

Yokogawa Corporation of America

The new Energy Star Guidelines for computers Ver 4 state:

Approved Meter

Approved meters will include the following attributes¹:

Power resolution of 1 mW or better;

Yokogawa Model WT210 meets or exceeds this requirement. Following are examples.

**Voltage Range = 150 Volts; Current Range = 5 mA; Full Scale Watt Display = 750.00 mW;
Resolution = 0.01 mW**

**Voltage Range = 150 Volts; Current Range = 10 mA; Full Scale Watt Display = 1.5000 W;
Resolution = 0.1 mW.**

See Supporting Document Page 4-10 from WT210 User's Manual IM760401-01E.

An available current crest factor of 3 or more at its rated range value; and

Yokogawa Model WT210 meets or exceeds this requirement. Crest Factor is selectable with a rating of 3 or 6 at the Rated Value or Full Scale of the measurement range.

See Supporting Document Page 16-5 from WT210 User's Manual IM760401-01E.

Lower bound on the current range of 10mA or less.

Yokogawa Model WT210 meets or exceeds this requirement. Full Scale current ranges are 5, 10, 20, 50, 100, and 200 mA and 0.5, 1, 2, 5, 10 and 20 Amps at Crest Factor setting of 3. The effective input range is 1 to 130 % of the Full Scale range. Current can be measured as low as 50 micro Amps.

See Supporting Document Page 16-1 and 16-3 from WT210 Users Manual IM760401-01E

The following attributes in addition to those above are suggested:

Frequency response of at least 3 kHz; and

Yokogawa Model WT210 meets or exceeds this requirement.

Frequency response is DC to 100 kHz.

Calibration with a standard that is traceable to the U.S. National Institute of Standards and Technology (NIST).

Yokogawa Corporation of America can provide a NIST Traceable Calibration service with adjustments to manufacturers specifications. Calibration and adjustment can be made using a commercially available calibration source like the Fluke Model 5520A or equivalent.

¹ *Characteristics of approved meters taken from IEC 62301 Ed 1.0: Measurement of Standby Power*

Accuracy

Measurements of power of 0.5 W or greater shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level. Measurements of power of less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level. The power measurement instrument shall have a resolution of:

Yokogawa Model WT210 meets or exceeds this requirement.

Specified accuracy is +/- 0.1% of Reading plus +/- 0.1% of range at 45 to 66 Hz line frequency and unity power factor. For power measurements of 0.5 W or less, with Voltage range of 150 V and Current range of 5 mA, uncertainty is 0.00125 W at 45 to 66 Hz line frequency and unity power factor.

0.01 W or better for power measurements of 10 W or less;

**Reading = 10 W, Display Range = 15.000 W. Resolution = 0.001 W
Based on Voltage range of 150 V and Current range of 100 mA**

0.1 W or better for power measurements of greater than 10 W up to 100 W; and

**Reading = 10 W, Display Range = 15.000 W. Resolution = 0.001 W
Based on Voltage range of 150 V and Current range of 100 mA**

**Reading = 100 W, Display Range = 150.00 W. Resolution = 0.01 W
Based on Voltage range of 150 V and Current range of 1 A**

1 W or better for power measurements of greater than 100 W.

150 V range, 2 A range, Watt Display = 300.00 W. Resolution = 0.01 W

150 V range, 5 A range, Watt Display = 750.00 W. Resolution = 0.01 W

150 V range, 10 A range, Watt Display = 1.5000 kW. Resolution = 0.1 W

150 V range, 20 A range, Watt Display = 3.0000 kW. Resolution = 0.1 W

See Supporting Document Page 4-9 from WT210 User's Manual IM760401-01E for additional information on display resolution.

All power figures should be in watts and rounded to the second decimal place. For loads greater than or equal to 10 W, three significant figures shall be reported.

