Power View

Power Analyzer

PZ4000

- Wide measurement bandwidth (DC, up to 2 MHz)
- Accurately capturing of input waveforms using high-speed (maximum 5 MS/s) sampling
  - Voltage and current waveform display and analysis functions to enable power calculations on fluctuating inputs
- Harmonic analysis (up to 500th order) and Fast Fourier Transform (FFT) functions to enable high-frequency power spectrum analysis
  - Simultaneous measurement of many channels using multiple units and external trigger function
- Environmentally friendly design based on YOKOGAWA’s “Guidelines for Designing Products for the Environment” and “Criteria for Environmental Assessment in Product Design.”
  - Sensor input module enables evaluation of motor efficiency and total efficiency.
A new power measurement from YOKOGAWA

A power meter that displays measured waveforms

Measured voltages and currents are sampled at high speed (maximum 5 MS/s). Power is calculated from the sampled data along with accurately displayed waveforms.

Benefits for the user

Correlation between displayed waveforms and calculated power values

Waveform displays and calculated values (e.g., power values) are based on sampled data stored in internal memory, so they are correlated with each other.

Check measurement effectiveness easily

Measured waveforms and calculated values can be checked at the same time to prevent erroneous measurements.

No probe needed for waveform measurements

Voltage and current waveforms can be measured without using oscilloscope differential probes and current probes. The PZ4000 can make waveform measurements much more accurately than with conventional oscilloscopes.

Wide bandwidth, high-precision measurements

Measurements can be made over a wide frequency range (DC up to 2 MHz), making it possible to measure power loss on electronic components, high-frequency lighting equipment, and other devices.

Benefits for the user

High precision power measurements at high frequency

The PZ4000 lets you make high-precision measurements of voltage, current, and consumed power in equipment driven at frequencies ranging from several tens of kHz to approximately 100 kHz.

Lamp current measurement in fluorescent bulb

With the PZ4000, you can measure lamp current of fluorescent bulb using Delta Computation function. It computes the difference of the instantaneous values between output current of electric ballast and cathode current.

Loss measurement when actual load is applied to electronic components

With the PZ4000, you can measure power loss resulting from actual load applications, instead of evaluating characteristics based on small signals using an LCR meter or impedance analyzer.

Power measurements on extremely low-frequency signals

Take full advantage of the 4M word internal memory (optional; enough for 4 million samples) to obtain precise measurements of extremely low-frequency (several mHz) signals.
A power meter capable of dynamically capturing load fluctuations

Internal memory (maximum 4 M words) stores your measurements. You can calculate and display voltage, current, and power values for specific portions of the total memory (equivalent to 100 k words of data). The display makes it easy to see how the load fluctuates with time.

**Benefits for the user**

Inrush current and power measurements (at switch-on)

In the past, it was necessary to measure inrush current and power values at power-on using measuring instruments such as oscilloscopes. The PZ4000 makes these measurements much more accurately and greatly simplifies this procedure.

Power measurements in specific states (specific spans in internal memory)

Power measurements on equipment with fluctuating loads are normally obtained by measuring the energy in certain operating patterns over a long time period using an integration function. The average power value is then calculated. In contrast, The PZ4000 lets you make power measurements over a specific period defined by adjustable cursors. This reduces the time required for measurements.

**Graphical power analysis**

The PZ4000 lets you analyze harmonics (up to 500th order) using high-speed sampling. With the FFT calculation function, you can perform spectrum analysis in the high-frequency range (up to 2.5 MHz). Analysis results are displayed on spectrum graphs. In addition, vectors showing the fundamental components of distorted waveforms can be displayed to give a visual presentation of the load balance in a 3-phase power supply system.

**Benefits for the user**

Distorted wave power spectrum analysis

With the PZ4000, you don’t need a frequency analyzer to perform spectrum analysis on the carrier component of an inverter. Up to now, this type of analysis is difficult. A major advantage with the PZ4000 is that you can input signals directly without using probes. This removes any error due to probe tolerance.

The load balance evaluation in a three-phase equipment

The vector display using the harmonic analysis function lets you visually know the condition of each phase in a 3-phase equipment. This makes evaluation simpler than when calculations are performed manually based on numerical data.
The PZ4000 is a power analyzer based on a new set of concepts and designed for R&D work relating to environmentally friendly energy-conserving products and technologies. These products and technologies were the focus of the Third Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3; held in Kyoto in December 1997), and are rapidly being adopted around the world. In order to support R&D for these products and technologies, the PZ4000 was designed based on YOKOGAWA’s Environmentally Harmonious Product Design Guidelines and Product Design Environmental Assessment Standards, which are intended to protect the global environment. The PZ4000 has been developed and produced at ISO14001-approved offices.

