

3196

POWER QUALITY ANALYZER

400Hz Measurement Function

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Introduction

- This product has the additional 400Hz power supply line measurement to Model 3196 Power Quality Analyzer.
- This manual explains the different operations from the standard instrument only.
- Refer to the basic warnings, cautions and notes in the quick start manual or detailed manual (CD-R) supplied with the standard instrument carefully to avoid any accident or danger. Those are not explained in this manual.

Chapter 1 Overview

This product has the additional 400Hz power supply line measurement to Model 3196 Power Quality Analyzer.

Measurement on 50/60Hz line is possible as same as the standard instrument.

This 400Hz function is applicable only on Model 3196 Ver1.30m or later.

Difference from the standard instrument when 400Hz mode is set

- ◆ Power quality between 360Hz and 440Hz are measured.
- ◆ Voltage RMS value is calculated every 1 cycle without any gap by using the sampling data of 256 points / 8 cycles. Dip, swell and interruption events are watched by the maximum or minimum value of voltage RMS value for every 4 cycles.
- ◆ The other RMS value events (frequency, current RMS, power, harmonics, unbalance factor, K factor, etc.) are watched by the calculation of every 200ms (80 cycles) without any gap.
- ◆ Harmonics are measured up to 10th order.
- ◆ Measurements for inter-harmonics and flicker are not available.
- ◆ EN50160 mode measurement is not available.
- ◆ The measurement data cannot be analyzed by Model 9624 PQA-HiVIEW. Use Model 9624-10 PQA-HiVIEW Pro for data analysis. (400Hz analysis function will be added later to Model 9624-10.)

Chapter 2 Making System Settings (SYSTEM screen)

2.1 Main Settings (MEASURE screen)

SYSTEM

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DF2

MAIN

MEASURE

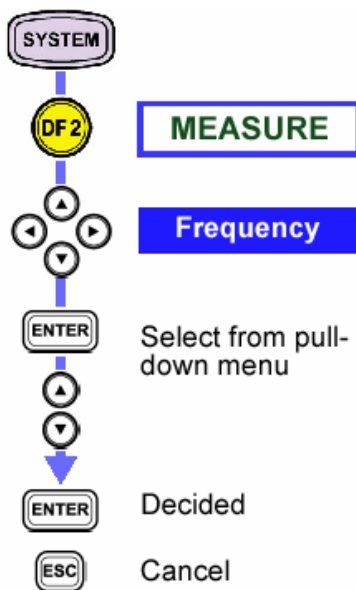
CH 1, 2, 3		CH 4	
3P4W	300V 50A	AC	300V 50A
Wiring	3P4W	AC	
Clamp	1mV/A 9661	1mV/A 9661	
U Range	300V	300V	
PT Ratio	1	1	
I Range	50A	50A	
CT Ratio	1	1	

UReference	100 V
Frequency	400Hz
PLL Source	U1
U CalcType	相電圧
Harm Calc	実効値
THD Calc	THD_F
PF Type	PF
Flicker	OFF
TimePlot U	Urms
EN50160	OFF

Choose the line to measure. Measurable CH will be decided.
Press enter key to show selectable menu in the display.

2003/09/12 11:09:43

Measurement frequency settings



UReference	100 V
Frequency	400Hz
PLL source	U1
U CalcType	相電圧
Harm Calc	実効値

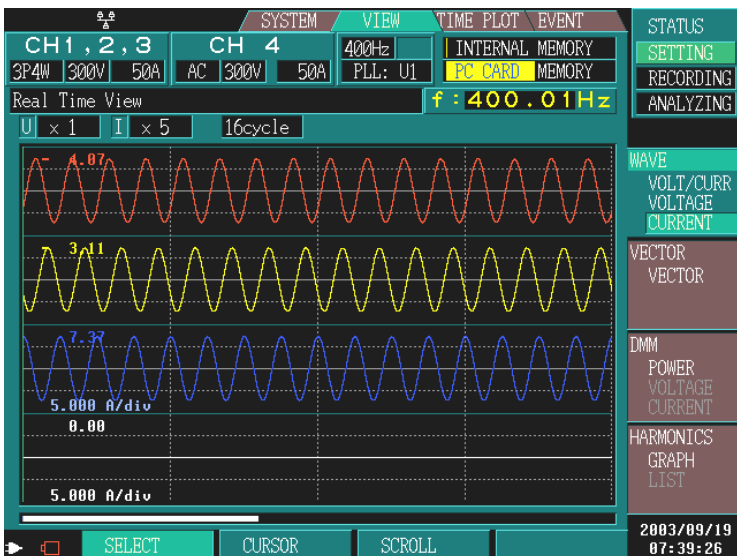
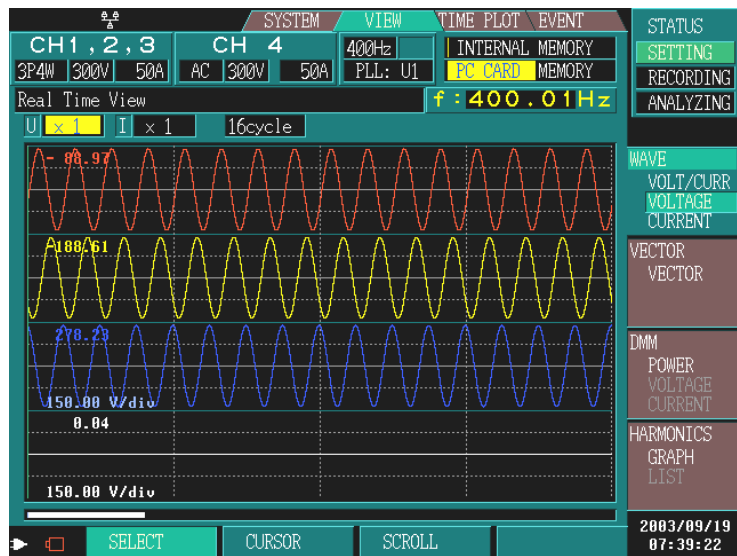
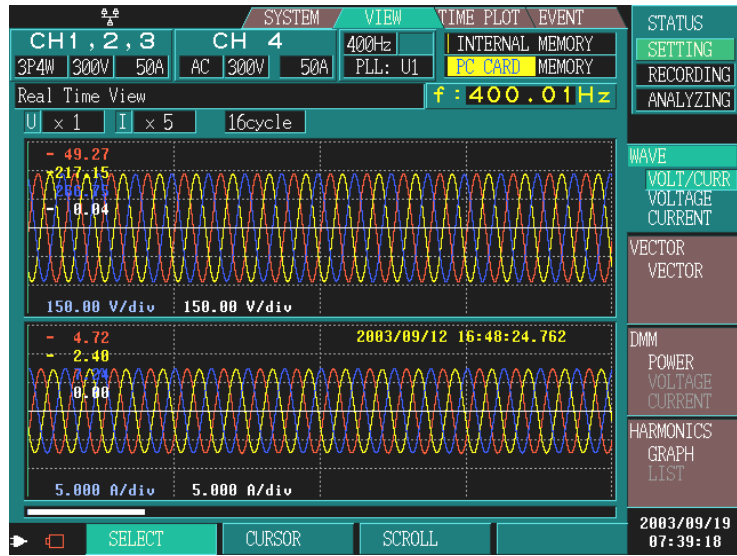
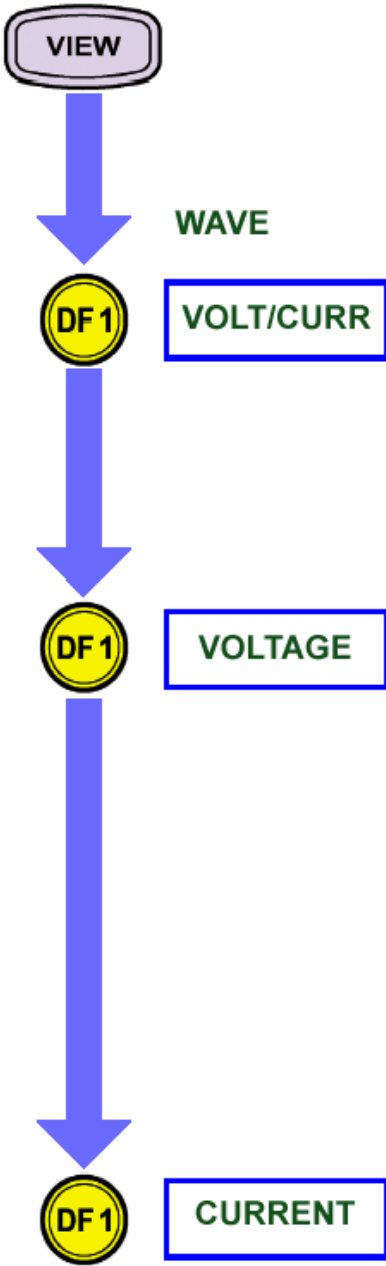
50Hz, 60Hz, 400Hz

- Set the frequency used for internal processing.
- To use on the 400Hz power supply line, set this to 400Hz. Then, the measurement between 360Hz and 440Hz are possible.

