Next generation in precision

WT5000
Precision Power Analyzers
As renewable energy, electric vehicles, and energy efficient technologies gain wider adoption, the need for reliability in testing efficiency, performance, and safety has never been greater.

Changing application needs and evolving international standards call for custom measurements and consistent accuracy. With the WT5000 Precision Power Analyzer, engineers have a versatile platform that not only delivers reliable measurements today but is ready for the challenges of tomorrow.

With its unmatched accuracy and modular architecture, the WT5000 empowers engineers to innovate with precision, flexibility, and confidence to quickly bring their products from concept to market.

The WT5000 delivers:

**Reliability** – With a guaranteed accuracy of ±0.03%, harmonic comparisons up to the 500th order, and custom computations, the WT5000 delivers multichannel measurements that everyone can trust.

**Versatility** – Seven slots for user-swappable power elements and diverse options enable expansion and reconfiguration of the WT5000 as application needs change. Additionally, the speed and torque from four separate motors can be measured.

**Simplicity** – With a full touchscreen experience, supported by hardware hotkeys and powerful software for remote measurements, connecting, configuring, and measuring power has never been easier.
Precision at the fingertips

Multi-channel measurements

Measure from up to seven 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.

Unmatched accuracy

The WT5000 is the world’s most accurate precision power analyzer with a basic power accuracy of ±0.03%. Its accuracy specifications are guaranteed from 1% to 130% of the selected voltage and current ranges. With minimum influence of low-power factor (0.02% of apparent power) the unit is also accurate at large phase shifts and frequencies.

- AC power accuracy: 0.01% of reading + 0.02% of range
- DC power accuracy: 0.02% of reading + 0.05% of range
- 10 MS/s 18 bit ADC

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.
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.

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.

Precision measurements for every application

<table>
<thead>
<tr>
<th>Field</th>
<th>Application purpose</th>
<th>Measurement parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric vehicles</td>
<td>Powertrain efficiency</td>
<td>DC and AC power parameters, torque, speed electrical, mechanical and overall efficiency, power consumption, and loss</td>
</tr>
<tr>
<td></td>
<td>Motor evaluation</td>
<td></td>
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<tr>
<td></td>
<td>Battery charging/discharging</td>
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<td>Renewable energy</td>
<td>Power conditioner evaluation</td>
<td>Boost converter and inverter efficiency</td>
</tr>
<tr>
<td></td>
<td>Maximum power point tracking</td>
<td>Battery voltage, motor rotation pulse</td>
</tr>
<tr>
<td></td>
<td>Harmonic analysis</td>
<td>Harmonic distortion factor, ripple factor</td>
</tr>
<tr>
<td>Industrial robotics</td>
<td>Power consumption analysis, Operation and standby mode testing</td>
<td>Efficiency, duty cycle</td>
</tr>
<tr>
<td></td>
<td>Transient power analysis</td>
<td>Sensor receiving wave, receiving pulse</td>
</tr>
<tr>
<td>Home and office appliances</td>
<td>Standby power testing</td>
<td>AC power, voltage, current at standby and operation modes</td>
</tr>
<tr>
<td></td>
<td>Lighting – switching and PWM modulation</td>
<td>Average active power</td>
</tr>
<tr>
<td>Transformer testing</td>
<td>Loss measurement and short circuit testing</td>
<td>AC power, low-power factor</td>
</tr>
<tr>
<td>Healthcare and medical</td>
<td>Power consumption measurement to guarantee quality</td>
<td>Low- and high-frequency power measurement</td>
</tr>
<tr>
<td>medical equipment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Precision made easy

1. **Peripheral device connection**
   Two USB ports for connection to 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 seven 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 synchronization**
   One main (master) unit and three sub (slave) units, a total of four units can be connected.

8. **RGB output**
   Video signal output for 1280 x 800 WXGA high-resolution RGB display

9. **30 A input element**
   High-accuracy 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.

10. **5 A input element**
    High-accuracy element, from 5 mA to 5 A direct current and 1.5 to 1000 V direct voltage input. Users can install, remove or swap these input elements themselves.

