WT3000 SPEC

WT3000 Specifications

Inputs

Item	Specification
Input terminal type	Voltage Plug-in terminal (safety terminal) Current • Direct input: Large binding post • External sensor input: Insulated BNC connector
Input type	Voltage Floating input, resistive potential method Current Floating input, shunt input method
Measurement range	Voltage 15 V, 30 V, 60 V, 100 V, 150 V, 300 V, 600 V, 1000 V (for crest factor 3) 7.5 V, 15 V, 30 V, 50 V, 75 V, 150 V, 300 V, 500 V (for crest factor 6) Current • Direct input 500 mA, 1 A, 2 A, 5 A, 10 A, 20 A, 30 A (for crest factor 3) 250 mA, 500 mA, 1 A, 2.5 A, 5 A, 10 A, 15 A (for crest factor 6) • External sensor input 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V (for crest factor 3) 25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V, 5 V (for crest factor 6)
Instrument loss (input resistance)	Voltage Approximately 10 MΩ // 5 pF Current • Direct input: Approximately 5.5 mΩ + approximately 0.03 μH • External sensor input: Approximately 1 MΩ
Instantaneous maximum allowed input (1 second or less)	Voltage Peak voltage of 2.5 kV or RMS of 1.5 kV, whichever is lower Current • Direct input: Peak current of 150 A or RMS of 50 A, whichever is lower • Current sensor input: Peak not to exceed 10 times the range
Continuous maximum allowed input	Voltage Peak voltage of 1.6 kV or RMS of 1.1 kV, whichever is lower Current • Direct input: Peak current of 90 A or RMS of 33 A, whichever is lower • Current sensor input: Peak not to exceed 5 times the range
Continuous maximum common mode voltage (50/60 Hz)	1000 Vrms
Influence from common mode voltage	Apply 1000 Vrms with the voltage input terminals shorted and the current input terminals open. • 50/60 Hz: ±0.01% of range or less • Reference value up to 200 kHz Voltage: ±3/range * f% of range or less. However, 3% or less. Current direct input and current sensor input: ± (max. range/range)* 0.001 * f% of range or less. However, 0.01% or less. The units of f are kHz. The maximum rated range within equations is 30 A or 10 V.
Line filter	Select OFF, 500 Hz, 5.5 kHz, or 50 kHz.
Frequency filter	Select OFF, or ON
A/D converter	Simultaneous voltage and current conversion and 16-bit resolution. Conversion speed (sampling rate): Approximately 5 μsec. See harmonic measurement items for harmonic display. Approximately 10 μsec for flicker display.
Range switching	Can be set for each input element.
Trigger range functions	Increasing range value • When the measured values of U and I exceed 110% of the range rating • When the peak value exceeds approximately 330% of the range rating (or approximately 660% for crest factor 6) Decreasing range value • When the measured values of U and I fall to 30% or less of the range rating, and Upk and Ipk are 300% or less of the lower range value (or 600% for crest factor 6)

Display

Display	8.4-inch color TFT LCD monitor
Total number of pixels*	640 (horiz.) x 480 (vert.) dots
Waveform display resolution	501 (horiz.) x 432 (vert.) dots
Display update rate	Same as the data update rate. However, the rate is 250 msec when the data update rate is 50 or 100 msec

* Up to 0.02% of the pixels on the LCD may be defective.

