DISCONTINUED

YOKOGAWA

Sophisticated Features

Numerical, Waveform, and Trend Displays

Digital Power Meter

WT 1600

3-Year Warranty

- Frequency Power Range DC, 0.5 Hz to 1 MHz
- Basic Power Accuracy: ±0.1%
- Current Input Range: 10 mA to 5 A or 1 A to 50 A
- Voltage Input Range: 1.5 V to 1000 V
- Up to Six Input Elements in one Instrument (3 phase power input from two systems in one unit)
- 50 ms data storing interval
- Standard integration and harmonic measurement functions
- A variety of display formats
- Standard external current sensor input for use with current clamps

Supports crest factor 6

Allows measurement conditions to be easily set for crest factors of 5 or more as required by IEC62018 and other international standards.

CE (WT1600)

Bulletin 7601-00E

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A High-Precision, Wideband Digital Power Meter

Use separate input elements for measurements ranging from large currents down the to very small currents that occur during standby operation

Superior Performance

■ High Precision and Wide Bandwidth

Basic power accuracy: 0.1%
Frequency power range: DC, 0.5 Hz to 1 MHz

■ Up to Six-Phase Input on One Unit. Synchronized Measurements Between Two Units

A single WT1600 unit can make up to six different power measurements (six inputs each for voltage and current). With the measure start-stop function (synchronized measurement), two WT1600 units (12 inputs) can be synchronized.

■ Wide Current Input Ranges

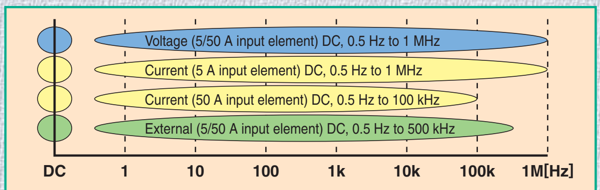
The WT1600 has two different input elements. A 5 A input element is provided for measuring extremely small currents, while a 50 A input element serves to measure large currents. Both of the elements can be installed together in the WT1600. The current for the 5 A input element can be set as low as 10 mA for measuring extremely small currents in energy-saving equipment.

● **Two input elements**
◆ 5 A input element
10/20/50/100/200/500 mA, 1/2/5 A (DC, 0.5 Hz to 1 MHz)
◆ 50 A input element
1/2/5/10/20/50 A (DC, 0.5 Hz to 100 kHz)

Current sensor input range (same for 5 A and 50 A input elements; standard)
50/100/250/500 mV, 1/2.5/5/10 V (DC, 0.5 Hz to 500 kHz)

■ Wide Voltage Range

1.5/3/6/10/15/30/60/100/150/300/600/1000 V
(DC, 0.5 Hz to 1 MHz)

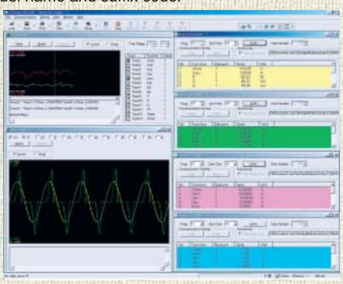


Application Software (sell separately)

■ WTViewer 760122

WTViewer is an application software tool that reads numeric, waveform, and harmonic data measured with the WT1600 Digital Power Meter. Data can be transferred into your personal computer via Ethernet, GP-IB (parallel) or RS-232 (serial) communications. When connected via Ethernet, the FTP client and server functions can be used. Data from up to four WT1600s can be acquired.

*1 requires optional ethernet function(/C10)
*2 When running multiple WT1600s simultaneously, the same requirement exists for the model name and suffix code.



You can download a 30-day trial version of WTViewer from our Web site with unlimited use of functions.

Superior Functions

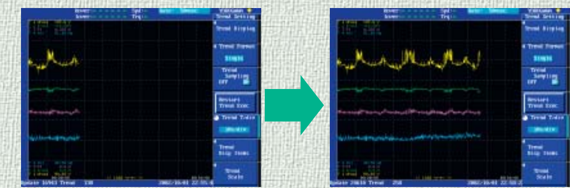
■ Data Storing as Fast as 50ms (20 Times per Second)

The data can be stored at intervals as short as 50ms. The WT1600 rapidly calculates input parameters such as voltage rms, current rms, and power. Measurements can be stored in a 11-MB internal memory, which is helpful for applications such as:

- Evaluation of characteristics at motor startup including torque and rpms (requires the optional motor evaluation function)
- Measurement of rapidly fluctuating secondary voltage and lamp current when a light is turned on

■ Trend Display

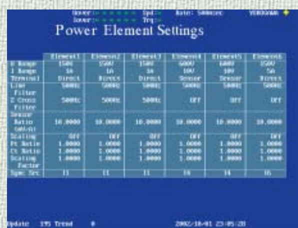
The WT1600 displays measurements for each display updating interval in a time series. The time axis (T/div) can be set in the range of 3 seconds to 24 hours (wave off). Changes in up to 16 different parameters, such as voltage, current, active power, and apparent power, can be observed simultaneously in long-term continuous tests.



Up to 16 different parameters can be observed

■ A Variety of Display Formats

In addition to numerical data, the WT1600 can display input signal waveforms. Eleven different display formats can be selected on a single WT1600 unit, so it is not necessary to connect an external waveform viewer to check waveforms.



Setup Parameters

■ Display Harmonic Data as Bar Graphs, Vectors, and Lists

The harmonic measurement function is a standard feature on the WT1600. It is capable of measuring waveforms with a fundamental frequency ranging from 10 Hz to 1 kHz. Analysis results up to the 100th order from 50/60 Hz fundamental waves can be displayed as numerical values or bar graphs.

Numeric + Bar display

Vector display

A Full Range of Features and Options / Example Applications

● 6.4-Inch TFT Color LCD

Capable of displaying an easy-to-view four-parameter display (two parameters during simultaneous display with waveforms), or increasing the number of parameters up to 78.

● Rotary Knob

Can be used in combination with keys next to the screen for easy operation. The rotary knob allows the user to rapidly locate the desired parameter from numerous parameters shown on the screen.

● Saving Waveforms, Numerical Values, and Screenshots

Waveforms, numerical values, and screenshots can be saved to the 3.5-inch floppy drive (standard feature) or the optional internal hard drive. Settings can be saved and retrieved.