11. **Current sensor element**
    High-accuracy element, built-in DC power supply, enables both easy wiring and reliable high-precision, large-current measurements. Users can install, remove or swap these input elements themselves.
    *Firmware version 3.01 or later is required.

12. **Motor evaluation function 1 (optional)**
    Select Torque (Pulse/Analog) and A/B/Z (Pulse) inputs or two sets of Torque (Pulse/Analog) and A (Pulse) inputs.

13. **Motor evaluation function 2 (optional)**
    Select Torque (Pulse/Analog) and A/B/Z (Pulse) inputs or two sets of Torque (Pulse/Analog) and A (Pulse) inputs.
    */MTR2 option requires installation of /MTR1 option.
The direct input terminal adopted male type large safety terminals prevent any mistakes as voltage input terminals. A dedicated safety terminal adapter set is attached as standard.

Easy wiring and reliable high-precision large current measurements by using the current sensor element.
Customize/configure the test bench

Evaluate motors, drives, and inverters

Measure more than just electrical parameters. The motor evaluation function enables measurements of rotational speed and direction, synchronous speed, slip, torque, mechanical power, electrical angle, and motor efficiency from an analog or pulse output of torque sensors or pulse outputs of rotation sensors.

Up to two motors can be measured per WT5000 when the determination of the rotation direction and the electrical angle is needed. A simple setting in the motor configuration menu allows a single WT5000 to take synchronous measurements from up to four torque and rotation sensors, enabling users to determine the overall efficiency from four-wheel driven vehicles.

![Image of motor configurations](image1)

A single WT5000 configured for simultaneous, synchronized measurements from two motors to determine torque, rotation speed, direction, and electrical angles of A/B and Z phases.

Use /MTR1 and /MTR2 options together to measure up to four motors simultaneously.

![Image of motor configurations](image2)

A single WT5000 configured for simultaneous synchronized measurements from four torque and rotation sensors to determine overall efficiency of four motors.
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.

Communications

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

Extend measurements with multi-unit synchronization

When synchronizing four WT5000s with one main unit and three sub units, there is access to 28 input elements for electrical power measurements and up to 16 motor evaluation functions. The WTViewerE software supports this performance.
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.

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.

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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.

### Maximum waveform trace count

<table>
<thead>
<tr>
<th>USB 3.0</th>
<th>Gigabit Ethernet (VXI-11)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample rate (S/s)</strong></td>
<td><strong>Maximum waveform trace count</strong></td>
</tr>
<tr>
<td>2 M</td>
<td>2</td>
</tr>
<tr>
<td>1 M</td>
<td>6</td>
</tr>
<tr>
<td>500 k</td>
<td>14</td>
</tr>
<tr>
<td>10 k to 200 k</td>
<td>22</td>
</tr>
</tbody>
</table>
Current sensor module with DC power supply

Use of the internal DC power supply for AC/DC current sensors simplifies the preparations before measurement and the measurement setup only requires the current sensor and a connecting cable. Using an external DC power supply and additional wiring is no longer required. There are three sensor connection cable lengths available; i.e., 3 m, 5 m, and 10 m.

*Firmware version 3.01 or later is required.

Characteristic example of the current sensor element

*These only shows 760903 current sensor element’s characteristic.

Phase correction

The WT5000 offers gain and phase correction functions for precision power measurement. In some applications, external sensors and probes are required to enable high-current measurement. In order to maximize accuracy during measurement, it is recommended to correct gain and phase error or calibrate the measurement setup.
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.

**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.
Applications
Electric vehicle development

Overview

Between 16% and 18% of the total charge of an electric car is consumed by electric drive system losses. Electric and hybrid car manufacturers therefore need to accurately evaluate motor and inverter control in order to achieve higher precision and greater efficiency. Additionally, the accurate analysis of inverter waveforms without interference from switching noise is a key part of evaluating the motor drive circuit.