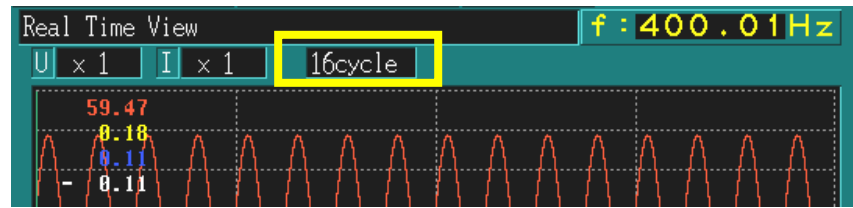
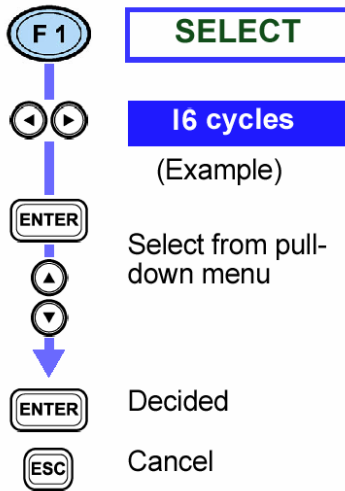
NOTE

When the frequency is set to 400Hz, the measurement mode becomes 400Hz dedicated mode. Some functions available on standard instruments are not settable in this mode. In "MEASURE" screen, "Flicker" and "EN50160" are fixed at OFF, and these functions cannot be used.

3.1 Waveform Display



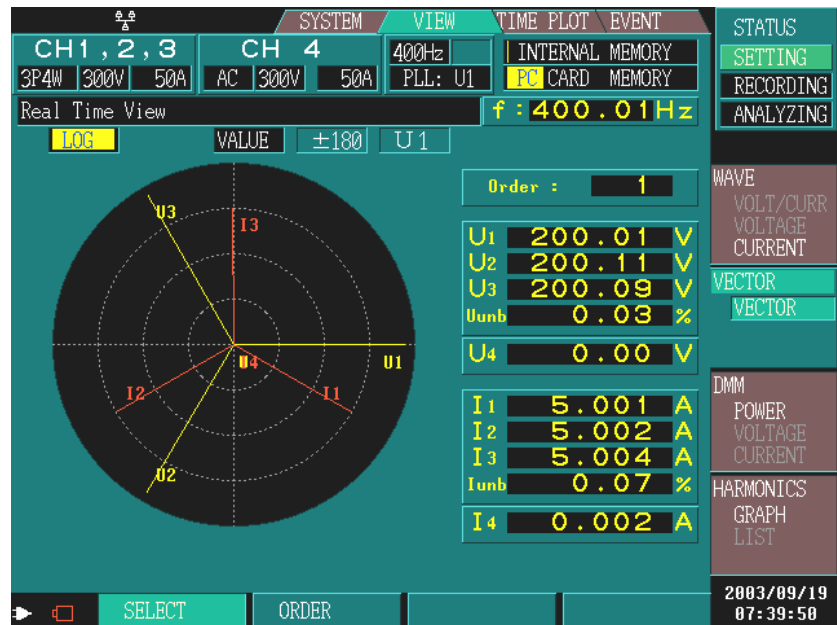
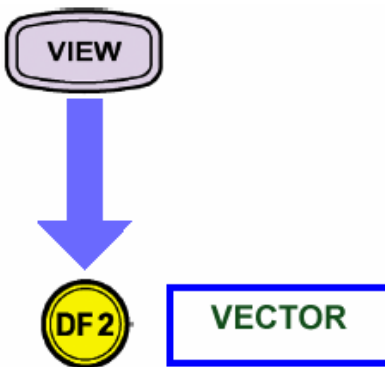
Enlarging waveforms (Changing X-axis scale of waveforms)



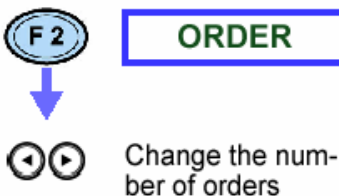
For 50Hz: **2 cycles, 4 cycles, 10 cycles**
 For 60Hz: **2 cycles, 4 cycles, 10 cycles, 12 cycles**
 For 400Hz: **16 cycles, 32 cycles, 80 cycles**

The waveforms are displayed over the entire screen in the selected number of cycles

3.2 Vector Display



Changing harmonic order number to display

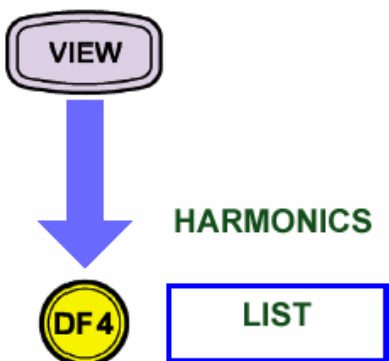
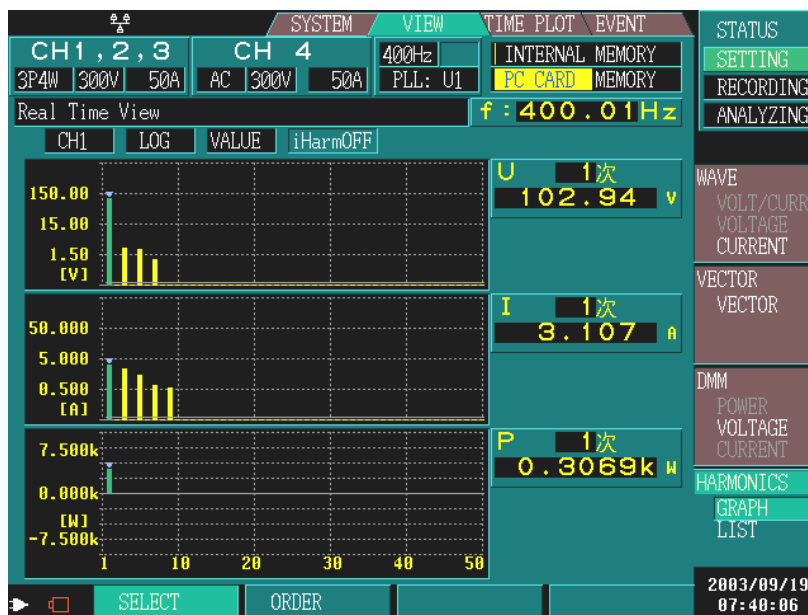
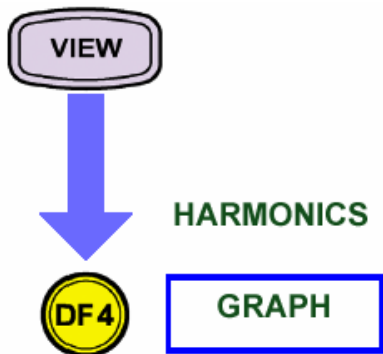


You can select the order number to display.

When using the 400Hz mode, you change from fundamental wave (1st) to 10th orders. If you change the order number, the values change along with the vectors.

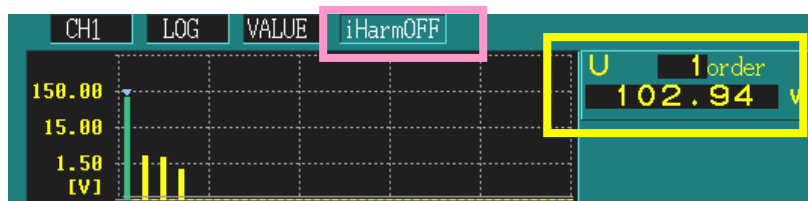
In this case, the voltage and current unbalance factors remain the same as the values calculated using the fundamental wave (1st order).

3.3 Harmonics Bar Graph and List Display



In the harmonics bar graph and list screens, the harmonics from the fundamental wave (1st) to 10th orders are displayed in 400Hz mode.

Changing harmonic order number to display



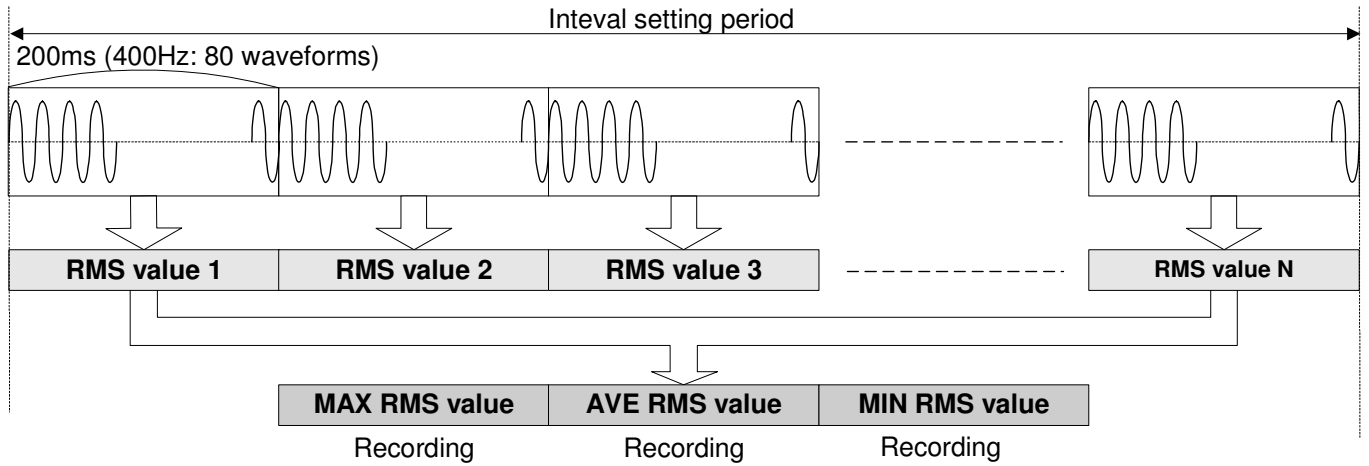
You can select the order number to display. If you change the order number, the values change along with the bar graph.