Calculation Functions

			Single-phase, 3 wire	3 phase, 3 wire	3 phase, 3 wire (3 voltage 3 current)	3 phase, 4 wire
UΣ	[V]		(U1+U2)/2		(U1+U2+U3)/3	
IΣ	[A]		(I1+I2)/2		(I1+I2+I3)/3	
PΣ	[W]		P1+P2			P1+P2+P3
SΣ	[VA]	TYPE1, TYPE2	S1+S2	$\frac{\sqrt{3}}{2}$ (S1+S2)	$\frac{\sqrt{3}}{3}$ (S1+S2+S3)	S1+S2+S3
		TYPE3	$\sqrt{P\Sigma^2+Q\Sigma^2}$			
QΣ	[var]	TYPE1	Q1+Q2			Q1+Q2+Q3
		TYPE2	$\sqrt{S\Sigma^2-P\Sigma^2}$			
		TYPE3	Q1+Q2			Q1+Q2+Q3
PcΣ	[W]		Pc1+Pc2			Pc1+Pc2+Pc3
WPΣ	[Wh]		WP1+WP2			WP1+WP2+WP3
WP+Σ	[Wh]		WP+1+WP+2			WP+1+WP+2+WP+3
WP−Σ	[Wh]		WP−1+WP−2			WP-1+WP-2+WP-3
qΣ	[Ah]		q1+q2			q1+q2+q3
q+Σ	[Ah]		q+1+q+2			q+1+q+2+q+3
q−Σ	[Ah]		q−1+q-2			q-1+q-2+q-3
WQΣ	[varh]		$\frac{1}{N}\sum_{n=1}^{N}\lvert Q\Sigma(n)\rvert \times$Time QΣ(*n*) is the nth reactive power Σ function , and N is the number of data updates.			
WSΣ	[VAh]		$\frac{1}{N}\sum_{n=1}^{N} S\Sigma(n)\times$Time SΣ(*n*) is the nth apparent power Σ function, and N is the number of data updates.			
λΣ			$\frac{P\Sigma}{S\Sigma}$			
ØΣ	[°]		$\cos^{-1}\left(\frac{P\Sigma}{S\Sigma}\right)$			

Note1) The instrument's apparent power (S), reactive power (Q), power factor (l), and phase angle (Ø) are calculated using measured values of voltage, current, and active power. (However, reactive power is calculated directly from sampled data when TYPE3 is selected.) Therefore, when distorted waveforms are input, these values may be different from those of other measuring instruments based on different measuring principals.

Note 2) The value of Q in the QS calculation is calculated with a preceding minus sign (-) when the current input leads the voltage input, and a plus sign when it lags the voltage input, so the value of QS may be negative.

η [%]	Set a efficiency calculation up to 4
User-defined functions F1–F20	Create equations combining measurement function symbols, and calculate up to twenty numerical data.

Waveform Display (WAVE display)

Waveform display items	Voltage and current from elements 1 through 4 Motor version torque and waveform of revolution speed

Accurancy

	Voltage/current	Power
[Conditions]	DC:	DC:
	0.05% of reading+0.05% of range	0.05% of reading+0.1% of range
Temperature: 23±5°C	0.1Hz≤f<30Hz	0.1Hz≤f<30Hz
Humidity: 30 to 75%RH	0.1% of reading+0.2% of range	0.2% of reading+0.3% of range
Input waveform:	30Hz≤f<45Hz	30Hz≤f<45Hz
Sine wave	0.03% of reading+0.05% of range	0.05% of reading+0.05% of range
Common mode voltage:	45Hz≤f≤66Hz	45Hz≤f≤66Hz
0 V	0.01% of reading+0.03% of range	0.02% of reading+0.04% of range
Crest factor: 3	66Hz<f≤1kHz	66Hz<f≤1kHz
Line filter: OFF	0.03% of reading+0.05% of range	0.05% of reading+0.05% of range
λ (power factor): 1	1kHz<f≤10kHz	1kHz<f≤10kHz
After warm-up.	0.1% of reading+0.05% of range	0.15% of reading+0.1% of range
After zero level	10kHz<f≤50kHz	10kHz<f≤50kHz
compensation or range	0.3% of reading+0.1% of range	0.3% of reading+0.2% of range
value change while	50kHz<f≤100kHz	50kHz<f≤100kHz
wired.	0.012×f% of reading+0.2% of range	0.014×f% of reading+0.3% of range
f is frequency	100kHz<f≤500kHz	100kHz<f≤500kHz
6-month after calibration	0.009×f% of reading+0.5% of range	0.012×f% of reading+1% of range
* These conditions are all accuracy condition in this section.	500kHz<f≤1MHz	500kHz<f≤1MHz
	(0.022×f−7)% of reading+1% of range	(0.048×f−19)% of reading+2% of range

