Test&Measurement

YOKOGAWA

Verifying transformer losses

WT5000
Precision Power Analyzer
Transformer Version

Precision Making

Bulletin WT5000TR-01EN

nbn Austria GmbH

Transformers play a critical role in the power grid, aiding the efficient and reliable transmission of electrical energy from one network to another. To develop economical and ecologically friendly transformers for utility providers, manufacturers need to reduce losses and costs at every stage of the development cycle.

Every kilowatt of power loss exceeding the limits under no-load conditions can cost a manufacturer tens of thousands of dollars in fines. The more precise the measurement, the lower the penalties, building greater trust with the customer.

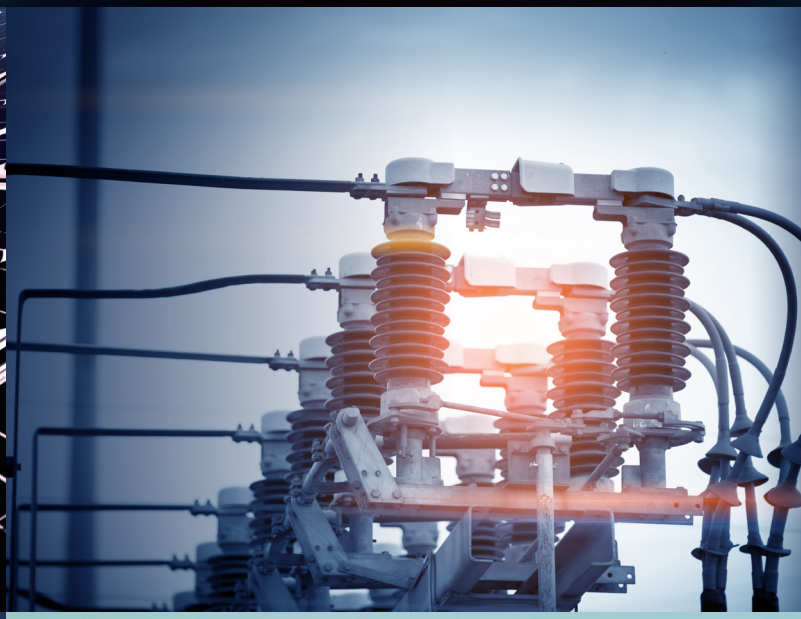
Yokogawa supports the transformer industry with a power analyzer dedicated to meet its needs for high accuracy. Whether during R&D, production- or acceptance testing, the WT5000 Transformer version ensures the consistently reliable measurements that engineers need as they seek to reduce the total cost of ownership for utility companies.

The WT5000 Precision Power Analyzer - Transformer Version delivers:

Accuracy – With 0.008% accuracy, the WT5000 Transformer Version is the world's most accurate power analyzer. It also achieves the highest possible accuracy at power factors as low as 0.001 when performing no load loss measurements on transformers.

Trust – Delivered with calibration certificates from Yokogawa's ISO17025 accredited calibration laboratory, the WT5000 Transformer Version delivers the confidence needed in low power factor measurements to ensure compliance with the IEC60076-8 standard.

Simplicity – With a full touchscreen experience, supported by hardware hotkeys and powerful software for remote data capture, connecting and configuring power measuring systems has never been easier.



Verify transformer losses with the world's most accurate power analyzer

Best accuracy at low power factors

The WT5000 Precision Power Analyzer – Transformer Version is the world´s most accurate power analyzer, offering the best accuracies at low power factors for commercial frequencies of 45 to 66 Hz.

Low power factors have a dramatic effect on accuracy. The instrument offers accuracy of 0.6% of the reading for measurement at a power factor as low as 0.01 at 100 V and 1 A. This makes the unit ideal for precise testing of transformer losses according to the IEC60076-8.

Accredited calibration certificates

When every kilowatt lost beyond specified limits can cost thousands of dollars in fines, it becomes necessary to have confidence in the measurement of power losses.

To address this, the WT5000 Transformer Version is optimized by accredited calibration at 53Hz at power factors of 1, 0.5, 0.05, 0.01 and 0.001. Additional calibration up to 100kHz ensures performance when measuring distorted waveforms, for example during no-load loss current measurements of transformers. This enables the integrated transformer measurement system to measure power losses with great accuracy and to determine any drift as described in the IEC60076-8 Standard.

CALIBRATION
RvA K 164

ilac-MRA

Accuracy specifications

As shown in the table below, the WT5000 Transformer Version offers unparalleled accuracy performance by calibration at power factors as low as 0.001

WT5000 Transformer Version accuracy specifications		
Range 100V 1A or 5A, Frequency 45-65 Hz, Temperature 23 +/- 3 deg C, update rate 2 seconds		
Voltage 100 V range	**% of reading**	**% of reading**
	12 months	24 months
10% to 110% of range	0.005	0.006
Current 1 A or 5 A range	**% of reading**	**% of reading**
	12 months	24 months
10% to 110% of range	0.005	0.006
Power accuracy		
12-month accuracy calculation [% of reading]	24-month accuracy calculation [% of reading]	
$P_{spec} = \frac{\left(\left(\frac{6 \cdot 10^{-5}}{cos\varphi}\right) \cdot P\right) + (2 \cdot 10^{-5} \cdot P)}{P} \cdot 100\%$	$P_{spec} = \frac{\left(\left(\frac{6 \cdot 10^{-5}}{cos\varphi}\right) \cdot P\right) + (4 \cdot 10^{-5} \cdot P)}{P} \cdot 100\%$	
Power 100 V, 1 A or 5 A range	12 months	24 months
PF 1	0.008	0.010
PF 0.5	0.014	0.016
PF 0.05	0.12	0.12
PF 0.02	0.30	0.30
PF 0.01	0.60	0.60
PF 0.005	1.2	1.2
PF 0.002	3.0	3.0
PF 0.001	6.0	6.0

Direct readout of corrected power for potential transformers

When small loads are connected to the potential transformers, the WT5000 Precision Power Analyzer – Transformer Version directly supports both standard formulas used to calculate the correct power.