注記

In “harmonics graph” and “harmonics list” screens, the inter-harmonics setting is fixed as “iHarm OFF” and it is not displayable.

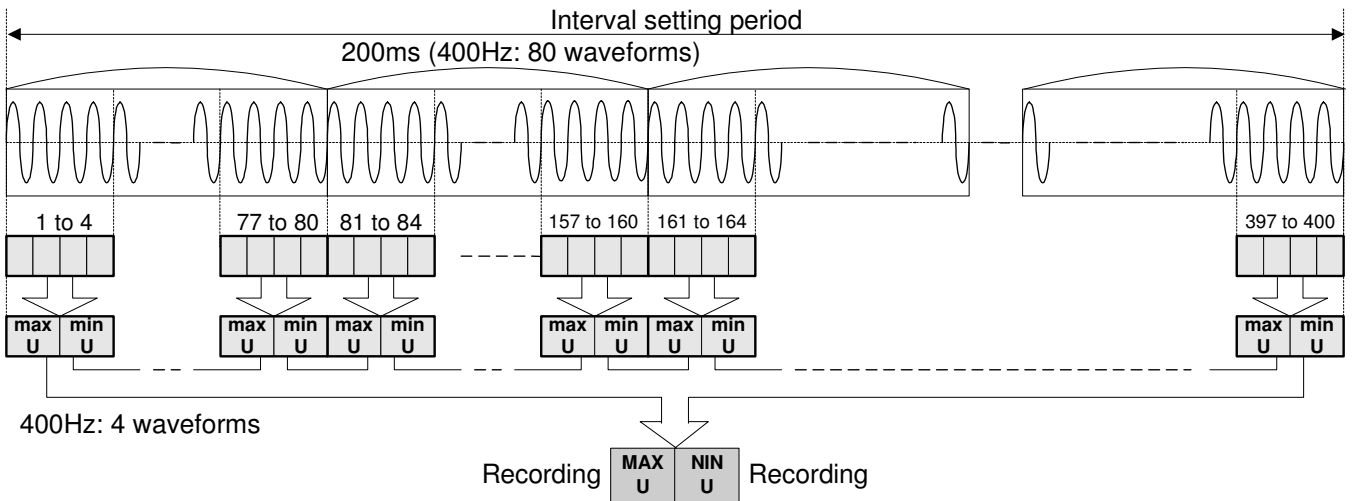
4.1 RMS Value Calculation Method

RMS graph, Harmonics graph



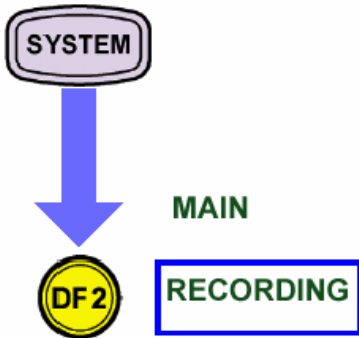
In the 400Hz mode, the RMS values (all RMS values except voltage and flicker) are calculated for every 80 waveforms (200ms) continuously without any gap. By using these RMS values, MAX/MIN/AVE values or AVE value only are recorded for every interval setting period. The RMS and harmonics graphs display the data of these recorded values. (example) If the interval period is set to 1s, there are 5 calculated values in 1s. Then, MAX/MIN/AVE values or AVE value only are recorded in these 5 values.

Voltage fluctuation graph

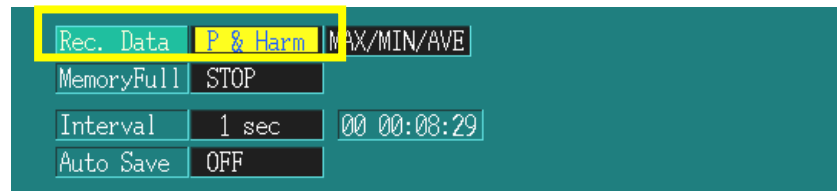
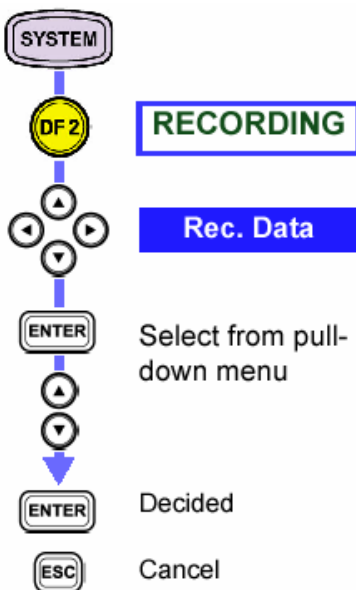


In the 400Hz mode, the RMS voltage value is calculated in every 1 waveform without any gap, and the maximum and minimum values are detected from every 4 waveforms. The MAX/MIN values in the interval setting period are recorded based on these maximum and minimum values. The voltage fluctuation graph displays this recording data. (example) If the interval period is set to 1s, there are 400 calculated values in 1 cycle. Then, MAX and MIN values only are recorded in these 400 values.

4.1 Main Settings (RECORDING screen)



Settings for record data



P&Harm Power

Record all calculated values except inter-harmonics
Record all calculated values except harmonics and inter-harmonics

- Select the item pattern to record. The selected data can be displayed in the time series graph.
- In the 400Hz mode, inter-harmonics recording is not available because there is no "ALL DATA" selection.
-

Changes in RMS value

Recorded item	1	2
Freq (frequency)	<input type="radio"/>	<input type="radio"/>
U (RMS voltage)	<input type="radio"/>	<input type="radio"/>
Upeak (voltage peak)	<input type="radio"/>	<input type="radio"/>
I (RMS current)	<input type="radio"/>	<input type="radio"/>
Ipeak (current peak)	<input type="radio"/>	<input type="radio"/>
Uave (voltage average)	<input type="radio"/>	<input type="radio"/>
Iave (current average)	<input type="radio"/>	<input type="radio"/>
P (active power)	<input type="radio"/>	<input type="radio"/>
S (apparent power)	<input type="radio"/>	<input type="radio"/>
Q (reactive power)	<input type="radio"/>	<input type="radio"/>
PF (power factor)	<input type="radio"/>	<input type="radio"/>

Changes in RMS value

Recorded item	1	2
KF (K factor)	<input type="radio"/>	<input type="radio"/>
Uunb (voltage unbalance factor)	<input type="radio"/>	<input type="radio"/>
Iunb (current unbalance factor)	<input type="radio"/>	<input type="radio"/>
U-THD (total harmonic voltage distortion factor)	<input type="radio"/>	<input type="radio"/>
I-THD (total harmonic current distortion factor)	<input type="radio"/>	<input type="radio"/>

1: P
2: P&Harm

Changes in harmonics

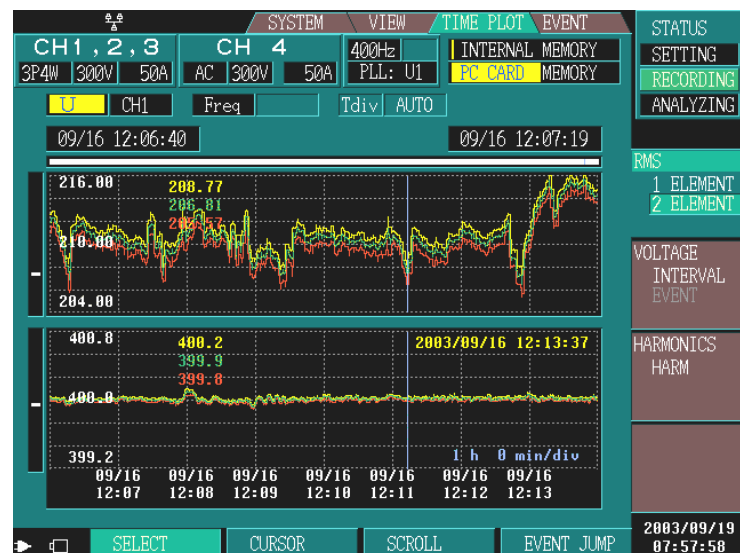
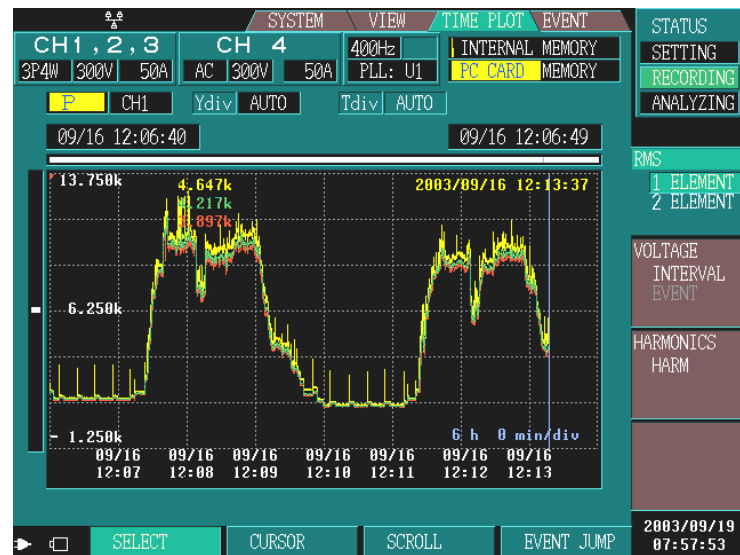
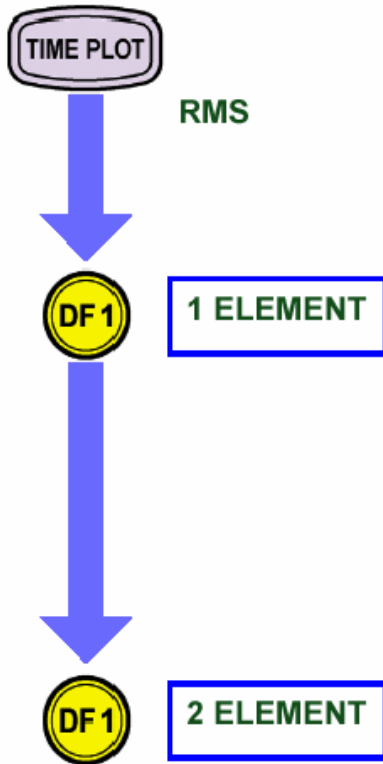
Recorded item	1	2
Harmonic voltage	<input checked="" type="radio"/>	<input type="radio"/>
Harmonic current	<input checked="" type="radio"/>	<input type="radio"/>
Harmonic power	<input checked="" type="radio"/>	<input type="radio"/>
Harmonic phase difference	<input checked="" type="radio"/>	<input type="radio"/>