* The units of f in the reading error equation are kHz.
- Accuracy of waveform display data, Upk and Ipk
  Add 3% of range to the accuracy above. However, add 3% of range +5mV for external input(reference value). Effective input range is within ±300%
- Influenced by changes in temperature after zero level correction or range value changes.
  Add 50ppm of range/°C to the voltage DC accuracy, 0.2 mA/°C to the current DC accuracy, 0.02 mV/°C to the external current DC accuracy, and influence of voltage times influence of current to the power DC accuracy.
- Influence of self heating due to current input
  When the input signal is current, add 0.00002 x I²% of rdg, and for DC add 0.00002 x I²% of rdg + 0.003 x I²mA to the current and power accuracy. I is the reading value of current (A). Please note that the influence of self-heating is present until the shunt resistance temperature drops, even when the current input value is small.
- Additions to accuracy according to the data update rate
  Add 0.05% of rdg when it is 100 ms, and 0.1% of rdg when 50ms.
- Range of guaranteed accuracy by frequency, voltage, and current
  All accuracies between 0.1 Hz and 10 Hz are reference values.
  If the voltage exceeds 750 V at 30 kHz–100 kHz, or exceeds {2.2 x 10^4/ f(kHz)}V at 100 kHz–1 MHz, the voltage and power values are reference values.
  If the current exceeds 20 A at DC, 10 Hz–45Hz, or 400 Hz–200 kHz; or if it exceeds 10 A at 200 kHz–500 kHz; or exceeds 5 A at 500 kHz–1 MHz, the current and power accuracies are reference values.
- Accuracy for crest factor 6: Range accuracy of crest factor 3 for two times range of crest factor 6.

	Voltage/current	Power
Influence of power factor (λ)	—	When λ=0 Apparent power reading×0.03% in the 45 to 66 Hz range All other frequencies are as follows (however, these are only reference values): Apparent power reading× (0.03+0.05×f(kHz))% When 0 < λ< 1 Add power reading× (tanØ× (effect when λ = 0))%. However, Ø is the phase angle of voltage and current.
Influence of line filter	When cutoff frequency is 500 Hz "45 to 66Hz: Add 0.2% of reading Under 45 Hz: Add 0.5% of reading" When cutoff frequency is 5.5 kHz "66Hz or less: Add 0.2% of reading 66 to 500Hz: Add 0.5% of reading" When cutoff frequency is 50 kHz "500Hz or less: Add 0.2% of reading 500 to 5kHz: Add 0.5% of reading"	When cutoff frequency is 500 Hz "45 to 66Hz: Add 0.3% of reading Under 45 Hz: Add 1% of reading" When cutoff frequency is 5.5 kHz "66Hz or less: Add 0.3% of reading 66 to 500Hz: Add 1% of reading" When cutoff frequency is 50 kHz "500Hz or less: Add 0.3% of reading 500 to 5kHz: Add 1% of reading"
Lead/Lag Detection (d (LEAD)/G (LAG) of the phase angle and symbols for the reactive power QΣ calculation) * The s symbol shows the lead/lag of each element, and "-" indicates leading.	The phase lead and lag are detected correctly when the voltage and current signals are both sine waves, the lead/lag is 50% of the range rating (or 100% for crest factor 6), the frequency is between 20 Hz and 10 kHz, and the phase angle is ± (5° to 175°) or more.	
Temperature coefficient	±0.02% of reading/° at 5–18° or 28–40 °C.	
Effective input range	Udc and Idc are 0 to ±130% of the measurement range Urms and Irms are 1 to 130%* of the measurement range (or 2%–130% for crest factor 6) Umn and Imn are 10 to ±130% of the measurement range Urmn and Irmn are 10 to ±130%* of the measurement range Power is 0 to ±130%* for DC measurement, 1 to 130%* of the voltage and current range for AC measurement, and up to ±130%* of the power range. However, when the data update rate is 50 ms, 100 ms, 5 sec, 10 sec, or 20 sec, the synchronization source level falls below the input signal of frequency measurement. 140% of the voltage and current range ratingThe accuracy at 110 to 130% of the measurement range is the reading error ×1.5.	
Max. display	140% of the voltage and current range rating	
Min. display	Urms and Irms are up to 0.3% relative to the measurement range (or up to 0.6% for a crest factor of 6). Umn, Urmn, Imn, and Irmn are up to 1% (or 2% for a crest factor of 6). Below that, zero suppress. Current integration value q also depends on the current value.	

