YOKOGAWA

2536 Digital Power Meters WT1010/WT1030/WT1030M

WT1030M(253640)
426 × 132 × 400 mm 10 kg
(18 × 5-1/4 × 17" 22.0 lbs)

CE

3-Year Warranty

RS-232-C GP-IB

★
Safety Standards; EN61010-1, CAT II, Pollution degree 2
EMI Standard; EN55011 Group 1 Class A
Immunity Standard; EN50082-2: 1995

The increasing need for energy conservation in recent years has resulted in a daily increase in power converter operating frequencies for achieving miniaturization and higher efficiency. Therefore the need for high accuracy power measurement, e.g. of the distorted waveform, in higher frequency is increasing.

Taking for example inverter driven motors, the carrier frequency goes up to 15 kHz by adopting IGBT, on the other hands, evaluation in low speed rotation is also in demand. Therefore users are looking for power meters with wider than usual bandwidth.

We developed a new power meter with high basic performance, high noise immunity and high reliability. The model WT1000 achieves high speed, high accuracy and wide bandwidth measurements by using a digital sampling system. Furthermore it has motor evaluation function measuring output signals from a torque meter (torque and revolution speed) and compute total efficiency of the motor.

FEATURES

- **10 measured values/100 ms high speed communication**
- **Measurement of overall motor efficiency by means of motor evaluation function (torque input, revolution speed)**
- **Real-time waveform output**
- **High accuracy (0.1%) & wide band width (DC, 0.5 Hz to 300 kHz)**
- **1000 Vrms high voltage measurement**
- **Harmonic analysis from a fundamental frequency of 10 to 440 Hz**
- **Phase measurement between 3-phase inputs and measurement of active, reactive or apparent power of the fundamental wave, by harmonic analysis**

SPECIFICATIONS

Input

Item	Voltage	Current
Input circuit type	Floating input	
	Resistive voltage divider	Shunt input
Rated inputs (ranges, rms)	15/30/60/100/150/300/600/1000 V	Direct input: 0.5/1/2/5/10/20 A External input (optional): 250/500 m/1/2.5/5/10 V
Input impedance	Approx. 2.4 MΩ, approx. 13 pF	Direct input: Approx. 6 mΩ + approx. 0.07 µH External input: Approx. 100 kΩ
Instantaneous maximum allowable input (20 ms for 1 cycle)	Peak voltage of 4.0 kV, or RMS value of 2.8 kV, whichever is less	Peak current of 450 A, or RMS value of 300 A, whichever is less External input: Peak value of no more than 15 times the range
Instantaneous maximum allowable input (1 s)	Peak voltage of 2.8 kV, or RMS value of 2.0 kV, whichever is less	Peak value of 150 A, or RMS value of 40 A, whichever is less External input: Peak value of no more than 10 times the range
Continuous maximum allowable input	Peak voltage of 2.0 kV, or RMS value of 1.5 kV, whichever is less	Peak current of 100 A, or RMS value of 30 A, whichever is less External input: Peak value of no more than 5 times the range
Continuous maximum common mode voltage	600 Vrms (When the protective cover for the output connector is used) CAT II 400 Vrms (When the protective cover for the output connector is removed) CAT II	
Common mode rejection ratio at 600 Vrms between input terminals and case	At 50/60 Hz: ±0.01% of range maximum (voltage input terminals shorted, and current input terminals open) Reference value: 100 kHz maximum ±{(maximum range rating)/(range rating) × 0.001 × 1% of range} or less, but no less than 0.01%; Unit of f is kHz.	
Input terminals	Binding posts	Large binding posts; External input: BNC
A/D conversion	Simultaneous sampling of voltage and current inputs: Resolution: 16 bits; Maximum conversion rate: Approx. 17 µs	
Range switch	Range can be switched manually, automatically or by communication control, for each element.	
Automatic range switching	Range up: When the measured value exceeds 110% of the rated range or the peak value exceeds approximately 330% of the rated range Range down: When the measured value becomes 30% or less of the rated range	
Measurement mode switching	The following modes can be set for each element, and also for each voltage and current measurement circuit RMS: True RMS MEAN: Rectified mean calibrated to RMS value DC: Simple mean	

