5.1 Signal Input Section

Power measurement element

Item	Specifications
Number of elements	Select from 1, 2, 3, and 4 (-HV, -WB).
Input terminal type	Voltage • HV element: Plug-in terminals (safety terminals) Ø4 mm safety banana jacks • WB element: Plug-in terminals (safety terminals) Ø4 mm safety banana jacks
I/O terminal type	Current Circular 20-pin connector
Input format	Voltage • HV element: Differential input through resistive voltage divider • WB element: Isolated input through voltage divider Current • When the sensor output type is current: Isolated input through shunt input • When the sensor output type is voltage: Isolated input through resistive voltage divider
Output voltage	• ±15 V • ±12 V
Output current	• 1.8 A/output (±15 V) • 0.8 A/output (±12 V)
Measurement range	Voltage • HV element: When the crest factor is CF3 6 / 15 / 30 / 60 / 150 / 300 / 600 / 1000 / 2000 V When the crest factor is CF6/CF6A 3 / 7.5 / 15 / 30 / 75 / 150 / 300 / 500 / 1000 V • WB element: When the crest factor is CF3 6 / 15 / 30 / 60 / 150 / 300 / 600 / 1000 V When the crest factor is CF6/CF6A 3 / 7.5 / 15 / 30 / 75 / 150 / 300 / 500 V • For the 2000 V range of the high-voltage element, the crest factor is 1.5 when the crest factor setting is CF3 and 3 when it is CF6.
	Current • When the sensor output type is current: When the crest factor is CF3 25 m / 50 m / 100 m / 250 m / 500 m / 1 A When the crest factor is CF6/CF6A 12.5 m / 25 m / 50 m / 125 m / 250m / 500 mA • When the sensor output type is voltage: When the crest factor is CF3 50 m / 100 m / 200 m / 500 m / 1 / 2 / 5 V When the crest factor is CF6/CF6A 25 m / 50 m / 100 m / 250 m / 500 m / 1 / 2.5 V • For the 5 V voltage input range, the crest factor is 2 when the crest factor setting is CF3 and 4 when it is CF6.
Instrument loss	Voltage • HV element: Input resistance 10 MΩ ± 1 % (between each terminal and ground), input capacitance < 5 pF (between each terminal and ground) • WB element: Input resistance 2 MΩ ± 1 % (between terminals), input capacitance < 10 pF (between terminals)
Input impedance	Current • When the sensor output type is current: input resistance: approx. 500 mΩ • When the sensor output type is voltage: Input resistance: 1 MΩ ± 1 % (between terminals), input capacitance < 10 pF (between terminals)
Instantaneous maximum allowable input (within 1 s)	Voltage • WB element: 3000 V peak, 1 s or less Current • When the sensor output type is current: 1.8 A peak, 0.1 s or less • When the sensor output type is voltage: 10 V RMS, 0.1 s or less

5.1 Signal Input Section

Item	Specifications
Continuous maximum allowable input	Voltage • HV element: 2100 V RMS or ±3000 V peak, whichever is lower • WB element: 1300 V RMS or ±2000 V peak, whichever is lower Input voltage frequency > 100 kHz: (1400 − f) Vrms or less Input voltage frequency > 1 MHz: $400/(f/1000)^2$ Vrms or less f is the frequency of the input voltage in units of kHz. Current • When the sensor output type is current: 1.1 A RMS or ±1.6 A peak, whichever is less • When the sensor output type is voltage: 8 V RMS or ±10 V peak, whichever is lower
Maximum rated voltage to ground (DC, 50/60 Hz)	Voltage • HV element voltage input terminals (VOLTAGE terminal, ± terminals) 2000 V AC/DC measurement category Other (estimated transient overvoltage 0 V) 1500 V DC CAT II 1000 V AC CAT II 1000 V AC/DC CAT III • WB element voltage input terminals (VOLTAGE terminal, ± terminals) 1000 V DC CAT II Current • When the sensor output type is current: 42 V peak • When the sensor output type is voltage: 42 V peak
Influence of isolation voltage	HV element voltage 50/60 Hz: 95 dB typ 100 kHz: 50 dB typ WB element voltage 50/60 Hz: 95 dB typ 100 kHz: 60 dB typ Current No specification (grounded when current sensor/current probe is connected) • Specified as CMRR (dB) according to the following formula. • CMRR (dB) = $20\times\log_{10}(Ec / M)$ Ec: Voltage to ground: M: Measurement influence • 1000 V is applied between an input terminal and case with the voltage input terminals shorted.
A/D converter	Simultaneous conversion of voltage and current inputs. Resolution: 16 bits Sample rate: 2.5 MS/s
Lower limit of measurement frequency	As follows. Data update interval — Lower limit of measurement frequency 10 ms — 200 Hz 50 ms — 45 Hz 100 ms — 20 Hz 200 ms — 10 Hz 500 ms — 5 Hz 1 s — 2 Hz 2 s — 1 Hz 5 s — 0.5 Hz 10 s — 0.2 Hz 20 s — 0.1 Hz Auto — 0.1 Hz (Time out 20 s)
Maximum display	140 % of the rated voltage or current range Specifications by range are as follows. High-voltage element voltage input 2000 V range: 110 % 1 A current input range when the sensor output type is current: 125 % 5 V current input range when the sensor output type is voltage: 125 % Twice that of CF3 for CF6
Minimum display	Depending on the measurement range, the following are the minimum values that are displayed: • Urms, Uac, Irms, Iac: Up to 0.3 % • Umn, Urmn, Imn, Irmn: Up to 2 % Twice that of CF3 for CF6/CF6A When the input level is lower than the value above, the display shows zero if the zero suppression setting is on, otherwise it shows the measured value. Current integration value q depends on the current value.
Current sensor correction	See “General Functions.”
Frequency measurement	See “Frequency Measurement Function”
Harmonic measurement	See “Harmonic Measurement Function”
Peak overrange detection	See "General functions"

5.2 Accuracy

Accuracy (6 months)

Conditions

Temperature: 23 ± 5 °C, humidity: 30 to 75 % RH, input waveform: sine wave, λ(power factor): 1, isolation voltage: 0 V
Crest factor: CF3, line filter: OFF
Frequency filter: Used when the signal frequency is 1 kHz or less
Sync source signal level: Same as the frequency measurement conditions
AC specified in RMS, DC specified in DC
After warm-up time has elapsed, wired condition after zero-level compensation or measurement range change
The unit of f in the accuracy equations is kHz.

Accuracy (6 months)
HV Element

Voltage

Frequency	Accuracy
DC	±(0.018 % of reading + 0.02 % of range)
0.1 Hz ≤f< 10 Hz	±(0.08 % of reading + 0.1 % of range)
10 Hz ≤f< 45 Hz	±(0.08 % of reading + 0.1 % of range)
45 Hz ≤f≤ 66 Hz	±(0.018 % of reading + 0.02 % of range)
66 Hz <f≤ 1 kHz	±(0.03 % of reading + 0.05 % of range)
1 kHz <f≤ 10 kHz	±(0.2 % of reading + 0.1 % of range)
10 kHz <f≤ 50 kHz	±{(0.1×f)% of reading + 0.3 % of range}
50 kHz <f≤ 100 kHz	±{(0.15×f)% of reading + 0.3 % of range}
Frequency Band	DC to 300 kHz (Typical)

Current

Frequency	Accuracy
DC	± (0.018 % of reading + 0.02 % of range)
0.1 Hz ≤f< 10 Hz	± (0.08 % of reading + 0.1 % of range)
10 Hz ≤f< 45 Hz	± (0.08 % of reading + 0.1 % of range)
45 Hz ≤f≤ 66 Hz	±(0.018 % of reading + 0.02 % of range)
66 Hz <f≤1 kHz	± (0.03 % of reading + 0.05 % of range)
1 kHz <f≤ 10 kHz	±(0.2 % of reading + 0.1 % of range)
10 kHz <f≤ 50 kHz	±{(0.1×f)% of reading + 0.3 % of range}
50 kHz <f≤ 100 kHz	±{(0.15×f)% of reading + 0.3 % of range}
Frequency Band	DC to 300 kHz (Typical)

Power Factor (1)

Frequency	Accuracy
DC	±(0.018 % of reading + 0.02 % of range)
0.1 Hz ≤f< 0 Hz	±(0.08 % of reading + 0.1 % of range)
10 Hz ≤f< 45 Hz	±(0.08 % of reading + 0.1 % of range)
45 Hz ≤f≤ 66 Hz	±(0.018 % of reading + 0.02 % of range)
66 Hz <f≤ 1 kHz	±(0.05 % of reading + 0.05 % of range)
1 kHz <f≤ 10 kHz	±(0.2 % of reading + 0.1 % of range)
10 kHz <f≤ 50 kHz	±{(0.1×f)% of reading + 0.3 % of range}
50 kHz <f≤ 100 kHz	±{(0.15×f)% of reading + 0.3 % of range}

Accuracy (6 months)

WB Element

Voltage

Frequency	Accuracy
DC	±(0.018 % of reading + 0.02 % of range)
0.1 Hz ≤f< 10 Hz	±(0.08 % of reading + 0.1 % of range)
10 Hz ≤f< 45 Hz	±(0.08 % of reading + 0.1 % of range)
45 Hz ≤f≤ 66 Hz	±(0.018 % of reading + 0.02 % of range)
66 Hz <f≤ 1 kHz	±(0.05 % of reading + 0.05 % of range)
1 kHz <f≤ 10 kHz	±(0.2 % of reading + 0.1 % of range)
10 kHz <f≤ 50 kHz	± (0.3 % of reading + 0.1 % of range)
50 kHz <f≤ 100 kHz	± (0.6 % of reading + 0.2 % of range)
100 kHz <f≤ 500 kHz	± {(0.006×f)% of reading + 0.5 % of range}
500 kHz <f≤ 1 MHz	±{(0.022×f−8)% of reading + 1 % of range}
Frequency Band	DC to 2MHz (Typical)

Current

Frequency	Accuracy
DC	± (0.018 % of reading + 0.02 % of range)
0.1 Hz ≤f< 10 Hz	± (0.08 % of reading + 0.1 % of range)
10 Hz ≤f< 45 Hz	± (0.08 % of reading + 0.1 % of range)
45 Hz ≤f≤ 66 Hz	±(0.018 % of reading + 0.02 % of range)
66 Hz <f≤ 1 kHz	± (0.03 % of reading + 0.05 % of range)
1 kHz <f≤ 10 kHz	± (0.1 % of reading + 0.05 % of range)
10 kHz <f≤ 50 kHz	± (0.2 % of reading + 0.05 % of range)
50 kHz <f≤ 100 kHz	± (0.6 % of reading + 0.2 % of range)
100 kHz <f≤ 500 kHz	± {(0.012×f)% of reading + 0.5 % of range}
500 kHz <f≤ 1 MHz	± {(0.012×f)% of reading + 0.5 % of range}
Frequency Band	DC to 2 MHz (Typical)

Power Factor (1)

