WT1800E Series
High performance Power Analyzers
To curb global warming, greater efforts are being made to generate and use power more efficiently. The use of renewable energy sources like solar and wind power is growing and there is accelerated development of environmentally-friendly cars and energy-efficient machines and devices.

Developing these technologies requires accurate measurements to validate even the smallest changes in energy consumption. In the WT1800E high performance power analyzer, engineers have the ideal tool to accurately measure power, its quality and efficiency.

Whether analyzing multiphase inputs during motor and drive design or meeting the stringent efficiency standards of photovoltaic inverters, the WT1800E provides the versatility to help engineers bring their product concepts successfully to market.

The WT1800E delivers:

**Accuracy** – The WT1800E is the only instrument in its class that guarantees a power accuracy of 0.05% of reading plus 0.05% of range and is capable of harmonics analysis up to the 500th order of a 50/60 Hz fundamental frequency.

**Reliability** – Measurements need to be repeatable as well as accurate. The stability of the WT1800E ensures that precision measurements can be made today and over the long term.

**Flexibility** – With up to 6 input channels, a wide range of display and analysis features, and PC connectivity, the WT1800E is the measurement solution for a broad range of power efficiency and harmonic analysis requirements.
Features and benefits

6 inputs on a high resolution display

Make simultaneous measurements on up to 6 inputs at 2 MS/s (16 bits). The high resolution 8.4 inch XGA display of the WT1800E allows split screen viewing of up to 6 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 like pumps, fans and hybrid/electric vehicles. The unit can also display measurements in vector format or trending in time.

Harmonic analyses

Analyze harmonics up to the 500th order for a 50/60 Hz fundamental even at a data update interval of 50 milliseconds. The WT1800E features two options for analyzing harmonics in addition to power parameters,

- Harmonic measurement mode (/G5 option) for fundamental wave, harmonic components and total harmonic distortion (THD)
- Dual Harmonic option (/G6 option) for side by side measurement of harmonics on two different sources for example input and output of inverters, variable speed motors, lighting ballasts, UPS, etc.

Guaranteed accuracy across a wide range

Measure accurately at a wide range of voltage, current and frequency conditions. The basic power accuracy of the WT1800E is guaranteed between 1% to 110% of the selected voltage and current range. This equates to voltages from 15 mV to 1100 Vrms and currents from 0.1 mA to 5.5 Arms (for a 5 A input element) and 10 mA to 55 Arms (for a 50 A input element). The unit is also accurate during large phase shifts and high frequencies thanks to the minimized influence of the low power factor error (±0.07% of apparent power).

Power integration and auto ranging

Measure energy bought and sold in grid connections or charged and discharged in batteries. The WT1800E’s Power integration function integrates instantaneous values for both positive and negative readings. It also measures total energy (Wh) and current (Ah) when load conditions vary widely like in devices transitioning from standby to operation mode. Should an input signal start to fall out of the expected range, this function can automatically adjust the range while continuing to integrate the measured values.

Range configuration

Track signal changes faster by eliminating unnecessary range changes. The WT1800E’s range configuration function allows users to select input ranges based on their specific use cases so that optimal range settings are achieved quicker. This reduces the time during repetitive production tests, such as setting to OFF, 100 V, OFF and so on, which is performed frequently on the production line.

High speed data capture

The High Speed data capturing function can measure Sigma-Urms, Sigma-Irms and Sigma-P from DC signal and three phase devices every 5 ms when External Synchronization is OFF or, 1 ms to 100 ms when External Synchronization is ON depending on the frequency of the clock signal.
**Flexible & automatic data updates**

Manually or automatically set measurement intervals. The WT1800E offers 9 data update interval between 50 ms to 20 s but can also follow fluctuating input frequencies by changing the data update rate automatically. This is useful when measuring devices like motors whose input signal frequency varies with RPM.

**Motor evaluation function**

Measure more than just electrical parameters. The motor evaluation function enables measurement of rotation speed and direction, torque, mechanical power, synchronous speed, slip, electrical angle, motor efficiency and total system efficiency from the analog or pulse outputs of rotation and torque sensors.

**Features and benefits**

- **Flexible & automatic data updates**
  - Manually or automatically set measurement intervals.
  - WT1800E offers 9 data update intervals between 50 ms to 20 s.
  - Can follow fluctuating input frequencies by changing the data update rate automatically.
  - Useful for measuring devices like motors whose input signal frequency varies with RPM.

- **Motor evaluation function**
  - Measures rotation speed and direction, torque, mechanical power, synchronous speed, slip, electrical angle, motor efficiency, and total system efficiency.

- **WTViewerE application software**
  - Easily view, control, and download measurements from your PC.
  - Connects up to four WT1800Es to a PC via a communications interface.
  - Makes numeric, waveform, trend, and harmonic data from the unit easily accessible via PC.

- **User defined events and computations**
  - WT1800E’s event trigger function allows users to set limits for capture of readings that fall into or out of a specific range of power, current, or other parameters.
  - Data that meets the trigger conditions are stored, printed, saved to a USB memory device, etc.
  - Users can also define and use up to 20 expressions for custom calculations.

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**DC power supply for AC/DC current sensors (/PD2 option)**

The WT1800E can be equipped with a DC power supply for the CT series of AC/DC current sensors. By using dedicated connection cables and shunt resistors, the WT1800E can measure large currents. Improved S/N ratio and noise immunity is achieved by connecting the sensors in this way.

*EX1 to /EX6 options must be installed in the WT1800E to be able to use the Shunt Resistor Box.
The WT1800E in detail

1. External media slot
2. Element setting
3. U/I range display
4. Display settings
5. Measurement item selection
6. Integration settings
7. Data saving
8. Built-in printer (/B5 Option)

1. Voltage input terminals
2. Current input terminals
3. GP-IB port
4. BNC connector for two-system synchronized measurement
5. Ethernet port (1000BASE-T/100BASE-TX)
6. USB port (PC)
7. External current sensor input terminals (/EX Option)
8. Torque and speed input terminals (/MTR Option)
9. D/A output (/DA Option)
10. RGB port (/V1 Option)
**Two types of input element**

**Basic Power Accuracy:** ±(0.05% of reading + 0.05% of range)*1

**Measurement Bandwidth:** DC, 0.1 Hz to 1 MHz

**Low Power Factor Error:** Power factor influence when \( \cos \theta = 0 \)

\[ \text{Error} = 0.07\% \text{ of } S \]

\( S \) is reading value of apparent power
\( \theta \) is phase angle between voltage and current

**Temperature range:** 23 ±5˚C

**Current Range**

- **Direct Input:** 1/2/5/10/20/50 A*
  - 10/20/50 mA, 1/2/5 A*

- **External Input:** 50/100/200/500 mV, 1/2/5/10 V**2

**Voltage Range:** 1.5/3/6/10/15/30/60/100/150/300/600/1000 V*

**Effective input range:** 1% to 110%

**Data Update Interval:** 50 ms to 20 s or Auto

*1 Please refer to “specifications” in detail
*2 Voltage range and current range are for crest factor 3

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**Example of basic characteristics showing the WT1800E’s high precision and excellent stability**

- **Example of frequency versus power accuracy characteristic at unity power factor**
- **Example of effect of common mode voltage on readings**
- **Example of frequency versus power accuracy at zero power factor**

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Both 5 A and 50 A input elements can be installed in a single unit. This enables engineers to use a single WT1800E for multiple applications such as standby power measurement and the evaluation of various operating modes of the device under test.
Applications

The WT1800E is a versatile instrument, unlocking precision power measurement capabilities for researchers, designers and engineers working on a wide variety of applications in energy efficiency and conservation and renewable energy. Whether it is for the manufacture of energy efficient devices and appliances, hybrid/electric vehicles or renewable energy technologies, the WT1800E is a universal meter for power electronic measurements and energy analysis. Key applications include:

- Plug-in Hybrid and Electric Vehicles
- Industrial equipment such as Inverters, Motors and Pumps
- Renewable energy technologies such as Solar and Wind power
- Office and Home appliances like Air conditioners and Refrigerators
- IT Data center equipment like Servers, Routers and Switches
- Battery charging and Portable devices
- Ballasts, LEDs & Fluorescent lighting
- Aircraft Power systems

The following pages cover some typical applications for the WT1800E.
Inverter and motor testing

Overview

Electric and hybrid vehicles have many electrical and mechanical components and therefore an overall performance evaluation requires the efficiency measurement of both. With 6 channels of power inputs, flexible operation and a wide bandwidth, the WT1800E is ideal for efficiency tests between the input and output of inverters. An optional motor evaluation function enables the measurement of rotation speed and changes in torque.