Voltage fluctuation

Recorded item	1	2
Voltage	<input type="radio"/>	<input type="radio"/>

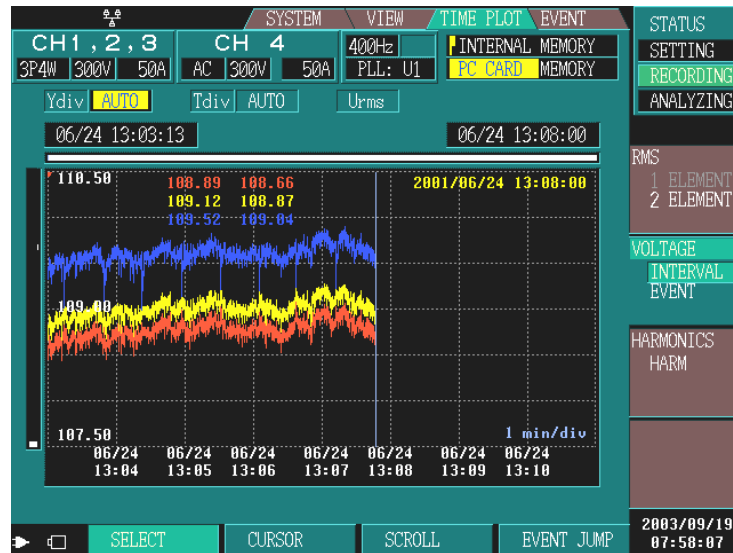
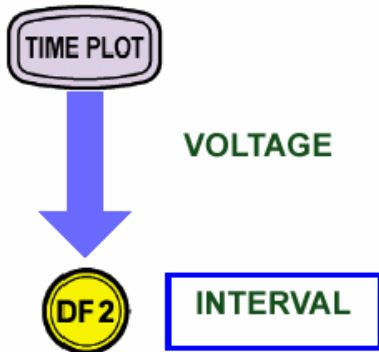
4.2 Changes in RMS Value

Items calculated every 200ms are displayed in time series for every interval period.



4.3 Voltage Fluctuation

The RMS voltage values calculated every 1 waveform in the 400Hz mode are displayed in time series as the maximum and minimum values of every interval period.

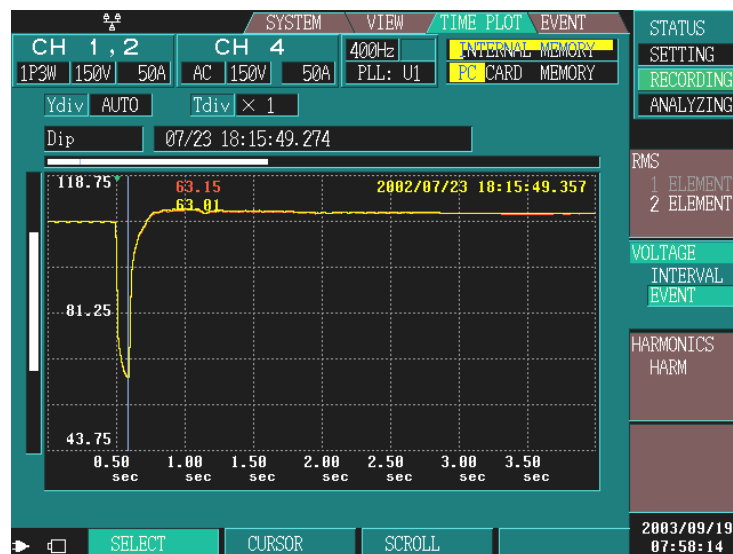
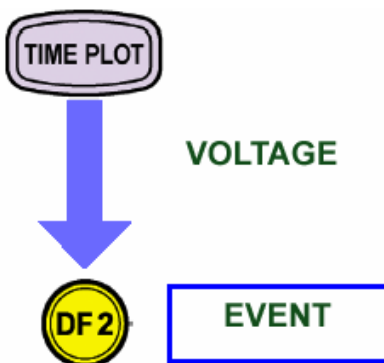


Display the time series graph for U1, U2 and U3. The updated values are displayed in MAX and MIN.

- Red: U1
- Yellow: U2
- Blue: U3

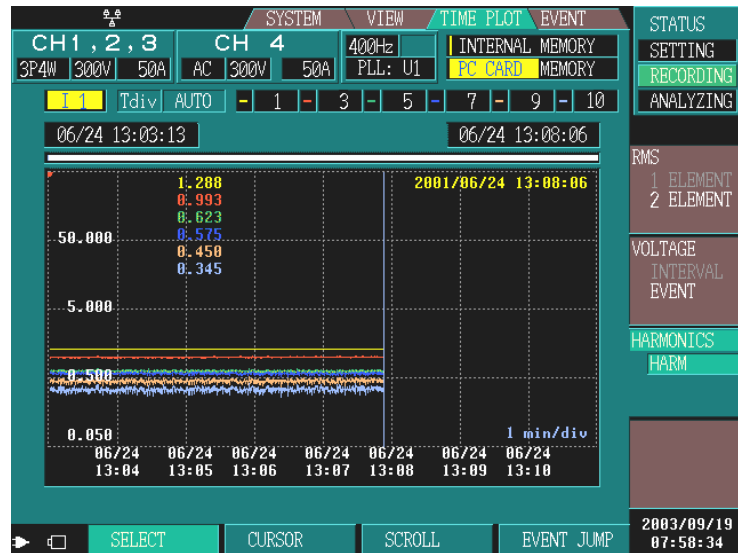
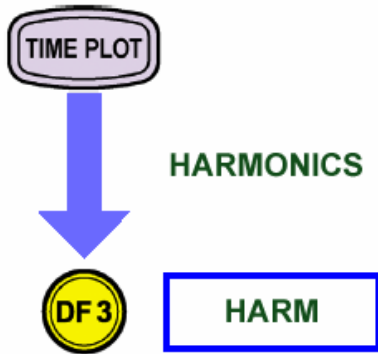
4.4 Voltage Fluctuation Graph for Events

The RMS voltage values calculated every 1 waveform in the 400Hz mode are displayed in time series as the maximum and minimum for 10 seconds.



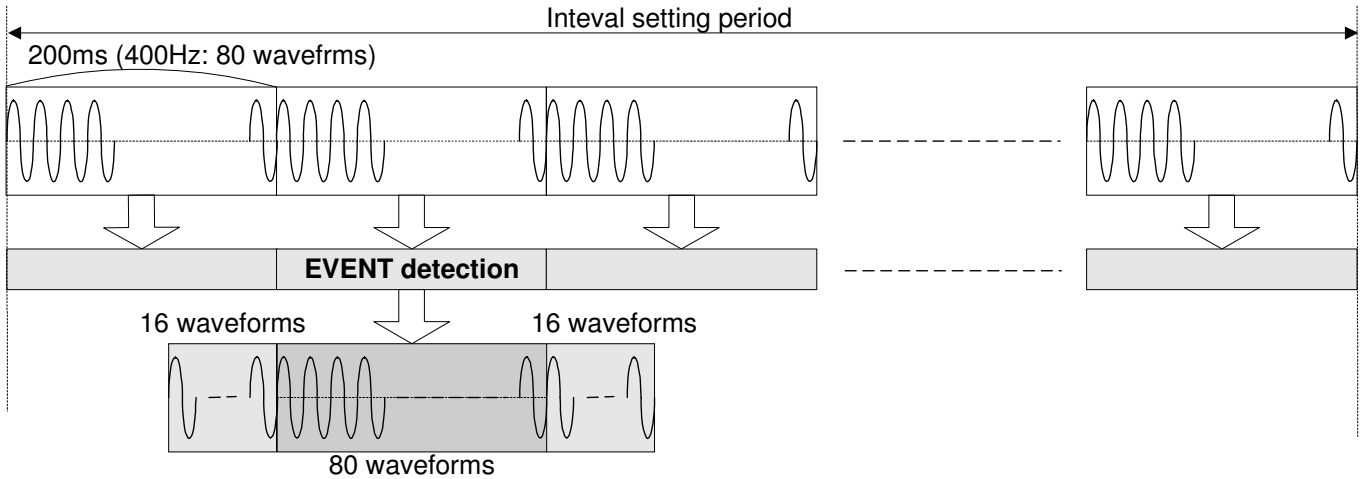
4.5 Changes in Harmonics

The harmonic calculation result in every 200ms is displayed in time series for every interval period. Six orders can be selected and displayed in a graph.