ENERGY STAR Program Requirements for Computers: Version 4.0

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4.4 Selecting the Measurement Range When Using Direct Input

On the WT210

- When the crest factor is set to 3

Voltage Range (V)	Current Range					
	500.00 mA	1.0000 A	2.0000 A	5.0000 A	10.000 A	20.000 A
15.000	7.5000 W	15.000 W	30.000 W	75.000 W	150.00 W	300.00 W
30.000	15.000 W	30.000 W	60.000 W	150.00 W	300.00 W	600.00 W
60.000	30.000 W	60.000 W	120.00 W	300.00 W	600.00 W	1.2000 kW
150.00	75.000 W	150.00 W	300.00 W	750.00 W	1.5000 kW	3.0000 kW
300.00	150.00 W	300.00 W	600.00 W	1.5000 kW	3.0000 kW	6.0000 kW
600.00	300.00 W	600.00 W	1.2000 kW	3.0000 kW	6.0000 kW	12.000 kW

Voltage Range (V)	Current Range					
	5.0000 mA	10.000 mA	20.000 mA	50.000 mA	100.00 mA	200.00 mA
15.000	75.000 mW	150.00 mW	300.00 mW	750.00 mW	1.5000 W	3.0000 W
30.000	150.00 mW	300.00 mW	600.00 mW	1.5000 W	3.0000 W	6.0000 W
60.000	300.00 mW	600.00 mW	1.2000 W	3.0000 W	6.0000 W	12.000 W
150.00	750.00 mW	1.5000 W	3.0000 W	7.5000 W	15.000 W	30.000 W
300.00	1.5000 W	3.0000 W	6.0000 W	15.000 W	30.000 W	60.000 W
600.00	3.0000 W	6.0000 W	12.000 W	30.000 W	60.000 W	120.00 W

- When the crest factor is set to 6

Voltage Range (V)	Current Range					
	250.00 mA	500.00 mA	1.0000 A	2.5000 A	5.0000 A	10.000 A
7.5000	1.8750 W	3.7500 W	7.5000 W	18.750 W	37.500 W	75.000 W
15.000	3.7500 W	7.5000 W	15.000 W	37.500 W	75.000 W	150.00 W
30.000	7.5000 W	15.000 W	30.000 W	75.000 W	150.00 W	300.00 W
75.000	18.750 W	37.500 W	75.000 W	187.50 W	375.00 W	750.00 W
150.00	37.500 W	75.000 W	150.00 W	375.00 W	750.00 W	1.5000 kW
300.00	75.000 W	150.00 W	300.00 W	750.00 W	1.5000 kW	3.0000 kW

Voltage Range (V)	Current Range					
	2.5000 mA	5.0000 mA	10.000 mA	25.000 mA	50.000 mA	100.00 mA
7.5000	18.750 mW	37.500 mW	75.000 mW	187.50 mW	375.00 mW	750.00 mW
15.000	37.500 mW	75.000 mW	150.00 mW	375.00 mW	750.00 mW	1.5000 W
30.000	75.000 mW	150.00 mW	300.00 mW	750.00 mW	1.5000 W	3.0000 W
75.000	187.50 mW	375.00 mW	750.00 mW	1.8750 W	3.7500 W	7.5000 W
150.00	375.00 mW	750.00 mW	1.5000 W	3.7500 W	7.5000 W	15.000 W
300.00	750.00 mW	1.5000 W	3.0000 W	7.5000 W	15.000 W	30.000 W

Note

When the maximum display is 99999 (when the number of displayed digits is set to 5), if the range is set to auto, the measuring range switches according to range up/range down conditions. Therefore, the range may vary even if the measured values remain the same.