Delta computation

Obtain the line and phase voltages from the sums and differences of the instantaneous values of voltage and current in each element.

- Line voltages and phase currents that are not measured are computed in the three-phase three-wire system (Figure 1).
- Star-delta conversion: Line voltage is computed from the phase voltage using the three-phase four-wire system data.
- Delta-star conversion: Phase voltage is computed from the line voltage in the three-phase three-wire system (3V3A system) (Figure 2).

The WT1800E advantages

Wide bandwidth and High speed sampling

The WT1800E is capable of 16-bit high resolution and 2 MHz sampling making it possible to measure faster signals with higher precision.

Motor evaluation: Electrical angle/rotation/direction

Measure rotation speed, torque, and output (mechanical power) of motors from analog/pulse inputs of rotation or torque sensors.

Harmonics and dual harmonics

Simultaneously measure distortion factors like THD, fundamental and harmonic components. Harmonics up to the 500th order can be measured even at 50 ms data update rate. Users can also measure harmonics on two different sources simultaneously.

Battery charge/discharge measurements

In integrated measurement, the battery charge and discharge can be evaluated. Instantaneous positive and negative values captured at a high-speed sampling rate of 2 MS/s are integrated.

Line filter to remove high frequency components

In the power evaluation of inverter waveforms, measurement values are affected by high frequency components. A digital filter function makes it possible to remove unnecessary high frequency components superimposed on signals. The filter can be independently set for each input element. An analog filter for 1 MHz/300 kHz, and a digital filter that can be set from 100 Hz to 100 kHz in increments of 100 Hz are available as standard.
Efficiency of renewable energy systems

The WT1800E advantages

Multiple channels and wide input range
Evaluate Power conditioner efficiency using 6 input channels for simultaneous measurements from the inputs and outputs of boost converter, inverter, and storage battery. Direct input terminals (voltage range: 1.5 V to 1000 V and current range: 10 mA to 5 A or 1 A to 50 A) make it possible to perform high-precision measurements without using a current sensor.

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

Ripple factor and power loss measurements
A user-defined function makes it possible to compute power loss, DC voltage and DC current ripple factors between the input and output. Up to 20 arithmetic expressions can be set. Display names for the arithmetic operations F1, F2, and so on can be freely changed.

Typical arithmetic expressions
1. DC voltage ripple factor = ([Voltage peak value (+) – Voltage peak value (−)]/2 × DC voltage value (mean)) × 100
2. Power loss = Output power – Input power

Energy bought/sold and charged/discharged
Measure the amount of power sold/bought in grid interconnection and of battery charge/discharge. Measure the amount of power sold/bought in grid interconnections and in battery charge/discharges. The WT1800E enables the integration of current (q), apparent power (WS), reactive power (WQ), as well as the effective power integration in sold/bought power and charge/discharge modes. Furthermore, a user-defined function makes it possible to calculate the Average active power within the integration period.

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 improves the efficiency in the overall energy system. The WT1800E provides up to 6 power inputs per unit for measuring voltage, current, power, and frequency (for AC) before and after each converter, as well as the converter and charging efficiencies.

Measuring instantaneous peak power
In photovoltaic power generation, an MPPT control varies the voltage to maximize energy harvested from the solar panel. The WT1800E is capable of measuring not only the voltage, current, and power but also the voltage, current, and power peak values for both plus (+) and minus (−) sides.
**Efficiency of inverter-motor in electric vehicles**

Overview

The WT1800E supports power measurements on up to 6 input channels making it ideal for evaluating the efficiency between the input and output of an electric vehicle. A motor evaluation function (option) makes it possible to simultaneously monitor voltage, current, and power changes, as well as changes in rotation speed, torque and mechanical power.

Typical repetitive high-speed charging and discharging signals

Effective power \( (W+) \)

Effective power \( (W−) \)

Charge current amount Ah (power amount Wh) and discharge current amount-Ah (power amount-Wh) can be integrated.

**Battery charge/discharge measurements**

In integrated measurement, the battery charge and discharge can be evaluated. Instantaneous positive and negative values captured at 2 MS/s high-speed sampling rate are integrated, and each of the total values is displayed.

The **WT1800E advantage**

**Wide bandwidth and High speed sampling**

The WT1800E is capable of 16-bit high resolution and 2 MHz sampling making it possible to measure faster signals with greater precision.

**Harmonics and dual harmonics**

Motor testing is performed at various rotation speeds. The WT1800E supports a lower limit frequency of 0.1 Hz to enable measurement of harmonics at a very low motor rotation speed without using an external sampling clock.

**Motor evaluation:**

**Electrical angle/rotation/direction**

Measure rotation speed, torque, and output (mechanical) power of motors from analog/pulse outputs of rotation or torque sensors.

**Individual null function:**

**Offset correction for each input**

A common problem when testing inverter motors is the presence of ambient noise that can mean test values are non zero even before testing begins. The WT1800E’s null function allows users to enable, disable or reset the offset values for voltage, current and motor input signals of each element separately.

**DA output and remote control**

Sometimes users may want to check changes in data, along with other measurement data (temperature, etc.) at the same time that communication data, such as voltage, current, power, and efficiency is required. A DA output function allows users to generate analog signals on up to 20 channels.
**Specifications**

### Inputs

- **Input terminal type**
  - Voltage: Plug-in terminal (safety terminal)
  - Current: Direct input: Large binding post, External current sensor input: Insulated BNC connector

- **Input type**
  - Floating input, resistive potential method

- **Current**
  - Floating input, shunt input method

- **Measurement range**
  - Voltage: 1.5 V, 3 V, 5 V, 10 V, 15 V, 30 V, 60 V, 100 V, 150 V, 300 V, 600 V, 1000 V (Crest factor CF3) 0.75 V, 1.5 V, 3 V, 5 V, 7.5 V, 15 V, 30 V, 75 V, 150 V, 300 V, 600 V (for Crest factor CF6/CF6A)
  - Current: 50 A input element: 1 A, 2 A, 5 A, 10 A, 20 A, 50 A (for Crest factor CF3) 500 mA, 1 A, 2 A, 5 A, 10 A, 20 A, 50 A (for Crest factor CF6/CF6A)
  - External current sensor input: 50 mA, 100 mA, 200 mA, 500 mA, 1 V, 2 V, 5 V, 10 V (for Crest factor CF3) 25 mA, 50 mA, 100 mA, 250 mA, 500 mA, 1 V, 2.5 V, 5 V (for Crest factor CF6/CF6A)

### Instrument loss

- **Voltage**
  - Resistances: Approxiately 2 MΩ, Input capacitances: Approximately 10 pF

- **Current**
  - Direct input: 50 A input element: Approximately 2 mΩ, Approximately 0.07 µH
  - External current sensor input: Approximately 1 MΩ

### Instantaneous maximum allowable input (20 ms or less)

- **Voltage**
  - Peak voltage of 4 kV or RMS of 2 kV, whichever is lower

- **Current**
  - Direct input: 50 A input element: Peak current of 450 A or RMS of 300 A, whichever is lower
  - 5 A input element: Peak current of 30 A or RMS of 15 A, whichever is lower

### Continuous maximum allowable input

- **Voltage**
  - Peak voltage of 2 kV or RMS of 1.1 kV, whichever is lower

- **Current**
  - Direct input: 50 A input element: Peak current of 150 A or RMS of 55 A, whichever is lower

### Continuous maximum common mode voltage (50/60 Hz)

- **Input voltage terminals**: 1000 Vrms

- **Current input**
  - with EX option: 1000 Vrms (Maximum allowable voltage that can be measured) 600 Vrms (Rated voltage of EN61010-2-030 standard)
  - without EX option: 1000 Vrms

- **External current sensor input connector**: 600 Vrms

- **Important Safety Note**: Do not touch the inside of the BNC connector of the External Current Sensor input for safety reasons.