Key requirements

- Multi-phase measurements from battery, inverter, and motor
- Evaluation of motor characteristics such as torque, rotation speed and direction, slip, and electrical angle
- Battery charging/discharging characteristics
- Harmonic analysis of inverter signals at various rotation speeds

The WT5000 advantage

With high-accuracy, multi-channel power measurements, evaluation of up to four motors and harmonic comparison capabilities, the WT5000 helps automotive engineers improve conversion efficiency, reduce charging times, and improve driving range.

Guaranteed accuracy in multi-channel measurements

The WT5000 enables simultaneous measurements of voltage, current, power, torque, rotation speed, electrical angle, and mechanical power.

Motor evaluation and mechatronic efficiency

Measure rotation speed, torque, and output (mechanical power) of motors from analog/pulse inputs of rotation or torque sensors. A single WT5000 can be configured for synchronized measurements from up to four motors simultaneously.

Battery charging and discharging characteristics

Integration of instantaneous positive and negative values of energy allows the evaluation of battery charging and discharging characteristics.

Harmonics analysis and comparisons

With the ability to measure harmonics up to the 500th order even at low rotation speeds, the WT5000 supports harmonic analysis without the need for an external sampling clock.
Renewable energy development

Overview

Energy generated by photovoltaic cell modules and wind turbines is converted from DC to AC by a power conditioner. Minimizing losses in these conversions is key to improving the efficiency of the overall energy system.

Key requirements

- Multi-phase measurements from boost converter, inverter, and storage battery
- Evaluation of maximum power and instantaneous peak values
- Energy bought and sold in grid
- Battery charging/discharging characteristics
- Harmonic analysis of inverter signals at various generator speeds

The WT5000 advantage

The WT5000 helps engineers working in the development of renewable energy solutions, to improve conversion efficiency by offering precision insights in charging, discharging, storage, and overall efficiency.

Multi-channel power measurements

Evaluate power conditioner efficiency with simultaneous measurements from the inputs and outputs of the boost converter, inverter, and storage battery. With measurement capabilities from up to seven input elements, the WT5000 is ideal for voltage, current, power, and frequency (for AC) before and after each converter, as well as converter efficiency and charging efficiency.

Instantaneous peak power

In photovoltaic power generation, a Maximum Power Point Tracker (MPPT) controller varies the voltage to maximize energy harvested from the solar panel. The WT5000 is capable of measuring not only the voltage, current, and power but also the voltage, current, and power peak value plus (+) and minus (−) sides, respectively.

Energy bought/sold and charged/discharged

The WT5000 provides a current integration (q), apparent power integration (WS), reactive power integration (WQ), and effective power integration capable of integration in the power sold/bought and charge/discharge modes.

Harmonics analysis and comparisons

Voltage fluctuations and harmonics flow into the power systems due to reverse power flow. The harmonic measurement function enables measurement of harmonic components to compute and display total harmonic distortion (THD) and harmonic distortion factor.
Overview

Motor drive technology has become more complex in recent years, pure sine-wave PWM is less common, and cases where the mean voltage differs greatly from the fundamental voltage waveform are more frequent.

Key requirements
- Multi-phase measurements from battery, inverter, and motor
- Evaluation of motor characteristics such as torque, rotation speed and direction, slip, and electrical angle
- Harmonic analysis of inverter signals at various rotational speeds

The WT5000 advantage

With high-accuracy, multi-channel power measurements, motor evaluation and harmonic comparison capabilities, the WT5000 helps engineers in motor and drive development improve power consumption and conversion efficiency in inverter/motor drive systems.

Guaranteed accuracy across a wide range

The WT5000 guarantees a basic power accuracy of ±0.03%, between 1% and 130% of the selected voltage and current measurement ranges, at 50/60 Hz. It supports simultaneous measurements from the inputs and outputs of the boost converter, inverter, and storage battery.

Inverter and motor efficiency

In addition to computing power conversion efficiency of the inverter and motor (up to seven power inputs), the WT5000 also allows the measurement of rotational speed, torque, and output (mechanical power) from the analog/pulse inputs of the rotation or torque sensor.

