digits (Numeric Resolution)

You can choose to display five digits or six digits of the numeric data.

### Intensity (Intensity)

You can set the intensities of the grid (Grid), cursor (Cursor), and marker (Marker) to values within the range of 1 to 8.

## Key and Knob Setup (Key/Knob Setup)

### Turning On or Off the Click Sound (Click Sound)

You can turn on or off the click sound that is generated when you operate the jog shuttle.

### START/STOP Key Response Time (START/STOP Response Time)

You can set the response time of the START/STOP key to instant (Quick) or 1 s or more (> 1sec).

### Key Lock (Key Protect)

You can lock the operation keys to prevent unintentional changes to the current state of the PX8000.

- Type (Type)
  Select whether to lock all the keys (ALL) or to lock all keys except the START/STOP key (Except START/STOP).
- Release Method (Release Type)
  Select whether to release the key lock by pressing the KEY PROTECT key (Key) or by entering a password (Password).
- Password (Password)
  Specify the password to use to release the key lock. Specify the password using up to eight alphanumeric characters. If you forget the password, you can release the key lock by turning the PX8000 on while holding down the RESET key. Note that all settings will be initialized when you do this.
  ▶ See here.

## Frequency Display When the Frequency Measurement Is Less Than Lower Limit (Freq Display at Frequency Low)

When the frequency of the input signal is lower than the frequency that the PX8000 can measure, you can choose to display the frequency as “0” or “Error.”

## AUX Display When the Pulse Frequency Measurement Is Less Than the Lower Limit (Aux Display at Pulse Freq Low)

When the pulse frequency of the AUX input signal is lower than the frequency that the PX8000 can measure, you can choose to display the values of AUX functions as “0” or “Error.”

## Analysis Setup (Analysis Setup)

### Cursor Read Mode (Cursor Read Mode)

You can select whether to perform cursor measurements on P-P compressed display data or the data that has been acquired in the acquisition memory.

- Display data (Display)
  Cursor measurements are performed on the display data.
- Acquisition (ACQ)
  Cursor measurements are performed on sampled data in acquisition memory.
  ▶ See here.

# Self-Test (Self Test)

You can test the keyboard and memory operations.

## Test Type (Self Test)

You can perform the following tests.

### Key Test (Key Board)

Tests whether the front-panel keys are operating properly. If the name of the key that you press is highlighted, the key is operating properly.

### Memory Test (Memory)

You can test the internal memory to determine whether it is functioning normally. If it is functioning normally, “Pass” appears. If an error occurs, “Error” appears.

### SD Memory Card Test (SD Card)

You can test an SD memory card to determine whether it is functioning normally. If an error occurs, “Error” appears.

### Printer Test (Printer)

Tests whether the optional built-in printer is operating properly. If the print density is correct, the built-in printer is operating properly. If an error occurs, the built-in printer does not print properly.

## Keyboard Test (Soft Key)

This test appears when you set Test Item to Key Board. You can test whether the keyboard displayed on the screen is functioning properly. If the characters that you type appear correctly in the keyboard’s input box, the keyboard is functioning properly.

## Executing a Test (Test Exec)

The selected self-test starts.

## If an Error Occurs during a Self-Test

If an error occurs even after you carry out the following procedure, contact your nearest YOKOGAWA dealer.

- Execute the self-test again several times.
- Check whether the media being tested is properly inserted.
- Check that the paper is set properly in the built-in printer and that paper is not jammed.

# Storing and Recalling Setup Data (Setup Data Store and Recall)

You can save up to 16 sets of setup data to specific internal memory areas. It is convenient to save setup data that you use frequently. You can save a set of setup data to one of the following numbers.

1 to 16

By specifying these numbers, you can store and recall setup data easily.

You can attach comments in the same way that you can when you save waveform data.

▶ See here.

## Overview (Overview)

You can display the following information about the PX8000. The instrument numbers of the PX8000 and each module are also displayed. However, the instrument numbers of the AUX module (760851) is not displayed.

- Model
- Record Length
- Serial No: Instrument number
- Product ID: Unique number assigned to each instrument. This number is necessary for the purchase of additional options.
- Slot: Names of the inserted modules, instrument number, instrument number of the pairing module, calibration time
- Installed options
- Default Language
- Firm Version: Firmware version number
- FPGA1/2 Version: FPGA1/2 version number

## Key Lock (KEY PROTECT)

You can lock the operation keys to prevent unintentional changes to the current state of the PX8000. When the keys are locked, pressing any keys other than KEY PROTECT has no effect, and the USB mouse and keyboard cannot be used.

▶ See here.

## NUM LOCK

Press this key to use the ELEM1 to ELEM4, U1 to U4, I1 to I4, and P1 to P4 keys to enter numbers. After you press NUM LOCK, you can press a  key to enter the number, sign, unit prefix, or exponent displayed to the upper right of the key in white, or to confirm an entry or selection (ENTER).

# Appendix

## Appendix 1 Symbols and Determination of Measurement Functions

### Measurement Functions Used in Normal Measurement

(Table 1/2)

| Measurement Function | | Methods of Computation and Determination<br>For information about the symbols in the equations, see the notes on the next page. | | | | |
|---|---|---|---|---|---|---|
| Voltage U [V] | True rms value: Urms<br>Rectified mean value calibrated to the rms value: Umn<br>Simple average: Udc<br>Rectified mean value: Urmn<br>AC component: Uac | Urms | Umn | Udc | Urmn | Uac |
| | | $\sqrt{\mathrm{AVG}[u(n)^2]}$ | $\frac{\pi}{2\sqrt{2}}\mathrm{AVG}[\lvert u(n)\rvert]$ | $\mathrm{AVG}[u(n)]$ | $\mathrm{AVG}[\lvert u(n)\rvert]$ | $\sqrt{\mathrm{RMS}^2\text{-}\mathrm{DC}^2}$ |
| Current I [A] | True rms value: Irms<br>Rectified mean value calibrated to the rms value: Imn<br>Simple average: Idc<br>Rectified mean value: Irmn<br>AC component: Iac | Irms | Imn | Idc | Irmn | Iac |
| | | $\sqrt{\mathrm{AVG}[i(n)^2]}$ | $\frac{\pi}{2\sqrt{2}}\mathrm{AVG}[\lvert i(n)\rvert]$ | $\mathrm{AVG}[i(n)]$ | $\mathrm{AVG}[\lvert i(n)\rvert]$ | $\sqrt{\mathrm{RMS}^2\text{-}\mathrm{DC}^2}$ |

| Measurement Function | | Methods of Computation and Determination |
|---|---|---|
| Active power P [W] | | $\mathrm{AVG}[u(n)\cdot i(n)]$ |
| Apparent power S [VA] | TYPE1, TYPE2 | Select from Urms • Irms, Umn • Imn, Udc • Idc, Umn • Irms, and Urmn • Irmn. |
| | TYPE3 | $\sqrt{P^2 + Q^2}$ |
| Reactive power Q [var] | TYPE1, TYPE2 | $s \cdot \sqrt{S^2 - P^2}$<br>s is -1 for a lead phase and 1 for a lag phase |
| | TYPE3 | $\sum_{k=min}^{max} Q(k)$<br>Q(k) = Ur(k) • Ij(k) –Uj(k) • Ir(k)<br>Ur(k) and Ir(k) are the real number components of U(k) and I(k)<br>Uj(k) and Ij(k) are the imaginary components of U(k) and I(k)<br>Valid only when harmonics are being measured correctly. |
| Power factor λ | | $\frac{P}{S}$ |
| Phase difference Φ [˚] | | $\cos^{-1}\left(\frac{P}{S}\right)$<br>The phase angle can be switched between lead (D)/lag (G) display and 360˚ display. |
| Voltage frequency: fU (FreqU) [Hz]<br>Current frequency: fI (FreqI) [Hz] | | The voltage frequency (fU) and current frequency (fI) are measured by detecting the zero-crossing points.<br>You can simultaneously measure frequencies of all the installed elements. |
| Maximum voltage: U + pk [V] | | The maximum u(n) for every data update |
| Minimum voltage: U – pk [V] | | The minimum u(n) for every data update |
| Maximum current: I + pk [A] | | The maximum i(n) for every data update |
| Minimum current: I - pk [A] | | The minimum i(n) for every data update |
| Maximum power: P + pk [W] | | The maximum u(n) • i(n) for every data update |
| Minimum power: P – pk [W] | | The minimum u(n) • i(n) for every data update |
| Voltage crest factor: CfU<br>Current crest factor: CfI | | Voltage crest factor CfU = $\frac{Upk}{Urms}$<br>Upk = \|U + pk\| or \|U – pk\| whichever is larger<br>Current crest factor CfI = $\frac{Ipk}{Irms}$<br>Ipk = \|I + pk\| or \|I – pk\| whichever is larger |
| Corrected Power Pc [W] | IEC76-1(1976), IEEE C57.12.90-1993 | $\frac{P}{P1 + P2\left(\frac{Urms}{Umn}\right)^2}$<br>P1, P2: coefficients defined in the applicable standards |
| | IEC76-1(1993) | $P\left(1 + \frac{Umn - Urms}{Umn}\right)$ |

(Continued on next page)

(Table 2/2)

<table>
<tr><td colspan="3">Measurement Function</td><td colspan="4">Methods of Computation and Determination<br>For information about the symbols in the equations, see the notes.</td></tr>
<tr><td rowspan="12">Σ functions</td><td colspan="2">Wiring system</td><td>Single-phase, three-wire 1P3W</td><td>Three-phase, three-wire 3P3W</td><td>Three-phase, three-wire with three-voltage, three-current method. 3P3W(3V3A)</td><td>Three-phase, four-wire 3P4W</td></tr>
<tr><td colspan="2">UΣ [V]</td><td colspan="2">(U1 + U2) / 2</td><td colspan="2">(U1 + U2 + U3) / 3</td></tr>
<tr><td colspan="2">IΣ [A]</td><td colspan="2">(I1 + I2) / 2</td><td colspan="2">(I1 + I2 + I3) / 3</td></tr>
<tr><td colspan="2">PΣ [W]</td><td colspan="3">P1 + P2</td><td>P1 + P2 + P3</td></tr>
<tr><td rowspan="2">SΣ [VA]</td><td>TYPE1, TYPE2</td><td>S1 + S2</td><td>$\frac{\sqrt{3}}{2}(S1 + S2)$</td><td>$\frac{\sqrt{3}}{3}(S1 + S2 + S3)$</td><td>S1 + S2 + S3</td></tr>
<tr><td>TYPE3</td><td colspan="4">$\sqrt{P\Sigma^2 + Q\Sigma^2}$</td></tr>
<tr><td rowspan="3">QΣ [var]</td><td>TYPE1</td><td colspan="3">Q1 + Q2</td><td>Q1 + Q2 + Q3</td></tr>
<tr><td>TYPE2</td><td colspan="4">$\sqrt{S\Sigma^2 - P\Sigma^2}$</td></tr>
<tr><td>TYPE3</td><td colspan="3">Q1 + Q2</td><td>Q1 + Q2 + Q3</td></tr>
<tr><td colspan="2">PcΣ [W]</td><td colspan="3">Pc1 + Pc2</td><td>Pc1 + Pc2 + Pc3</td></tr>
<tr><td colspan="2">λΣ</td><td colspan="4">$\frac{P\Sigma}{S\Sigma}$</td></tr>
<tr><td colspan="2">ΦΣ [°]</td><td colspan="4">$\cos^{-1}\left(\frac{P\Sigma}{S\Sigma}\right)$</td></tr>
</table>

- u(n) denotes the instantaneous voltage.
- i(n) denotes the instantaneous current.
- n denotes the $n^{th}$ measurement period. The measurement period is determined by the synchronization source setting.
- AVG[ ] denotes the simple average of the item in brackets determined over the data measurement interval. The data measurement interval is determined by the synchronization source setting.
- PΣ denotes the active power of wiring unit Σ. Elements are assigned to wiring unit Σ differently depending on the number of elements that are installed in the PX8000 and the selected wiring system pattern.
- The numbers 1, 2, and 3 used in the equations for UrmsΣ, UmnΣ, UrmnΣ, UdcΣ, UacΣ, IrmsΣ, ImnΣ, Irmn,Σ IdcΣ, Iac,Σ PΣ, SΣ, QΣ, and PcΣ indicate the case when elements 1, 2, and 3 are set to the wiring system shown in the table.
- Equation Type 3 for SΣ and QΣ can only be selected on models with the harmonic measurement option.
- On the PX8000, S, Q, λ, and Φ are derived through the computation of the measured values of voltage, current, and active power (however, when Type 3 is selected, Q is calculated directly from the sampled data). Therefore, for distorted signal input, the value obtained on the PX8000 may differ from that obtained on other instruments that use a different method.
- For Q [var], when the current leads the voltage, the Q value is displayed as a negative value; when the current lags the voltage, the Q value is displayed as a positive value. The value of QΣ may be negative, because it is calculated from the Q of each element with the signs included.

## Measurement Functions Used in Harmonic Measurement (Option)

(Table 1/4)

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

(Continued on next page)

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

* For details on the type of S and Q equations, see “Apparent Power and Reactive Power Computation Types” under “Numeric Computation.”

(Table 2/4)

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

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

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

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

**(Table 3/4)**

| Measurement Function | | Methods of Computation and Determination | | | |
|---|---|---|---|---|---|
| Σ Function | Wiring system | Single-Phase, Three-Wire (1P3W) | Three-Phase, Three-Wire (3P3W) | Three-Voltage, Three-Current Method (3V3A) | Three-Phase, Four-Wire (3P4W) |
| | UΣ [V] | (U1 + U2) / 2 | | (U1 + U2 + U3) / 3 | |
| | IΣ [A] | (I1 + I2) / 2 | | (I1 + I2 + I3) / 3 | |
| | PΣ [W] | P1 + P2 | | | P1 + P2 + P3 |
| | SΣ [VA] (TYPE3)* | $\sqrt{P\Sigma^2 + Q\Sigma^2}$ | | | |
| | QΣ [var] (TYPE3)* | Q1 + Q2 | | | Q1 + Q2 + Q3 |
| | λΣ | $\frac{P\Sigma}{S\Sigma}$ | | | |

- The numbers 1, 2, and 3 used in the equations for UΣ, IΣ, PΣ, and QΣ, indicate the case when elements 1, 2, and 3 are set to the wiring system shown in the table.
- Only the total value and the fundamental wave (1st harmonic) are computed for Σ.

* For details on the type of S and Q equations, see “Apparent Power and Reactive Power Computation Types” under “Numeric Computation.”

**(Table 4/4)**

| Measurement Function | Methods of Computation and Determination |
|---|---|
| ΦU1-U2(°) | Phase angle between U1(1) and the fundamental voltage of element 2, U2(1) |
| ΦU1-U3(°) | Phase angle between U1(1) and the fundamental voltage of element 3, U3(1) |
| ΦU1-I1(°) | Phase angle between U1(1) and the fundamental current of element 1, I1(1) |
| ΦU2-I2(°) | Phase angle between U2(1) and the fundamental current of element 2, I2(1) |
| ΦU3-I3(°) | Phase angle between U3(1) and the fundamental current of element 3, I3(1) |
| ΦI1-I2(°) | Phase angle between I1(1) and the fundamental current of element 2, I2(1) |
| ΦI2-I3(°) | Phase angle between I2(1) and the fundamental current of element 3, I3(1) |
| ΦI3-I1(°) | Phase angle between I3(1) and the fundamental current of element 1, I1(1) |

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

## Measurement Functions Used in Delta Computation

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

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

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

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

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

## Measurement Functions for Auxiliary Input

When Motor Mode Is Enabled

| Measurement Function | Methods of Computation and Determination |
|---|---|
| **Rotating speed**<br>**AUX3**<br>**AUX5**<br>**AXU7** | When the input signal from the revolution sensor is DC voltage (an analog signal):<br>**A(X – NULL)+ B**<br>A: slope of the input signal<br>X: input voltage from the revolution sensor [v]<br>B: offset<br>NULL: null value [v]<br>When the input signal from the revolution sensor is the number of pulses:<br>$A\frac{(X-NULL)}{N}$<br>A: Coefficient for converting Hz to rps, rpm, or rph<br>X: pulse frequency [Hz]<br>N: number of pulses per revolution<br>NULL: null value [Hz]<br>(Error or 0 can be selected for when the value is less than the lower limit of pulse measurement.) |
| **Torque**<br>**AUX4**<br>**AUX6**<br>**AXU8** | When the input signal from the torque meter is DC voltage (an analog signal):<br>**A(X – NULL)+ B**<br>A: slope of the input signal<br>X: input voltage from the torque meter [V]<br>B: offset<br>NULL: null value [V]<br>When the input signal from the torque meter is a pulse signal:<br>**A(X – NULL)+ B**<br>A: torque pulse coefficient<br>X: pulse frequency [Hz]<br>B: torque pulse offset<br>NULL: null value [Hz]<br>The PX8000 computes the torque pulse coefficient and torque pulse offset from torque values (the unit is N•m) at the upper and lower frequency limits.<br>Normally use a scaling factor of 1. If you are using a unit other than N•m, set the unit conversion ratio. |
| **Monitor output**<br>**Pm2**<br>**Pm3**<br>**Pm4** | $\frac{2\pi \cdot \text{Speed} \cdot \text{Torque}}{60} \cdot \text{Scaling factor}$<br>When the unit of **torque** is N•m, and the scaling factor is 1, the unit of motor output **Pm** is W. |

When Motor Mode Is Disabled

| Measurement Function | Methods of Computation and Determination |
| --- | --- |
| **AUX3**<br>**AUX4**<br>**AUX5**<br>**AUX6**<br>**AUX7**<br>**AUX8** | When the input signal from the sensor is DC voltage (an analog signal):<br>**A(X – NULL)+ B**<br>A: slope of the input signal<br>X: value of the input voltage from the sensor [V]<br>B: offset<br>NULL: null value [V]<br><br>When the input signal from the sensor is the number of pulses:<br>**A(X – NULL)+ B**<br>A: slope of the input signal<br>X: pulse frequency [Hz]<br>B: offset<br>NULL: null value [Hz]<br>(Error or 0 can be selected for when the value is less than the lower limit of pulse measurement.) |

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

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

## Power

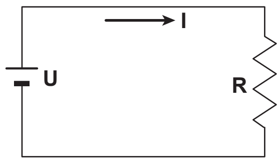
Electrical energy can be converted into other forms of energy and used. For example, it can be converted into the heat in an electric heater, the torque in a motor, or the light in a fluorescent or mercury lamp. In these kinds of examples, the work that electricity performs in a given period of time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

### DC Power

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

P = UI [W]

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

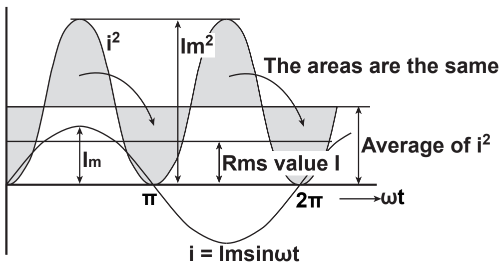



### Alternating Current

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

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

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




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

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

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

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

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

These relationships also apply to sinusoidal voltages.