Standard Features

- **GP-IB or RS-232**
- **Floppy Disk Drive**
- **11-MB Internal Memory for store/recall**
- **VGA Output**
- **Measure Start-Stop Function**
  Enables synchronized measurement between two WT1600 units.
- **External Clock Input**
  Enables accurate measurement of harmonics when using low-frequency signal inputs.
- **Integration by Polarity**

VGA output display

Optional Features for More-Efficient Measurements

● Ethernet Port (10BASE-T) and Internal Hard Drive

The Ethernet function allow you to use FTP server, FTP client, Network printing, Automatic Mail Transfer (SMTP), and others.

● D/A Output (30 channels)

Analog outputs are available for up to 30 measurement parameters. With the 6-element WT1600, as many as five analog outputs are available for each element.

● Motor Evaluation

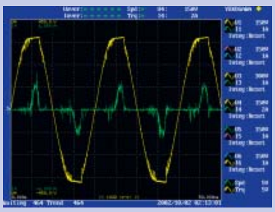
The WT1600 can measure the output from a speed and torque sensor on the output of an electric motor, and calculate torque, rotating speed, mechanical power, synchronous speed, slip, motor efficiency, and total efficiency. Both analog and pulse inputs can be accepted from the sensor. In addition to numerical values, waveforms can be displayed to provide a visual picture of fluctuations in parameter values.

● Built-In Printer

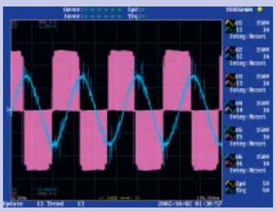
● SCSI Interface

Simultaneous Measurement of 3 Phase Inverter I/O with Single Unit. Efficiency Calculations also Passible

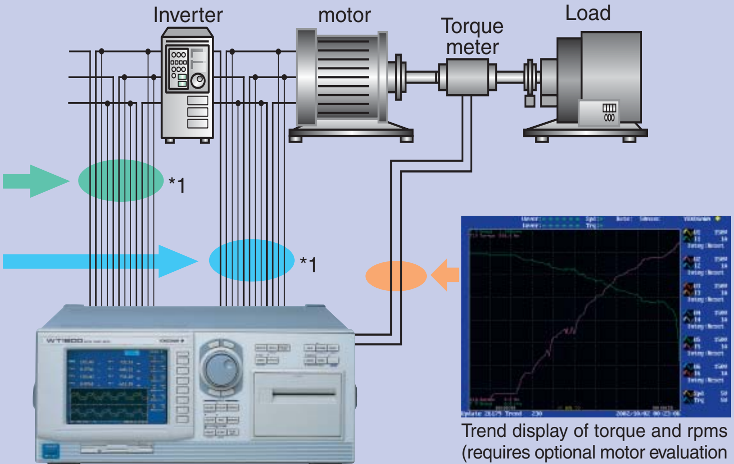
*1 751574 can measure large current up to 600A peak



Input signal



Output signal



Trend display of torque and rpms (requires optional motor evaluation function)

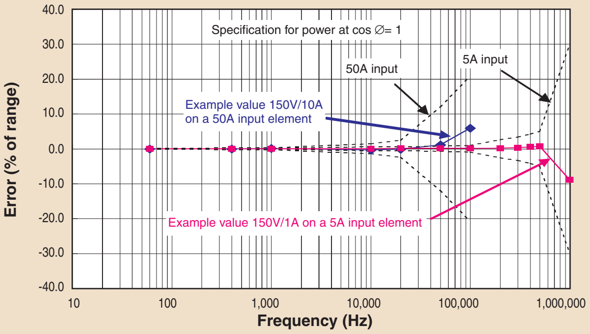
Current Transducer
751574 (DC to 100 kHz/600 Apk)

- Wide dynamic range: 0 to 600 A (DC)/600 Apeak (AC)
- Wide measurement frequency range: DC to 100 kHz (-3 dB)
- Highly precise basic accuracy: ±(0.05% of reading + 40 µA)
- Requires DC ±15 V power supply, connectors, and load resistors.

* For detailed specification for crest factor 6, see specifications page on this bulletin.

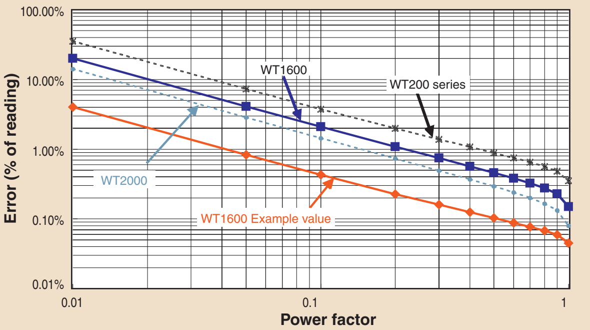
Basic Characteristics (crest factor 3)

Example of frequency versus power accuracy characteristic



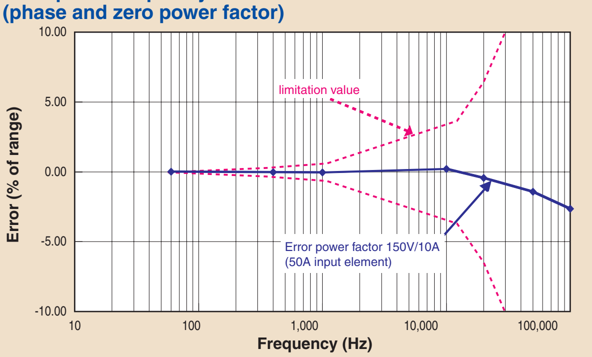
Example value (5A input element) : 0.12%@100kHz
Example value (50A input element): -0.10%@20kHz

Power factor error with respect to the reading value for an arbitrary power factor

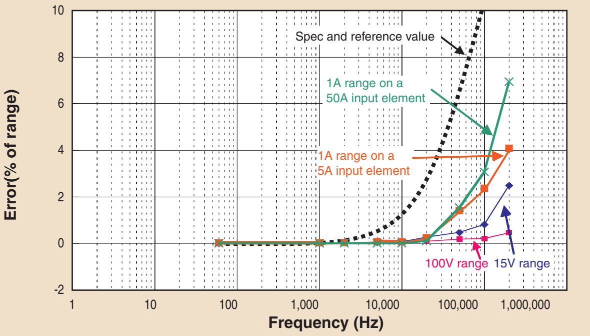


Example value 0.045% (cosø= 1)
Example value 0.43% (cosø= 0.1)

Example of frequency characteristics (phase and zero power factor)



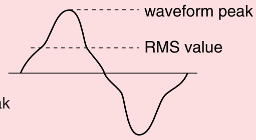
Effect of common mode voltage on reading value



SUPPORTS Crest Factor 6

NEW

The crest factor is the ratio of the waveform peak value and the RMS value.



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

When checking the measurable crest factor of our power measuring instruments, please refer to the following equation.