Harmonics analysis and comparisons

With the ability to measure harmonics up to the 500th order even at low rotation speeds, the WT5000 supports harmonic analysis without the need of an external sampling clock.

Inverter/motor drives

Inverter/Motor Load

- Input signal
- Output signal
- Trend display of torque and rpms (requires /MTR1 or /MTR2 option)
Magnetic characteristics testing

Overview
In transformer or reactor development, the WT5000 can be used to evaluate magnetic material characteristics using the Epstein frame system.

Key requirements
• High-precision measurements of primary coil current and secondary coil voltage are needed
• High accuracy in low-power factor is needed
• The magnetic flux density B and AC magnetic field H are key parameters to calculate iron loss

The WT5000 advantage

Highest voltage and current accuracy
WT5000 provides the highest power accuracy:
- 0.01% of reading + 0.02% of range (50/60 Hz)

High accuracy at low-power factor
Effect of power factor on the WT5000:
- 0.02% of S (0.5 A or more)
- 0.07% of S (200 mA or less)

Power calibration

Overview
For those who use a large number of power meters, the WT5000 can be used as a reference standard for periodic in-house calibration of power measurement instruments, such as the WT300E series and WT500.

Key requirements
• Sufficient power accuracy is needed for power measurement instruments
• Power factor is adjustable, and the accuracy in low-power factor is guaranteed

The WT5000 advantage

Highest power accuracy
WT5000 provides the highest power accuracy:
- 0.01% of reading + 0.02% of range (50/60 Hz)

High accuracy at low power factor
Effect of power factor of the WT5000:
- 0.02% of S (0.5 A or more)
- 0.07% of S (200 mA or less)
Harmonic and voltage fluctuation/flicker measurement

Harmonics regulation test*1*2

Combined with the /G7 option of the WT5000 and the integrated software platform IS8011/IS8012, the WT5000-measured harmonic data can be saved into a PC to judge the level according to IEC regulations. To support large equipment over 16 A/phase (IEC61000-3-12), the special CT200 current sensor model can be used.

Voltage fluctuation and flicker regulation test*1*2

The WT5000 with the /G7 option can measure voltage fluctuation and can conduct a flicker test, according to IEC61000-3-3 regulations. This option shows a trend of parameters such as dc, dmax and Pinst (instantaneous flicker sensation). To capture test results, this option generates a comprehensive test report.

*1: Supported standards:
- Harmonics
  - EN61000-3-2, IEC61000-3-2, EN61000-3-12, IEC61000-3-12, JIS C 61000-3-2
- Voltage fluctuation/flicker
  - EN61000-3-3, IEC61000-3-3, EN61000-3-11, IEC61000-3-11

*2: 30 A/5 A High Accuracy Element (760901/760902) are available.

*3: GP-IB, Ethernet, and USB communications are available.
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.

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.

Test Application:
- Automotive Power Train
- Wind Power Inverter
- Motors/Drives/Inverters
- Home/Office Appliances
- Solar Power Inverter

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.

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.

* A WT5000 with a 760903 current sensor element installed is available with version 1.61 or later of the WTViewerE.

* Data update rate is required to set 50 msec or slower when using the WTViewerE.
**Specifications for 760901 (30 A high accuracy element), 760902 (5 A high accuracy element), and 760903 (current sensor element)**

**Element style and the installation**

<table>
<thead>
<tr>
<th>Element</th>
<th>Plug-in unit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of slots</td>
<td>7</td>
</tr>
<tr>
<td>Installed style</td>
<td>Modular style dedicated to WT5000 (main body)</td>
</tr>
<tr>
<td>Mixed installation</td>
<td>Possible for both 30 A and 5 A element together</td>
</tr>
<tr>
<td>Installation with empty slot</td>
<td>Possible, however, user cannot make use of elements after empty slot.</td>
</tr>
<tr>
<td>Live installation or pulling out</td>
<td>Impossible</td>
</tr>
</tbody>
</table>