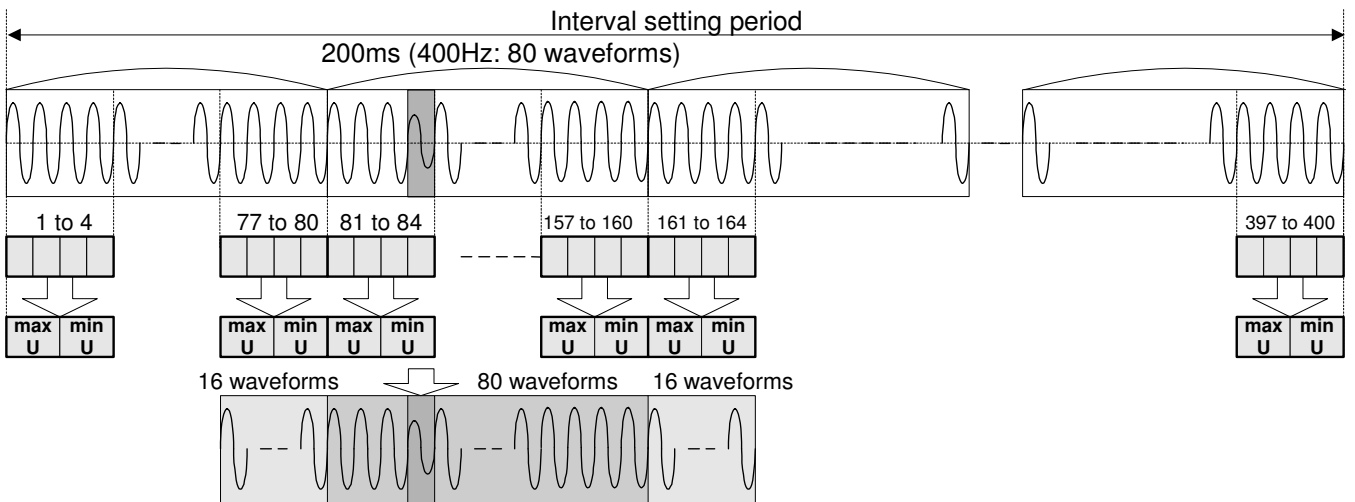
5.1 Event Detection Method and Recording Waveform

RMS Graph, Harmonics Graph



In the 400Hz mode operation, RMS values (all RMS values except voltage and flicker) are calculated in every 80 waveforms (200ms) continuously without any gap. The EVENT is detected by comparing these RMS values to the set threshold values. When an EVENT is detected, 16 waveforms are added before and after the relevant 80 waveforms and these 112 waveforms are recorded as the event waveform.

Voltage Swell, Voltage Dip, Interruption



In the 400Hz mode operation, the RMS voltage value is calculated in every 1 waveform and the maximum and minimum values are detected for every 4 waveforms. The EVENT is detected by comparing these maximum and minimum values to the set threshold values. When an EVENT is detected, the maximum and minimum values are recorded for 10 seconds as the voltage fluctuation event waveform. Also, the 112 waveforms of 80 waveforms of relevant period and additional 16 waveforms before and after are recorded as the event waveform.

5.2 Event Settings and Threshold Ranges

Item	Order selection	Measure-ment selection	Positive and negative	Channel selection			Threshold
Voltage frequency			Approximately	PLL source	-	OFF	0 to 80Hz
Voltage waveform comparison				1,2,3	-	OFF	0 to 100%
External event				Input terminal	-	OFF	None
Voltage transient			±	1,2,3,4	-	OFF	0 to 2000Vpk
Voltage swell				1,2,3	-	OFF	0 to 200%
Voltage dip				1,2,3	-	OFF	0 to 100%
Instantaneous voltage interruption (interruption)				1,2,3	-	OFF	0 to 100%
RMS voltage value	Upper / Lower	Phse to n / line-to-line		1,2,3	4	OFF	0 to 600Vrms
RMS voltage (SENSE)				1,2,3	4	OFF	0 to 60Vrms
RMS current value				1,2,3	4	OFF	0 to 500Arms
Voltage waveform peak (±)			±	1,2,3	4	OFF	0 to 1.8kV
Current waveform peak (±)			±	1,2,3	4	OFF	0 to 2.0kA
Active power			±	1,2,3	sum	OFF	0 to 3MW
Reactive power			±	1,2,3	sum	OFF	0 to 3Mvar
Apparent power				1,2,3	sum	OFF	0 to 3MVA
Power factor/Displacement power factor		PF/DPF	±	1,2,3	sum	OFF	0 to 1
K factor				1,2,3	4	OFF	0 to 500%
Total harmonic voltage distortion factor		-F/-R		1,2,3	4	OFF	0 to 500%
Total harmonic current distortion factor		-F/-R		1,2,3	4	OFF	0 to 500%
Voltage unbalance factor				-	sum	OFF	0 to 100%
Current unbalance factor				-	sum	OFF	0 to 100%
Harmonic voltage	1st to 10th orders	RMS/%		1,2,3	4	OFF	0 to 600Vrms / 0 to 100%
Harmonic current	1st to 10th orders	RMS/%		1,2,3	4	OFF	0 to 5kA / 0 to 100%
Harmonic power	1st to 10th orders	RMS/%	±	1,2,3	sum	OFF	0 to 3MW / 0 to 100%
Harmonic voltage-current phase difference	1st to 10th orders		±	1,2,3	sum	OFF	0 to 180°

*1: The recorded threshold is the multiplication result when the PT ratio and CT ratio are set.

*2: For harmonics, settings can be made individually for each harmonic order.

*3: Measurement settings can be selected for each type of measurement (phase-to-n or line-to-line, and -F or -R)

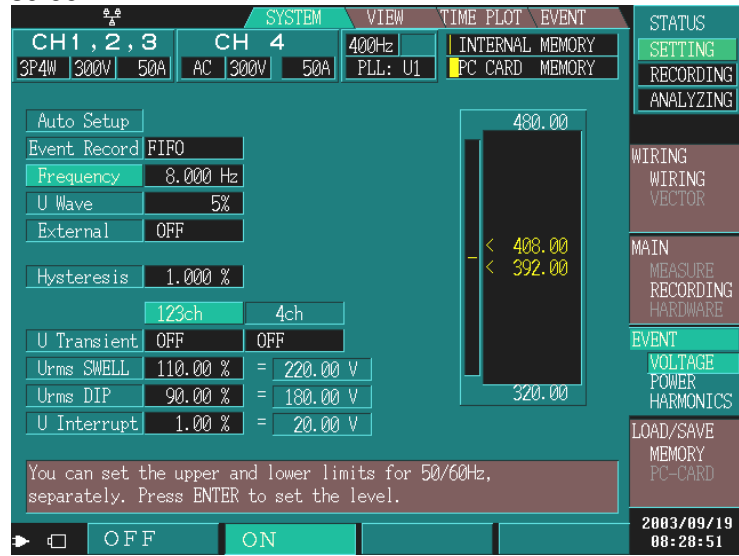
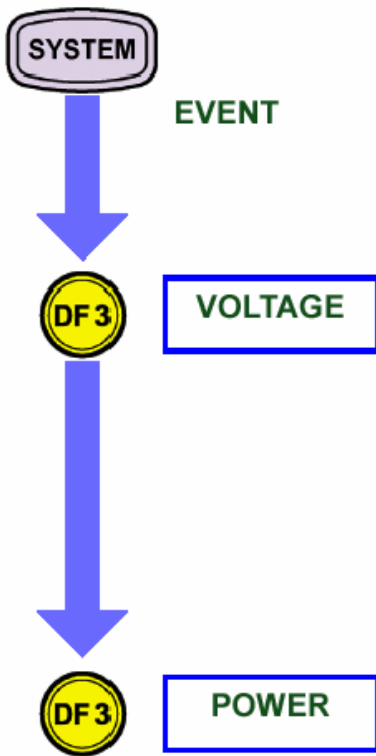
*4: Plus and minus (±) indicates that the threshold is specified as an absolute value. (Events are detected using absolute values regardless of whether they are positive or negative.)

*5: You can set the thresholds individually for channels that are separate and not off.

