SPECIFICATIONS

Input

Item	VoltageV	CurrentA
Input circuit type	Floating input	
	Resistive voltage divider	Shunt input
Rated inputs (range rms)	10/15/30/60/100/150/ 300/600 V	Direct input 1/2/5/10/20/30 A External shunt input: 50/100/200 mV
Input impedance	Input resistance Approx. 2 MΩ Input capacitance Approx. 15 pF	Direct input: Approx. 6 mΩ + approx. 0.07 µH External shunt input: Approx. 100 kΩ
Frequency range	DC and 2 Hz to 500 kHz	
Instantaneous maximum allowable input for 1s	The peak voltage is 2500 V, or the RMS value is 3 times the range, whichever is less.	The peak current is 90 A, or the RMS value is 50 A, whichever is less. External input: The peak value is 20 times the range or less.
Continuous maximum allowable input	The peak voltage is 1400 V, or the RMS value is 2.5 times the range, whichever is less.	The peak current is 60 A, or the RMS value is 35 A, whichever is less. External input: The peak value is 10 times the range or less.
Continuous maximum common mode voltage	600 Vms (when the protective cover for the output connector is used) CAT II 400 Vms (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 input)	Voltage input terminals shorted, current input terminals opened: Better than -80 dB (±0.01% of rdg or less)	
	Reference value: 200 kHz max ±((0.18 × f) / (Range rating))% of rdg or less (Unit of f: kHz)	Reference value: 200 kHz max ±((0.03 × f) / (range rating))% of rdg or less (Unit of f: kHz)
Input terminals	Binding posts	Large binding posts External shunt input: BNC
A/D converter	Simultaneous conversion of voltage and current inputs Resolution: 16 bits Maximum conversion rate: 104 kHz	
Overload input detection	Alarm lamp lights at approx. 350% of the input range (approx. 700% of range when crest factor is 6)	
Range switching	The range can be switched manually, automatically, or by communication control for each element.	
Auto range switching	Range up: When the measured value exceeds 110% of the rated value, or when the peak value exceeds 350% of the peak value. Range down: When the measured value becomes less than 30% of the rated value.	
Measurement mode switching	The mode can be set for each element and also for each voltage and current measurement circuit.	

Display Functions

Display: 7-segment LED (light emitting diode)
Display contents: 4 displays

DISPLAY	Display contents	Display resolution
A	V, A, W (each element)	V, A, W: 50000 Wh, Ah: 500000 Hz: 199999
B	V, A, W (each element)	
C	V, A, W, VA, var, PF, deg, Vpk (each element)	
D	V, A, W, Apk, THD*, VHz, AHz Wh, Ah (each element), η (efficiency)	

Unit: m, k, M, V, A, W, VA, var, pk, Hz, h, deg, %
Display update rate: Select from 0.25 sec (FAST), 0.5 sec (MID) and 2.0 sec (SLOW).
Peak hold function: Selectable to hold item as follows
PEAK: Vpk and Apk can be held at maximum value
ALL: Measurement value of V, A, W, VA, var, Vpk, Apk can be held at maximum value.
Response time: Maximum of twice the display update rate
(The time taken for the display to fall within the accuracy of the final value when the filter is OFF and an abrupt change is made from 0 to 100% of the range, or from 100 to 0% of the range)

Display scaling function
Significant digits: Selected automatically according to the significant digits in the voltage and current range.
Setting range: 0.0001 to 10000
Set values: "DISPLAY A": Not displayed
"DISPLAY B": PT ratio
"DISPLAY C": CT ratio
"DISPLAY D": Power scaling factor

Display averaging function
Method: One of the following two types can be selected.
Exponential averaging
Moving averaging
For exponential averaging, the attenuation Constant can be selected, and for moving averaging, the average number, N, can be set to 8, 16, 32, 64, 128 or 256.
For harmonic mark measurements
For exponential avaraging the attenuator Constant is 5.625 when the frequency of the PLL sync source is 55 Hz or more but less than 66 Hz, and is 4.085 in other cases.
(when data length = 8192)

MATH function
Algorithm: Display D, when selecting the efficiency fanction η, will show the efficiency. In addition it is possible to show the result of Display A +, –, / or × Display B on Display D.