Display Functions

Display update period: Selectable from 100, 250 , 500 ms, 2, and 5 s.
Peak hold function: Vpk and Apk can be held at maximum value.
Response time: Maximum of twice the display update rate + 100 ms
Display scaling function: The display of PT ratio, CT ratio and power scaling factor can be scaled.
Resolution: The decimal point position and unit are determined in such a way that the resolution of the voltage or current range, 300000, is not exceeded.
Setting range: 0.0001 to 10000
Averaging function:
- For normal mode measurements
  The following two functions can be selected:
  Exponential averaging
  Moving averaging
  The attenuation constant can be set in the case of exponential averaging, and the number of averages (N) can be set to 8, 16, 32, 64, 128 or 256 in the case of moving averaging.
- For harmonic mode measurements
  For exponential averaging the attenuation constant is 5.625 when the frequency of the PLL sync source is 55 Hz or more but less than 75 Hz, and is 4.6875 in other cases.

External Control

Signals EXT-HOLD, EXT-TRIG, EXT-PRINT
Input TTL level negative pulses

WT1010/WT1030/WT1030M

Measurement Functions

	Voltage/current	Power
Method	Digital multiplication method	
Crest factor	"3" at rated input	
Temperature: 23±5°C Humidity: 30 to 75% RH Supply voltage: specified voltage ±5% Input waveform; sine wave Common mode voltage: 0 V Line filter: OFF. Power factor: cos φ = 1 3-month accuracy The unit of f is kHz.	DC: ± (0.1% of rdg + 0.2% of rng) 0.5 Hz ≤ f < 45 Hz: ± (0.1% of rdg + 0.3% of rng) 45Hz ≤ f ≤ 66Hz: ±(0.1% of rdg + 0.1% of rng) 66 Hz < f ≤ 1 kHz: ±(0.1% of rdg + 0.2% of rng) 1 kHz < f ≤ 10 kHz: ± (0.08 × f% of rdg + 0.3% of rng) 10 kHz < f ≤ 100 kHz ±(0.04 × f% of rdg + 0.7% of rng) 100 kHz < f ≤ 300 kHz ±(0.12 × (f – 100)% of rdg + 5% of rng) However, the accuracy between 0.5 and 10 Hz and also at 100 kHz or above is the design value.	DC: ± (0.2% of rdg + 0.3% of rng) 0.5 Hz ≤ f < 45 Hz: ± (0.2% of rdg + 0.5% of rng) 45 Hz ≤ f ≤ 66Hz: ± (0.1% of rdg + 0.1% of rng) 66 Hz < f ≤ 1 kHz: ± (0.2% of rdg + 0.2% of rng) 1 kHz < f ≤ 10 kHz: ± (0.09 × f% of rdg + 0.4% of rng) 10 kHz < f ≤ 100 kHz: ± (0.06 × f % of rdg + 1.0% of rng) 100 kHz < f ≤ 200 kHz ± (0.22 × (f –100)% of rdg + 7% of rng) However, the accuracy between 0.5 and 10 Hz and also at 100 kHz or above is the design value.
Effect of power factor The unit of f is kHz.	—	When cosφ = 0 45 Hz ≤ f ≤ 66 Hz: Add 0.25% of range Reference data: Up to 100 kHz Add (0.15 + 0.2 × f)% of range
Effective input range	10 to 110% of range rated value	
Temperature coefficient	±0.03% of range/°C between 5 and 18°C and between 28 and 40°C	
1-year accuracy	The reading error of the 3-month accuracy is multiplied by a factor of 1.5.	
LEAD/LAG phase detection accuracy	When both the voltage and current inputs are sine waves, and the input level is 50% or more of the range rating: ±5 deg (20 kHz to 10 kHz)	
Line filter function	Measurement can be done when a low-pass filter is inserted into the input circuit. The cutoff frequency (fc) can be selected 500 Hz, 1 kHz, 2 kHz and 6.5 kHz	
Accuracy when line filter is ON	Voltage/current: For fc/5 or below, add 1% of reading to the accuracy when the filter is OFF. Power: For fc/5 or below, add 2% of reading to the accuracy when the filter is OFF.	
Measurement lower limit frequency	Display update rate: 100 ms / 250 ms / 500 ms / 2 s / 5 s	Measurement lower limit frequency: 25 Hz / 10 Hz / 5 Hz / 1.5 Hz / 0.5 Hz

Note: The above 3-month and 1-year accuracy values apply after a range or measurement mode has been changed after the warm-up period (approx. 30 minutes).