16.1 Input

Item	Specifications
Input terminal type	Voltage Plug-in terminal (safety terminal structure) Current <ul style="list-style-type: none"> • Direct input: Large binding post • Current sensor input (option): BNC connector (insulation type)
Input format	Voltage Floating input, resistive voltage divider Current Floating input, shunt input
Measurement range (Rated value)	Voltage 15 V, 30 V, 60 V, 150 V, 300 V, 600 V Current <ul style="list-style-type: none"> • DC input <ul style="list-style-type: none"> • When the crest factor is set to 3 <ul style="list-style-type: none"> • Common to WT210 and WT230: 0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A • WT210 only: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200mA • When the crest factor is set to 6 <ul style="list-style-type: none"> • Common to WT210 and WT230: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, and 10 A • WT210 only: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, and 100 mA • External sensor input (option) <ul style="list-style-type: none"> • When the crest factor is set to 3 Either "2.5 V, 5 V, and 10 V" or "50 mV, 100 mV, 200 mV" • When the crest factor is set to 6 Either "1.25 V, 2.5 V, and 5 V" or "25 mV, 50 mV, 100 mV"
Input impedance	Voltage Input resistance: Approx. 2 M Ω , input capacitance: Approx. 13 pF Current <ul style="list-style-type: none"> • DC input <ul style="list-style-type: none"> • WT230 Input resistance: Approx. 6 mΩ, input inductance: Approx. 0.1 μH • WT210 (when the crest factor is set to 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A ranges; when the crest factor is set to 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, and 10 A ranges) Input resistance: Approx. 6 mΩ + 10 mΩ (max)*, input inductance: Approx. 0.1 μH • WT210 (when the crest factor is set to 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges; when the crest factor is set to 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, and 100 mA ranges) Input resistance: Approx. 500 mΩ, input inductance: Approx. 0.1 μH • External sensor input <ul style="list-style-type: none"> • When the crest factor is set to 3: 2.5 V, 5 V, and 10 V ranges; when the crest factor is set to 6: 1.25 V, 2.5 V, and 5 V ranges Input resistance: Approx. 100 kΩ • When the crest factor is set to 3: 50 mV, 100 mV, and 200 mV ranges; when the crest factor is set to 6: 25 mV, 50 mV, and 100 mV ranges Input resistance: Approx. 20 kΩ
Instantaneous maximum allowable input (1 period, for 20 ms)	Voltage Peak value of 2.8 kV or RMS value of 2.0 kV, whichever is less. Current <ul style="list-style-type: none"> • DC input <ul style="list-style-type: none"> • When the crest factor is set to 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A ranges; when the crest factor is set to 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, and 10 A ranges Peak value of 450 A or RMS value of 300 A, whichever is less. • When the crest factor is set to 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges; when the crest factor is set to 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, and 100 mA ranges Peak value of 150 A or RMS value of 100 A, whichever is less. • External sensor input Peak value less than or equal to 10 times the rated range.

* Factory default

16.2 Accuracy

Voltage and Current Accuracy

Item	Specifications														
Accuracy	<p>Requirements</p> <ul style="list-style-type: none"> • Temperature: 23±5°C. • Humidity: 30 to 75%RH. • Power factor: 1 • Crest factor: 3 • Input waveform: Sine wave • Common-mode voltage: 0 V • Scaling function: OFF • Number of displayed digits: 5 digits • Frequency filter: Turn ON to measure voltage or current of 200 Hz or less • After warm-up time has passed • After wiring is complete and zero-level compensation or measurement range is changed. <p>Accuracy (3 months after calibration)</p> <table border="1"> <thead> <tr> <th>Frequency</th> <th>Accuracy (The accuracy shown below is the sum of reading and range errors.)</th> </tr> </thead> <tbody> <tr> <td>DC</td> <td>±(0.2% of reading + 0.2% of range)</td> </tr> <tr> <td>0.5 Hz ≤ f < 45 Hz</td> <td>±(0.1% of reading + 0.2% of range)</td> </tr> <tr> <td>45 Hz ≤ f ≤ 66 Hz</td> <td>±(0.1% of reading + 0.1 % of range)</td> </tr> <tr> <td>66 Hz < f ≤ 1 kHz</td> <td>±(0.1% of reading + 0.2 % of range)</td> </tr> <tr> <td>1 kHz < f ≤ 10 kHz</td> <td>±((0.07 × f)% of reading + 0.3 % of range)</td> </tr> <tr> <td>10 kHz < f ≤ 100 kHz</td> <td>±(0.5 % of reading + 0.5 % of range) ± [(0.04 × (f - 10))% of reading]</td> </tr> </tbody> </table> <p>* The unit of f in the read error equation is kHz.</p> <p>Add ±10 μA to the DC accuracy of current.</p>	Frequency	Accuracy (The accuracy shown below is the sum of reading and range errors.)	DC	±(0.2% of reading + 0.2% of range)	0.5 Hz ≤ f < 45 Hz	±(0.1% of reading + 0.2% of range)	45 Hz ≤ f ≤ 66 Hz	±(0.1% of reading + 0.1 % of range)	66 Hz < f ≤ 1 kHz	±(0.1% of reading + 0.2 % of range)	1 kHz < f ≤ 10 kHz	±((0.07 × f)% of reading + 0.3 % of range)	10 kHz < f ≤ 100 kHz	±(0.5 % of reading + 0.5 % of range) ± [(0.04 × (f - 10))% of reading]
Frequency	Accuracy (The accuracy shown below is the sum of reading and range errors.)														
DC	±(0.2% of reading + 0.2% of range)														
0.5 Hz ≤ f < 45 Hz	±(0.1% of reading + 0.2% of range)														
45 Hz ≤ f ≤ 66 Hz	±(0.1% of reading + 0.1 % of range)														
66 Hz < f ≤ 1 kHz	±(0.1% of reading + 0.2 % of range)														
1 kHz < f ≤ 10 kHz	±((0.07 × f)% of reading + 0.3 % of range)														
10 kHz < f ≤ 100 kHz	±(0.5 % of reading + 0.5 % of range) ± [(0.04 × (f - 10))% of reading]														
Effective input range	1 to 130% with respect to the rated range of voltage or current. (Except, add the reading error × 0.5 for the range of 110% to 130% of the rated range.)														
Lower limit of measurement frequency	<table border="1"> <thead> <tr> <th>Display update rate</th> <th>0.1 s</th> <th>0.25 s</th> <th>0.5 s</th> <th>1 s</th> <th>2 s</th> <th>5 s</th> </tr> </thead> <tbody> <tr> <td>Lower limit of measurement frequency</td> <td>25 Hz</td> <td>10 Hz</td> <td>5 Hz</td> <td>2.5 Hz</td> <td>1.5 Hz</td> <td>0.5 Hz</td> </tr> </tbody> </table>	Display update rate	0.1 s	0.25 s	0.5 s	1 s	2 s	5 s	Lower limit of measurement frequency	25 Hz	10 Hz	5 Hz	2.5 Hz	1.5 Hz	0.5 Hz
Display update rate	0.1 s	0.25 s	0.5 s	1 s	2 s	5 s									
Lower limit of measurement frequency	25 Hz	10 Hz	5 Hz	2.5 Hz	1.5 Hz	0.5 Hz									
Effect when the line filter is turned ON	45 to 66 Hz: Add 0.2% of reading. Less than 45 Hz: Add 0.5% of reading.														
Temperature coefficient	Add ±0.03% of reading/°C in the range 5 to 18°C or 28 to 40°C.														
Accuracy 12 months after calibration	Add ±(reading error of the accuracy at 3 months after calibration × 0.5)														
Accuracy when the crest factor is set to 6	Accuracy obtained by doubling the measurement range error for the accuracy when the crest factor is set to 3.														

