

Chapter 15 Specifications

15.1 Input

Item	Voltage (V)	Current (A)
	Floating input	
Input circuit type	Resistive voltage divider	Shunt input
Rated inputs (range rms)	15/30/60/150/300/600V	Direct input: 0.5/1/2/5/10/20 A External input (optional): 2.5/5/10 V or 50/100/200 mV
Input impedance	Input resistance approx.2MΩ, Input capacitance approx.13 pF	Direct input: approx. 6 mΩ + approx. 0.1 μH External input: 2.5/5/10 V - approx. 100 kΩ; 50/100/200 mV - approx. 20 kΩ
Instantaneous maximum allowable input for 20 ms, 1 cycle	The peak is 2.8 kV or the RMS value is 2.0 kV, whichever is less.	The peak is 450 A or the RMS value is 300 A, whichever is less. External input: Peak value is 10 times the range or less.
Instantaneous maximum allowable input for 1 s	The peak is 2.0 kV or the RMS value is 1.5 kV, whichever is less.	The peak is 150 A or the RMS value is 40 A, whichever is less. External input: Peak value is 10 times the range or less.
Continuous maximum allowable input	The peak is 1.5 kV or the RMS value is 1.0 kV, whichever is less.	The peak is 100 A or the RMS value is 30 A, whichever is less. External input: Peak value is 5 times the range or less.
Continuous maximum common mode voltage (at 50/60 Hz)	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	50/60 Hz, better than -80 dB (±0.01% of range maximum) Voltage input terminals : short, Current input terminals : open Reference value: 50 kHz max. $\pm\{(\text{maximum range rating})/(\text{range rating}) \times 0.001 \times f\%$ of range) or less; 0.01% or more; the unit f: kHz	
Input terminals	Binding posts	Direct input: Large binding posts, External input: Safety terminals
A/D conversion	Simultaneous sampling of voltage and current inputs; Resolution: 12 bits; Maximum conversion rate: approx. 22μs (approx. 45 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	The following modes can be set manually or by communication control: RMS: True RMS measurement 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 voltage and current	