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

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

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

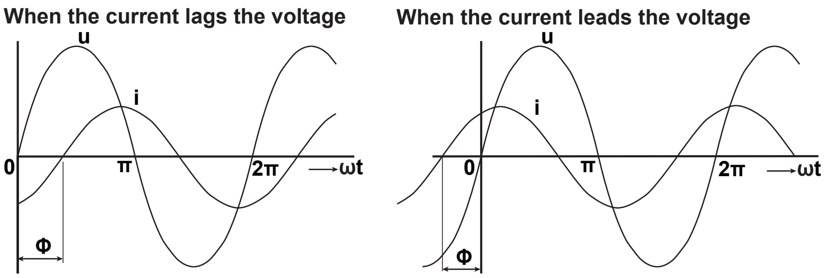
**Vector Display of Alternating Current**

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

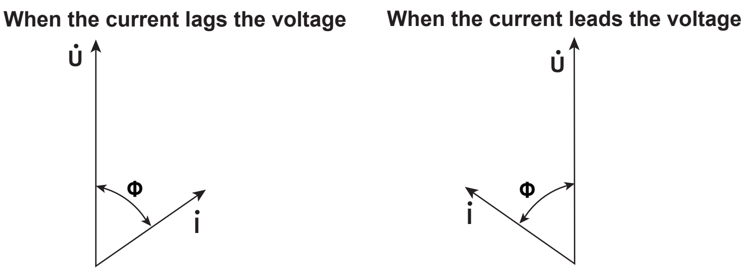
Voltage: u = Umsint

Current: i = Imsin(t-Φ)

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

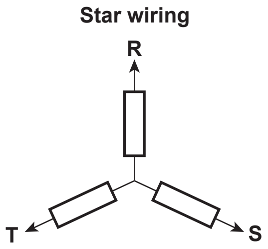


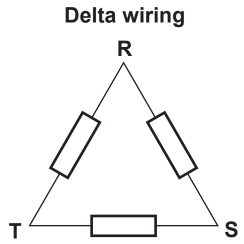

A vector display is used to clearly convey the magnitude and phase relationships between the voltage and current. A positive phase angle is represented by a counterclockwise angle with respect to the vertical axis. Normally, a dot is placed above the symbol representing a quantity to explicitly indicate that it is a vector. The magnitude of a vector represents the rms value.



### Three-Phase AC Wiring

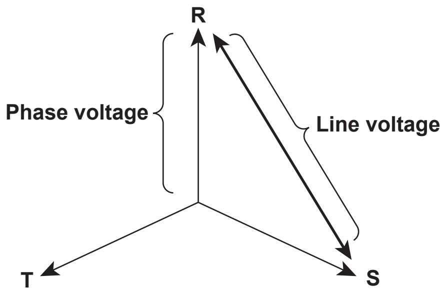
Generally three-phase AC power lines are connected in star wiring configurations or delta wiring configurations.



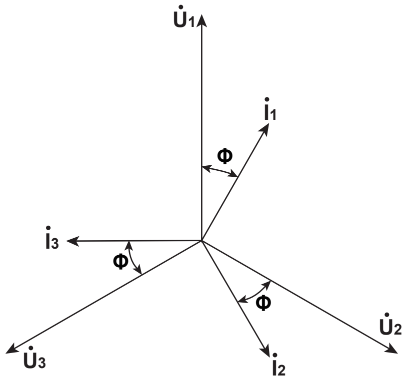

### Vector Display of Three-Phase Alternating Current

In typical three-phase AC power, the voltage of each phase is offset by 120°. The figure below expresses this offset using vectors. The voltage of each phase is called the phase voltage, and the voltage between each phase is called the line voltage.




If a power supply or load is connected in a delta wiring configuration and no neutral line is present, the phase voltage cannot be measured. In this case, the line voltage is measured. Sometimes the line voltage is also measured when measuring three-phase AC power using two single-phase wattmeters (the two-wattmeter method). If the magnitude of each phase voltage is equal and each phase is offset by 120°, the magnitude of the line voltage is $\sqrt{3}$ times the magnitude of the phase voltage, and the line voltage phase is offset by 30°.

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



### AC Power

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

If the instantaneous voltage $u = U_m\sin\omega t$ and the instantaneous current $i = I_m\sin(\omega t - \Phi)$, the instantaneous AC power p is as follows:

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

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

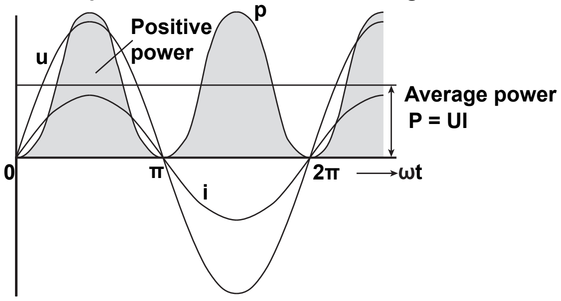
p is the sum of the time-independent term, $UI\cos\Phi$, and the AC component term of the voltage or current at twice the frequency, $-UI\cos(2\omega t - \Phi)$.

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

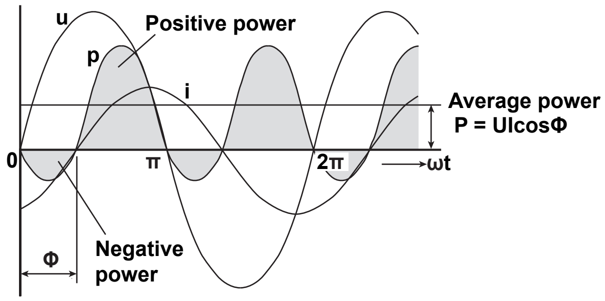
$P = UI\cos\Phi$ [W]

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

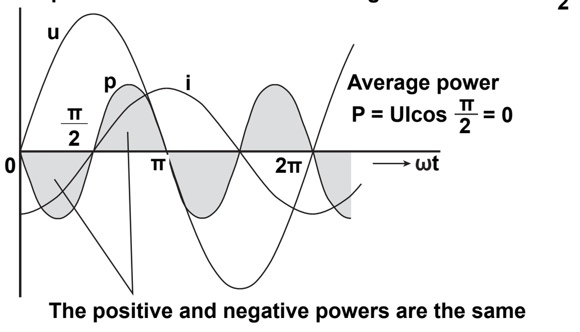
**When the phase difference between voltage and current is 0**




**When the phase difference between voltage and current is Φ**




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



### Active Power and the Power Factor

In alternating electrical current, not all of the power calculated by the product of voltage and current, UI, is consumed. The product of U and I is called the apparent power. It is expressed as S. The unit of apparent power is the volt-ampere (VA). The apparent power is used to express the electrical capacity of a device that runs on AC electricity.
The true power that a device consumes is called active power (or effective power). It is expressed as P. This power corresponds to the AC power discussed in the previous section.

$S = UI$ [VA]

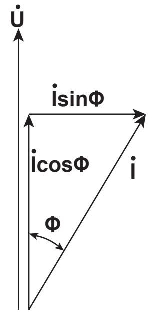
$P = UI\cos\Phi$ [W]

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

### Reactive Power

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

$Q = UI\sin\Phi$ [var]




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

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

## Harmonics

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

### Terminology

The terminology related to harmonics is described below.

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

### Interference Caused by Harmonics

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

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

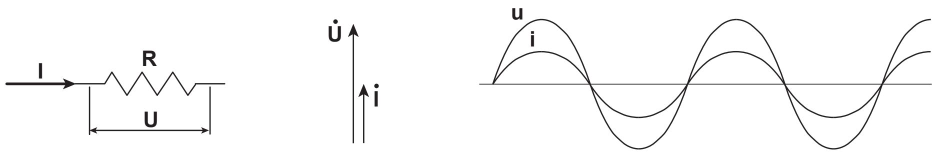
## AC RLC Circuits

### Resistance

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

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

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

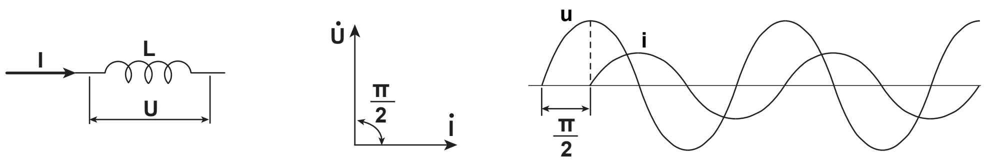



### Inductance

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

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

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

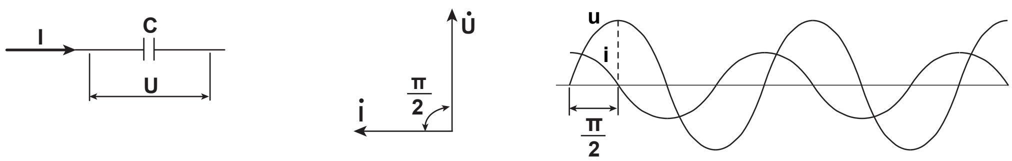



### Capacitance

The current i when an AC voltage whose instantaneous value u = $U_m$sinωt is applied to a capacitive load C [F] is expressed by the equation below.

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

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



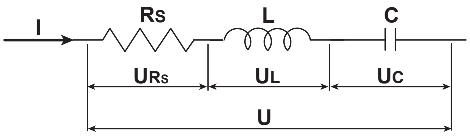
### Series RLC Circuits

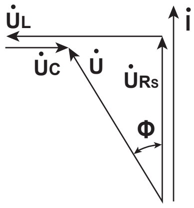
The equations below express the voltage relationships when resistance $R_S$ [Ω], inductance L [H], and capacitance C [F] are connected in series.

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

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

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




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

$$X_S = X_L - X_C$$

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

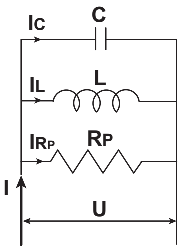
### Parallel RLC Circuits

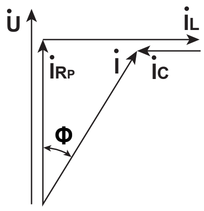
The equations below express the current relationships when resistance $R_P$ [Ω], inductance L [H], and capacitance C [F] are connected in parallel.

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

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

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




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

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

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

# Appendix 3 Power Range

- The table below shows actual voltage and current range combinations and the power ranges that result from them. The table shows the active power range (unit: W). The same ranges are set for apparent power (unit: VA) and reactive power (unit: var). Just read the unit as VA or var.
- The table is for when the number of displayed digits is six.
  - If the value is less than or equal to 600000: 6 digits. If the value is greater than 600000: 5 digits.
  - If the number of displayed digits is 5, the least significant digit is removed from the values in the table. For information on how to set the number of displayed digits, see “Environment Settings (Preference)” under “Other Features.”

### Active Power Range of Each Element

| Current Range | Voltage Range [V] | | | | | |
|---|---|---|---|---|---|---|
| [A] | 1.50000 | 3.00000 | 6.00000 | 10.0000 | 15.0000 | 30.0000 |
| 10.0000m | 15.000 mW | 30.000 mW | 60.000 mW | 100.00 mW | 150.00 mW | 300.00 mW |
| 20.0000m | 30.000 mW | 60.000 mW | 120.00 mW | 200.00 mW | 300.00 mW | 600.00 mW |
| 50.0000m | 75.00 mW | 150.00 mW | 300.00 mW | 500.00 mW | 0.75000 W | 1.50000 W |
| 100.000m | 150.00 mW | 300.00 mW | 600.00 mW | 1.00000 W | 1.50000 W | 3.00000 W |
| 200.000m | 300.00 mW | 600.00 mW | 1.20000 W | 2.00000 W | 3.00000 W | 6.00000 W |
| 500.000m | 0.75000 W | 1.50000 W | 3.00000 W | 5.00000 W | 7.5000 W | 15.0000 W |
| 1.00000 | 1.50000 W | 3.00000 W | 6.00000 W | 10.0000 W | 15.0000 W | 30.0000 W |
| 2.00000 | 3.00000 W | 6.00000 W | 12.0000 W | 20.0000 W | 30.0000 W | 60.0000 W |
| 5.00000 | 7.5000 W | 15.0000 W | 30.0000 W | 50.0000 W | 75.000 W | 150.000 W |

| Current Range | Voltage Range [V] | | | | | |
|---|---|---|---|---|---|---|
| [A] | 60.0000 | 100.000 | 150.000 | 300.000 | 600.000 | 1000.00 |
| 10.0000m | 600.00 mW | 1.00000 W | 1.50000 W | 3.00000 W | 6.00000 W | 10.0000 W |
| 20.0000m | 1.20000 W | 2.00000 W | 3.00000 W | 6.00000 W | 12.0000 W | 20.0000 W |
| 50.0000m | 3.00000 W | 5.00000 W | 7.5000 W | 15.0000 W | 30.0000 W | 50.0000 W |
| 100.000m | 6.00000 W | 10.0000 W | 15.0000 W | 30.0000 W | 60.0000 W | 100.000 W |
| 200.000m | 12.0000 W | 20.0000 W | 30.0000 W | 60.0000 W | 120.000 W | 200.000 W |
| 500.000m | 30.0000 W | 50.0000 W | 75.000 W | 150.000 W | 300.000 W | 500.000 W |
| 1.00000 | 60.0000 W | 100.000 W | 150.000 W | 300.000 W | 600.000 W | 1.00000 kW |
| 2.00000 | 120.000 W | 200.000 W | 300.000 W | 600.000 W | 1.20000 kW | 2.00000 kW |
| 5.00000 | 300.000 W | 500.000 W | 0.75000 kW | 1.50000 kW | 3.00000 kW | 5.00000 kW |

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

| Current Range | Voltage Range [V] | | | | | |
|---|---|---|---|---|---|---|
| [A] | 1.50000 | 3.00000 | 6.00000 | 10.0000 | 15.0000 | 30.0000 |
| 10.0000m | 30.000 mW | 60.000 mW | 120.000 mW | 200.00 mW | 300.00 mW | 600.00 mW |
| 20.0000m | 60.000 mW | 120.000 mW | 240.00 mW | 400.00 mW | 600.00 mW | 1200.00 mW |
| 50.0000m | 150.00 mW | 300.00 mW | 600.00 mW | 1000.00 mW | 1.50000 W | 3.00000 W |
| 100.000m | 300.00 mW | 600.00 mW | 1200.00 mW | 2.00000 W | 3.00000 W | 6.00000 W |
| 200.000m | 600.00 mW | 1200.00 mW | 2.40000 W | 4.00000 W | 6.00000 W | 12.00000 W |
| 500.000m | 1.50000 W | 3.00000 W | 6.00000 W | 10.00000 W | 15.0000 W | 30.0000 W |
| 1.00000 | 3.00000 W | 6.00000 W | 12.00000 W | 20.0000 W | 30.0000 W | 60.0000 W |
| 2.00000 | 6.00000 W | 12.00000 W | 24.0000 W | 40.0000 W | 60.0000 W | 120.0000 W |
| 5.00000 | 15.0000 W | 30.0000 W | 60.0000 W | 100.0000 W | 150.000 W | 300.000 W |

| Current Range | Voltage Range [V] | | | | | |
|---|---|---|---|---|---|---|
| [A] | 60.0000 | 100.000 | 150.000 | 300.000 | 600.000 | 1000.00 |
| 10.0000m | 1200.00 mW | 2.00000 W | 3.00000 W | 6.00000 W | 12.00000 W | 20.0000 W |
| 20.0000m | 2.40000 W | 4.00000 W | 6.00000 W | 12.00000 W | 24.0000 W | 40.0000 W |
| 50.0000m | 6.00000 W | 10.00000 W | 15.0000 W | 30.0000 W | 60.0000 W | 100.0000 W |
| 100.000m | 12.00000 W | 20.0000 W | 30.0000 W | 60.0000 W | 120.0000 W | 200.000 W |
| 200.000m | 24.0000 W | 40.0000 W | 60.0000 W | 120.0000 W | 240.000 W | 400.000 W |
| 500.000m | 60.0000 W | 100.0000 W | 150.000 W | 300.000 W | 600.000 W | 1000.000 W |
| 1.00000 | 120.0000 W | 200.000 W | 300.000 W | 600.000 W | 1200.000 W | 2.00000 kW |
| 2.00000 | 240.000 W | 400.000 W | 600.000 W | 1200.000 W | 2.40000 kW | 4.00000 kW |
| 5.00000 | 600.000 W | 1000.000 W | 1.50000 kW | 3.00000 kW | 6.00000 kW | 10.00000 kW |

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

| Current Range | Voltage Range [V] | | | | | |
|---|---|---|---|---|---|---|
| [A] | 1.50000 | 3.00000 | 6.00000 | 10.0000 | 15.0000 | 30.0000 |
| 10.0000m | 45.000 mW | 90.000 mW | 180.000 mW | 300.00 mW | 450.00 mW | 900.00 mW |
| 20.0000m | 90.000 mW | 180.000 mW | 360.00 mW | 600.00 mW | 900.00 mW | 1800.00 mW |
| 50.0000m | 225.00 mW | 450.00 mW | 900.00 mW | 1500.00 mW | 2.25000 W | 4.50000 W |
| 100.000m | 450.00 mW | 900.00 mW | 1800.00 mW | 3.00000 W | 4.50000 W | 9.00000 W |
| 200.000m | 900.00 mW | 1800.00 mW | 3.60000 W | 6.00000 W | 9.00000 W | 18.00000 W |
| 500.000m | 2.25000 W | 4.50000 W | 9.00000 W | 15.00000 W | 22.5000 W | 45.0000 W |
| 1.00000 | 4.50000 W | 9.00000 W | 18.00000 W | 30.0000 W | 45.0000 W | 90.0000 W |
| 2.00000 | 9.00000 W | 18.00000 W | 36.0000 W | 60.0000 W | 90.0000 W | 180.0000 W |
| 5.00000 | 22.5000 W | 45.0000 W | 90.0000 W | 150.0000 W | 225.000 W | 450.000 W |

| Current Range | Voltage Range [V] | | | | | |
|---|---|---|---|---|---|---|
| [A] | 60.0000 | 100.000 | 150.000 | 300.000 | 600.000 | 1000.00 |
| 10.0000m | 1800.00 mW | 3.00000 W | 4.50000 W | 9.00000 W | 18.00000 W | 30.0000 W |
| 20.0000m | 3.60000 W | 6.00000 W | 9.00000 W | 18.00000 W | 36.0000 W | 60.0000 W |
| 50.0000m | 9.00000 W | 15.00000 W | 22.5000 W | 45.0000 W | 90.0000 W | 150.0000 W |
| 100.000m | 18.00000 W | 30.0000 W | 45.0000 W | 90.0000 W | 180.0000 W | 300.000 W |
| 200.000m | 36.0000 W | 60.0000 W | 90.0000 W | 180.0000 W | 360.000 W | 600.000 W |
| 500.000m | 90.0000 W | 150.0000 W | 225.000 W | 450.000 W | 900.000 W | 1500.000 W |
| 1.00000 | 180.0000 W | 300.000 W | 450.000 W | 900.000 W | 1800.000 W | 3.00000 kW |
| 2.00000 | 360.000 W | 600.000 W | 900.000 W | 1800.000 W | 3.60000 kW | 6.00000 kW |
| 5.00000 | 900.000 W | 1500.00 W | 2.25000 kW | 4.50000 kW | 9.00000 kW | 15.00000 kW |

# Appendix 4 Setting the Measurement Period

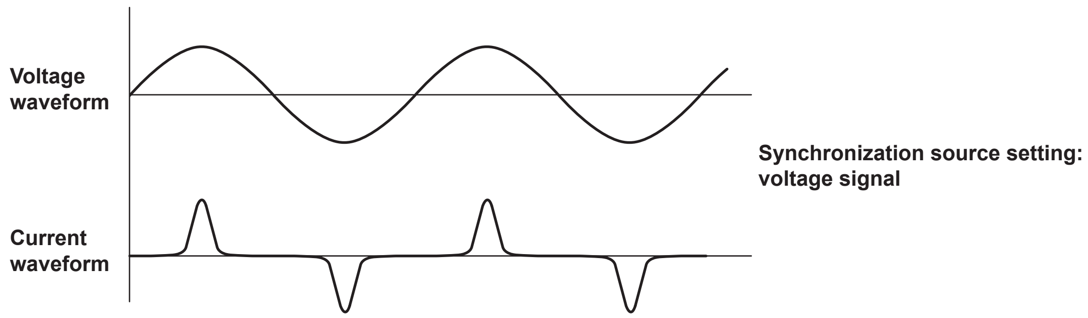
To make correct measurements on the PX8000, you must set its measurement period properly.

The PX8000 uses its frequency measurement circuit (see appendix 14) to detect the period of the input signal that is selected using the synchronization source setting. The measurement period is an integer multiple of this detected period. The PX8000 determines the measured values by averaging the data sampled in the measurement period. The input signal used to determine the measurement period is called the synchronization source.
The measurement period is automatically determined inside the PX8000 when you specify the synchronization source.