16.2 Accuracy

Active Power Accuracy

Item	Specifications	
Accuracy	Requirements Same as the conditions for voltage and current.	
	Accuracy (3 months after calibration)	
	Frequency	Accuracy (The accuracy shown below is the sum of reading and range errors.)
	DC	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$
	$0.5 \text{ Hz} \leq f < 45 \text{ Hz}$	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$
	$45 \text{ Hz} \leq f \leq 66 \text{ Hz}$	$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$
	$66 \text{ Hz} < f \leq 1 \text{ kHz}$	$\pm(0.2\% \text{ of reading} + 0.2\% \text{ of range})$
	$1 \text{ kHz} < f \leq 10 \text{ kHz}$	$\pm(0.1\% \text{ of reading} + 0.3\% \text{ of range}) \pm \{[0.067 \times (f - 1)]\% \text{ of reading}\}$
	$10 \text{ kHz} < f \leq 100 \text{ kHz}$	$\pm(0.5\% \text{ of reading} + 0.5\% \text{ of range}) \pm \{[0.09 \times (f - 10)]\% \text{ of reading}\}$
		* The unit of f in the read error equation is kHz.
	Add $\pm 10 \mu\text{A} \times \text{voltage reading}$ to the DC accuracy of power.	
Influence of power factor	When power factor (PF) = 0 (VA: apparent power) <ul style="list-style-type: none"> $\pm 0.2\%$ of VA for $45 \text{ Hz} \leq f \leq 66 \text{ Hz}$. $\pm \{(0.2 + 0.2 \times f)\%$ of VA} for up to 100 kHz as reference data. The unit for frequency f is kHz. When $0 < \text{PF} < 1$ (ϕ : phase angle of the voltage and current) Add the power reading $\times \{\tan\phi \times (\text{influence when PF} = 0)\}\%$.	
Effect when the line filter is turned ON	45 to 66 Hz: Add 0.3% of reading. Less than 45 Hz: Add 1% of reading.	
Temperature coefficient	Same as the temperature coefficient for voltage and current.	
Accuracy 12 months after calibration	Add $\pm(\text{reading error of the accuracy at 3 months after calibration} \times 0.5)$	
Accuracy when the crest factor is set to 6	Accuracy obtained by doubling the measurement range error for the accuracy when the crest factor is set to 3.	