15.2 Measurement Functions

Item	Voltage/current	Effective power
	Digital sampling method, summation averaging method	
Method	DC, 10 Hz to 50 kHz	
Frequency range	DC, 10 Hz to 50 kHz	
Crest factor	"3" at rated input	
Display accuracy	DC : $\pm(0.2\% \text{ of rdg} + 0.2\% \text{ of rng})^*$	DC : $\pm(0.3\% \text{ of rdg} + 0.3\% \text{ of rng})^*$
Accuracy (within 3 months after calibration)	10Hz ≤ f < 45Hz : $\pm(0.3\% \text{ of rdg} + 0.2\% \text{ of rng})$	10Hz ≤ f < 45Hz : $\pm(0.5\% \text{ of rdg} + 0.3\% \text{ of rng})$
(Conditions)	45Hz ≤ f ≤ 66Hz : $\pm(0.15\% \text{ of rdg} + 0.1\% \text{ of rng})$	45Hz ≤ f ≤ 66Hz : $\pm(0.25\% \text{ of rdg} + 0.1\% \text{ of rng})$
Temperature: 23 ±5°C	66Hz < f ≤ 1kHz : $\pm(0.3\% \text{ of rdg} + 0.2\% \text{ of rng})$	66Hz < f ≤ 1kHz : $\pm(0.5\% \text{ of rdg} + 0.3\% \text{ of rng})$
Humidity: 30% to 75% R.H.	1kHz < f ≤ 10kHz : $\pm(0.2\% \text{ of rdg} + 0.3\% \text{ of rng})$	1kHz < f ≤ 10kHz : $\pm(0.3\% \text{ of rdg} + 0.5\% \text{ of rng})$
Supply voltage: Specified Voltage ±5%	10kHz < f ≤ 20kHz : $\pm\{(0.05 \times f)\% \text{ of rdg}\}$	10kHz < f ≤ 20kHz : $\pm\{(0.08 \times f)\% \text{ of rdg}\}$
Input waveform: Sine wave	10kHz < f ≤ 20kHz : $\pm(0.5\% \text{ of rdg} + 0.5\% \text{ of rng})$	10kHz < f ≤ 20kHz : $\pm(0.8\% \text{ of rdg} + 0.8\% \text{ of rng})$
Common mode voltage: 0 V DC	$\pm\{(0.15 \times (f-10))\% \text{ of rdg}\}$	$\pm\{(0.19 \times (f-10))\% \text{ of rdg}\}$
Filter: ON at 200 Hz or less	Reference value	Reference value
Scaling: OFF	20kHz < f ≤ 50kHz : $\pm(0.5\% \text{ of rdg} + 0.5\% \text{ of rng})$	20kHz < f ≤ 50kHz : $\pm(0.8\% \text{ of rdg} + 0.8\% \text{ of rng})$
This accuracy are guaranteed by YOKOGAWA calibration system.	$\pm\{(0.15 \times (f-10))\% \text{ of rdg}\}$	$\pm\{(0.25 \times (f-10))\% \text{ of rdg}\}$
Note: The unit f in accuracy expressions is kHz.	* DC: ±0.2% of range is added if the 0.5/1 A range is selected.	* DC: ±0.2% of range is added if the 0.5/1 A range is selected.
Effect of power factor		cosφ = 0 45 Hz ≤ f ≤ 66 Hz: add ±0.25% of range Reference data (up to 50kHz): add $\pm\{(0.23 + 0.4 \times f\text{kHz})\% \text{ of range}\}$ 1 > cosφ > 0 add the product of tanφ and the effect on cosφ = 0.
Note: The φ is the phase angle between the voltage and current, and the f is frequency.		
Effective input range	With the input range at 10% to 110%, the above specified accuracy is valid. With the input range at 110% to 130%, the above specified reading accuracy increased 0.5 times is added to the accuracy.	
Accuracy (within 12 months after calibration)	The above specified reading accuracy increased 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, 28 to 40°C	
Display update rate	4 times/s	

15.3 Frequency Measurement

Input:	V1, V2, V3, A1, A2, A3
Operating principle:	Reciprocal counting method
Frequency ranges:	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 200Hz, FILTER must be ON to obtain the specification accuracy. Minimum input frequency is more than 20% of frequency measurement range.

15.4 Communication

Communication Specifications (GP-IB & RS-232-C)	
GP-IB:	Electrical specifications: IEEE St'd 488.2-1987 Mechanical specifications: IEEE St'd 488.2-1987 Interface function: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0
RS-232-C:	Transmission mode: Start stop synchronization Baud rate: 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps