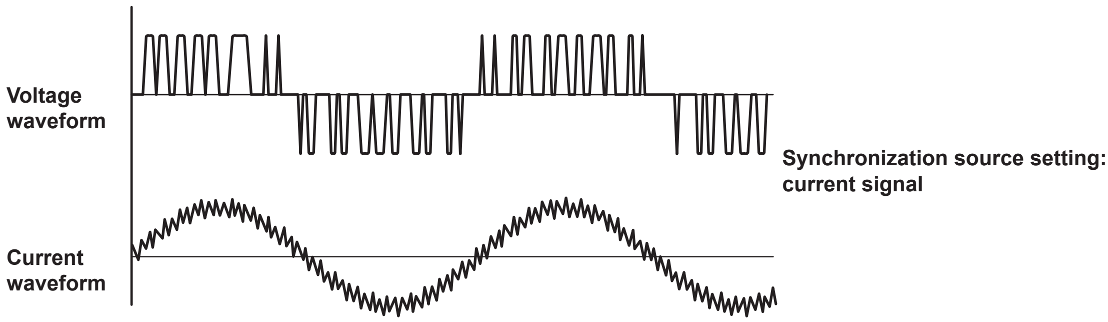
You can select the synchronization source signal from the options listed below.
U1, I1, U2, I2, U3, I3, U4, I4, External, and None
* The available options vary depending on the installed elements.
For example, if the synchronization source for element 1 is set to I1, an integer multiple of the period of I1 becomes the measurement period. By averaging the sampled data in this measurement period, the PX8000 computes the measured values for element 1, such as U1, I1, and P1.

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

Select input signals with stable input levels and frequencies (with little distortion) as synchronization sources. Correct measured values can only be obtained if the period of the synchronization source signal is detected accurately. On the PX8000, display the frequency of the input signal that you have selected as the synchronization source, and confirm that the frequency is being measured correctly. The most suitable synchronization source is the input signal that is the most stable and that provides accurate measured results. For example, if a switching power supply is being measured and the voltage waveform distortion is smaller than the current waveform distortion, set the synchronization source to the voltage signal.

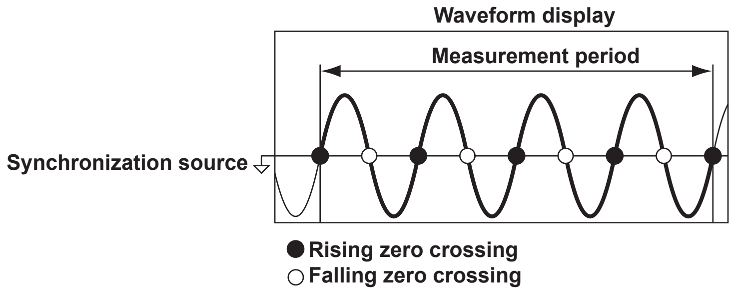


As another example, if an inverter is being measured and the current waveform distortion is smaller than the voltage waveform distortion, set the synchronization source to the current signal.



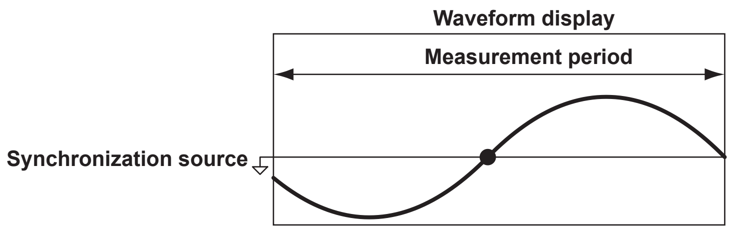

### Zero Crossing

- The rising (or falling) zero crossing is the time when the synchronization source passes through level zero (the center of the amplitude) on a rising (or falling) slope. The measurement period on the PX8000 is between the first rising (or falling) zero crossing and the last rising (or falling) zero crossing in the waveform display.
- The PX8000 determines the measurement period on the basis of the first rising or falling zero crossing within the waveform display.




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

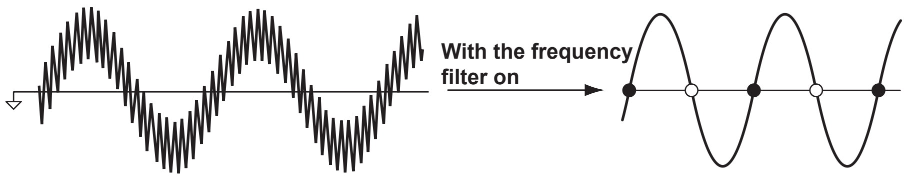
If the total number of rising and falling zero crossings on the input signal that has been set as the synchronization source is less than two within the waveform display, the period cannot be detected. Also, the period cannot be detected if the AC amplitude is small. For information on the detectable frequency levels, see the conditions listed under “measurement range” under “Frequency” Measurement” in section 7.5, “Features,” in the Getting Started Guide, IM PX8000-03EN.
If the period cannot be detected, the entire waveform display is used to average the sampled data.



Because of the reasons described above, the measured voltage and current values may be unstable. If this happens, lengthen the time axis setting (TIME/DIV) so that more periods of the input signal fit within the waveform display.

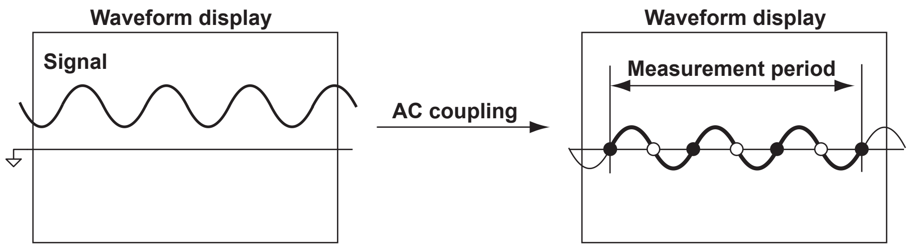
### When the Waveform of the Synchronization Source Is Distorted

Change the synchronization source to a signal that allows for more stable detection of the period (switch from voltage to current or from current to voltage). Also, turn on the frequency filter.
The PX8000 reduces the effects of noise by using hysteresis when it detects zero crossings. If the synchronization source is distorted or harmonics and noise are superposed on the signal to a level exceeding this hysteresis, harmonic components will cause zero crossing detection to occur frequently, and the zero crossing of the fundamental frequency will not be detected stably. Consequently, the measured voltage and current may be unstable. When high frequency components are superposed on the current waveform such as in the aforementioned inverter example, turn the frequency filter on to stably detect zero crossings. Use of the filter is appropriate if it makes the measured frequency accurate and more stable. Because the frequency filter can be used to facilitate the detection of the synchronization source's zero crossings, it is sometimes called the synchronization source filter or the zero-crossing filter.




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

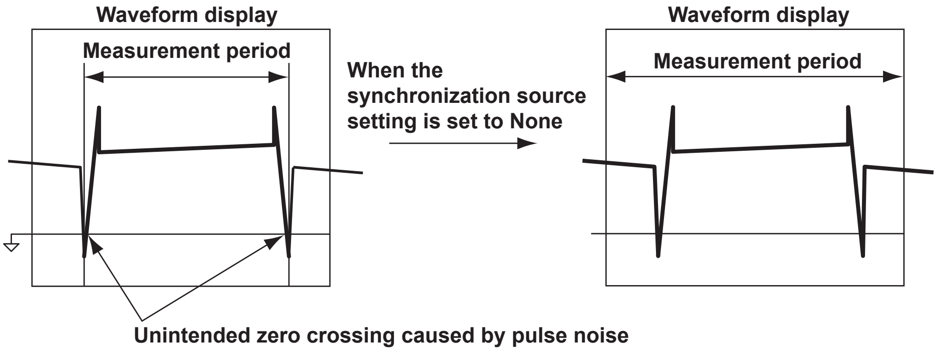
The measured values may be unstable if the period of the AC signal cannot be detected accurately. Change the synchronization source to a signal that allows for more stable detection of the period (switch from voltage to current or from current to voltage). The frequency detection circuit is AC coupled. Even with AC signals in which there are no zero crossings because of an offset, the period can be detected if the AC amplitude is greater than or equal to the detection level* of the frequency measurement circuit.
With this feature, the measurement period is set to an integer multiple of the period of the AC signal.




When Measuring a DC Signal

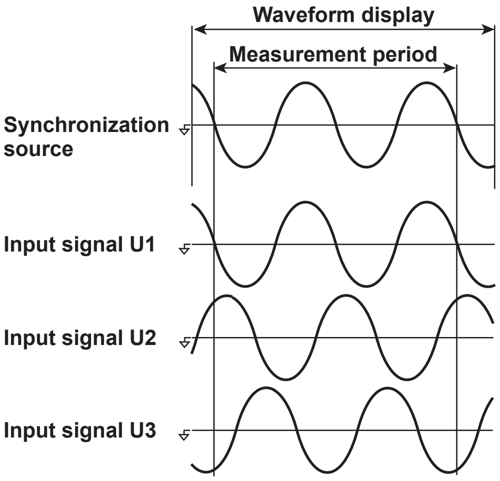
When there are ripples in the DC signal, if the level of the ripples is greater than or equal to the detection level* of the frequency measurement circuit and the period can be detected accurately and stably, a more accurate DC measurement is possible. If a large AC signal is superposed on a DC signal, you can achieve a more stable measurement by detecting the AC signal period and averaging it.
In addition, if a small fluctuating pulse noise riding on the DC signal crosses level zero, that point is detected as a zero crossing. As a result, sampled data is averaged over an unintended period, and measured values such as voltage and current may be unstable. You can prevent these kinds of erroneous detections by setting the synchronization source to OFF. All of the sampled data in the waveform display is used to determine measured values. Set the synchronization source according to the signal under measurement and the measurement objective.

* See the conditions listed under "measurement range" under "Frequency Measurement" in section 7.5, "Features," in the Getting Started Guide, IM PX8000-03EN.




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

If a three-phase device is measured with elements 1 and 2 using a three-phase, three-wire system, set the synchronization source of elements 1 and 2 to the same signal. For example, set the synchronization source of elements 1 and 2 to U1 or I1. The measurement periods of elements 1 and 2 will match, and it will be possible to measure the Σ voltage, Σ current, and Σ power of a three-phase device more accurately.
Likewise, if a three-phase device is measured with elements 1, 2, and 3 using a three-phase, four-wire system, set the synchronization source of elements 1, 2, and 3 to the same signal.
To facilitate this sort of configuration, the synchronization source setting on the PX8000 is linked to the Σ wiring unit of the wiring system (when independent element configuration is turned off). If independent element configuration is turned on, the synchronization source of each element in the Σ wiring unit can be set independently.



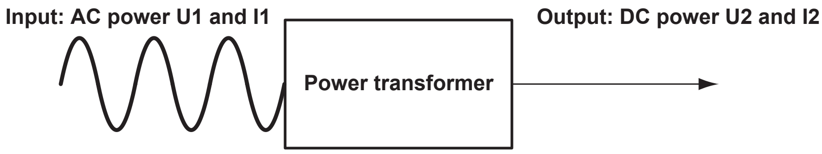

| Synchronization Source Setup Example | |
|---|---|
| Element 1 | U1 (or I1) |
| Element 2 | |
| Element 3 | |

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

- **Power Transformer with Single-Phase Input and Single-Phase Output**

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

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




| Synchronization Source Setup Example | |
|---|---|
| Element 1 | U1 (or I1) |
| Element 2 | |

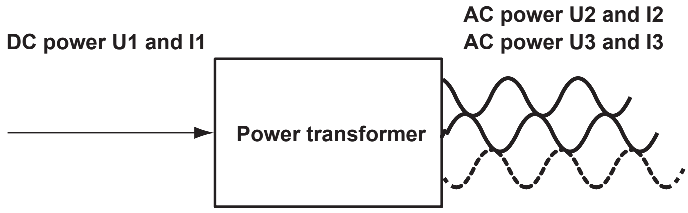
Likewise, if you are using elements 1 (DC end) and 2 (AC end) to measure a device that converts single-phase DC power to single-phase AC power, set the synchronization source of elements 1 and 2 to the voltage (or current) on the AC power end (element 2). In the example shown in the figure below, set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


| Synchronization Source Setup Example | |
|---|---|
| Element 1 | U2 (or I2) |
| Element 2 | |

- **Power Transformer with Single-Phase DC Input and Three-Phase AC Output**

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

  In this example, set the synchronization source of elements 1, 2, and 3 to U2 (or I2, U3, or I3). The measurement periods of the input signal and all output signals will match, and it will be possible to measure the power conversion efficiency of the power transformer more accurately.
  - Single-phase DC power: Connect to element 1.
  - Three-phase AC power: Connect to elements 2 and 3 using a three-phase, three-wire system.




| Synchronization Source Setup Example | |
|---|---|
| Element 1 | U2 (or I2, U3, or I3) |
| Element 2 | |
| Element 3 | |

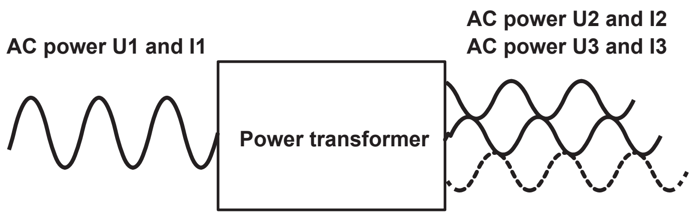
- **Power Transformer with Single-Phase AC Input and Three-Phase AC Output**

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

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

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

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




| Synchronization Source Setup Example | |
|---|---|
| Element 1 | U1 (or I1) |
| Element 2 | U2 (or I2, U3, or I3) |
| Element 3 | |

- The measurement period for determining the numeric data of the peak voltage or peak current is the entire span of the waveform display, regardless of the measurement period settings discussed above. Therefore, the measurement period for the measurement functions that are determined using the maximum voltage or current value (U+pk, U-pk, I+pk, I-pk, CfU, and CfI) is also the entire span of the waveform display.
- For details on the measurement period for measurement functions related to harmonic measurement, see “Harmonic Measurement Start Point” under “Numeric Computation.”

# Appendix 5 Measurement Accuracy and Measurement Error

Instruments such as power meters have specifications for measurement accuracy or measurement errors. For example, on the PX8000, the voltage and current accuracy in the range of 45 Hz to 1 kHz is ±(0.1% of reading + 0.1 % of range).

## Reading Error and Range Error

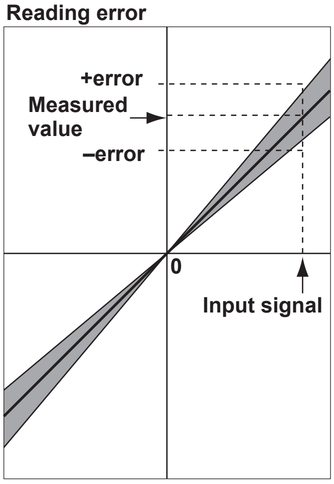
### Reading error: of reading

The error indicated by “of reading” is called reading error. The error is calculated on the basis of the measured reading (measured values). It is an error that is included at a given ratio of the measured values. The larger the measured value, larger the reading error that is included. The smaller the measured value, smaller the reading error that is included.

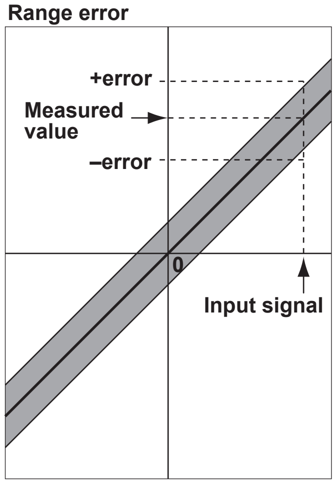
### Range error: of range

The error indicated by “of range” is called range error. The error is calculated on the basis of the measurement range that is used in measurement. It is an error that is included at a given magnitude in the measured values. The range error that is included is of the same magnitude regardless of whether the measured value is large or small.

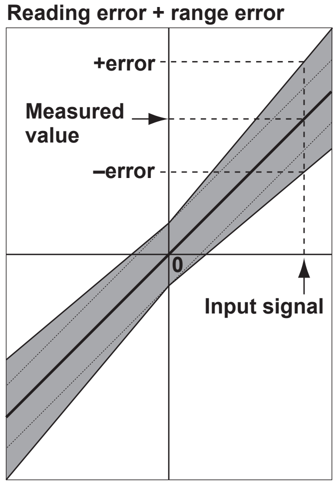
**Reading error**




**Range error**




**Reading error + range error**




To see how much error is included in the measured values, let us look at several computation examples for a 60 Hz sine wave input signal.
The examples assume that the number of displayed digits on the PX8000 is set to 5.

## Voltage and Current Measurement Error

### Example 1: Measuring 1 Arms Using the 1 A Measurement Range

When the measured value is 1.0000 [A], the reading error and range error are as follows:

- Reading error: 1.0000 [A]×0.1% = 0.001 [A]
- Range error: 1 [A]×0.1% = 0.001 [A]

The error included in 1.0000 [A] is the sum of the reading and range errors, which is ±0.002 [A]. This corresponds to 0.2% of the displayed value.

Application of an input signal whose value is the same as the name of the measurement range is referred to as rated range input. And, such input signals are called rated range signals.

### Example 2: Measuring 1 Arms Using the 5 A Measurement Range

In this example, we measure the same input using the 5 A range. When the measured value is 1.0000 [A], the reading error and range error are as follows:

- Reading error: 1.0000 [A]×0.1% = 0.001 [A]
- Range error: 5 [A]×0.1% = 0.005 [A]

The error included in 1.0000 [A] is the sum of the reading and range errors, which is ±0.006 [A]. This corresponds to 0.6% of the measured value.
The error has increased even though the same current signal as example 1 was measured. As this example illustrates, using a measurement range that is unnecessarily large for an input signal results in larger measurement errors. It is import to measure using a measurement range that is appropriate for the input signal.

If the input signal is not a sine wave and includes distortions and spikes, select a somewhat large measurement range that would not cause peak over-ranges to occur.

### Example 3: Measuring 0.5 Arms Using the 1 A Measurement Range

Next, we measure 0.5 A using the 1 A measurement range (the same as example 1). When the measured value is 0.5000 [A], the reading error and range error are as follows:

- Reading error: 0.5000 [A]×0.1% = 0.0005 [A]
- Range error: 1 [A]×0.1% = 0.001 [A]

The error included in 0.5000 [A] is the sum of the reading and range errors, which is ±0.0015 [A]. This corresponds to 0.3% of the measured value.
When we compare this result with that of example 1, we notice the following:

- The reading error has been reduced in accordance with the input amplitude.
- The range error has not changed.

As a result, the error is 0.3%, which is slightly larger than 0.2% of example 1. This is also because the measurement range is large relative to the input signal. In this case, we should use the 0.5 A measurement range.

## Measurement Error of Active Power

On the PX8000, the power accuracy in the range of 45 Hz to 1 kHz is ±(0.1% of reading + 0.1 % of range).
Let us calculate the error for the following example.

- Voltage measurement range: 150 V, measured voltage: 100.00 V
- Current measurement range: 1A, measured current: 0.8000 A
- Measured power: 80.00 W
- 60 Hz sine wave for both voltage and current
- Phase difference between the voltage and current signals = 0°

### Power Range

The power measurement range is defined as voltage measurement range × current measurement range. In this example, the power measurement range is 150 V×1 A = 150 W. We use this power measurement range to calculate the range error.

The reading error and range error included in the measured power (80.00 W) are as follows:

- Reading error: 80.00 [W]×0.1% = 0.08 [W]
- Range error: 150 [W]×0.1% = 0.15 [W]

The error included in 80.00 [W] is the sum of the reading and range errors, which is ±0.23 [W]. This corresponds to 0.2875% of the displayed value.

## Power Factor Influence (Power Factor Error)

The previous example was for when the phase difference between the voltage and current signals was 0°, or in other words, when the power factor was 1. Next, we will calculate the error for an example in which the power factor is not 1.