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

* However, the peak value of the measured signal must be less than or equal to the continuous maximum allowed input.

* The crest factor on a power meter is specified by how many times peak input value is allowed relative to rated input value.

Even if some measured signals exist whose crest factors are larger than the specifications of the instrument (the crest factor standard at the rated input), you can measure signals having crest factors larger than the specifications by setting a measurement range that is large relative to the measured signal. For example, even if you set CF = 3, CF5 or higher measurements are possible as long as the measured value (RMS) is 60% or less than the measuring range. Also, for a setting of CF = 3, measurements of CF = 300 are possible with the minimum effective input (1% of measuring range).

* Crest factor 6 is supported by the WT1600 of firmware versions 3.21 and later.

Related Products

751552 Clamp on Probe

- Measurement frequency range: 30 Hz to 5 kHz
- Basic accuracy: 0.3% of reading
- Maximum allowed input: AC 1000 Arms, max 1400 Apk (AC)
- Current output type: 1 mA/A

A separately sold fork terminal adapter set (758921), measurement leads (758917), etc. are required for connection to WT1600. For detailed information, see Power Meter Accessory Catalog Bulletin 7515-52E.

960 01 Clamp on Probe

- Measurement frequency range: 20 Hz to 20 kHz
- Basic accuracy: 1.0% of reading + 0.2 mV (40 Hz to 1 kHz)
- Maximum allowed input: AC 400 Arms
- 1 Output: 10 mV/A

A separately sold adapter (366921 or 758924) is required for connection to WT1600. This is a Yokogawa M&C Product. For detailed information, see http://www.yokogawa.com/MCC/clamp.htm#96001
1 Use with low-voltage circuits (42 V or less).

* 96001 is a Yokogawa M&C product.

758917 Measurement leads

Two leads in a set. Use 758917 in combination with 758922 or 758929. Total length: 75 cm
Rating: 1000 V, 32 A

758923 Safety terminal adapter set

(spring-hold type) Two adapters in a set.

758931 Safety terminal adapter set

Screw-fastened adapters. Two adapters in a set. 1.5 mm Allen wrench included for tightening.

758921 1 ⚠ Fork terminal adapter

Two adapters (red and black) to a set. Used when attaching banana plug to binding post.

758929 ⚠ Large alligator adapters

For connection to measurement leads (758917). Two in a set.
Rating: 1000 V

758924 Conversion adapter

For conversion between BNC and female banana plug

⚠ Due to the nature of this product, it is possible to touch its metal parts. Therefore, there is a risk of electric shock, so the product must be used with caution.

For more information on WT1600 features and a description of the functions, go to
http://www.yokogawa.com/tm/Bu/WT1600/

Specifications

Input

Parameter		Voltage	Current (5A input element)	Current (50A input element)
Input type		Floating input		
		Resistive potential division method	Shunt input method	
Rated value (range-value)	Crest factor 3	1.5/3/6/10/15/30/60/100/150/300/600/1000V	Direct input:10m/20m/50m/100m/200m/500m/1/2/5A External input:50m/100m/250m/500m/1/2.5/5/10V	Direct input:1/2/5/10/20/50A External input:50m/100m/250m/500m/1/2.5/5/10V
	Crest factor 6	750m/1.5/3/5/7.5/15/30/50/75/150/300/500V	Direct input:5m/10m/25m/50m/100m/250m/500m/1/2.5A External input:25m/50m/125m/250m/500m/1.25/2.5/5V	Direct input:0.5/1/2.5/5/10/25A External input:25m/50m/125m/250m/500m/1.25/2.5/5V
Instrument loss (input resistance)		Approximately 2MΩ	Direct input: Approximately 100mΩ + Approximately 0.07μH External input: Approximately 100kΩ	Direct input: Approximately 2mΩ + Approximately 0.07μH External input: Approximately 100kΩ
Instantaneous maximum allowed input (1 cycle, 20ms duration)		Peak voltage of 4 kV or rms of 1.5 kV (whichever is lower)	Peak current of 30 A or rms of 15 A (whichever is lower) External input: Peak not to exceed 10 times range-value	Peak current of 450 A or rms of 300 A (whichever is lower) External input: Peak not to exceed 10 times range-value
Continuous maximum allowed input		Peak voltage of 1.5 kV or rms of 1 kV (whichever is lower)	Peak current of 10 A or rms of 7 A (whichever is lower) External input: Peak not to exceed 5 times range-value	Peak current of 150 A or rms of 50 A (whichever is lower) External input: Peak not to exceed 5 times range-value
Continuous maximum common mode voltage (50/60Hz)		600 Vrms CATII		
Influence from common mode voltage		With voltage input terminals shorted and current input terminals open (50/60 Hz): ±0.01% of rng or less (±(0.01 × 15/(rated value of rng))% of rng or less for 10-V rng or less). Reference value up to 100 kHz: ±(0.1 × f% of rng) or less, (±(0.1 × f × 15/(rated value of rng))% of rng or less for 10-V range or less), but no less than 0.01% Or, two times these values for crest factor 6. ; frequency unit: kHz		
Input terminal type		Plug-in terminal (safety terminal)	Direct input: Large binding post External input: BNC connector (insulation type)	
A/D converter		Voltage/current input simultaneous conversion, 16-bit resolution, conversion speed (sampling period) of approximately 5 μsec		
Switching range-value		Range-value can be set independently for each element, through manual setting, automatic setting, or online setting		
Auto-range function		Increasing range-value: Range-value is increased when rms exceeds 110% of rated value or peak value exceeds approximately 330% (or 660% for crest factor 6) of rated value. Decreasing range-value: Range-value is decreased when peak is 300% (or 600% or less for crest factor 6) or less of lower range-value while rms is 30% or less of rated value.		