15.5 Computing Functions

	Effective Power (W)	Apparent Power (VA)	Reactive Power (var)	Power Factor (PF)	Phase Angle (deg)
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 $i=1, 3$	$VA_i=V_i \times A_i$ $i=1, 3$	var_i $=\sqrt{(VA_i)^2 - W_i^2}$ $i=1, 3$	PF_i $=\frac{W_i}{VA_i}$ $i=1, 3$	ϕ_i $=\cos^{-1}(\frac{W_i}{VA_i})$ $i=1, 3$
	ΣW $=W_1+W_3$	ΣVA $=VA_1+VA_3$	Σvar $=var_1+var_3$	ΣPF $=\frac{\Sigma W}{\Sigma VA}$	$\Sigma \phi$ $=\cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
3-phase 3-wire (two power meter method)	W_i $i=1, 3$	$VA_i=V_i \times A_i$ $i=1, 3$	var_i $=\sqrt{(VA_i)^2 - W_i^2}$ $i=1, 3$	PF_i $=\frac{W_i}{VA_i}$ $i=1, 3$	ϕ_i $=\cos^{-1}(\frac{W_i}{VA_i})$ $i=1, 3$
	ΣW $=W_1+W_3$	ΣVA $=\frac{\sqrt{3}}{2}(VA_1+VA_3)$	Σvar $=var_1+var_3$	ΣPF $=\frac{\Sigma W}{\Sigma VA}$	$\Sigma \phi$ $=\cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
3-phase 3-wire (three power meter method)	W_i $i=1,2,3$	$VA_i=V_i \times A_i$ $i=1,2,3$	var_i $=\sqrt{(VA_i)^2 - W_i^2}$ $i=1,2,3$	PF_i $=\frac{W_i}{VA_i}$ $i=1,2,3$	ϕ_i $=\cos^{-1}(\frac{W_i}{VA_i})$ $i=1,2,3$
	ΣW $=W_1+W_2+W_3$	ΣVA $=\frac{\sqrt{3}}{3}(VA_1+VA_2+VA_3)$	Σvar $=var_1+var_2+var_3$	ΣPF $=\frac{\Sigma W}{\Sigma VA}$	$\Sigma \phi$ $=\cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
3-phase 4-wire	W_i $i=1,2,3$	$VA_i=V_i \times A_i$ $i=1,2,3$	var_i $=\sqrt{(VA_i)^2 - W_i^2}$ $i=1,2,3$	PF_i $=\frac{W_i}{VA_i}$ $i=1,2,3$	ϕ_i $=\cos^{-1}(\frac{W_i}{VA_i})$ $i=1,2,3$
	ΣW $=W_1+W_2+W_3$	ΣVA $=VA_1+VA_2+VA_3$	Σvar $=var_1+var_2+var_3$	ΣPF $=\frac{\Sigma W}{\Sigma VA}$	$\Sigma \phi$ $=\cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
Computing Range	Depends on the selected V and A ranges	Depends on the selected V and A ranges	Same as apparent power (var ≤ 0)	-1 to 0 to 1	-180 to 0 to 180
Display resolution	10000	10000	10000	±1.000	±180.0
Computing accuracy (for the value operated from the measured value)	—	±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 effective 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, the 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. The detected lead/lag accuracy is ±5 degrees over the frequency range of 20 Hz to 2 kHz.

15.6 Display Functions

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

DISPLAY	Displayed Value	Maximum Reading
A	V, A, W, VA, var (each element), elapsed integration 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

* Vpk, Apk, and MATH are supported only for ROM versions 2.01 or later.

Unit: m, k, M, V, A, W, VA, var, Hz, h±, deg, %

Display update rate: 4 times/s

Response time: Approximately 0.5 s (time for displayed value to settle within accuracy specifications of final value after step change from 0% to 100% or 100% to 0% of rated range)

Display scaling function Significant digits: Selected automatically according to significant digits in the voltage and current ranges
Reassign ratio: 0.001 to 1000

Averaging function: 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 when the RMS value is greater than 140% of the range or the peak value is greater than 300% of the range.

15.7 Integrator Function

Display resolution: Depending on elapsed time value, the resolution will be changed.
Maximum display: -99999 to 99999 MWh (or 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 to 999 h:59 min (000 h:00 min will be shown when manual integration mode is selected automatically.)
Count overflow: If the integration count flows above 999999 MWh (or MAh) or below -99999 MWh (or MAh), integration stops and the elapsed time is held on the display.
Accuracy: ±(display accuracy + 0.2% of rdg) However, only when the input signal is continuous.
Timer accuracy: ±0.02%
Remote control: Start, stop, and reset can be remotely controlled by external contact signals.
However, the /DA4 or /DA12 options must be installed.