Accuracy of Other Parameters and Computation Accuracy

- For the accuracy of frequency voltage and current, see "Frequency Measurement" in section 16.3, "Functions."
- For the accuracy of integrated values Wh, Wh+, Wh-, Ah, Ah+, and Ah- and the integration timer, see "Integration" in section 16.3, "Functions."
- For the accuracy of voltage, current and power during harmonic measurement, see "Harmonic Measurement" in section 16.3, "Functions."
- For the D/A output accuracy, see section 16.5, "D/A Output."

16.3 Functions

Voltage, Current, and Active Power Measurements

Item	Specifications
Measurement method	Digital sampling method, summation averaging method
Crest factor	3 or 6
Wiring system	WT210 (single-phase model, 760401) Single-phase, two-wire (1P2W) WT230 (three-phase, three-wire model, 760502) Select from single-phase, two-wire (1P2W); single-phase, three-wire (1P3W); and three-phase, three-wire (3P3W) WT230 (three-phase, four-wire model, 760503) Select from single-phase, two-wire (1P2W); single-phase, three-wire (1P3W); three-phase, three-wire (3P3W); three-phase, four-wire (3P4W); and three-voltage, three-current (3V3A).
Range switching	Select fixed range or auto range.
Auto range	Step up When the measured value exceeds 130% of the rated range or the peak value exceeds approximately 300% (Approx. 600% if the crest factor is set to 6) of the rated range. For the WT230, when the condition is met on any of the input elements. Step down Range down: When the measured value becomes less than 30% of the rated range and the peak value is less than 300% (Less than or equal to 600% if the crest factor is set to 6) of the subordinate range. For the WT230, when the condition is met on all input elements.
Measurement mode switching	Select from RMS (the true RMS value of voltage and current), VOLTAGE MEAN (the rectified mean value calibrated to the RMS value of the voltage and the true RMS value of the current), DC (simple average of voltage and current).
Measurement synchronization source	Select voltage, current, or the entire period of the display update rate for the signal used to achieve synchronization during measurement.
Line filter	Select OFF or ON (cutoff frequency of 500 Hz).
Peak measurement	Measures the peak value of voltage or current from the instantaneous voltage or instantaneous current that is sampled.
Zero-level compensation	Creates a zero input condition inside the WT210/WT230 and sets the level at that point as the zero level.

Frequency Measurement

Item	Specifications														
Measured item	WT210 (single-phase model, 760401) Select voltage (V) or current (A). WT230 (three-phase, three-wire model, 760502) Select voltage of input element 1 (V1), voltage of input element 3 (V3), current of input element 1 (A1), or current of input element 3 (A3). WT230 (three-phase, four-wire model, 760503) Select voltage of input element 1 (V1), voltage of input element 2 (V2), voltage of input element 3 (V3), current of input element 1 (A1), current of input element 2 (A2), or current of input element 3 (A3).														
Method	Reciprocal method														
Frequency measuring range	Varies depending on the display update period (see description given later) as follows.														
	<table border="1"> <thead> <tr> <th>Display Update Rate</th> <th>Measurement Range</th> </tr> </thead> <tbody> <tr> <td>0.1 s</td> <td>25 Hz to 100 kHz</td> </tr> <tr> <td>0.25 s</td> <td>10 Hz to 100 kHz</td> </tr> <tr> <td>0.5 s</td> <td>5 Hz to 100 kHz</td> </tr> <tr> <td>1 s</td> <td>2.5 Hz to 100 kHz</td> </tr> <tr> <td>2 s</td> <td>1.5 Hz to 50 kHz</td> </tr> <tr> <td>5 s</td> <td>0.5 Hz to 20 kHz</td> </tr> </tbody> </table>	Display Update Rate	Measurement Range	0.1 s	25 Hz to 100 kHz	0.25 s	10 Hz to 100 kHz	0.5 s	5 Hz to 100 kHz	1 s	2.5 Hz to 100 kHz	2 s	1.5 Hz to 50 kHz	5 s	0.5 Hz to 20 kHz
Display Update Rate	Measurement Range														
0.1 s	25 Hz to 100 kHz														
0.25 s	10 Hz to 100 kHz														
0.5 s	5 Hz to 100 kHz														
1 s	2.5 Hz to 100 kHz														
2 s	1.5 Hz to 50 kHz														
5 s	0.5 Hz to 20 kHz														