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WT110/WT130 DIGITAL POWER METER

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INTRODUCTION

Among its various power meters, this company's Model 2885 Standard Watt Converter and Model 2533 Digital Power Meter are employed around the world, and they are used in a wide range of applications from standard equipment to general-purpose uses. Model 2532, the first model to use a digital sampling system, first appeared on the market in 1991. The following year, the general-purpose Model 2534 and 2535 Digital Power Meters, which used the total-averaging method based on digital sampling, were introduced. Although these models met the market need for a low price and were highly praised, especially in the electric appliance market, the need arose in the market for new products with a greater noise immunity, surge resistance, and efficiency. As the successors to these instruments, the presently developed WT110 and WT130 are superior in every way: on the performance side, with a greater measurement range; on the function side, with harmonic wave analysis; and on the operational side, with improved insulation between voltage and current.

Furthermore, since these are successors to earlier models, the design specifications were based on minute analyses of those models, and new functions and performance features were incorporated, while low prices were maintained. In addition, the development time from planning to sales was just one short year, even though the complex parts were designed for interchangeability and reuse.

The WT110 is a single-phase model and the WT130 is a 3-phase model. Figure 1 is an external view of the models. (The following is a description of the WT100 series.)

FEATURES

The main functions and features of the WT100 series are as follows.

(1) Large LED display

We focused on the display functions for this development, and took clear visibility and ease of use into consideration. Since visibility is one of the key elements during wiring and panel installation, an LED display as large as one in the enhanced

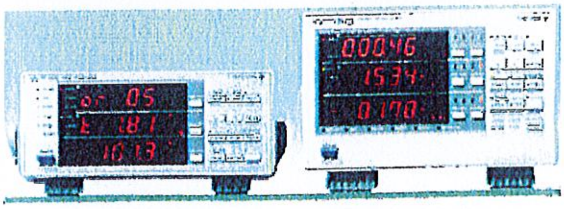


Figure 1 External View of the WT100 Series

*1 Measuring Instruments Business Division

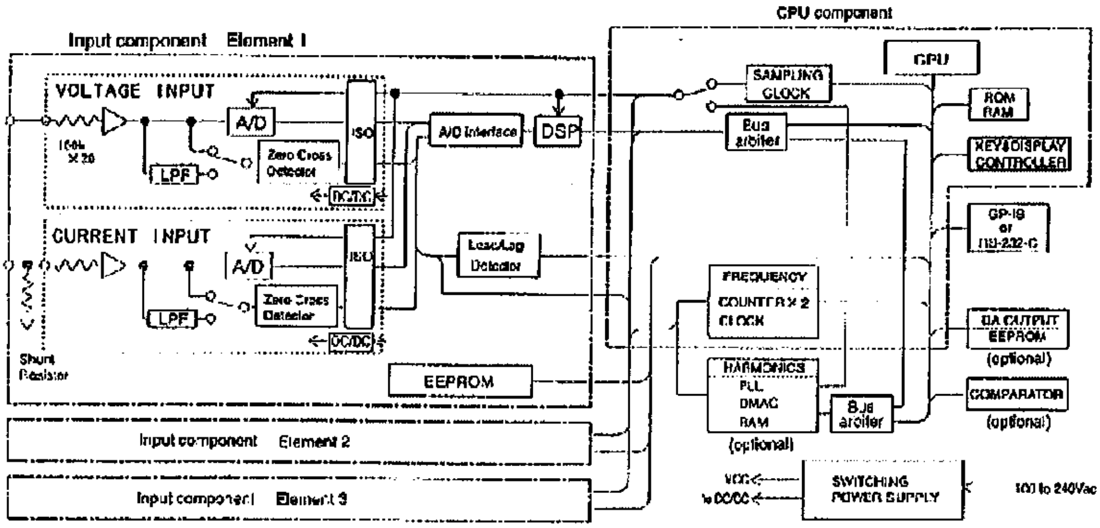


Figure 2 WT130 Block Diagram

models was adopted. The operation keys were designed to function in the same manner as other models, and consideration was given to their layout and operation.

(2) Compact and lightweight

The existing 3-phase power meters are regular-size meters, but the WT100 series was developed at half the size for portability. As a result, the total weight of a single meter was kept below 5 kg, so the unit is easy to carry, and two of the meters can be installed together on a rack mount.

(3) Greater surge resistance

Reconsideration was given to the construction of the existing shunt resistor, and a board shape that had a superior surge resistance was adopted, while the allowable error was increased and the trimming process was eliminated. As a result, a significantly improved surge resistance (300 Arms/20 ms) was realized, and costs were cut in half.

(4) Input component

This component serves as insulation between modules and it separates the voltage from the current within the same module. It has a 2-layer insulation construction based on the IEC1010 standard.

(5) Harmonic wave analysis function (optional)

Recently, with the implementation of power harmonic wave regulations, market demand regarding harmonic waves has increased. These units are suitable for the measurement of regular harmonic waves and were designed to take measurements easily and at low cost.

(6) Comparator output (optional)

A 4-channel relay contact output was provided for GO/NO-GO determination in production and inspection lines. Single-mode and dual-mode outputs are available, and by combining them, 5 types of determinations can be made. This option is also equipped with a DA output.