**Basic performance (reference values)**

**Frequency characteristics (voltage and current)**

<table>
<thead>
<tr>
<th>Error (% of rdg)</th>
<th>150Vrms (300Vpk range)</th>
<th>5Arms (20Apk range)</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.00</td>
<td>10.00</td>
<td>5.00</td>
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</tr>
<tr>
<td>20.00</td>
<td>15.00</td>
<td>-10.00</td>
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</table>

<table>
<thead>
<tr>
<th>Input frequency [Hz]</th>
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<th>100</th>
<th>1000</th>
<th>10000</th>
<th>100000</th>
</tr>
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<tbody>
<tr>
<td>Error (% of rdg)</td>
<td>10</td>
<td>100</td>
<td>1000</td>
<td>10000</td>
<td>100000</td>
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<tr>
<td>1000000</td>
<td>10</td>
<td>100</td>
<td>1000</td>
<td>10000</td>
<td>100000</td>
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</tbody>
</table>

**Frequency characteristics (phase and zero power factor)**

<table>
<thead>
<tr>
<th>Error (% of VA) and phase angle (deg)</th>
<th>10</th>
<th>100</th>
<th>1000</th>
<th>10000</th>
<th>100000</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1000</td>
<td>10000</td>
<td>100000</td>
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</tbody>
</table>

**Linearity (current input)**

<table>
<thead>
<tr>
<th>Error (% of rdg)</th>
<th>DC</th>
<th>60Hz</th>
<th>300kHz</th>
<th>DC specification</th>
<th>60-Hz specification</th>
<th>300-kHz specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
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<td>1000</td>
<td>10000</td>
<td>100000</td>
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<td>10000000</td>
<td>100000000</td>
</tr>
</tbody>
</table>

**Stability**

<table>
<thead>
<tr>
<th>Rate of change [% of rdg]</th>
<th>200Vpk range, +DC</th>
<th>10Apk range, +DC</th>
<th>200Vpk range, 1kHz</th>
<th>10Apk range, 1kHz</th>
<th>10Apk range, 1MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

The 6.4-inch color TFT display can display as many as 78 measured data at the same time. Waveforms can also be displayed. The layout for keys and menus is similar to that used in the DL Series of digital oscilloscopes. A rotary knob is used to enter measurement time and waveform time axis (and linked sampling rate) settings for easier waveform measurements. The jog dial feature gives you direct, intuitive control. A floppy disk can be inserted in this slot to save measured values and save or load waveform and setting data. Range settings and other parameters for individual voltages and currents can be entered using these keys.
Different modules for different uses

253751 Power measurement module:
Voltage direct input ranges: 30, 60, 120, 200, 300, 600, 1200, 2000 Vpk (1000 Vrms)
Current direct input ranges: 0.1, 0.2, 0.4, 1, 2, 4, 10 Apk (5 Arms)
Current sensor input ranges: 0.1, 0.2, 0.4, 1 Vpk (500 mVrms)

253752 Power measurement module:
Voltage direct input ranges: 30, 60, 120, 200, 300, 600, 1200, 2000 Vpk (1000 Vrms)
Current direct input ranges: 0.1, 0.2, 0.4, 1, 2, 4, 10 Apk (5 Arms, upper terminal)
Current direct input ranges: 1, 2, 4, 10, 20, 40, 100 Apk (20 Arms, lower terminal)
Current sensor input ranges: 0.1, 0.2, 0.4, 1 Vpk (500 mVrms)

253771 Sensor input module:
Torque computing analog input 1 / 2 / 5 / 10 / 20 / 50 Vpk
Revolution speed computing analog input 1 / 2 / 5 / 10 / 20 / 50 Vpk
Revolution speed computing pulse input Maximum input range ±5 Vpk
Effective input range Min. 1 Vp-p