IEC76-1 (1976), IEEE C57.12.90-2010

$$P = \frac{P_m}{P_1 + k \,.\, P_2}$$

$$k = \left(\frac{U}{U'}\right)^2$$

IEC76-1(2011)

$$P_0 = P_m\,(1 + d\,)$$

$$d = \frac{U' - U}{U'}$$

Where

P or P_0 = corrected power
P_m = measured power
P_1 = ratio of hysteresis loss to total iron losses
P_2 = ratio of eddy current losses to total iron losses
U' = mean value of voltage
U = rms value of voltage

The European Standards Laboratory

As one of the few ISO 17025 certified organization that offers calibration up to 100kHz, Yokogawa is uniquely equipped to guarantee the power accuracy specifications of the WT5000 Transformer Version and improve upon it with calibration. This to ensure performance when measuring distorted waveforms, for example during no-load loss and current measurements of transformers.

In pursuit of precision, Yokogawa's ISO/IEC17025 accredited (RvA K164) European Standards Laboratory offers quantifiable confidence in a measurement system and its results. The European Standards Laboratory enables users to get world's most accurate measurement results. It provides a form of quality assurance and trust which enables engineers to develop the next generation technologies that are environmentally friendly, energy efficient and stand out with leading performance.

ISO/IEC17025 Accreditation (RvA K164)

Quality systems such as ISO9001 aim at confirming the compliance of the management system to an international standard but does not specifically evaluate the technical competence of a laboratory.

Laboratories that are accredited to ISO/IEC17025, like the Yokogawa European Standards Laboratory, have demonstrated that they are technically competent and able to produce precise and accurate calibration measurements that are globally recognized.

ILAC MRA: "Accredited once, accepted everywhere"

ILAC Mutual Recognition Arrangement enhances the acceptance of products across national borders, removing so the need for additional calibration in import countries. In this way the ILAC MRA promotes international trade and the freetrade goal of "accredited once, accepted everywhere" can be realized.

RvA is a co-signatory to ILAC MRA, assuring in this way compliance with relevant international accreditation standards. Altogether there are 90 accredited signatories worldwide such as DakkS (Germany), UKAS (UK), SAS (Switzerland), COFRAC (France), Accredia (Italy).

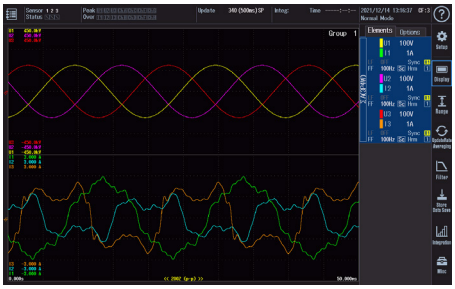
Feature and benefits

Advanced Harmonic analysis

Evaluate and compare input and output harmonics of inverters, motors, or power conditioners up to the 500th order. The WT5000 allows users to not only measure harmonics and power simultaneously but also offers side-by-side comparison of harmonics from two different input sources.

The effects of noise and aliasing are minimized by anti-aliasing and line filters with Digital Parallel Path technology, allowing simultaneous power analysis of wide-band and narrow-band components.

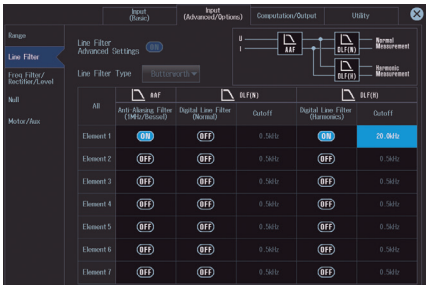
During the no-load loss test, the current will be a distorted waveform due to the Eddy current and hysteresis in the core. The WT5000 Precision Power Analyzer – Transformer Version enables users to measure harmonics and distortions while simultaneously measuring power.



Advanced filtering

In addition to low pass frequency filters and line filters, the WT5000 features advanced filtering capabilities that provide unprecedented control to analyze even the toughest of waveforms with precision.

- Synchronization source filter: Instead of synchronizing to zero-crossings, users can select any specific point of the synchronization source signal.
- Enhanced frequency filter: Allows users to simultaneously measure fundamental and switching frequencies without influencing any other parameter.
- Digital parallel path filters: Supported by a high-frequency anti-aliasing filter, two separate line filters for normal and harmonic measurements ensure accuracy without aliasing in wideband and harmonic measurements. Users can limit the number of harmonic orders to eliminate attenuation in low-bandwidth measurements.



Multi-channel measurements

Using the WT5000 Transformer Version, engineers can measure either three or four different power phases at 10 MS/s (18 bits). The high resolution, 10.1 inch WXGA display allows split screen viewing of up to seven waveforms and can display up to 12 pages of diverse measurement parameters, making it ideal for efficiency tests of inverter-driven motors, renewable energy technologies, and traction applications such as pumps, fans, and electric vehicles. Measurements are also displayed in vector format or trending in time.

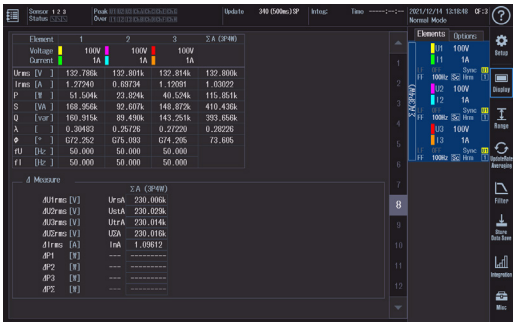
Intuitive operation

Operable by touch and/or hardware hotkeys independently, the WT5000 offers a seamless and intuitive experience that makes connecting, configuring, and measuring easier than ever before. The 10.1 inch WXGA touchscreen delivers excellent noise immunity even in high-noise environments such as motors and inverters.