Frequency Measurement Functions

Measurement input: Select one input from V1, V2, V3, A1, A2, and A3.
Measurement method: Reciprocal method
Frequency range:

Display update rate	Frequency range
100 ms	40 Hz ≤ f ≤ 500 kHz
250 ms	20 Hz ≤ f ≤ 500 kHz
500 ms	10 Hz ≤ f ≤ 500 kHz
2 s	2 Hz ≤ f ≤ 100 kHz
5 s	1.5 Hz ≤ f ≤ 90 kHz

±(0.05% of rdg + 1 digit)
Input is at least 10% of rated range.
Frequency filter is ON when input frequency is 100 Hz or less.
Frequency is no more than 440 Hz when frequency filter is ON (however, input must be at least 30% of rated range).

Communication Function

Standard model comes with GP-IB & RS-232-C.

GP-IB
- Electrical and mechanical specifications: IEEE St'd 488-1978 (JIS C 1901-1987)
- Functional specifications: SH1, AH1, T5, L4, SR1, RL1, PR0, DC1, DT1, C0
- Protocol: IEEE St'd 488.2-1987
- Code used: ISO (ASCII) code
- Address: 0 to 30 talker/listener addresses can be set.

RS-232-C
- Transmission mode: Start-stop synchronization
- Baud rate: 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps

Computing Functions

		Active Power (W)	Apparent Power (VA)	Reactive Power (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 $\Sigma W = W_1+W_3$	$VA_i=V_i \times A_1$ i=1, 3 $\Sigma VA = VA_1+VA_3$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ i=1, 3 $\Sigma var = var_1+var_3$	$PF_i = \frac{W_i}{VA_i}$ i=1, 3 $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{W_i}{VA_i})$ i=1, 3 $\Sigma \varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 3-wire (two power meter method)	W_i i=1, 3 $\Sigma W = W_1+W_3$	$VA_i=V_i \times A_i$ i=1, 3 $\Sigma VA = \frac{\sqrt{3}}{2}(VA_1+VA_3)$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ i=1, 3 $\Sigma var = var_1+var_3$	$PF_i = \frac{W_i}{VA_i}$ i=1, 3 $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{W_i}{VA_i})$ i=1, 3 $\Sigma \varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 3-wire (three power meter method)	W_i i=1, 2, 3 $\Sigma W = W_1+W_3$	$VA_i=V_i \times A_i$ i=1, 2, 3 $\Sigma VA = \frac{\sqrt{3}}{3}(VA_1+VA_2+VA_3)$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ i=1, 2, 3 $\Sigma var = var_1+var_3$	$PF_i = \frac{W_i}{VA_i}$ i=1, 2, 3 $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{W_i}{VA_i})$ i=1, 2, 3 $\Sigma \varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 4-wire	W_i i=1, 2, 3 $\Sigma W = W_1+W_2+W_3$	$VA_i=V_i \times A_i$ i=1, 2, 3 $\Sigma VA = VA_1+VA_2+VA_3$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ i=1, 2, 3 $\Sigma var = var_1+var_2+var_3$	$PF_i = \frac{W_i}{VA_i}$ i=1, 2, 3 $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{W_i}{VA_i})$ i=1, 2, 3 $\Sigma \varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
Computating Range		Depends on selected V and A ranges	Depends on selected V and A ranges	Depends on selected Vand A ranges (var ≥ 0)	-1 to 0 to 1	LEAD 180 to 0 to LAG 180 or 0 to 360
Maximum Display or Display Resolution		30000	30000	30000	±1.0000	0.01
Computing Accuracy		—	±0.001% of VA range	±0.001% of VA range	±0.0001	Calculated from the power factor, with an additional error of ±0.005°

Notes 1: The apparent power (VA), reactive power (var), power factor (PF), and phase angle (deg) measurement 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.

2: When the Current or Voltage value is less than 0.5% of range, the VA and var will be displayed 0, and PF/deg will be displayed as Error.

3: Regarding the detected accuracy of the Lead and Lag, both voltage and current of the rated input are specified at 50% or more for sinusoidal waveforms.
The detected Lead/Lag accuracy is ±5 degree over the frequency range 20 Hz to 10 kHz.