Back panel designed for both safety and performance

Motor evaluation function and synchronized measurements

PZ4000 with model 253771 sensor input module can measure the output from torque meter (or torque sensor with transducer for torque and rotating speed), and compute torque, rotating speed, mechanical power, synchronous speed, slip, motor efficiency and total efficiency. The PZ4000 can show torque and rotating speed as waveforms on the display. Using MATH function, the trend curve of Mechanical power and efficiency can be displayed. The PZ4000 can also show torque vs rotating speed curve on the display using X-Y display. If more than 4 inputs are required for measuring 3-phase power from an Inverter and motor, two PZ4000’s can be connected, together in a master-slave configuration for up to 8 synchronized measurement channels. (Note: There is maximum difference between PZ units of 3 microseconds plus two sample points.)
Specifications

Inputs
Type: Plug-in inputs
Slots: 4
Specifications (253751 and 253752 power measurement modules)

Voltage input
Current input
Input type
Floating input
Resistive input
Direct input: 1, 2, 4, 10, 20, 40, 100 A (5 Arms)
Direct input: 5 A
Direct input: 1 A

Rated values (ranges)
Direct inputs: 30, 60, 120, 200, 300, 600, 1200, 2000 Vtyp (1000 Vrms)

Slots: 4
Type: Plug-in inputs

Specifications
0.1 Hz
coefficient

Temperature
Line filter effects
Power factor influence
(f is in kHz)

Accuracy
Accuracy (253751 and 253752 power measurement modules)

Voltage/current
Power
Accuracy Conditions

Temperature: 23°C ± 3°C
Humidity: 50% ± 10%
Input waveform: Line sine Common-mode voltage 0 V
Power factor: cos φ = 1
Within 3 months after calibration
DC accuracy is specified with null function and line filter (1 kHz) on.

For applications where a 5% range accuracy is exceeded, add 0.15% of range to the above accuracy
specifications.

Note 1: The apparent power (S), reactive power (Q), power factor (φ), and phase angle (θ) for the
PZ4000 are calculated based on voltage, current, and active power. However, reactive power is measured directly during harmonic measurement. Therefore, during distorted
wave input, there may be a difference between these values and those of other measuring
instruments based on different measurement principles.

Note 2: If the input range is less than 0.25% of the range rating, zero will be displayed for
the apparent power (S) and reactive power (Q), and errors will be displayed for the power
factor (φ) and phase angle (θ).

Note 3: If both the voltage and current are sinusoidal, and there is no great difference between
voltage and current in terms of ratio to input to measurement range, then the leadlag
phase angle will be correctly detected.

Note 4: There are no accuracy specifications for 0 and 180.5 degrees when phase reading is
0 to 360.
Measurement function items:
U (voltage), I (current), P (active power), S (apparent power), Q (reactive power), X (resistance), X_s, X_p (reactance), f, and ln(f) (efficiency), P_r (Corrected Power), F1 to F4 (user-defined functions).