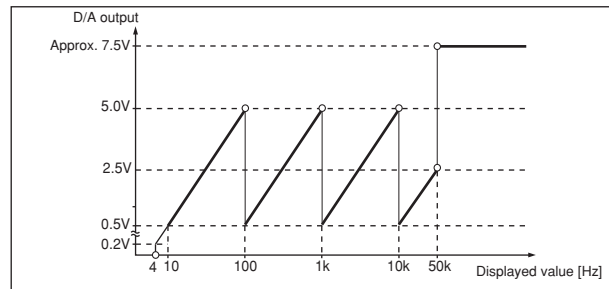
15.8 Internal Memory Function

Measurement data Number of data that can be stored:
WT110 (253401): 600 blocks
WT130 (253502): 300 blocks
WT130 (253503): 200 blocks
Each block has following data:
measurement setting mode, measurement ranges, V, A, W, Wh+, Wh-, Ah+, Ah-, elapsed time and frequency
Writing intervals: 250 ms and 1 s to 99 h: 59 min: 59 s
Reading intervals: 250 ms and 1 s to 99 h: 59 min: 59 s (both intervals can be set on a second basis)
Panel setup information: Four-pattern information can be written/read.

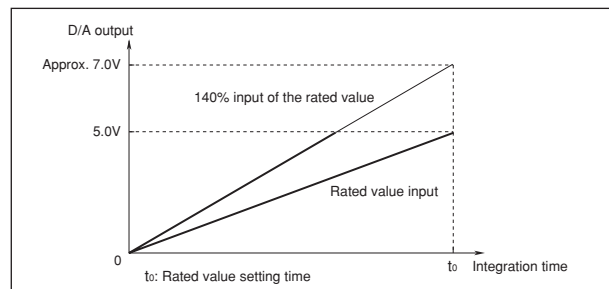
15.9 D/A Converter (optional)

Output voltage: ±5 VDC FS (approximately ±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: Identical to display update interval
Temperature coefficient: ±0.05% of f.s./ °C

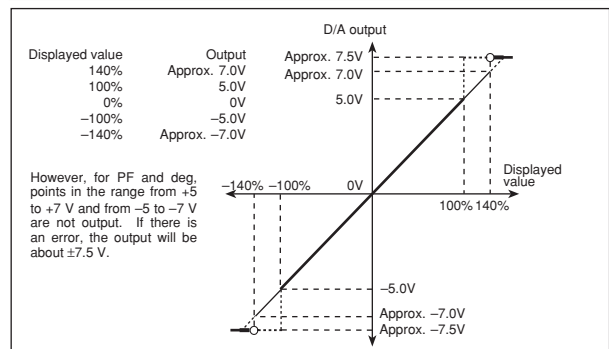
• Frequency



• Integration



• Other items



15.10 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: Refer to item "Input."

15.11 Comparator Output (optional)

Output method: Normally open and normally closed relay contact outputs (one pair)
 Number of output channels and channel setup: 4 (Can be set for each channel.)
 Contact capacity: 24 V/0.5 A
 D/A output (4 channels): Refer to item "D/A Output (Optional)."

**15.12 External Control and Input Signals
 (in combination with the D/A converter and comparator options)**

External Control and Input/Output signals
 EXT-HOLD, EXT-TRIG, EXT-START, EXT-STOP, EXT-RESET,
 INTEG-BUSY
 (However, the /DA4 or /DA12 options must be installed. Only EXT-
 HOLD and EXT-TRIG are available if the /CMP option is installed.)
 Input level:- TTL negative pulse