(7) Display value adjustment by user

ISO-based measurement control is important to users of meters. Conventional power meters cannot be easily adjusted or calibrated by users, but with the WT100 series, display value adjustments can be made manually or via telecommunications. This allows users to reduce maintenance costs.

BASIC CONSTRUCTION

The basic construction of the WT130 is shown in Figure 2. The WT130 is made up of an input component, CPU, display component, I/F component, and power supply.

1. Input Component

The input component consists of voltage and current circuits, an A/D converter, and a DSP and DC/DC converter power supply. Both the voltage and current circuits are insulated. The A/D converter is a 12-bit/100 kHz general-purpose converter. The DSP, like that in the existing models, is a 16-bit fixed-point arithmetic general-purpose component. The construction is double-insulated, with the assumption that it is CE certified, and it has parts that can withstand insulation values greater than 3700 V.

The voltage input component has a 2 MΩ input resistance consisting of 20 100 kΩ chip resistors. In the earlier models, a high withstanding voltage and high-accuracy resistance were used because the input component's resistance divided a high voltage of 600 V. But in the newest models, the voltage applied to 1 unit was reduced by lining up the chip resistors, so regular chip resistors could be used. This allowed the cost of the component to fall to 1/10th that of the one in the existing models. And for safety during a separate breakdown, which is required by

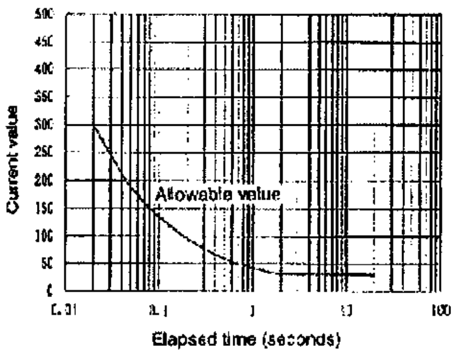


Figure 3 Current Surge Resistance Properties

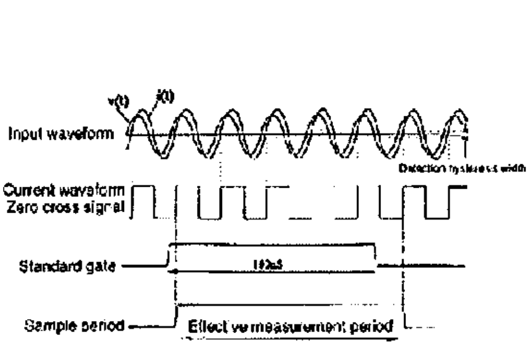


Figure 4 Measuring Principle

safety regulations in all countries, variation of the input resistance stops at 5%, even if one of the chip resistors short-circuits, and fuses or other safety devices are not required.

The current input component consists of a 5 mΩ shunt resistor and an amplifier. The previous wide-band precision shunt resistor for current detection had a low surge resistance and was susceptible to burnout and other problems. In order to solve these problems, the resistor was given a board shape, the trimming to adjust the resistance value was eliminated, and the shape was redesigned to improve further the frequency properties. Figure 3 shows the current surge resistance properties of the shunt resistor.

2. Effective Power Measuring Principle

The measuring principle is described in the following.

Instantaneous data obtained by sampling are added over a set interval. This total is divided by the number of samples taken and measurement data are obtained, standardized with the total-averaging method. This set interval is determined by synchronizing the input signal cycle. And the standardization process is done in real time with a 16-bit DSP within a display update cycle of 250ms.

The DSP is used to compute the effective power and the voltage and current root-mean-square (rms) values, according to the following equations.

$$\text{Effective power} = \frac{1}{N}\sum_{K=1}^{N} v(k)\cdot i(k) \cdots\cdots (1)$$

$$\text{Voltage rms} = \sqrt{\frac{1}{N}\sum_{K=1}^{N} v(k)^2} \cdots\cdots (2)$$

$$\text{Current rms} = \sqrt{\frac{1}{N}\sum_{K=1}^{N} i(k)^2} \cdots\cdots (3)$$

where

v(k) = the voltage instantaneous value due to k number of samples

i (k) = the current instantaneous value due to k number of samples

n = an integer

N = the number of samples synchronized with the input cycle

The effective measurement period is generated by the hardware, and the number of samples N is then determined. The effective measurement period obtained by synchronizing the input signal is described in the following.

Figure 4 shows the principle by which the effective measurement period is determined. The current's input waveform is converted to a square-wave zero-cross signal by a zero-cross detector. The period in which the reference gate is synchronized with the start of this zero-cross signal is the effective measurement period synchronized with the current signal. A similar zero-cross detector is equipped on the voltage side, and the measurement period synchronized with the voltage signal is obtained by the same principle as that of the current signal.

With the DSP, the sampling period is modified according to the equipment in which measurement is taking place, the input conditions, or other conditions, and the following 3 measurement values are obtained at all times.

(a) value after synchronizing the current signal;

(b) value after synchronizing the voltage signal;

(c) value in a fixed cycle (200 ms)

Any of these measurement values can be selected as the real measured value, depending on the following conditions.

If (a) is selected:

* If the effective measurement periods obtained after synchronizing the voltage and current signals are both within the display update cycle

* If the effective measurement period obtained after synchronizing the voltage signal is longer than the display update cycle

In the case of normal current measurement, this refers to the determination made after synchronizing the current signal.

