HIOKI

High-precision Power Analysis Through Sensing Technology

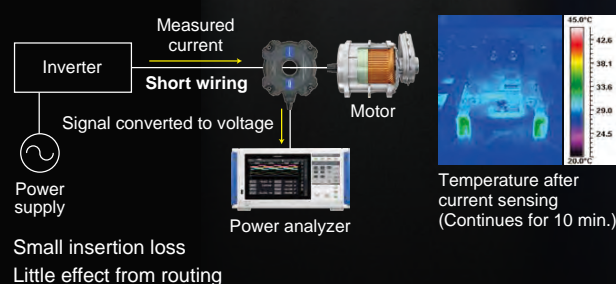## Superior affinity between power analyzers and current sensors

Hioki develops both power analyzers and current sensors. Advanced sensing technology is a prerequisite for accurate power analysis. Given the high affinity between current sensors and power analyzers, precise power analysis is possible.

For high voltage measurements above 1500 V
AC/DC HIGH VOLTAGE DIVIDER VT1005
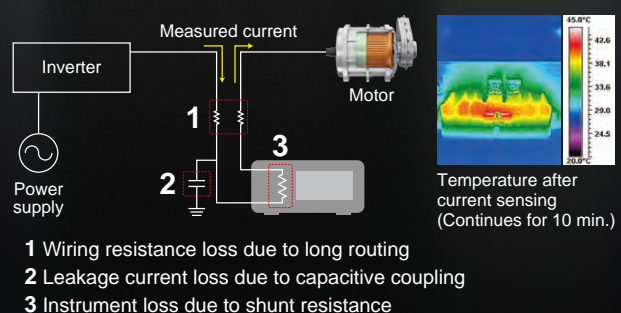Divides and outputs voltages of up to 5000 V

The current sensor method is an approach to making measurements that closely resemble the actual operating environment

**Measurement example using the current sensor method**

Measured current
Short wiring
Inverter
Signal converted to voltage
Power supply
Motor
Power analyzer

Temperature after current sensing
(Continues for 10 min.)

Small insertion loss
Little effect from routing

Measurement example using the direct wiring method

Measured current
Inverter
Power supply
Motor

1
2
3

Temperature after current sensing
(Continues for 10 min.)

1 Wiring resistance loss due to long routing
2 Leakage current loss due to capacitive coupling
**3** Instrument loss due to shunt resistance

Important points in evaluating high-efficiency inverters

When evaluating the power conversion efficiency of an inverter, the inverter's input and output power are measured, and its efficiency is calculated. PWM (pulse width modulated) inverter output, which has been widely used in recent years, contains the fundamental and its harmonic, the switching frequencies, and its harmonic component. Since switching frequencies are high, current sensors that can measure over a wide bandwidth are needed for the measurement process.
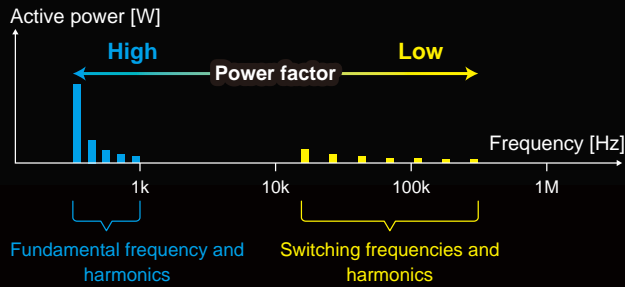
Active power spectogram for an inverter's output power.
The ability to measure low-powerfactor, high-frequency components is essential.
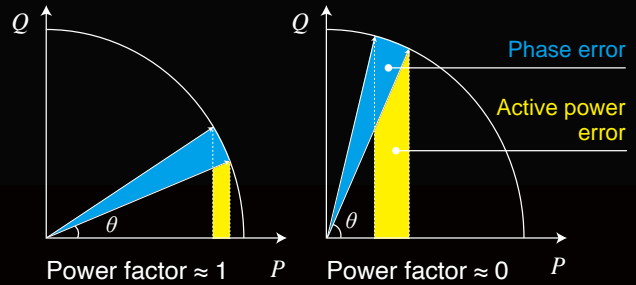
At low power factors, phase error has a significant effect on power error.
Phase accuracy of current sensor is important.