**Input (760901/760902)**

**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: Continuous maximum voltage to earth (DC to 50/60 Hz) 1000 V CAT II
- Current: Continuous maximum voltage to earth (DC to 50/60 Hz) 1000 V CAT II

**Instrument loss**
- Voltage: Input resistance: 10 MΩ ±1% (Approx. 12 pF)
  - Current: Input resistance: 6.5 MΩ ±10% + Approx. 0.3 µH

**Instantaneous maximum allowable input (1 s or less)**
- Voltage: Peak value: 150 mA, 500 mA, 1 A, 2.5 A, 5 A, 10 A, 15 A (crest factor CF3)
- Current: Peak current: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, 10 A (crest factor CF3)

**Continuous maximum allowable input**
- Voltage: Peak value 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: Peak current of 0.9 A or RMS of 33 A whichever is lower

**Voltage Continuous maximum voltage to earth (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 input sensor 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 x % of range) or less
- Current: ±(Maximum rated range)/(rated range) ± 0.001 x % of range) or less

**Digital filtering average method**
- FAST: 100 Hz
- MID: 10 Hz
- SLOW: 1 Hz
- VSDLV: 0.1 Hz

**Input (760903)**

**Output terminal type**
- Sensor power: D-sub 9-pin socket
  - Probe power: Dedicated connector

**Output voltage**
- Sensor power: ±1 V
  - Probe power: ±12 V

**Output current**
- Sensor power: 0.8 A
  - Probe power: 0.8 A
  - Probe power supply: The total absolute value of the positive and negative currents of the power supply is included in the positive sensor power supply current.

**Input terminal type**
- Voltage: Same as 760901
  - Current: Same as 760901
- Current: Input: Input through shunt
  - Probe input: Input through resistive voltage divider

**Measurement range**
- Voltage: Same as 760901
  - Current: Same as 760901

**Input impedance**
- Voltage: Input resistance: 10 MΩ ±1% (Approx. 12 pF)
  - Current: Input resistance: 6.5 MΩ ±10% + Approx. 0.3 µH

**Instantaneous maximum allowable input**
- Voltage: Peak value: 150 mA, 500 mA, 1 A, 2.5 A, 5 A, 10 A, 15 A (crest factor CF3)
- Current: Peak current: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, 10 A (crest factor CF3)

**Continuous maximum allowable input**
- Voltage: Peak value 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: Peak current of 0.9 A or RMS of 33 A whichever is lower

**Voltage Continuous maximum voltage to earth (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 input sensor 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 x % of range) or less
  - Current: ±(Maximum rated range)/(rated range) ± 0.001 x % of range) or less
- External Current Sensor input: Input resistance: 10 Ω Approx. 10 Ω + approx. 0.2 μH
  - Input resistance: 5 Ω Approx. 5 Ω + approx. 0.2 μH
  - Input resistance: 1.5 Ω Approx. 1.5 Ω + approx. 0.2 μH

**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 averaged method
Input resistance: 5 kΩ
Peak value: 0.3 A or rms value of 0.22 A, whichever is less.
Input resistance: 10 kΩ
Peak value: 0.15 A or rms value of 0.11 A, whichever is less.

Probe input:
• Maximum of 5 times the range or rms value of 2.5 V, whichever is less.

Maximum rated voltage to earth (DC to 50/60 Hz)
Voltage input terminal
1000 V CAT II

Influence of voltage to earth
1000 Vm/s is applied between an input terminal and WT5000 with the voltage input terminals shorted.
50/60 Hz: ±0.01% of range or less.
Reference values up to 200 kHz:
• Voltage: ±(maximum rated range)/(rated range) × 0.001 × % of range
• Voltage: ±(maximum rated range)/(rated range) × 0.001 × % of range
• Voltage: ±(maximum rated range)/(rated range) × 0.001 × % of range

DC to 10 MHz (Typical, −3 dB)

±(0.03% of rdg + 0.03% of rng)

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

Conditions
• Temperature: 23°C ± 5°C.
• Humidity: 30% to 75% RH.
• Input waveform: 50/60 Hz.
• Common mode voltage: 0 V.
• Crest factor: CF3
• Line filter: OFF
• Frequency filter: On (1 kHz or less when average method is used).
• Signal level of source: Same as frequency measurement.
• After warm-up time (30 minutes)
• After zero calibration of measurement range change under wiring with calibrators.
• Unit of fc in below formulas is kHz.