Three phase delta calculation

Check line voltage and phase voltage simultaneously without changing wiring. The built-in delta computation function allows both star-delta and delta-star conversion.
It allows users to calculate individual phase voltages from the line voltages measured in a three-phase, three-wire (3V3A) system.

The R-S line-to-line voltage can be calculated in systems measured from a three-phase, three-wire method (using two input elements).



Custom triggers and computations

Define and use event triggers and custom computations as per application needs. The event trigger function allows users to set limits to capture readings that fall within or outside a specific range of power, current, or other parameters. Users can also define and use up to 20 different expressions for custom calculations. Data that meets the trigger conditions can be stored, printed, or saved to a USB memory device.

Precision made easy

1 Peripheral Device Connection
Two USB ports for connection to a storage, keyboard, mouse etc.

2 10.1 inch WXGA Touch Screen
A 10.1 inch resistive touch screen delivers excellent noise immunity performance even in environments with high electrical noise such as motors and inverters.

3 Display Format setting
Comprehensive range of display functions for power analysis, including numeric/waveform/vector/bar.

4 Input element and range setting keys
Set the voltage and current ranges on up to 7 input elements.

5 Store and Integration function key
Store and Integration function setting and execution key

6 Communication functions
USB (3.0), Ethernet (VXI-11) and GP-IB

7 Connectors for multi-unit synchronizations
One master and three slaves, a total of 4 units can be connected.

8 RGB output
Video signal output for 1280 × 800 dots WXGA high resolution RGB display

9 30 A input element
Transformer version element, from 0.5 to 30 A direct current and 1.5 to 1000 V direct voltage input. Users can install, remove or swap these input elements themselves.

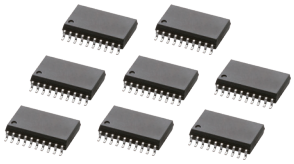
9

The direct input terminal adopted male type large safety terminals preventing any mistakes as voltage input terminals. A dedicated safety terminal adapter set is attached as standard.

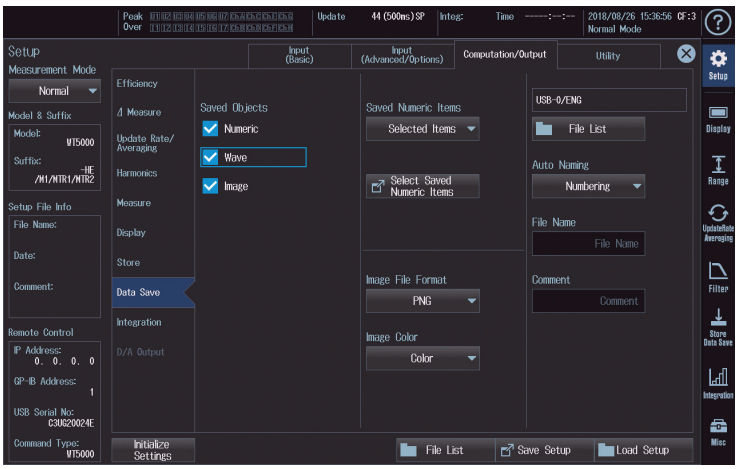
Up to 32 GB of internal memory

The WT5000 offers up to 32 GB of internal storage memory that can be used to store and recall various custom configurations and test setups. It can also be used to log large amounts of measurement data over long periods of time, behaving just like a logger. This large non-volatile memory makes it easy to store data without preparing any external media. Save Waveform/ Numeric/Screen Copy data or Setting Information.

Standard: 2 GB

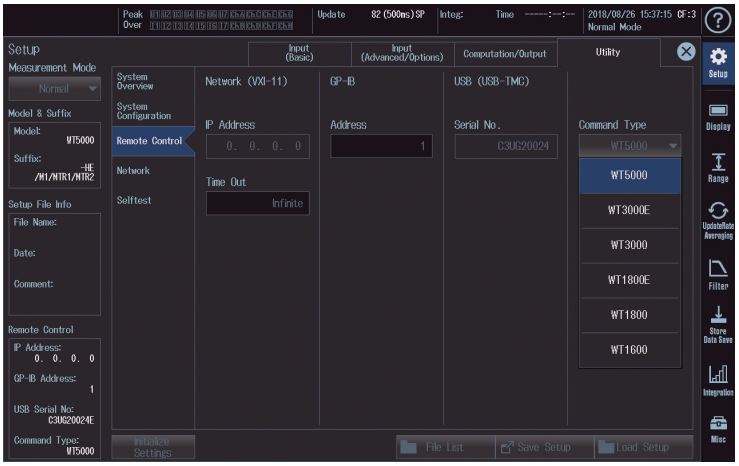


/M1 option: 32 GB



Communications

Not only does the WT5000 support GP-IB, USB and Ethernet communications but is also backward compatible with communication commands of previous models.



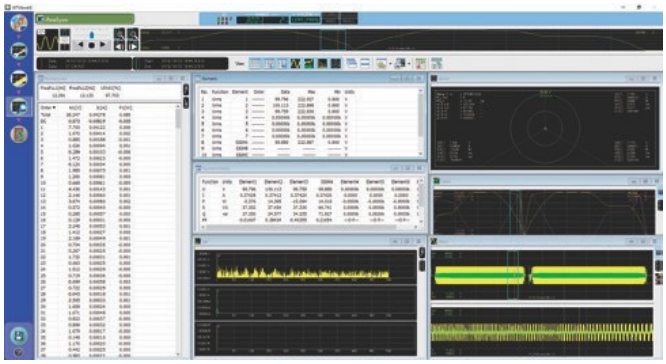
Customize your test bench

Raw waveform data streaming*1

In addition to benefitting from the highly accurate numerical data measured by the WT5000, one can stream to a PC the raw waveform data with a sample speed of up to 2 MS/s. Voltage and current waveforms as well as the motor signals can be streamed to a PC. This allows engineers to study the transient behavior simultaneously when measuring efficiency or energy consumption.