Measurement Functions

Method	Digital multiplication method		
Temperature: 23 ± 3˚C	Crest factor 3: Up to 300 (in the valid input range). 3 (when inputting rated values of the measuring range). However, 2 for the 1000 V range.		
	Crest factor 6: Up to 600 (in the valid input range). 6 (when inputting rated values of the measuring range). However, 4 for the 500V range.		
Accuracy Conditions Temperature: 23 ±3°C Humidity: 30 to 75%RH Input waveform: Sine wave Common mode voltage: 0 V Line filter: OFF Power factor: cosø = 1 After warm up time has passed Wired condition after zero level compensation or range value change 3-month after calibration Unit for f in accuracy calculation formula is kHz	Frequency	Voltage/Current Accuracy: ± (reading error + measurement range error)	Power Accuracy: ± (reading error + measurement range error)
	DC	0.1% of rdg + 0.2% of rng	0.1% of rdg + 0.2% of rng
	0.5 Hz ≤ f < 10 Hz	0.1% of rdg + 0.2% of rng	0.2% of rdg + 0.3% of rng
	10 Hz ≤ f < 45 Hz	0.1% of rdg + 0.1% of rng	0.1% of rdg + 0.2% of rng
	45 Hz ≤ f ≤ 66 Hz	0.1% of rdg + 0.05% of rng	0.1% of rdg + 0.05% of rng
	66 Hz < f ≦ 1 kHz	0.1% of rdg + 0.1% of rng (Voltage, 5A input element current direct input and external input) 0.2% of rdg + 0.1% of rng (50A input element current direct input)	0.2% of rdg + 0.1% of rng
	1 kHz < f ≤ 50 kHz	0.3% of rdg + 0.1% of rng (Voltage, 5A input element current direct input) (0.015 × f + 0.3)% of rdg + 0.1% of rng (External input) (0.1 × f + 0.2)% of rdg + 0.1% of rng (50A input element current direct input)	0.3% of rdg + 0.2% of rng (Voltage, 5A input element current direct input) (0.02 × f + 0.3)% of rdg + 0.2% of rng (External input) (0.1×f+0.2)% of rdg + 0.2% of rng (50A input element current direct input)
	50 kHz < f ≤ 100 kHz	0.6% of rdg + 0.2% of rng (Voltage, 5A input element current direct input) (0.009 × f + 0.6)% of rdg + 0.2% of rng (External input) (0.1 × f +0.2)% of rdg + 0.2% of rng (50A input element current direct input)	0.7% of rdg + 0.3% of rng (5A input element current direct input) (0.009 × f + 0.9)% of rdg + 0.3% of rng (External input) (0.3×f-9.5)% of rdg + 0.3% of rng (50A input element current direct input)
	100 kHz< f ≤ 500 kHz	0.006*f% of rdg + 0.5% of rng (Voltage, 5A input element current direct input) (0.03 × f-1.5)% of rdg + 0.5% of rng (External input)	0.008*f% of rdg + 1% of rng (5A input element current direct input) (0.06 × f - 4)% of rdg + 1% of rng (External input)
	500 kHz< f ≤ 1 MHz	(0.022 × f-8) of rng + 1% of rng (Voltage, 5A input element current direct input)	(0.048 × f - 20) of rdg + 2% of rng (5A input element current direct input)
	Power factor influence Ø is phase angle between voltage and current	When cos ø = 0, 45 Hz to 66 Hz: 0.15% of apparent power reading is added to the above power accuracy. For other frequencies: Reference value For 5 A input element current direct input, add (0.15 + 0.05 × f)% of apparent power reading to the above accuracy. For 50 A input element current direct input, add (0.15 + 0.3 × f)% of apparent power reading to the above accuracy. For external input, add (0.15 + 0.1 × f)% of apparent power reading to the above accuracy. When 0 < cos ø < 1, add (tan ø × (influence of power factor = 0)) of power reading.	
Effective input range	Voltage, current: Rms and AC: 1% to 110% of rated range-value, DC: 0% to ±110% of rated range-value, Mean: 10% to 110% of rated range-value Power: DC measurement: 0% to ±110% of rated range-value, AC measurement: Up to ±110% of power range-value, with voltage and current within 1% to 110% of rated range-value (Sync source signal level must be 10% or more (20% or more for crest factor 6) of rated range value) Effective input is in the range up to 1000V at Voltage , 5A at 5A input element, 50A at 50A input element and 10V at External input.		
Accuracy of crest factor 6	Add the accuracy of measurement range error (three months accuracy of crest factor 3 after calibration) × 1 to the accuracy three months after calibration.		
One-year accuracy	Add the accuracy of reading error (three months after calibration) × 0.5 to the accuracy three months after calibration.		
Line filter function	Measurement can be made with a line filter inserted in the input circuit. Cutoff frequency (fc): 500 Hz or 5.5 kHz		
Line filter on accuracy	Cut-off frequency of 500 Hz: Voltage, current: Add 0.2% of rdg in range of 45 to 66 Hz. Under 45 Hz, add 0.5% of rdg. Power: Add 0.3% of rdg in range of 45 to 66 Hz. Under 45 Hz, add 1% of rdg. Cutoff frequency of 5.5 kHz: Voltage, current: Add 0.2% of rdg under 66 Hz. At 66 Hz to 500 Hz, add 0.5% of rdg. Power: Add 0.3% of rdg under 66 Hz. At 66 Hz to 500 Hz, add 1% of rdg.		
Temperature coefficient	±0.03% of rdg/˚C at 5 to 20˚C and 26 to 40˚C		
Conditions for detecting lead and lag	Lead and lag are detected correctly when the voltage and current signals are both sine waves, the lead and lag amplitude is greater than or equal to 50% (or 100% for crest factor 6) of the measurement range, the frequency is between 20 Hz to 10 kHz, and the phase angle is ±(5 to 175°). *1		
Measurement lower limit frequency	Data update rate: 50 msec / 100 msec / 200 msec / 500 msec / 1 sec / 2 sec / 5 sec Measurement lower limit frequency: 45 Hz / 25 Hz / 15 Hz / 5 Hz / 2.5 Hz / 1.5 Hz / 0.5 Hz		

Current and power DC accuracy (5 A input element) -----Add 20 μA to current and 20 μA × (voltage reading) to power
Current and power DC accuracy (50 A input element) -----Add 1 mA to current and 1 mA × (voltage reading) to power
External input -----Add (0.05/scaling value) A to current and (0.05/scaling value) A × (voltage reading) to power
Zero level correction or as a zero level correction in current and power DC accuracy relating to temperature changes following range-value changes, add 10 μA /°C to current and add (10 μA × voltage reading) /°C to power for the 5 A input element. For the 50 A input element, add 1 mA /°C to current and add (1 mA × voltage reading) /°C to power. For external input, add (0.05/scaling value) A/°C to current and add {(0.05/scaling value) A × (voltage reading)} /°C to power.
Current rms, mean, AC-----Accuracy figures are specified with line filter turned ON for 2 mA or less on a 5 A input element, for 200 mA or less on a 50 A input element, for 10/(scaling value) A or less on a external input.
Add (0.006 × I^2)% at 5 A input element.
Add (0.00006 × I^2)% at 50 A input element.
Add 0.1% of range if the display updating period is 50 msec.
All accuracy of 0.5 Hz to 10 Hz: Reference values
Voltage ----- Reference values in cases where f(Hz) × voltage(V) > 2.2 × 10^7 at 100 kHz or higher.
Current ----- Reference values for 20 AAC or higher (except for range of 50 Hz to 400 Hz) or higher
For currents less than 5 mA with frequencies above 1 kHz, the current accuracy and the power accuracy figures are the reference values.
Add 20% of rng to the accuracy above for the accuracy of the waveform display data, voltage peak (Upk), and current peak (Ipk) in the range up to 1 MHz. (Reference Value)
Effective input range of Upk and Ipk is within 300% (within ±600% for crest factor 6) in the range. However, within ±200% for the 1000 V range of crest factor 3 (within ±400% in the 500 V range of crest factor 6).

rdg: reading, rng: range   Maximum measurement value must be within maximum allowed input.   *1: Frequency is between 20 Hz to 1 kHz for 50 A Input Element.