Measurement lower limit frequency	Data update rate	50ms	100ms	250ms	500ms	1s	2s	5s	10s	20s
	Measurement lower limit frequency	45Hz	25Hz	20Hz	10Hz	5Hz	2Hz	0.5Hz	0.2Hz	0.1Hz

Accuracy of apparent power S (reference value)	Voltage accuracy + current accuracy
Accuracy of reactive power Q (reference value)	Accuracy of apparent power $+(\sqrt{(1.0004-\lambda^2)} - \sqrt{(1-\lambda^2)})$ % of range
Accuracy of power factor λ (reference value)	± [(λ–λ/1.0002)+ |cosØ–cos{Ø+sin⁻¹{influence of power factor of power when λ=0%/100)}}] ±1digit Ø is the phase difference of voltage and current.
Accuracy of phase difference Ø (reference value)	± [Ø–cos–1 (λ/1.0002) + sin⁻¹ {(influence of power factor of power when λ=0%)/100)}] deg λ1digit
One-year accuracy	Add the accuracy of reading error (Six-month after calibration) × 0.5 to the accuracy six-month after calibration

Functions

Measurement method: Digital multiplication method

Crest factor: 3 or 6 (when inputting rated values of the measurement range), and 300 relative to the minimum valid input. However, 1.6 or 3.2 at the maximum range (when inputting rated values of the measurement range), and 160 relative to the minimum valid input.

Measurement interval: Interval for determining the measurement function and performing calculations.
• When data update rate is 50 ms, 100 ms, 10 s, or 20 s.
Excluding amount of current q given amount of energy Wp and when in DC mode, the measurement interval is set at the zero cross of the reference signal (synchronization source).
• When data update rate is 250 ms, 500 ms, 1 s, or 2 s
Measured using the exponential average relative to the sampling data within the data update rate.
• When using harmonic display (required/G5 option)
The selected FFT data length is the measurement interval.

Wiring: You can select one of the following five wiring settings.
1P2W (single phase, two-wire), 1P3W (single phase, 3 wire), 3P3W (3 phase, 3 wire), 3P4W (3 phase, 4 wire), 3P3W(3V3A) (3 phase, 3 wire, 3 volt/3 amp measurement).
However, the number of available wiring settings varies depending on the number of installed input elements. Up to four, or only one, two, or three wiring settings may be available.

Compensation Functions:
• Efficiency Compensation
Compensation of instrument loss during efficiency calculation
• Wiring Compensation
Compensation of instrument loss due to wiring
• 2 Wattmeter Method Compensation
Compensation for 2 wattmeter method

Scaling: When inputting output from external current sensors, VT, or CT, set the current sensor conversion ratio, VT ratio, CT ratio, and power coefficient in the range from 0.0001 to 99999.9999.

Input filter: Line filter or frequency filter settings can be entered.

Averaging:
• The average calculations below are performed on the normal measurement parameters of voltage U, current I, power P, apparent power S, reactive power Q. Power factor λ and phase angle Ø are determined by calculating the average of P and S.
Select exponential or moving averaging.
• Exponential average
Select an attenuation constant of 2, 4, 8, 16, 32, or 64.
• Moving average
Select the number of averages from 8, 16, 32, 64, 128, or 256.
• The average calculations below are performed on the harmonic display items of voltage U, current I, power P, apparent power S, reactive power Q. Power factor λ is determined by calculating the average of P and Q.
Only exponential averaging is performed. Select an attenuation constant of 2, 4, 8, 16, 32 or 64

Data update rate: Select 50 ms, 100 ms, 250 ms, 500 ms, 1 s, 2 s, 5 s, 10 s, or 20 s. However, when the data update rate is 50 ms or 100 ms the display update rate is 250 ms.