In Synchronized data

The raw waveform data is streamed without any gaps, can be combined, and is synchronized with the numerical data. Abnormal findings in numerical data can be directly linked and evaluated in the waveform data. For example, one can find numeric parameters variation caused by the influence of imposed high-frequency noise.



Display examples of WTViewerE

Maximum waveform trace count

USB 3.0

Sample rate (S/s)	Maximum waveform trace count
2 M	2
1 M	6
500 k	14
10 k to 200 k	22

Gigabit Ethernet (VXI-11)

Sample rate (S/s)	Maximum waveform trace count
2 M	2
1 M	4
500 k	6
10 k to 200 k	22

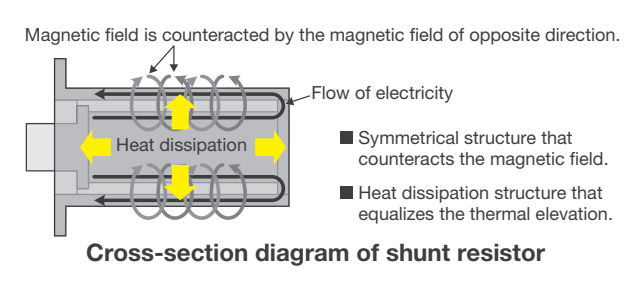
*1: To stream the raw waveform data to a PC, it is possible to make use of WTViewerE 761941. This can also be done by making use of dedicated communication commands for programming. Data update rate is required to set 1 sec when using data streaming by the WTViewerE.

Next generation in precision

Having worked with engineers in the areas of R&D, production, QA, and field testing, Yokogawa Test&Measurement recognizes the importance of reliable and precise measurements for making critical decisions in product development and compliance. For more than 100 years, we have pushed the limits of measurement accuracy and integrity with every generation of our measurement technologies.

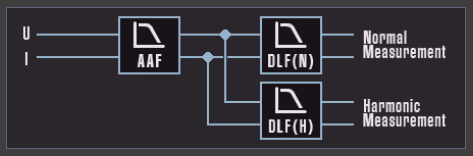
The WT5000 ushers in a new era of precision power measurements that provides engineers with the accuracy and confidence to keep up with evolving international standards, as well as the flexibility to adapt to ever changing application needs. Combining the very best in isolation, noise immunity, current sensing, and filtering in a modular architecture, the WT5000 is an extensible measurement platform that unlocks precision power analysis for electromechanical systems in electric vehicles, renewable energy, industrial equipment, and home and office appliances.

Precision current sensing - The coaxial construction of current shunts in the swappable 30 A input element ensures low resistance, low inductance, low impact on phase shift, and minimizes heat dissipation. Heat flow pathways are optimized in the shunts and across the instrument to ensure even distribution and minimum effect on resistance.

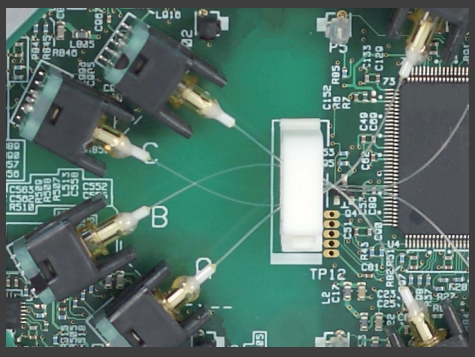


Cross-section diagram of shunt resistor

Advanced filtering - Whether it is for custom synchronization of measurements, smoothening of signal fluctuations, or simultaneous wideband and harmonic power analysis, the advanced filtering options of the WT5000 put the user in control of measurements without compromising on accuracy.



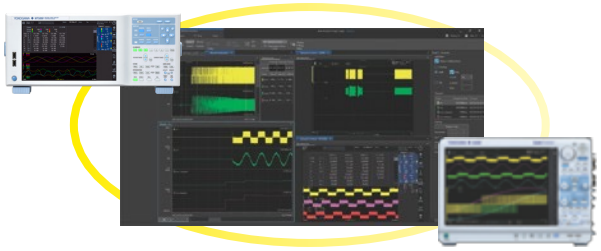
Noise and isolation - Special shielding and optical transmission protect against noise and crosstalk. Yokogawa isoPRO technology ensures fast data transmission (maximum 10 MS/s) and industry-leading isolation to the input elements. It is designed particularly for energy-saving applications, at high voltage, large currents and high frequency. Noise flow routes are optimized for minimum effect on the measurement circuitry.



Software

Integrated measurement software platform IS8000

The IS8000 software platform is an integrated solution that accelerates engineering workflow. It is a revolutionary software solution that tightly integrates the timing, control, and data collection from multiple instruments, creating a comprehensive measurement suite that delivers high confidence, efficiency, and unity.