If (b) is selected:

* If only the effective measurement period obtained after synchronizing the voltage signal is within the display update cycle

This corresponds to instances where, for example, only a voltage signal is input.

If (c) is selected:

* If both effective measurement periods obtained after synchronizing the voltage and current signals are longer than the display update cycle

This corresponds to instances where the input signal cycle is lower than the measurement frequency range or where the respective input signal levels are lower than the standard level.

Final determination of which computation results are to be used as the real computation results is made after computation of the 3 measurement periods has been completed, not after the measurement period has been determined as described above. This allows data to be sampled within the optimum measurement period, regardless of the input waveform, and prevents a lengthening of the input response time.

3. Other Measurement Items

Based on the DSP computation results, the CPU is used to compute apparent power, reactive power, the power factor, phase angle, and integrating value. The integrating value consists of a power integrating value and a current integrating value, either of which can give positive-negative polarity differentiation results. The integrating value is the time-converted value of the DSP computation results of the effective power value and current value, added according to the different symbols. The addition of the effective measurement period of the measurement results may give different results than those obtained with meters with different working principles.

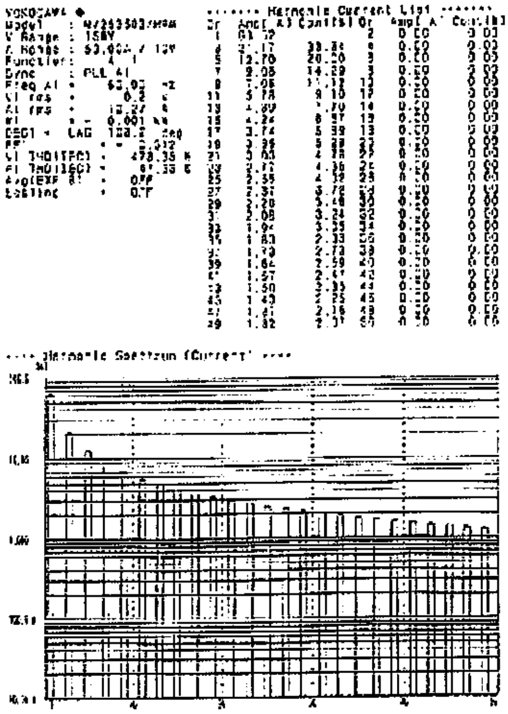


Figure 5 Example of the Block Output of Harmonic Wave Analysis Results

FUNCTION

1. Harmonic Wave Analysis and External Output

Guidelines for measures against harmonic waves established by the Ministry of Trade and Industry indicate that concerns regarding measurement of the harmonic wave current are mounting, even in Japan.

This meter is equipped with an optional harmonic wave analysis function that can be added inexpensively. The hardware needed to add this function consists of a PLL synchronous circuit, DMA controller, and 32 k bytes of RAM.

The instantaneous data of a 1-cycle portion of the basic frequency obtained at the sampling clock, where the basic input signal is multiplied 512 times by the PLL synchronous circuit, are stored in RAM by the DMA controller, via the DSP. Then, up to the 50th FFT analysis is performed with the main CPU. The content factor, distortion factor, phase angle for each degree of basic wave, and other data needed for harmonic wave control measures are obtained.

The analysis results can be output as communication output to a plotter or printer. An example of a plotter output is shown in Figure 5.

2. Comparator Function

The 4 relay contact outputs allow setting of individual measurement functions and determination values, and if a measured value exceeds a determination value, the contacts can be changed. By combining these outputs with 2 channels, the high-low limit, high-high limit, and low-low limit can be set, which is advantageous for GO/NO-GO determinations in production and inspection lines.

CONCLUSION

The WT100 series' measuring principle, functions, and features were described above. These meters are used principally for the measurement of power consumed by household appliances, such as air conditioners, automated office equipment, and other appliances, and they can be applied partially to the measurement of the output of invertor equipment. These meters are equipped with a rich array of functions: a comparator function, which is needed at production sites, and harmonic wave analysis, to which a lot of attention has been given. They can, therefore, be expected to be applied to a wide variety of services.

Our line of power meters was made even more complete by the introduction of the WT100 series. Future power meters should be thought of as new products developed from the WT series. ◆