Frequency	Accuracy
DC	±(0.018 % of reading + 0.02 % of range)
0.1 Hz ≤f< 10 Hz	±(0.08 % of reading + 0.1 % of range)
10 Hz ≤f< 45 Hz	±(0.08 % of reading + 0.1 % of range)
45 Hz ≤f≤ 66 Hz	±(0.018 % of reading + 0.02 % of range)
66 Hz<f≤ 1 kHz	±(0.05 % of reading + 0.05 % of range)
1 kHz<f≤ 10 kHz	±(0.2 % of reading + 0.1 % of range)
10 kHz<f≤ 50 kHz	±(0.3 % of reading + 0.2 % of range)
50 kHz<f≤ 100 kHz	±(0.7 % of reading + 0.3 % of range)
100 kHz<f≤ 500 kHz	±{(0.015×f)% of reading + 1 % of range}
500 kHz<f≤ 1 MHz	±{(0.041×f-13)% of reading + 2 % of range}

- For the HV element voltage input range, add the following values to the accuracies listed above:
  Voltage accuracy (6V range): ± 0.015 % of range
  Voltage accuracy (15V range): ± 0.005 % of range
  Add to the power accuracy according to the following formula. I is the current reading (A).
  Voltage-added accuracy (V) × I (W)

- For the current input range (sensor output type: current), add the following values to the accuracy values above.
  DC current accuracy: ±12 μA
  Add to the power accuracy according to the following formula. U is the voltage reading (V).
  Current-added accuracy (A) × U (W)

- For the current input range (sensor output type: voltage), add the following values to the accuracy values above.:
  Current accuracy (50 mV range): ± 0.02 % of range
  Current accuracy (100 mV range): ± 0.01 % of range
  Add to the power accuracy according to the following formula. U is the voltage reading (V).
  Current-added accuracy (A) × U (W)

- The accuracy for 110 to 130 % of the measurement range is range error × 1.5.
- When the input voltage exceeds 600 V, add 0.02 % of reading to the voltage and power accuracies.

- Guaranteed accuracy ranges for frequency, voltage, and current
  All accuracy figures for 0.1 Hz to 10 Hz are for reference only.
  For voltages that exceed 30 kHz and also exceed 750 V, the voltage and power values are reference values.

- Influence of temperature changes after zero-level compensation or range change
  Add the following values to the accuracies listed above.
  DC voltage accuracy: ±0.08 % of range/°C
  When the sensor output type is current DC accuracy: ±0.05 % of range/°C
  When the sensor output type is voltage DC accuracy: ±0.03 % of range/°C

  Add to the power accuracy according to the following formula. I is the current reading (A). U is the voltage reading (V).
  Voltage-added accuracy (V) × I (W)
  Current-added accuracy (A) × U (W)

- Influence of self-generated heat caused by voltage input
  Add the following values to the voltage accuracies.

  HV element voltage
  AC input signal: ±(0.025 × U^2 % of reading)
  DC input signal: ±(0.025 × U^2 % of reading + 0.025 × U^2 % of range)

  WB element voltage
  AC input signal: ±(0.1 × U^2 % of reading)
  DC input signal: ±(0.1 × U^2 % of reading + 0.1 × U^2 % of range)
  Even if the voltage input decreases, the influence from self-generated heat continues until the temperature of the input resistor decreases. U is the voltage reading (kV).

  Add to the power accuracy according to the following formula. I is the current reading (A).
  Voltage-added accuracy (V) × I (W)

  Even if the voltage input decreases, the influence from self-generated heat continues until the temperature of the input resistor decreases.

- Influence of self-generated heat caused by current input
  Add the following values to the current accuracies.
  When the sensor output type is current
  AC input signal: ±(0.06 × I^2 % of reading)
  DC input signal: ±(0.06 × I^2 % of reading + 0.06 × I^2 % of range)
  I is the current reading (CT scaling off) (A).
  Add to the power accuracy according to the following formula. U is the voltage reading (V).
  Current-added accuracy (A) × U (W)

  Even if the current input decreases, the influence from self-generated heat continues until the temperature of the input resistor decreases.

- Influence of data update interval
  Add the following values.
  10 ms: ± 0.03 % of reading
  50 ms: ± 0.03 % of reading
  100 ms: ± 0.02 % of reading

- Accuracy when the crest factor is set to CF6 or CF6A:
  The same as the accuracy when the crest factor is CF3 after doubling the range.

5.2 Accuracy

Item	Specifications
Power factor (λ) influence	Based on the following calculation formula When λ = 0 45 - 66Hz: ± 0.07 % of S Other frequencies: WB ± (0.07 + 0.05 × f) % of S (reference value) HV element ± (0.07 + 0.15 × f) % of S (reference value) 0 < λ < 1 ± P×[(power reading accuracy %) + (power range accuracy %)×(power range/S) + {tanφ×(influence % when λ = 0)}] S is the apparent power reading. P is the active power reading. φ is the phase angle reading between voltage and current. The unit of f is kHz.
Accuracy at 1 year	1.5 times the accuracy at 6 months
Temperature coefficient	At 5 °C to 18 °C or 28 °C to 40 °C, add the following value. ± 0.01 % of reading/°C
Effective input range	Voltage, current As follows: Udc, Idc: 0 to ±110 % of range Urms, Irms: 1 to 110 % of range Umn, Imn: 10 to 110 % of range Urmn, Irmn: 10 to 110 % of range
	Below are range-specific specifications. Udc (HV element, range: 2000 V): 0 to ±105 % of range Urms (HV element, range: 2000 V): 1 to 105 % of range Umn (HV element, range: 2000 V): 10 to 105 % of range Urmn (HV element, range: 2000 V): 10 to 105 % of range Udc (WB element, range: 1000 V): 0 to ±130 % of range Urms (WB element, range: 1000 V): 1 to 130 % of range Umn (WB element, range: 1000 V): 10 to 130 % of range Urmn (WB element, range: 1000 V): 10 to 130 % of range
	Power Provided that the effective input ranges for voltage and current are satisfied, the following applies. DC: 0 to ±110 % of range AC: 0 to ±110 % of range
	Below are range-specific specifications. DC (HV element, range: 2000 V): 0 to ± 105 % of range AC (HV element, range: 2000 V): 0 to ± 105 % of range DC (WB element, range: 1000 V): 0 to ±130 % of range AC (WB element, range: 1000 V): 0 to ±130 % of range The sync source level must meet the frequency measurement conditions. See “Frequency Measurement Function.”
Accuracies of waveform data Upk and Ipk	Add the following value to the voltage or current accuracy (reference value). The effective input range is within the crest factor of each range. HV element voltage ± (5 / range + 0.1) % of range WB element voltage ± (33 / range + 0.3) % of range Current (When the sensor output type is current) ± (0.02 / range + 0.1) % of range Current (When the sensor output type is voltage) ± (0.1 / range + 0.1) % of range
Accuracy of apparent power S	Voltage accuracy + current accuracy
Accuracy of reactive power Q	Accuracy of apparent power ± {$\sqrt{(1.0002 - \lambda^2)} - \sqrt{(1-\lambda^2)}$}×100 % of range λ is the power factor reading between voltage and current.
Accuracy of power factor λ	±[|λ − λ/1.0002| + |cosφ − cos{φ + $\sin^{-1}$ (influence of power factor of power when λ = 0 (%)/100)}|] ± 1 digit φ is the phase angle reading between voltage and current. λ is the power factor reading between voltage and current. When the voltage or current is rated range input.
Accuracy of phase difference φ	± [|$\cos^{-1}$ (λ) − $\cos^{-1}$ (λ/1.0002)| + $\sin^{-1}${(influence from the power factor when λ = 0 %)/100}] deg ± 1 digit λ is the power factor of the voltage and current. When the voltage or current is rated range input
Lead and lag detection	• Phase difference: ±(5° to 175°) • Frequency: 20 Hz to 10 kHz • Condition: Sine wave • At least 50 % of the measurement range (at least 100 % for CF6 and CF6A)

Item	Specifications
Line filter	When the line filter is on, add the following to the voltage, current, and active power accuracies. Voltage, current f ≤ (fc/10): ±(20×f/fc) % of reading Active power f ≤ (fc/10): ±(40×f/fc) % of reading When applying 300 kHz for fc, add the following to the “influence of temperature changes after zero-level compensation or range change.” ± 0.015 % of range/°C In the accuracy formula, fc is the cutoff frequency and f is the input frequency. The unit is kHz. The upper limit of the guaranteed accuracy range is fc/10. For filter function specifications, see “Filter Function.”
Accuracy of VT and CT combinations	Accuracy when combined with CTs Calculate the accuracy when this instrument is combined with a CT as follows: This applies to combinations with the various sensors (CT) described in this manual. Current accuracy Add the CT amplitude accuracy to the current accuracy of this instrument. Active power (power factor 1) accuracy Add to the power accuracy of this instrument the value (%) calculated from the CT amplitude accuracy (the value converted to A) using the following formula. ±(CT amplitude accuracy/I) × 100% Effect of the power factor (λ) When λ = 0 Calculate from the CT phase accuracy and the effect of the power factor on power when λ = 0 for this instrument (%) using the following formula. ±sin(sin^{-1}(effect of the power factor on power when λ = 0 for this instrument (%)/100) + CT phase accuracy) × 100% of S When 0 < λ < 1 Calculate from the CT amplitude accuracy (the value converted to A), CT phase accuracy, and the effect of the power factor on power when λ = 0 for this instrument (%) using the following formula. ±P × [(power reading accuracy (%) + (CT amplitude accuracy/I) × 100%) + (power range accuracy (%)) × (power range/S) + {tanφ × (effect of the power factor on power when λ = 0 (%))}] The unit of CT amplitude accuracy is A, and the unit of phase accuracy is °. I is the current reading [A], S is the apparent power reading [VA], and P is the active power reading [W]. φ is the phase angle between voltage and current [°].