High-precision synchronized measurement of power values and waveform data

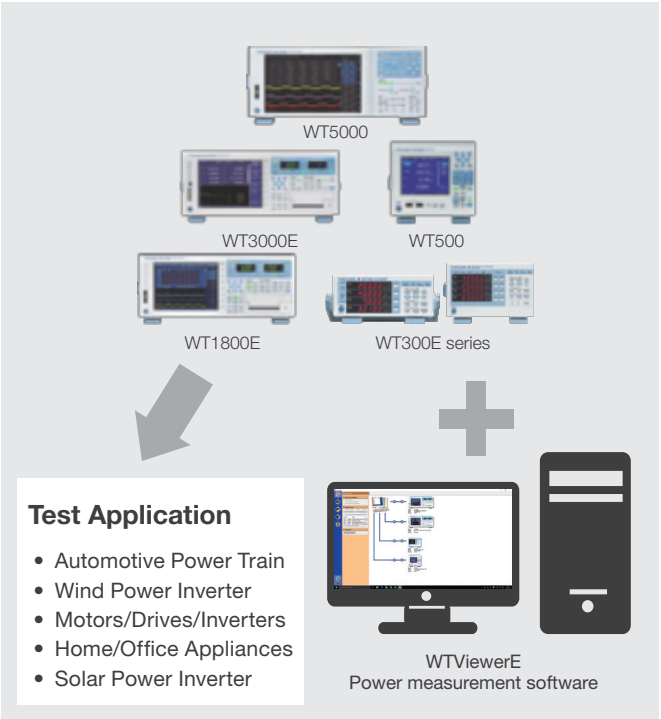
The DL950 ScopeCorder and WT5000 support the IEEE1588 standard. This allows power measured values and transient physical quantities to be synchronized with an error of less than 500 µs and displayed on the IS8000. It is effective for efficiency evaluation and ECU design, which are essential for designing more efficient motor inverters.

Real-time control

WTViewerE allows users to analyze and control remote measurements in real time or use previously acquired data. In the online mode, users have real-time control of measurements from each connected instrument, allowing them to remotely start or stop integration or collect live measurement values. Users can analyze the latest acquired or previously stored data in the offline mode as well.

Application software for WT series WTViewerE

WTViewerE software enables PC connectivity for Yokogawa power analyzers such as the WT5000, WT3000E, WT1800E, WT500, and WT300E through Ethernet, USB, GPIB, or RS232. With multi-channel measurements, multi-unit connectivity, and multilingual support, the WTViewerE allows users to easily control, monitor, collect, analyze, and save remote measurements from up to any four power analyzers simultaneously.



Multi-channel measurements

With the WTViewerE, users can simultaneously view up to 12 waveforms, eight trends, eight vectors, and six harmonic bar graphs in split screen mode or zoom in using cursors for more detail on a particular area of interest. Users can customize, save, and load screen layouts as well as specify the data to be saved in CSV format. The software also allows users to create custom computations combining values from multiple power analyzers.

Specifications for 760901 Transformer Version (30 A)

Input (760901)

Input terminal type

Voltage: Plug-in terminal (safety terminal)

Current: Direct input: Plug-in terminal (safety terminal)
External Current Sensor input: Isolated BNC

Input format

Voltage: Floating input, resistive voltage divider

Current: Floating input, through shunt

Measurement range

Voltage: 1.5/3/6/10/15/30/60/100/150/300/600/1000 V (Crest factor CF3)
0.75/1.5/3/5/7.5/15/30/50/75/150/300/500 V (Crest factor CF6/CF6A)

Current: Direct input 760901: 500 mA, 1 A, 2 A, 5 A, 10 A, 20 A, 30 A (Crest factor CF3)
250 mA, 500 mA, 1 A, 2.5 A, 5 A, 10 A, 15 A (Crest factor CF6/CF6A)

External Current Sensor input
50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V (Crest factor CF3)
25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V, 5 V (Crest factor CF6/CF6A)

Instrument loss

Voltage: Input resistance 10 MΩ ±1% (Approx. 12 pF)

Current: Direct input 760901: Input resistance: 6.5 mΩ ±10% + Approx. 0.3 µH

External Current Sensor input
Input resistance 1 MΩ ±1% (Approx. 50 pF)

Instantaneous maximum allowable input (1 s or less)

Voltage: Peak voltage of 2.5 kV or RMS of 1.5 kV whichever is lower

Current: Direct input 760901: Peak current of 150 A or RMS of 50 A whichever is lower

External Current Sensor input
Peak voltage is less than 10 times of the range or 25 V whichever is lower

Continuous maximum allowable input

Voltage: Peak voltage of 1.6 kV or RMS of 1.5 kV whichever is lower
If the frequency of the input voltage exceeds 100 kHz, (1200 – f) Vrms or less, the "f" indicates the frequency of the input voltage and the unit is kHz

Current: Direct input 760901: Peak current of 90 A or RMS of 33 A whichever is lower

External Current Sensor input
Peak voltage is less than 5 times the range or 25 V whichever is lower

Voltage Continuous maximum voltage to earth (DC to 50/60 Hz)

Voltage input terminals: (DC to 50/60 Hz) 1000 V CAT II

Current input terminals: (DC to 50/60 Hz) 1000 V CAT II

External Current Sensor input connector: (DC to 50/60 Hz) 1000 V CAT II

Influence from common mode voltage

Apply 1000 Vrms for input terminal and case with the voltage input terminals shorted, the current input terminals open, and the external current sensor input terminals shorted.

50/60 Hz: ±0.01% of range or less
Reference value: Up to 200 kHz:
Voltage: ±{(Maximum rated range)/(rated range) × 0.001 × f% of range} or less
Current: Direct input
±{(Maximum rated range)/(rated range) × 0.001 × f% of range} or less
External Current Sensor input
±{(Maximum rated range)/(rated range) × 0.001× f% of range} or less
However, 0.01% or more, unit of f is kHz

The maximum rated range which is equation is Voltage 1000 V, Current direct input 30 A for 760901, External Current Sensor input 10 V.