Specifications

Input

Item	Voltage V	Current A
Input circuit type	Floating input Resistance voltage divider	Floating input Shunt input
Rated inputs (range)	15/30/60/150/300/600V	Direct input: 5/10/20/50/100/200 mA (for WT200 only) 0.5/1/2/5/10/20 A (for WT200/WT130) External input (optional): 2.5/5/10 V or 50/100/200 mV
Equipment loss (input resistance)	Input resistance: Approx. 2 MΩ, Input capacitance: Approx. 13 pF	Direct input: Approx. 6 mΩ + approx. 0.1 µH (0.5 to 20 A, WT200/WT130),Approx. 500 mΩ (5 mA to 200 mA, WT200) External input: 2.5/5/10 V - approx. 100 kΩ or 50/100/200 mV - approx. 20 kΩ
Instantaneous maximum allowable input for one cycle, 20 ms	Peak voltage of 2.8 kV or rms of 2.0 kV, whichever is less	0.5 to 20 A (WT200/WT130): Peak current of 450 A or rms of 300 A, whichever is less 5 to 200 mA (WT200): Peak current of 150 A or rms of 100 A, whichever is less For external input, the peak value is equal to or less than 10 times range.
Instantaneous maximum allowable input for 1 sec.	Peak voltage of 2.0 kV or rms of 1.5 kV, whichever is less	0.5 to 20 A (WT200/WT130): Peak current of 150 A or rms of 40 A, whichever is less 5 to 200 mA (WT200): Peak current of 30 A or rms of 20 A, whichever is less For external input, the peak value is equal to or less than 10 times range.
Continuous maximum allowable input	Peak voltage of 1.5 kV or rms of 1.0 kV, whichever is less	0.5 to 20 A (WT200/WT130): Peak current of 100 A or rms of 25 A, whichever is less (WT200) Peak current of 100 A or rms of 30 A, whichever is less (WT130) 5 to 200 mA (WT200): Peak current of 30 A or rms of 20 A, whichever is less For external input, the peak value is equal to or less than 5 times range.
Continuous maximum common-mode voltage (at 50/60 Hz input)	600 Vrms (with the output connector protective cover used) CAT II, 400 Vrms (with the output connector protective cover removed) CAT II	
Common-mode rejection ratio at 600 Vrms between input terminal and case	With voltage input terminals short and current input terminals open, 50/60 Hz, -80 dB or more (±0.01% of range or less) Reference value: 50 kHz max., ±{(maximum range rating)/(range rating) × 0.001 × 1% of rng} or less (voltage range, 0.5 A to 20 A current range) ±{(maximum range rating)/(range rating) × 0.0002 × 1% of rng} or less (WT200, 5 mA to 200 mA range) 0.01% or more. The unit of "f" is kHz.	
Input terminals	Binding posts	Direct input: Large binding posts, External input: Safety terminals
A/D conversion	Simultaneous conversion of voltage and current inputs, Resolution: 12 bits, Maximum conversion rate: Approx. 26 µs (at approx. 38 kHz)	
Range switching	Range can be selected manually, automatically, or by communication control.	
Automatic range switching	Range up: When the measured value exceeds 110% of the rated range or the peak value exceeds approximately 300% of the rated range Range down: When the measured value becomes less than 30% of the rated range and the peak value is less than approximately 300% of the subordinate range	
Measurement mode switching	One of the following modes can be set (manually or by communication control): RMS: True RMS measurements for both voltage and current; V MEAN: Rectified mean calibrated to an RMS sine wave measurement for voltage, and true RMS measurement for current; DC: Mean value measurement for both voltage and current	

Notes: Direct input and external sensor input of current cannot be used simultaneously. When the input is switched for use, note that the ± terminals are shared.

Measurement Functions

Item	Voltage/current	Active power
Method	Digital sampling method and summation averaging method	
Frequency range	DC, 10 Hz to 50 kHz	
Crest factor	"3" at rated input	
Display accuracy Accuracy (within 3 months after calibration) Conditions: Temperature: 23 ± 5°C Humidity: 30 to 75% R.H. Supply voltage: 100 V ± 5% Input waveform: Sine wave Common-mode voltage: 0 V DC Filter: ON at 200 Hz or less Scaling: OFF After CAL is performed, accuracy is assured by YOKOGAWA calibration system. Note: The unit of "f" in accuracy expressions is kHz.	DC: ± (0.2 % of rdg + 0.2 % of rng)* 10Hz ≦ f < 45Hz : ± (0.3 % of rdg + 0.2 % of rng) 45Hz ≦ f ≦ 66Hz : ± (0.15 % of rdg + 0.1 % of rng) 66Hz < f ≦ 1kHz : ± (0.3 % of rdg + 0.2 % of rng) 1kHz < f ≦ 10kHz : ± (0.2 % of rdg + 0.3 % of rng) ± {(0.05 ×)% of rdg} 10kHz < f ≦ 20kHz ± (0.5 % of rdg + 0.5 % of rng) ± [(0.15 × (f-10))% of rdg] Reference value 20kHz < f ≦ 50kHz : ± (0.5 % of rdg + 0.5 % of rng) ± [(0.15 × (f-10))% of rdg] *DC: ±0.2% of range is added if the 0.5/1 A range is selected (WT130 only)	DC: ± (0.3 % of rdg + 0.3 % of rng)* 10Hz ≦ f < 45Hz : ± (0.5 % of rdg + 0.3 % of rng) 45Hz ≦ f ≦ 66Hz : ± (0.2 % of rdg + 0.1 % of rng)(WT200) ± (0.25 % of rdg + 0.1 % of rng)(WT130) 66Hz < f ≦ 1kHz : ± (0.5 % of rdg + 0.3 % of rng) 1kHz < f ≧ 10kHz : ± (0.3 % of rdg + 0.5 % of rng) ± {(0.08 x f)% of rdg} 10kHz < f ≦ 20kHz : ± (0.8 % of rdg + 0.8 % of rng) ± [(0.19 × (f-10))% of rdg] Reference value 20kHz < f ≦ 50kHz : ± (0.8 % of rdg + 0.8 % of rng) ± [(0.25 × (f-10))% of rdg] *DC: ±0.2% of range is added if the 0.5/1 A range is selected (WT130 only)
Effect of power factor Note: The unit of "f" in accuracy expressions is kHz.	——	cosφ = 0 45 Hz ≦ f ≦ 66 Hz: Add ±0.25% of range to display accuracy. Reference data (50 kHz max.): ±{(0.23 + 0.4 x f)% of rng} 1 > cosφ > 0 Add the value of the influence of cosφ = 0 times tanφ to display accuracy. Note that φ represents the phase angle between voltage and current.
Effective input range	For the input range of 10% to 110%, the above specified accuracy is valid. For the input range of 110% to 130%, the above specified reading accuracy increased by 0.5 times is added to the accuracy.	
Accuracy (within 12 months after calibration)	The above specified reading accuracy increased by 0.5 times is added to the accuracy (within 3 months after calibration).	
Temperature coefficient	±0.03% of range/°C at 5 to 18°C and 28 to 40°C	
Display update rate	4 times/s	