### Rated voltage to ground

- **Input voltage terminals**: 1000 V

- **Current input**
  - with EX option: 1000 V (Maximum allowable voltage that can be measured) 600 Vrms (Rated voltage of EN61010-2-030 standard)
  - without EX option: 1000 V

- **External current sensor input connector**: 600 Vrms

- **Important Safety Note**: Do not touch the inside of the BNC connector of the External Current Sensor input for safety reasons.

### Influence from common 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
  - Refer to the manual for details.

### Line filter

- **Frequency filter**
  - Under condition of other than Auto data update interval
    - OFF: 100 Hz, 1 kHz, or 10 kHz
    - ON: 200 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz, 12 kHz, and 25 kHz

- **A/D converter**
  - Simultaneous voltage and current input conversion: Resolution: 16 bit Conversion speed (sampling period): Approximately 500 ms.

### Range switching

- A range can be set for each input element.

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**Auto range functions**

- **Range up**
  - When the measured values of Urms and Irms exceed 110% of the range (exceeded 200% when crest factor is set to CF6A)
  - When the peak value of the input signal exceeds approximately 330% of the range (approximately 660% for crest factor CF3/CF6A)

- **Range down**
  - When the following conditions are met, the range setting switches down.
  - When the measured values of Urms and Irms fall to 30% or less of the range
  - When the measured values of Urms and Irms fall to 105% or less of the lower range (range to which the range setting switches down)
  - When the measured values of Urms and Irms fall to 30% or less of the lower range (500% or less for crest factor CF6/CF6A)

**Display**

- **Display**
  - 8.4-inch TFT LCD display

- **Total number of pixels**
  - 128 (horizontal) × 768 (vertical) dots
  - Up to approximately 0.002% of the pixels on the LCD may be defective.

**Display update rate**

1) The display update interval of numeric display alone is 200 ms to 500 ms (which varies depending on the number of display items) when the data update rate is 50 ms, 100 ms, and 200 ms.

2) The display update interval of display items other than numeric display (including custom display) is approximately 1 s when the data update interval is 50 ms, 100 ms, 200 ms, and 500 ms.

3) If the measurement mode display is set to Normal Mode (Trg), measurement takes place from when a trigger is detected over the data update interval.

**Display items**

- **Calculation Functions**

- **Measurement Function**
  - Single-phase: 3-2-2

- **Voltage**
  - U[ ] W1+U2/3

- **Current [ ]**
  - I[ ] W1+I2/3

- **Apparent Power**
  - S2 [VA]

- **Reactive Power**
  - Q2 [var]

- **Active Power**
  - P2 [W]

- **Peak power**
  - P[ ] W

- **Integrated Apparent Power**

- **Integrated Current**

- **Integrated Voltage**

- **Frequency**

**Phase angle**

- **Power Factor**

**Note**

1) The instrument's apparent power (S), reactive power (Q), and phase difference (θ) are calculated using measured values of voltage, current, and active power.

2) When reactive power is calculated directly from sampled data when TRG is selected. Therefore, when distorted waveforms are input, these values may be different from those of other measuring instruments based on different measurement principles.
Resistance and reactance of the load circuit (Ω)

\[ R_k(x); \text{Resistance of the load circuit to the harmonic of order } k \]
\[ x; \text{when the resistance } R_k, \text{the inductance } L_k, \text{and the } \]
\[ \text{capacitor } C_k \text{ are connected in series} \]
\[ X_k(x); \text{Reactance of the load circuit to the harmonic of order } k \]
\[ x; \text{when the resistance } R_k, \text{the inductance } L_k, \text{and the } \]
\[ \text{capacitor } C_k \text{ are connected in parallel} \]
\[ P_k(x); \text{Power of the load circuit to the harmonic of order } k \]
\[ x; \text{when the resistance } R_k, \text{the inductance } L_k, \text{and the } \]
\[ \text{capacitor } C_k \text{ are connected in series} \]
\[ X_k(x); \text{Reactance of the load circuit to the harmonic of order } k \]
\[ x; \text{when the resistance } R_k, \text{the inductance } L_k, \text{and the } \]
\[ \text{capacitor } C_k \text{ are connected in parallel} \]

Harmonic content [%]

\[ \text{Uthf (k): Ratio of the harmonic voltage } U_k \text{ to } U_1 \text{ or } U \]
\[ \text{Phdf (k): Ratio of the harmonic current } I_k \text{ to } I_1 \text{ or } I \]
\[ \text{Phf (k): Ratio of the active harmonic power } P_k \text{ to } P_1 \text{ or } P \]
\[ \text{Total harmonic distortion (%): Ratio of the harmonic voltage } U_k \text{ to } U_1 \text{ or } U \]
\[ \text{Total harmonic content current to } I_1 \text{ or } I \]

Telephone harmonic factor

\[ \text{Us: Voltage telecommunication factor, } \]
\[ \text{Tf: Current telecommunication factor} \]

Harmonic voltage factor

\[ \text{Udc: Simple mean value, } \]
\[ \text{Uac: AC component} \]

Harmonic current factor

\[ \text{Ir: Harmonic current factor} \]

K-factor

\[ \text{The total value is calculated by obtaining the fundamental wave (the 1st order) and all harmonic} \]
\[ \text{components (from the 2nd order to the upper limit value for the measured order). Also, the DC} \]
\[ \text{component (dc) can be added to the equation.} \]

Correlation calculation

\[ \Delta U_1, \Delta U_2, \Delta U_3; \text{Phase voltage that can be computed for a three-phase system} \]
\[ \Delta U_1, \Delta U_2, \Delta U_3; \text{Line voltage that is not measured but can be computed for a three-phase, four-wire system} \]

Delta Calculation

\[ \text{Voltage difference} \]
\[ \Delta U_1, \Delta U_2, \Delta U_3; \text{Voltage that is not measured but can be computed for a three-phase, four-wire system} \]
\[ \text{Phase voltage that can be computed by a three-phase, three-wire (3VA) system} \]
\[ \text{Phase voltage that can be computed by a three-phase, four-wire system} \]
### Specifications

**WT1800E**

**Power Accuracy**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Power reading error (A) + Measurement range error</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>±0.05% of reading + 0.05% of range</td>
</tr>
<tr>
<td>0.1 Hz ≤ f &lt; 10 Hz</td>
<td>±0.08% of reading + 0.1% of range</td>
</tr>
<tr>
<td>10 Hz ≤ f &lt; 40 Hz</td>
<td>±0.09% of reading + 0.1% of range + (2 µA × f)</td>
</tr>
<tr>
<td>45 Hz ≤ f &lt; 60 Hz</td>
<td>±0.05% of reading + 0.05% of range + (2 µA)</td>
</tr>
<tr>
<td>60 Hz ≤ f &lt; 1 kHz</td>
<td>±0.02% of reading + 0.2% of range</td>
</tr>
</tbody>
</table>

**Waveform/Trend**

- Waveform display: Displays the waveforms of the voltage and current from elements 1 through 6, in a sequential line graph. Number of measurement channels: up to 16 parameters.
- Trend display: Displays trends in numerical data of the measurement functions in a sequential line graph.

**Bar Graph/Vector**

- Bar graph display: Displays the size of each harmonic in a bar graph.
- Vector display: Displays the vector of the phase difference in the fundamental waves of voltage and current.

### Accuracy

#### Voltage and Current: Accuracy (six-month)

**Conditions:** Temperature: 23±5°C, Humidity: 30 to 75%RH, Input waveform: Sine wave, Power factor (λ): 1, Common mode voltage: 0 V, Crest factor: CF3, Line filter: OFF.

#### Voltage

- Frequency: DC
  - Accuracy: ±0.05% of reading + 0.05% of range.
- 0.1 Hz ≤ f < 10 Hz
  - Accuracy: ±0.03% of reading + 0.05% of range.
- 10 Hz ≤ f < 45 Hz
  - Accuracy: ±0.03% of reading + 0.05% of range + (2 µA).
- 45 Hz ≤ f < 60 Hz
  - Accuracy: ±0.03% of reading + 0.05% of range + (2 µA).
- 60 Hz ≤ f < 1 kHz
  - Accuracy: ±0.5% of reading + 0.2% of range.
- 1 kHz ≤ f < 50 kHz
  - Accuracy: ±0.1% of reading + 0.1% of range.
  - Direct input of the 50 A input element: ±0.2% of reading + 0.1% of range.
- 50 kHz ≤ f < 1 MHz
  - Accuracy: ±0.3% of reading + 0.2% of range.
- 100 kHz ≤ f < 500 kHz
  - Accuracy: ±0.002% ± 0.1% of reading + 1% of range.
- 500 kHz ≤ f < 1 MHz
  - Accuracy: ±(Reading error + Measurement range error) ±10 µA.
- Frequency bandwidth: 5 MHz to 300 MHz
  - Accuracy: ±0.002% ± 0.1% of range.