A/D converter

Simultaneous voltage and current input conversion
Resolution: 18 bit
Conversion speed (Sampling period): Maximum 100 ns

Lower frequency limit of measurement

Sync source period average method

Data update rate	50 ms	100 ms	200 ms	500 ms
Measurement lower limit frequency	45 Hz	20 Hz	10 Hz	5 Hz

Data update rate	1 s	2 s	5 s	10 s	20 s
Measurement lower limit frequency	2 Hz	1 Hz	0.5 Hz	0.2 Hz	0.1 Hz

Digital filtering average method
FAST: 100 Hz
MID: 10 Hz
SLOW: 1 Hz
VSLOW: 0.1 Hz

Accuracy specifications outside the range specified in the table on page 5 (six-month)

One-year Accuracy
Multiply the reading accuracy of the six-month accuracy by a factor of 1.5.

Conditions
Temperature: 23±5°C.
Humidity: 30 to 75% RH.
Input waveform: Sine wave.
λ (Power factor): 1.
Common mode voltage: 0 V.
Crest factor: CF3
Line filter: OFF
Frequency filter: On (1 kHz or less when average method is Sync source period average)
Signal level of Synch source: Same as frequency measurement
After warm-up time (30 minutes)
After Zero calibration of measurement range change under wiring with calibrators
Unit of f of below formulas is kHz
Input range
AC: 1 to 110% of range
DC: 0 to 110% of range

Voltage

DC	±(0.02% of reading + 0.05% of range)
0.1 Hz ≤ f < 10 Hz	±(0.03% of reading + 0.05% of range)
10 Hz ≤ f < 45 Hz	±(0.03% of reading + 0.05% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.02% of range)
66 Hz < f ≤ 1 kHz	±(0.03% of reading + 0.04 of range)
1 kHz < f ≤ 10 kHz	±(0.1% of reading + 0.05% of range) Add 0.015% × f of reading (lower than 10 V range)
10 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.1% of range)
50 kHz < f ≤ 100 kHz	±(0.6% of reading + 0.2% of range)
100 kHz < f ≤ 500 kHz	±{(0.006 × f)% of reading + 0.5% of range}
500 kHz < f ≤ 1 MHz	±{(0.022 × f – 8)% of reading + 1% of range}
Bandwidth	DC to 10 MHz (Typical, –3 dB)

Current

DC	±(0.02% of reading + 0.05% of range)
0.1 Hz ≤ f < 10 Hz	±(0.03% of reading + 0.05% of range)
10 Hz ≤ f < 45 Hz	±(0.03% of reading + 0.05% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.02% of range) ±0.5 µA* *only direct input of 760902
66 Hz < f ≤ 1 kHz	±(0.03% of reading + 0.04 of range)
1 kHz < f ≤ 10 kHz	±(0.1% of reading + 0.05% of range)
10 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.1% of range)
50 kHz < f ≤ 100 kHz	±(0.6% of reading + 0.2% of range)
100 kHz < f ≤ 200 kHz	±{(0.00725 × f – 0.125)% of reading + 0.5% of range}
200 kHz < f ≤ 500 kHz	±{(0.00725 × f – 0.125)% of reading + 0.5% of range}
500 kHz < f ≤ 1 MHz	±{(0.022 × f – 8)% of reading + 1% of range}
Bandwidth	Direct input: DC to 5 MHz (Typical, –3 dB) External Current Sensor input: DC to 5 MHz (Typical, –3 dB)

Power (PF=1)

DC	±(0.02% of reading + 0.05% of range)
0.1 Hz ≤ f < 10 Hz	±(0.08% of reading + 0.1% of range)
10 Hz ≤ f < 30 Hz	±(0.08% of reading + 0.1% of range)
30 Hz ≤ f < 45 Hz	±(0.05% of reading + 0.05% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.02% of range)
66 Hz < f ≤ 1 kHz	±(0.05% of reading + 0.05% of range)
1 kHz < f ≤ 10 kHz	±(0.15% of reading + 0.1% of range) Add 0.01% × f of reading (lower than 10 V range)
10 kHz < f ≤ 50 kHz	±(0.3% of reading + 0.2% of range)
50 kHz < f ≤ 100 kHz	±(0.7% of reading + 0.3% of range)
100 kHz < f ≤ 200 kHz	±{(0.008 × f)% of reading + 1% of range}
200 kHz < f ≤ 500 kHz	±{(0.008 × f)% of reading + 1% of range}
500 kHz < f ≤ 1 MHz	±{(0.048 × f – 20)% of reading + 1% of range}

*rdg: reading, rng: range

- 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 to 100 kHz, the voltage and power values are reference values.
  If the current exceeds 20 A at DC, 10 Hz to 45 Hz, or 400 Hz to 100 kHz, the current and power accuracies are reference values.
- Influence of data update rate
  Add the following value to the accuracy with Sync source period method
  50 ms: ±0.03% of reading
  100 ms: ±0.02% of reading
- Accuracy for crest factor CF6/CF6A
  Same as the range accuracy of crest factor CF3 for twice the range.
- Influence of Power Factor λ
  When λ = 0
  ±Apparent power reading × 0.02% of the range, 45 Hz to 66 Hz
  For frequencies other than the above (Reference values):
  ±Apparent power reading × (0.02 + 0.05 × f)%
  When 0 < λ < 1
  ±Power reading × [(power reading error %) + (power range error %) × (power range/apparent power reading) + {tan Ø × (influence % when λ = 0)}]
  However, Ø is the phase angle between the voltage and current.

Temperature coefficient
±0.01% of reading/°C at 5 to 18°C or 28 to 40°C

Effective input range
Udc and Idc: 0 to ±130% of the measurement range except for 1000 V range
1000 V rage: 0 to ±150%
Urms and Irms: 1 to 130% of the measurement range for crest factor CF3
Umn and Imn: 10 to 130% of the measurement range
Urmn and Irmn: 10 to 130% of the measurement range
Power
DC measurement: 0% to ±130%*
AC measurement: 1% to 130%* of the voltage and current ranges; up to ±130%* of the power range

*The accuracy for 110% to 130% of the measurement range (excluding the 1000 V range) is range error × 1.5. If the input voltage exceeds 600 V, add 0.02% of reading. However, the signal level for the signal sync period average must meet the input signal level for frequency measurement. When the crest factor is set to CF6 or CF6A, double the lower limit.