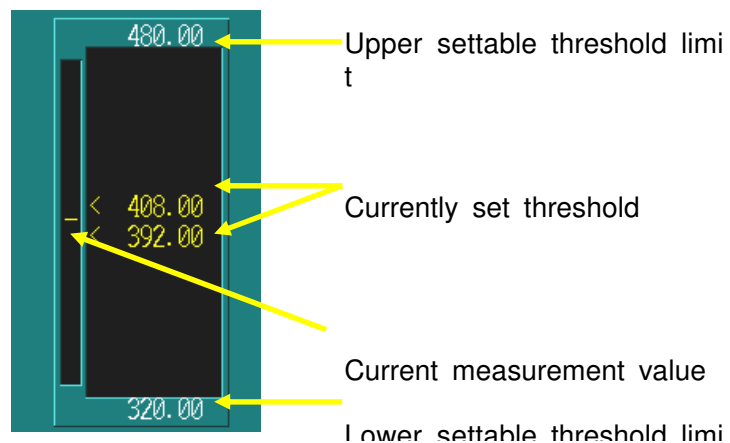
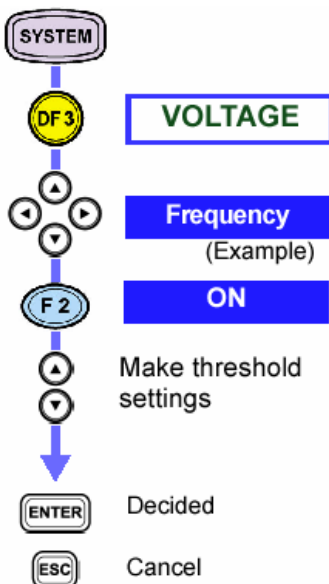
*6: Hysteresis is selected as a percentage value common to all thresholds in the range of 0 to 10%. Frequency hysteresis is fixed at 0.1Hz.

5.3 Voltage/Power Event Settings

The event settings can be made in items and thresholds in the SYSTEM screen.



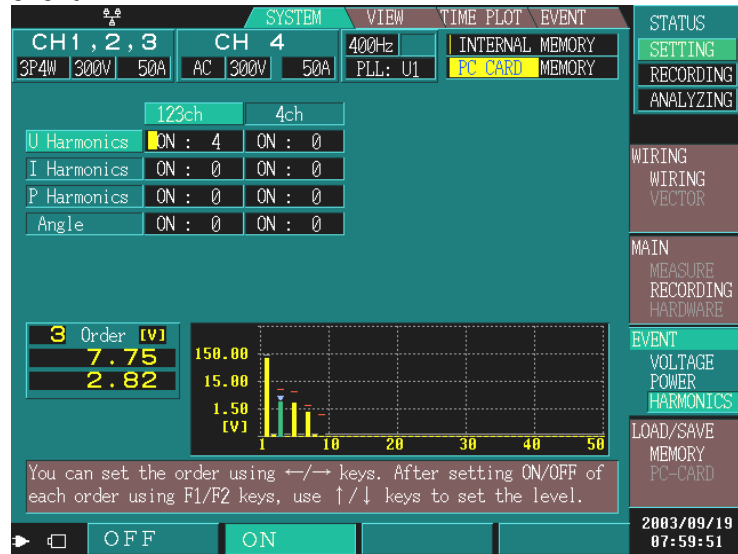
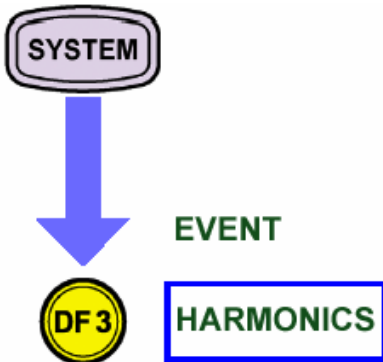
Threshold settings for frequency event (example)



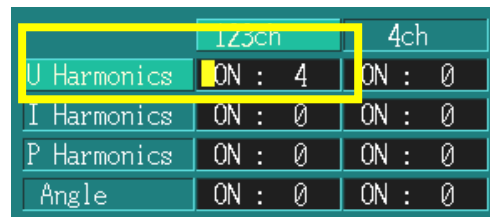
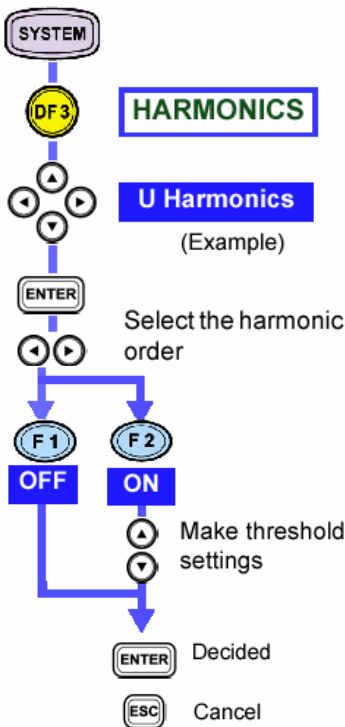
When the threshold is set at "8Hz", the threshold is set for $\pm 8\text{Hz}$ for 400Hz (392Hz and 408Hz).

5.4 Harmonic Event Settings

Make the following settings in the SYSTEM screen for the harmonic event.

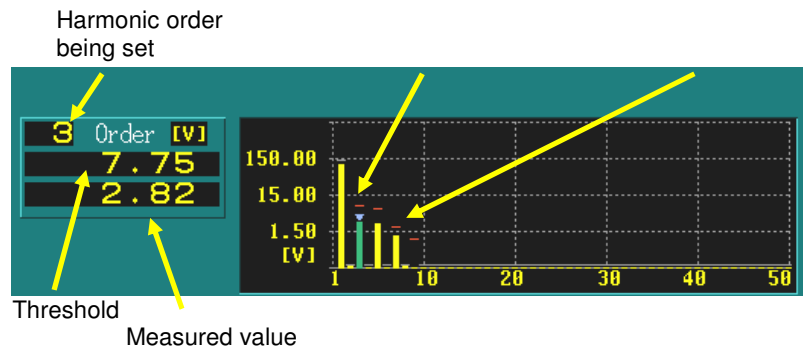


Event ON/OFF settings and threshold settings



Set ON/OFF for each harmonic order. (ON: numeric value)
The numeric value indicates the total number of harmonic orders set to ON.

- OFF** Disables voltage harmonic event functions
- ON** Enables voltage harmonic event functions



In the 400Hz mode operation, the thresholds are set individually for harmonics (harmonic voltage, harmonic current, harmonic power, harmonic voltage-current phase difference) from 1st to 10th orders.

5.5 Event List Display

Displays the events in a list.

No.	Date	Time	Event Category
1	09-16	17:42:59.067	Stop
2	09-16	17:42:55.307	Dip CH1 IN
3	09-16	17:42:47.287	Dip CH1 IN
4	09-16	17:42:39.277	Dip CH1 IN
5	09-16	17:42:31.277	Dip CH1 OUT
6	09-16	17:42:31.257	Dip CH1 IN
7	09-16	17:42:23.267	Dip CH1 OUT
8	09-16	17:42:23.247	Dip CH1 IN
9	09-16	17:42:15.227	Dip CH1 IN
10	09-16	17:42:08.067	Start

Event details list

2003/9/16	17:42:47.287	Dip CH1 IN	90.00%
2003/9/16	17:42:47.307	Dip CH1 OUT	11.07 V 0:00:00.020

Information that is recorded as the event includes the start time, stop time and event parameters set in the SYSTEM screen. The maximum number of events recorded is 100 for the internal memory and 1000 for the PC card. If different multi-parameter events occur within the same 200ms span, they are grouped and displayed together as one event. The contents of the multi-parameter events are displayed in the lower part of the screen.

Event details list display

2003/9/16	17:42:47.287	Dip CH1 IN	90.00%
2003/9/16	17:42:47.307	Dip CH1 OUT	11.07 V 0:00:00.020

Event occurrence time Event parameter Worst value Event existing period

Events are grouped for IN (when exceeding threshold) and OUT (when returning within or lower than threshold).

For the events of voltage swell, voltage dip and interruption, the worst value (in dip event, the lowest value within the event period) and event existing period are displayed.

注記

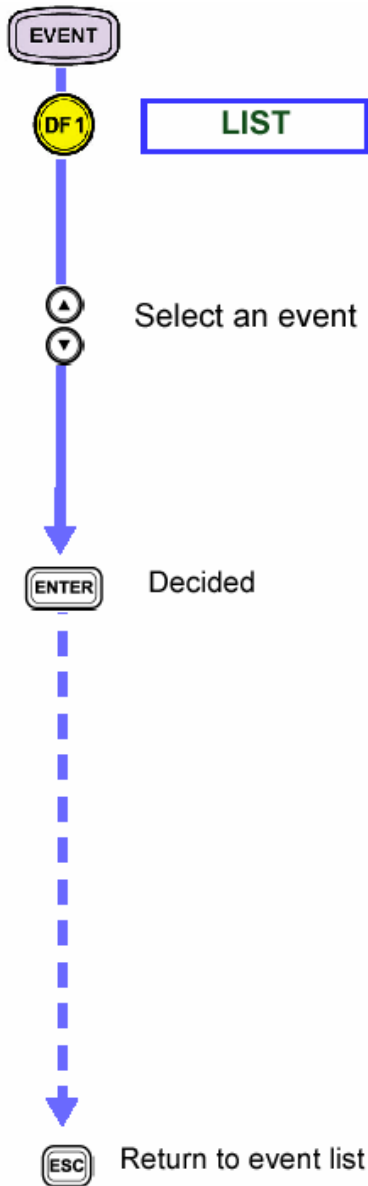
Notes for the use in the 400Hz mode

The worst value of RMS voltage value is correct, because the RMS voltage value is calculated in every 1 waveform.