Specifications

Calculation Functions

			Single-phase, three-wire	Three-phase, three-wire (2 voltage, 2 current)	Three-phase, three-wire (3 voltage, 3 current)	Three-phase, four-wire
Voltage ΣU			(U1+U2)/2		(U1+U2+U3)/3	
Current ΣI			(I1+I2)/2		(I1+I2+I3)/3	
Active power ΣP			P1+P2			P1+P2+P3
Reactive power Q, ΣQ	Normal measurement	$Qi=\sqrt{(S^2-P^2)}$	Q1+Q2			Q1+Q2+Q3
	Harmonic measurement	Qi				
Apparent power S, ΣS	Normal measurement	Si=Ui × Ii	S1+S2	$\frac{\sqrt{3}}{2}$(S1+S2)	$\frac{\sqrt{3}}{3}$(S1+S2+S3)	(S1+S2+S3)
	Harmonic measurement	$Si=\sqrt{(Pi^2+Qi^2)}$	$\sqrt{(\Sigma P^2+\Sigma Q^2)}$			
Power factor λ, Σλ	Power factor λ, Σλ	λi=Pi/Si	ΣP/ΣS			
Phase angle φ, Σφ	Phase angle φ, Σφ	$\phi i=\cos^{-1}(Pi/Si)$	$\phi i=\cos^{-1}(\Sigma P/\Sigma S)$			
Calculation precision (of calculated values relative to measured values)		Apparent power (S) and reactive power (Q): ±0.001% of power range-value Power factor (λ): ±0.0001 Phase angle (φ): ±0.005° relative to calculation from power factor				

Note 1: Apparent power (S), reactive power (Q), power factor (λ), and phase angle (φ) for this equipment are calculated from active power. (However, reactive power during harmonic measurement is the sum of every order.) Therefore, in the case of distorted-wave input, these values may be different from those of other instruments based on different measurement principles.
Note 2: Since the phase is determined using the equation ø≥=W/VA, there is no rule for accuracy.
Note 3:The value of var in the É∞var 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 É∞var may be negative.

Other parameters (during normal measurement)

Upk, Ipk (peak value), CF (crest factor), FF (form factor), |Z| (impedance), Rs and Rp (resistance), Xs and Xp (reactance), η and 1/η (efficiency), Pc (Corrected Power), F1 to F4 (user-defined functions), delta calculations (three-phase three-wire_3V3A conversion, Y-Δ conversion, Δ-Y conversion)

Wiring settings: Settings can be divided into three groups (ΣA, SB, and ΣC).

Each group is selected from the following: 1P2W (single-phase two-wire, one element used), 1P3W (single-phase three-wire, two elements used), 3P3W (three-phase three-wire, two elements used), 3V3A (three-phase three-wire, three elements used), 3P4W (three-phase four-wire, three elements used).

Display Functions

Display	6.4-inch color TFT LCD
Pixels in full screen:	640 × 480 (The LCD unit may contain defects of approximately 0.02% in the pixels of the full screen)
Display type	
Numerical values:	Normal measurement: 4/8/16/42/78/ALL Harmonic measurement:4/8/16/Single List/Dual List
Waveforms:	Single/Dual/Triad/Quad
Vector:	Phase diagram for first-order components in harmonic measurement
Bar:	Bar graph up to upper limit of analyzed orders in harmonic measurement
Trend:	Trend display of measured/calculated values
Data updating rate:	Selected from 50msec/100msec/200msec/500msec/1sec/2sec/5sec. (waveform OFF) However, Maximum data update is approximately 620ms when waveform data acquisition is ON.
Display update rate	Same as the data update rate. However, When waveform data acquisition is OFF Numeric display (16 or less value) Maximum 100msec The others display setting Maximum 200msec Note: Data can be stored in the internal memory every data update late
Max. Display	140% of the voltage and current range rating
Min. Display	Urms, Uac, Irms, and Iac are up to 0.3% relative to the measuring range (or up to 0.6% for a crest factor of 6). Umn and Imn 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.
Response type:	Up to data updating rate × 2 (with waveform acquisition off)
Display scaling function:	PT ratio, CT ratio, and power scaling factor can be scaled.
Averaging functions	
Normal measurement	Methods: Exponential average or simple moving average.
Exponential average:	Attenuation constant of 2, 4, 8, 16, 32, or 64
Moving average:	Number of averages (N) set to 8, 16, 32, 64, 128, or 256
Harmonic measurement	When using an exponential average, the attenuation constant is 5.625 if the frequency of the PLL synchronization source is 55 Hz or greater but less than 75 Hz; otherwise, the attenuation constant is 4.6875. (When data length = 8192)
Display resolution	U,I,P: During rated range-value input, the decimal place and the counting unit are set so that the display does not exceed a count value of 60,000. ΣU, ΣI, ΣP: The decimal place and the counting unit are the same as for the maximum range-value of the calculated element.

Key lock function is available (version 3.21 and later)

Frequency Measurement Functions

Measurement input	Select three of the following: U1,I1, U2,I2, U3,I3, U4,I4, U5,I5, U6,I6	
Measurement method:	Reciprocal method	
Frequency range	Data updating rate	Frequency range
	50 msec	45 Hz ≦ f ≦ 1 MHz
	100 msec	25 Hz ≦ f ≦ 1 MHz
	200 msec	15 Hz ≦ f ≦ 500 kHz
	500 msec	5 Hz ≦ f ≦ 200 kHz
	1 sec	2.5 Hz ≦ f ≦ 100 kHz
	2 sec	1.5 Hz ≦ f ≦ 50 kHz
	5 sec	0.5 Hz ≦ f ≦ 20 kHz

However, measurement range is up to 100 kHz for 50A input element, up to 500 kHz for external input.