CT, cable combination restrictions

Item	Specifications
Combination with CT1000	Use within the following ambient temperature derating. CT ambient temperature 45 °C or more: Primary current 900 Apeak or less CT ambient temperature 45 °C or less: Follows the CT1000 specifications
Combination with a dedicated 10-m current sensor connection cable	CT2000 A primary current: 2100 Apeak or less

5.3 Motor Evaluation for Encoder (/EM1, /EM1RM1, /EM2 option)

Item		Specifications	
Input connector type		Isolated BNC	
Input format		Isolated input	
Input resistance		Input resistance: 1 MΩ ± 1 %, input capacitance: approx. 47 pF	
Continuous maximum allowable input		Peak and DC ± 22 V or less	
Maximum rated voltage to ground		±42 Vpeak or less	
Input channels		/EM1, /EM2, /EM1RM1	ChA (torque signal 1/external signal 1): Analog input/pulse input ChB (speed signal 1/external signal 3): Pulse input ChC (phase B/torque signal 2/external signal 2): Analog input/pulse input ChD (phase Z/speed signal 2/external signal 4): Pulse input
		/EM2	ChE (torque signal 3/external signal 5): Analog input/pulse input ChF (phase A/speed signal 3/external signal 7): Pulse input ChG (phase B/torque signal 4/external signal 6): Analog input/pulse input ChH (phase Z/speed signal 4/external signal 8): Pulse input
Input type	Analog input	Range	1/2/5/10/20 V
		Range setting	Fixed/Auto range Auto range Range increase: When the measured value exceeds 110 % of range or when the peak value exceeds approx. 150 % Range decrease: When the measured value is 30 % of the range or less and the peak value is less than 125 % of the next lower range
		Input range	±110 % of range
		Maximum display	±130 % of the rated range
		Bandwidth	20kHz (-3 dB) Typ
		Sample rate	2.5 Ms/s
		Resolution	16 bit
		Accuracy (6 months)	±(0.05 % of reading + 0.05 % of range) Accuracy guarantee conditions Humidity: 30% RH to 75% RH Voltage to ground: 0 V After the warm-up time has elapsed, perform zero-level compensation with the wiring connected. Add the temperature coefficient from 5 °C to 18 °C and from 28 °C to 40 °C. For 1-year accuracy, multiply the reading component (% of reading) of the 6-month accuracy by 1.5.
		Temperature coefficient	± 0.03 % of range/°C
		Line filter	Low-pass filter Filter response: Butterworth Cutoff frequency fc: 100 Hz, 500 Hz, 1 kHz
	Pulse inputs	Range	10 V
		Input range	±12 Vpeak
		Detection level	H level: Approx. 2 V or more L level: Approx. 0.8 V or less
		Pulse width	500 ns or more However, 50 % duty cycle for detecting forward rotation
		Frequency measurement range	2 Hz to 1 MHz
		Maximum display	1000000 rpm when the number of pulses per revolution of the rotational signal is 60
		Rotation direction detection	2 Hz to 1 MHz When the pulse noise filter is in use: 10 kHz: 2 Hz to 3 kHz 100 kHz: 2 Hz to 30 kHz 1 MHz: 2 Hz to 300 kHz

Item	Specifications	
	Accuracy(1 year)	±(0.03 + f / 10000) % of reading ± 1 mHz The unit of f is kHz.
	Detection level	H level: Approx. 2 V or more L level: Approx. 0.8 V or less
	Pulse noise filter	Low-pass filter fc 10kHz, 100kHz, 1MHz
	Z pulse delay correction	See “Phase correction of electric angle.”
Peak overrange detection	150 % of the range or more	

5.4 Motor Evaluation for Resolver (/RM1, /EM1RM1, /RM2 option)

Item		Specifications	
Input connector type		Isolated BNC	
Input format		Isolated input	
Input resistance		Input resistance: 1 MΩ ± 1 %, input capacitance: approx. 47 pF	
Continuous maximum allowable input		Peak and DC ± 22 V or less	
Maximum rated voltage to ground		±42 V peak or less	
Input channels		/RM1, /EM1RM1, /RM2:	ChA (torque signal 1/external signal 1): Analog input/pulse input ChB (carrier signal 1/external signal 3): Analog input/resolver input ChC (sine signal 1/external signal 2): Analog input/resolver input ChD (cosine signal 1/external signal 4): Analog input/resolver input
		/EM1RM1, /RM2:	ChE (torque signal 3/external signal 5): Analog input/pulse input ChF (carrier signal 3/external signal 7): Analog input/resolver input ChG (sine signal 3/external signal 6): Analog input/resolver input ChH (cosine signal 3/external signal 8): Analog input/resolver input
Input type	Analog input	Range	1/2/5/10/20 V
		Range setting	Fixed/auto range setting Auto range setting function Range up: When the measured value exceeds 110 % of the range or the peak value exceeds approximately 150 %. Range down: When the measured value is 30 % of the range or less and the peak value is less than 125 % of the next lower range.
		Input range	±110 % of range
		Maximum display	±130 % of the rated range
		Bandwidth	ChA, E: 20 kHz (–3 dB) Typ ChB, C, D, F, G, H: 1 MHz (–3 dB) Typ
		A/D converter	Resolution: 16 bits Sample rate: Approx. 2.5 MS/s
		Accuracy (6 months)	ChA, E: ±(0.05 % of reading + 0.05 % of range) ChB, C, D, F, G, H: ±(0.1 % of reading + 0.2 % of range) Accuracy guarantee conditions Humidity: 30 % RH to 75 % RH Isolation voltage 0 V Zero-level compensation performed under wired conditions after warm-up time has elapsed For 5 °C to 18 °C and 28 °C to 40 °C, add the temperature coefficient. For the accuracy at 1 year, multiply the accuracy at 6 months by 1.5.
		Temperature coefficient	ChA, E: ±0.03 % of range/°C ChB, C, D, F, G, H: ±0.04 % of range/°C
		Line filter	Off or low-pass filter Low-pass filter Filter response: Butterworth Cutoff frequency fc: Select from 100 Hz, 500 Hz, and 1 kHz.
	Pulse inputs	Range	10 V
		Input range	±12 V peak
		Detection level	H level: Approx. 2 V or more L level: Approx. 0.8 V or less
		Pulse width	500 ns or more
		Frequency measurement range	2 Hz-1 MHz
		Maximum display	A measured value equivalent to the maximum display pulse input of 1 MHz, or 1,000,000 rpm when the number of pulses per rotation of the rotation signal is 60
		Accuracy (1 year)	±(0.03 + f / 10000) % of reading±1 mHz f is the measured frequency in units of kHz.
		Pulse noise filter	Off or low-pass filter Low-pass filter Cutoff frequency: 10 kHz, 100 kHz, 1 MHz

Item		Specifications	
	Resolver input	Range	1/2/5/10/20 V
		Range setting	Fixed/auto range setting Auto range setting function Range up When the peak value exceeds 110 % of the range or when peak over occurs Range down When the peak value is less than 105 % of the next lower range
		Input range	±110 % of range
		Bandwidth	1 MHz (-3 dB) Typ
		Electrical angle measurement error	±0.1 ° Typ Provided that the motor has one pole pair, the resolver axis multiplication factor is 1, the carrier frequency is not more than one-tenth of the line filter cutoff frequency, and the motor frequency is 16 Hz or less.
		A/D converter	Resolution: 16 bits Sample rate: 2.5 MS/s
		Rotating speed accuracy (1 year)	±(0.05 + f / 10000) % of reading ± 1 mHz f is the measured frequency in units of kHz. Specified as the frequency measurement value of the Z pulse after calculation by the resolver operation function Accuracy guarantee conditions • Peak-to-peak resolver input amplitude is at least 50 % of the range. • The carrier frequency of the resolver input is within the supported carrier frequency range of the resolver operation function. • The post-calculation Z-pulse frequency is within the pulse input frequency measurement range.
		Maximum display	150,000 rpm
		Line filter	Off or low-pass filter Low-pass filter Filter response: Butterworth Cutoff frequency fc: Select from 10 kHz, 20 kHz, 50 kHz, 100 kHz, and 200 kHz.
		Tracking filter	See “Resolver operation function.”
Peak overrange detection		150 % of the range or more	

5.5 Display

Instrument screen

Item	Specifications
Display	2.9-inch monochrome STN LCD module
Resolution of the entire screen*	256 × 128 dots (H × V)
Display language	English
Display update interval	1) When the update mode is Constant or Auto: 1 s However, if the data update interval exceeds 1 second, it is the same as the data update interval. 2) When the update mode is Trigger: After trigger detection, the measurement range and measured data for the data update rate are calculated, and the display is updated based on the results. The time it takes for the next trigger to become ready after a trigger is as follows: • When the data update interval is 10 ms to 500 ms: approx. 1 s • When the data update interval is 1 s to 20 s: data update interval + 500 ms
Measurement display	Number of displayed digits: For 60000 and less: 5 digits For values exceeding 60000: 4 digits Display format: element-based numeric display, measurement function-based numeric display, four-value numeric display No-data display symbol: --- Error display symbol: Error For errors that occur when the frequency measurement or motor or AUX pulse measurement is less than the lower limit, Error or zero can be selected.
Information Display	Communication settings (IP address), input status (peak overrange, current sensor status), system overview, message log, and error display
Other screens	Setup menu Settings menu: save/restore settings file, save message log, multi-device synchronization settings, time settings, firmware update/add options

* About 0.002 % of the pixels on the LCD screen may be defective.

External monitor output and Web server screen

Item	Specifications
Display language	Japanese, English, Chinese, German
Display update interval	1) When the update mode is Constant or Auto: 1 s However, if the data update interval exceeds 1 second, it is the same as the data update interval. 2) When the update mode is Trigger: The display is updated after a trigger is detected and the measurement range and measurement data determined from the data update rate are calculated. The time it takes for the next trigger to become ready after a trigger is as follows: • When the data update interval is 50 ms to 500 ms: approx. 1 s[1] • When the data update interval is 1 s to 20 s: data update interval + 500 ms[1] The web server screen is not updated when the data update interval is 10 ms. 1 During synchronous operation in multi-unit synchronization mode, add 150 ms per connected sub unit.
Measurement display	Number of displayed digits: For 60000 and less: 5 digits For values exceeding 60000: 4 digits Display format: ALL, 4, 8, 16, Matrix, Hrm List Single, Hrm List Dual No-data display symbol: --- Error display symbol: Error For errors that occur when the frequency measurement or motor or AUX pulse measurement is less than the lower limit, Error or zero can be selected.

Item	Specifications
Waveform display	Peak-to-peak compressed data Waveform display items Voltage, current: elements 1 to 4 Torque, speed: Motors 1 and 2 (/EM1, /RM1[1], /EM2, /EM1RM1[1], /RM2[1]) Motors 3 and 4 (/EM2, /EM1RM1[1], /RM2[1]) External signal: Aux1 to 4 (/EM1, /RM1, /EM2, /EM1RM1, /RM2) Aux5 to 8 (/EM2, /EM1RM1, /RM2) 1 Motor Evaluation for Resolver only for motors 1 and 3
	Split screen: Single, Dual, Triad, Quad, Hexa Vertical axis: Auto, Manual (set zoom and position) Time scale : Time/div range of 0.1 ms to 2 s when the update mode is not Auto[2] Time/div range of 0.1 ms to 5 ms when the update mode is Auto[2] 2 In 1-2-5 steps for times less than or equal to 1/10th of the data update interval
	Triggering Trigger type: edge Trigger mode: select from auto and normal. Trigger source: select from voltage, current, and Ext Clk (external clock) During synchronous operation in multi-unit synchronization mode, select the trigger source unit from Main and Sub1 to 4. Trigger slope: select from rising, falling, or rising and falling. Fixed to rising when the trigger source is Ext Clk (external clock). Trigger level When the trigger source is set to the voltage or current applied to an input element, the trigger level can be set to a value that is within the range defined by the middle of the screen ± 100 % (to the top and bottom edges of the screen). Resolution: 0.1 % Trigger delay: ≤ 2 µs When the trigger source is Ext Clk (external clock) TTL level When wiring with delta transformation is specified, the trigger is based on the input after delta conversion. Time axis zoom feature: none Amplitude zoom feature: set between 0.1x to 100x Display interpolation: off, two-point linear interpolation Grid: selectable (frame, grid, X-Y) When the data update interval is 10 ms, the waveform data is not updated.
Bar graph display	Displays a bar graph of the amplitude and phase of each harmonic Split graph: Single, Dual, T Vertical scale: Log, Linear Range setting: auto or manual (set the upper and lower limits) Display range: start harmonic: 0 to 90, end harmonic: 10 to 100
Vector display	Displays the phase difference between the fundamental voltage signal and fundamental current signal as a vector. Divisions: 2 Screen zoom feature: 0.1x to 100x Numeric display: available
Other measurement screen display items	Setup menu Measurement mode, time, data update interval, data update count, peak overrange information, sensor status information, integration settings/status, storage status, crest factor, averaging, element settings/status, option settings/status