Accuracy

Item		Voltage/current	Power
Conditions Humidity 30 to 75% RH Supply voltage Specified V±5% Input waveform Sine wave In-phase voltage 0 V Power factor Cos ϕ = 1 Line filter OFF Crest factor 3 Scaling OFF 6-month accuracy The unit of f in the accuracy calculation formula is kHz	Temperature 23±3°C except 600V, 100/20A/ 30A rang	45 Hz ≤ f ≤ 66 Hz ±(0.03% of rdg +0.03% of rng)	45 Hz ≤ f ≤ 66 Hz ±(0.04% of rdg+0.04% of rng)
	Temperature 23±5°C	DC: ±(0.04% of rdg+0.08% of rng) 2 Hz ≤ f < 30 Hz ±(0.1% of rdg + 0.2% of rng) 30 Hz ≤ f ≤ 1 kHz ±(0.03% of rdg+0.05% of rng) 1 kHz < f ≤ 10 kHz ±(0.02 × f% of rdg+0.1% of rng) 10 kHz < f ≤ 50 kHz ±[0.018 × (f–10) % of rdg+ 0.3% of rng] 50 kHz < f ≤ 100 kHz ±[0.03 × (f–50) % of rdg+ 1.0% of rng] 100 kHz < f ≤ 500 kHz ±[0.035 × (f–100) % of rdg+ 2.5% of rng] 2 Hz ≤ f < 10 Hz and more than 200 kHz is the design value. If the display update rate is 10 Hz or more -> MID If the display update is 2 Hz or more -> SLOW	DC: ±(0.08% of rdg+0.12% of rng) 2 Hz ≤ f < 30 Hz ±(0.2% of rdg + 0.5% of rng) 30 Hz ≤ f ≤ 1 kHz ±(0.05% of rdg+0.05% of rng) 1 kHz < f ≤ 10 kHz ±(0.05 × f% of rdg + 0.2% of rng) 10 kHz < f ≤ 50 kHz ±[0.045 × (f–10)% of rdg+ 0.7% of rng] 50 kHz < f ≤ 100 kHz ±[0.05 × (f–50)% of rdg+ 2.5% of rng] 100 kHz < f < 300 kHz ±[0.11 × (f–100)% of rdg+ 5.0% of rng] 2 Hz ≤ f < 10 Hz and more than 200 kHz is the design value. If the display update rate is 10 Hz or more -> MID If the display update is 2 Hz or more -> SLOW
Effect of power factor		—	When cos ϕ = 0 45 Hz ≤ f ≤ 66 Hz Add±0.1% of rng 66 Hz < f ≤ 440 Hz Add±0.15% of rng Reference data: 300 kHz max Add (0.15 + 0.15 × f) of rng Indication error when 1 > cos ϕ > 0 Add a value equal to the product of the effect on cos ϕ = 0 and tan ϕ (ϕ is the phase angle between the voltage and current).
Effective input range		Between 10 and 110% of the rated input value (The accuracy when the input is between 110 and 130% is 1.5 times the read value error.)	
Accuracy at CF set to 6		1.5 times the range error of a crest factor of 3 (accuracy when the above temperature is 23±5°C)	
Temperature coefficient		±0.02% of rag/°C between 5 and 18°C and between 28 and 40°C	
Data update rate		0.25 s, 0.5 s, 2.0 s	
Line filter function		Measurement can be performed with low pass filters inserted into the input circuit and the frequency measurement circuit. A cutoff frequency (fc) can be selected from 500 Hz and 5.5 kHz.	
Accuracy when the line filter is ON		For fc/10 or less: Add±1% of rng when the filter is OFF.	For fc/10 or less: Add±2% of rng when the filter is OFF.
One year's accuracy		Reading error for 6 months multiplied by 1.5.	
Detection range of leading phase/lagging phase		±5 deg (20 Hz to 10 kHz) for sinusoidal voltage and current inputs, crest factor of 3, and at least 50% of range rating	
Measurement lower limit frequency		Display update rate; Measurement lower limit frequency 250 ms 20 Hz or higher 500 ms 10 Hz or higher 2 sec 2 Hz or higher	