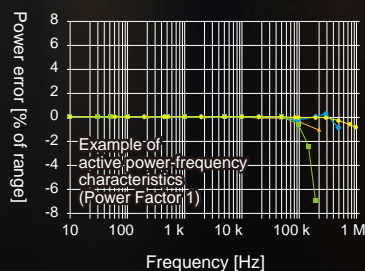**For high current measurements above 2000 A**
SENSOR UNIT CT9557
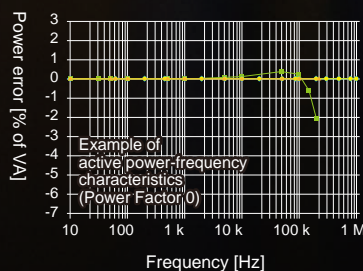The current sensor output is added and output
Accurately measures large currents up to 8000 A (4 wires)

Current sensor with defined phase accuracy can accurately measure power
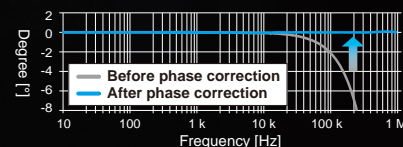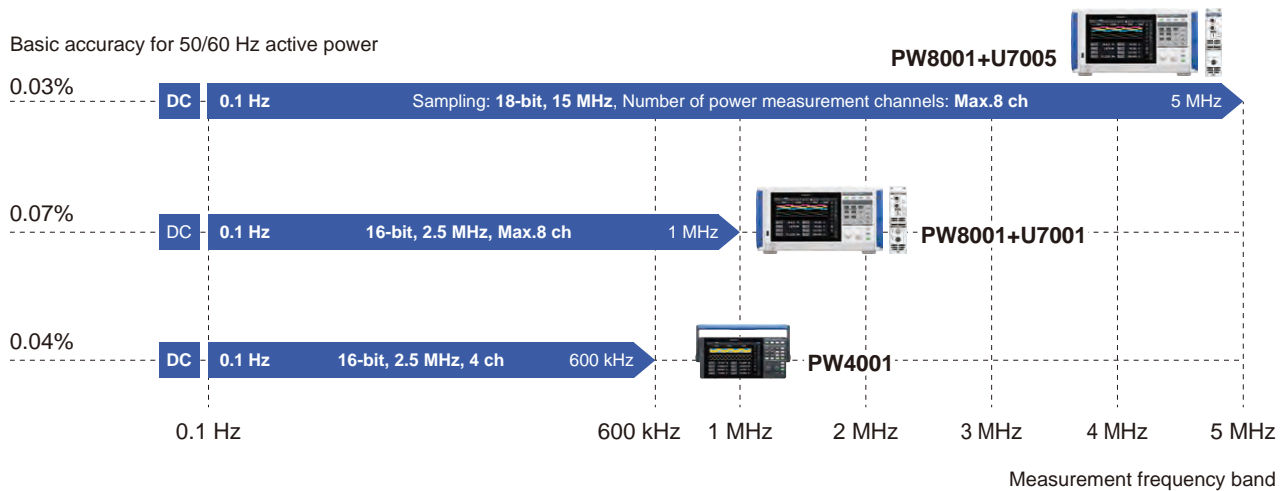
HIOKI specifies the phase accuracy of current sensors for more accurate power measurement. By correcting the phase characteristics of the current sensor with a power analyzer, low power factor power can be accurately measured down to higher frequencies.

Example of the phase correction for the CT6904A AC/DC current sensor

- ● PW8001+U7005 (1500 V/50 A range)
- ▲ PW4001 (1500 V/50 A range)
- ◆ PW8001+U7001 (1500 V/50 A range)
- ■ PW3390 (150 V/50 A range)

Power analyzer lineup

Basic accuracy for 50/60 Hz active power

0.03%	DC	0.1 Hz — Sampling: **18-bit, 15 MHz**, Number of power measurement channels: **Max.8 ch**	5 MHz

PW8001+U7005

| 0.07% | DC | 0.1 Hz — 16-bit, 2.5 MHz, Max.8 ch — 1 MHz |

PW8001+U7001

| 0.04% | DC | 0.1 Hz — 16-bit, 2.5 MHz, 4 ch — 600 kHz |

PW4001

0.1 Hz   600 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz
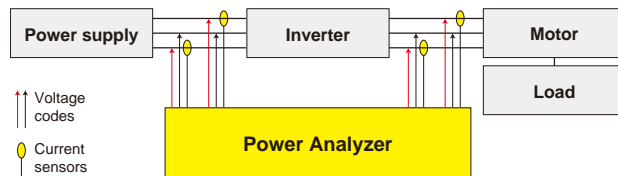
Measurement frequency band

Applications

Power conversion efficiency evaluation of inverters

Measure input and output power for power conversion devices like inverters and calculate efficiency and loss.