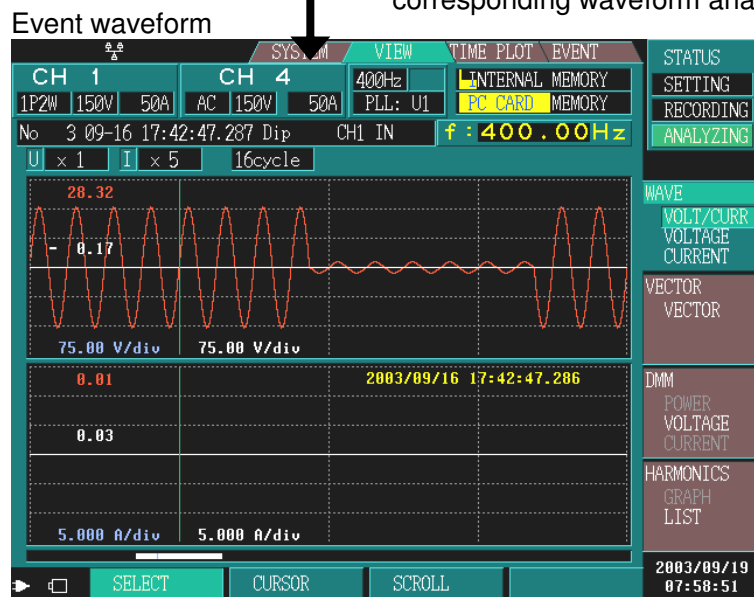
However, the time accuracy of event detection time and event existing period is 10ms resolution, because the comparison to the set threshold is made by the maximum and minimum values of every 4 waveforms.

For example, when there is a dip event for 6 waveforms, the event existing period should be 15ms (6 waveforms/400Hz), but the displayed period is 10ms or 20ms.

5.6 Analyzing Event Waveform



Select an event to display a corresponding waveform analysis



This screen shows the dip event lasted for 6 waveforms, as an example. You can analyze 112 waveforms made by 80 waveforms of event detected period and additional 16 waveforms for both before and after.

Chapter 6 Product Specifications

- The specifications are applied to the 400Hz measurement version of Model 3196 Power Quality Analyzer. The specifications not specified here is compatible to the specifications of Model 3196 in standard.

Environmental and Safety Specifications

- Only the differences on 400Hz measurement frequency from the standard instrument are listed.

Maximum rated voltage to earth: [Applicable for 50/60Hz only](#)
Dielectric strength: [Applicable for 50/60Hz only](#)

General Specifications

- Only the differences on 400Hz measurement frequency from the standard instrument are listed.

-1. Input Specifications

Input resistance ([400Hz](#)): Voltage: $4M\Omega \pm 10\%$ (differential input)
Current: $200k\Omega \pm 10\%$
PLL synch frequency range: [360Hz to 400Hz](#)
Sampling frequency ([400Hz](#)): For calculations (except harmonics): [256 points / 8 cycles](#)
For harmonic analysis: [2048 points / 80 cycles](#)

-2. Basic Specifications

Power supply: 9458 AC ADAPTER (SINO-AMERICAN SA60-12V)(12VDC \pm 5%, 4.5A)
Rated voltage: 100V to 240VAC (a change in voltage of $\pm 10\%$ taken into consideration)
50/60Hz, maximum rated current 1.2A
[Not allowed to use with the rated voltage at 400Hz.](#)
9459 BATTERY PACK (Sanyo 6HR-AU) (Ni-MH) for backup during power off
Recharge function: Using the 9458 AC ADAPTER or 9450 BATTERY PACK to recharge while the 3196 is operating

-3. Accessories and Options

Accessories: 9438-02 VOLTAGE CORD
1 set: 8 cords (red, yellow, blue, and gray (one each) and 4 black cords)
9458 AC ADAPTER 1 (The power cord can be selected in country specifications)
Strap 1
Quick Start Manual1 (booklet)
Instruction Manual 1 disc (CD-R)
(Detailed manual, EN50160 manual, Down96 Download application software)
Instruction Manual for EN50160 1 (booklet)
[Instruction Manual for 400Hz1 \(booklet\)](#)
LAN connector cover 1
Input cord label 1
9459 BATTERY PACK 1 (Ni-MH, 7.2V / 2700mAh)

Measurement Specifications

- Only the differences on 400Hz measurement frequency from the standard instrument are listed.

-1. Measurement Items

1) Items measured in every 1 cycle (256 points/8 cycles at 400Hz) without gaps

Item	Variable	1P2W	1P3W 3P3W2M	3P3W3M	3P4W	MAX/ MIN/ AVE
Voltage swell	Uswell	1	1,2	1,2,3	1,2,3	
Voltage dip (sag)	Udip	1	1,2	1,2,3	1,2,3	
Voltage instantaneous interruption (interruption)	Uinterruption	1	1,2	1,2,3	1,2,3	
RMS voltage value (every 1 cycle)	U	1	1,2	1,2,3	1,2,3	**
Voltage fluctuation	ΔU	1	1,2	1,2,3	1,2,3	**

2) Items measured in every 200ms (80 cycles at 400Hz) without gaps

Item	Variable		1P2W	1P3W 3P3W2M	3P3W3M	3P4W	MAX/ MIN/ AVE
Voltage frequency	Freq		PLL source	PLL source	PLL source	PLL source	*
Voltage waveform peak (\pm)	Upeak		1,4	1,2,4	1,2,3,4	1,2,3,4	
Current waveform peak (\pm)	Ipeak		1,4	1,2,4	1,2,3,4	1,2,3,4	
RMS voltage value	Urms	Phase -N/ LINE- LINE	1,4	1,2,4, ave	1,2,3,4, ave	1,2,3,4, ave	*
RMS current value	Irms		1,4	1,2,4, ave	1,2,3,4, ave	1,2,3,4, ave	*
Active power	P		1	1,2,sum	1,2,3,sum	1,2,3,sum	*
Apparent power	S		1	1,2,sum	1,2,3,sum	1,2,3,sum	*
Reactive power	Q		1	1,2,sum	1,2,3,sum	1,2,3,sum	*
Power factor / displacement power factor	PF/DPF		1	1,2,sum	1,2,3,sum	1,2,3,sum	*
Voltage unbalance factor	Uunb		-	-	sum	sum	*
Current unbalance factor	Iunb		-	-	sum	sum	*
Harmonic voltage (1st to 10th orders)	Uharm	RMS/ %	1,4	1,2,4	1,2,3,4	1,2,3,4	*
Harmonic current (1st to 10th orders)	Iharm	RMS/ %	1,4	1,2,4	1,2,3,4	1,2,3,4	*
Harmonic power (1st to 10th orders)	Pharm	RMS/ %	1	1,2,sum	sum	1,2,3,sum	*
Harmonic voltage phase angle (1st to 10th orders)	θ_{uharm}		1,4	1,2,4	1,2,3,4	1,2,3,4	
Harmonic current phase angle (1st to 10th orders)	θ_{iharm}		1,4	1,2,4	1,2,3,4	1,2,3,4	
Harmonic voltage-current phase difference (1st to 10th orders)	θ_{harm}		1	1,2,sum	sum	1,2,3,sum	*
Total harmonic voltage distortion factor	Uthd	-F/-R	1,4	1,2,4	1,2,3,4	1,2,3,4	*
Total harmonic voltage distortion factor	Ithd	-F/-R	1,4	1,2,4	1,2,3,4	1,2,3,4	*
K factor	KF		1,4	1,2,4	1,2,3,4	1,2,3,4	*

Note) In the 400Hz mode operation, the measurement of Short interval flicker (Pst), Inter-harmonic voltage, Inter-harmonic current, Total inter-harmonic voltage distortion factor, Total inter-harmonic current distortion factor, ΔV_{10} flicker, and IEC flicker are not possible.

-2. Conditions of Guaranteed Accuracy

Fundamental waveform range for guaranteed accuracy: 360 to 440Hz

-3. Miscellaneous Measurement Items

[RMS Voltage]

Measurement method: True RMS type

Measurement at 256 points per 8 cycles about once every 80 cycles (200ms) at 400Hz

Measurement accuracy: $\pm 0.2\% \text{rdg} \pm 0.6\% \text{f.s.}$

[RMS Current]

Measurement method: True RMS type

Measurement at 256 points per 8 cycles about once every 80 cycles (200ms) at 400Hz

Measurement accuracy: $\pm 0.2\% \text{rdg} \pm 0.6\% \text{f.s.}$ + clamp sensor specification accuracy

[RMS Voltage] (1 cycle calculation at 400Hz)

Measurement method: True RMS type

Measurement by square average of 1 cycle data obtained at 256 points per 8 cycles sampling

(The line-to-line voltage is used for three-phase 3-wire (3P3W3M) systems, and the phase-to-neutral voltage is used for three-phase 4-wire systems)

Limitations:

The values recorded in the voltage fluctuation event graph are the maximum and minimum values of RMS voltage in every 1 cycle.

[Voltage Swell]

Voltage swell height: swell to (threshold) %

When the RMS voltage (maximum value of 4 RMS voltage values (1 cycle calculated value at 400Hz) within 20ms) exceeds the threshold in the positive direction, the swell is detected and the threshold height is displayed.

Voltage swell detection time: The resolution of voltage swell detection time is 10ms (=4 cycles).

[Voltage Dip]

Voltage dip depth: dip to (threshold) %

When the RMS voltage (minimum value of 4 RMS voltage values (1 cycle calculated value at 400Hz) within 20ms) exceeds the threshold in the negative direction, the dip is detected and the threshold depth is displayed.

Voltage dip detection time: The resolution of voltage dip detection time is 10ms (=4 cycles).