#### Current

- Frequency: DC
  - Accuracy: ±0.05% of reading + 0.05% of range.
- 0.1 Hz ≤ f < 10 Hz
  - Accuracy: ±0.03% of reading + 0.05% of range.
- 10 Hz ≤ f < 45 Hz
  - Accuracy: ±0.03% of reading + 0.05% of range + (2 µA).
- 45 Hz ≤ f < 60 Hz
  - Accuracy: ±0.03% of reading + 0.05% of range + (2 µA).
- 60 Hz ≤ f < 1 kHz
  - Accuracy: ±0.5% of reading + 0.2% of range.
- 1 kHz ≤ f < 50 kHz
  - Accuracy: ±0.1% of reading + 0.1% of range.
  - Direct input of the 50 A input element: ±0.2% of reading + 0.1% of range.
- 50 kHz ≤ f < 1 MHz
  - Accuracy: ±0.3% of reading + 0.2% of range.
  - Direct input of the 50 A input element: ±0.5% of reading + 0.2% of range.
- 100 kHz ≤ f < 200 kHz
  - Accuracy: ±0.006% ± 0.1% of range + 1% of range.
- 200 kHz ≤ f < 500 kHz
  - Accuracy: ±0.006% ± 0.1% of range + 1% of range.
- 500 kHz ≤ f < 1 MHz
  - Accuracy: ±0.002% ± 0.1% of reading + 1% of range.
  - Direct input of the 50 A input element: ±0.1% of reading + 0.1% of range.
- Frequency bandwidth: 5 MHz to 300 MHz
  - Accuracy: ±0.002% ± 0.1% of range.

**Influence of power factor (λ)**

- When λ = 0
  - Apparent power reading: ±0.07% of range.
  - Direct input of the 50 A input element: ±0.08% of reading + 0.1% of range.
- When 0 < λ < 1
  - Power reading: ±(0.05 × f) ± 0.3% of range.
  - Direct input of the 50 A input element: ±(0.05 × f) ± 0.3% of range.

**Accuracy**

- Voltage DC accuracy: ±0.0000001 × U + 0.0000001 × U range.
- Power factor range: ±0.07% of range.
- Crest factor CF6/CF6A: ±0.0000001 × U + 0.0000001 × U range.
- Accuracy of the waveform display data, Offset and Break: ±0.0000001 × U ± 0.0000001 × U range.
- Influence from the self-heating: continues until the temperature of the input resistor decreases.
- Influence from the self-compensation of the range change: within ±30% of range (within ±60% for Crest factor CF3/CF3A).

**Frequency Filter**

- For frequencies other than the above (Design values):
  - Frequency bandwidth: 5 kHz to 300 MHz
  - Accuracy: ±0.002% ± 0.1% of range.
- Influence from the self-compensation continues when the temperature of the output resistor decreases, even if the current input changes to a small value.
- Influence from the self-heating: caused by the input current:
  - Add the following value to the accuracy.
  - AC input signal: ±(0.0000001 × U + 0.0000001 × U range).
  - DC input signal: ±(0.0000001 × U + 0.0000001 × U range).
  - The influence from the self-heating continues until the temperature of the output resistor decreases, even if the current input changes to a small value.
- Influence from the current sensor input error:
  - Add the following value to the accuracy.
  - AC current input: ±(0.0000001 × U + 0.0000001 × U range).
  - DC current input: ±(0.0000001 × U + 0.0000001 × U range).
  - The influence from the self-heating continues until the temperature of the output resistor decreases, even if the current input changes to a small value.
- Influence from the current sensor input error:
  - Add the following value to the accuracy.
  - AC input signal: ±(0.0000001 × U + 0.0000001 × U range).
  - DC input signal: ±(0.0000001 × U + 0.0000001 × U range).
  - The influence from the self-heating continues until the temperature of the output resistor decreases, even if the current input changes to a small value.
- Influence from the current sensor input error:
  - Add the following value to the accuracy.
  - AC input signal: ±(0.0000001 × U + 0.0000001 × U range).
  - DC input signal: ±(0.0000001 × U + 0.0000001 × U range).
  - The influence from the self-heating continues until the temperature of the output resistor decreases, even if the current input changes to a small value.
- Influence from the current sensor input error:
  - Add the following value to the accuracy.
  - AC input signal: ±(0.0000001 × U + 0.0000001 × U range).
  - DC input signal: ±(0.0000001 × U + 0.0000001 × U range).
  - The influence from the self-heating continues until the temperature of the output resistor decreases, even if the current input changes to a small value.
Specifications

Measurement Functions and Conditions

Crest factor: 300 (relative to the minimum valid input)  
CF3: 3 (relative to the rated value of the measurement range)  
CF3/CF6: 6 (relative to the rated value of the measurement range)

Measurement period

Interval for determining the measurement function and performing calculations.
- The measurement period is set by the zero crossing of the reference signal (synchronization source) excluding wake-up MP and warming up period during DC mode.  
Timing of Data update is different (minimum time resolution is 50 ms) among elements with different reference signals (synchronization sources) setting when the Data update interval is set to Auto. Timeout period can be selected from 1 s, 5 s, 10 s or 20 s. And full period of timeout becomes actual measurement period when synchronization source signal does not input any cycles during the timeout period.
- Harmonic display
The measurement period is from the beginning of the data update interval to 1024 or 8192 points at the harmonic sampling frequency.
- Measurement period detection method
Analog signal zero cross detection method when Data update interval is set to other than Auto. In case of sampling data level detection method when Data update interval is set to Auto, data level can be set arbitrarily.

Wiring

TP2W (single-phase, two-wires), TP3W (single-phase, 3-wires), TP5W (3-phase, 3-wires), TP4W (3-phase, 4-wires), TP3W (3/4V) (3-phase, 3-wires, 3-rods/3-amp measurement)
However, the number of available wiring systems varies depending on the number of installed input elements.

Scaling

When inputting output from external current sensors, VT or CT, set the current sensor conversion ratio, VT ratio, and power coefficient in the range from 0.001 to 9999.9999.
CT ratio can be set automatically by selecting a model name of CT series. Current sensor conversion ratio can be set automatically by selecting a model name of dedicated shunt resistors.

Averaging

- The average calculation below are performed on the normal measurement parameters of voltage U, current I, power P, apparent power S, and reactive power Q. Power factor Q and phase angle are determined by calculating the average of P and S.
- Select exponential or moving averaging.
  Exponential averaging: Select an attenuation constant from 2 through 64.
  Moving averaging: Select the number of averages from 8 through 64.
- Harmonic measurement
  Only exponential averaging is available.

Data update interval

Select 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s, 20 s, or Auto.  
Period detection method is different depending on update interval.  
50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s, 20 s: Analog signal zero cross detection method
Auto: Sampling data level detection method

Response time

At maximum, twice the data update interval (only during numerical display)  
When Data update interval is set to Auto, response time is signal cycle period and added 50 ms.

Hold

Holds the data display.
Single: Executes a single measurement during measurement hold.
When the Data update interval is set to Auto, single measurement cannot be executed.

Zero level compensation

Compensates the zero level. Null compensation range: ±10% of range  
Can be set individually for each of the following input signals.  
Voltage and current of each input element  
Rotation speed and torque  
6LU1 and ALN1

Frequency Measurement

The frequencies of voltages and currents for all input elements can be measured.