5.6 Controls

Control devices	Power switch, control keys
Key control functions	Functions controlled directly with keys Direct control items: • Menu, HOLD key, key control to external monitor, key lock, release remote • Panel menus can be controlled using the arrow, SET, and ESC keys.
LED Indicator	(1) Data update LED (UPDATE) Green light blinks during data update.
	(2) Peak overrange LED (PEAK OVER) The LED lights red when a peak overrange is detected on the voltage/current/optional input channel.
	(3) Hold LED (HOLD key) The LED lights green when measurement hold is on.
	(4) Current sensor power supply overcurrent LED (OVER CURRENT) If an overcurrent occurs in the current sensor or probe, one or more elements with interrupted power supply will blink red. During synchronous operation in multi-unit synchronization mode, the power supply status of sub units is also reflected.
	(5) Multi-unit synchronization mode and synchronous mode LED (MAIN/SUB) Lights as follows according to the multi-unit synchronization mode • MAIN on/blinking: multi-unit synchronization mode main unit • SUB on/blinking: multi-unit synchronization mode sub unit • MAIN/SUB both off: multi-unit synchronization mode off Lights green as follows according to the synchronous operation status • Solid: synchronous operation on (Operating) • Blinking: Synchronous operation off (OFF) or standby (STANDBY)
	(6) Multi-unit synchronization sub unit number and unit connection status LED (SUB UNIT) When multi-unit synchronization mode is Main Unit, the connection status with the sub unit is displayed. When multi-unit synchronization mode is Sub unit, the sub unit number assigned to this instrument and the connection status with the main unit are displayed. • Off: Not used • Green solid: normal connection • Green blinking: connecting • Red blinking: connection error
	(7) External monitor key control LED (KEY TO EXT MONITOR) Lights blue when the cross key, SET key, ESC key, and MENU key are controlling an external monitor output or web server.
	(8) Key lock (KEY LOCK) Lights green when front panel key operations are locked.
	(9) Remote (REMOTE) Lights green when remote mode is enabled via communications and key operations are restricted.
	(10) Emergency operation stop LED (MENU key) The MENU key lights red when the system has automatically shutdown due to a fan stoppage or internal temperature error detection.

5.7 Wiring Systems

Item	Specifications
Method	Single-phase two-wire (1P2W) Single-phase three-wire (1P3W) Three-phase three-wire (3P3W, 3P3W (3V3A), 3P3W (3V3AR)), 3P3W (3V3A)→3P4W*, 3P3W (3V3AR)→3P4W*) Three-phase four-wire (3P4W)(3P4W, 3P4W→3P3W (3V3AS)*)

* Wiring system with the delta transformation function
Waveform, basic measurement values, and harmonics, as well as measured values computed from them, are computed based on values that have been transformed between phase voltage and line-to-line voltage.
The original measured values before delta transformation are displayed as delta computation values.
The rectifier cannot be turned on when a wiring system with the delta transformation function is set.

5.8 Measuring Mode

Measurement functions determined for each input element

Item	Specifications	
During normal measurement	Computing method Sync source period average Calculated using sync source period average in auto update mode	
	Constant-interval update mode	Data update interval 10 ms/50 ms/100 ms/200 ms/500 ms/1 s/2 s/5 s/10 s/20 s Display screen: LCD: numeric display External monitor output: numeric, waveform (free run), bar, vector Single or split display Measurement function: normal, harmonic
	Trigger update mode	Display screen: LCD: numeric display External monitor output: numeric, waveform (trigger operation), bar, vector Single or split display Measurement function: normal, harmonic However, the integration feature is not available.
	Auto update mode	Data update interval: 10 ms, 50 ms Timeout: 1 s, 5 s, 10 s, or 20 s Screen: same as constant-interval update mode Measurement function: same as constant-interval update mode

5.9 Function

General functions

Item	Specifications
Crest factor setting	Select crest factor CF3, crest factor CF6, or crest factor CF6A.
Element	Can be set for each input element and wiring unit
Range setting	Fixed/set Fixed range setting Manually set the range of your choice. (only ranges that are selected by the valid measurement range selection function) Range Σ link: ON: Set the range for each wiring unit. OFF: Set the range for each element. Auto range setting Auto range setting function Range increase The range is increased if any of the following conditions are met. • When the measured value of Urms or Irms exceeds 110 % of the selected range (220 % when the crest factor is set to CF6A) • The input signal peak value (Upk, Ipk) is greater than or equal to approximately 310 % of the present range. (greater than or equal to 620 % for crest factor CF6/CF6A) Range decrease The measurement range is decreased when all the following conditions are met. • The data of Urms or Irms is less than or equal to 30 % of the measurement range. • The data of Urms or Irms is less than or equal to 105 % of the next lower range. • For CF3, the data of Upk or Ipk is less than or equal to 290 % of the next lower range. • CF6/CF6A, the data of Upk or Ipk is less than or equal to 580 % of the next lower range. Peak overrange occurrence range setting function A function that changes the range to the specified range when a peak overrange occurs Valid measurement range selection function A function that lets you select the valid measurement range according to the usage conditions. Ranges set to Use are included in the range configuration. All other ranges are excluded from range selection.
Element scaling	A feature that allows direct reading by setting the current sensor conversion ratio, VT ratio, CT ratio, and power coefficient SF • CT ratio can be set automatically by selecting a model name of CT series. Source measurement function Set voltage U, current I, power (P, S, Q), maximum voltage (U+pk)/minimum voltage (U-pk), maximum current (I+pk)/minimum current (I–pk), maximum power (P+pk)/minimum power (P–pk), and VT ratio in the following range. Selectable range: 0.0001 to 99999.9999 For wiring with delta transformation, scaling is applied to VT and CT ratio data before delta transformation. Scaling is applied to SF data after delta transformation.

Item	Specifications
Averaging	Type: Exponential average, moving average Target: Normal measurement function Urms, Umn, Udc, Urmn, Uac, Irms, Imn, Idc, Irmn, Iac, P, S, Q, fU, fI, Torque, Speed, Pm, Aux (/EM1, /RM1, /EM2, /EM1RM1, /RM2 option) Harmonic measurement function U(k), I(k), P(k), S(k), Q(k) Exponential averaging, attenuation constant: 2 to 64 Moving average, average count: 8 to 64 Data reset: Averaging is reset if a setting of any of the functions below is changed. Averaging type, averaging attenuation constant Range, crest factor, range Σ link, wiring Scale value Line filter, frequency filter Data update interval, averaging method, sync source Zero-level compensation Maximum harmonic order, minimum harmonic order, harmonic window span Waveform observation time, measurement mode, update mode, multi-unit synchronization mode * During auto update mode, only exponential averaging can be used. * When multi-unit synchronization mode is on, only exponential averaging can be used.
Hold	Measurement hold: Suspends the measurement and display operations and holds the data display of each measurement function. However, measurement is not suspended during integration. Only the display is held. Communication output, and the like are also held. However, if only the display is held and measurement is continuing during integration, the storage function saves the measured values that are being updated.
Single measurement	A single measurement is performed at the specified data update rate while a measurement is being held and the hold state is maintained. If you press SINGLE when the measurement is not being held, measurement is performed again from that point. * When the update mode is Auto, single measurement is not possible.
Zero-level compensation (CAL)	Measurement element's circuit offset correction feature Manual: Executed under the current settings through a key operation or communication. Auto: Automatically executed when the measurement range is changed, when the filter is changed, or when integration is started. For wiring with delta transformation, zero-level compensation (Cal) is performed on data before delta transformation.
Zero-level compensation (Null)	Offset correction feature for all measurement circuits including measurement elements Executed under the current settings through a key operation or communication. Null state setting target: Set the target channel for the null ON operation. Null value update: Select the correction value for when null is ON: New: most recent DC measurement value or Hold: previous null value held last time [Upper null limit] For current input, the sum of the current offset correction value and the null correction value is considered the total offset. For voltage input, the null correction value is considered the total offset. The following is the upper limit for the total offset value. Analog input (Element/Motor/Aux): 10 % of range rating Pulse and resolver input (Motor/Aux) Speed: 10 % of [60/N 10000 Hz] [rpm] Torque: 10 % of the absolute value of Rated Upper [Nm] Rated Upper: The larger of "Nm-Hz coordinates × 2 points" for determining the linear scaling value Aux: 10 % of the upper pulse input specification limit 2 MHz [Hz] For wiring with delta transformation, zero-level compensation (Null) is performed on data before delta transformation. Do not perform zero-level correction (NULL) on resolver input.

Item	Specifications	
Phase difference polarity	The phase difference φ between the voltage and current indicates the current phase relative to the voltage of each element. Select the signs to apply to the lead and lag of this phase difference. • Lead(-)/Lag(+) Lead: negative (-) Lag: positive (+) • Lead(+)/Lag(-) Lead: positive (+) Lag: negative (-) The following measurement functions change signs depending on the phase difference polarity. Phase difference: φ, phase difference between the fundamental components: φfnd, Phase difference of harmonic measurement: φ(k), φU1-U2, φU1-U3, φU1-I1, φU2-I2, φU3-I3 Other angles, the phase angle between U(1) and U(k): φU(k), the phase angle between I(1) and I(k): φI (k), and the electric angles: EaU1 to EaU7 are not affected by the phase difference polarity setting. Lead is positive (+), and lag is negative (-). For wiring with delta transformation, phase difference polarity is calculated based on the phase difference after delta transformation.	
Current sensor correction	Input element current correction function Can be set for each element. Can be turned on or off.	
	Amplitude correction	Selectable range: 0.800000 - 1.200000 Resolution: 0.000001
	Offset correction	Selectable range: ±9.99999E±3 Resolution: 6 digits, floating point E-3 to E+3 Valid resolution: resolution of the measurement range Correction range: Up to ±10 % of the measurement range for the combined total of current offset correction and null zero level correction.
	Phase correction	Frequency setting range: 50 Hz, 60 Hz, 0.1 kHz to 999.9 kHz (0.1 kHz steps), 1 MHz Phase difference setting range: −180.000° to +180.000°* * The phase difference can be set within the range where the time difference between input and output is ±10 μs. * Correction accuracy: 1 ns typ
Phase correction of electric angle	Phase correction of electric angle function of the motor evaluation option Selectable range: −180.00 to 180.00°	
Auto sensor setting	Detected current sensors are automatically set to the corresponding current sensor models. For each element, the function can be turned on or off. Detectable current sensors: CT2000A, CT1000A Connect the current sensor before turning on the instrument. Current sensors connected after the instrument is turned on are not detected. • Auto sensor setting is ON • Current sensor detected To set different types of current sensors for the elements in the same wiring unit, set Range Σ Link to OFF.	
Storage	Stores numeric data to internal memory and a USB memory device	
	Save interval	Data update interval, specified time, or specified interval
	Synchronization	Manual, real time, integration, event, single shot
	Storage count	1 to 9999999
	Time interval	10 ms to 99 h59 m59 s
	File format	Binary
	Maximum data file size	1 GB
	Saved data conversion	Converts to CSV. Saves to USB memory. • CSV file size of up to 4 GB can be converted. • When the binary file is in the internal memory, a CSV file is saved in the root directory of the USB memory device.
	Auto CSV conversion	CSV conversion is performed automatically when the binary file is completed after storage is completed or finished. (ON/OFF)
Data save	Save numeric data, waveform data, and screen images to the internal memory, a USB memory device, or a network drive	
Saving and Loading Setup Parameters	Save setup parameters to the internal memory, a USB memory device, or a network drive Load saved setup parameters.	
File operation	Create folder, copy, move, rename, protect, delete	