Accuracy	±(0.05% of reading + 1 digit) Note: Within accuracy-assured range ±(0.05% of rdg + 1 digit) for the measurement function parameters. Input signal level is greater than or equal to 0.6 V (voltage input), 25 mV (external input), 5 mA (5-A input element), or 150 mA (50-A input element) and the signal is greater than or equal to 30% (from 0.5 Hz to less than 440 Hz, with zero crossing filter ON), 10% (from 440 Hz to 500 kHz), or 30% (from more than 500 kHz to 1 MHz) of the measurement range. However, input signal level is 2 times for crest factor 6.
Zero cross filter	OFF, 500 Hz

Integration Functions

The integrating functions do not work during waveform acquisition or in harmonic analysis mode ON.

Measured parameters:	Power (Wp), positive-only power (+Wp), negative-only power (-Wp), current (q), positive-only current (+q), negative-only current (-q) (For current integration, select only one of the following for each element: rms, mean, DC, AC.), time (Time)
Mode	Standard integration mode (timer mode) Continuous integration mode (repeat mode) Manual integration mode
Individual element integration	Integration can be started/stopped element by element using GP-IB or serial (RS-232) communications.
Timer	Integration can be stopped automatically according to a timer setting. Setting range: 0000h00min00sec to 10000h00min00sec
Count overflow	If the integration value exceeds ±999999 MWh(MAh), the elapsed time is saved and the operation is stopped.
Accuracy	±(unit accuracy + 0.05% of rdg)
Timer accuracy	±0.02%

Harmonic Measurement Functions

Measurements	Select one of the following: ΣA, ΣB, ΣC
Method	PLL synchronization or external sampling clock
Measurement frequency range	PLL synchronization: Synchronization source fundamental frequency of 10 Hz to 1 kHz External sampling clock: Fundamental wave of 0.5 Hz to 100 Hz (Input 2048 times the fundamental frequency. The waveform is a square wave with a duty cycle of 50% at the TTL level.)
Analyzed parameters	For each order: U, I, P, S, Q, λ, φ(U-I), φU, φI (phase difference of harmonic component relative to fundamental wave), |Z|, Rs, Rp, Xs, Xp Total: U, I, P, S, Q, λ, φ Σ calculation of fundamental wave and total: U, I, P, S, Q, and λ For each order: Harmonic content of U, I, and P THD of U, I, and P UTHF (voltage telephone harmonic factor), ITHF (current telephone harmonic factor), UTIF (voltage telephone influence factor), ITIF (current telephone influence factor), HVF (harmonic voltage factor), HIF (harmonic current factor)
FFT data length	8192, 4096, or 2048
FFT processed word length	32 bits
Window function	Rectangular
Anti-aliasing filter	Set by line filter (fc = 5.5 kHz)
PLL synchronization	

Fundamental frequency (Hz)	Sampling frequency	Window width relative to FFT data length (number of fundamental wave cycles)			Maximum analyzed orders
		8192	4096	2048	
10 ≦ f< 20	f × 2048	4	2	1	100
20 ≦ f< 40	f × 1024	8	4	2	100
40 ≦ f< 75	f × 512	16	8	4	100
75 ≦ f< 150	f × 256	32	16	8	100
150 ≦ f< 440	f × 128	64	32	16	50
440 ≦ f ≦1000	f × 64	128	64	32	25

External sampling clock

Fundamental frequency (Hz)	Sampling frequency	Window width relative to FFT data length (number of fundamental wave cycles)			Maximum analyzed orders
		8192	4096	2048	
0.5 ≦ f≦ 100	f × 2048	4	2	1	100

However, it is 1 ≦ f ≦ 100 when the FFT data length is 8192
Accuracy:±(reading error + measurement range error) (Line filter 5.5 kHz ON)

	Voltage/Current	Power
0.5 Hz ≦ f < 10 Hz	0.4% of rdg + 0.2% of rng	0.7% of rdg + 0.3% of rng
10 Hz ≦ f < 45 Hz	0.4% of rdg + 0.1% of rng	0.6% of rdg + 0.2% of rng
45 Hz ≦ f ≦ 66 Hz	0.3% of rdg + 0.05% of rng	0.4% of rdg + 0.05% of rng
66 Hz < f ≦ 1 kHz	1% of rdg + 0.1% of rng	1.5% of rdg + 0.1% of rng
1 kHz < f ≦ 2.5 kHz	2% of rdg + 0.1% of rng	---------

	However, the amplitude level of the PLL source is 30% of range or more (or 60% for a crest factor of 6). Two times range error for crest factor 6. During nth-order component input, add {(n/(m+1))/50}% of the nth-order reading to (n-m)th order and (n+m)th order.
Line filter OFF	For normal measurement accuracy, during nth-order component input, add {(n/(m+1))/50}% of the nth-order reading to (n-m)th order and (n+m)th order. Add (n/500)% of the nth-order reading to the nth-order component.

Waveform Display Functions

Data memory size	1 kW (Peak to peak compressed data)
Vertical axis zoom	0.1-100 times
Waveform display format	1, 2, 3, or 4 split display
Data interpolation	Dot or linear interpolation
Cursor measurement	When you place the cursor on the waveform, the value of that point is displayed.
Triggers	
Mode	Auto/Normal
Type	Edge
Source	U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6, external
Slope	Rising/falling/both
Position	0% (fixed)
Sample rate	Approximately 200 kHz
Time/Div	0.5 msec to 500 msec (not to exceed 1/10 of display updating period)

The frequency that allows displaying of waveforms is up to approximately 10 kHz.

Trend Display

Measurement item	Maximum 16 items
Horizontal axis	
Normal (waveform OFF)	3/6/10/30sec/1/3/6/10/30min/1/3/6/12/24hour/div
Normal (waveform ON)	1 to 500 P/div (P/div is the number of data points per grid section)
Harmonic measurement	1 to 500 Points/div (P/div is the number of data points per grid section)
Scale	Auto/Manual

Internal Memory

Internal memory size	Approximately 11 MB
Store interval	Maximum 50msec (waveform OFF) to 99 hour 59 minutes 59 seconds. * Store interval is maximum approximately 620ms when waveform data acquisition is ON.

Guideline for Storage Time (Waveform Display OFF, Integration Function OFF)

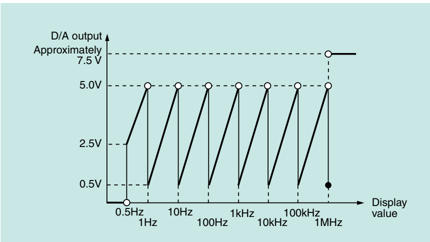
channel number	items (each channel)	store interval	Measurable time
3ch	3	50ms	2 hours 50 minutes
3ch	10	1 second	22 hours
6ch	10	50ms	35 minutes
6ch	20	1 second	6 hours

Note: Depending on the user-defined math, integration, and other settings, the actual measurement time may be shorter than stated above.