Response time: At maximum, two times the data update rate (only during numerical display)

Hold: Holds the data display.

Single: Executes a single measurement during measurement hold.

Zero level compensation/Null: Compensates the zero level.

Integration

Mode: Select a mode of Manual, Standard, Continuous (repeat), Real Time Control Standard, or Real Time Control Continuous (Repeat).

Timer: Integration can be stopped automatically using the integration timer setting. 0000h00m00s~10000h00m00s

Count over: If the count over integration time reaches the maximum integration time (10000 hours), or if the integration value reaches max/min display integration value (±999999 MWh or ±999999 Mah), the elapsed time and value is saved and the operation is stopped.

Accuracy: ± (power and current accuracy + time accuracy)

Time accuracy: 0.02% of reading

Display

• Numerical display function

Display resolution: 600000

Number of display items: Select 4, 8, 16, all, single list, or dual list.

• Waveform display items

No. of display rasters: 501

Display format: Peak-peak compressed data

Time axis: Range from 0.5 ms–2 s/div. However, it must be 1/10th of the data update rate.

Triggers
- Trigger Type: Edge type
- Trigger Mode: Select Auto or Normal. Triggers are turned OFF automatically during integration.
- Trigger Source: Select voltage, current, or external clock for the input to each input element.
- Trigger Slope: Select (Rising), (Falling), or (Rising/Falling).
- Trigger Level: When the trigger source is the voltage or current input to the input elements. Set in the range from the center of the screen to ±100% (top/bottom edge of the screen). Setting resolution: 0.1%

When the trigger source is Ext Clk, TTL level.

Vertical axis Zoom: Voltage and current input to the waveform vertical axis zoom input element can be zoomed along the vertical axis. Set in the range of 0.1 to 100 times.

ON/OFF: ON/OFF can be set for each voltage and current input to the input element.

Format: You can select 1, 2, 3 or 4 splits for the waveform display.

Interpolation: Select dot or linear interpolation.
Select graticule or cross-grid display.

Other display ON/OFF: Upper/lower limit (scale value), and waveform label ON/OFF.

Cursor measurements: When you place the cursor on the waveform, the value of that point is measured.

Zoom function: No time axis zoom function

* Since the sampling frequency is approximately 200 kHz, waveforms that can be accurately reproduced are those of about 10 kHz.

• Vector Display/Bar Graph Display

Vector display: Vector display of the phase difference in the fundamental waves of voltage and current.

Bar graph display: Displays the size of each harmonic in a bar graph.

• Trend display

Number of measurement channels Up to 16 parameters
Displays trends (transitions) in numerical data of the measurement functions in a sequential line graph.

• Simultaneous display: Two windows can be selected (from numerical display, waveform display, bar graph display, or trend display) and displayed in the upper and lower parts of the screen.

• Saving and Loading Data: Settings, waveform display data, numerical data, and screen image data can be saved to media.
Saved settings can be loaded from a medium.

Motor Evaluation Function (-MV, Motor Version)

Measurement Function	Method of Determination/Equation
Speed	Method of Determination/Equation When the input signal from the revolution sensor is DC voltage (analog signal) Input voltage from revolution sensor x scaling factor Scaling factor: Number of revolutions per 1 V input voltage When the input signal from the revolution sensor is number of pulses $\frac{\text{Number of input pulses/minute from revolution sensor}}{\text{No of pulses/revolution}} \times \text{Scaling factor}$
Torque	When the type of input signal from the torque meter is DC voltage (analog signal) Input voltage from torque meter x scaling factor Scaling factor: Torque per 1 V input voltage When the type of input signal from the torque is number of pulses Enter N·m equivalent to upper- and lower-limit frequencies to determine an inclination from these two frequencies, and then multiply the number of pulses.
SyncSp	$\frac{120 \times \text{freq. of the freq. meas. source}}{\text{no. of poles of the motor}}$
Slip[%]	$\frac{\text{SyncSp-Speed}}{\text{SyncSp}} \times 100$
Motor output Pm	$\frac{2\pi \times \text{Speed} \times \text{Torque}}{60} \times \text{scaling factor}$