Influence of Line filter
Bessel 5 orders LPF, fc = 1 MHz
Voltage/Current Up to 100 kHz: Add ±(20 × f/fc) % of reading
Power Up to 100 kHz: Add ± (40 × f/fc) % of reading
Refer to WT5000 (main body) line filter, if lower than 100 kHz of fc

Frequency measurement
Measurement range

Update rate	Measurement range
50 ms	45 Hz ≤ f ≤ 2 MHz
100 ms	20 Hz ≤ f ≤ 2 MHz
200 ms	10 Hz ≤ f ≤ 2 MHz
500 ms	5 Hz ≤ f ≤ 2 MHz
1 s	2 Hz ≤ f ≤ 2 MHz
2 s	1 Hz ≤ f ≤ 2 MHz
5 s	0.5 Hz ≤ f ≤ 2 MHz
10 s	0.2 Hz ≤ f ≤ 2 MHz
20 s	0.1 Hz ≤ f ≤ 2 MHz

Accuracy ±(0.06% of reading + 0.1 mHz)

Conditions
Signal level: For crest factor CF3, more than 30% of range
For crest factor CF6/6 A, more than 60% of range
When the frequency is smaller than or equal to 2 times of the above lower frequency, the input level of more than 50% of ranges is necessary.
Frequency filter: 0.1 Hz ≤ f < 100 Hz: 100 Hz
100 Hz ≤ f < 1 kHz: 1 kHz
1 kHz ≤ f < 100 kHz: 100 kHz

Harmonic Measurement

Measurement target All installed elements

Method PLL synchronization method

Frequency range
Fundamental frequency: 0.1 Hz to 300 kHz
Analysis frequency: 0.1 Hz to 1.5 MHz

PLL source
Select the voltage or current of input elements, or the external clock.
Input level: See element specifications
The condition under frequency filter ON is the same as frequency measurement.
Condition of frequency filter ON
0.1 Hz < f < 100 Hz: 100 Hz
100 Hz < f < 1 kHz: 1 kHz
1 kHz < f < 10 kHz: 10 kHz
10 kHz < f < 100 kHz: 100 kHz

FFT points Select from 1024 or 8192

Window function Rectangular

Anti-aliasing filter Set with line filter and harmonic filter

FFT points 8192 (10 MS/s)

Fundamental frequency	Sampling rate	Window width	Upper limit of measured order	
			U, I, P, Ø, ØU, ØI	Other measured values
0.5 Hz to 3 kHz	f × 1024	8 waves	500* order	100 order
3 kHz to 7.5 kHz	f × 1024	8 waves	200* order	100 order
7.5 kHz to 15 kHz	f × 512	16 waves	100 order	100 order
15 kHz to 30 kHz	f × 256	32 waves	50 order	50 order
30 kHz to 75 kHz	f × 128	64 waves	20 order	20 order
75 kHz to 150 kHz	f × 64	128 waves	10 order	10 order
150 kHz to 300 kHz	f × 32	256 waves	5 order	5 order

*Upper limit of measured order is 100 or smaller, when Update Rate is set to 50 ms.

Accuracy
PLL source input level
15 V or more of range for voltage input.
200 mV or more of range for external current sensor input.
50% or more of the measurement range rating for crest factor CF3.
100% or more of the measurement range rating for crest factor CF6/CF6A.
For 500 mA, 1 A, 2 A range, 20 Hz to 1 kHz.

Accuracy
Add the following accuracy to the normal measurement accuracy.
• When the line filter is OFF

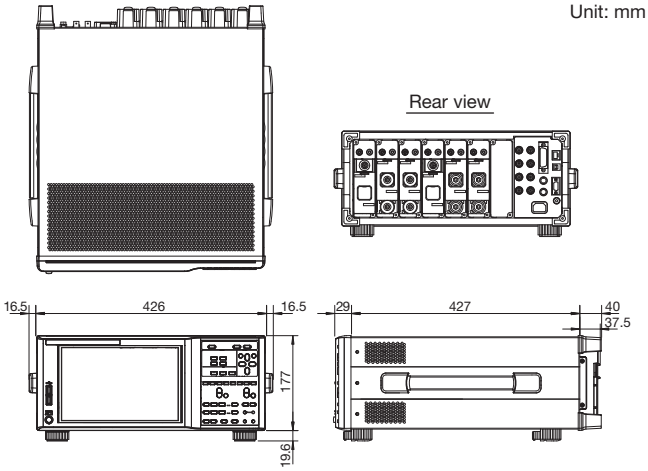
Frequency	Voltage, Current
0.1 Hz ≤ f < 10 Hz	±(0.01% of reading + 0.03% of range)
10 Hz ≤ f < 45 Hz	±(0.01% of reading + 0.03% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.01% of reading + 0.03% of range)
66 Hz < f ≤ 440 Hz	±(0.01% of reading + 0.03% of range)
440 Hz < f ≤ 1 kHz	±(0.01% of reading + 0.03% of range)
1 kHz < f ≤ 10 kHz	±(0.01% of reading + 0.03% of range)
10 kHz < f ≤ 50 kHz	±(0.05% of reading + 0.1% of range)
50 kHz < f ≤ 100 kHz	±(0.1% of reading + 0.2% of range)
100 kHz < f ≤ 500 kHz	±(0.1% of reading + 0.5% of range)
500 kHz < f ≤ 1.5 MHz	±(0.5% of reading + 2% of range)