15.13 General Specifications

Warm-up time: Approx. 30 min.
 Ambient temperature and humidity range: 5 to 40°C, 20% to 80% R.H. (no condensation)
 Operating altitude: 2000m or below
 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
 Above: 50 MW 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
 Above: AC 3700 V for 1 minute at 50/60 Hz
 Power supply: Between case and power plug: AC 1500 V for 1 minute at 50/60 Hz
 Any power supply voltage between 100 and 240 V; frequency: 50/
 60 Hz
 Vibration test condition: Sweep test - Frequency: 8 to 150 Hz sweep, all 3 directions for
 1 minute
 Endurance test - Frequency: 16.7 Hz, all 3 directions; amplitude of
 4 mm for 2 h
 Impact condition: Impact test: Acceleration at 490 m/s², all 3 directions
 Free-fall test - Height: 100 mm, 1 time for each 4 sides
 Power consumption: WT110:30 VA maximum; WT130: 50 VA maximum (Power supply :
 240V)
 WT110:20 VA maximum; WT130: 32 VA maximum (Power supply :
 100V)
 External dimensions: WT110: Approx. W × H × D : 213 × 88 × 350 (mm),
 8-3/8 × 3-1/2 × 13-3/4 (inch)
 WT130: Approx. W × H × D : 213 × 132 × 350 (mm),
 8-3/8 × 5-3/16 × 13-3/4 (inch)
 Weight: WT110: 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
 Spare fuse (for WT130 only)
 24-pin connector
 User's Manual
 Rubber feed
 Emission* Complying Standard:EN55011-Group1, Class A
 This is a Class A product for industrial environment. In a
 domestic environment, this product may cause radio
 interference in which cause the user may be required to take
 adequate measures.
 Cable Condition:
 Measuring Input
 WT100
 To bundle the wires between source and load with
 Ferrite Core (A1179MN).
 WT130
 To bundle the wires between source and load for each
 phase and to separate the input signal wires by less
 than 50 mm between each phase and neutral line.
 External Sensor Input (installed /EX1 or /EX2 option)
 500 mm max
 External Input/Output Signals (installed /DA4, /DA12, /CMP option)
 To use shielded wires
 Immunity* Complying Standard: EN50082-2:1995
 Susceptibility Under Immunity Condition
 Measuring Input : ±5 % of range max
 DA Output : ±40 % of range max
 Testing Condition
 Voltage : range 150 V Input, 100 V/50 Hz
 Current : range 1 A Input, 1 A/50 Hz
 Safety standard* Complying Standard :EN61010
 Overvoltage Category II
 Pollution degree 2

* Applies to products manufactured after Jan. 1997 having the CE Mark. For all other products, please contact your nearest YOKOGAWA representative as listed on the back cover of this manual.

15.14 Total 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
 Maximum reading: 9999
 Items to be analyzed: V1, V2, V3, A1, A2, A3, W1, W2, W3, deg1, deg2, deg3
 Each harmonic components, Total Vrms, Total Arms, Total
 effective power, PF of the fundamental, Phase-angle of
 fundamental, For each harmonic phase-angle related to the
 fundamental, Total harmonic distortion ratio in %, and contents
 ratio in %.
 However, a simultaneous analysis can be made for a specified
 input module.

Sampling speed/method: The sampling speed depends on the fundamental frequency to be
 input:

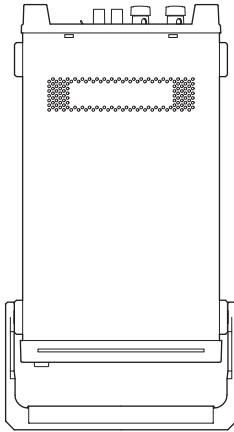
Input frequency range	Sampling frequency	Window up to the n th harmonic	Order
40 ≤ f < 70 Hz	f × 512 Hz	1 period of f	50
70 ≤ f < 130 Hz	f × 256 Hz	2 period of f	50
130 ≤ f < 250 Hz	f × 128 Hz	4 period of f	50
250 ≤ f < 440 Hz	f × 64 Hz	8 period of f	30

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

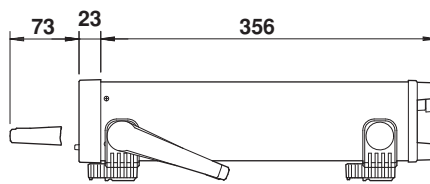
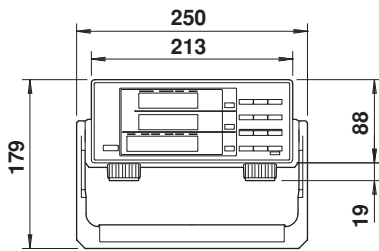
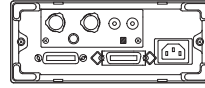
15.15 External Dimensions