Revolution signal, torque signal

• When revolution and torque signals are DC voltage (analog input)

Connector type	Insulated BNC connector
Input range	1 V,2 V,5 V,10 V,20 V
Effective input range	0%–±110% of measurement range
Input resistance	Approximately 1 MΩ
Continuous maximum allowed input	±22 V
Continuous maximum common mode voltage	±42 Vpeak or less
Accuracy	±(0.1% of reading+0.1% of range)
Temperature coefficient	±0.03% of range/°C

• When revolution and torque signals are pulse input

Connector type	Insulated BNC connector
Frequency range	2 Hz–200 kHz
Amplitude input range	±5 Vpeak
Effective amplitude	1 V (peak-to peak) or less
Input waveform duty ratio	50%, square wave
Input resistance	Approximately 1 MΩ
Continuous maximum common mode voltage	±42 Vpeak or less
Accuracy	±(0.05% of reading+1mHz)

Added Frequency Measurement (/FQ Optional)

Device under measurement: Select up to two frequencies of the voltage or current input to the input elements for measurement. If the frequency option (/FQ) is installed, the frequencies of the voltages and currents being input to all input elements can be measured.

Measurement method: Reciprocal method

Measurement range:

Data Update Rate	Measuring Range
50ms	45Hz≤f≤1MHz
100ms	25Hz≤f≤1MHz
250ms	10Hz≤f≤500kHz
500ms	5Hz≤f≤200kHz
1s	2.5Hz≤f≤100kHz
2s	1.5Hz≤f≤50kHz
5s	0.5Hz≤f≤20kHz
10s	0.25Hz≤f≤10kHz
20s	0.15Hz≤f≤5kHz

Accuracy: ±0.05% of reading

When the input signal levels are greater than or equal to 25 mV (current external sensor input) and 150 mA (current direct input) respectively, and the signal is greater than or equal to 30% (0.1 Hz–440 Hz, frequency filter ON), 10% (440 Hz–500 kHz), or 30% (500 kHz–1 MHz) of the measurement range. However, when the measuring frequency is smaller or equal to 2 times of above lower frequency, the input signal is greater than or equal to 50%.

Add 0.05% of reading when current external input is smaller than or equal to 50 mV input signal level for each is double for crest factor 6.

Delta Calculation Function (/DT Optional)

Item	Delta Calculation Setting	Symbols and Meanings
Voltage Current	Udiff, Idiff	Calculated differential voltage and current
	3P3W→3V3A	Line to line voltage and phase current are determined in the calculation for a 3 phase 3 wire connection
	DELTA→STAR	Phase voltage and neutral current are determined in the calculation for 3 phase 3 wire (3V3A) connection
	STAR→DELTA	Line to line voltage and neutral current determined in the calculation for a 3 phase 4 wire connection

Harmonic Measurement Function (/G5 Optional)

Device under Measurement: All Installed Elements

Method: PLL synchronization

Frequency range: PLL source of the fundamental frequency is in the range 10 Hz–440 Hz.

PLL source: Select voltage, current, or external clock for each input element.

Word length for FFT: 32 bits

Window function: Rectangular

Anti-aliasing filter: Set using a line filter (5.5 kHz or 50 kHz)

Sample rate (sampling frequency), window width, and upper limit of analyzed orders for PLL synchronization.

• During Harmonic Display

Fundamental Frequency	Sample Rate	Window Width	Upper Limit of Analyzed orders
10Hz to 20Hz	f*3000	3	100
20Hz to 40Hz	f*1500	6	100
40Hz to 55Hz	f*900	10	100
55Hz to 75Hz	f*750	12	100
75Hz to 150Hz	f*450	20	50
150Hz to 440Hz	f*150	75	15

Accuracy ±(reading error + measurement range error)

• When Line Filter is ON (5.5 kHz)