Measurement method

Reciprocal method

<table>
<thead>
<tr>
<th>Measurement range</th>
<th>Data update rate</th>
<th>Measuring range</th>
<th>Data update rate</th>
<th>Measuring range</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 ms</td>
<td>45 Hz</td>
<td>±1.0 kHz from 1 kHz</td>
<td>100 ms</td>
<td>25 Hz</td>
</tr>
<tr>
<td>200 ms</td>
<td>12.5 Hz</td>
<td>±5 kHz from 5 kHz</td>
<td>500 ms</td>
<td>5 Hz</td>
</tr>
<tr>
<td>500 ms</td>
<td>5 Hz</td>
<td>±10 kHz from 1 kHz</td>
<td>1 s</td>
<td>2.5 Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 s</td>
<td>2.5 Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 s</td>
<td>6.25 Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 s</td>
<td>6.25 Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 s</td>
<td>12.5 Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Auto</td>
<td>±1 Hz</td>
</tr>
</tbody>
</table>

Accuracy

±0.05% of reading ±0.1 mHz
When the input signal level is 30% or more of the measurement range  
(80% or more for Crest factor CF6/CF6A).
However:
- The input signal is 50% or more of the range.
  The frequency is smaller or equal to 2 times of above lower frequency  
10 mA range setting of 5 A input element
  1 A range setting of 50 A input element
- When the Data update interval is set to other than Auto, the 1 kHz frequency filter is ON at 100 Hz to 1 kHz.
- When the Data update interval is set to Auto, 100 Hz cutoff frequency filter is set to ON for 0.1 Hz to 1 kHz, and 1 kHz cutoff frequency filter is set to ON for 1 Hz to 1 kHz.
- Display resolution
  9999

Minimum frequency resolution

0.001 Hz

Frequency measurement filter (the Data update interval is set to other than Auto)
Select from OFF, 100 Hz or 1 kHz.
(For Data update interval is set to Auto)
Select from OFF, 100 Hz, 200 Hz, 400 Hz, 800 Hz, 1.6 kHz, 3.2 kHz, 6.4 kHz, 12.8 kHz or 25.6 kHz.

Integration

Mode
Select a mode from Manual, Standard, Continuous (repeat), Real Time Control Standard, and Real Time Control Continuous (Repeat).
- When Data update interval is set to Auto, integration will execute in Manual mode and timer mode only. Other Integration modes like Continuous, Real Time Control Standard and Real Time Control Continuous are not supported.

Integration timer

Integration can be stopped automatically using the timer setting. 00000000 ms to 1000000000 ms
Specifications

WT1800E

16

Count over
If the integration time reaches the maximum integration time (10000 hours), or
the integration value reaches maximum/minimum display integration value1), the
eclipsed time and integration value is saved and the operation is stopped.

1) MP: ±0.009999 MWh
W: ±0.009999 MWh
WL: ±0.009999 MWh.

Integration Resume Action after Recovery of Power Failure
Even if a case of power supply loss due to instantaneous power failure while
integration, integration can be continued after the recovery. When Data update interval is set to Auto, this feature is not supported. Integration state always becomes to "Error" after the recovery, and it does not continue the integration process.

Auto range
Voltage and Current: Available [When the Data Update Interval is set to other than Auto.]
• Motor Inputs and Auxiliary Inputs: Not available
• When Element is dependent is set to ON: Not available
• When S and O Formula are set to Type 3: Not available

Accuracy
±(normal measurement accuracy ±0.02% of reading)

Timer accuracy
±0.02% of reading

Harmonic Measurement (50/60 Option)
Measured source: All installed elements
Method: PLL synchronization method [without external sampling clock function]
Frequency range: When the Data update interval is set to other than Auto, or when the Data update interval is set to Auto and FFT data length is set to 8192, Fundamental frequency of the PLL source is in the range of 0.5 Hz to 2.6 kHz.
When the Data update interval is set to Auto and FFT data length is set to 1024, Fundamental frequency of the PLL source is in the range of 0.1 Hz to 2.6 kHz.
PLL source:
• Select the voltage or current of each input element or the external clock.
• If the /G5 option is selected and if the Data update interval is set to other than Auto, two PLL sources can be selected, and dual harmonic measurement can be performed. If the /G5 option is selected, one PLL source is selectable.
• Input level
15 V or more of range for voltage input.
50 mA or more of range for direct current 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 CF/CRFA.
20 Hz to 1 kHz for the 1 A or 2 A range of the 50 A input element.

• The frequency filter ON condition is the same as with frequency measurement.

FFT data length
1024 when the data update rate is 50 ms, 100 ms, or 200 ms
8192 when the data update rate is 500 ms, 1 s, 2 s, 10 s, or 20 s
Select from 1024 or 8192 when the Data update interval is set to Auto

Window function: Rectangular
Anti-aliasing filter: Set using a line filter
Sample rate, window width, and upper limit of the measured order

1024 FFT points [data update interval 50 ms, 100 ms, 200 ms]

<table>
<thead>
<tr>
<th>Fundamental frequency</th>
<th>Sampling rate</th>
<th>Window width</th>
<th>Upper limit of measured order</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Hz to 60 Hz</td>
<td>f = 1024</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>600 Hz to 1200 Hz</td>
<td>f = 512</td>
<td>2</td>
<td>255</td>
</tr>
<tr>
<td>1200 Hz to 2600 Hz</td>
<td>f = 256</td>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>

However, the maximum measured order is 1 at a data update rate of 50 ms.

8192 FFT points [data update interval 500 ms, 1 s, 2 s, 5 s, 10 s, 16 s, 20 s]

<table>
<thead>
<tr>
<th>Fundamental frequency</th>
<th>Sampling rate</th>
<th>Window width</th>
<th>Upper limit of measured order</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 Hz to 1.5 Hz</td>
<td>f = 8192</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>1.5 Hz to 5 Hz</td>
<td>f = 4096</td>
<td>2</td>
<td>500</td>
</tr>
<tr>
<td>5 Hz to 10 Hz</td>
<td>f = 2548</td>
<td>4</td>
<td>500</td>
</tr>
<tr>
<td>10 Hz to 600 Hz</td>
<td>f = 1024</td>
<td>8</td>
<td>500</td>
</tr>
<tr>
<td>600 Hz to 1200 Hz</td>
<td>f = 512</td>
<td>16</td>
<td>255</td>
</tr>
<tr>
<td>1200 Hz to 2600 Hz</td>
<td>f = 256</td>
<td>32</td>
<td>100</td>
</tr>
</tbody>
</table>

FFT points 1024 [Data update interval Auto]

<table>
<thead>
<tr>
<th>Fundamental frequency</th>
<th>Sampling rate</th>
<th>Window width</th>
<th>Upper limit of measured order</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1 Hz to 75 Hz</td>
<td>f = 1024</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>75 Hz to 600 Hz</td>
<td>f = 1024</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>600 Hz to 1200 Hz</td>
<td>f = 512</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>1200 Hz to 2600 Hz</td>
<td>f = 256</td>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>

FFT points 8192 [Data update interval Auto]

<table>
<thead>
<tr>
<th>Fundamental frequency</th>
<th>Sampling rate</th>
<th>Window width</th>
<th>Upper limit of measured order</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 Hz to 75 Hz</td>
<td>f = 1024</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>75 Hz to 600 Hz</td>
<td>f = 1024</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>600 Hz to 1200 Hz</td>
<td>f = 512</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>1200 Hz to 2600 Hz</td>
<td>f = 256</td>
<td>32</td>
<td>100</td>
</tr>
</tbody>
</table>

Accuracy
Add the following accuracy to the normal measurement accuracy.
• When the line filter is set to OFF and Update interval is set to other than Auto

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Voltage</th>
<th>Current</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 Hz ≤ 10 Hz</td>
<td>±0.05% of reading +0.25% of range</td>
<td>±0.05% of reading +0.25% of range</td>
<td>±0.1% of reading +0.5% of range</td>
</tr>
<tr>
<td>10 Hz ≤ 45 Hz</td>
<td>±0.05% of reading +0.25% of range</td>
<td>±0.05% of reading +0.25% of range</td>
<td>±0.1% of reading +0.5% of range</td>
</tr>
<tr>
<td>45 Hz ≤ 66 Hz</td>
<td>±0.05% of reading +0.25% of range</td>
<td>±0.05% of reading +0.25% of range</td>
<td>±0.1% of reading +0.5% of range</td>
</tr>
<tr>
<td>66 Hz ≤ 440 Hz</td>
<td>±0.05% of reading +0.25% of range</td>
<td>±0.05% of reading +0.25% of range</td>
<td>±0.1% of reading +0.5% of range</td>
</tr>
<tr>
<td>1 kHz ≤ 1 kHz</td>
<td>±0.5% of reading +0.25% of range</td>
<td>±0.5% of reading +0.25% of range</td>
<td>±0.1% of reading +0.5% of range</td>
</tr>
<tr>
<td>10 kHz ≤ 150 kHz</td>
<td>±0.5% of range +1% of range</td>
<td>±1% of range +2% of range</td>
<td>±1% of range +2% of range</td>
</tr>
<tr>
<td>100 kHz ≤ 260 kHz</td>
<td>±1% of range +2% of range</td>
<td>±1% of range +2% of range</td>
<td>±2% of range +4% of range</td>
</tr>
</tbody>
</table>