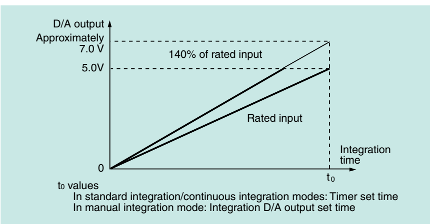
D/A Output (optional) (/DA)

D/A conversion resolution	12 bits
Response time	At maximum, two times the display update rate.
Output Voltage	±5VF.S for each rated value
Update interval	Same as the data update rate on the main unit
Number of outputs	30 parameters (each channel can be set separately)
Accuracy	±(display accuracy +0.2% of F.S.)(F.S. = 5 V)
Maximum output current	±0.1 mA
Temperature coefficient	±0.05% of F.S./°C
Output format	

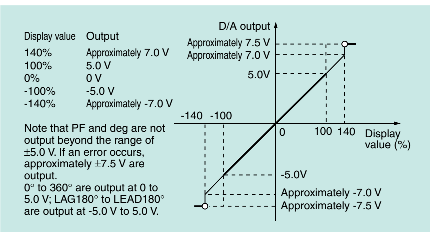
Frequency



Integrated values



Other parameters



Motor Evaluation Functions (optional) (/MTR)

The motor evaluation functions do not work in harmonic measurement mode.

Calculated parameters	Torque, rpms, mechanical power, synchronization speed, slip, motor efficiency, total efficiency
Measured parameters	
Analog input for calculating torque and rpms	
Input resistance	Approximately 1MΩ
Accuracy	±(0.1% of rdg + 0.2% of rng)
Input range-values	1/2/5/10/20 V
Effective input range	Up to ±110% of range-value
Temperature coefficient	±0.03% of rng/°C
Pulse input for rpm calculation	
Input resistance	Approximately 1MΩ
Accuracy	±0.05% of rdg + 1 mHz + 1 digit
Input range	±5 Vpk
Effective amplitude	1 Vp-p or higher
Input waveform	50% duty ratio rectangular wave
Frequency measurement range	2 Hz to 200 kHz

Built-in Printer (optional) (/B5)

Printing method	Thermal line-dot
Dot density	8 dots/mm
Paper width	80 mm
Effective recording width	72 mm
Recorded information	Screenshots, list of measured values, harmonic bar graph printouts, settings

Ethernet (optional) (/C10)

Transmission method	Ethernet (10BASE-T)
Supported services	FTP server, FTP client, LPR (network printing), SMTP (automatic mail transfer), DHCP, DNS
Electrical and mechanical specifications	As per IEEE802.3
Connector	RJ-45 connector
Other	Cannot be used for DIAdem and other protocols.

Built-in Hard Disk (optional) (/C10)

Capacity	10 GB (2 GB×5) IBM format
SCSI ID	4 (fixed)

External I/O

EXT CLK	(Sync source during normal measurement, PLL source or external sampling clock during harmonic analysis)
Connector	BNC
Input voltage	TTL level
	EXT MEAS.START (external measurement start I/O), EXT MEAS.STOP (external measurement stop I/O)
Connector	BNC
Synchronized measurement	Connect the EXT MEAS.START terminal of the master unit with the EXT MEAS.START terminal of the slave unit, and connect the EXT MEAS.STOP terminal of the master unit with the EXT MEAS.STOP terminal of the slave unit.
Internal floppy drive	
Size	3.5-inch
Format	1.44 MB
Communication functions	

GP-IB or serial (RS-232) provided as a standard function.

GP-IB interface	
	Electrical and mechanical specifications As per IEEE St'd 488-1978 Functional specifications SH1, AH1, T6, L4, SR1, RL1, PR0, DC1, DT0, C0 Protocol: As per IEEE St'd 488.2 1992
Serial (RS-232) interface	
Connector	D-Sub 9-pin
Specification	EIA-574 (specifications for 9-pin interface in EIA-232 (RS-232) standard)
Transfer rate	1200, 2400, 4800, 9600, 19200 bps
VGA video output	
Connector type	D-Sub 15-pin (VGA VIDEO OUT)
Output format	VGA-compatible
SCSI interface (optional)	
Specification	SCSI(Small Computer System Interface) ANSI X3.131-1986
Connector	D-sub half-pitch 50-pin (pin type)
Connector pin assignments	Unbalanced (single-end), internal terminator

General Specifications

Safety standard*[1]	Complying standard EN61010-1 Overvoltage category (Installation category) II*[2] Pollution degree 2 *[3]
Emission *[1]	Complying standard EN61326 Class A EN61000-3-2 EN61000-3-3 AS/NZS 2064 Class A
Immunity *[1]	Complying standard EN61326 Annex A*[4]
Warmup time	Approximately 1 hour
Operating temperature and humidity ranges	5 to 40°C, 20 to 80%RH when not using the printer, 5 to 40°C, 35 to 80%RH when using the printer.(no condensation)
Storage temperature	-25 to 60°C (no condensation)
Operating elevation	2000 meters or less
Insulating resistance	50 MΩ or higher at 500 VDC Between casing and power plug Between voltage input terminals (ganged) and casing Between current input terminals (ganged) and casing Between voltage input terminals (ganged) and current input terminals (ganged) Between input terminals of each element. Between torque/speed input terminals (ganged) and casing Between torque input terminals (ganged) and speed input terminals (ganged) Between input terminals of each element.
Withstand voltage	1500 VAC for one minute at 50/60 Hz Between casing and power plug 3700 VAC for one minute at 50/60 Hz Between voltage input terminals (ganged) and casing Between current input terminals (ganged) and casing Between voltage input terminals (ganged) and current input terminals (ganged) Between input terminals of each element.
Rated supply voltage	100 to 120 VAC, 200 to 240 VAC (switches automatically)
Allowed supply voltage fluctuation range	90 to 132 VAC, 180 to 264 VAC
Rated supply frequency	50/60 Hz
Allowed supply frequency fluctuation range	48 to 63 Hz
Consumed power	Maximum 150 VA (when using internal printer)
External dimensions	Approximately 426 mm (W) × 177 mm (H) × 400 mm (D) (excluding protrusions)
Weight	Approximately 15 kg (main unit with 6 input elements and options installed)

*1 Emission, immunity and safety standards apply to products having the CE Mark. For all other products, please contact your nearest YOKOGAWA representative as listed on the back cover of this manual.
*2 Overvoltage Categories define transient overvoltage levels, including impulse withstand voltage levels. Overvoltage Category II: Applies to equipment supplied with electricity from fixed installations like a distribution board.
*3 Pollution Degree: Applies to closed atmospheres (with no , or only dry, non-conductive pollution). Pollution Degree 2: Applies to normal indoor atmospheres (with only non-conductive pollution).
*4 Annex A (normative): Immunity test requirements for equipment intended for use in industrial locations.