Efficiency and loss calculations (PW8001)
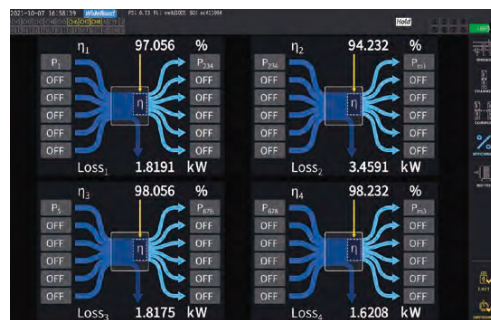

Harmonic analysis of the 500th-order (PW8001)

Detect power conversion efficiency and loss

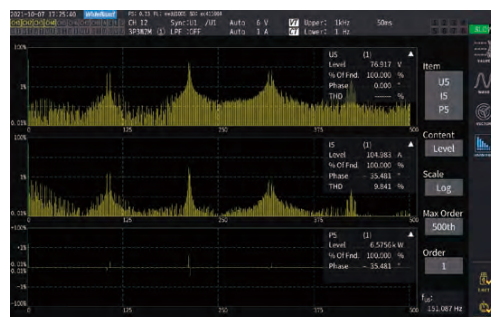| Number of power measurement channels	
PW8001	Up to 8 channels (specified at time of purchase)
PW4001	4 ch

Efficiency and loss calculations	
PW8001	Max.4 each for efficiency and loss (with Auto mode)
PW4001	Max.4 each for efficiency and loss (with Auto mode)

The PW8001's Auto mode automatically switches calculation formulas depending on the direction of power flow.

Accuracy for active power*	DC	50 Hz/60 Hz	10 kHz
PW8001+U7005	±(0.02% + 0.03%)	±(0.01% + 0.02%)	±(0.05% + 0.05%)
PW8001+U7001	±(0.02% + 0.05%)	±(0.02% + 0.05%)	±(0.2% + 0.05%)
PW4001	±(0.03% + 0.01%)	±(0.03% + 0.01%)	±(0.2% + 0.05%)

*±(% of reading + % of range)

Harmonics measurement

	Synchronization frequency range	Maximum analysis order
PW8001+U7005	0.1 Hz to 1.5 MHz	500th
PW8001+U7001	0.1 Hz to 1 MHz	500th
PW4001	0.1 Hz to 600 kHz	500th

The instrument can perform harmonic analysis for each channel's voltage, current, and active power and display the results. The PW8001 and PW4001 can analyze harmonics for individual channels, and they can simultaneously measure harmonics in multiple circuits at different frequencies.
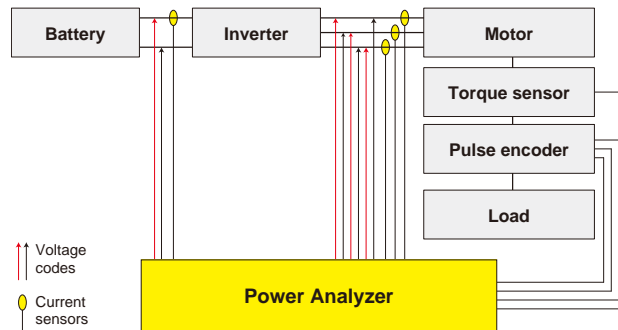
Common-mode rejection ratio (CMRR)

	50 Hz/60 Hz	100 kHz
PW8001+U7005	120 dB or greater	110 dB or greater
PW8001+U7001	100 dB or greater	80 dB typical
PW4001	80 dB or greater	-

When evaluating an equipment that produces noise, such as an inverter, it is essential to consider how effectively the device can withstand noise.

Evaluation of inverters and motors

Efficiency and loss can be calculated from the power on the input and output sides of inverters and motors. Torque meter and pulse encoder signals can be input to the power analyzer to simultaneously analyze and record the motor's torque, rotation speed, and mechanical output.