• When the line filter is ON
Add the accuracy of the line filter to the accuracy of when the line filter is OFF
All the items below apply to any of the tables.
• When the Crest factor is set to CF3
• When a (power factor) = 1
• Power figures that exceed 2.6 kHz are reference values.
• For the voltage range, add the following values.
Voltage accuracy: ±0.5 mV
Power accuracy: ±[5 mV/voltage range rating] ± 100% of range
• For the direct current input range, add the following values.
6 A element
Current accuracy: ±5 μA
Power accuracy: ±[5 mV/current range rating] × 100% of range
50 A element
Current accuracy: ±4 mA
Power accuracy: ±[4 mA/current range rating] × 100% of range
• For the external current sensor range, add the following values.
Current accuracy: ±2 mLA
Power accuracy: ±[2 mLA/external current sensor range rating] × 100% of range
• Add ±[50%/reading] of reading to the m order component of the voltage and current, and add ±[25%/reading] to the m order component of the power.
• Accuracy when the Crest factor CF/CRFA
Same as when the range is doubled for Crest factor CF3.

The guaranteed accuracy range by frequency and voltage/current is the same as the guaranteed range of normal measurement.

• The adjacent orders of the input order may be affected by the side ripples.
Under the condition of Data update interval is set to other than Auto, or Data update interval is set to Auto and PPL points is 8192.
• For m order component input when the PLL source frequency is 2 Hz or more, add ±[n/(m+1)5%/reading] of the m order reading to the (m+n) order and (m−n) order of the voltage and current, and add ±[n/(m+1)25%/reading] of the m order reading to the (m+n) order and (m−n) order of the power.
• For m order component input when the PLL source frequency is less than 2 Hz, add ±[n/(m+1)20%/reading] of the m order reading to the (m+n) order and (m−n) order of the voltage and current, and add ±[n/(m+1)10%/reading] of the m order reading to the (m+n) order and (m−n) order of the power.
• Under the condition of Data update interval is set to Auto and PPL points is 1024.
• For m order component input when the PLL source frequency is 75 Hz or more, add ±[n/(m+1)5%/reading] of the m order reading to the (m+n) order and (m−n) order of the voltage and current, and add ±[n/(m+1)25%/reading] of the m order reading to the (m+n) order and (m−n) order of the power.

For m order component input when the PLL source frequency is less than 75 Hz, add ±[n/(m+1)10%/reading] to the (m+n) order and (m−n) order of the voltage and current, and add ±[n/(m+1)15%/reading] of the m order reading to the (m+n) order and (m−n) order of the power.

For m order component input when the PLL source frequency is 75 Hz or more, add ±[n/(m+1)5%/reading] of the m order reading to the (m+n) order and (m−n) order of the voltage and current, and add ±[n/(m+1)25%/reading] of the m order reading to the (m+n) order and (m−n) order of the power.
**Specifications**

<table>
<thead>
<tr>
<th>Motor Evaluation Function (MTR Option)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input terminal</td>
<td>Torque, speed (A, B, Z)</td>
</tr>
<tr>
<td>Input resistance</td>
<td>Approximately 1 kΩ</td>
</tr>
<tr>
<td>Input connector type</td>
<td>Insulated BNC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analog Input (Speed is input to the A terminal)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>1 V, 2 V, 5 V, 10 V, 20 V</td>
</tr>
<tr>
<td>Input range</td>
<td>±110%</td>
</tr>
<tr>
<td>Line filter</td>
<td>OFF, 100, 1 kHz</td>
</tr>
<tr>
<td>Continuous maximum allowable input</td>
<td>±22 V</td>
</tr>
<tr>
<td>Maximum common mode voltage</td>
<td>±42 Vpeak</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>Approximately 200 kS/s</td>
</tr>
<tr>
<td>Resolution</td>
<td>16-bit</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.03% of reading + ±0.03% of range</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>±0.03% of range°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pulse Input (TORQUE, SPEED)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed is input to the A terminal if the direction is not detected. If the direction is detected, the A and B phases of the rotary encoder are input to the A and B terminals. The 2nd phase is input to the Z terminal of the rotary encoder for electric angle measurement.</td>
<td></td>
</tr>
<tr>
<td>Input range</td>
<td>±12 Vpeak</td>
</tr>
<tr>
<td>Frequency measurement range</td>
<td>2 Hz to 1 MHz</td>
</tr>
<tr>
<td>Maximum common mode voltage</td>
<td>±42 Vpeak</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.03% of reading + ±1 mHz</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>±0.03% of range°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Auxiliary Input (/AUX Option)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input terminal</td>
<td>AUX1/AUX2</td>
</tr>
<tr>
<td>Input connector type</td>
<td>Analog</td>
</tr>
<tr>
<td>Input resistance</td>
<td>Approximately 1 MΩ</td>
</tr>
<tr>
<td>Input connector type</td>
<td>Insulated BNC</td>
</tr>
<tr>
<td>Range</td>
<td>50 m, 100 m, 200 m, 500 m, 1, 2, 5, 10, 20 V</td>
</tr>
<tr>
<td>Input range</td>
<td>±110%</td>
</tr>
<tr>
<td>Line filter</td>
<td>OFF/100Hz/1 kHz</td>
</tr>
<tr>
<td>Continuous maximum allowable input</td>
<td>±22 V</td>
</tr>
<tr>
<td>Common mode voltage</td>
<td>±42 Vpeak</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>Approximately 200 kS/s</td>
</tr>
<tr>
<td>Resolution</td>
<td>16-bit</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.03% of reading + ±0.03% of range</td>
</tr>
<tr>
<td>Temperature compensation</td>
<td>±0.03% of range°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DA Output and Remote Control (DA Option)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DA conversion resolution</td>
<td>16-bit</td>
</tr>
<tr>
<td>Output voltage</td>
<td>±5 V FS (maximum approximately ±7.5 V) relative to each rated value</td>
</tr>
<tr>
<td>Update rate</td>
<td>Same as the update time interval</td>
</tr>
<tr>
<td>Output</td>
<td>20 channels (Output parameter can be set for each channel)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.03% of reading + ±0.03% of range</td>
</tr>
<tr>
<td>Minimum load</td>
<td>100 kΩ</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>±0.03% of FS°C</td>
</tr>
<tr>
<td>Continuous maximum common mode voltage</td>
<td>±42 Vpeak or less</td>
</tr>
</tbody>
</table>

| Remote Control Signal                        | EXT START, EXT STOP, EXT RESET, INTEG BUSY, EXT HOLD, EXT PRINT |
| Input level                                  | 0 to 5 V |