### When the Power Factor is 0

This is an example for when the phase difference is 90°, or in other words, when the power factor is 0. Theoretically, the active power is 0 W, apparent power is 80 VA, and the reactive power is 80 var. This assumes an ideal capacitive (C) load or an ideal inductive (L) load. For details, see appendix 2.

When the power factor (λ) = 0, the power error on the PX8000 is defined as follows:
±0.15% of S (S: apparent power) in the 45 Hz ≤ f ≤ 66 Hz range

When the measured apparent power is 80.00 [VA], the error in the measured power (0.00 W) is as follows:
80.00 × ±0.15% = ±0.12 [W]

### When the Power Factor Is Greater Than 0 but Less Than 1

As an example, let us calculate the error for when the power factor is 0.5, or in other words, when the phase difference between the voltage and current (Φ) is 60°.

- The power accuracy in the range of 45 Hz to 1 kHz: ±(0.1% of reading + 0.1 % of range)
- Voltage measurement range: 150 V, measured voltage: 100.00 V
- Current measurement range: 1A, measured current: 0.8000 A
- Power measurement range: 150 W, measured power: 40.00 W, measured apparent power: 80.00 VA, measured reactive power: 69.28 var

When 0 < λ < 1, the power error on the PX8000 is defined as follows:
(Power reading) × [(power reading error %) + (power range error %) × (power range/indicated apparent power value) + {tan Φ × (influence when λ = 0)%}],

If we substitute the above value into this equation, the power error becomes as follows:
40.00 [W] × [ 0.1% + 0.1% × (150/80.00) + {tan60° × (influence (%) when λ = 0)}]
= 40.00 [W] × {0.1 + 0.1 × (150/80.00) + √3 × 0.15}%
= 0.2189 [W]

The error in the measured power (40.00 W) is ±0.2189 [W].

## Error in Three-Phase Power

The error when measuring power of a three-phase, three-wire system using elements 1 and 2 of the PX8000 is explained with the next example.

- Voltage measurement range: 150 V, measured voltage: 100 V for U1, U2, and UΣ
- Current measurement range: 1 A, measured current: 0.8 A for I1, I2, and IΣ
- Measured power: P1 = 69.28 W, P2 = 69.28W, PΣ = 138.56 W
- 60 Hz sine wave for both voltage and current
- Phase difference between the voltage and current signals = 0°
- Phase angle between phases = 60°

### Three-Phase Measurement Range

For the three-phase measurement range, refer to the table of Σ function equations on page App-2. This table shows the expressions that the PX8000 uses to internally calculate the measured values. This table also applies to how to think about the measurement range. In this example, we will apply the three-phase, three-wire (3P3W) column.

### Voltage and Current

Three-phase voltage (UΣ) measurement range = (U1 measurement range + U2 measurement range)/2
= (150 + 150)/2 = 150
Three-phase current (IΣ) measurement range = (I1 measurement range + I2 measurement range)/2
= (1 + 1)/2 = 1

The reading error and range error included in the measured three-phase voltage (UΣ; 100.00 V) are as follows:

- Reading error: 100.00 [V]×0.1% = 0.1 [V]
- Range error: 150 [V]×0.1% = 0.15 [V]

The error included in 100.00 [V] is the sum of the reading and range errors, which is ±0.25 [V]. This corresponds to 0.25% of the displayed value. Because the measured values of U1 and U2 are the same, UΣ also has the same error. The same calculation method applies for the currents.

### Power

Referring to the table of Σ function equations on page App-2, the power range is as follows:
Three-phase power (PΣ) measurement range
= P1 measurement range + P2 measurement range
= (U1 measurement range × I1 measurement range) + (U2 measurement range × I2 measurement range)
= (150 × 1) + (150 × 1)
= 300

The reading error and range error included in the measured three-phase power (PΣ; 138.56 W) are as follows:

- Reading error: 138.56 [W]×0.1% = 0.13856 [W]
- Range error: 300 [W]×0.1% = 0.3 [W]

The error included in 138.56 [W] is the sum of the reading and range errors, which is ±0.43856 [W]. This corresponds to approximately 0.317% of the displayed value.

### Accuracy and Precision

Measurement accuracy refers to how close a measurement is to the true value. In other words, it indicates the deviation of a measured value from the true value. Measurement precision refers to how close measurements of the same quantity are to each other.
For example, let us consider the measured results of two voltmeters when 1.00 V is measured three times.

| | Voltmeter A | Voltmeter B |
|---|---|---|
| 1st measurement | 1.02 V | 1.04 V |
| 2nd measurement | 1.00 V | 1.05 V |
| 3rd measurement | 0.98 V | 1.06V |

Voltmeter A measurements are closer to the true value (1.00 V). We can say that voltmeter A is more accurate than voltmeter B.
On the other hand, the three voltmeter B measurements are closer to each other than those of voltmeter A. We can say that voltmeter B is more precise than voltmeter A.

### Measurement Error

A measurement error is the difference between the actual measurement and the true value.

# Appendix 5 User-Defined Function Operands

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

## Measurement Functions Used in Normal Measurement

| Measurement Function | User-Defined Function | | Parameter in ( ) | |
|---|---|---|---|---|
| | | | Element | Wiring Unit |
| | | Example | E1 to E4 | 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 |
| Irms | IRMS( ) | IRMS(E1) | Yes | Yes |
| Imn | IMN( ) | IMN(E1) | Yes | Yes |
| Idc | IDC( ) | IDC(E1) | Yes | Yes |
| Irmn | IRMN( ) | IRMN(E1) | Yes | Yes |
| Iac | IAC( ) | IAC(E1) | Yes | Yes |
| P | P( ) | P(E1) | Yes | Yes |
| S | S( ) | S(E1) | Yes | Yes |
| Q | Q( ) | Q(E1) | Yes | Yes |
| λ | LAMBDA( ) | LAMBDA(E1) | Yes | Yes |
| Φ | PHI( ) | PHI(E1) | Yes | Yes |
| fU | FU( ) | FU(E1) | Yes | No |
| fI | FI( ) | FI(E1) | Yes | No |
| U+pk | UPPK( ) | UPPK(E1) | Yes | No |
| U-pk | UMPK( ) | UMPK(E1) | Yes | No |
| I+pk | IPPK( ) | IPPK(E1) | Yes | No |
| I-pk | IMPK( ) | IMPK(E1) | Yes | No |
| P+pk | PPPK( ) | PPPK(E1) | Yes | No |
| P-pk | PMPK( ) | PMPK(E1) | Yes | No |
| CfU | CFU( ) | CFU(E1) | Yes | No |
| CfI | CFI( ) | CFI(E1) | Yes | No |
| Pc | PC( ) | PC(E1) | Yes | Yes |

### Efficiency

| Measurement Function | User-Defined Function | | Parameter in ( ) | |
|---|---|---|---|---|
| | | | Element | Wiring Unit |
| | | Example | E1 to E4 | SA, SB |
| η1 | ETA1( ) | ETA1( ) | None or space* | |
| η2 | ETA2( ) | ETA2( ) | None or space* | |
| η3 | ETA3( ) | ETA3( ) | None or space* | |
| η4 | ETA4( ) | ETA4( ) | None or space* | |

* You cannot omit the parentheses.

### User-Defined Functions

| Measurement Function | User-Defined Function | | Parameter in ( ) | |
|---|---|---|---|---|
| | | | Element | Wiring Unit |
| | | Example | E1 to E4 | SA, SB |
| 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.

### Auxiliary Input (When motor mode is off)

| Measurement Function | User-Defined Function | | Parameter in ( ) | |
|---|---|---|---|---|
| | | | Element | Wiring Unit |
| | | Example | E2 to E4 | SA, SB |
| 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.

### Auxiliary Input (When motor mode is on)

| Measurement Function | User-Defined Function | | Parameter in ( ) | |
|---|---|---|---|---|
| | | | Element | Wiring Unit |
| | | Example | E2 to E4 | SA, SB |
| Aux3 (Rotating speed) | AUX3( ) | AUX3( ) | None or space* | |
| Aux4 (Torque) | AUX4( ) | AUX4( ) | None or space* | |
| Pm2 (Monitor output) | PM2( ) | PM2( ) | None or space* | |
| Aux5 (Rotating speed) | AUX5( ) | AUX5( ) | None or space* | |
| Aux6 (Torque) | AUX6( ) | AUX6( ) | None or space* | |
| Pm3 (Monitor output) | PM3( ) | PM3( ) | None or space* | |
| Aux7 (Rotating speed) | AUX7( ) | AUX7( ) | None or space* | |
| Aux8 (Torque) | AUX8( ) | AUX8( ) | None or space* | |
| Pm4 (Monitor output) | PM4( ) | PM4( ) | None or space* | |

* You cannot omit the parentheses.

## Delta Computation

| Measurement Function | User-Defined Function | | Parameter in ( ) | |
|---|---|---|---|---|
| | | | Element | Wiring Unit |
| | | Example | E1 to E4 | SA, SB |
| ΔU1( ) | DELTAU1( ) | DELTAU1(E5) | No | Yes |
| ΔU2( ) | DELTAU2( ) | DELTAU2(E5) | No | Yes |
| ΔU3( ) | DELTAU3( ) | DELTAU3(E5) | No | Yes |
| ΔUΣ( ) | DELTAUSIG( ) | DELTAUSIG(E5) | No | Yes |
| ΔI( ) | DELTAI( ) | DELTAI(E5) | No | Yes |
| ΔP1( ) | DELTAP1( ) | DELTAP1(E5) | No | Yes |
| ΔP2( ) | DELTAP2( ) | DELTAP2(E5) | No | Yes |
| ΔP3( ) | DELTAP3( ) | DELTAP3(E5) | No | Yes |
| ΔPΣ( ) | DELTAPSIG( ) | DELTAPSIG(E5) | No | Yes |
| ΔU1rms( ) | DELTAU1RMS( ) | DELTAU1RMS(E5) | No | Yes |
| ΔU2rms( ) | DELTAU2RMS( ) | DELTAU2RMS(E5) | No | Yes |
| ΔU3rms( ) | DELTAU3RMS( ) | DELTAU3RMS(E5) | No | Yes |
| ΔUΣrms( ) | DELTAUSIGRMS( ) | DELTAUSIGRMS(E5) | No | Yes |
| ΔU1mean( ) | DELTAU1MN( ) | DELTAU1MN(E5) | No | Yes |
| ΔU2mean( ) | DELTAU2MN( ) | DELTAU2MN(E5) | No | Yes |
| ΔU3mean( ) | DELTAU3MN( ) | DELTAU3MN(E5) | No | Yes |
| ΔUΣmean( ) | DELTAUSIGMN( ) | DELTAUSIGMN(E5) | No | Yes |
| ΔU1rmean( ) | DELTAU1RMN( ) | DELTAU1RMN(E5) | No | Yes |
| ΔU2rmean( ) | DELTAU2RMN( ) | DELTAU2RMN(E5) | No | Yes |
| ΔU3rmean( ) | DELTAU3RMN( ) | DELTAU3RMN(E5) | No | Yes |
| ΔUΣrmean( ) | DELTAUSIGRMN( ) | DELTAUSIGRMN(E5) | No | Yes |
| ΔU1dc( ) | DELTAU1DC( ) | DELTAU1DC(E5) | No | Yes |
| ΔU2dc( ) | DELTAU2DC( ) | DELTAU2DC(E5) | No | Yes |
| ΔU3dc( ) | DELTAU3DC( ) | DELTAU3DC(E5) | No | Yes |
| ΔUΣdc( ) | DELTAUSIGDC( ) | DELTAUSIGDC(E5) | No | Yes |
| ΔU1ac( ) | DELTAU1AC( ) | DELTAU1AC(E5) | No | Yes |
| ΔU2ac( ) | DELTAU2AC( ) | DELTAU2AC(E5) | No | Yes |
| ΔU3ac( ) | DELTAU3AC( ) | DELTAU3AC(E5) | No | Yes |
| ΔUΣac( ) | DELTAUSIGAC( ) | DELTAUSIGAC(E5) | No | Yes |
| ΔIrms( ) | DELTAIrms( ) | DELTAIRMS(E5) | No | Yes |
| ΔImean( ) | DELTAIMN( ) | DELTAIMN(E5) | No | Yes |
| ΔIrmean( ) | DELTAIRMN( ) | DELTAIRMN(E5) | No | Yes |
| ΔIdc( ) | DELTAIDC( ) | DELTAIDC(E5) | No | Yes |
| ΔIac( ) | DELTAIAC( ) | DELTAIAC(E5) | No | Yes |

### Harmonic Measurement Option

| Measurement Function | User-Defined Function | | Left Parameter in ( , ) or Parameter in ( ) | | Right Parameter in ( , ) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Element | Wiring Unit | Harmonic Order | | | |
| | | | | | Total Value | DC | Fundamental Wave | Harmonics |
| | | Example | E1 to E4 | SA, SB | ORT | OR0 | OR1 | OR2 to OR500 |
| U_k | UK( , ) | UK(E1,OR3) | Yes | Yes | Yes | Yes | Yes | Yes |
| I_k | IK( , ) | IK(E1,OR3) | Yes | Yes | Yes | Yes | Yes | Yes |
| P_k | PK( , ) | PK(E1,OR3) | Yes | Yes | Yes | Yes | Yes | Yes |
| S_k | SK( , ) | SK(E1,OR3) | Yes | Yes | Yes | Yes | Yes | Yes |
| Q_k | QK( , ) | QK(E1,OR3) | Yes | Yes | Yes | Yes | Yes | Yes |
| λ_k | LAMBDAK( , ) | LAMBDAK(E1,OR3) | Yes | Yes | Yes | Yes | Yes | Yes |
| Φ_k | PHIK( , ) | PHIK(E1,OR3) | Yes | No | Yes | No | Yes | Yes |
| ΦU | UPHI( , ) | UPHI(E1,OR3) | Yes | No | No | No | No | Yes |
| ΦI | IPHI( , ) | IPHI(E1,OR3) | Yes | No | No | No | No | Yes |
| Z | ZK( , ) | ZK(E1,OR3) | Yes | No | No | Yes | Yes | Yes |
| Rs | RSK( , ) | RSK(E1,OR3) | Yes | No | No | Yes | Yes | Yes |
| Xs | XSK( , ) | XSK(E1,OR3) | Yes | No | No | Yes | Yes | Yes |
| Rp | RPK( , ) | RPK(E1,OR3) | Yes | No | No | Yes | Yes | Yes |
| Xp | XPK( , ) | XPK(E1,OR3) | Yes | No | No | Yes | Yes | Yes |
| Uhdf | UHDF( , ) | UHDF(E1,OR3) | Yes | No | No | Yes | Yes | Yes |
| Ihdf | IHDF( , ) | IHDF(E1,OR3) | Yes | No | No | Yes | Yes | Yes |
| Phdf | PHDF( , ) | PHDF(E1,OR3) | Yes | No | No | Yes | Yes | Yes |
| 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 | | | | |
| fPLL | PLLFRQ( ) | PLLFRQ( ) | No | No | | | | |
| ΦU1-U2 | PHIU1U2( ) | PHIU1U2(E5) | No | Yes | | | | |
| ΦU1-U3 | PHIU1U3( ) | PHIU1U3(E5) | No | Yes | | | | |
| ΦU1-I1 | PHIU1I1( ) | PHIU1I1(E5) | Yes | Yes | | | | |
| ΦU2-I2 | PHIU2I2( ) | PHIU2I2(E5) | No | Yes | | | | |
| ΦI1-I2 | PHII1I2( ) | PHII1I2(E5) | No | Yes | | | | |
| ΦI2-I3 | PHII2I3( ) | PHII2I3(E5) | No | Yes | | | | |
| ΦI3-I1 | PHII3I1( ) | PHII3I1(E5) | No | Yes | | | | |
| ΦU3-I3 | PHIU3I3( ) | PHIU3I3(E5) | No | Yes | | | | |

# Appendix 7 Relationship between the Time Axis Setting, Record Length, and Sample Rate

### When the Record Length Is 100 kpoint, 250 kpoint, 500 kpoint, or 1 Mpoint

| Time/div | Record Length | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 100 kpoint | | 250 kpoint | | 500 kpoint | | 1 Mpoint | |
| | Sample Rate (S/s) | Display Record Length (Points) | Sample Rate (S/s) | Display Record Length (Points) | Sample Rate (S/s) | Display Record Length (Points) | Sample Rate (S/s) | Display Record Length (Points) |
| 100 ns | 100 M | 100 | 100 M | 100 | 100 M | 100 | 100 M | 100 |
| 200 ns | 100 M | 200 | 100 M | 200 | 100 M | 200 | 100 M | 200 |
| 500 ns | 100 M | 500 | 100 M | 500 | 100 M | 500 | 100 M | 500 |
| 1 μs | 100 M | 1 k | 100 M | 1 k | 100 M | 1 k | 100 M | 1 k |
| 2 μs | 100 M | 2 k | 100 M | 2 k | 100 M | 2 k | 100 M | 2 k |
| 5 μs | 100 M | 5 k | 100 M | 5 k | 100 M | 5 k | 100 M | 5 k |
| 10 μs | 100 M | 10 k | 100 M | 10 k | 100 M | 10 k | 100 M | 10 k |
| 20 μs | 100 M | 20 k | 100 M | 20 k | 100 M | 20 k | 100 M | 20 k |
| 50 μs | 100 M | 50 k | 100 M | 50 k | 100 M | 50 k | 100 M | 50 k |
| 100 μs | 100 M | 100 k | 100 M | 100 k | 100 M | 100 k | 100 M | 100 k |
| 200 μs | 50 M | 100 k | 100 M | 200 k | 100 M | 200 k | 100 M | 200 k |
| 500 μs | 20 M | 100 k | 50 M | 250 k | 100 M | 500 k | 100 M | 500 k |
| 1 ms | 10 M | 100 k | 20 M | 200 k | 50 M | 500 k | 100 M | 1 M |
| 2 ms | 5 M | 100 k | 10 M | 200 k | 20 M | 400 k | 50 M | 1 M |
| 5 ms | 2 M | 100 k | 5 M | 250 k | 10 M | 500 k | 20 M | 1 M |
| 10 ms | 1 M | 100 k | 2 M | 200 k | 5 M | 500 k | 10 M | 1 M |
| 20 ms | 500 k | 100 k | 1 M | 200 k | 2 M | 400 k | 5 M | 1 M |
| 50 ms | 200 k | 100 k | 500 k | 250 k | 1 M | 500 k | 2 M | 1 M |
| 100 ms | 100 k | 100 k | 200 k | 200 k | 500 k | 500 k | 1 M | 1 M |
| 200 ms | 50 k | 100 k | 100 k | 200 k | 200 k | 400 k | 500 k | 1 M |
| 500 ms | 20 k | 100 k | 50 k | 250 k | 100 k | 500 k | 200 k | 1 M |
| 1 s | 10 k | 100 k | 20 k | 200 k | 50 k | 500 k | 100 k | 1 M |
| 2 s | 5 k | 100 k | 10 k | 200 k | 20 k | 400 k | 50 k | 1 M |
| 3 s | 2 k | 60 k | 5 k | 150 k | 10 k | 300 k | 20 k | 600 k |
| 4 s | 2 k | 80 k | 5 k | 200 k | 10 k | 400 k | 20 k | 800 k |
| 5 s | 2 k | 100 k | 5 k | 250 k | 10 k | 500 k | 20 k | 1 M |
| 6 s | 1 k | 60 k | 2 k | 120 k | 5 k | 300 k | 10 k | 600 k |
| 8 s | 1 k | 80 k | 2 k | 160 k | 5 k | 400 k | 10 k | 800 k |
| 10 s | 1 k | 100 k | 2 k | 200 k | 5 k | 500 k | 10 k | 1 M |
| 20 s | 500 | 100 k | 1 k | 200 k | 2 k | 400 k | 5 k | 1 M |
| 30 s | 200 | 60 k | 500 | 150 k | 1 k | 300 k | 2 k | 600 k |
| 1 min | 100 | 60 k | 200 | 120 k | 500 | 300 k | 1 k | 600 k |
| 2 min | 50 | 60 k | 200 | 240 k | 200 | 240 k | 500 | 600 k |

When the time axis setting is 100 ms or greater (the settings surrounded by bold lines) and the trigger mode is Auto or Auto Level, waveforms are displayed in roll mode.