Model and Suffix Codes

Model	Suffix codes	Description					
760101		WT1600 digital power meter main unit					
		Element Number					
		1	2	3	4	5	6
Element types and quantities The numbers in the "Descrip-tion" column have the following meanings. 50: 50 A input element 5: 5 A input element Blank: No element Elements are inserted in the or-der shown starting on the left side on the back.	-01	50					
	-02	50	50				
	-03	50	50	50			
	-04	50	50	50	50		
	-05	50	50	50	50	50	
	-06	50	50	50	50	50	50
	-10	5					
	-11	5	50				
	-12	5	50	50			
	-13	5	50	50	50		
	-14	5	50	50	50	50	
	-15	5	50	50	50	50	50
	-20	5	5				
	-21	5	5	50			
	-22	5	5	50	50		
	-23	5	5	50	50	50	
	-24	5	5	50	50	50	50
	-30	5	5	5			
	-31	5	5	5	50		
	-32	5	5	5	50	50	
	-33	5	5	5	50	50	50
	-40	5	5	5	5		
	-41	5	5	5	5	50	
	-42	5	5	5	5	50	50
	-50	5	5	5	5	5	
	-51	5	5	5	5	5	50
	-60	5	5	5	5	5	5
Communication functions	-C1	GP-IB					
	-C2	Serial (RS-232)					
Power cord	-D	UL/CSA Standard					
	-F	VDE Standard					
	-R	SAA Standard					
	-Q	BS Standard					
	-H	GB Standard					
Option specifications	/B5	Internal printer					
	/C7	SCSI interface					
	/C10	Ethernet, HDD, SCSI					
	/DA	30-channel DA output					
	/MTR	Motor evaluation function					

* The WT1600 unit cannot be purchased without any elements. Select an element type (5 A or 50 A) and quantity.
Note: In order to add elements and options after the WT1600 has been delivered, the WT1600 must be modified at the factory. Be aware of this in making your product selections. For further details, see Yokogawa's home page or contact our sales office.

■Standard accessories

Power cord, Spare power fuse, Rubber feet, current input protective cover, User's manual, communication interface user's manual, printer roll paper(provided only with /B5), 36-pin connector (provided only with /DA)
The B9284LK external sensor cable (blue) and the safety terminal adapter are sold separately.

■Rack Mount

Product	Model	Description	Order Q'ty
Rack mounting kit	751535-E4	For EIA	1
Rack mounting kit	751535-J4	For JIS	1

■Clamp on Probe

Model	Specification	Order Q'ty
96001*	20 Hz to 20 kHz, 600Apk (400 Arms)	1
751552	30 Hz to 5 kHz, 1400Apk (1000Arms)	1

* For detailed information, see Power Meter Accessory Catalog Bulletin 7515-52E
* 96001 is a Yokogawa M&C product.

■Accessory (sold separately)

Product	Model /parts number	Description	Order Q'ty
Test read set	758917	A set of 0.8m long, red and black test leads	1
Small alligator-clip	758922⚠	Rated at 300V and used in a pair	1
Large alligator-clip	758929⚠	Rated at 1000V and used in a pair	1
Safety terminal adapter	758923	(spring-hold type) Two adapters to a set.	1
Safety terminal adapter	758931	(screw-fastened type) Two adapters to a set.	1
Conversion adapter	751512[1]	1.5 mm hex Wrench is attached Safety-terminal-binding-post adapter	1
Conversion adapter	758924	BNC-banana-jack(female) adapter	1
Conversion adapter	366922[1]	BNC-banana-jack(male) adapter	1
Fork terminal adapter	758921⚠	Banana-fork adapter	1
External sensor cable	B9284LK	Current sensor input connector. Length 0.5m	1
printer roll paper	B9316FX	Thermal paper, 10 meters (1roll)	1

⚠ Due to the nature of this product, it is possible to touch its metal parts. Therefore, there is a risk of electric shock, so the product must be used with caution.
1: Use these products with low-voltage circuits (42V or less).

■Application Software

Product	Model	Description	Order Q'ty
WTViewer	760122	Data acquisition software	1

■Current Sensor Unit and Current Transducer

Model Code	Suffix Code	Description
751521		Single phase
751523	-10	3 phase U, V
	-20	3 phase U, W
	-30	3 phase U, V, W
Supply voltage	-1	100V AC (50/60Hz)
	-3	115V AC (50/60Hz)
	-7	230V AC (50/60Hz)
Power cord	-D	UL/CSA standard
	-F	VDE standard
	-R	SAA standard
	-J	BS standard
	-H	GB Standard

Accuracy assurance and calibration are possible when the Current Sensor Unit (Model 751521, 751523) is combined with WT series instruments or the PZ4000.

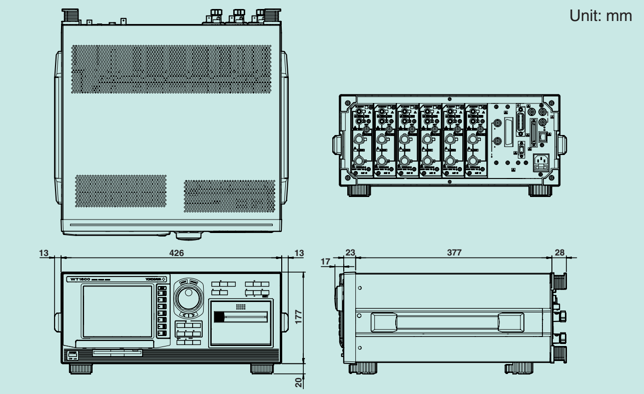
Model Code	Description
751574	Max. 600 Apeak DC-CT

Assured accuracy and calibration are not possible when the Current Transducer (Model 751574) is combined with WT series instruments or the PZ4000. Also please be aware that measurement errors can occur depending on the conductor and wiring.

Accessories for 751574

Product	Pare No.	Speciffications	Minimum Purchase Quantity
Output connector	B8200JQ	D-Sub 9 pin, with screws	1
Burden resistor	B8200JR	10 Ω 4 pcs.	1

Exterior (WT1600)



The TCP/IP software used in this product and the documentation for that TCP/IP software are based in part on BSD Networking Software, Release 1 licensed from The Regents of the University of California.

YOKOGAWA

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