Item	Specifications
Master and Slave Synchronized Measurement	A feature for synchronizing the measurement start on slave devices to the master device Connector type: BNC: Same for master and slaves I/O level: TTL: Same for master and slaves Output logic: Negative logic, falling edge: Applies to the master Output hold time: Low level, 500 ns or more: Applies to the master Input logic: Negative logic, falling edge: Applies to slaves Minimum pulse width: Low level, 500 ns or more: Applies to slaves Measurement start output signal delay: Applies to the master: within 1 µs Measurement start delay: Applies to slaves: within 2 µs Maximum number of connected units: 4 units Data update interval: 50 ms to 20 s Measuring mode: During normal measurement
History	Holds the past measurement update data history up to the maximum number of history entries • Maximum number of historical entries: 40 The data in the history is transmitted according to the history communication output mode.
	History communication output mode • N update: Notifies via the status register after every N data updates since measurement began. The range of numerical data transmitted from the history is over the history communication output count (N), counting backward from the notification point.
	History communication output count • Manually select the number times to output update data at once during history communication output. • Range: 1 to 20
	Communication output command • History communication numeric data output • History communication numeric list output
User-defined function	A function for performing computation by combining measurement function symbols Calculation count: 20 Maximum number of operands: 16 Number of characters in an expression: Up to 120 Number of unit characters: Up to 8 Operators: +, -, ×, ÷, ABS, SQR, SQRT, LOG, LOG10, EXP, NEG, SIN, COS, TAN, ASIN, ACOS, ATAN Parameters: Element, Σ unit, harmonic order
MAX Hold	Can be defined using the user-defined function
Efficiency formula	4
User-defined events	Uses measurement functions and user-defined events as criteria. Event: Measurement condition Reference condition: <, <=, =, >, >=, != Number of events: 8
Peak overrange detection	Elements, Motor(/EM1, /RM1, /EM2, /EM1RM1, /RM2) When any element or motor range tolerance is exceeded, the peak overrange indicator LED lights red. Peak overrange information is displayed on the LCD screen's peak overrange status display and on the external monitor output screen. Peak overrange detection for elements is determined before the digital LPF. For wiring with delta transformation, peak overrange detection for elements is performed before delta transformation.
System configuration	Date and time, message language, menu language
Time setting	Sets the time at startup using the Simple Network Time Protocol (SNTP)
Time synchronization feature	Synchronization source: Supports IEEE1588-2008 (PTP v2) (slave only) Supports PTP packets of Layer3 (UDP/IPv4) and Layer2 (Ethernet) Supports Ordinary Clock Supports E2E and P2P delay correction Synchronization target: time data (excluding data update rate and sampling clock) Synchronization accuracy: ±10 µs Typical (when synchronized), ±0.02 % (when not synchronized)
Initialization function	Returns the settings to their factory default values Settings that are not initialized: date and time, communication settings, menu language, message language, environmental settings* Maximum hold reset function for integration start * Environmental settings (Preference): Indication that appears when the frequency or motor pulse frequency is less than the lower limit, decimal point and separator used when saving to ASCII format (.csv), date format Starting the instrument with the ESC key held down returns all settings except the date and time to their factory default values.

Item	Specifications
Self-test	Memory, keyboard
Upgrading	Updates the firmware and prompts the user to input the add-on package license keys

Averaging function

Method	Math
Sync source period average	Averaging performed over a specified period Set the calculation period using the set reference signal (sync source) (excluding WP and DC q) Synchronization source: UE, IE, EXT CLK, Z (/EM1, /RM1, /EM2, /EM1RM1, /RM2 option) The period of UE and IE is detected using a specified trigger value from the waveform sampling data (E is the element number.) For wiring with delta transformation, if the sync source is set to UE or IE, the computation period is set based on the data after delta transformation. Data update interval: • When the update mode is Constant or Trigger: 10 ms/50 ms/100 ms/200 ms/500 ms/1 s/2 s/5 s/10 s/20 s • When the update mode is Auto: 10 ms/50 ms Averaging period: • When the update mode is Constant or Trigger: Data update interval or less • When the update mode is Auto: Timeout period or less

Filter function

Item	Specifications
Line filter	For elements 1 to 4 Can be set separately for each element Calculation rate: Calculation rate: 2.5 MS/s Filter response: Butterworth Filter form: IIR Filter type: LPF Filter order: 2 Cutoff characteristics: −12 dB/Oct (typical) LPF: cutoff frequency: 100 Hz - 200 kHz, 300 kHz Resolution: 100 Hz * Analog filter Filter response: Bessel Filter type: LPF Filter order: 4 Valid for the following cases when the line filter is on • When advance line filter setting is off • When advance line filter setting is on and AAF is on Anti-aliasing: Set using the analog filter
	For Elements 1 to 4 harmonic measurement The anti-aliasing filter used for resampling in harmonic measurement can be configured independently of the filter used for normal measurement. It can be configured independently for each element. When advanced line filter setting is OFF, the filter follows the element line filter. When advanced line filter setting is ON, the filter is used for harmonic measurement (independent of the element line filter). Calculation rate: Calculation rate: 2.5 MS/s When advance line filter setting is off According to the line filter for the element When advance line filter setting is on For harmonic measurement (independent of the line filter for the element) Filter response: Butterworth Filter form: IIR Filter type: LPF Filter order: 4 Cutoff characteristics: −24 dB/Oct (typical) LPF: cutoff frequency 100 Hz to 200 kHz, 300 kHz* Resolution: 100 Hz * Analog filter Filter response: Bessel Filter type: LPF Filter order: 4 Auto Harmonic Filter Settings Automatic setting of the cutoff frequency based on the fundamental frequency fundamental frequency — cutoff frequency 0.10 Hz to 0.35 Hz — 0.1 kHz 0.35 Hz to 1.8 Hz — 0.5 kHz 1.8 Hz to 9.0 Hz — 2.5 kHz 9.0 Hz to 45 Hz — 12.6 kHz 45 Hz to 75 Hz — 64.3 kHz 75 Hz to 98 Hz — 105.8 kHz 98 Hz to 197 Hz — 139.6 kHz 197 Hz to 395 Hz — 140.3 kHz 395 Hz to 760 Hz — 139.9 kHz 760 Hz to 1410 Hz — 134.6 kHz 1410 Hz to 1970 Hz — 124.6 kHz 1970 Hz to 2600 Hz — 175.1 kHz Valid for the following cases when the line filter is on • When advance line filter setting is off • When advance line filter setting is on and AAF is on Anti-aliasing: Set with the analog filter and digital filter

Item	Specifications
	For motor/resolver (/EM1, /RM1, /EM2, /EM1RM1, /RM2) Can be set for the analog input of each channel Calculation rate: Calculation rate: 2.5 MS/s Filter response: Butterworth
Frequency filter	Elements 1 to 4, for frequency measurement and sync source Can be set separately for each element Calculation rate: Calculation rate: 2.5 MS/s Filter response: Butterworth Filter form: IIR+FIR Filter type: LPF Filter order: 2 Select from OFF, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, 16 kHz, 32 kHz Automatically selects from OFF, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, and 32 kHz based on the input voltage frequency Cutoff characteristics: −12 dB/Oct (typical)

Integration function

Item	Specifications
Sample rate	2.5 MS/s
Calculation period	Manual, integration time, real-time control Integration time repetition, real-time control repetition Integration timer range: 0 h00 m00 s to 10000 h00 m00 s Count over: When the maximum integration time (10000 hours) is reached or when an integrated value reaches the maximum or minimum displayable integrated value (±999999 MWh, ±999999 MAh, ±999999 MVAh, ±999999 Mvarh), the integration time and value at that point are held and integration is stopped. Runs manually when the update mode is Auto. Does not run during integration-time or real-time control.
Power failure recovery	The integration restart function resumes integration operation upon power restoration if a power outage occurs during integration. This function cannot be used during auto update mode or multi-unit synchronization mode. Integration results in error and cannot be continued.
Independent integration	Integration can be executed separately for each element. Independent integration is fixed to off during multi-unit synchronization.
Auto calibration	Auto offset calibration function Zero-level compensation is performed at the current range of all elements approximately every hour.
Timer accuracy	±0.02 % of reading
Integration accuracy	±[Power accuracy (or current accuracy) + timer accuracy)

Frequency measurement function

Item	Specifications
Device under measurement	Measures the frequency of the voltage or current applied to all input elements
Measurement system	A/D data level trigger gate generation Reciprocal method
Display resolution	99999
Minimum frequency resolution	0.0001 Hz

Item	Specifications
Measurement time period	0.1 Hz ≤ f ≤ 1 MHz 100 kHz or less for HV element voltage
	The measurement range is limited by the element's measurement bandwidth. The measurement range is limited by the data update interval. As follows:

Data update interval	Measurement time period
10 ms	200 Hz ≤ f ≤ 1 MHz
50 ms	45 Hz ≤ f ≤ 1 MHz
100 ms	20 Hz ≤ f ≤ 1 MHz
200 ms	10 Hz ≤ f ≤ 1 MHz
500 ms	5 Hz ≤ f ≤ 1 MHz
1 s	2Hz ≤ f ≤ 1 MHz
2 s	1 Hz ≤ f ≤ 1 MHz
5 s	0.5 Hz ≤ f ≤ 1 MHz
10 s	0.2 Hz ≤ f ≤ 1 MHz
20 s	0.1 Hz ≤ f ≤ 1 MHz

	In auto update mode, refer to the table above by substituting "timeout period" with "data update interval". The display limit is 1.1 times the upper limit of the measurement range (1.1 MHz). Display: Error, 32-bit floating-point value: 0xFFFFFFFE
Accuracy	±5 mHz (45 to 66 Hz, update rate 50 ms or more) ±0.06 % of reading ± 0.1 mHz (otherwise)
Conditions	45 to 66 Hz and update rate 50 ms or higher: for inputs whose signal level is 50 % or higher of the measurement range. For input that is 100 % or higher if the crest factor is CF6/CF6A In all other cases: For inputs whose signal level is 30 % or higher of the measurement range For input that is 60 % or higher if the crest factor is CF6/CF6A where Frequency filter setup condition

Measurement range	Cutoff frequency
0.1 Hz to 100 Hz	fc=125 Hz
100 Hz to 200 Hz	fc=250 Hz
200 Hz to 400 Hz	fc=500 Hz
400 Hz to 800 Hz	fc=1 kHz
800 Hz to 1.6 kHz	fc=2 kHz
1.6 kHz to 3.2 kHz	fc=4 kHz
3.2 kHz to 6.4 kHz	fc=8 kHz
6.4 kHz to 12.8 kHz	fc=16 kHz
12.8 kHz to 30 kHz	fc=32 kHz

Frequency detection signal level setting	Setting range Rectifier OFF: ±100 % of range Rectifier ON: 0 % to +100 % of range

When auto frequency filter is on Measurement range Cutoff frequency

Input frequency	Cutoff frequency
0.1 Hz to 100 Hz	125 Hz
97 Hz to 200 Hz	250 Hz
194 Hz to 400 Hz	500 Hz
388 Hz to 800 Hz	1 kHz
776 Hz to 1.6 kHz	2 kHz
1.5 kHz to 3.2 kHz	4 kHz
3.1 kHz to 30 kHz	32 kHz
30 kHz	32 kHz

• A 3 % hysteresis is applied for range-down switching.
• When the input frequency exceeds 30 kHz, turn OFF the auto frequency filter.