4: When the phase angle display shows an angle smaller than 5 degree at 0° and 180°, the accuracy is not specified.

5: If the scaling values set for each element differ from each other in the case of Σ computation, the number of display digits will be limited so that Σ value does not exceed 30000 when the rated value is input to each corresponding element. A voltage of 5 V (full scale) will be output from the D/A converter as the Σ value obtained when the rated value is input to each corresponding element.

6: As for Σ var computation, if a phase condition of current is LEAD against same channel's voltage, the polarity is set to minus(–). Also, if the condition is LAG, it is set to plus(+).

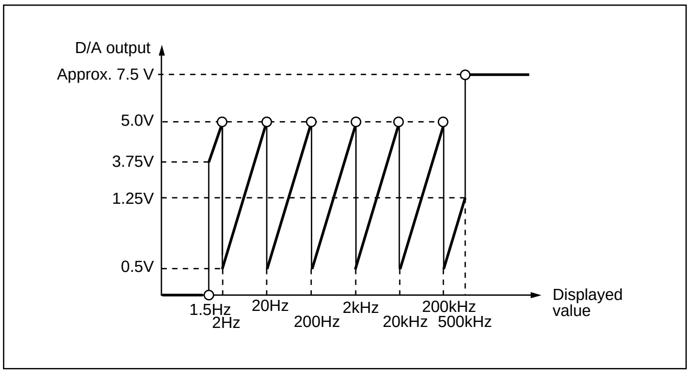
Motor Evaluation Functions (253640)

Computing items: Torque, revolution speed, mechanical power, synchronous speed, slip, motor efficiency and total efficiency
Measurement items: Torque, revolution speed
Torque computing analog inputs:
  Input resistance: Approx. 100 kΩ
  Accuracy: ±(0.1% of rdg + 0.1% of F.S.)
  Effective input range: Up to ±11 V
  Rated input: 10 V/F.S.
  Temperature coefficient: ±0.03% of rng/°C
Revolution speed computing analog input:
  Input resistance: Approx. 100 kΩ
  Accuracy: ±(0.1% of rdg + 0.1% of F.S.)
  Effective input range: Up to ±11 V
  Rated input: 10 V/F.S.
  Temperature coefficient: ±0.03% of rng/°C
Revolution speed computing pulse input:
  Input resistance: Approx. 200 kΩ
  Accuracy: ±(0.05% of rdg + 2 digits)
  Effective frequency range
  100 ms: 25 Hz ≤ f ≤ 200 kHz
  250 ms: 10 Hz ≤ f ≤ 200 kHz
  500 ms: 5 Hz ≤ f ≤ 200 kHz
  2s: 1.5 Hz ≤ f ≤ 50 kHz
  5s: 0.5 Hz ≤ f ≤ 25 kHz
Amplitude input range: Up to ±10 V peak
  Effective amplitude: 1 Vpp minimum

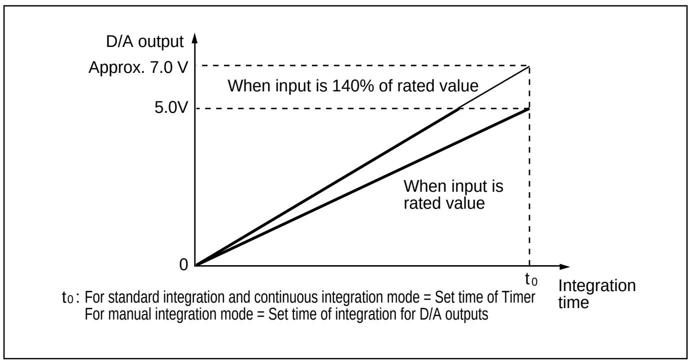
D/A Outputs (optional)

Number of outputs: 14 items (can be set for each channel)
Accuracy: ±(display accuracy + 0.2% of F.S.)
Output voltage: ±5 V F.S. (approx. ±7.5 V maximum) with respect to each rated value
Maximum output current: ±1 mA
Temperature coefficient: ±0.05% of rng/°C
Update rate: Identical to update rate
Output format