Frequency Measurement Function

Measurement input: V1, V2, V3, A1, A2, A3
Measurement method: Reciprocal method
Measurement frequency range:
Depends upon the display update rate as shown below (auto range).
250 ms: 2 k/20 k/200 k/1000 kHz
500 ms: 200/2 k/20 k/200 k/500 kHz
25: 20/200/2 k/20 k/100 kHz
Maximum display: 199999
250 ms: 18.00 Hz
500 ms: 9.000 Hz
25: 18000 Hz
Accuracy: ±0.05% of rdg
- When the voltage and current are both at least 30% of the range rating
- When the crest factor is 3 and the frequency is at least 20% of the minimum frequency range
- For 200 Hz or less, when the filter is ON

Computing Functions

		Active Power (W)	Apparent Power (VA)	Reactive Power (var)	Power Factor (PF)	Phase Angle (deg)
Calculation formula	Single phase, 2-wire	W	$VA = V \times A$	$\sqrt{(VA)^2 - W^2}$	$\frac{W}{VA}$	$\cos^{-1}(\frac{W}{VA})$
	Single phase, 3-wire	W_i (i=1, 3) $\Sigma W = W_1 + W_3$	$VA_i = V_i \times A_i$ (i = 1, 3) $\Sigma VA = VA_1 + VA_3$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ (i = 1, 3) $\Sigma var = var_1 + var_3$	$PF_i = \frac{W_i}{VA_i}$ (i = 1, 3) $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{W_i}{VA_i})$ (i = 1, 3) $\Sigma\varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase 3-wire (2 voltages, 2 currents)	W_i (i = 1, 3) $\Sigma W = W_1 + W_3$	$VA_i = V_i \times A_i$ (i = 1, 3) $\Sigma VA = \frac{\sqrt{3}}{2}(VA_1 + VA_3)$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ (i = 1, 3) $\Sigma var = var_1 + var_3$	$PFi = \frac{Wi}{VAi}$ (i = 1, 3) $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi_i = \cos^{-1}(\frac{Wi}{VAi})$ (i = 1, 3) $\Sigma\varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase, 3-wire (3 voltages, 3 currents)	W, i = 1, 2, 3 (W2 does not have a physical meaning.)	$VA_i = V_i \times A_i$ (i = 1, 2, 3) $\Sigma VA = \frac{\sqrt{3}}{3}(VA_1 + VA_2 + VA_3)$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ (i = 1, 2, 3) $\Sigma var = var_1 + var_3$	$PFi = \frac{Wi}{VAi}$ (i = 1, 2, 3) $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi_i = \cos^{-1}(\frac{Wi}{VAi})$ (i = 1, 2, 3) $\Sigma\varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
	3-phase, 4-wire	W_i (i = 1, 2, 3) $\Sigma W = W_1 + W_2 + W_3$	$VA_i = V_i \times A_i$ (i = 1, 2, 3) $\Sigma VA = VA_1 + VA_2 + VA_3$	$var_i = \sqrt{(VA_i)^2 - W_i^2}$ (i = 1, 2, 3) $\Sigma var = var_1 + var_2 + var_3$	$PFi = \frac{Wi}{VAi}$ (i = 1, 2, 3) $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\varphi i = \cos^{-1}(\frac{Wi}{VAi})$ (i = 1, 2, 3) $\Sigma\varphi = \cos^{-1}(\frac{\Sigma W}{\Sigma VA})$
Calculation range		The rated value depends upon the V and A ranges.	The rated value depends upon the V and A ranges.	Same as the apparent power (var > 0)	–1 to 0 to 1	LEAD 180 to 0 LAG 180 or 0 to 360
Maximum display or display resolution		50000	50000	50000	±1.0000	0.01
Calculation accuracy (with respect to the calculation value from the measurement value)		—	±0.001% of the rated value (VA)	±0.001% of the rated value (VA)	±0.0001	±0.005° with respect to the calculation from the power factor