Harmonic measurement function

Measurement functions determined for each input element

Item	Specifications
Device under measurement	All installed elements
Method	PLL synchronization method
Frequency range	Fundamental frequency: 0.1 Hz to 2.6 kHz Analysis frequency: 0.1 Hz to 260 kHz
PLL source	Select the input element's voltage or current or external clock. Input level: • 50 % or more of the rated measurement range when the crest factor is CF3. • 100 % or more of the rated measurement range when the crest factor is CF6 or CF6A. The conditions in which frequency filters are turned on are the same as those for frequency measurements.
Number of FFT points	Auto set to 1024 or 8192
Window function	Rectangular
Anti-aliasing	Set with the analog filter or harmonic measurement filter

Harmonic analysis when auto harmonic filter is off

Fundamental frequency	Number of FFT points	Sample rate	Window width	Upper limit of harmonic analysis*
0.1 Hz to 197 Hz	8192	f×8192	1 waves	100
197 Hz to 395 Hz	8192	f×4096	2 waves	100
395 Hz to 760 Hz	8192	f×2048	4 waves	100
760 Hz to 1410 Hz	1024	f×1024	1 waves	100
1410 Hz to 2600 Hz	1024	f×512	2 waves	100

The upper measured harmonic limit is 50 when multi-unit synchronization mode is Main or Sub Unit.

Harmonic analysis when auto harmonic filter is on

Fundamental frequency	Number of FFT points	Sample rate	Window width	Upper limit of harmonic analysis*	Harmonic filter Cutoff frequency [Hz]
0.10 Hz to 0.35 Hz	8192	f×8192	1 waves	100	0.1 k
0.35 Hz to 1.8 Hz	8192	f×8192	1 waves	100	0.5 k
1.8 Hz to 9.0 Hz	8192	f×8192	1 waves	100	2.5 k
9.0 Hz to 45 Hz	8192	f×8192	1 waves	100	12.6 k
45 Hz to 75 Hz	8192	f×8192	1 waves	100	64.3 k
75 Hz to 98 Hz	8192	f×8192	1 waves	100	105.8 k
98 Hz to 197 Hz	8192	f×8192	1 waves	50	139.6 k
197 Hz to 395 Hz	8192	f×4096	2 waves	25	140.3 k
395 Hz to 760 Hz	8192	f×2048	4 waves	13	139.9 k
760 Hz to 1410 Hz	1024	f×1024	1 waves	7	134.6 k
1410 Hz to 1970 Hz	1024	f×512	2 waves	5	124.6 k
1970 Hz to 2600 Hz	1024	f×512	2 waves	3	175.1 k

The upper measured harmonic limit is 50 when multi-unit synchronization mode is Main or Sub Unit.

Item	Specifications
Harmonic measurement accuracy	Accuracy Add the following accuracy values to the normal measurement accuracy values. • When the line filter is off • When the crest factor is set to CF3 • When λ (the power factor) is 1 Frequency — Voltage, current 0.1 Hz ≤ f ≤ 260 kHz — ±(0.05 % of reading + 0.25 % of range) Frequency — Power 0.1 Hz ≤ f ≤ 260 kHz — ±(0.1 % of reading + 0.5 % of range)

- When the line filter is on
  Add the line filter influence to the accuracy values when the line filter is off.
- Power figures that exceed 10 kHz are for reference only.
- Add (n/500) % of reading to the nth component of the voltage and current, and add (n/250) % of reading to the nth component of the power.
- The accuracy when the crest factor is CF6 or CF6A is the same as that when the crest factor is CF3 after doubling the measurement range.
- The guaranteed accuracy ranges for frequency, voltage, and current, are the same as the guaranteed ranges for ordinary measurement.
- The neighboring harmonic orders may be affected by the side lobes from the input harmonic order.

  For nth order component input, add {[n/(m+1)]/50} % of (the nth order reading) to the n + mth order and n − mth order of the voltage and current, and add {[n/(m+1)]/25} % of (the nth order reading) to the n + mth order and n − mth order of the power.

- When the update mode is Constant or Trigger:
  When the data update interval is 10 ms, the harmonic analysis function is not available.
- When the update mode is Auto:
  When the data update interval is 10 ms, there is a 100-ms measurement pause (10 data update intervals) between harmonic calculations.
  The maximum harmonic order that can be measured is 10.
- The measured harmonic order upper limit is set to the lowest value among the input elements in the group.

Resolver operation function

Item	Specifications
Feature overview	Rotating speed is calculated by calculating the angle from the carrier signal, sine signal, or cosine signal applied to the Motor Evaluation Function for Resolver (input type: resolver) and converting to Z pulse.
Computation result storage format	Single-precision floating-point (32 bit)
Calculation rate	2.5 MS/s
Calculation type	The angle of rotation is computed from the carrier signal, sine signal, and cosine signal. Supported carrier frequencies: 1 kHz to 20 kHz Tracking filter bandwidth setting: 100 Hz, 250 Hz, 1 kHz, 2 kHz

Multi-unit synchronization(/SY1 Option)

Item	Specifications
Synchronization Configuration	4 (dedicated ports) • Up to four sub units can be connected to a main unit.
Synchronized measurement	Measurement modes available for multi-unit synchronization • Normal measurement mode's constant-interval update mode, trigger update mode, and auto update mode
Synchronization accuracy	±400 ns • Measurement start delay applied to sub units ±400 ns • Time synchronization applied to sub units: ±400 ns • Common ZC signal and common PLL signal shared between units 1) Synchronization accuracy between units sharing common ZC signals and common PLL signals for the specified synchronization source or PLL source: ±400 ns 2) Maximum delay time from ZC detection at the input source designated for the common ZC signal and common PLL signal shared between units to ZC detection at each unit's synchronization source or PLL source: cable length [m] × 20 ns ± 400 ns
Synchronization	Synchronization function for main unit and sub units • Data update interval synchronization • Synchronized integration • Time synchronization • Synchronization source synchronization • PLL source synchronization • Harmonic analysis trigger synchronization for electrical angle measurement • Trigger source synchronization for triggered measurement mode Synchronized operation of sub units from main unit • Integration start, stop, reset; hold, single; manual calibration; NULL • Set the sub unit's measurement range and other measurement conditions from the main unit
Measurement data collected by main unit	The following items are collected from each sub unit from the main unit. • All normal measurement values, all harmonic analysis values (up to the 50th harmonic), all PP compressed waveform data Measurement data collected from sub units are output from the main unit. • Output target: external monitor output screen, communication output, store, data save to file, CAN output Measurement data collected from sub units can be used in efficiency calculation, user-defined computation, and user-defined events of the main unit.
Setup synchronization	Set measurement conditions from the main unit to sub units • Unit-specific setting range, line filter, frequency filter, various types of scaling, wiring, harmonic settings, etc. Unit common settings • Update mode, update interval, averaging, measurement settings, etc. Setting File • The main unit saves and restores the settings for all units in a single setting file.

Item	Specifications
Synchronization configuration	Setting synchronization Sets measurement conditions from the main unit to the subunits. • Unit-specific settings: ranges, line filters, frequency filters, various scaling, wiring, harmonic settings, etc. Common unit settings • Update mode, update interval, averaging, measurement settings, etc. Setup file • The main unit saves and restores the settings of all units in one setup file.
Compatible devices	WT1500

During multi-unit synchronization, the data update interval cannot be set to 10 ms.

5.10 Measurement Function Computation

Normal measurement function

Measurement functions determined for each input element

Item	Symbols and Meanings
Voltage (V)	Urms: true rms value, Umn: rectified mean value calibrated to the rms value, Udc: simple average, Urmn: rectified mean value, Uac: AC component, Ufnd: fundamental component
Current (A)	Irms: true rms value, Imn: rectified mean value calibrated to the rms value, Idc: simple average, Irmn: rectified mean value, Iac: AC component, Ifnd: fundamental component
Active power (W)	P Pfnd: Fundamental power component
Apparent power (VA)	S Sfnd: Fundamental component
Reactive power (var)	Q Qfnd: Fundamental component
Power factor	λ λfnd: Fundamental component
Phase difference (°)	Φ Φfnd: Fundamental component
Frequency (Hz)	fU (FreqU): voltage frequency, fI (FreqI): current frequency The fU and fI of elements 1 to 4 can be measured simultaneously.
Corrected Power(W)	Pc Applicable standards: IEC76-1 (1976), IEC76-1 (2011)
Voltage max. and min. (V)	U+pk: maximum voltage, U-pk: minimum voltage
Current max. and min. (A)	I+pk: maximum current, I-pk: minimum current
Power max. and min. (W)	P+pk: maximum power, P-pk: minimum power
Crest factor (peak-to-rms ratio)	CfU: voltage crest factor, CfI: current crest factor
Integration	Time: integration time WP: sum of positive and negative watt hours WP+: sum of positive P (consumed watt hours) WP−: sum of negative P (watt hours returned to the power supply) q: Sum of positive and negative ampere hours q+: sum of positive I (ampere hours) q−: sum of negative I (ampere hours) WS: volt-ampere hours* WQ: var hours* By using the current mode setting, you can select to integrate the ampere hours using Irms, Imn, Idc, Iac, or Irmn.
Voltage ripple rate	Urip
Current ripple rate	Irip

Measurement Functions (Σ Functions) Determined for Each Wiring Unit (ΣA and ΣB)

Item	Symbols and Meanings
Voltage (V)	UrmsΣ: true rms value, UmnΣ: rectified mean value calibrated to the rms value, UdcΣ: simple average, UrmnΣ: current rectified mean value, UacΣ: AC component
Current (A)	IrmsΣ: true rms value, ImnΣ: rectified mean value calibrated to the rms value, IdcΣ: simple average, IrmnΣ: current rectified mean value, IacΣ: AC component
Active power (W)	PΣ
Apparent power (VA)	SΣ
Reactive power (var)	QΣ
Corrected Power(W)	PcΣ Applicable standards IEC76-1(1976), IEC76-1(2011)