Frequency	Power
0.1 Hz ≤ f < 10 Hz	±(0.02% of reading + 0.06% of range)
10 Hz ≤ f < 45 Hz	±(0.02% of reading + 0.06% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.02% of reading + 0.06% of range)
66 Hz < f ≤ 440 Hz	±(0.02% of reading + 0.06% of range)
440 Hz < f ≤ 1 kHz	±(0.02% of reading + 0.06% of range)
1 kHz < f ≤ 10 kHz	±(0.02% of reading + 0.06% of range)
10 kHz < f ≤ 50 kHz	±(0.1% of reading + 0.2% of range)
50 kHz < f ≤ 100 kHz	±(0.2% of reading + 0.4% of range)
100 kHz < f ≤ 500 kHz	±(0.2% of reading + 1% of range)
500 kHz < f ≤ 1.5 MHz	±(1% of reading + 4% of range)

General specifications (including WT5000 main body)

Warm-up time	About 30 minutes	
Operation environment	Temperature	5 to 40°C
	Humidity	20 to 80% RH (no condensation)
	Operating altitude	2000 m or lower
	Installation location	Indoors
Storage environment	Temperature	–25 to 60°C (no condensation)
	Humidity	20 to 80% RH (no condensation)
Rated power supply voltage	100 to120 VAC, 220 to 240 VAC	
Allowable power supply voltage fluctuation range	90 to 132 VAC, 198 to 264 VAC	
Rated power supply frequency	50/60 Hz	
Allowable power supply frequency fluctuation range	48 Hz to 63 Hz	
Power consumption	Maximum 560 VA	

Unit: mm



WT5000 and 30 A element (760901)

CLASS 1 LASER PRODUCT
クラス1レーザ製品
1 类激光产品
(EN 60825-1:2014)
(IEC 60825-1:2007, GB 7247.1-2012)

Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No.50, dated June 24, 2007
4-9-8 Myojin-cho, Hachioji-shi, Tokyo 192-8566, Japan

Model and Suffix code

Model	Suffix Code	Descriptions
WT5000		Precision Power Analyzer – Transformer Version
Number of elements*	-03	Transformer Version - 3 element
	-04	Transformer Version - 4 element
Selected current range	-1A	Calibrated current range, 1A
	-5A	Calibrated current range, 5A
Menu	-HE	English menu
Power Cord	-F	VDE/Korean Standard
	-Q	BS Standard
Option	/M1	32 GB Built-in Memory
	/MTR1	Motor Evaluation 1/AUX input*
	/DA20**	20 CH D/A Output
	/MTR2**	Motor Evaluation 2/ AUX input*
	/DS	Data streaming
	/G7	IEC Harmonic/Flicker Measurement

*More than 4 elements on request
**Select only one of these options. /MTR2 option requires installation of /MTR1 option.

Standard accessories

WT5000
Power cord, Rubber feet, Cover panel B8216JA 7 sets, User's manual, expanded user's manual, communication interface user's manual, connector (provided only with/DA20)

760901
Safety terminal adapter B9317WB/B9317WC (provided two adapters in a set times input element number) Safety terminal adapter A1650JZ/A1651JZ*1 (provided black/red two adapters in a set, times of 30 A input element number)*2

User's manuals
Start guide (booklet), function/operation, communication manuals (electric file)
*1: When additional standard accessories are needed, order accessory products, 758931.
*2: When additional standard accessories are needed, order accessory products, 761951.

Yokogawa's Approach to Preserving the Global Environment

- Yokogawa's electrical products are developed and produced in facilities that have received ISO14001 approval.
- In order to protect the global environment, Yokogawa's electrical products are designed in accordance with Yokogawa's Environmentally Friendly Product Design Guidelines and Product Design Assessment Criteria.

This is a Class A instrument based on Emission standards EN61326-1 and EN55011 and is designed for an industrial environment.
Operation of this equipment in a residential area may cause radio interference, in which case users will be responsible for any interference which they cause.

NOTICE
● Before operating the product, read the user's manual thoroughly for proper and safe operation.

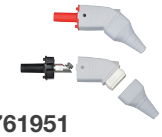
Accessory (sold separately)

Model number	Product	Description
366924 ⚠*1	BNC-BNC Cable	1 m
366925 ⚠*1	BNC-BNC Cable	2 m
701901	1:1 Safety BNC Adapter Lead	1000 V CAT II
701902	Safety BNC-BNC Cable	1000 V CAT II, 1 m
701903	Safety BNC-BNC Cable	1000 V CAT II, 2 m
751542-E4	Rack Mounting Kit	For EIA
751542-J4	Rack Mounting Kit	For JIS
758917	Test Lead Set	A set of 0.75 m long, red and black test leads
758922 ⚠	Small Alligator-clip	Rated at 300 V CAT II two in a set
758923	Safety Terminal Adapter	Two adapters to a set (spring-hold type)
758924	Conversion Adapter	BNC-banana-Jack (female) adapter
758929 ⚠	Large Alligator-clip	Rated at 1000 V CAT II and used in a pair
758931	Safety Terminal Adapter Set	Two adapters to a set (Screw-fastened type), 1.5 mm hex Wrench is attached.
761941*	WTViewerE	Viewer software for WT series
761951	Safety Terminal Adapter Set	Two adapters to a set for 30 A current (6 mm screw-fastened type)

Parts number	Product	Description	Order Q'ty
B9284LK ⚠	External Sensor Cable	Current sensor input connector, Length 0.5 m	1
B9317WD	Wrench	For 761953	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 (42 V or less).

758931
Safety terminal adapter set
Screw-fastened adapters.
Two adapters in a set.
1.5 mm Allen wrench included for tightening.



761951
Safety terminal adapter set
Screw-fastened type adapters for 30 A element.
Black/Red two adapters in a set.

Additional option license*

760991	-DS	Data Streaming
	-G7	IEC Harmonic/Flicker Measurement

*Separately sold license product (customer-installable).

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