Notes 1: The apparent power (VA), reactive power (var), power factor (PF), and phase angle (deg) measurement in this instrument are computed digitally from the voltage, current and active power. If the input is non- sinusoidal, the measured values may differ from those obtained with instruments employing different measurement principles.
2: When the Current or Voltage value is less than 0.3% of range, the VA and var will be displayed 0, and PF/deg will be displayed as Error.
3: Regarding the detected accuracy of the Lead and Lag,both voltage and current of the rated input are specified at 50% or more for sinusoidal waveforms set at crest factor 3.
The detected Lead/Lag accuracy is ±5 degree over the frequency range 20 Hz to 10 kHz.
4: When the phase angle display shows an angle smaller than 5 degree at 0° and 180°, the accuracy is not specified.
5: If the scaling values set for each element differ from each other in the case of Σ computation, the number of display digits will be limited so that Σ value does not exceed 30000 (crest factor. 3) of 10000 (crest factor, 6) when the rated value is input to each corresponding element. A voltage of 5 V (full scale) will be output from the D/A converter as the Σ value obtained when the rated value is input to each corresponding element.
6: In a Σ var calculation, the var value of each phase is calculated as a negatively signed value when the phase of the current input is advanced with respect to the voltage input, and is calculated as a positively signed value when the phase is lagging.

Integration Functions

Maximum display: 500000
According to the displayed value, the resolution will be changed.
Frequency range: DC to 50 kHz
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: 00min to 999 h: 59 min
(000 h: 00min will be shown when manual integration mode is selected.)
Display: Display A shows : Elapsed time
Display B/C shows : Watt
Display D shows : Watt, Wh, Ah, Hz
Output: For the output of the printer, communication and D/A, fourteen free selectable items from the above can be set. However, only the measured data of the frequency which has been previously set will be output.
Count Overflow: If integration count overflows the maximum displayable value, integration stops and the elapsed time is held on the display.
Real Time Counting: The integration time can be controlled REAL TIME.
Accuracy: ±(display accuracy + 0.05% of rdg)
Timer accuracy: ±0.005%
Remote Control: Start, stop and reset can be remotely controlled by external contact signals.

Communication Functions

Communication Specifications (GP-IB & RS-232-C)
GP-IB
Electrical and mechanical specifications: EEE St'd 488-1978 (JIS C 1901-1987)
Functional specifications: SH1, AH1, T5, L4, SR1, RL1, PR0, DC1, DT1, C0
Protocol: IEEE St'd 488.2-1987
Code used: ISO (ASCII) code
Address: 0 to 30 talker/listener addresses can be set.
RS-232-C
Transmission mode: Start Stop Synchronization
Baud Rate: 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps

External Control

Signal: EXT-HOLD, EXT-TRIG, EXT-PRINT, EXT-START, EXT-STOP, EXT-RESET, INTEG-BUSY, FLICKER-BUSY
Input: TTL level negative pulses

Printer (optional)

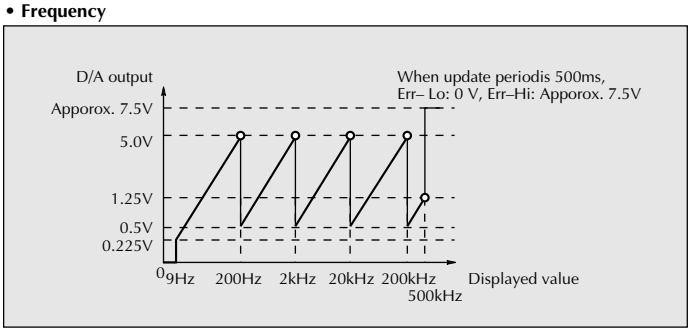
Contents of printing For normal measurement:
Printing of numerical values - All items
(Can be set freely, however is set in common with the communication output.)
For harmonic analysis function (optional):
Printing of numerical values - V, A, W, VA, var, PF, deg
Bar graphs - V, A, W, deg
For flicker measurement function (optional):
At end of 1 observation period - dc, dmax, d(t) 200 ms, Pst and evaluation criteria, evaluation results and total accuracy function (CPF) graph for each parameter
At end of all observation periods - Plt, Overall evaluation
Printing method: Thermal line dot printing

D/A Output (optional)