Item	Symbols and Meanings
Integration	WPΣ: sum of positive and negative watt hours WP+Σ: sum of positive P (consumed watt hours) WP−Σ: sum of negative P (watt hours returned to the power supply) qΣ: sum of positive and negative ampere hours q+Σ: sum of positive I (ampere hours) q−Σ: sum of negative I (ampere hours) WSΣ: Integration of SΣ* WQΣ: Integration of QΣ*
Power factor	λΣ
Phase difference (°)	ΦΣ
Three-phase voltage unbalance factor	UubfΣ
Three-phase current unbalance factor	IubfΣ

Harmonic measurement function

Measurement functions determined for each input element

Item	Symbols and Meanings	
Voltage (V)	U(k): rms voltage value of harmonic order k[1]	U: total rms voltage[2]
Current (A)	I(k): rms current value of harmonic order k	I: total rms current[2]
Active power (W)	P(k): active power of harmonic order k	P: total active power[2]
Apparent power (VA)	S(k): apparent power of harmonic order k	S: total apparent power[2]
Reactive power (var)	Q(k): reactive power of harmonic order k	Q: total reactive power[2]
Power factor	λ(k): power factor of harmonic order k	λ: total power factor (Total value[2])
Phase difference (°)	Φ(k): phase difference between the voltage and current of harmonic order k, Φ: total phase difference ΦU(k): phase difference between harmonic voltage U(k) and the fundamental wave U(1) ΦI(k): phase difference between harmonic current I(k) and the fundamental wave I(1)	
Load circuit Impedance (Ω)	Z(k): impedance of the load circuit in relation to harmonic order k	
Load circuit resistance and Reactance (Ω)	Rs(k): resistance of the load circuit in relation to harmonic order k when resistor R, inductor L, and capacitor C are connected in series Xs(k): reactance of the load circuit in relation to harmonic order k when resistor R, inductor L, and capacitor C are connected in series Rp(k): resistance of the load circuit in relation to harmonic order k when R, L, and C are connected in parallel Xp(k): reactance of the load circuit in relation to harmonic order k when R, L, and C are connected in parallel	
Fundamental voltage component (V)	Ufnd: U(1)	
Fundamental current component (A)	Ifnd: I(1)	
Fundamental active power (W)	Pfnd: P(1)	
Fundamental apparent power (VA)	Sfnd: S(1)	
Fundamental reactive power (var)	Qfnd: Q(1)	
Fundamental power factor	λfnd: λ(1)	
Phase difference between the fundamental voltage signal and fundamental current signal (°)	Φfnd:Φ(1)	
Harmonic distortion factor (%)	Uhdf(k): ratio of harmonic voltage U(k) to U(1) or U Ihdf(k): ratio of harmonic current I(k) to I(1) or I Phdf(k): ratio of harmonic active power P(k) to P(1) or P	
Total harmonic distortion (%)	Uthd: ratio of the total harmonic voltage to U(1) or U[3] Ithd: ratio of the total harmonic current to I(1) or I[3] Pthd: ratio of the total harmonic active power to P(1) or P[3]	

Item	Symbols and Meanings
Telephone harmonic factor (applicable standard IEC34-1 (1996))	Uthf: voltage telephone harmonic factor, Ithf: current telephone harmonic factor
Telephone influence factor (applicable standard IEEE Std 100 (1996))	Utif: voltage telephone influence factor, Itif: current telephone influence factor
Harmonic voltage factor[4]	hvf: harmonic voltage factor
Harmonic current factor[4]	hcf: harmonic current factor
K-factor	Ratio of the sum of squares whose harmonic components are weighted to the sum of squares of the electric current harmonics

1 Harmonic order k is an integer from 0 to the upper limit of harmonic analysis. The 0th order is the DC component. The upper limit is determined automatically according to the PLL source frequency. It can go up to the 100th harmonic order.
2 The total value is determined according to the equation on page App-5 of IMWT1501-01EN from the fundamental wave (1st harmonic) and all harmonic components (2nd harmonic to the upper limit of harmonic analysis). The DC component can also be included.
3 Total harmonic values are determined from all harmonic components (the 2nd harmonic to the upper limit of harmonic analysis) according to the equations on page App-7 of IMWT1501-01EN.
4 The expression may vary depending on the definitions in the standard. For details, see the corresponding standard.

Motor evaluation function for encoder and resolver

The number of motors that can be measured varies depending on the type of revolution signal and whether electrical angle measurement is available.

Item	Symbols and Meanings
Motor rotating speed	Speed
Motor torque	Torque
Sync speed	SyncSp
Slip (%)	Slip
Motor output	Pm
Auxiliary input	AUX

The number of motors that can be measured varies depending on the type of rotation signal and whether electrical angle measurement is used.

Conditions		Maximum number of motors for which motor output (Pm) and motor efficiency can be measured				
Revolution signal input type	**Electrical angle measurement**	**/EM1**	**/RM1**	**/EM1RM1**	**/EM2**	**/RM2**
Encoder	Yes	1	N/A	1	2	N/A
Encoder	No	2	N/A	2	4	N/A
Resolver	Yes	N/A	1	1	N/A	2
Resolver	No	N/A	1	1	N/A	2

Measurement range

Applicable for communication output and storage function

Item	Symbols and Meanings
Voltage measurement range	RngU[V]
Current measurement range	RngI[A] (when the sensor output type is Voltage, the unit is [V])
Speed measurement range	RngSpd[V]
Torque measurement range	RngTrq[V]
Aux measurement range	RngAux[V]

Timestamp

Measurement data timestamp

Item[1]	Symbols and Meanings
Data update interval's date[2]	TS Date
Data update interval's time[2]	TS Time
Data update interval's fractional time[2]	TS Subsec[usec]
Normal measurement: Measurement period's date of power elements 1 to 4[3]	TS Date NrmPwr1-4
Normal measurement: Measurement period's time of power elements 1 to 4[3]	TS Time NrmPwr1-4
Normal measurement: Measurement period's fractional time of power elements 1 to 4[3]	TS Subsec NrmPwr1-4[usec]
Normal measurement: Measurement period's date of motor evaluation 1 to 4[3]	TS Date NrmMtr1-4
Normal measurement: Measurement period's time of motor evaluation 1 to 4[3]	TS Time NrmMtr1-4
Normal measurement: Measurement period's fractional time of motor evaluation 1 to 4[3]	TS Subsec NrmMtr1-4[usec]
Normal measurement: Measurement period's date of auxiliary inputs 1 to 8[3]	TS Date NrmAux1-8
Normal measurement: Measurement period's time of auxiliary inputs 1 to 8[3]	TS Time NrmAux1-8
Normal measurement: Measurement period's fractional time of auxiliary inputs 1 to 8[3]	TS Subsec NrmAux1-8
Harmonic measurement: Measurement period's date of power elements 1 to 4[3]	TS Date HrmPwr1-4
Harmonic measurement: Measurement period's time of power elements 1 to 4[3]	TS Time HrmPwr1-4
Harmonic measurement: Measurement period's fractional time of power elements 1 to 4[3]	TS Subsec HrmPwr1-4[usec]

1 The data update interval's timestamp is the start position of the data update interval. The measurement period's timestamp is the first sample of the measurement period.
2 Timestamps valid in all update modes (Constant, Trigger, and Auto).
3 Timestamps valid when the update mode is Auto.

Update status

Applicable for communication output and storage function

Item	Symbols and Meanings
Power element measurement update status for normal measurement[4]	UpdateStsPwr
Motor evaluation data update status for normal measurement[4]	UpdateStsMtr
Auxiliary signal input data update status for normal measurement[4]	UpdateStsAux
Power element data update status for harmonic measurement[4]	UpdateStsHrm

4 Valid when the update mode is Auto.

5.11 Auxiliary I/O

External start signal I/O connector

Item	Specifications
Input connector type	BNC: Same for master and slaves
Input level	TTL: Same for master and slaves
Output logic	Negative logic, falling edge: Applies to the master
Output hold time	Low level, 500 ns or more: applies to the master
Input logic	Negative logic, falling edge: Applies to slaves
Minimum pulse width	Low level, 500 ns or more: applies to the slave
Measurement start delay	Master: Within (6 µs + 12.8 µs + phase correction time) Slave: (–2 µs – 12.8 µs – phase correction time) to (–12.8 µs – phase correction time)

External clock input section

Item	Specifications	
Input connector type	BNC	
Input level	TTL	
Sync signal input	Input frequency range: Input waveform:	Same as the frequency measurement range 50 % duty cycle rectangular wave
Trigger input	Input logic: Minimum pulse width: Trigger delay:	Negative logic, falling edge 1 µs (–12 µs – phase correction time) to (2 µs – 12 µs – phase correction time)
Harmonic measurement PLL source input	Frequency range: Input waveform:	0.5 Hz to 2.6 kHz 50 % duty cycle rectangular wave

CAN data output(/CN1 option)

Item	Specifications
Connector type	D-sub 9 pin (male) The pin arrangement is as follows.

Pin	Signal name	I/O	Function
1	N.C	—	Not used
2	CAN_L	Out	CAN low signal
3	GND	—	Ground (COM)
4	N.C.	—	Not used
5	N.C.	—	Not used
6	N.C.	—	Not used
7	CAN_H	Out	CAN high signal
8	N.C.	—	Not used
9	N.C.	—	Not used

One-inch screws (number 4-40 UNC) are used.
The shell and the enclosure case are internally connected.
Pin 3 is internally isolated from the enclosure case.

Number of ports	1
I/O type	Isolated unbalanced
Maximum input voltage	–3 V to +10 V (between CAN_H & CAN_L and GND)
Supported protocols	CAN, CAN FD (ISO 11898-1: 2015 or non-ISO) Physical layer: ISO-11898 (High Speed Communication)
Terminator	Can be enabled or disabled
Terminator resistance	110 Ω to 130 Ω
Bit rate (CAN)	125 kbps, 250 kbps, 500 kbps, 1 Mbps
Bit rate (CAN FD)	500 kbps, 1 Mbps
Data bit rate (CAN FD)	500 kbps, 1 Mbps, 2 Mbps, 4 Mbps
Sample point	Setting resolution varies according to the 50.0 % to 91.6 % bit rate
Format	Standard, extended
Setup ID	Standard format: 0x000 to 0x7FF, extended format: 0x00000000 to 0x1FFFFFFF
Data output interval	Output at the update rate
Output data	Select normal measurement data or harmonic analysis data

5.12 Peripheral Device Connection

USB

Item	Specifications
Connector type	Type A connector (receptacle)
Number of ports	2
Electrical and mechanical specifications	USB Rev. 2.0 compliant
Supported transfer mode	HS(High Speed)mode(480 Mbps), FS(Full Speed)mode(12 Mbps), LS(Low Speed)mode(1.5 Mbps)
Compatible devices	Mass storage devices that comply with USB Mass Storage Class Ver. 1.1 Available space: 8 TB, partition format: MBR/GPT, format type: FAT32/FAT16/exFAT 104 or 109 keyboards that comply with USB HID Class Ver. 1.1 Wireless LAN adapter
Power supply	5 V, 500 mA (for each port)

Item	Specifications
Connector type	Type C connector (receptacle)
Number of ports	1
Electrical and mechanical specifications	USB Rev. 2.0 compliant
Supported transfer mode	HS(High Speed)mode(480 Mbps), FS(Full Speed)mode(12 Mbps), LS(Low Speed)mode(1.5 Mbps)
Compatible devices	Mass storage devices that comply with USB Mass Storage Class Ver. 1.1 Available space: 8 TB, partition format: MBR/GPT, format type: FAT32/FAT16/exFAT 104 or 109 keyboards that comply with USB HID Class Ver. 1.1 USB HID Class Ver. 1.1-compliant touch panel (supports multi-touch with up to two touch points) Wireless LAN adapter
Video output	Equivalent to DisplayPort Alternate Mode Resolution: 1280x720 dot Approx. 60-Hz Vsync (75 MHz dot clock frequency)
Power supply	Equivalent to USB Power Delivery 5 V, 3 A (15 W max.)