### When the Record Length Is 2.5 Mpoint, 5 Mpoint, 10 Mpoint, or 25 Mpoint

| Time/div | Record Length | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2.5 Mpoint | | 5 Mpoint | | 10 Mpoint | | 25 Mpoint | |
| | Sample Rate (S/s) | Display Record Length (Points) | Sample Rate (S/s) | Display Record Length (Points) | Sample Rate (S/s) | Display Record Length (Points) | Sample Rate (S/s) | Display Record Length (Points) |
| 100 ns | 100 M | 100 | 100 M | 100 | 100 M | 100 | 100 M | 100 |
| 200 ns | 100 M | 200 | 100 M | 200 | 100 M | 200 | 100 M | 200 |
| 500 ns | 100 M | 500 | 100 M | 500 | 100 M | 500 | 100 M | 500 |
| 1 µs | 100 M | 1 k | 100 M | 1 k | 100 M | 1 k | 100 M | 1 k |
| 2 µs | 100 M | 2 k | 100 M | 2 k | 100 M | 2 k | 100 M | 2 k |
| 5 µs | 100 M | 5 k | 100 M | 5 k | 100 M | 5 k | 100 M | 5 k |
| 10 µs | 100 M | 10 k | 100 M | 10 k | 100 M | 10 k | 100 M | 10 k |
| 20 µs | 100 M | 20 k | 100 M | 20 k | 100 M | 20 k | 100 M | 20 k |
| 50 µs | 100 M | 50 k | 100 M | 50 k | 100 M | 50 k | 100 M | 50 k |
| 100 µs | 100 M | 100 k | 100 M | 100 k | 100 M | 100 k | 100 M | 100 k |
| 200 µs | 100 M | 200 k | 100 M | 200 k | 100 M | 200 k | 100 M | 200 k |
| 500 µs | 100 M | 500 k | 100 M | 500 k | 100 M | 500 k | 100 M | 500 k |
| 1 ms | 100 M | 1 M | 100 M | 1 M | 100 M | 1 M | 100 M | 1 M |
| 2 ms | 100 M | 2 M | 100 M | 2 M | 100 M | 2 M | 100 M | 2 M |
| 5 ms | 50 M | 2.5 M | 100 M | 5 M | 100 M | 5 M | 100 M | 5 M |
| 10 ms | 20 M | 2 M | 50 M | 5 M | 100 M | 10 M | 100 M | 10 M |
| 20 ms | 10 M | 2 M | 20 M | 4 M | 50 M | 10 M | 100 M | 20 M |
| 50 ms | 5 M | 2.5 M | 10 M | 5 M | 20 M | 10 M | 50 M | 25 M |
| 100 ms | 2 M | 2 M | 5 M | 5 M | 10 M | 10 M | 20 M | 20 M |
| 200 ms | 1 M | 2 M | 2 M | 4 M | 5 M | 10 M | 10 M | 20 M |
| 500 ms | 500 k | 2.5 M | 1 M | 5 M | 2 M | 10 M | 5 M | 25 M |
| 1 s | 200 k | 2 M | 500 k | 5 M | 1 M | 10 M | 2 M | 20 M |
| 2 s | 100 k | 2 M | 200 k | 4 M | 500 k | 10 M | 1 M | 20 M |
| 3 s | 50 k | 1.5 M | 100 k | 3 M | 200 k | 6 M | 500 k | 15 M |
| 4 s | 50 k | 2 M | 100 k | 4 M | 200 k | 8 M | 500 k | 20 M |
| 5 s | 50 k | 2.5 M | 100 k | 5 M | 200 k | 10 M | 500 k | 25 M |
| 6 s | 20 k | 1.2 M | 50 k | 3 M | 100 k | 6 M | 200 k | 12 M |
| 8 s | 20 k | 1.6 M | 50 k | 4 M | 100 k | 8 M | 200 k | 16 M |
| 10 s | 20 k | 2 M | 50 k | 5 M | 100 k | 10 M | 200 k | 20 M |
| 20 s | 10 k | 2 M | 20 k | 4 M | 50 k | 10 M | 100 k | 20 M |
| 30 s | 5 k | 1.5 M | 10 k | 3 M | 20 k | 6 M | 50 k | 15 M |
| 1 min | 2 k | 1.2 M | 5 k | 3 M | 10 k | 6 M | 20 k | 12 M |
| 2 min | 2 k | 2.4 M | 2 k | 2.4 M | 5 k | 6 M | 20 k | 24 M |

When the time axis setting is 100 ms or greater (the settings surrounded by bold lines) and the trigger mode is Auto or Auto Level, waveforms are displayed in roll mode.

### When the Record Length Is 50 Mpoint or 100 Mpoint

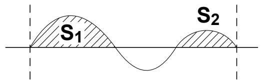
| Time/div | Record Length 50 Mpoint Sample Rate (S/s) | 50 Mpoint Display Record Length (Points) | 100 Mpoint Sample Rate (S/s) | 100 Mpoint Display Record Length (Points) |
|---|---|---|---|---|
| 100 ns | 100 M | 100 | 100 M | 100 |
| 200 ns | 100 M | 200 | 100 M | 200 |
| 500 ns | 100 M | 500 | 100 M | 500 |
| 1 µs | 100 M | 1 k | 100 M | 1 k |
| 2 µs | 100 M | 2 k | 100 M | 2 k |
| 5 µs | 100 M | 5 k | 100 M | 5 k |
| 10 µs | 100 M | 10 k | 100 M | 10 k |
| 20 µs | 100 M | 20 k | 100 M | 20 k |
| 50 µs | 100 M | 50 k | 100 M | 50 k |
| 100 µs | 100 M | 100 k | 100 M | 100 k |
| 200 µs | 100 M | 200 k | 100 M | 200 k |
| 500 µs | 100 M | 500 k | 100 M | 500 k |
| 1 ms | 100 M | 1 M | 100 M | 1 M |
| 2 ms | 100 M | 2 M | 100 M | 2 M |
| 5 ms | 100 M | 5 M | 100 M | 5 M |
| 10 ms | 100 M | 10 M | 100 M | 10 M |
| 20 ms | 100 M | 20 M | 100 M | 20 M |
| 50 ms | 100 M | 50 M | 100 M | 50 M |
| 100 ms | 50 M | 50 M | 100 M | 100 M |
| 200 ms | 20 M | 40 M | 50 M | 100 M |
| 500 ms | 10 M | 50 M | 20 M | 100 M |
| 1 s | 5 M | 50 M | 10 M | 100 M |
| 2 s | 2 M | 40 M | 5 M | 100 M |
| 3 s | 1 M | 30 M | 2 M | 60 M |
| 4 s | 1 M | 40 M | 2 M | 80 M |
| 5 s | 1 M | 50 M | 2 M | 100 M |
| 6 s | 500 k | 30 M | 1 M | 60 M |
| 8 s | 500 k | 40 M | 1 M | 80 M |
| 10 s | 500 k | 50 M | 1 M | 100 M |
| 20 s | 200 k | 40 M | 500 k | 100 M |
| 30 s | 100 k | 30 M | 200 k | 60 M |
| 1 min | 50 k | 30 M | 100 k | 60 M |
| 2 min | 20 k | 24 M | 50 k | 60 M |

When the time axis setting is 100 ms or greater (the settings surrounded by bold lines) and the trigger mode is Auto or Auto Level, waveforms are displayed in roll mode.

# Appendix 8 How to Calculate the Area of a Waveform

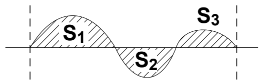
## Integ1TY

Area of the positive amplitude : $S_1 + S_2$



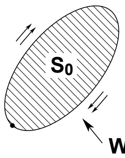

## Integ2TY

Area of the positive amplitude – area of the negative amplitude:
$S_1 + S_3 - S_2$



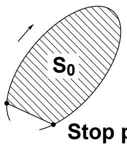

## Integ1XY

(1) Multiple Loops



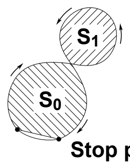

**Area S = n × $S_0$**
**n: The number of loops**
**Start point, stop point**
**Waveform**

(2) Non-Closed Curve



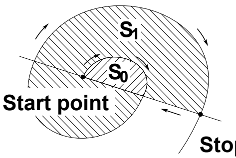

**Area S = $S_0$**
**Area enclosed by a curve connecting the start and stop points**
**Start point**
**Stop point**

(3) Loop Tracing a Figure-Eight




**Area S = $|S_0 - S_1|$**
**Start point**
**Stop point**

(4) Loop Tracing a Spiral

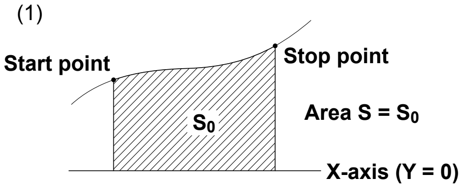



**Area S = $S_0$ × 2 + $S_1$**
**The number of overlaps varies according to the number of loops.**
**Start point**
**Stop point**

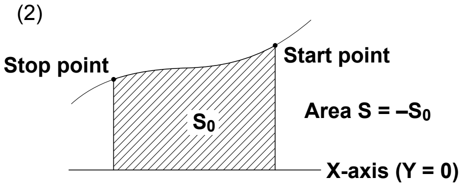
## Integ2XY

(1) When Each Y Data Point Corresponds to a Single X Data Point

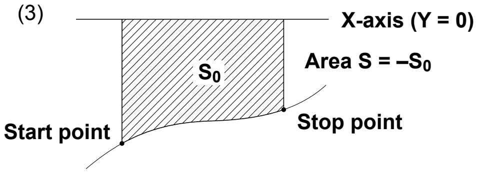
(1)



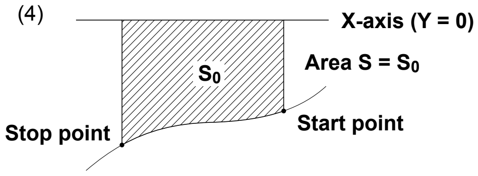

(2)



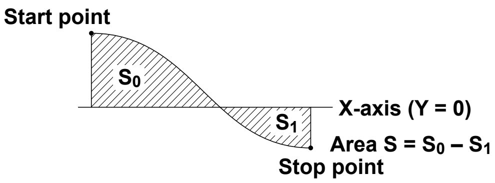

(3)



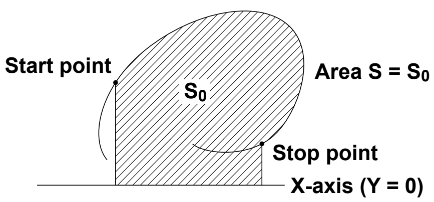

(4)

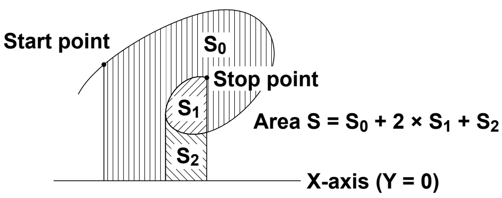



(2) When the Waveform Extends into the Negative Side




(3) When Multiple Y Data Corresponds to One Point of X Data



# Appendix 9 User-Defined Computation

## TREND, TRENDM, and TRENDD Functions

Source channels: Voltage waveform, current waveform, power waveform, AUX waveform (C1 to C8, P1 to P4)
Calculation period reference signal: Synchronization source of the element that the source channel belongs to

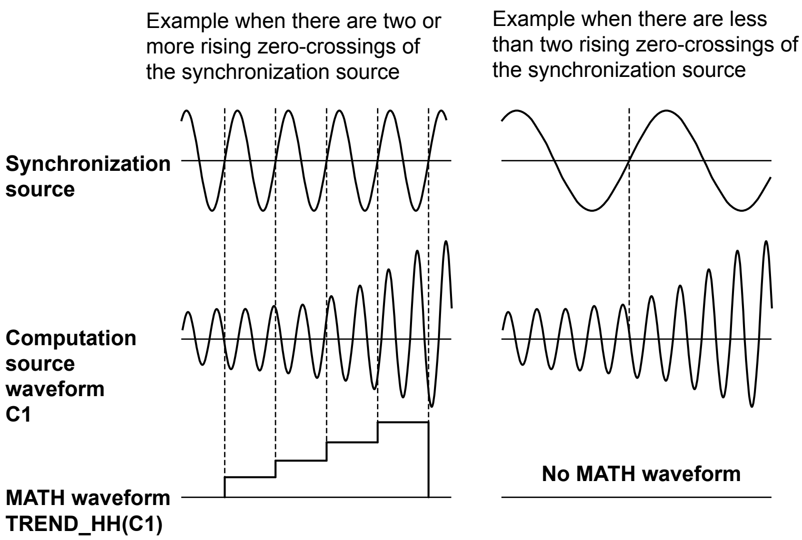
- **TREND, TREND_HH, TREND_LL, TREND_XX**

  The true rms (RMS) value of the source channel is calculated for the following calculation period.

| Function | Calculation Period |
|---|---|
| TREND | (a) or (b) below by assuming the start point to be the first edge detected in the calculation period<br>(a): For each cycle from the rising edge to the next rising edge<br>(b): For each cycle from the falling edge to the next falling edge |
| TREND_HH | For each cycle from the rising edge to the next rising edge |
| TREND_LL | For each cycle from the falling edge to the next falling edge |
| TREND_XX | (c) or (d) below by assuming the start point to be the first edge detected in the calculation period<br>(c): For each half cycle from the rising edge to the falling edge<br>(d): For each half cycle from the falling edge to the rising edge |

If the synchronization source is set to None, the rms value of the entire calculation period is calculated.

For example, TREND_HH(C1) calculates the true rms (RMS) value for each cycle from the rising edge to the next rising edge of the voltage waveform of element 1.




- **TRENDM, TRENDM_HH, TRENDM_LL, TRENDM_XX**

  The rectified mean value calibrated to the rms value (MEAN) of the source channel is calculated. The calculation period is the same as above.

- **TRENDD, TRENDD_HH, TRENDD_LL, TRENDD_XX**

  The simple average (DC) of the source channel is calculated. The calculation period is the same as above.

## TRENDF Function

Source channel: Voltage waveform, current waveform (C1 to C8)

Frequency for (a) or (b) below is calculated for the source channel by assuming the start point to be the first edge detected in the calculation period.

(a): For each cycle from the rising edge to the next rising edge

(b): For each cycle from the falling edge to the next falling edge

## ZC Function

Source channel: Voltage waveform, current waveform (C1 to C8), input signal received through the TRIGGER IN terminal (EXT)

The zero-crossing of the source channel is detected.

| Waveform Label | Description |
|---|---|
| 0 | Period until the first zero-crossing is detected |
| −1 | Period where the signal is lower than the zero-crossing |
| 1 | Period where the signal is higher than the zero-crossing |
| 0 | Period where the last zero-crossing cannot be detected |

# Digital Filter

## Type

| Type | Bandwidth |
|---|---|
| Gauss (Gaussian) | LowPass |
| Sharp | LowPass/HighPass/BandPass |
| IIR (Butterworth) | LowPass/HighPass/BandPass |

## Filter Order

See the following table for the filter orders.

| | | 2% | 5% | 10% | 20% | 30% (Cutoff) |
|---|---|---|---|---|---|---|
| Gauss | LowPass | 49 | 21 | 9 | 5 | 5 |
| Sharp | LowPass | 88 | 36 | 18 | 9 | 8 |
| | HighPass | 159 | 65 | 33 | 17 | 13 |
| IIR | LowPass | 4 | 4 | 4 | 3 | 2 |
| | HighPass | 4 | 4 | 4 | 4 | 3 |

## Filter Characteristics

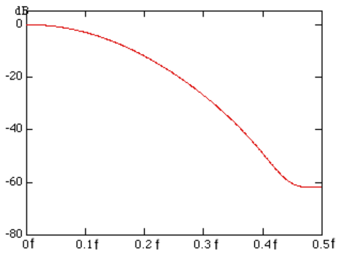
| Filter | Pass-band Ripple | Attenuation Slope | Attenuation at the Stop-band | Phase |
|---|---|---|---|---|
| Gauss | 0 dB | * | – | Linear phase |
| Sharp | ±0.3 dB | −40 dB at 1 oct (Lowpass), | −40 dB | Linear phase |
| | | −40 dB at −1 oct (Highpass) | – | Linear phase |
| IIR | 0 dB | −5 dB at 1/6 oct (Lowpass), | – | Non-linear phase |
| | | −20 dB at −1 oct (Highpass) | – | |

* For Gaussian filter: $-3.0 \times (f/fc)^2$ dB (f: frequency, fc: cutoff frequency)

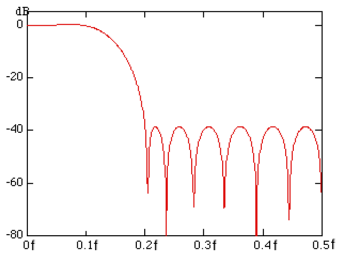
## Frequency Characteristics of Filters

f: Sampling frequency (Hz)

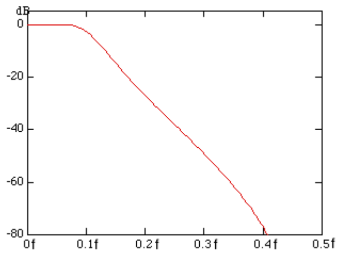
**Gauss (10% cutoff)**




**Sharp (Low pass; 10% cutoff)**




**IIR (Low pass; 10% cutoff)**




The higher the filter order the longer it takes for computation.

## Hilbert Function (HLBT)

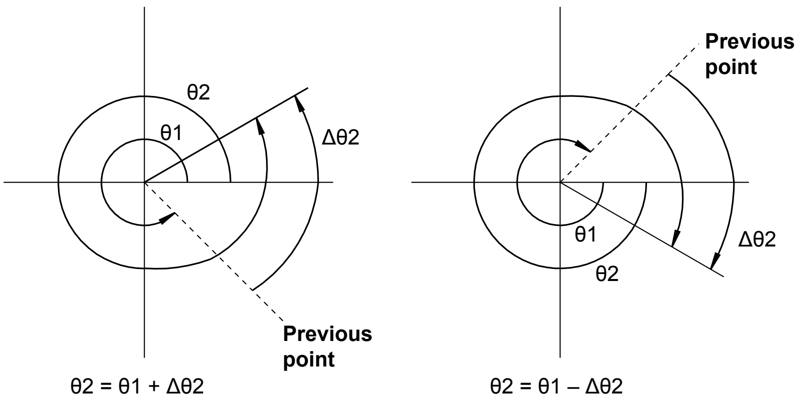
Normally, when we analyze real-time signals, it is useful to think of these signals as the real part of functions of complex variables, and to carry out the actual signal analysis using such functions.
If the real-time signal is considered to be the real part of the function, the imaginary part can be determined with the Hilbert transform of the real part.
The Hilbert transform does not change the order of the individual variables. The Hilbert transform of a time signal results in another time signal.
The Hilbert transform procedure is as follows.
When a time-domain signal is transformed, the signal is first transformed into the frequency domain through Fourier transform. Next, the phase of each frequency component is shifted by −90 degrees if the frequency is positive and +90 degrees if the frequency is negative. Lastly, taking the inverse Fourier transform completes the Hilbert transform.