Delta computation (during normal measurement only):
Calculated by taking the sum of difference of instantaneous voltage and current values and the average value of the following is selected.
Measurement parameters: ΔUms, ΔUm, ΔU, ΔI, ΔIac, ΔS, ΔP, ΔQ, ΔX, ΔX_s, ΔX_p, Δf, Δln(f) (voltage only)
△f = ⌈f ± Δf⌉
3 phase wave/3VxA conversion
V-A conversion:Phase voltage-level conversion, neutral line level conversion
△V = ⌈V ± ΔV⌉
Waveform calculations
Parameters
Window function Rectangular
FFT processing word length 32 bits
FFT data points 8192
Set record length Same as normal.
FFT data points 8192
FFT processing word length Rectangular
Window function Rectangular
PLL synchronization options
Either external clock or voltage/current in all installed power measurement modules can be used when PLL is not used. When this is done, the fundamental frequency is 1/4069 of the external clock.
Set record length Same using cross-zero filter.
Measurement accuracy
Fundamental frequency (Hz) Sampling rate (Hz) Number of samples Measurement accuracy
20 Hz ≤ f ≤ 40 Hz f × 4096 ≤ 500 50
80 Hz ≤ f ≤ 160 Hz f × 1024 ≤ 80 50
20 Hz ≤ f ≤ 320 Hz f ≤ 512 16 200 25
40 Hz ≤ f ≤ 640 Hz f ≤ 256 32 50 25
1.28 kHz ≤ f ≤ 2.56 kHz f ≤ 64 128 10 10
5.12 kHz ≤ f ≤ 8 kHz f ≤ 32 256 15
Note 1: Hysteresis is applied across each of the above fundamental frequency bands.
Display
Display area
Numerical
Pixel area for waveform
6.4-inch color liquid crystal display
640 × 480 (The liquid crystal display may contain approximately 0.02% defects among all display pixels.)
Pixel area for full display
501 × 432
Waveforms
Single, Dual, Triple, Quad
Vector
Phase diagram for fundamental component during harmonic measurement
Bar
Graph up to maximum number of analysis orders during harmonic measurement
Simultaneous display
Numerical value + waveform, numerical value + bar, waveform + bar
X-Y display
Any one of the following can be selected for the X-axis: CH1, CH2, MATH1, MATH2. The rest of these are simultaneously displayed on the Y-axis.
Alarm display
Displayed on screen (only sensed during observation period);
Peak over: When instantaneous value exceeds approximately 125% of range.
Display updating cycle
Depends on the observation time and record length. The display updating cycle is approximately 2 seconds in normal measurement mode, using a 100 ms observation time, 100 k word record length setting, and 8 channels, with numerical value calculation ON and waveform calculation off.
The display updating cycle is approximately 2 seconds in harmonic measurement mode, using a 100 ms observation period, 100 k word record length setting, and 8 channels, with numerical value calculation ON and waveform calculation off.
Note: Sensor input module 235771 can use Element 4 slot only.
Select either analog or pulse for revolution speed computing input.
Frequency measurements
Measurement accuracy
Accuracy
≤ f < 80 Hz ± 0.01% of rdg + 0.05% of rng
≤ f < 40 Hz ± 0.03% of rdg
≤ f < 20 Hz ± 0.05% of rdg
≤ f < 6.4 kHz ± 0.1% of rdg

Frequency measurement filter
Set using zero-cross filter.

Harmonic measurement
Measurement accuracy
Mode
Accuracy
CR, Auto, Auto Level, Normal, and (with edge trigger)
≤ 0.1% of rdg
Always compared with accuracy
HF cut-off frequency: set using zero-cross filter.
Automatically selected when the record length and observation time are set.
When HF is selected as the trigger mode, the trigger level is automatically selected.
Select trigger mode.
Trigger types
Rising, falling, both
Hysteresis is applied across each of the above fundamental frequency bands.
Dimensions (PZ4000)

<table>
<thead>
<tr>
<th>Description</th>
<th>Model or part number</th>
<th>Product</th>
<th>Order quantity</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack mounting kit</td>
<td>751535-E4</td>
<td>For EIA</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rack mounting kit</td>
<td>751535-J4</td>
<td>For JIS</td>
<td>1</td>
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<tr>
<td>BNC cable</td>
<td>366924</td>
<td>BNC cable BNC–BNC, 1 m</td>
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<tr>
<td>BNC cable</td>
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<td>BNC cable BNC–BNC, 2 m</td>
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<td>BNC cable</td>
<td>366926</td>
<td>BNC–alligator clip cable</td>
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<tr>
<td>Conversion adapter</td>
<td>9-pin/2-pin conversion adapter</td>
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<tr>
<td>Measurement lead</td>
<td>758917</td>
<td>75 cm, two leads (red and black) in a set</td>
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<tr>
<td>Fork terminal adapter set</td>
<td>758921</td>
<td>4 mm fork terminal, banana terminal conversion, red and black (one each)</td>
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<tr>
<td>Alligator clip adapter (rated for 300 V)</td>
<td>758922</td>
<td>Banana–alligator conversion, two in a set</td>
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<td>Alligator clip adapter (rated for 100 V)</td>
<td>758929</td>
<td>Banana–alligator conversion, two in a set</td>
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<tr>
<td>Fuse</td>
<td>A1354EF</td>
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<td>Input cable</td>
<td>B9284LJ</td>
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<td>Current input protective cover</td>
<td>B9315DJ</td>
<td>Acrylic current input protective cover</td>
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<td>Printer roll chart</td>
<td>B9850NX</td>
<td>Thermal paper, 30 meters (one roll equals one unit)</td>
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</tbody>
</table>

*: EIA-574 standard
*: EIA-232 standard (RS-232)

NOTICE
- Before operating the product, read the instruction manual thoroughly for proper and safe operation.
- If this product is for use with a system requiring safeguards that directly involve personnel safety, please contact the Yokogawa sales offices.