5.13 Computer Interface

Ethernet interface

Item	Specifications
Connector type	RJ-45
Number of ports	1
Electrical and mechanical specifications	IEEE802.3 compliant, Auto-MDIX
Transmission system	Ethernet1000Base-T/100BASE-TX/10BASE-T
Communication protocol	TCP/IP
Supported services	FTP server, DHCP client, DNS client, multicast DNS (mDNS), remote control (VXI-11, Socket, HiSLIP), UDP, SNTP client, FTP client, Modbus/TCP server, web server

USB PC interface

Item	Specifications
Connector type	Type B connector (receptacle)
Number of ports	1
Electrical and mechanical specifications	USB Rev. 2.0 compliant
Supported transfer mode	HS(High Speed)mode(480 Mbps), FS(Full Speed)mode(12 Mbps), LS(Low Speed)mode(1.5 Mbps)
Supported protocols	USBTMC-USB488(USB Test and Measurement Class Ver.1.0)
System requirements	A PC running Windows 11 with a standard USB port (a separate device driver is required for connection to the PC)

5.14 Multi-unit Synchronization Interface

Item	Specifications
Connector type	SFP • Uses optical transceiver module 720941, sold separately
Optical fiber cable	50/125 µm multi mode optical fiber With Duplex-LC (2-core LC) connector
Maximum cable length	300 m
Number of ports	4

5.15 Storage

Item	Specifications
Format	FAT16/FAT32/exFAT
Internal memory	2 GB (standard) or 32 GB (/M1 option)

* FAT16/FAT32 format used by this instrument is not compatible with Windows.
8.3 format is case-insensitive.
LFN is case-sensitive.

5.16 System Maintenance Processing

Alarm generation and operation

Item	Specifications
Fan stop	Fan stop alarm indication Emergency operation stop after about 60 seconds[1]
Internal temperature error	Temperature error alarm indication Emergency operation stop[1]

1 Emergency operation stop
Stops supplying power to each power element and motor input (/EM1, /RM1, /EM2, /EM1RM1, /RM2), CAN output (/CN1)
System Failure LED lights red

5.17 General Specifications

Item	Specifications
Warm-up time	Approx. 30 minutes
Operating environment	Temperature: 5 °C to 40 °C Humidity: 20 % RH to 80 % RH (no condensation)
Operating altitude	2000 m or less
Installation location	Indoor use
Storage environment	Temperature: -25 °C to 60 °C Humidity: 20 % RH to 80 % RH (no condensation)
Rated supply voltage	100 Vac to 120 Vac, 220 Vac to 240 Vac
Permitted supply voltage range	90 Vac to 132 Vac, 198 Vac to 264 Vac
Rated power frequency	50/60 Hz
Permitted supply frequency range	48 to 63 Hz
Maximum power consumption	300 VA
Cooling method	Forced air cooling, exhaust through left and right side panels and top panel
Installation orientation	Horizontal
External dimensions (see the external dimensions figure.)	426 mm (W) x 88 mm (H) x 484.2 mm (D) (excluding handles and protrusions)
Weight	Weight: Approx. 7.6 kg (-BN, main unit with 4-input element and /EM2/CN1 option installed)
Battery backup	The setup parameters and internal clock are backed up by a lithium battery.
Safety standards	Compliant standards (complies with one unit only) EN 61010-1, EN IEC 61010-2-030, EN 61010-031 Overvoltage Category II[1] Measurement category O (Other), CAT II, CAT III[2] Pollution degree 2[3]
Emissions	Compliant standards (complies with one unit only) EN 61326-1 Class A Group 1[4], EN 61000-3-2, EN 61000-3-3 EMC Regulatory Arrangement in Australia and New Zealand EN 61326-1 Class A Group 1[4] Korea Electromagnetic Conformity Standard (한국 전자파적합성기준) This product is classified as Class A (for use in industrial environments). Operation of this product in a residential area may cause radio interference, in which case the user will be required to correct the interference. In addition, when a measurement lead or probe is connected to an input element or when the device under measurement is connected to the instrument, the emission requirements may no longer be met. In such cases, the user will be required to take appropriate measures. Cable conditions • Functional ground terminal Use a cable.[5] • Voltage measurement cables Attach by passing the two measurement cables through the ferrite core[8] • Current sensor connection terminals Use dedicated cables. • EXT CLK, MEAS. START input terminals Use BNC cables.[5] • Motor evaluation function terminals, AUX input terminals Use safety BNC cables.[5] • The external monitor output connector Use a shielded USB cable.[5] • USB port (PC) Use a shielded USB cable.[5] • USB ports (for peripheral devices) Use shielded USB cables.[5] • Ethernet port Use a category 7 or better Ethernet cable (STP)[6] • CAN/CAN FD signal output connector Use a shielded CAN FD cable.[5]

5.17 General Specifications

Item	Specifications
Immunity	Compliant standards (complies with one unit only) EN 61326-1 Table 2 (for use in industrial locations) When a measurement lead or probe is connected to an input element or when the device under measurement is connected to the instrument, the immunity requirements may no longer be met. In such cases, the user will be required to take appropriate measures. Influence in the immunity environment Measurement input: within ±20 % of range (within ±40 % of range when CF6 is specified) Current probe input: within ±300 mV Cable conditions Same as the cable conditions for emission above.
Environmental standard[7]	EU RoHS Directive compliant

If you obtained this manual separately from the product, the specifications in this manual may differ from those of the product.

1 The overvoltage category is a value used to define the transient overvoltage condition and includes the rated impulse withstand voltage. Overvoltage category II applies to electrical equipment that is powered through a fixed installation, such as a wall outlet wired to a distribution board.

2 The measurement category of this instrument is CAT II, CAT III, and Other (O). Do not use for measurements in Measurement Category IV.
Measurement category O (Other) applies to measurement of other types of circuits that are not directly connected to a main power source.
Measurement Category II applies to electrical equipment that is powered through a fixed installation, such as a wall outlet wired to a distribution board, and to measurement performed on such wiring.
Measurement category III applies to measurement of facility circuits, such as distribution boards and circuit breakers.
Measurement category IV applies to measurement of power source circuits, such as entrance cables to buildings and cable systems, for low-voltage installations.

3 Pollution Degree applies to the degree of adhesion of a solid, liquid, or gas that deteriorates withstand voltage or surface resistivity. Pollution Degree 2 applies to normal indoor atmospheres (with only non-conductive pollution).

4 Group 1: Equipment that does not intentionally generate or use radio-frequency (RF) energy

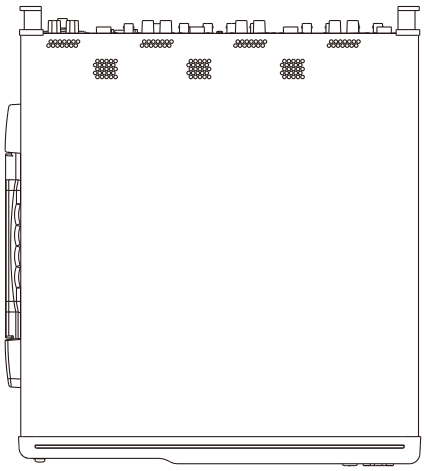
5 Use cables of length 3 m or less.

6 Use cables of length 30 m or less.

7 For conformity to environmental regulations and/or standards other than EU, contact your nearest YOKOGAWA office (PIM 113-01Z2).

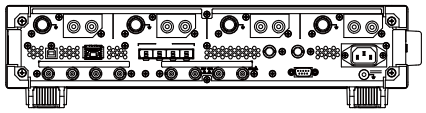
8 TDK ZCAT2436-1330A

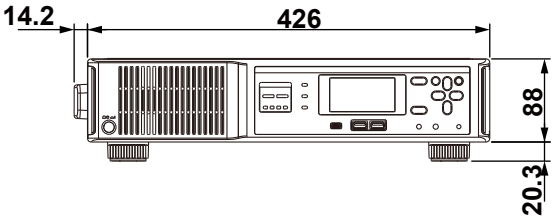
5.18 External Dimensions

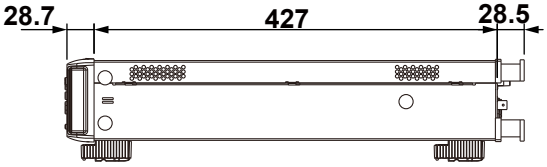


Unit: mm

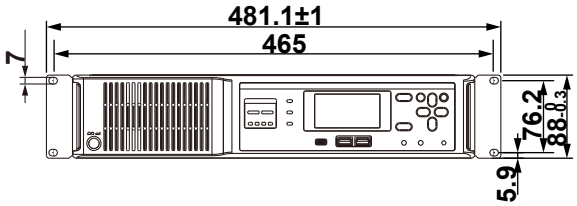
Rear view

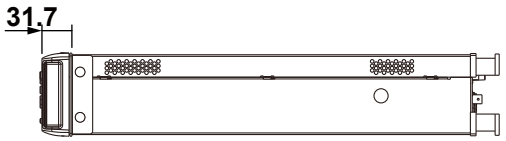




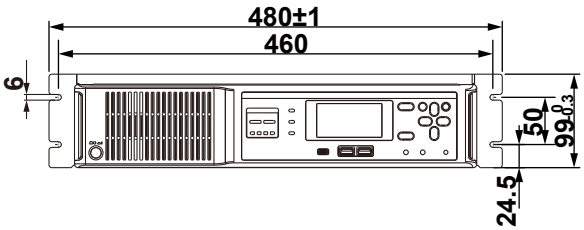


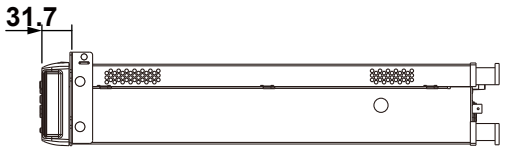
EIA rack mount dimensions





JIS rack mount dimensions





Unless otherwise specified, tolerances are ±3 % (however, tolerances are ±0.3 mm when below 10 mm).