**Example**

- The Hilbert transform can be used to analyze an envelope waveform.
  AM (amplitude modulation): SQRT(C1 × C1 + HLBT(C1) × HLBT(C1))
  Demodulation of an FM Signal: DIF(PH(C1, HLBT(C1)))

## Phase Function (PH)

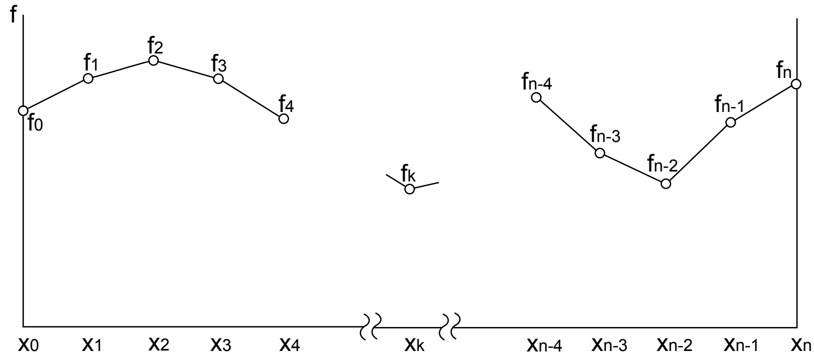
Phase function PH(X1, Y1) computes $\tan^{-1}$(X1/Y1).
The phase function takes the phase of the previous point into consideration and continues to sum even when the value exceeds ±π (the ATAN function reflects at ±π).
The unit is radians.



## Differentiation and Integration (DIF, DDIF, INTG, and IINTG)

### Differentiation (DIF, DDIF)

The computation of the first-order and second-order differentiated values uses the 5th order Lagrange interpolation formula to derive a point of data from the five points of data before and after the target.
The figure below shows data f0 to fn with respect to sampling times x0 to xn. The derivative and integrated values corresponding to these data points are computed as shown below.




- Equations for First Order Derivatives

**Point** $x_0$ $\quad f_0' = \dfrac{1}{12h}[-25f_0 + 48f_1 - 36f_2 + 16f_3 - 3f_4]$

**Point** $x_1$ $\quad f_1' = \dfrac{1}{12h}[-3f_0 - 10f_1 + 18f_2 - 6f_3 + f_4]$

**Point** $x_2$ $\quad f_2' = \dfrac{1}{12h}[f_0 - 8f_1 + 8f_3 - f_4]$

**Point** $x_k$ $\quad f_k' = \dfrac{1}{12h}[f_{k-2} - 8f_{k-1} + 8f_{k+1} - f_{k+2}]$

**Point** $x_{n-2}$ $\quad f_{n-2}' = \dfrac{1}{12h}[f_{n-4} - 8f_{n-3} + 8f_{n-1} - f_n]$

**Point** $x_{n-1}$ $\quad f_{n-1}' = \dfrac{1}{12h}[-f_{n-4} + 6f_{n-3} - 18f_{n-2} + 10f_{n-1} + 3f_n]$

**Point** $x_n$ $\quad f_n' = \dfrac{1}{12h}[3f_{n-4} - 16f_{n-3} + 36f_{n-2} - 48f_{n-1} + 25f_n]$

**h = Δx is the sampling interval (s) (example: $h = 200 \times 10^{-6}$ at 5 kHz)**

- Equations for Second Order Derivatives (DDIF)

**Point** $x_0$ $\quad f_0'' = \dfrac{1}{12h^2}[35f_0 - 104f_1 + 114f_2 - 56f_3 + 11f_4]$

**Point** $x_1$ $\quad f_1'' = \dfrac{1}{12h^2}[11f_0 - 20f_1 + 6f_2 + 4f_3 - f_4]$

**Point** $x_2$ $\quad f_2'' = \dfrac{1}{12h^2}[-f_0 + 16f_1 - 30f_2 + 16f_3 - f_4]$

**Point** $x_k$ $\quad f_k'' = \dfrac{1}{12h^2}[-f_{k-2} + 16f_{k-1} - 30f_k + 16f_{k+1} - f_{k+2}]$

**Point** $x_{n-2}$ $\quad f_{n-2}'' = \dfrac{1}{12h^2}[-f_{n-4} + 16f_{n-3} - 30f_{n-2} + 16f_{n-1} - f_n]$

**Point** $x_{n-1}$ $\quad f_{n-1}'' = \dfrac{1}{12h^2}[-f_{n-4} + 4f_{n-3} + 6f_{n-2} - 20f_{n-1} + 11f_n]$

**Point** $x_n$ $\quad f_n'' = \dfrac{1}{12h^2}[11f_{n-4} - 56f_{n-3} + 114_{n-2} - 104f_{n-1} + 35f_n]$

### Integration (INTG, IINTG)

The first and second order integrated values are derived using the trapezoidal rule.

- Equations for First Order Integration (INTG)

**Point** $x_0$ $I_0 = 0$

**Point** $x_1$ $I_1 = \frac{1}{2}(f_0 + f_1)h$

**Point** $x_2$ $I_2 = \frac{1}{2}(f_0 + f_1)h + \frac{1}{2}(f_1 + f_2)h = I_1 + \frac{1}{2}(f_l + I_2)h$

**Point** $x_n$ $I_n = I_{n-1} + \frac{1}{2}(f_{n-1} + f_n)h$

- Equations for Second Order Integration (IINTG)

**Point** $x_0$ $II_0 = 0$

**Point** $x_1$ $II_1 = \frac{1}{2}(I_0 + I_1)h$

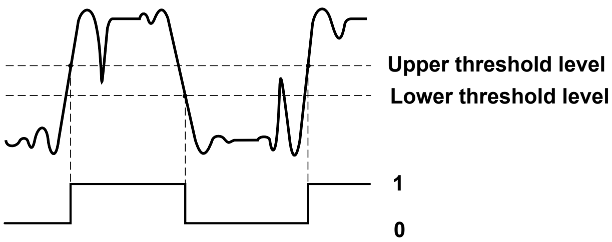
**Point** $x_2$ $II_2 = \frac{1}{2}(I_0 + I_1)h + \frac{1}{2}(I_1 + I_2)h = II_1 + \frac{1}{2}(I_l + I_2)h$

**Point** $x_n$ $II_n = II_{n-1} + \frac{1}{2}(I_{n-1} + I_n)h$

## Binary Conversion (BIN)

Binary conversion is performed through the use of the specified threshold levels.

BIN(C1)



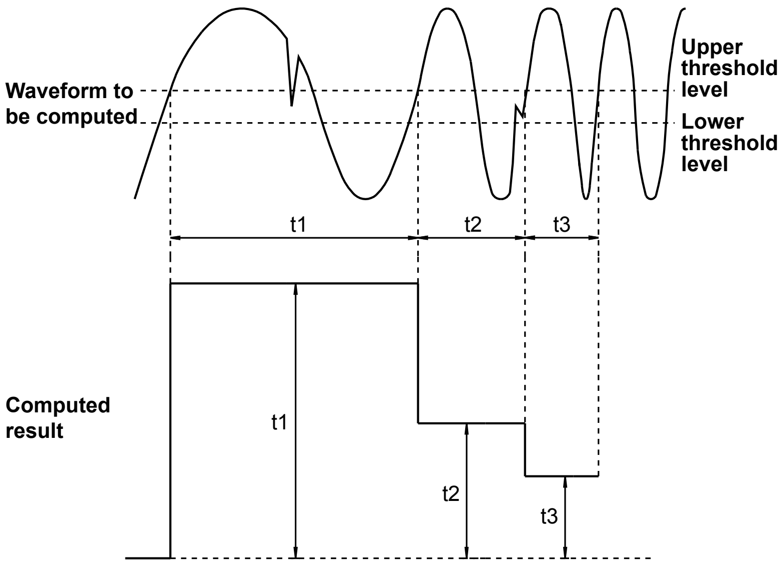
### Pulse Width Computation

The signal is converted to binary values according to the preset threshold levels, and the time of the pulse width is plotted as the Y-axis value for that interval.

You can select one of the following interval.

| | |
|---|---|
| PWHH | From a rising edge to the next rising edge. |
| PWHL | From a rising edge to the next falling edge. |
| PWLH | From a falling edge to the next rising edge. |
| PWLL | From a falling edge to the next falling edge. |
| PWXX | From a rising or falling edge to the next rising or falling edge. |
| FV | Inverse of PWHH |

**Example for PWHH**




# FFT Function - user-defined

Each frequency component G of a linear spectrum is represented by G = R + jI, where R is the real part and I is the imaginary part.

### Linear Spectrum

The linear spectrum can be directly determined with the FFT. Through this spectrum, the magnitude and phase of each frequency component included in the measured waveform can be found. The power spectrum and cross spectrum can also be determined from the linear spectrums of one or two signals.

The FFT is a complex function. The linear spectrum produces the real part and imaginary part of the frequency components. The magnitude and phase of the linear spectrum can also be determined from this result.

The PX8000 can determine the following spectrums.

| Item | Expression | Computation |
|---|---|---|
| Real part | LS-REAL | R |
| Imaginary part | LS-IMAG | I |
| Magnitude | LS-MAG | $\sqrt{(R^2+I^2)}$ |
| Log magnitude | LS-LOGMAG | $20 \times \log \sqrt{(R^2+I^2)}$ |
| Phase | LS-PHASE | $\tan^{-1}(I/R)$ |

Log magnitude reference (0 dB): 1 Vpeak

### RMS Spectrum

The RMS spectrum expresses the amplitudes of the linear spectrum with RMS values. It dose not contain phase information.
The PX8000 can determine the following spectra.

| Item | Expression | Computation |
|---|---|---|
| Magnitude | RS-MAG | $\sqrt{(R^2+I^2)/2}$ |
| Log magnitude | RS-LOGMAG | $20 \times \log \sqrt{(R^2+I^2)/2}$ |

Log magnitude reference (0 dB): 1 Vrms

### Power Spectrum

The power spectrum expresses the power (squared value) of each frequency component included in the measured signal. It is determined by taking the product of the linear spectrum and its complex conjugate. It does not contain phase information.
The PX8000 can determine the following spectrums.

| Item | Expression | Computation |
|---|---|---|
| Magnitude | PS-MAG | DC component $R^2 + I^2$ |
| | | AC component $(R^2 + I^2)/2$ |
| Log magnitude | PS-LOGMAG | DC component $10 \times \log(R^2 + I^2)$ |
| | | AC component $10 \times \log\{(R^2 + I^2)/2\}$ |

Log magnitude reference (0 dB): 1 $\mathrm{Vrms}^2$

### Power Spectrum Density

The power spectrum density expresses the power spectrum per unit frequency. It is determined by dividing the power spectrum by the frequency resolution Δf found during the analysis of the power spectrum. The computation varies depending on the window function.
Power spectrum density is used to compare power spectrums analyzed at different frequency bands. However, it is not necessary for signals having a line spectrum such as sine waves.
The PX8000 can determine the following spectrums.

| Item | Expression | Computation |
|---|---|---|
| Magnitude | PSD-MAG | PS-MAG/(Δf × k) |
| Log magnitude | PSD-LOGMAG | 10 × log PS-MAG/(Δf × k) |

Log magnitude reference (0 dB): 1 $\mathrm{Vrms}^2$

### Overall Value

The overall value is the total RMS value determined from the frequency spectrum included in the signal. The overall value is the square root of the summation of the power spectrums of all frequencies.

$$\textbf{Overall value} = \sqrt{\frac{2 \times PS_0 + \Sigma\, PS_i}{k}} \ \textbf{(Vrms)}$$

“Rms = overall value” appears on the screen when automated measurement of waveform parameters is being performed (MEASURE is set to ON) on the channel that has been selected for power spectrum computation (PS or PSD) and Rms is set to ON.
However, when Window is set to Exponential, overall values are not displayed.

### k

k varies as indicated below depending on the selected time window.

| Time Window Type | k |
|---|---|
| Rect (rectangular window) | 1 |
| Hanning (hanning window) | 1.5 |
| FlatTop (flattop window) | 3.19693 |
| Hamming (hamming window) | 1.3628 |

### Cross Spectrum

The cross spectrum is determined from two signals. It is the product of the linear spectrum of one signal (Gy) and the complex conjugate ($Gx^*$) of the linear spectrum of the other signal (Gx).
If the linear spectrums of the two signals are represented by

$Gx = Rx + jIx$

$Gy = Ry + jIy$

then the cross spectrum Gyx is

$Gyx = Gy \times Gx^*$

$= (Ry + jIy)(Rx - jIx) = Ryx + jIyx$

where $Ryx = RyRx + IyIx$

$Iyx = RxIy - RyIx$

The PX8000 can determine the following spectrums.

| Item | Expression | Computation |
|---|---|---|
| Real part | CS-REAL | $Ryx/2$ |
| Imaginary part | CS-IMAG | $Iyx/2$ |
| Magnitude | CS-MAG | $\sqrt{(Ryx^2+Iyx^2)}/2$ |
| Log magnitude | CS-LOGMAG | $10 \times \log (\sqrt{(Ryx^2+Iyx^2)}/2)$ |
| Phase | CS-PHASE | $\tan^{-1}(Iyx/Ryx)$ |

### Transfer Function

The transfer function expresses the frequency responses of the input to and the output from the transfer system. The transfer function is determined by the ratio of the output linear spectrum (Gy) and the input spectrum (Gx) at each frequency. Also, as can be seen from the following equation, the transfer function can be defined as the ratio of the cross spectrum of the input and output (Gyx) and the input power spectrum (Gxx).

Transfer function $= Gy/Gx = (Gy \times Gx^*)/(Gx \times Gx^*) = Gyx/Gxx$

$= (Ryx + jIyx)/(Rx2 + Ix2)$

The PX8000 can determine the following items.

| Item | Expression | Computation |
|---|---|---|
| Real part | TF-REAL | $Ryx/(Rx^2 + Ix^2)$ |
| Imaginary part | TF-IMAG | $Iyx/(Rx^2 + Ix^2)$ |
| Magnitude | TF-MAG | $\sqrt{(Ryx^2+Iyx^2)}/(Rx^2 + Ix^2)$ |
| Log magnitude | TF-LOGMAG | $20 \times \log \sqrt{(Ryx^2+Iyx^2)}/(Rx^2 + Ix^2)$ |
| Phase | TF-PHASE | $\tan^{-1}(Iyx/Ryx)$ |

The magnitude of the transfer function shows the ratio of the magnitudes of the output linear spectrum and the input linear spectrum while the phase shows the phase difference of the two.

### Coherence Function

The coherence function expresses the ratio of the output power generated by the input signal to the transfer system and the total output power.

Coherence function $= Gyx \times Gyx^*/(Gxx \times Gyy)$

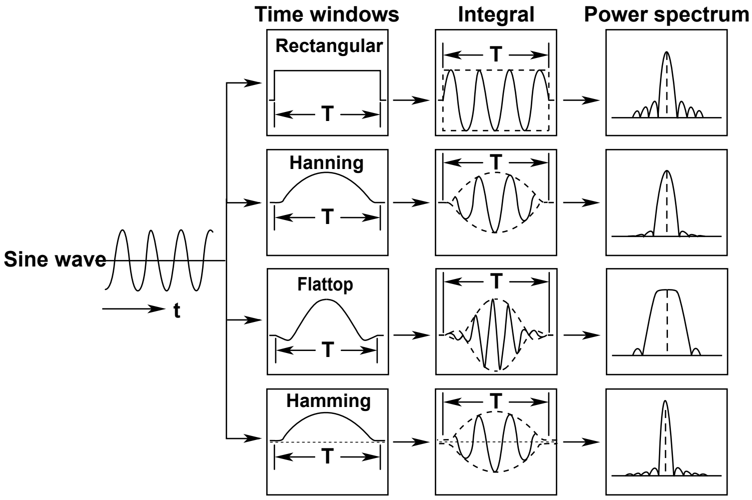
| Item | Expression | Computation |
|---|---|---|
| Phase | CH-MAG | $\tan^{-1}(Ryx^2 + Iyx^2)/(Gxx \times Gyy)$ |

If the output signal is due entirely to the input signal, the coherence function becomes 1. As the ratio decreases, it falls below 1. Thus, the coherence function always takes on a value between 0 and 1.

On one data acquisition, the coherence function becomes 1 across all frequencies. Make sure to take the frequency average of the computation.

### Time Windows

You can use a rectangular, Hanning, flattop, Hamming, or exponential time window.
The rectangular window is suited to transient signals, such as impulse waves, which attenuate completely within the time window. The Hanning, flattop, and Hamming windows allow continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, they are suited to continuous signals. The Hanning window provides a higher frequency resolution compared to the flattop window. However, the flattop window has a higher level of accuracy. The Hamming window is a corrected Hanning window. The frequency resolution of its main beam is greater than that of the Hanning window. The Hamming window is best suited for dividing close signals. When the waveform being analyzed is a continuous signal, consider the above characteristics in selecting the proper window to be applied. When the waveform being analyzed is a continuous signal, consider the above characteristics in selecting the proper window to be applied.




**Rectangular** : $W(t) = u(t) - u(t - T)$ u(t): **Step function**

**Hanning** : $W(t) = 0.5 - 0.5 \cos\left(2\pi \frac{t}{T}\right)$

**Flattop** : $W(t) = \left\{0.54 - 0.46 \cos\left(2\pi \frac{t}{T}\right)\right\} \frac{\sin\{2\pi(1 - 2t/T)\}}{2\pi(1 - 2t/T)}$

**Hamming** : $W(t) = 0.54 - 0.46 \cos\left(2\pi \frac{t}{T}\right)$

The exponential window is used to eliminate noise components from the signal. It is suited for the signals of impulse-excitation frequency-response tests and other similar signals. On the PX8000, the exponential window and force window are activated simultaneously.

Exponential Window

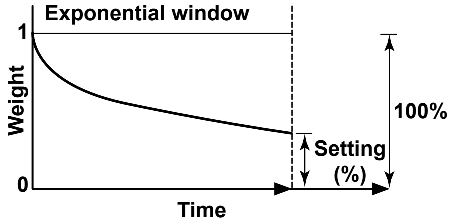
The damping rate is set in terms of the weight of the last data point, with the weight of the first data point in the specified number of FFT points taken to be 100% (= 1). You can set the damping rate in the range of 1 to 100% (1% resolution). The exponential window damps the signal exponentially along the time axis. It is effective when the signal does not attenuate fully within the record length. When the damping rate is set to 100%, the window functions like a rectangular window.

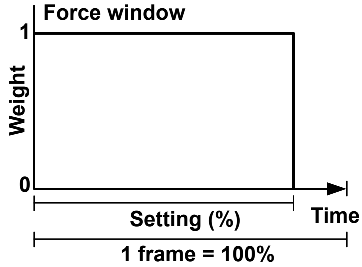
Force Window

Set the area over which computation is performed in terms of a percentage from the first FFT point, taking the set number of FFT points to be 100%. The areas (force 1 and force 2) can be set in the range of 1 to 100% (1% resolution) of the input/output signal. When an area is set to 100%, the window functions like a rectangular window. On the PX8000, the outer area is the average of the results of the window function for the data outside the area.

Force1: This setting applies to the input signals of one-waveform and two-waveform FFTs.

Force2: This setting applies to the output (response) signal (second parameter) of a two-waveform FFT.

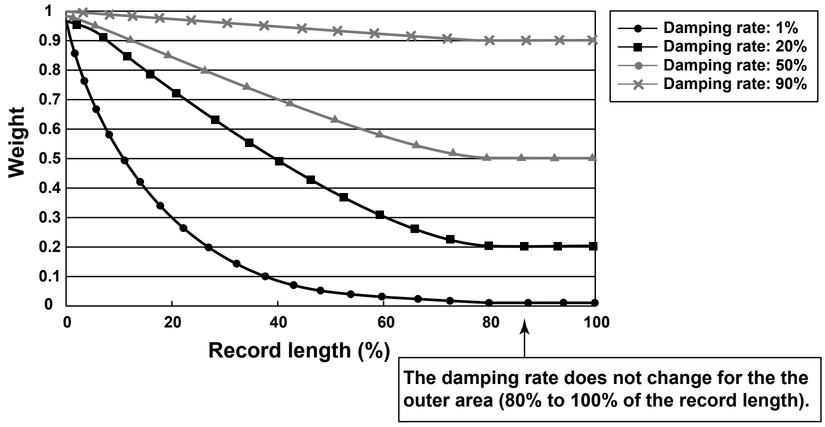



Combined Form of the Exponential and Force Windows

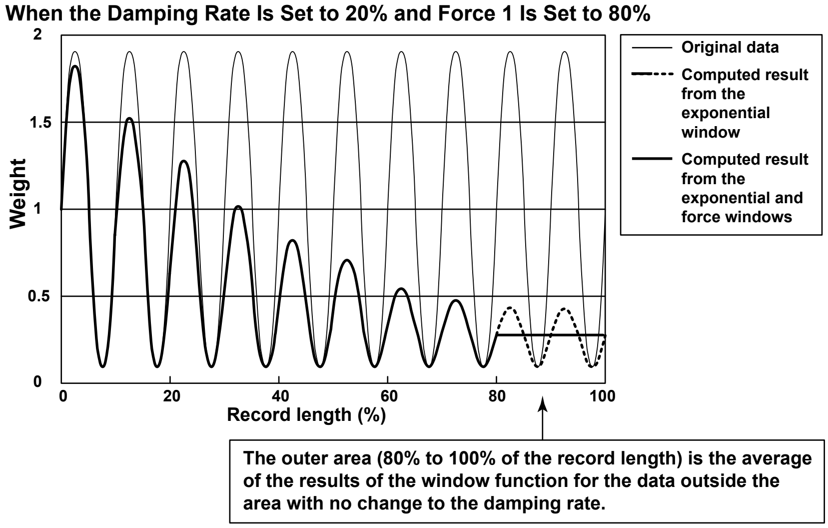
The PX8000 uses a window function that combines the exponential window and force window to perform computations. The outer area of the force window is the average of the results of the window function for the data outside the area.