Input range
Ac 1 to 110% of range
DC 0 to 110% of range

Accuracy
<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Udc 1000 V rage: 0% to ±150%</td>
<td></td>
</tr>
<tr>
<td>Current: 0% to ±150% when the voltage measurement range is 1000 V; 0% to ±130% otherwise</td>
<td></td>
</tr>
</tbody>
</table>

• Influence of Power Factor
When k < 1
• Apparent power reading = 0.02% of the range. 45 Hz to 66 Hz
• For frequencies other than the above (Reference values):
• Apparent power reading = (0.01 + 0.01%)/k

When k = 1
• Apparent power reading + [tan Ø × (influence % when |Ø| = 0)]

However, Ø is the phase angle between the voltage and current.

Temperature coefficient (760901/760902)
±0.01% of reading at 5°C to 18°C or 28°C to 40°C

Temperature coefficient (760903)
At 6°C to 18°C or 28°C to 40°C, add the following value to the voltage measurement accuracy:
±0.01% of reading at 5°C
At 5°C to 18°C or 28°C to 40°C, add the following value to the current and power measurement accuracy.
When the input voltage is 10.0 V or 50.0 V:
±0.01% of reading at 5°C

Effective input range
Udo: and Idc: 0% to ±130% of the measurement range (excluding the 1000 V range)*
Udo: 1000 V range: 0% to ±150%
Urm and Irn: 1% to 130% of the measurement range*
Um and Im: 10% to 130% of the measurement range*
Urms and Irms: 1% to 130% of the measurement range*
Ac measurement: 1% to 130% of the voltage and current ranges, up to a 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 CF7, double the lower limit.

Influence of Line filter (760903)
Bessel 5 orders LPF, fc = 1 MHz
Voltage/Current: Up to 100 kHz: Add ±(x + 1)% of reading

Power: Up to 100 kHz: Add (0.015 × fc)°% of reading
Refer to WT5000 (main body) line filter, if lower than 100 kHz of fc

Influence of Line filter (760901/760902)
Bessel 5th order LPF, cutoff frequency: 1 MHz

The advanced line filter setting is on
When the advanced line filter setting is on
When the anti-aliasing filter function (AAF) is on, add the following to the voltage, current, and active power accuracies.
Voltage, current f ≤ (fc/10): ± (20 × f/fc) % of reading
Active power f ≤ (fc/10): ± (40 × f/fc) % of reading
For the filter specifications for f < than less or equal to 100 kHz, see “Line filter” in section 6.7.
When the advanced line filter setting is on
When the anti-aliasing filter function (AAF) is on, add the following to the voltage, current, and active power accuracies.
Voltage, current f ≤ (fc/10): ± (20 × f/fc) % of reading
Active power f ≤ (fc/10): ± (40 × f/fc) % of reading
For the filter specifications for f < than less or equal to 100 kHz, see “Line filter” in section 6.7.
When the high frequency rejection function (HFR) is on, add the following to the voltage, current, active power accuracies.
If the AAF is set to ON simultaneously, the accuracy addition of the AAF takes precedence.
Current f = 0: ± 0.01% of reading
Power f = 0: ± 0.01% of reading

Appendix
• Active power (power factor 1)

Accuracy
• Accuracy of peak power reading = ±0.01% of apparent power reading
However, be aware that these figures are reference values.
The unit of fc and in the accuracy equations is kHz.
### Frequency measurement