Note: "rdg" means reading and "rng" means range.

Frequency Measurement

Input: One of V1, V2, V3, A1, A2, and A3 is selected.
Operating principle: Reciprocal counting method
Frequency range: 10 Hz to 50 kHz
Accuracy: ±(0.1% of rdg + 1 digit)
Minimum input is more than 30% of rated range.
When an input frequency is less than 200 Hz, FILTER must be ON to obtain the specified accuracy.
Minimum input frequency is more than 20% of frequency measurement range.

Communication

Either GP-IB or RS-232-C is selected.
GP-IB
Electrical and mechanical specifications: IEEE Std. 488-1978 (JIS C 1901-1987)
Functional specifications: SH1, AH1, T5, L4, SR1, RL1, PR0, DC1, DT1, C0
Protocol: IEEE Std. 488.2-1987
Code used: ISO (ASCII) code
Address: 0 to 30 talker/listener addresses are settable.
RS-232-C
Transmission mode: Start-stop synchronization
Baud rate: 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps

		Active power (W)	Apparent power (VA)	Reactive (var)	Power factor (PF)	Phase angle (deg)
Computation	1-phase 2-wire	W	VA=V×A	$\sqrt{(VA)^2-W^2}$	$\frac{W}{VA}$	$\cos^{-1}(\frac{W}{VA})$
	1-phase 3-wire	W_i i=1, 3 Σ W $=W_1+W_3$	$VA_i=V_i \times A_i$ i=1, 3 Σ VA $=VA_1+VA_3$	var_i $=\sqrt{(VA_i)^2-W_i^2}$ i=1, 3 Σ var $=var_1+var_3$	PF_i $=\frac{W_i}{VA_i}$ i=1, 3 Σ PF $=\frac{\Sigma W}{\Sigma VA}$	φ_i $=\cos^{-1}(\frac{W_i}{VA_i})$ i=1, 3 Σ φ $=\cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 3-wire (two-power-meter method)	W_i i=1, 3 Σ W $=W_1+W_3$	$VA_i=V_i \times A_i$ i=1, 3 Σ VA $=\frac{\sqrt{3}}{2}\times(VA_1+VA_3)$	var_i $=\sqrt{(VA_i)^2-W_i^2}$ i=1, 3 Σ var $=var_1+var_3$	PF_i $=\frac{W_i}{VA_i}$ i=1, 3 Σ PF $=\frac{\Sigma W}{\Sigma VA}$	φ_i $=\cos^{-1}(\frac{W_i}{VA_i})$ i=1, 3 Σ φ $=\cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 3-wire (three-power-meter method)	W_i i=1, 2, 3 (Note that W_2 does not have physical meaning.) Σ W $=W_1+W_3$	$VA_i=V_i \times A_i$ i=1, 2, 3 Σ VA $=\frac{\sqrt{3}}{3}\times(VA_1+VA_2+VA_3)$	var_i $=\sqrt{(VA_i)^2-W_i^2}$ i=1, 2, 3 Σ var $=var_1+var_3$	PF_i $=\frac{W_i}{VA_i}$ i=1, 2, 3 Σ PF $=\frac{\Sigma W}{\Sigma VA}$	φ_i $=\cos^{-1}(\frac{W_i}{VA_i})$ i=1, 2, 3 Σ φ $=\cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 4-wire	W_i i=1, 2, 3 Σ W $=W_1+W_2+W_3$	$VA_i=V_i \times A_i$ i=1, 2, 3 Σ VA $=VA_1+VA_2+VA_3$	var_i $=\sqrt{(VA_i)^2\times W_i^2}$ i=1, 2, 3 Σ var $=var_1+var_2+var_3$	PF_i $=\frac{W_i}{VA_i}$ i=1, 2, 3 Σ PF $=\frac{\Sigma W}{\Sigma VA}$	φ_i $=\cos^{-1}(\frac{W_i}{VA_i})$ i=1, 2, 3 Σ φ $=\cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
Computing range		Depends on selected V and A ranges.	Depends on selected V and A ranges.	Same as apparent power (var ≧ 0)	–1 to 0 to 1	–180 to 0 to 180
Display resolution		9999*	9999*	9999*	± 1.000*	± 180.0
Computing accuracy (relative to the value calculated from measured values)		—	±0.005% of VA range	±0.005% of var range	0.0005	Resolution (power factor ±0.0005)

Note 1: The apparent power (VA), reactive power (var), power factor (PF), and phase angle (deg) measurements in this instrument are computed digitally from the voltage, current, and active power. If the input is non-sinusoidal, the measured values may differ from those obtained with instruments employing different measurement principles.