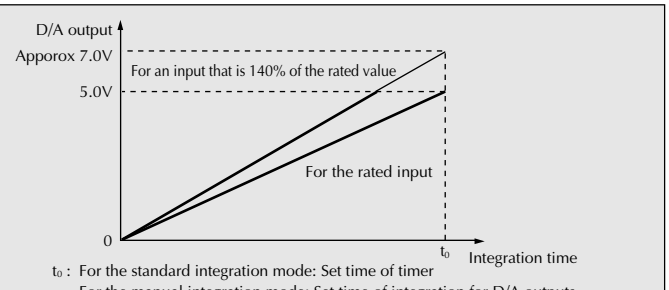
Number of outputs: 14 items (can be set for each channel)
Resolution: 12 bits
Accuracy: ±(display accuracy +0.2% of rng)
Output voltage: ±5 V FS with respect to each rated value (max. approx. ±7.5 V)
Maximum output current: ±1 mA
Temperature coefficient: ±0.05% of rng/°C
Update rate: Same as update rate of main unit

Output type

- **Frequency**

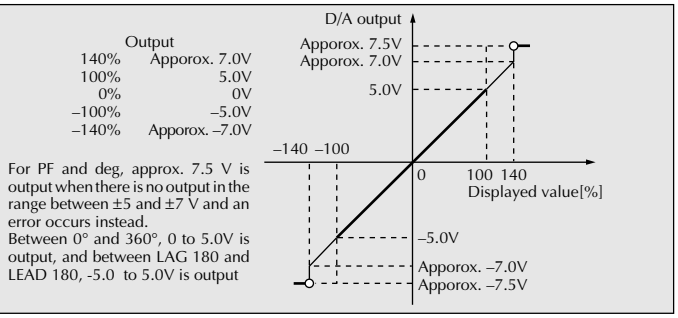


• **Integration**



t_0 : For the standard integration mode: Set time of timer
For the manual integration mode: Set time of integration for D/A outputs

• **Other items**



Harmonic Analysis Function (optional)

Type: PLL sync method
Measurement frequency: The fundamental frequency range is 10 Hz to 440 Hz.
Display resolution: 50000
Harmonics to be measured: Steady-state and fluctuating harmonics
Analysis items: Each harmonic level of V, A, W and deg, RMS voltage, RMS current, active power, VA, var, PF and deg of furelamental wave, ΣV, ΣA, ΣW harmonic distortion, each harmonic content, fundamental wave voltage, current, phase angle, phase angle between each harmonic and the fundamental wave
Sampling rate/window width/analysis order:
Depends on the input frequency as follows when the PLL sync method is used.

Fundamental Frequency	Sampling Frequency [Hz]	Window Width with Respect to FFT Data Length (Number Fundamental)					Maximum Analysis Order
		8192	4096	2048	1024	512	
10 ≤ f < 20	f × 2048	4	2	1	-	-	50 (50)*
20 ≤ f < 40	f × 1024	8	4	2	1	-	50 (50)*
40 ≤ f < 70	f × 512	16	8	4	2	1	50 (50)*
70 ≤ f < 130	f × 256	32	16	8	4	2	50 (25)*
130 ≤ f < 250	f × 128	64	32	16	8	4	50 (13)*
250 ≤ f ≤ 440	f × 64	128	64	32	16	8	25 (9)*

* ( ) indicates Anti-aliasing filter is ON.

FFT processing word length: 32 bits
Window function: Rectangular
Data acquisition operation: Continuously, no dead time
Averaging: Exponential average for time constant of 1.5 seconds (when the fundamental frequency is 50/60 Hz)
Display update period: 250, 500 ms/2 s
Anti-aliasing filter: At fundamental frequency of 50/60 Hz, the aliasing up to the 40th analysis order is -50 dB or better (when the line filter is ON and the cutoff frequency is 5.5 kHz).
Accuracy: As follows when the crest factor = 3
When the anti-aliasing filter is ON

Voltage/current	Active power	Phase angle
10 Hz ≤ f < 40 Hz	10 Hz ≤ f < 40 Hz	10 Hz ≤ f < 40 Hz
±(1% of rdg+0.3% of rng)	±(3% of rdg+0.5% of rng)	±15deg
40Hz ≤ f ≤ 500Hz	40Hz ≤ f ≤ 500Hz	40Hz ≤ f ≤ 2.5kHz
±(1% of rdg+0.05% of range)	±(2% of rdg+0.01% of range)	±10deg
500Hz < f ≤ 2.5kHz	COSφ=1	2.5kHz < f ≤ 3.5kHz
±(2% of rdg+0.05% of range)		±15deg
2.5kHz < f ≤ 3.5kHz		
±(5% of rdg+0.2% of range)		