<table>
<thead>
<tr>
<th>Measurement range</th>
<th>Update rate</th>
<th>Measurement range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 Hz ≤ f &lt; 10 Hz</td>
<td>10 ms</td>
<td>200 Hz ≤ f ≤ 2 MHz</td>
</tr>
<tr>
<td>10 Hz ≤ f ≤ 1 kHz</td>
<td>50 ms</td>
<td>45 Hz ≤ f ≤ 2 MHz</td>
</tr>
<tr>
<td>1 kHz ≤ f ≤ 10 kHz</td>
<td>100 ms</td>
<td>20 Hz ≤ f ≤ 2 MHz</td>
</tr>
<tr>
<td>10 kHz ≤ f ≤ 100 kHz</td>
<td>500 ms</td>
<td>5 Hz ≤ f ≤ 2 MHz</td>
</tr>
<tr>
<td>100 kHz ≤ f ≤ 500 kHz</td>
<td>5 s</td>
<td>2 Hz ≤ f ≤ 2 MHz</td>
</tr>
<tr>
<td>1 MHz ≤ f ≤ 2 MHz</td>
<td>10 s</td>
<td>1 Hz ≤ f ≤ 2 MHz</td>
</tr>
<tr>
<td>10 MHz ≤ f ≤ 50 MHz</td>
<td>20 s</td>
<td>0.5 Hz ≤ f ≤ 2 MHz</td>
</tr>
<tr>
<td>100 MHz ≤ f ≤ 500 MHz</td>
<td>100 s</td>
<td>0.2 Hz ≤ f ≤ 2 MHz</td>
</tr>
<tr>
<td>500 MHz ≤ f ≤ 1 MHz</td>
<td>500 s</td>
<td>0.1 Hz ≤ f ≤ 2 MHz</td>
</tr>
</tbody>
</table>

#### Conditions
- **Signal level:** For crest factor CF3, more than 30% of range
- When the frequency is smaller than or equal to 2 times 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 ≤ f ≤ 1 kHz; 1 kHz ≤ f ≤ 100 kHz; 10 kHz ≤ f ≤ 100 kHz.

#### Notes (760903)
- Limitations when used in combination with the CT1000
  - Use within the following ambient temperature derating.
  - CT ambient temperature 45°C or more: Primary current 900 Apk or less
  - CT ambient temperature 45°C or less: Follows the CT1000 specifications
- Restrictions when used with the 10 m sensor cable 761966

### Harmonic Measurement

#### Measurement target
- All installed elements

#### Method
- PLL synchronization method

#### Frequency range
- Fundamental frequency: 0.1 Hz to 300 Hz
- 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: 1 kHz
- 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
- Select with line filter and harmonic filter

### FFT points 8192 (10 MS/s)

#### Fundamental frequency
- Sampling rate: 10 kHz
- Window width: 0.5 Hz
- Upper limit of measured order: 30th order

#### Fundamental frequency
- Sampling rate: 10 kHz
- Window width: 0.5 Hz
- Upper limit of measured order: 30th order

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

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Voltage, Current</th>
<th>±(0.01% of reading + 0.03% of range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 Hz ≤ f &lt; 10 Hz</td>
<td>±0.01% of reading + 0.03% of range</td>
<td></td>
</tr>
<tr>
<td>10 Hz ≤ f ≤ 1 kHz</td>
<td>±0.01% of reading + 0.03% of range</td>
<td></td>
</tr>
<tr>
<td>1 kHz ≤ f ≤ 10 kHz</td>
<td>±0.01% of reading + 0.03% of range</td>
<td></td>
</tr>
<tr>
<td>10 kHz ≤ f ≤ 100 kHz</td>
<td>±0.01% of reading + 0.03% of range</td>
<td></td>
</tr>
<tr>
<td>100 kHz ≤ f ≤ 500 kHz</td>
<td>±0.01% of reading + 0.03% of range</td>
<td></td>
</tr>
<tr>
<td>500 kHz ≤ f ≤ 1 MHz</td>
<td>±0.01% of reading + 0.03% of range</td>
<td></td>
</tr>
</tbody>
</table>

### Data Streaming (DS option is required)
- IEC Harmonic Measurement
- IEC Voltage fluctuation and Flicker
- Please see the brochure of specifications (Bulletin WT5000-02 EN).