Note 2: When the current or voltage is less than 0.5% of the range, VA and var will be displayed as 0, and PF/deg will be displayed as an error.

Note 3: The Lead and Lag are displayed for V and A input at 50% or more of the rated range. The detected lead/lag accuracy is ±5 degrees over the frequency range of 20 Hz to 2 kHz.

Note 4: In a Σvar calculation, the var value of each phase is calculated as a negatively signed value when the phase of the current input is advanced with respect to the voltage input, and is calculated as a positively signed value when the phase is lagging.

* The WT200 can provide 5-digit display (note that the resolution is 20000).

Display Function

Display type: 7-segment LED
Number of displays: 3

Display	Displayed value	Maximum Reading
A	V, A, W, VA, var (each element), elapsed integrating time	V, A, W: 9999
B	V, A, W, PF, deg (each element), % (contents ratio in %, THD)	Wh, Ah: 999999
C	V, A, W, V · AHz, ±Wh, ±Ah (each element), Vpk, Apk, MATH	V, AHz : 9999

* In the WT200 either 4 or 5 digits for display can be selected.

Unit: m, k, M, V, A, W, VA, var, Hz, h±, deg, %
Display update rate: 4 times/s
Response time: Approx. 0.5 s (time for displayed value to settle within specified accuracy of final value after step change from 0% to 10% or 100% to 0% of rated range)

Display scaling function
Significant digits: Selected automatically according to significant digits in the voltage and current ranges
Setting range: 0.001 to 9999 (WT200), 0.001 to 1000 (WT130)

Averaging function:
Either of the following two algorithms can be selected:
Exponential averaging
Moving averaging
Response can be set; for exponential averaging, the attenuation constant can be selected and for moving averaging, the number of averages (N) can be set to 8, 16, 32, or 64.

Peak over-range display
The alarm LED will light up if the rms value is greater than 140% of the range or the peak value is greater than 300% of the range.

MAX hold function (WT200 only)
Capable of storing the maximum values for V, A, W, VA, var, Vpk, and Apk.

MATH function
Method: When the DISPLAY C function is set to MATH, the efficiency (WT130 only) and input crest factor can be measured, and the results of four arithmetic operations of measured values can be displayed on Displays A and B as well as the average active power after time-conversion of Integrating power (WT200 only).

Integrator Function

Display resolution: Depending on integrated value, the resolution will be changed (for WT200).
Depending on elapsed time value, the resolution will be changed (for WT130).
Maximum display: –99999 to 999999 MWh/MAh
Modes: Standard integration mode (timer mode)
Continuous integration mode (repeat mode)
Manual integration mode
Timer: When the timer is set, integration will be stopped automatically.
Setting range: 000 h:00 min:00 sec to 10000 h:00 min:00 sec (WT200)
Setting range: 000 h:00 min to 999 h:59 min (WT130)
(When set time is 0, the manual integration mode is automatically selected.)
Type: Standard type Adds active power and current value of normal measurements.
Advanced type (WT200 only) Integrates active power and current values in short time intervals, not depending on input signal period.
Count overflow: If the integration count exceeds 999999 MWh/MAh or -999999 MWh/MAh, integration stops and the elapsed time is held on the display.
Accuracy: ± (display accuracy + 0.2% of rdg)
Timer accuracy: ±0.02%
Remote control: Start, stop, and reset can be remotely controlled by an external contact signal. Note that this is available only when the /DA4 or /DA12 option has been installed.

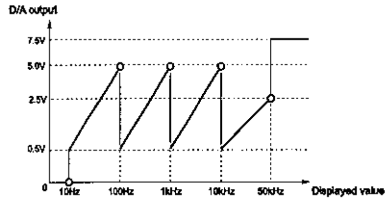
Internal Memory Function

Measurement data: Number of data that can be stored: WT200 (253421): 600 blocks
WT130 (253502): 300 blocks
WT130 (253503): 200 blocks
Writing interval: 250 ms, or 1 s to 99 h:59 min:59 sec
Reading interval: 250 ms, or 1 s to 1 h (both intervals can be set in units of second)
Panel setup information: Four-pattern information can be written/read.

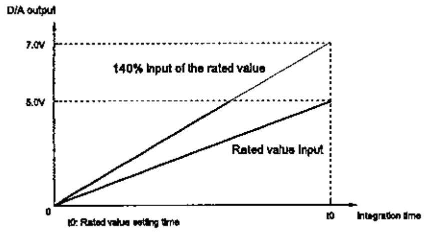
D/A Converter (Optional)

Output voltage: ±5 V DC FS (approx. ±7.5 V maximum) at rated value or range
Number of output channels: 12 when the /DA12 option is installed; 4 when the /DA4 option is installed
Output data selection: Can be selected for each channel.
Accuracy: ± (display accuracy + 0.2% of range)
Update rate: Same as display update rate
Temperature coefficient: ±0.05% of f.s./°C
Output format

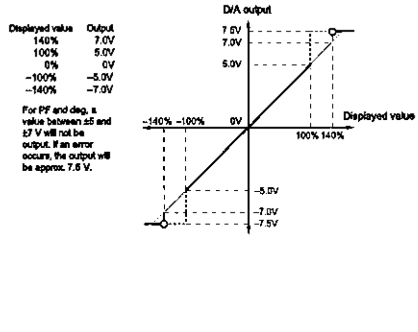
Frequency



Integration



Other items



External Input (Optional)

Either /EX1 or /EX2 can be selected as a voltage-output-type current sensor.
/EX1: 2.5/5/10 V
/EX2: 50/100/200 mV
Specifications: See the "Input" item.