Sampling Frequency	Voltage Current	Power
10Hz≤f<30Hz	0.25% of reading+0.3% of range	0.5% of reading+0.4% of range
30Hz≤f≤66Hz	0.2% of reading+0.15% of range	0.4% of reading+0.15% of range
66Hz<f≤440Hz	0.5% of reading+0.15% of range	1.2% of reading+0.15% of range
440Hz<f≤1kHz	1.2% of reading+0.15% of range	2% of reading+0.15% of range
1kHz<f≤2.5kHz	2.5% of reading+0.15% of range	6% of reading+0.2% of range

· Power exceeding 440 Hz is a reference value.
· During nth order component input, add (n^{th} order reading) of (n/(m+1))/50% to the (n+m)th order and (n–m)th order.
· Add (n/500)% of reading to n^{th} order components

• When Line Filter is ON (5.5 kHz)

Sampling Frequency	Voltage Current	Power
10Hz≤f<30Hz	0.25% of reading+0.3% of range	0.45% of reading+0.4% of range
30Hz≤f≤440Hz	0.2% of reading+0.15% of range	0.4% of reading+0.15% of range
440Hz<f≤2.5kHz	1% of reading+0.15% of range	2% of reading+0.2% of range
2.5kHz<f≤5kHz	2% of reading+0.15% of range	4% of reading+0.2% of range
5kHz<f≤7.5kHz	3.5% of reading+0.15% of range	6.5% of reading+0.2% of range

· Power exceeding 440 Hz is a reference value.
· During nth order component input, add (n^{th} order reading) of (n/(m+1))/50% to the (n+m)th order and (n–m)th order.
· Add (n/500)% of reading to n^{th} order components

• When Line Filter is OFF

Sampling Frequency	Voltage Current	Power
10Hz≤f<30Hz	0.15% of reading+0.3% of range	0.25% of reading+0.4% of range
30Hz≤f≤440Hz	0.1% of reading+0.15% of range	0.2% of reading+0.15% of range
440Hz<f≤2.5kHz	0.6% of reading+0.15% of range	1.2% of reading+0.2% of range
2.5kHz<f≤5kHz	1.6% of reading+0.15% of range	3.2% of reading+0.2% of range
5kHz<f≤7.5kHz	2.5% of reading+0.15% of range	5% of reading+0.2% of range

· Power exceeding 440 Hz is a reference value.
· During nth order component input, add (n^{th} order reading) of (n/(m+1))/50% to the (n+m)th order and (n–m)th order.
· Add (n/500)% of reading to n^{th} order components

D/A Output (/DA Optional)

D/A conversion resolution: 16 bits

Response time: At maximum, two times the data update rate.

Output voltage: ±5 V FS (max. approximately ±7.5 V) for each rated value

Update rate: Same as the data update rate on the main unit.
However, select 10 ms or 20 ms during high speed D/A output.
The maximum response time is up to two times the display update rate plus 10 ms.

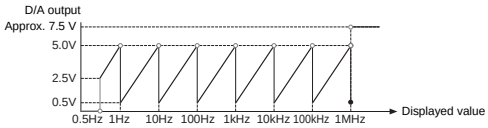
Number of outputs: 20 channels (each channel can be set separately)

Accuracy: ± (accuracy of a given measurement function + 0.1% of FS)
FS = 5V

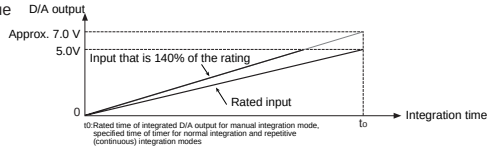
Minimum load: 100 kΩ

Temperature coefficient: ±0.05% of FS/°C

Frequency

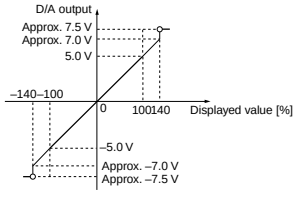


Integrated Value



Other Items

Displayed Value	Output
140%	Approx. 7.0 V
100%	5.0 V
0%	0 V
–100%	–5.0 V
–140%	Approx. –7.0 V



Note that PF and deg are not output beyond the range of ±5.0 V.
If an error occurs, approximately ±7.5 V are output.
0° to 360° are output at 0 to 5.0 V; LAG180° to LEAD180° are output at -5.0 V to 5.0 V.