WT110(253401)

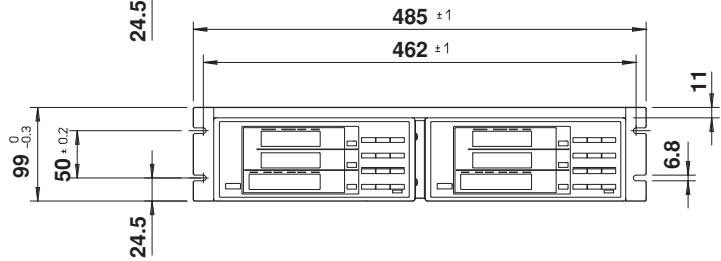
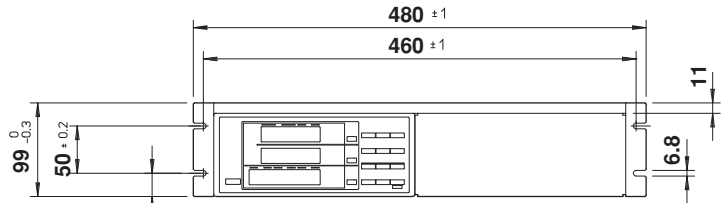
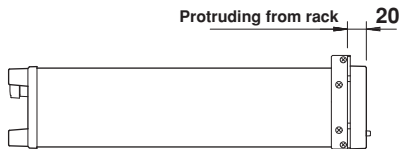
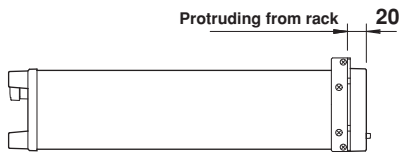
Unit:mm



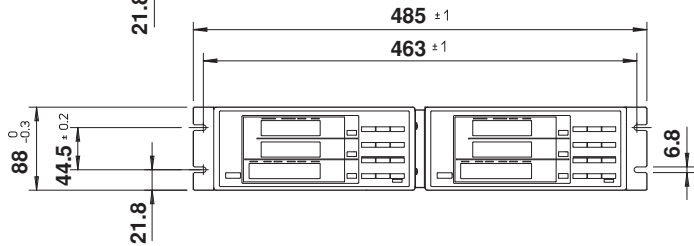
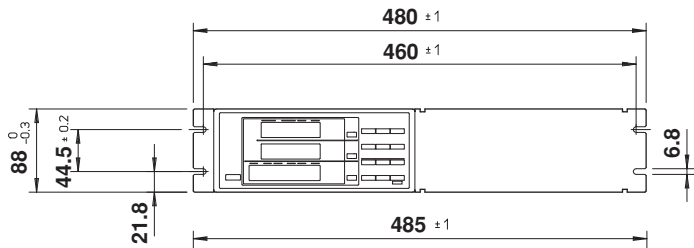
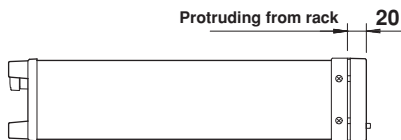
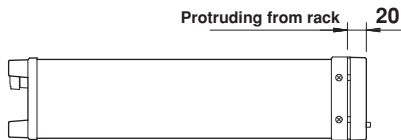
Rear