[Instantaneous Voltage Interruption (Interruption)]

Instantaneous interruption depth: Interruption to (threshold) %

When the RMS voltage (minimum value of 4 RMS voltage values (1 cycle calculated value at 400Hz) within 20ms) exceeds the threshold in the negative direction, the instantaneous interruption is detected and the instantaneous interruption depth is displayed.

Instantaneous interruption detection time: The resolution of instantaneous interruption detection time is 10ms (=4 cycles).

[ΔU Voltage Fluctuation]

Measurement method: Change in RMS voltage (1 cycle calculated value at 400Hz) with respect to standard voltage

[Frequency]

Measurement method: Reciprocal frequencies are sampled at 2MHz about once every 80 cycles (approximately every 200ms).

Measurement range: 360.00 to 440.00Hz

Measurement range: 999.99Hz

Measurement source: One of voltages U1, U2 or U3 (the same as the PLL synchronization source)

Measurement accuracy: Less than $\pm 100 \text{mHz}$

For a sine wave input with a voltage range of 30% to 110%.

[Voltage Waveform Peak]

Measurement method: Waveform consists of 256 points per 8 cycles, measured every 80 cycles at 400Hz, respectively (approx. 200ms).

Maximum and minimum sampling points within 200ms

[Current Waveform Peak]

Measurement method: Waveform consists of 256 points per 8 cycles, measured every 80 cycles at 400Hz, respectively (approx. 200ms).

Maximum and minimum sampling points within 200ms

[Active Power]

Measurement method: Waveform consists of 256 points per 8 cycles, measured every 80 cycles at 400Hz, respectively (approx. 200ms).

Calculated by averaging sampled voltage and current waveform data

Measurement accuracy: $\pm 0.4\% \text{rdg.} \pm 0.6\% \text{f.s.}$ + clamp sensor specification accuracy (power factor = 1)
(The total is the sum of the channels used.)

Power factor influence: $\pm 4.0\% \text{rdg.}$ (360 to 440Hz, power factor = 0.5)

[Displacement Power Factor]

Measurement accuracy: $\pm 0.5\% \text{rdg.} \pm 0.6\% \text{f.s.} \pm 1 \text{dgt.}$ (sum value is $\pm 3 \text{dgt.}$)

[Harmonic Voltage, Harmonic Current, Harmonic Power] (including fundamental frequency component)

Harmonic analysis window width: 80 cycles at 400Hz

Harmonic analysis orders: 1st to 10th orders (when the fundamental frequency is 360 to 440Hz)

Measurement accuracy: At 400Hz

Harmonic voltage, current

1st to 2nd	$\pm 0.5\% \text{rdg.} \pm 0.2\% \text{f.s.}$
3rd to 6th	$\pm 1.0\% \text{rdg.} \pm 0.3\% \text{f.s.}$
7th to 10th	$\pm 1.0\% \text{rdg.} \pm 0.3\% \text{f.s.} \pm 0.5 \times (k-6)\% \text{rdg.}$ (k: harmonic ordes)

Harmonic power

1st to 2nd	$\pm 0.5\% \text{rdg.} \pm 0.2\% \text{f.s.}$
3rd to 6th	$\pm 1.0\% \text{rdg.} \pm 0.3\% \text{f.s.}$
7th to 10th	$\pm 1.0\% \text{rdg.} \pm 0.3\% \text{f.s.} \pm 1.0 \times (k-4)\% \text{rdg.}$ (k: harmonic ordes)

However, the clamp sensor's accuracy is added when calculating harmonic current and harmonic power.

[Harmonic Voltage-Current Phase Difference] (including fundamental frequency component)

Measurement accuracy: At 400Hz

1st to 10th : $\pm (0.16^\circ \times k + 2^\circ)$ (k: harmonic ordes)

However, clamp sensor accuracy is added.

-4. Other Characteristics

Frequency characteristic: 440Hz to 1kHz: $\pm 3\% \text{f.s.}$

1kHz to 3kHz: $\pm 10\% \text{f.s.}$ (RMS voltage, RMS current), $\pm 15\% \text{f.s.}$ (active power)

Temperature characteristic: AC: Within $\pm 0.05\% \text{f.s.}/^\circ\text{C}$ (from 0 to 18°C and from 28 to 40°C)

DC: Within $\pm 0.1\% \text{f.s.}/^\circ\text{C}$ (from 0 to 18°C and from 28 to 40°C)

Effect of common mode voltage: $\pm 2\% \text{f.s. or less}$ (600Vrms, 400Hz, between voltage input terminal and instrument case)

Effect of external magnetic field: Not specified.

Event Specifications

- Only the differences on 400Hz measurement frequency from the standard instrument are listed.

-1. Event items

Event category	Event	Variable	Orders
Harmonic voltage	Harmonic voltage	U_HARM	1st to 10th
Harmonic current	Harmonic current	I_HARM	1st to 10th
Harmonic power	Harmonic power	P_HARM	1st to 10th
	Harmonic voltage-current phase difference	PHASE	1st to 10th

Measurement Functions and Analysis Functions

- Only the differences on 400Hz measurement frequency from the standard instrument are listed.
- 1) Waveform display
Display axis settings: Vertical axis: x1/3, x1/2, x1, x2, x5, x10
Time axis: x16, x32, x80
(In "ANALYSIS" mode, 16 cycles are added to each before and after the recorded event, so that analysis shall be made by scrolling.)
 - 2) Vector display
Cursor measurement: Cursor position value for the harmonic order (1st to 10th orders)
 - 3) Harmonic display
Harmonic bar graph display
Display format: 3 divided display
Area 1: Harmonic voltage or Harmonic voltage phase angle
No inter-harmonic voltage display
Area 2: Harmonic current or Harmonic current phase angle
No inter-harmonic current display
Area 3: Harmonic power or Harmonic voltage-current phase difference or none
Display selection: ch: CH1, CH2, CH3, CH4
Vertical axis display format: LINEAR, LOG
Display items 1: Inter-harmonics is fixed to OFF.
Display items 2: VALUE (RMS value), PHASE (phase angle) (No inter-harmonics)
Cursor measurement: Cursor position value of harmonic order (1st to 6th)
 - 4) Voltage fluctuation graph display (interval)
Display items: Urms, ΔU
S(t) is not available.
 - 5) Voltage fluctuation graph display (event)
Display items: Urms (1 cycle calculated value at 400Hz) without gaps
The displayed value is the maximum and minimum values of RMS voltage for every 1 cycle of 400Hz.
 - 6) Flicker graph display
Not available
 - 7) Flicker list display
Not available

Setting Functions

- Only the differences on 400Hz measurement frequency from the standard instrument are listed.

-1. System settings

Measured line frequency: 50/ 60/ 400Hz
 Flicker measurement: OFF
 Voltage recording: Urms/ ΔU
 EN50160: OFF

-2. Time series data settings

MAX/MIN/AVE settings: AVE value/(MAX value, MIN value, AVE value)

Voltage value (1 cycle calculated value at 400Hz) is recorded in MAX and MIN values regardless to the MAX/MIN/AVE settings.

Recorded item settings: Power (Pattern 1) / P&Harm (Pattern 2)

In the 400Hz mode operation, All Data (Pattern 3) is not selectable.

Recorded item	Pattern 1	Pattern 2
Voltage	<input type="radio"/>	<input type="radio"/>
Frequency	<input type="radio"/>	<input type="radio"/>
RMS voltage	<input type="radio"/>	<input type="radio"/>
RMS curren	<input type="radio"/>	<input type="radio"/>
Voltage waveform peak	<input type="radio"/>	<input type="radio"/>
Current waveform peak	<input type="radio"/>	<input type="radio"/>
Active power	<input type="radio"/>	<input type="radio"/>
Apparent power	<input type="radio"/>	<input type="radio"/>
Reactive power	<input type="radio"/>	<input type="radio"/>
Power factor / displacement power factor	<input type="radio"/>	<input type="radio"/>
Voltage unbalance factor	<input type="radio"/>	<input type="radio"/>
Current unbalance factor	<input type="radio"/>	<input type="radio"/>

Recorded item	Pattern 1	Pattern 2
Harmonic voltage	×	<input type="radio"/>
Harmonic current	×	<input type="radio"/>
Harmonic power	×	<input type="radio"/>
Harmonic voltage-current phase difference	×	<input type="radio"/>
Inter-harmonic voltage	×	×
Inter-harmonic current	×	×
Total harmonic voltage distortion factor	<input type="radio"/>	<input type="radio"/>
Total harmonic current distortion factor	<input type="radio"/>	<input type="radio"/>
Total inter-harmonic voltage distortion factor	×	×
Total inter-harmonic current distortion factor	×	×
K Factor	<input type="radio"/>	<input type="radio"/>

-3. Event settings

Item	Order selection	Measurement selection	Positive and negative	Channel selection			Treshold
				PLL source	-	OFF	
Voltage frequency			Approximately	1,2,3	4	OFF	0 to 40Hz
Harmonic voltage	1st to 10th orders	RMS/%		1,2,3	4	OFF	0 to 600V / 0 to 100%
Harmonic current	1st to 10th orders	RMS/%		1,2,3	4	OFF	0 to 5000A / 0 to 100%
Harmonic power	1st to 10th orders	RMS/%	±	1,2,3	sum	OFF	0 to 3MW / 0 to 100%
Harmonic voltage-current phase difference	1st to 10th orders		±	1,2,3	sum	OFF	0 to 180°

Formulae

- When the 400Hz measurement frequency is selected, the number of cycles used in formulae is different. Refer to the measurement method of each item for details.