<table>
<thead>
<tr>
<th>Calculation and Event Function</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>User-defined function</td>
<td>Compute the numerical data (up to 20 equations) with a combination of measurement function symbols and operators.</td>
</tr>
<tr>
<td>Efficiency calculation</td>
<td>Up to 4 efficiencies can be displayed by setting measurement parameters for the efficiency equations.</td>
</tr>
<tr>
<td>User-defined event</td>
<td>Event: Set conditions for measured values. The functions triggered by the event are Auto Print, Store, and DA Output.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High Speed Data Capturing Function</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle of data capture</td>
<td>5 ms (When External Sync OFF)</td>
</tr>
<tr>
<td>Data update rate</td>
<td>1 s (It displays the last numeric data during the 1 s period)</td>
</tr>
<tr>
<td>Meas. parameter</td>
<td>Voltage, Current, Power for each element and °C</td>
</tr>
<tr>
<td>Source</td>
<td>U1 to U6/I (EXT), EXT, ±110%</td>
</tr>
<tr>
<td>Event</td>
<td>Set conditions for measured values.</td>
</tr>
<tr>
<td>Range</td>
<td>50 m, 100 m, 200 m, 500 m, 1, 2, 5, 10, 20 V</td>
</tr>
<tr>
<td>Torque, speed</td>
<td>86 days</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>±(0.03% of reading + ±1 mHz)</td>
</tr>
<tr>
<td>Pulse width</td>
<td>50 ms</td>
</tr>
<tr>
<td>Storage interval</td>
<td>1 s (It displays the last numeric data during the 1 s period)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Display</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerical Display</td>
<td></td>
</tr>
<tr>
<td>Display digit (display resolution)</td>
<td>less than 6000: 5 digits</td>
</tr>
<tr>
<td>Number of display items</td>
<td>6000 or more: 4 digits</td>
</tr>
<tr>
<td>Waveform Display</td>
<td></td>
</tr>
<tr>
<td>Display format</td>
<td>Peak-to-peak compression data</td>
</tr>
<tr>
<td>Waveform Display</td>
<td></td>
</tr>
<tr>
<td>Time axis</td>
<td>Range from 0.05 ms to 2 s/d. However, 1/10 or less of the data update interval when Data update interval is set to other than Auto.</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>Approximately 2 MS/s</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data Store Function</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Store</td>
<td>Store numerical data in media. (Media: USB storage device, maximum 1 GB)</td>
</tr>
<tr>
<td>Store interval</td>
<td>50 ms (when waveform display is OFF)</td>
</tr>
<tr>
<td>Storage time when using 1 GB memory (Numerical Store and Waveform Display OFF)</td>
<td></td>
</tr>
<tr>
<td>Number of measurement channels</td>
<td>3 ch</td>
</tr>
<tr>
<td>Number of measurement items</td>
<td>3 ch</td>
</tr>
<tr>
<td>Storage interval</td>
<td>50 ms</td>
</tr>
<tr>
<td>Storable time (Approximately)</td>
<td>5 days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>File Function</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Save</td>
<td>Save setting information, waveform display data, numerical data, and screen image data to media</td>
</tr>
<tr>
<td>Read</td>
<td>Read the saved setting information from media.</td>
</tr>
</tbody>
</table>

*One piece of data is 4 bytes, and the limit to the number of store operations is 9999999 counts. *If the update interval is set to Auto the storable time might be shortened.
Specifications

WT1800E

Auxiliary I/O

I/O Section for Master/Slave Synchronization Signals
Connector type: BNC connector Applicable to both master and slave
I/O level: TTL Applicable to both master and slave
Measurement start delay time: Within 15 sample intervals: Applicable to master
Within 1 y + 15 sample intervals: Applicable to slave

External Clock Input
Common
Connector type: BNC connector
Input level: TTL
When a synchronization source for normal measurement is used as the external clock for input
Frequency range: Same as the measurement range of frequency measurement.
Input waveform: Square waveform with a duty ratio of 50%
When a PLL source for harmonic measurement is used as the external clock for input
Frequency range: Harmonic measurement /G5 or /G6 option: 0.5 Hz to 2.6 kHz
Input waveform: Square waveform with a duty ratio of 50%
Trigger
Minimum pulse width: 1 µs
Trigger delay time: Within (1 y + 15 sample intervals)
RGB Output (Option)
Connector type: D-sub 15 pin (receptacle)
Output format: Analog RGB output

Computer Interface

GP-IB Interface
Compatible devices
National Instruments: PCI-GPIB and PCI-USB-GP
• PCIc-GP IB and PCIc-USB-GP
• PCMCIA-GP IB and PCMCIA-USB-GP
• GPIB-USB-HS and GPIB-USB-HS+
Use an NI-488.2M Version 1.60 or later driver
Electrical and mechanical specifications
Conforms to the IEEE Standard 488-1978 (JIS C 1901-1987)
Functional specifications
SH1, AH1, TL, LH, RL1, RL2, PR1, DCT, DFT, C0
Protocol
Conforms to the IEEE Standard 488-1992
Encoding
ISO (ASCII)
Mode
Addressable mode
Address
0 to 30
Cleaning remote mode
Remote mode can be cleared by pressing the LOCAL key (except during Local Lockout)

Ethernet Interface
Number of communication ports: 1
Connector type: RJ-45 connector
Electrical and mechanical specifications
Conforms to the IEEE802.3
Transmission method: Ethernet 100BASE-T, 10BASE-T, 10BASE-T
Communication protocol: TCP/IP
Applicable services
FTP server, DHCP, DNS, remote control (VXI-11), SNMP, FTP client Modbus/TCP server, Web server

USB PC Interface
Number of ports: 1
Connector type: Type B connector (receptacle)
Electrical and mechanical specifications
Conforms to the USB Revision 2.0
Applicable transfer standards: USB High Speed (480 Mbps), FS (Full Speed) (12 Mbps)
Applicable protocols
USB 1.1/2.0 (USB Test and Measurement Class Version 1.0)
Applicable system environments
The PC must run the Japanese or English version of Windows XP/7/8/8.1/10, and be equipped with a USB port.

USB for Peripheral Devices
Number of ports: 2
Connector type: USB type A connector (receptacle)
Electrical and mechanical specifications
Conforms to USB Revision 2.0

Applicable transfer standards
HS (High Speed) mode (480 Mbps), FS (Full Speed) mode (12 Mbps), LS (Low Speed) mode (1.5 Mbps)
Applicable devices
Mass storage device conforming to USB Mass Storage Class Version 1.1
Available space: 2 TB, Partition format: MBR, Format type: FAT32/FAT16
Mouse conforming to USB HID Class Version 1.1
Power supply
5 V, 500 mA (for each port). However, devices that exceed the maximum current consumption of 100 mA cannot be connected to two ports simultaneously.

Built-in Printer (1BS Option)
Printing method: Thermal line dot method
Dot density: 8 dots/mm

Paper width: 90 mm
Effective recording width: 72 mm
Auto Print
Allows you to set the interval time for printing to automatically print the measured values. The start/stop time can also be set.

Current Sensor Power (PD2 Option)
Number of channel: 6
Connector type: D-sub 9 pin (Plug)
Output voltage: ±15 V DC
Output current: 1.8 A/1 channel

General Specifications
Warp-up time: Approximately 30 minutes
Operation environment
Temperature: 5 to 40°C
Humidity: 20 to 80%RH (no condensation)
Operating altitude: 200 m or less
Installation location: Indoors
Storage environment
Temperature: –25 to 60°C
Humidity: 20 to 80%RH (no condensation)
Rated power supply voltage
100 to 240 VAC
Allowable power supply voltage fluctuation range
90 to 264 VAC
Rated power supply frequency
50/60 Hz
Allowable power supply frequency fluctuation range
48 to 63 Hz
Maximum power consumption
150 VA (when using a built-in printer)
450 VA (when using a built-in printer and Current Sensor Power)
Dimensions
Approximately 426 mm (W) × 177 mm (H) × 459 mm (D) (Excluding the protruding parts; /PD2 option is mounted.)
Weight
Approximately 17 kg (main body, 6 input elements, and options including /PD2 option)
Battery backup
Suitable information and built-in clock continue to operate with a lithium backup battery.

* Warning for Class A instruments
This is a Class A instrument based on Emission standards EN61326-1 and EN55011, and is designated 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.