JIS rack mount



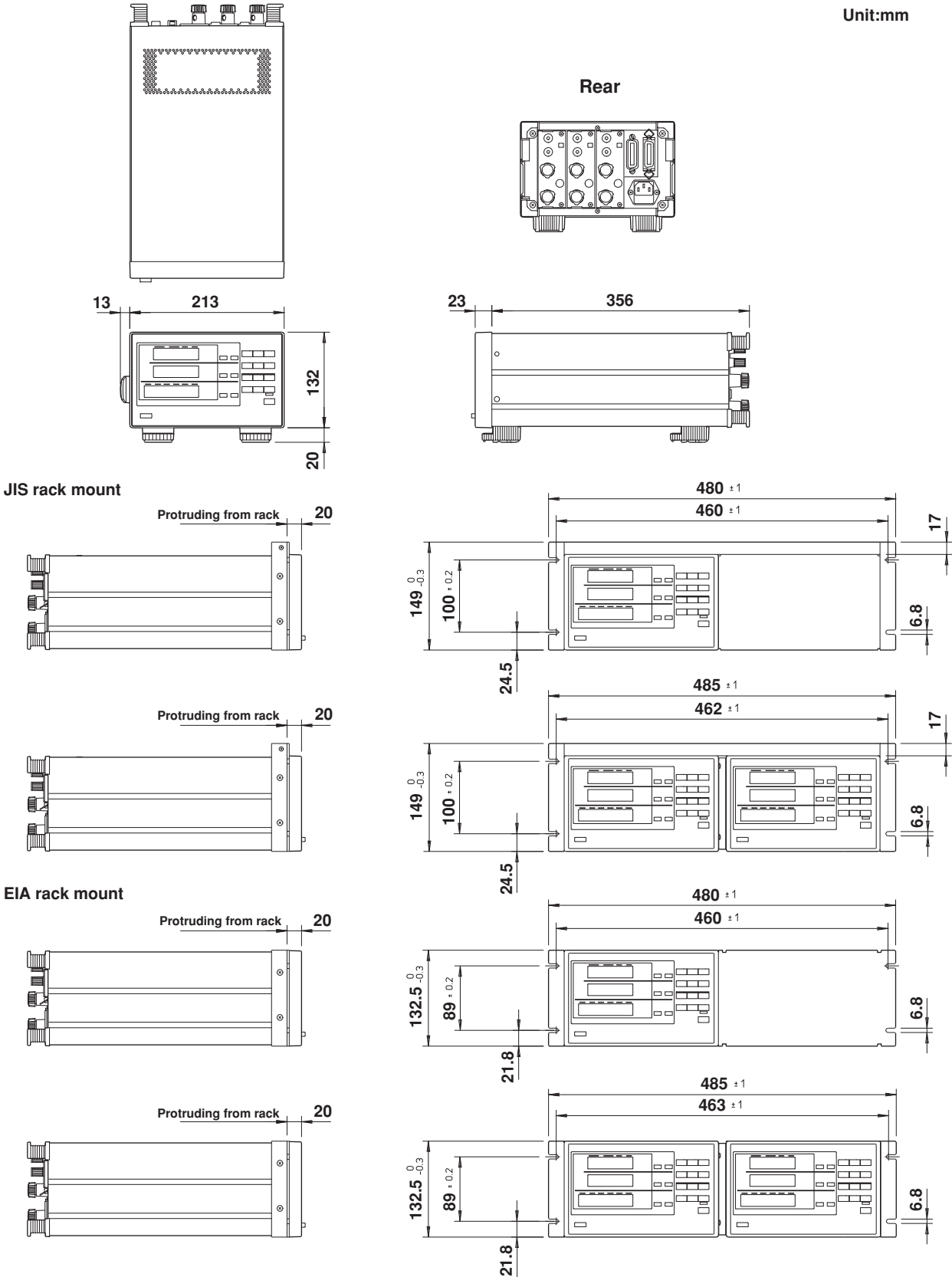
EIA rack mount



Unless other wise specified, tolerance is $\pm 3\%$ (However, tolerance is $\pm 0.3\text{mm}$ when below 10mm)

WT130(253502, 253503)

Unit:mm



Unless other wise specified, tolerance is ±3% (However, tolerance is ±0.3mm when below 10mm)