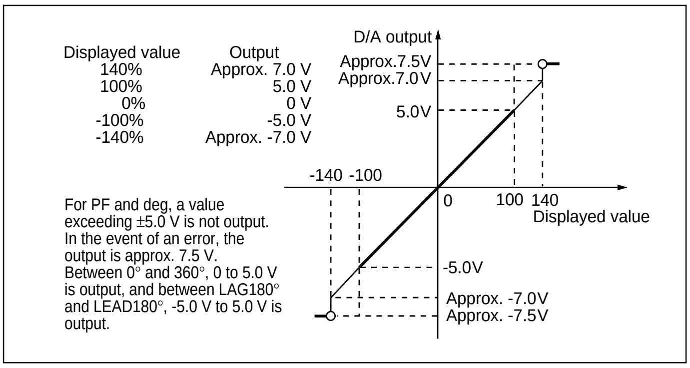
Frequency For Err-Lo, 0 V is output, and for Err-Hi, approx. 7.5 V is output



Integrated value



Other items



Printer (optional)

Printed contents: Normal measurement: Printout of numerical values - Data up to an arbitrarily set item can be output.
When the harmonic analysis function (optional) is used: Printout of numerical values - V, A, W, VA, var, deg, PF
Bar chart - V, A, W, deg
Printing method: Thermal line-dot printing

Integrator Functions (optional)

Display resolution: 300,000
The minimum display resolution changes along with the lapse of the integration time.
Mode: Standard integration mode (timer mode)
Continuous integration mode (repetitive mode)
Manual integration mode
Timer: Integration can be automatically stopped by means of a timer setting.
Set value 000 h 00 min to 999 h 59 min
(When set value is 000 h 00 min, manual mode is activated.)
Count overflow: If the integrated value exceeds ±999999 MWh (MAh), the lapsed time is held and the counter stops.
Accuracy: ±(Display accuracy + 0.05% of rdg)
Timer accuracy: ±0.005%

Harmonic Analysis Function (optional)

Method: PLL synchronization method or external sampling clock
Frequency range: PLL synchronization: Fundamental frequency between 10 and 440 Hz
External sampling clock: The fundamental frequency is between 0.5 and 20 Hz.
Items to be analyzed: V, A, W, deg harmonic levels, RMS voltage, RMS current, power, VA, var, and PF of the fundamental wave, inter-element phase angle, ΣV, ΣA, ΣW, total harmonic distortion, harmonic content
Sampling speed/Window width/Order
PLL synchronization: The above parameters depend upon the input fundamental frequency as follows.

Fundamental frequency	Sampling speed	Window width	Order
10 ≤ f < 20	f × 2048	4 periods of f;	50 (50)
20 ≤ f < 40	f × 1024	8 periods of f;	50 (50)
40 ≤ f < 70	f × 512	16 periods of f;	50 (50)
70 ≤ f < 130	f × 256	32 periods of f;	50 (25)
130 ≤ f < 250	f × 128	64 periods of f;	50 (13)
250 ≤ f ≤ 440	f × 128	64 periods of f;	50 (9)

External sampling clock

Fundamental frequency	Sampling speed	Window width	Order
0.5 Hz ≤ f ≤ 20	f × 2048	4 periods of f;	50(50)

The values in parentheses apply to when the anti-aliasing filter is ON.
Use an external sampling clock that is 2048 times the fundamental frequency. This clock must be a TTL level rectangular wave that has a duty of 50%.
FFT data length: 8192
FFT processing word length: 32 bits

Window function: Rectangular

Accuracy

	Voltage/Current	Power
When the anti-aliasing filter is ON	0.5Hz ≤ f < 45 Hz: ±(1% of rdg + 0.3% of rng)	0.5Hz ≤ f < 45 Hz: ±(2% of rdg + 0.5% of rng)
	45Hz ≤ f ≤ 66 Hz: ±(1% of rdg + 0.1% of rng)	45Hz ≤ f ≤ 66 Hz: ±(2% of rdg + 0.1% of rng)
	66 Hz < f ≤1 kHz: ±(1% of rdg + 0.2% of rng)	66Hz < f ≤ 500 Hz: ±(2% of rdg + 0.2% of rng)
	1 kHz < f ≤ 3.5 kHz: ±(2% of rdg + 0.3% of rng)	

The aliasing up to 40th order at a fundamental frequency of 50/60 Hz is at least -50 dB.