Comparator Output (Optional)

Output method: Normally open and normally closed relay contact outputs (in pairs)
Number of output channels and channel setup: 4 (settable for each channel)
Contact capacity: 24 V/0.5 A
D/A output (4 channels): See the "D/A Converter (Optional)" item.

External Control and Input Signals (only when the D/A or /CMP option has been installed)

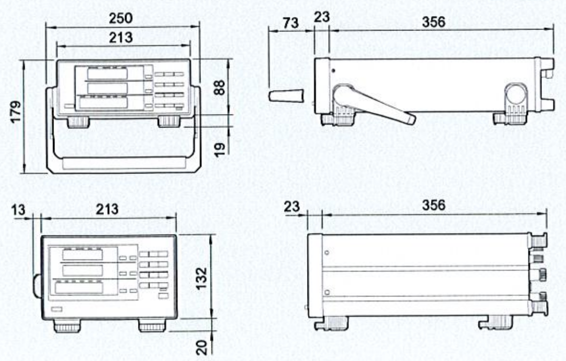
External control and input/output signals:
EXT-HOLD, EXT-TRIG, EXT-START, EXT-STOP, EXT-RESET, INTEG-BUSY
Note: That the /DA4 or /DA12 option must be installed.
Note: Only EXT-HOLD and EXT-TRIG are available when the / CMP option has been installed.
Input level: TTL negative pulse

General Specifications

EMI standard: EN55011 Group 1 Class A
EN50082-2: 1995
Safety standards: EN61010-1
Overvoltage Category II
Pollution degree 2
Warm-up time: Approx. 30 min.
Operating temperature and humidity range: 5 to 40°C, 20 to 80% R.H. (no condensation)
Storage temperature: –25 to 60°C (no condensation)
Operating altitude: 2000 m or less
Insulation resistance: Between voltage input terminals and case
Between current input terminals and output terminals
Between voltage input terminals and current input terminals
Between voltage input terminals of each element
Between current input terminals of each element
Between voltage input terminals and power plug
Between current input terminals and power plug
Between case and power plug
The above values must be 50 MΩ or more at 500 V DC.
Withstanding voltage: Between voltage input terminals and case
Between current input terminals and output terminals
Between voltage input terminals and current input terminals
Between voltage input terminals of each element
Between current input terminals of each element
Between voltage input terminals and power plug
Between current input terminals and power plug
The above values must be 3700 V for 1 minute at 50/60 Hz.
Between case and power plug: 1500 V for 1 minute at 50/60 Hz
Power supply: Any power supply voltage between 100 and 240 V; frequency: 50/60 Hz
Vibration test conditions: Sweep test - Frequency: 8 to 150 Hz sweep, all three directions for 1 minute
Endurance test - Frequency: 16.7 Hz, all three directions; amplitude of 4 mm for 2 hr
Impact conditions: Impact test: Acceleration of 490 m/s², all three directions
Free-fall test - Height:100 mm, 1 time for each of four sides
Power consumption: WT200: 35 VA max., WT130: 50 VA max. (for power supply of 240 V)
WT200: 25 VA max., WT130: 32 VA max. (for power supply of 100 V)
External dimensions: WT200: Approx. W × H × D: 213 × 88 × 350 (mm) (not including projections)
8-3/8 × 3-1/2 × 13-3/4 (inch) (not including projections)
WT130: Approx. W × H × D: 213 × 132 × 350 (mm) (not including projections)
8-3/8 × 5-3/16 × 13-3/4 (inch) (not including projections)
Weight: WT200: Approx. 3.0 (kg), 6.6 (lbs.)
WT130: Approx. 5.0 (kg), 11.0 (lbs.)
Accessories: Power cord: UL/CSA, VDE, SAA or BS standard, 1 pc.

External Dimension

Unit: mm



Harmonic Analysis Function (Optional)

Method: Synchronization to the fundamental frequency by using a phase locked loop (PLL) circuit
Frequency range: Fundamental frequency between 40 Hz and 440 Hz
Display resolution: 9999 (WT130), 9999 or 20000 (WT200)
Items analyzed: V, A, W, deg (WT200); V1, V2, V3, A1, A2, A3, W1, W2, W3, deg1, deg2, deg3 (WT130), each harmonic component, total Vrms, total Arms, total active power, PF of the fundamental wave, phase-angle of fundamental wave, total harmonic distortion ratio in %, and contents ratio in %
Note that simultaneous analysis can be made for one specified input mode.
Sampling speed/method:
The sampling speed depends on the fundamental frequency to be input:

Input frequency range	Sampling frequency	Window up to the n'th harmonic	Order
40≦f<70Hz	f×512Hz	1 period of f	50
70≦f<130Hz	f×256Hz	2 period of f	50
130≦f<250Hz	f×128Hz	4 period of f	50
250≦f≦440Hz	f×64Hz	8 period of f	30

FFT number of points: 512 points FFT
FFT calculation accuracy: 32 bits
Window: Rectangular window
Display update interval: Approx. 3 sec.
Accuracy: ±0.2% of range is added to the normal display accuracy.