Built-in Printer (/B5 Optional)

Printing method: Thermal line-dot

Dot density: 8 dots/mm

Paper width: 112 mm

Effective recording width: 104 mm

Recorded information: Screenshots, list of measured values, harmonic bar graph printouts, settings

Serial (RS-232) Interface (/C2 Optional)

Connector type	9-pin D-Sub (plug)
Electrical specifications	Conforms with EIA-574 (EIA-232 (RS-232) standard for 9-pin)
Connection type	Point-to-point
Communication mode	Full duplex
Synchronization method	Start-stop synchronization
Baud rate	Select from the following. 1200,2400,4800,9600,19200 bps

RGB Video Signal (VGA) Output Section (/V1 Optional)

Connector type	15-pin D-Sub (receptacle)
Output format	VGA compatible

Ethernet Communications (/C7 Optional) Sales announcement

Number of communication ports	1
Connector type	RJ-45 connector
Electrical and mechanical specifications	Conforms to IEEE 802.3.
Transmission system	Ethernet 100BASE—TX/10BASE-T
Transmission rate	10 Mbps
Protocol	TCP/IP
FTP Client	Settings, waveform display data, numerical data, and screen image data can be saved to an FTP server on the network. You can load settings saved on an FTP server. You can access the instrument from a PC or workstation residing on the same network as the FTP server, and download files from the instrument's PCMCIA card. However, the PC or workstation must be running FTP client software.
LPR client	Screen images can be print to a network printer.
SMTP client	Data from the instrument can be transmitted periodically to an e-mail message specified as the SMTP client.

External I/O

I/O Section for Master/Slave Synchronization Signals

Connector type	BNC connector: Both slave and master
I/O level	TTL: Same for both slave and master
Output logic	Negative logic, falling edge: Applies to master
Measurement start delay time	Within (100 ns + 1 sample rate): Applies to master
Output hold time	Low level, 200 ns or less: Applies to master
Input logic	Negative logic, falling edge: Applies to slave
Minimum pulse width	Low level, 200 ns or less: Applies to slave
Input delay time	Within (100 ns + 1 sample rate): Applies to slave

External Clock Input Section

Connector type	BNC connector
Input level	TTL
Inputting the synchronization source as the Ext Clk of normal measurement.	
Frequency range	Same as the measurement range for frequency measurement.
Input waveform	50% duty ratio square wave
Inputting the PLL source as the Ext Clk of harmonic measurement.	
Frequency range	10 Hz to 2.5 kHz
Input waveform	50% duty ratio square wave

For Triggers

Minimum pulse width	1 µs
Trigger delay time	Within (1 µs + 1 sample rate)

PC Card Interface	TYPE II (Flash ATA card)
GP-IB Interface	Use one of the following by NATIONAL INSTRUMENTS: • AT-GPIB • PCI-GPIB and PCI-GPIB+ • PCMCIA-GPIB and PCMCIA-GPIB+ Use driver NI-488.2M version 1.60 or later. Conforms electrically and mechanically to IEEE St'd 488-1978 (JIS C 1901-1987). Functional specification SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, and C0. Conforms to protocol IEEE St'd 488.2-1987.
Encoding	ISO (ASCII)
Mode	Addressable mode
Address	0–30
Clear remote mode	Remote mode can be cleared using the LOCAL key (except during Local Lockout).

General Specifications

Warm-up time	Approximately thirty minutes.
Operating temperature:	5–40°C
Operating humidity:	20–80% (when printer not used), 35 to 80% RH (when printer is used) (No condensation may be present)
Operating altitude	2000 m or less
Storage environment:	-25–60°C (no condensation may be present)
Storage humidity:	20 to 80% RH (no condensation)
Rated supply voltage	100–240 VAC
Allowed supply voltage fluctuation range	90–264 VAC
Rated supply frequency	50/60 Hz
Allowed supply frequency fluctuation	48 to 63 Hz
Maximum power consumption	150 VA (when using built-in printer)
Weight	Approximately 15 kg (including main unit, 4 input elements, and options)
Battery backup	Setup information and internal clock are backed up with the lithium battery