### 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 to 120 VAC, 220 to 240 VAC

#### Allowable power supply voltage fluctuation range
- 50 to 150 VAC, 138 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

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**WTS5000, 30 A and 5 A High Accuracy Elements (760901 and 760902), and Current Sensor Element (760903) includes LAZER source inside.**

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**Notes (760903) includes LAZER source inside.**
Related products

AC/DC Current Sensor

CT60/CT200/CT1000/CT1000A/CT2000A

AC/DC Current Sensors
- DC to 800 Hz/60 Apeak, DC to 500 Hz/220 Apeak, DC to 300 Hz/1000 Apeak
- DC to 300 Hz/1000 Arms (758923 Apeak), DC to 40 kHz/2000 Arms (3000 Apeak)
- Wide dynamic range: −2000 A to 0 A to +2000 A (DC)/2000 Arms (AC)
- Wide measurement frequency range: DC and up to 800 kHz
- High-precision fundamental accuracy: ±0.05% of reading + 30 μA
- ±15 V DC power supply, connector, and load resistor required.

Clamp-on Probe

751552

Current Clamp-on Probe
- AC 1000 Arms (1400 Apeak)
- Measurement frequency range: 30 Hz to 5 kHz
- Basic accuracy: ±0.3% of reading
- Maximum allowed input: AC 1000 Arms, DC 60 Apeak
- Internal output type: 1 mA/A

Current Sensor Unit

751522, 751524

Current Sensor Unit
- DC to 100 kHz/1000 Apeak
- Wide dynamic range: −1000 A to 0 A to +1000 A (DC)/1000 Apeak (AC)
- Wide measurement frequency range: DC to 100 kHz (−3 dB)
- High-precision fundamental accuracy: ±0.05% of reading + 40 μA

Adapters and Cables

Measurement leads
758917

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

Small alligator adapters
758922

For connection to measurement leads (758917). Two in a set. Rating: 300 V CAT II

Large alligator adapters
758929

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

Female-female type adapters
758921

Two adapters in a set. Black/Red

Safety terminal adapter set
758923

Two adapters in a set. Spring-hand type

Safety terminal adapter set
758931

Two adapters in a set. Screw-fastened type

Conversion adapter
758924

For conversion between male BNC and female banana plug

Converter for Current Sensor Element
761954/761955/761956

Total length: 3 m/5 m/10 m

Measurement using current sensor

Unit whose current is to be measured

Power meter's current direct input terminal

Measurement using clamp-on probe

Unit whose current is to be measured

Power meter's current input terminals

Measurement using voltage input terminal

Unit whose voltage is to be measured

Power meter's voltage input terminal

Note: A burden resistor is required for the CT1000, CT200, and CT60.
### Model and suffix code

<table>
<thead>
<tr>
<th>Model Code</th>
<th>Suffix Code</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT5000</td>
<td>-HC</td>
<td>Precision Power Analyzer</td>
</tr>
<tr>
<td>-HE</td>
<td>English Menu</td>
<td></td>
</tr>
<tr>
<td>-HU</td>
<td>Japanese/English Menu</td>
<td></td>
</tr>
</tbody>
</table>

### Accessories (sold separately)

<table>
<thead>
<tr>
<th>Model Code</th>
<th>Product Name</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>366924</td>
<td>BNC-BNC Cable</td>
<td>1 m</td>
</tr>
<tr>
<td>366925</td>
<td>BNC-BNC Cable</td>
<td>2 m</td>
</tr>
</tbody>
</table>

### Safety terminal adapter

Safety terminal adapter B9317WB/B9317WC (provided black/red two adapters in a set)

*Use these products with low-voltage circuits (42 V or less).

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### 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 EN50011 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.

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### NOTICES

- Before operating the product, read the user’s manual thoroughly for proper and safe operation.

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### Yokogawa Test & Measurement Corporation

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