When the anti-aliasing filter is OFF, the above parameters are the same as for normal measurement.

Relative deviation between PLL synchronization source and sampling frequency within ±0.03%

Effective input range: The peak value is up to 3 times the range rated value.

General Specifications

EMI Standard: EN55011 Group1 ClassA
EMS Standard: EN50082-2: 1995
Safety standard: EN61010-1
Overvoltage Category II
Pollution degree 2
Operating altitude: 2000 m or below
Operating temperature range: 5 to 40°C
Storage temperature: –25 to 60°C
Operating humidity range: 20 to 80% RH (no condensation)
Warmup time: Approx. 30 minutes
Insulation resistance: At least 50 MΩ at 500 V DC (between each terminal and case, between terminals, between each terminal and power plug, between case and power plug)
Withstand voltage: 3700 V AC 50/60 Hz for 1 minute (between each terminal and case, between terminals, between each terminal and power plug)
1500 V AC 50/60 Hz for 1 minute (between case and power plug)
Rated supply voltage: 100 to 120 V AC, 200 to 240 V AC
Allowable supply voltage variation: 90 to 132 V AC, 180 to 264 V AC
Rated supply frequency: 50/60 Hz
Allowable supply frequency variation: 48 to 63 Hz
Power consumption: 130 VA Max
Vibration test conditions: Sweep test; 2-way sweep from 8 to 150 Hz in all 3 directions for 1 minute each
Durability test; Frequency 16.7 Hz, amplitude of 4 mm in all 3 directions for 2 hours each
Impact conditions: Acceleration 490 m/s², in all 3 directions
Free-fall test: Height 100 mm, once on each of 4 sides
External dimensions: 426(W) × 132(H) × 400(D) mm, 16.8(W) × 5.2(H) × 15.8(D) inches
Weight: 3-phase, 4-wire model; Approx. 10 kg (21.8 lbs), Single phase model; Approx. 9 kg (19.6 lbs)

Waveform Output (optional)

Method: D/A output method
Conversion speed: Identical to A/D converter at input circuit
Output voltage: Approx. 2 V output for input range rating

Standard Accessories

Power cord: 1
Fuse: 2
Remote control connector: **A1005JD** × 1
External input connector cable (when /**EX1** or /**EX2** is added): **B9284LK** 1 per element
Printer paper (when /**B5** is added) : **B9293UA** 2 rolls

● Range Special - Tokuchu Model

70A rms input (Max. 100A range): for motor evaluation

2A to 50mA rms input (Standard $\times \frac{1}{10}$ ranges): for small power measurement

2V to 50mV rms input (Standard $\times \frac{1}{5}$ ranges): for wide range current sensor

AVAILABLE MODELS

Model	Suffix codes	Description
253610		**WT1010** 1-element model
253620		**WT1030** 2-elements model
253630		**WT1030** 3-elements model
253640		**WT1030M** motor version
Communication function	**-C1**	GP-IB
	-C2	RS-232-C
Supply voltage	**-1**	100 to 120 V AC (50/60 Hz)
	-5	200 to 240 V AC (50/60 Hz)
Power cord	**-D**	UL/CSA standard
	-F	VDE standard
	-R	SAA standard
	-J	BS standard
Optional features	**/B5**	Internal printer
	/INTG	Integration function
	/HRM	Total hamonic analysis function
	/DA	14-channel D/A output
	/WF	Waveform output
	/EX1	External input **253610** only
	/EX2	External input **253620**, **30**, **40**
	/U1	Torque unit Pin, Pft

● Wiring and Models

Wiring \ Model	253610	253620	253630, 253640
Single phase 2-wire	○	○	○
Single phase 3-wire	–	○	○
3-phase 3-wire (2-voltage, 2-current)	–	○	○
3-phase 3 wire (3-voltage, 3-current)	–	–	○
3-phase 4-wire	–	–	○

● Optional Accessories

Name	Model or part No.	Specification	Q'ty
Rack mounting	**751535-E3**	EIA	1
Rack mounting	**751535-J3**	JIS	1
Printer paper	**B9293UA**	58 mm width, 10 m (1 roll 1 unit)	10
External input connector	**B9284LK**	Necessary when/**EX1** or /**EX2** is to be installed and used	1

DIMENSIONS

Common to all models:

Unit: mm (inches)