When the anti-aliasing filter is OFF
Same as for normal measurement (Temperature : 23±5°)
- When the data length is 1024 or less or the fundamental frequency is less than 40 Hz, add range error × 3.
- The above accuracy is stipulated when the input for each analysis order is no more than 110% of the rated value. If the input range exceeds 110%, add range error × 2.
- When the crest factor is 6, range error is twice to the above crest factor = 3 accuracy.
- The input range is the range in which the "peak overload display LED" does not light. (within about ±350% of the measurement range) However, it must be within the maximum allowable input range.

Flicker Measurement (optional)

Measurement items: dc Relative steady-state voltage change
dmax Maximum relative voltage change
$d(t)_{200ms}$ Term within the voltage change during which the threshold level is exceeded
Regarding the above items, the maximum value is displayed within 1 observation term
Pst Short–term flicker indicator
Plt Long–term flicker indicator
Pst, Plt
Flicker scale: 0.01 to 6400 PU (20%) is divided logarithmically into 1024 parts.
1 observation term: 30 seconds to 15 minutes
Number of observation term: 1 to 99
Display update: 2 seconds (dc, dmax, d $(t)_{200ms}$)
At the end of each observation (Pst)
Steady-state condition: The relative voltage change can be set between 0.10 and 9.99% (0.01% steps).
Printer output: See the printer item.
Accuracy: Half-wave RMS value: ±0.1% of rdg +0.1% of rng
(45 Hz ≤ f ≤ 66 Hz)
dc, dmax, $d(t)_{200ms}$: In accordance with IEC1000-3-3.
Pst, Plt: ±5% when Pst = 1
The above accuracy applies to the following conditions.
- After warm-up of at least 2 hours.
- Subsequent ambient temperature change is no more than ±1°C.
- The input voltage is 50 to 110% of the range rating.

General Specifications

EMI standard: EN 55011 Group 1 class A
EMS standard: EN 50082-2: 1995
Safety Standard: EN61010-1
Over Voltage Category Ⅱ
Pollution degree 2
Operating altitude: 2000m or below
Working temperature range: 5 to 40°C
Storage temperature: –25 to 60°C
Working humidity range: 20 to 80% RH (no condensation)
Warmup time: Approx. 30 minutes
Insulation resistance: At least 50 MΩ at 500 V DC
(between each input terminal and case, between each input terminal, between each input terminal and power plug, between case and power plug)
Withstand voltage: 3700 V AC 50/60 Hz for one minute
(between each input terminal, between each input terminal and power plug)
2200 V AC 50/60 Hz for one minute
(between each input terminal, and case)
1500 V AC 50/60 Hz for one minute
(between case and power plug)
Power supply:

Setting	Alloweble Voltage range	Frequency
100 V	90 to 110 V	48 to 63 Hz
115 V	100 to 132 V	48 to 63 Hz
200 V	180 to 220 V	48 to 63 Hz
230 V	198 to 284 V	48 to 63 Hz

Power consumption: 120 VA max.
Accuracy of internal clock: Approx±30 seconds in one month
Vibration conditions: Sweep test 2-way sweep from 8 to 150 Hz in all 3 directions for 1 minute each
Durability test Frequency 16.7 Hz, amplitude of 4 mm in all 3 directions for 2 hours each
Impact conditions: Impact test Acceleration 490 m/s², in all 3 directions
Durability test Free-fall test Height 100 mm, once on each of 4 sides
External dimensions: Approx. 426 (W) × 132 (H) × 400 (D) mm
Mass: Approx. 13 kg (3-phase 4-line model),
Approx. 10 kg (single phase model)

Standard Accessories

Power cord: UL/CSA, VDE, SAA or BS standard × 1 pcs.
Fuse: 250 V/1.25 A (for 100/115 V) or 0.63 A (for 200/230 V) × 2 pcs. (1 pcs. is attached to the inside fuse holder)
Remote control connector: A1005JD × one
External shunt input connector cable: **B9384LK** One for each element
Printer paper (when /B5 is added): **B9293UA** 2 rolls
Rubber feet: **A9088ZM** 1pair