External dimensions
Without /PD2 option

With /PD2 option

Dedicated Cables and Shunt resistor BOXes for /PD2 option

A1559WL/A1560WL
A1323EZ/A1324EZ/A1325EZ
A1598WL
A1628WL

* /EX1 to /EX6 options must be installed in the WT1800E to be able to use of the Shunt Resistor Box.
## Accessories

### Related products

<table>
<thead>
<tr>
<th>AC/DC Current Sensor</th>
<th>Clamp on Probe</th>
<th>Current Sensor Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CT60/CT200/CT1000/CT2000A</strong></td>
<td><strong>751552</strong></td>
<td><strong>751522, 751524</strong></td>
</tr>
<tr>
<td><strong>AC/DC Current Sensors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• DC to 800 kHz/10 A peak</td>
<td>• AC 1000 Arms (1400 Apeak)</td>
<td>• DC to 100 kHz/100 A peak</td>
</tr>
<tr>
<td>• DC to 500 kHz/20 A peak</td>
<td>• Measurement frequency range: 30 Hz to 5 kHz</td>
<td>• Wide dynamic range: DC to 100 kHz (−3 dB)</td>
</tr>
<tr>
<td>• DC to 300 kHz/10 A peak</td>
<td>• Basic accuracy: ±0.3% of reading</td>
<td>• Wide dynamic range: DC to 100 kHz (−3 dB)</td>
</tr>
<tr>
<td>• Wide measurement frequency range: DC and up to 800 kHz</td>
<td>• Maximum allowed input: AC 1000 Arms, maximum 1400 Apeak (AC)</td>
<td>• Wide measurement range: DC to 100 kHz (−3 dB)</td>
</tr>
<tr>
<td>• Wide measurement frequency range: DC and up to 800 kHz</td>
<td>• Current output type: 1 mA/A</td>
<td>• Superior noise withstanding ability and CMRR characteristic due to optimized casing design</td>
</tr>
<tr>
<td>• High-precision fundamental accuracy: ±(0.05% of reading + 30 μA)</td>
<td>• Maximum allowed input: AC 1000 Arms, maximum 1400 Apeak (AC)</td>
<td><strong>Note:</strong> To avoid personal injury, use with a low-voltage circuit (42 V or less)</td>
</tr>
<tr>
<td>• Maximum allowed input: AC 1000 Arms, maximum 1400 Apeak (AC)</td>
<td>• Current output type: 1 mA/A</td>
<td><strong>Note:</strong> To avoid personal injury, use with a low-voltage circuit (42 V or less)</td>
</tr>
<tr>
<td>• Current output type: 1 mA/A</td>
<td>• Measurement frequency range: 30 Hz to 5 kHz</td>
<td><strong>Note:</strong> The coax cable is simply cut on the current sensor side. Preparation by the user is required.</td>
</tr>
<tr>
<td></td>
<td>• Maximum allowed input: AC 1000 Arms, maximum 1400 Apeak (AC)</td>
<td><strong>Note:</strong> To avoid personal injury, use with a low-voltage circuit (42 V or less)</td>
</tr>
<tr>
<td></td>
<td>• Current output type: 1 mA/A</td>
<td><strong>Note:</strong> To avoid personal injury, use with a low-voltage circuit (42 V or less)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Note:</strong> To avoid personal injury, use with a low-voltage circuit (42 V or less)</td>
</tr>
</tbody>
</table>

### Adapters and Cables

<table>
<thead>
<tr>
<th>758917</th>
<th>758922</th>
<th>758929</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement leads</strong></td>
<td><strong>Small alligator adapters</strong></td>
<td><strong>Large alligator adapters</strong></td>
</tr>
<tr>
<td>Two leads in a set. Use 758917 in combination with 758922 or 758929. Total length: 75 cm</td>
<td>For connection to measurement leads (758917). Two in a set. Rating: 300 V</td>
<td>For connection to measurement leads (758917). Two in a set. Rating: 1000 V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>758924</th>
<th>366924/25</th>
<th>B9284LK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conversion adapter</strong></td>
<td><strong>BNC cable</strong></td>
<td><strong>External Sensor Cable</strong></td>
</tr>
<tr>
<td>For conversion between male BNC and female banana plug</td>
<td>(BNC-BNC 1 m/2 m)</td>
<td>To connect the external input of the WT1800E to the current sensor. Length: 50 cm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>761902/03</th>
<th>758931</th>
<th>758921</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety BNC cable</strong></td>
<td><strong>Safety terminal adapter set</strong></td>
<td><strong>Fork terminal adapter</strong></td>
</tr>
<tr>
<td>(BNC-BNC 1 m/2 m)</td>
<td>Screw-fastened adapters. Two adapters in a set.</td>
<td>Two adapters (red and black) in a set. Used when attaching banana plug to binding post.</td>
</tr>
</tbody>
</table>

### Typical Voltage/Current Connections

#### Measurement using current sensor

**Connection example**

- Unit whose current is to be measured
- CT sensor
- DC power supply (15 V, 1.8 A)
- Four load resistors* connected in parallel
- Power meter's current input terminals

* A burden resistor is required for the CT1000, CT200 and CT60.

#### Measurement using clamp-on probe

**Unit whose current is to be measured**

- 751552
- 758917
- 758921
- Power meter's current input terminals

#### Measurement using voltage input terminal

**Unit whose voltage is to be measured**

- 751552
- 758917
- 758921
- Power meter's current input terminal

**Note:** To avoid personal injury, use with a low-voltage circuit (42 V or less).
**Model and Suffix code**

**Precision Power Analyzer**

<table>
<thead>
<tr>
<th>Model Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT1801E</td>
<td>5 A × 1 Input Element</td>
</tr>
<tr>
<td>WT1802E</td>
<td>5 A × 2 Input Elements</td>
</tr>
<tr>
<td>WT1803E</td>
<td>5 A × 3 Input Elements</td>
</tr>
<tr>
<td>WT1804E</td>
<td>5 A × 4 Input Elements</td>
</tr>
<tr>
<td>WT1805E</td>
<td>5 A × 5 Input Elements</td>
</tr>
<tr>
<td>WT1806E</td>
<td>5 A × 6 Input Elements</td>
</tr>
</tbody>
</table>

**Accessories**

- **Wireless Communication Interface**
- **400 MHz Bandwidth**
- **USB Interface**
- **GPIB Interface**
- **LAN Interface**
- **RS-232 Interface**
- **RS-485 Interface**
- **Ethernet Interface**
- **GPIO Interface**
- **I/O Interface**
- **Power Supply**
- **Battery**
- **Charger**
- **Carry Case**
- **User Manual**
- **Operator’s Guide**
- **Service Manual**
- **Warranty**
- **User’s Guide (electronic file)**

**Additional Options**

- **/EX1**
- **/EX2**
- **/EX3**
- **/EX4**
- **/EX5**
- **/EX6**
- **/G5**
- **/H**
- **/F**
- **/S**
- **/G**
- **/MTR**
- **/AUX**
- **/PD2**

**Model number | Product | Description**

- **366924** BNC-BNC Cable 1 m
- **366925** BNC-BNC Cable 2 m
- **701901** 1/1 Safety BNC Adapter Lead 1000 Vrms-CAT II for /MTR, /AUX
- **701902** Safety BNC-BNC Cable 1000 Vrms-CAT II, 1 m for /MTR, /AUX
- **701903** Safety BNC-BNC Cable 1000 Vrms-CAT II, 2 m for /MTR, /AUX
- **751535-E4** Rack Mounting Kit For EIA without /PD2 option model
- **751535-E4** Rack Mounting Kit For EIA with /PD2 option model
- **751535-J4** Rack Mounting Kit For JIS without /PD2 option model
- **751535-J5** Rack Mounting Kit For JIS with /PD2 option model
- **758917** Test Lead Set A set of 0.75 m long, red and black test leads
- **758920** Fork Terminal Adapter Banana-fork adapter, Two adapters to a set
- **758922** Small Alligator-clip Rated at 300 V 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 and used in a pair
- **758931** Safety Terminal Adapter Two adapters to a set (Screw-fastened type), 1.5 mm hex wrench is attached
- **CT60** AC/DC Current Sensor Maximum 60 Apeak, DC to 800 kHz (−3 dB)
- **CT200** AC/DC Current Sensor Maximum 200 Apeak, DC to 500 kHz (−3 dB)
- **CT1000** AC/DC Current Sensor Maximum 1000 Apeak, DC to 300 kHz (−3 dB)
- **CT2000A** AC/DC Current Sensor Maximum 2000 Arms, DC to 40 kHz (−3 dB)

**Parts number | Product | Description**

- **A1323EZ** Shunt Resistor Box 5 0 ±0.05%
- **A1324EZ** Shunt Resistor Box 10 0 ±0.02%
- **A1325EZ** Shunt Resistor Box 20 0 ±0.02%
- **A1559WL** Current Sensor Cable Cable length 3 m for Shunt Resistor Box
- **A1560WL** Current Sensor Cable Cable length 5 m for Shunt Resistor Box
- **A1589WL** Current Sensor Direct Cable Cable length 3 m (Burden resistor 2.7 Ω)
- **A1628WL** Current Sensor Direct Cable Cable length 5 m (Without burden resistor)
- **B9316FX** Printer Roll Paper Thermal paper, 10 m (1 roll)

**NOTICE**

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

**Yokogawa’s Approach to Preserving the Global Environment**

- Yokogawa’s electrical products are developed and produced in facilities that have received ISO14001 certification.
- 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.

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