**When the Force Window Area Is Set to 80% and the Data Outside the Area Is Taken into Account**




- Application Example on the PX8000

**When the Damping Rate Is Set to 20% and Force 1 Is Set to 80%**



### Notes about Executing FFT Computation

Computation is normally performed on the sampled data in the acquisition memory. However, for waveforms that have been acquired in envelope mode, computation is performed on the maximum and minimum values per acquisition interval.

# Appendix 10 USB Keyboard Key Assignments

| PX8000 | USB Keyboard |
|---|---|
| AQUIRE | CTRL+A |
| MATH | CTRL+B |
| Execute PRINT | CTRL+C or PRINT SCREEN |
| DISPLAY MODE | CTRL+D |
| DISPLAY SETTING | CTRL+E |
| FILE | CTRL+F |
| HELP | CTRL+G |
| NUMERIC | CTRL+H |
| Execute SAVE | CTRL+I |
| MANUALTRIG | CTRL+J |
| KEY PROTECT | CTRL+K |
| ALL CH | CTRL+L |
| MEASURE | CTRL+M |
| NUM LOCK | CTRL+N |
| POSITION/DELAY | CTRL+P |
| Execute CLEAR TRACE | CTRL+Q |
| Execute RESET | CTRL+R |
| SHIFT | CTRL+S |
| MODE (TRIGGER) | CTRL+T |
| CURSOR | CTRL+U |
| SIMPLE/ENHANCED | CTRL+W |
| NULL | CTRL+Y |
| ZOOM | CTRL+Z |
| U1 (CH1) | CTRL+1 |
| I1 (CH2) | CTRL+2 |
| U2 (CH3) or AUX3 (CH3) | CTRL+3 |
| I2 (CH4) or AUX4 (CH4) | CTRL+4 |
| U3 (CH5) or AUX5 (CH5) | CTRL+5 |
| I3 (CH6) or AUX6 (CH6) | CTRL+6 |
| U4 (CH7) or AUX7 (CH7) | CTRL+7 |
| I4 (CH8) or AUX8 (CH8) | CTRL+8 |
| SET | CTRL+ENTER |
| UTILITY | CTRL+/ |
| ELEM1 | CTRL+F1 |
| ELEM2 or Pm2 | CTRL+F2 |
| ELEM3 or Pm3 | CTRL+F3 |
| ELEM4 or Pm4 | CTRL+F4 |
| P1 | CTRL+F5 |
| P2 | CTRL+F6 |
| P3 | CTRL+F7 |
| P4 | CTRL+F8 |
| Turn ZOOM POSITION to the right | CTRL+INSERT |
| Turn VERTICAL POSITION to the right | CTRL+HOME |
| Turn ZOOM POSITION to the left | CTRL+DELETE |
| Turn VERTICAL POSITION to the left | CTRL+END |
| START/STOP | CTRL+* or F12 |
| FFT | CTRL+SHIFT+B |
| PRINT MENU | CTRL+SHIFT+C |
| CAL | CTRL+SHIFT+D |
| X-Y | CTRL+SHIFT+E |
| FILE UTILITY | CTRL+SHIFT+F |
| HISTORY | CTRL+SHIFT+H |
| SAVE MENU | CTRL+SHIFT+I |
| GO/NO-GO | CTRL+SHIFT+M |
| ACTION | CTRL+SHIFT+T |
| NULL SET | CTRL+SHIFT+Y |
| SEARCH | CTRL+SHIFT+Z |
| EXP (ELEM4 or Pm4) | E when NUM LOCK is illuminated on the PX8000 |
| k (U4 (CH7) or AUX7 (CH7)) + ENTER (P4) | K when NUM LOCK is illuminated on the PX8000 |

| PX8000 | USB Keyboard |
|---|---|
| m (I4 (CH8) or AUX8 (CH8)) + ENTER (P4) | M when NUM LOCK is illuminated on the PX8000 |
| 1 (I1 (CH2)) | 1 when NUM LOCK is illuminated on the PX8000 |
| 2 (I2 (CH4) or AUX4 (CH4)) | 2 when NUM LOCK is illuminated on the PX8000 |
| 3 (I3 (CH6) or AUX6 (CH6)) | 3 when NUM LOCK is illuminated on the PX8000 |
| 4 (U1 (CH1)) | 4 when NUM LOCK is illuminated on the PX8000 |
| 5 (U2 (CH3) or AUX3 (CH3)) | 5 when NUM LOCK is illuminated on the PX8000 |
| 6 (U3 (CH5) or AUX5 (CH5)) | 6 when NUM LOCK is illuminated on the PX8000 |
| 7 (ELEM1) | 7 when NUM LOCK is illuminated on the PX8000 |
| 8 (ELEM2 or Pm2) | 8 when NUM LOCK is illuminated on the PX8000 |
| 9 (ELEM3 or Pm3) | 9 when NUM LOCK is illuminated on the PX8000 |
| 0 (P1) | 0 when NUM LOCK is illuminated on the PX8000 |
| ENTER (P4) | ENTER when NUM LOCK is illuminated on the PX8000 |
| . (P2) | . when NUM LOCK is illuminated on the PX8000 |
| – (P3) | – when NUM LOCK is illuminated on the PX8000 |
| ESC | ESC or F8 |
| Select soft key 1 | F1 |
| Select soft key 2 | F2 |
| Select soft key 3 | F3 |
| Select soft key 4 | F4 |
| Select soft key 5 | F5 |
| Select soft key 6 | F6 |
| Select soft key 7 | F7 |
| SNAPSHOT | PAUSE |
| Turn ZOOM MAG to the right | INSERT |
| Turn VERTICAL SCALE to the right | HOME |
| Turn HORIZONTAL TIME/DIV to the right | PAGE UP |
| Turn ZOOM MAG to the left | DELETE |
| Turn VERTICAL SCALE to the left | End |
| Turn HORIZONTAL TIME/DIV to the left | PageDown |
| Right arrow | → |
| Left arrow | ← |
| Up arrow | ↑ |
| Down arrow | ↓ |

# Appendix 11 Default Values

**Example for a Model with Four Power Measurement Elements Installed**

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

| Item | Setting |
|---|---|
| **WIRING** | |
| Wiring | 1P2W |
| η Formula | |
| η1 | PΣB/PΣA |
| η2 | PΣA/PΣB |
| η3 | OFF/OFF |
| η4 | OFF/OFF |
| Udef1 | P1+None+None+None |
| Udef2 | P1+None+None+None |
| Element Independent | OFF |
| ΔMeasure | |
| ΔMeasure Type | - |
| ΔMeasure Mode | rms |
| Sensor Range Display Type | Direct |
| Deskew Setup | |
| Diff Time U | 0.000 ns |
| Diff Time I | 0.000 ns |
| Diff Time Sen | 0.000 ns |
| **ELEM1 to ELEM4 (voltage module and current module)** | |
| Line Filter | OFF |
| Freq Filter | OFF |
| Scaling | OFF |
| VT Scaling | 1.0000 |
| CT Scaling | 1.0000 |
| SF Scaling | 1.0000 |
| Sync Source | ELEM1: I1 |
| | ELEM2: I2 |
| | ELEM3: I3 |
| | ELEM4: I4 |
| CT Preset | Others |
| **ELEM2 to ELEM4 (AUX module)** | |
| Motor Mode | OFF |
| Name | ELEM2: Pm2<br>ELEM3: Pm3<br>ELEM4: Pm4 |
| Scaling | 1.0000 |
| Unit | W |
| Sync Source | None |
| **U1 to U4 (voltage module)** | |
| Range | 1000 V |
| Position | 0.00 div |
| Display | ON |
| Label | Channel nane |
| Vertical Scale | DIV |
| Vertical Zoom | ×1 |
| Offset | 0.0 V |
| Auto Range | OFF |
| **Item** | **Setting** |
| **I1 to I4 (current module)** | |
| Range | 5A |
| Position | 0.00 div |
| Display | ON |
| Label | Channel nane |
| Vertical Scale | DIV |
| Vertical Zoom | ×1 |
| Offset | 0.00 A |
| Auto Range | OFF |
| Ext Sensor | OFF |
| Sensor Ratio | 10.0000 mV/A (mΩ) |
| Sensor Preset | Others |
| **P1 to P4 (voltage module and current module)** | |
| Position | 0.00 div |
| Display | ON |
| Label | Channel nane |
| Vertical Scale | DIV |
| Vertical Zoom | ×2 |
| Offset | 0W |
| **U2 to U4, I2 to I4 (AUX module)** | |
| Range | 250 V |
| Position | 0.00 div |
| Display | ON |
| Label | Channel nane |
| Vertical Scale | DIV |
| Vertical Zoom | ×1 |
| Offset | 0.0 V |
| Auto Range | OFF |
| Aux Settings | Analog |
| Coupling | DC |
| Probe | 10:1 |
| BandWidth | Full |
| Pulse Level High | 2.4 V |
| Pulse Level Low | 0.4 V |
| **TIME/DIV** | |
| | 50 ms/div |
| **MODE** | |
| | Auto |
| **POSITION/DELAY** | |
| Position | 50.0% |
| Delay | 0.00 μs |
| **SIMPLE/ENHANCED** | |
| Setting | Simple |
| Source | U1 |
| Slope | Rising |
| Level | 0.0 V |
| Hysteresis | |
| Hold Off | 0.00 μs |
| **ACQUIRE** | |
| Record Length | 1 M |
| Acquisition Mode | Normal |
| Trigger Mode | Auto |
| Acquisition Count | Infinite |
| Time Base | Int |

| Item | Setting |
|---|---|
| **DISPLAY MODE** | |
| | Numeric+Wave |
| **DISPLAY SETTING (Numeric)** | |
| Format | 4 Items |
| Item No. | 1 |
| Function | Urms |
| Element/Σ | Element1 |
| Order | Total |
| **DISPLAY SETTING (Wave)** | |
| Format | 3 |
| Wave Setup | |
| Display | ON |
| Map | Auto |
| Label | Channel name |
| V Scale | DIV |
| Offset | U1 to U4: 0.0 V<br>I1 to I4: 0.00 A<br>P1 to P4: 0 W<br>AUX3 to AUX8: 0.0 V |
| Position | 0.00 div |
| V Zoom | U1 to U4: ×1<br>I1 to I4: ×1<br>P1 to P4: ×2<br>AUX3 to AUX8: ×1 |
| Dot Connect | Line |
| Graticule | Grid ( ) |
| Scale Value | ON |
| Trace Label | OFF |
| Extra Window | OFF |
| **DISPLAY SETTING (Bar)** | |
| Format | 1 |
| Item No. | 1 |
| Function | U |
| Element | Element1 |
| Start Order | 1 |
| End Order | 100 |
| Numeric | OFF |
| x Order | 1 |
| + Order | 15 |
| **DISPLAY SETTING (Vector)** | |
| Format | 1 |
| Item No. | 1 |
| Vector Object | ΣA |
| U Mag | 1.000 |
| I Mag | 1.000 |
| Numeric | ON |

| Item | Setting | | | |
|---|---|---|---|---|
| **NUMERIC** | | | | |
| Numeric Measure | ON | | | |
| Period | Zero Cross | | | |
| Averaging | OFF | | | |
| User Defined Function | ON/OFF | Name | Unit | Expression |
| Function1 | OFF | P-loss | W | P(E1)-P(E2) |
| Function2 | OFF | U-ripple | % | (UPPK(E1)-UMPK(E1))/2/UDC(E1)*100 |
| Function3 | OFF | I-ripple | % | (IPPK(E1)-IMPK(E1))/2/IDC(E1)*100 |
| Function4 | OFF | D-UrmsR | V | DELTAU1RMS(SA) |
| Function5 | OFF | D-UrmsS | V | DELTAU2RMS(SA) |
| Function6 | OFF | D-UrmsT | V | DELTAU3RMS(SA) |
| Function7 | OFF | D-UmnR | V | DELTAU1MN(SA) |
| Function8 | OFF | D-UmnS | V | DELTAU2MN(SA) |
| Function9 | OFF | D-UmnT | V | DELTAU3MN(SA) |
| Function10 | OFF | PhiU3-U2 | deg | 360-PHIU1U3(SA)+PHIU1U2(SA) |
| Function11 | OFF | Pp-p | W | PPPK(E1)-PMPK(E1) |
| Function12 | OFF | F12 | V | DELTAU1RMN(SA) |
| Function13 | OFF | F13 | V | DELTAU2RMN(SA) |
| Function14 | OFF | F14 | V | DELTAU3RMN(SA) |
| Function15 | OFF | F15 | V | DELTAU1DC(SA) |
| Function16 | OFF | F16 | V | DELTAU2DC(SA) |
| Function17 | OFF | F17 | V | DELTAU3DC(SA) |
| Function18 | OFF | F18 | V | DELTAU1MN(SA) |
| Function19 | OFF | F19 | V | DELTAU2MN(SA) |
| Function20 | OFF | F20 | V | DELTAU3MN(SA) |
| Formula | | | | |
| S Formula | Urms*Irms | | | |
| S,Q Formula | Type1 | | | |
| Pc Formula | IEC76-1(1976) | | | |
| IEC76-1(1976)'s P1 and P2 | P1 = 0.5000, P2 = 0.5000 | | | |
| Phase | 180 Lead/Lag | | | |
| Harmonics | | | | |
| Harmonics Mode | ON | | | |
| PLL Source | U1 | | | |
| Min Order | 1 | | | |
| Max Order | 100 | | | |
| Thd Formula | 1/Total | | | |
| Start Position | -5.000 div | | | |
| **X-Y** | | | | |
| Window1/2 | OFF | | | |
| Display | OFF | | | |
| Setup | | | | |
| Display | ON: XY1, XY5<br>OFF: XY2 to XY4, XY6 to XY8 | | | |
| X Trace | U1 | | | |
| Y Trace | I1 | | | |
| Start Point | –5.00 div | | | |
| End Point | 5.00 div | | | |
| Trace clear on Start | ON | | | |
| Main Ratio | 50% | | | |
| Window Layout | Side | | | |
| Combine Display | OFF | | | |
| Dot Connect | Line | | | |
| Decimation | 100k | | | |

| Item | Setting |
|---|---|
| **ZOOM** | |
| Display(Zoom1) | OFF |
| Display(Zoom2) | OFF |
| Zoom1/2 Position | 0.0000 div |
| Format Zoom1/2 | Main |
| Main Ratio | 50% |
| Window Layout | Side |
| Auto Scroll | |
| Target | Zoom1 |
| Speed | 4 |
| Allocation | All ON |
| **CURSOR** | |
| Type | OFF |
| Horizontal | |
| Trace | U1 |
| Cursor1 | 3.00 div |
| Cursor2 | -3.00 div |
| Vertical | |
| Trace | U1 |
| Cursor1 | -4.000 div |
| Cursor2 | 4.000 div |
| Marker | |
| Marker # | Marker1 X |
| Trace | U1 |
| Position | -3.000 div |
| Marker From | Mark |
| Degree | |
| Trace | U1 |
| Cursor1 | -4.000 div |
| Cursor2 | 4.000 div |
| Ref1 | -2.000 div |
| Ref2 | 2.000 div |
| RefValue | 360 |
| H & V | |
| Trace | U1 |
| V-Cursor1 | -4.000 div |
| V-Cursor2 | 4.000 div |
| H-Cursor1 | 3.00 div |
| H-Cursor2 | -3.00 div |
| **MEASURE** | |
| Mode | OFF |
| Measure Setup | |
| Trace | U1 |
| Detail Parameter | |
| Distal/Mesial/Proximal | |
| Mode | % |
| Distal | 90.00% |
| Mesial | 50.00% |
| Proximal | 10.00% |
| High/Low | Auto |
| Intg Mode | Normal |
| Delay Setup | |
| Mode | OFF |
| Polarity | Rising |
| Edge Count | 1 |
| Reference | Trace |
| Reference Trace | |
| Trace | U1 |
| Polarity | Rising |
| Edge Count | 1 |
| Time Range1 | -5.00 div |

| Item | Setting |
|---|---|
| Time Range2 | 5.00 div |
| (When Mode is set to ON, Statistics) | |
| 1-Cycle Mode | OFF |
| (When Mode is set to Cycle Statistics) | |
| Cycle Trace | U1 |
| **MATH** | |
| Mode | OFF |
| Math Setup | All OFF |
| Select Math Trace | 1 |
| Scaling Mode | Auto |
| Upper | 1.0000 |
| Lower | -1.0000 |
| Start Point | -5.00 div |
| End Point | 5.00 div |
| FFT Setup | |
| FFT Points | 1k |
| Window | Hanning |
| Filter Setup | |
| Filter Type | Gauss |
| Filter Band | Low-Pass |
| CutOff1 | 10.0% |
| Constant Setup | |
| K1 to K8 | 1.0000 |
| **FFT** | |
| FFT1/2 Display | OFF |
| FFT Setup | |
| Type | PS |
| Sub Type | LOGMAG |
| Source | U1 |
| Window | Hanning |
| Vert. Scale Mode | Auto |
| Center | 0.0000 |
| Sensitivity | 200.00E-03 |
| Start Point | -5.00 div |
| FFT Points | 1k |
| Main Ratio | 50% |
| Window Layout | Side |
| Horiz. Axis | Log Hz |
| Unit | |
| Horiz. Scale | Auto |
| **GO/NO-GO** | |
| Mode | OFF |
| Judgement Setup | |
| Mode | X |
| Trace | U1 |
| Zone No. | Zone1 |
| Logic | AND |
| ActCondition | Fail |
| Sequence | Continue |
| Acquisition Count | Infinite |
| Remote | OFF |
| Action Setup | |
| Beep | OFF |
| Print Image | OFF |
| Save Waveform | OFF |
| Save Numeric | OFF |
| Save Image | OFF |
| Time Range1 | -5.00 div |
| Time Range2 | 5.00 div |

| Item | Setting |
|---|---|
| **ACTION** | |
| Mode | OFF |
| Action Setup | |
| Beep | OFF |
| Print Image | OFF |
| Save Waveform | OFF |
| Save Numeric | OFF |
| Save Image | OFF |
| **SEARCH** | |
| Type | Edge |
| Edge | |
| Trace | U1 |
| Level | 0.0 V |
| Polarity | Rising |
| Hysteresis |  |
| Count | 1 |
| Result Window | Zoom1 |
| Pattern No. | No Match |
| Start Point | -5.00 div |
| End Point | 5.00 div |
| Time | |
| Absolute Time | Current date and time |
| Result Window | Zoom1 |
| **HISTORY** | |
| Display Mode | 1 Record |
| Select Record | 0 |
| Start Record | 0 |
| End Record | Oldest number |
| Search Mode | OFF |
| **PRINT MENU** | |
| Print To | File |
| Format | PNG |
| Color | ON |
| Background | Normal |
| File Setup | |
| Auto Naming | Numbering |
| File Name | |
| Comment | |
| **FILE** | |
| Save_Waveform | |
| Auto Naming | Numbering |
| Data Type | Binary |
| Range | Main |
| History | One |
| Save Trace | All ON |
| Save_Numeric | |
| Auto Naming | Numbering |
| Target | Selected |
| Select Items | Element1<br>Urms, Irms, P, S, Q, λ, Φ, FreqU, FreqI |
| Decimal Point for CSV File | Point |
| Save_Setup | |
| Auto Naming | Numbering |
| Save_Others | |
| Auto Naming | Numbering |
| Data Type | Screen Image |
| Format | PNG |
| Color | ON |
| Background | Normal |

| Item | Setting |
|---|---|
| **CAL** | |
| Cal at End for Elements | ON |
| Cal on Start for Auxiliaries | Auto |
| **NULL SET** | |
| NULL Setup | All ON |
| **UTILITY** | |
| System Config | |
| Date/Time | |
| Display | ON |
| Format | Year/Month/Day |
| Time Diff .GMT | Hour: 9, Minute: 0 |
| Time Synchro | |
| Time Synchro | OFF |
| IRIG Format | A |
| Modulation | AM |
| Impedance | 50 |
| Language | |
| Menu | English |
| Message | Depends on the language suffix code |
| LCD | |
| Auto OFF | OFF |
| Auto OFF Time | 1 min |
| Brightness | 3 |
| Storage Manager | |
| Media | SD |
| USB Keyboard | Depends on the language suffix code |
| Remote Ctrl | |
| GP-IB Address | 1 |
| Network Time Out | Infinite |
| Network | |
| TCP/IP | |
| DHCP | ON |
| DNS | Auto |
| FTP Server | |
| User Name | anonymous |
| TimeOut(s) | 1800 |
| Net Drive | |
| LoginName | anonymous |
| Passive | OFF |
| TimeOut(s) | 15 |
| SNTP | |
| TimeOut(s) | 3 |
| Adjust at Power ON | OFF |
| Preference | |
| Power On Action | |
| Start | OFF |
| Action | OFF |
| Terminal Setup | |
| Remote Stop | ON |
| Trigger Out | Normal |
| Pulse Width | 1 ms |
| Display Setup | |
| Menu Font Size | Large |
| Base Color | Blue |
| Scale Font Size | Small |
| Scale On Item | All |
| Numeric Frame | ON |
| Numeric Resolution | 5 dgts |

| Item | Setting |
|---|---|
| Intensity | |
| Grid | 3 |
| Cursor | 8 |
| Marker | 7 |
| Key/Knob Setup | |
| Click Sound | ON |
| START/STOP Response Time | Quick |
| Key Protect | |
| Type | All |
| Release Type | Key |
| Freq Display at Frequncy Low | Error |
| Aux Display at Pulse Freq Low | Error |
| Self Test | Keyboard |
| Setup Data Store/Recall | |
| No. | 1 |

## Numeric Data Display Order (Example for a Model with Four Power Measurement Elements Installed)

If you reset the order of the numeric data using Reset Items Exec, the data of each measurement function is displayed in the order indicated in the table below.