Model and Suffix Codes

Model	Suffix Code	Description	
253421		WT200, 1-input element model	
Power cord	-D	UL/CSA standard	
	-F	VDE standard	
	-R	SAA standard	
	-Q	BS standard	
Optional features	/C1	GP-IB communication function	Select one.
	/C2	RS-232-C communication function	
	/EX1	External input 2.5/5/10 V	Select one.
	/EX2	External input 50/100/200 mV	
	/HRM	Harmonic analysis function	
	/DA4	4-channel D/A output	Select one.
	/CMP	Comparator & D/A, each of 4 channels	

Note: The WT200 communication feature cannot be modified or provided later after delivery of the product.

Model	Suffix Code	Description	
253502		WT130, 2-input element model	
253503		WT130, 3-input element model	
Interface	-C1	GP-IB communication function	Select one.
	-C2	RS-232-C communication function	
Supply voltage	-0	Any power supply voltage between 100 and 240 V	
Power cord	-D	UL/CSA standard	
	-F	VDE standard	
	-R	SAA standard	
	-J	BS standard	
Optional features	/EX1	External input 2.5/5/10 V	Select one.
	/EX2	External input 50/100/200 mV	
	/HRM	Harmonic analysis function	
	/DA12	12-channel D/A output	Select one.
	/CMP	Comparator & D/A, each of 4 channels	

Wiring and Model

Wiring \ Model	253421	253502	253503
Single-phase, 2-wire	○	○	○
Single-phase, 3-wire	-	○	○
Three-phase, 3-wire (2-power-meter method)	-	○	○
Three-phase, 3-wire (3-power-meter method)	-	-	○
Three-phase, 4-wire	-	-	○

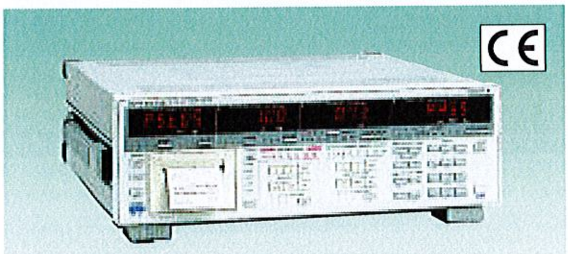
Accessories

Name	Model or Part Number	Specifications	Order Quantity
Rack-mount kit	751533-E2	Single-mounted WT200 for EIA	1
Rack-mount kit	751533-J2	Single-mounted WT200 for JIS	1
Rack-mount kit	751534-E2	Dual-mounted WT200 for EIA	1
Rack-mount kit	751534-J2	Dual-mounted WT200 for JIS	1
Rack-mount kit	751533-E3	Single-mounted WT130 for EIA	1
Rack-mount kit	751533-J3	Single-mounted WT130 for JIS	1
Rack-mount kit	751534-E3	Dual-mounted WT130 for EIA	1
Rack-mount kit	751534-J3	Dual-mounted WT130 for JIS	1

Related Products

■ WT2010/WT2030 Digital Power Meter

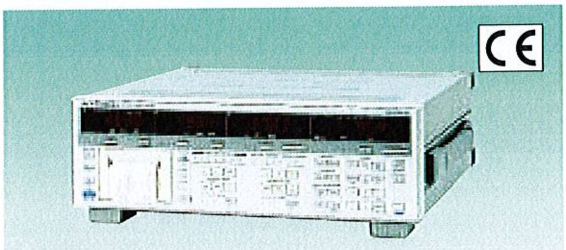
Enhanced power meter, incorporating a total harmonic analysis function conforming to the IEC standard.



- Outstanding performance: 0.03%/DC, 2 Hz to 500 kHz
- High accuracy: 0.08% (45 to 66 Hz)
- Total harmonic current/Flicker conforming to IEC1000-3-2 and -3 can be measured.

■ WT1010/WT1030/WT1030M Digital Power Meter

General-purpose mid-class models suitable for a wide range of applications



- Frequency response: DC, 0.5 Hz to 300 kHz
- High accuracy: 0.2% (45 to 66 Hz)
- Overall efficiency of a motor can be measured by using the motor evaluation function (only WT1030M).

■ PZ4000 Power Analyzer

New concept power meter capturing power fluctuations as waveforms

- Frequency response: DC to 2 MHz
- Sampling speed: 5 MS/s maximum
- Fundamental power accuracy: ±(0.1% of rdg + 0.025% of rng)
- Voltage and current waveform display and analysis function
- Motor evaluation function (when equipped with 253771 module)

■ DL708E/DL716 Digital Scope

For simultaneous measurement of voltage, temperature, distortion, and logic

- Inputs of up to 8 analog channels (DL708E)/16 analog channels + 32 logic bits (DL716)
- Eight types of mixed plug-in input units
- Record length of 64M words maximum (DL716's 16M words/ch. model)
- Built-in HDD (optional)

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Represented by :

MM-07E

[Ed : 05/b]

Printed in Japan, 009(YG)