### 4 Items Display

| Page | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Urms1 | Urms2 | Urms3 | Urms4 | UrmsΣA | UrmsΣB | η1 | F1:P-loss | F5:D-UrmsS | F9:D-UmnT | F13 | F17 |
| Irms1 | Irms2 | Irms3 | Irms4 | IrmsΣA | IrmsΣB | η2 | F2:U-ripple | F6:D-UrmsT | F10:PhiU3-U2 | F14 | F18 |
| P1 | P2 | P3 | P4 | PΣA | PΣB | η3 | F3:I-ripple | F7:D-UmnR | F11:Pp-p | F15 | F19 |
| λ1 | λ2 | λ3 | λ4 | λΣA | λΣB | η4 | F4:D-UrmsR | F8:D-UmnS | F12 | F16 | F20 |

### 8 Items Display

| Page | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Urms1 | Urms2 | Urms3 | Urms4 | UrmsΣA | UrmsΣB | P1 | F1:P-loss | F9:D-UmnT | F17 | – | – |
| Irms1 | Irms2 | Irms3 | Irms4 | IrmsΣA | IrmsΣB | P2 | F2:U-ripple | F10:PhiU3-U2 | F18 | – | – |
| P1 | P2 | P3 | P4 | PΣA | PΣB | P3 | F3:I-ripple | F11:Pp-p | F19 | – | – |
| S1 | S2 | S3 | S4 | SΣA | SΣB | P4 | F4:D-UrmsR | F12 | F20 | – | – |
| Q1 | Q2 | Q3 | Q4 | QΣA | QΣB | η1 | F5:D-UrmsS | F13 | – | – | – |
| λ1 | λ2 | λ3 | λ4 | λΣA | λΣB | η2 | F6:D-UrmsT | F14 | – | – | – |
| φ1 | φ2 | φ3 | φ4 | φΣA | φΣB | η3 | F7:D-UmnR | F15 | – | – | – |
| fU1 | fU2 | fU3 | fU4 | – | – | η4 | F8:D-UmnS | F16 | – | – | – |

### 16 Items Display

| Page | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Urms1 | Urms2 | Urms3 | Urms4 | UrmsΣA | P1 | F1:P-loss | F17 | – | – | – | – |
| Irms1 | Irms2 | Irms3 | Irms4 | IrmsΣA | P2 | F2:U-ripple | F18 | – | – | – | – |
| P1 | P2 | P3 | P4 | PΣA | P3 | F3:I-ripple | F19 | – | – | – | – |
| S1 | S2 | S3 | S4 | SΣA | P4 | F4:D-UrmsR | F20 | – | – | – | – |
| Q1 | Q2 | Q3 | Q4 | QΣA | PΣA | F5:D-UrmsS | – | – | – | – | – |
| λ1 | λ2 | λ3 | λ4 | λΣA | PΣB | F6:D-UrmsT | – | – | – | – | – |
| φ1 | φ2 | φ3 | φ4 | φΣA | – | F7:D-UmnR | – | – | – | – | – |
| Pc1 | Pc2 | Pc3 | Pc4 | PcΣA | – | F8:D-UmnS | – | – | – | – | – |
| fU1 | fU2 | fU3 | fU4 | UrmsΣB | η1 | F9:D-UmnT | – | – | – | – | – |
| fI1 | fI2 | fI3 | fI4 | IrmsΣB | η2 | F10:PhiU3-U2 | – | – | – | – | – |
| U+pk1 | U+pk2 | U+pk3 | U+pk4 | PΣB | η3 | F11:Pp-p | – | – | – | – | – |
| U-pk1 | U-pk2 | U-pk3 | U-pk4 | SΣB | η4 | F12 | – | – | – | – | – |
| I+pk1 | I+pk2 | I+pk3 | I+pk4 | QΣB | – | F13 | – | – | – | – | – |
| I-pk1 | I-pk2 | I-pk3 | I-pk4 | λΣB | – | F14 | – | – | – | – | – |
| CfU1 | CfU2 | CfU3 | CfU4 | φΣB | – | F15 | – | – | – | – | – |
| CfI1 | CfI2 | CfI3 | CfI4 | PcΣB | – | F16 | – | – | – | – | – |

### Matrix Display

| Page | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Urms | Urms | Irms | – | – | – | – | – | – | – | – | – |
| Irms | Umn | Imn | – | – | – | – | – | – | – | – | – |
| P | Udc | Idc | – | – | – | – | – | – | – | – | – |
| S | Urmn | Irmn | – | – | – | – | – | – | – | – | – |
| Q | Uac | Iac | – | – | – | – | – | – | – | – | – |
| λ | U+pk | I+pk | – | – | – | – | – | – | – | – | – |
| φ | U-pk | I-pk | – | – | – | – | – | – | – | – | – |
| fU | CfU | CfI | – | – | – | – | – | – | – | – | – |
| fI | fU | fI | – | – | – | – | – | – | – | – | – |

### All Items Display

| Page | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7* | 8* | 9* | 10* |
| Urms | Urms | Irms | F1:P-loss | η1 | ΔU1rms | U(k) | Uhdf(k) | Uthd | K-factor |
| Irms | Umn | Imn | F2:U-ripple | η2 | ΔU2rms | I(k) | Ihdf(k) | Ithd | ΦUi-Uj |
| P | Udc | Idc | F3:I-ripple | η3 | ΔU3rms | P(k) | Phdf(k) | Pthd | ΦUi-Uk |
| S | Urmn | Irmn | F4:D-UrmsR | η4 | ΔUΣrms | S(k) | Z(k) | Uthf | ΦUi-Ii |
| Q | Uac | Iac | F5:D-UrmsS | | ΔIrms | Q(k) | Rs(k) | Ithf | ΦUj-Ij |
| λ | U+pk | I+pk | F6:D-UrmsT | | ΔP1 | λ(k) | Xs(k) | Utif | ΦUk-Ik |
| φ | U-pk | I-pk | F7:D-UmnR | | ΔP2 | Φ(k) | Rp(k) | Itif | ΦIi-Ij |
| fU | CfU | CfI | F8:D-UmnS | | ΔP3 | ΦU(k) | Xp(k) | hvf | ΦIj-Ik |
| fI | Pc | | F9:D-UmnT | | ΔPΣ | ΦI(k) | | hcf | ΦIi-Ik |
| | P+pk | | F10:PhiU3-U2 | | | | | | |
| | P-pk | | F11:Pp-p | | | | | | |
| | | | F12 | | | | | | |
| | | | F13 | | | | | | |
| | | | F14 | | | | | | |
| | | | F15 | | | | | | |
| | | | F16 | | | | | | |
| | | | F17 | | | | | | |
| | | | F18 | | | | | | |
| | | | F19 | | | | | | |
| | | | F20 | | | | | | |

* Displayed on models with the harmonic measurement option

### Left Side of the Single List Screen* and Dual List Screen*

| Page | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Urms1 | Urms2 | Urms3 | Urms4 | UrmsΣA | UrmsΣB | F1 | F17 |
| Irms1 | Irms2 | Irms3 | Irms4 | IrmsΣA | IrmsΣB | F2 | F18 |
| P1 | P2 | P3 | P4 | PΣA | PΣB | F3 | F19 |
| S1 | S2 | S3 | S4 | SΣA | SΣB | F4 | F20 |
| 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 | |
| Ithd1 | Ithd2 | Ithd3 | Ithd4 | ΦUi-Ii | ΦUi-Ii | F9 | |
| Pthd1 | Pthd2 | Pthd3 | Pthd4 | ΦUj-Ij | ΦUj-Ij | F10 | |
| Uthf1 | Uthf2 | Uthf3 | Uthf4 | ΦUk-Ik | ΦUk-Ik | F11 | |
| Ithf1 | Ithf2 | Ithf3 | Ithf4 | ΦIi-Ij | ΦIi-Ij | F12 | |
| Utif1 | Utif2 | Utif3 | Utif4 | ΦIj-Ik | ΦIj-Ik | F13 | |
| Itif1 | Itif2 | Itif3 | Itif4 | ΦIi-Ik | ΦIi-Ik | F14 | |
| hvf1 | hvf2 | hvf3 | hvf4 | | | F15 | |
| hcf1 | hcf2 | hcf3 | hcf4 | | | F16 | |
| Kfact1 | Kfact2 | Kfact3 | Kfact4 | | | | |

* Displayed on models with the harmonic measurement option

# Appendix 12 TCP and UDP Port Numbers

The TCP and UDP port numbers that are used on the Ethernet interface of the PX8000 are listed below.

## TCP Port Numbers

| Port Number | Description | Used For |
|---|---|---|
| 20 | File Transfer [Default Data] | FTP server and FTP client* |
| 21 | File Transfer [Control] | FTP server and FTP client |
| 25 | Simple Mail Transfer Protocol | SMTP client |
| 515 | – | LPR client |
| 111 | – | Instrument control through the Ethernet interface |

## UDP Port Numbers

| Port Number | Description | Used For |
|---|---|---|
| 67 | Bootstrap Protocol Server | DHCP client |
| 68 | Bootstrap Protocol Client | (listen port) |
| 123 | Network Time Protocol | SNTP client |

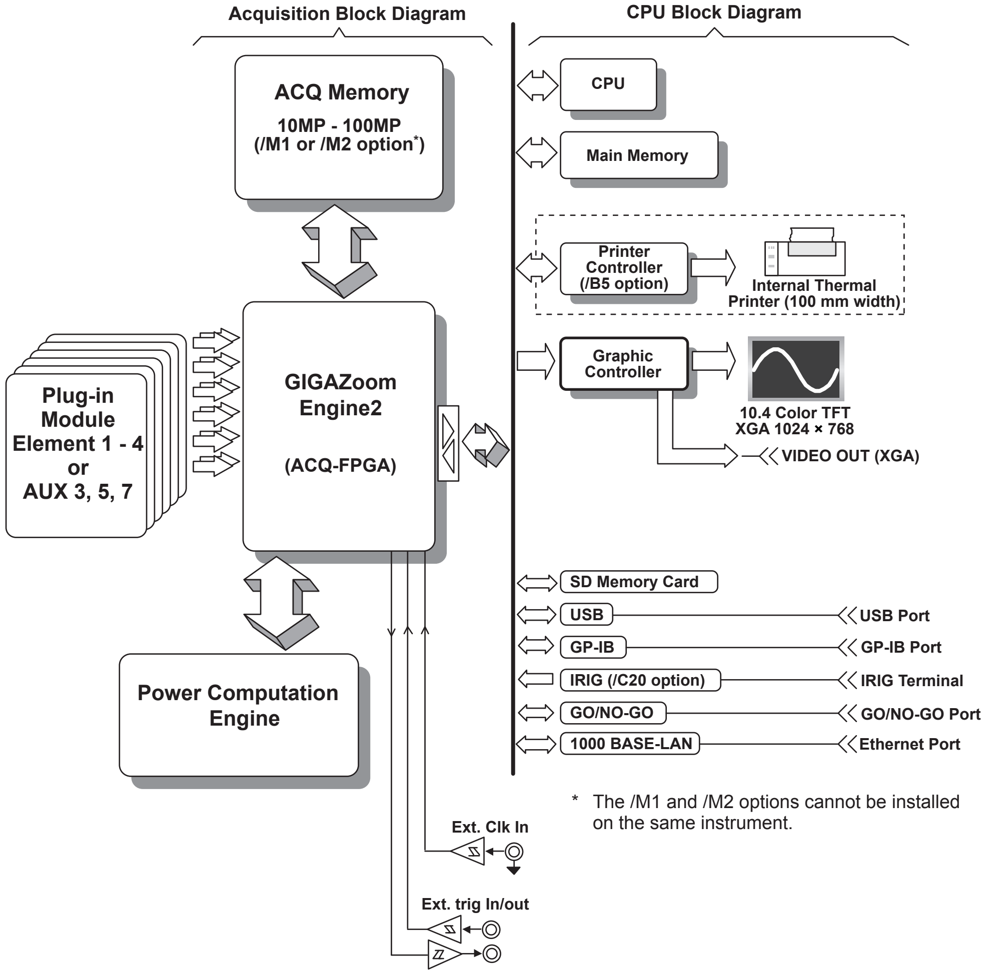
* The port number when FTP passive mode is disabled. When FTP passive mode is enabled, you can set any port number. When FTP passive mode is disabled, connections are established from the server. If you are connecting the PX8000 from behind a firewall, enable FTP passive mode.

# Appendix 13 Firmware Version

This manual covers firmware versions 2.01 and later of the PX8000.
To view the firmware version, press UTILITY and then the Overview soft key and check Firm Version on the Overview screen that is displayed.

# Appendix 14 Block Diagram

## Block Diagram of the PX8000



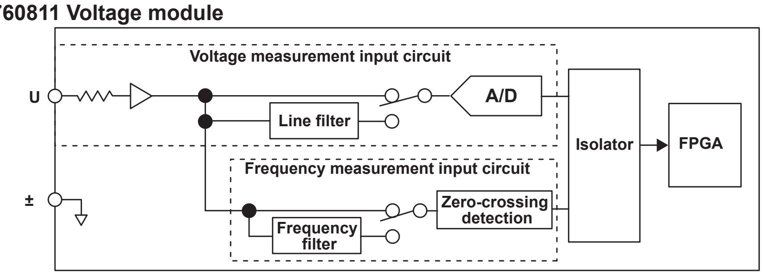

* The /M1 and /M2 options cannot be installed on the same instrument.

### Signal Flow of the PX8000

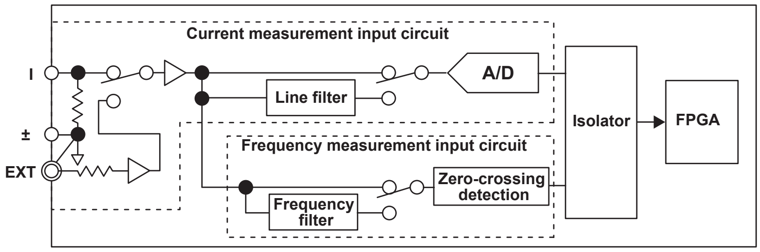
A power measurement element consists of a voltage module (760811) and a current module (760812/760813). The modules are mutually isolated. They are also isolated from the case.
The voltage signal that is applied to the 760811 is normalized using the voltage divider and the operational amplifier (op-amp) of the voltage input circuit. It is then sent to an A/D converter.
The 760812 is equipped with two types of input terminals: a current input terminal and an external current sensor input connector (EXT). Only one can be used at any given time. The voltage signal from a current sensor is applied to the external current sensor input connector. The voltage signal is normalized using the voltage divider and the operational amplifier (op-amp). It is then sent to a current A/D converter. On the other hand, a current input signal is applied to a current input terminal. The current signal is converted to a voltage signal by a shunt. Then, it is sent to the A/D converter in the same fashion as the voltage signal from the current sensor.
The 760813 is a current module without an external current sensor input connector (EXT). It only has a current input terminal.
The voltage signals that are applied to the A/D converters on the 760811, 760812, and 760813 are converted to digital values at an interval of approximately 10 ns. These digital values are isolated by the isolator and passed to the ACQ_FPGA. The ACQ_FPGA stores digital values in ACQ memory.
The digital values in ACQ memory are compressed at high speeds by GIGAZoom Engine2 to produce waveform display data, and this data passes through the graphics controller and is displayed on the XGA TFT color display. In addition, the power computation engine determines various power values from the digital values. The measured values are then transmitted to the CPU. Various computed values are determined from the measured values. The measured values and computed values are displayed and transmitted as measurement functions of normal measurement.

# Plug-in Module Block Diagram

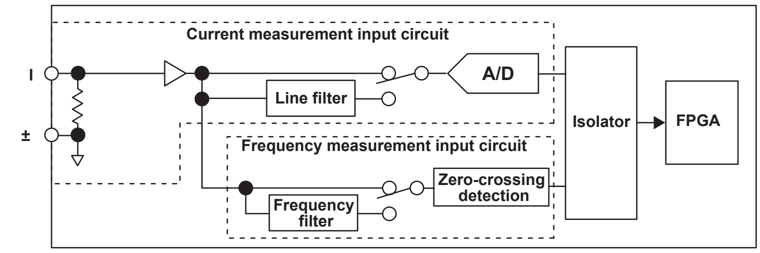
### 760811 Voltage module



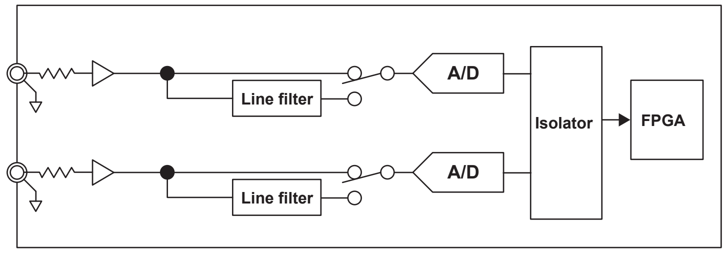

### 760812 Current module




### 760813 Current module




### 760851 AUX module



# Index

## R Page



## S Page



## T Page



## U Page



## V Page



## W Page

## X



## Y



## Z