Voltage codes
Current sensors

Battery — Inverter — Motor — Torque sensor — Pulse encoder — Load — Power Analyzer

Motor analysis

Number of motors that can be simultaneously analyzed	
PW8001	Max. 4 motors
PW4001	Max. 2 motors

Input signals from a torque meter and pulse encoder to analyze motor torque, speed, rotational direction, and electrical angle.

user-defined calculations (used when calculating motor parameters)	
PW8001	Up to 20 equations can be set
PW4001	Up to 20 equations can be set

Set calculation formulas as desired and display the results in real time. Calculate Ld and Lq motor parameters from electrical angle measurements.

Correction of torque meter measurement error	
PW8001	Zero correction, nonlinear correction*, friction correction*
PW4001	Zero correction, nonlinear correction*, friction correction*

*Enter the calibration values and points for compensating the sensor's error to calibrate the torque meter's value.
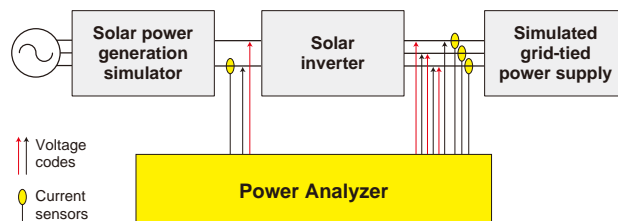
CAN or CAN FD communication

PW8001	Measured data can be converterd to CAN format and output (output function)
PW4001	・Measured data can be converted to CAN format and output (output function) ・CAN data and measured data can be saved simultaneously (input function)

Solar inverter efficiency measurements

Measure a solar inverter's input and output power and calculate efficiency and loss. Evaluate power generation systems that require measuring high voltages and multiple circuits, such as a multi-string solar inverter.

Voltage codes
Current sensors

Solar power generation simulator — Solar inverter — Simulated grid-tied power supply — Power Analyzer

Maximum input voltage

PW8001+U7005	1000 V AC/DC, ±2000 V peak
PW8001+U7001	1000 V AC, 1500 V DC, ±2000 V peak
PW4001	1000 V AC, 1500 V DC, ±2000 V peak

Use the VT1005 (option) to measure voltages of up to 5000 V with a power analyzer.

IEC standard compliant harmonic and flicker measurement

	IEC harmonics measurement	IEC Flicker Measurement
PW8001	Yes	Yes
PW4001	-	-

Measure harmonics in compliance with the IEC 61000-4-7 standard and flicker in compliance with the IEC 61000-4-15 standard.

Multi-string solar inverters evaluation

Optical link interface	
PW8001	Analysis of up to 16 channels
PW4001	-

Connect two power analyzers with the optical link interface to aggregate and analyze measured data on one instrument.

Power analyzer lineup

| Model		PW8001+U7005	PW8001+U7001	PW4001
	Applications	For measurement of SiC and GaN inverters and reactor/transformer loss	For measurement of high-efficiency IGBT inverters and solar inverters	For portability and high accuracy
Basic accuracy	Basic accuracy for 50/60 Hz power*1	±(0.01% + 0.02%)	±(0.02% + 0.05%)	±(0.03% + 0.01%)
	Accuracy for DC power*1	±(0.02% + 0.03%)	±(0.02% + 0.05%)	±(0.03% + 0.01%)
	Accuracy for 10 kHz power*1	±(0.05% + 0.05%)	±(0.2% + 0.05%)	±(0.2% + 0.05%)
	Accuracy for 50 kHz power*1	±(0.15% + 0.05%)	±(0.4% + 0.1%)	±(0.4% + 0.1%)
Measurement	Measurement frequency band	DC, 0.1 Hz to 5 MHz	DC, 0.1 Hz to 1 MHz	DC, 0.1 Hz to 600kHz
	Number of power measurement channels	1 to 8 channels, specify U7001 or U7005 when placing an order (mixed available)		4 channels
	Voltage, current ADC sampling	18-bit, 15 MHz	16-bit, 2.5 MHz	16-bit, 2,5 MHz
	Voltage range	6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1500 V		6 V, 15 V, 30 V, 60 V, 150 V, 300 V, 600 V, 1500 V
	Current range	40 mA to 2000 A*2	**probe1:** 40 mA to 2000 A*2 **probe2:** 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V	40 mA to 8000 A*2
	Data update rate	1 ms, 10 ms, 50 ms, 200 ms		1 ms, 10 ms, 50 ms, 200 ms
	Common-mode rejection ratio (CMRR)	50/60 Hz: 120 dB or greater 100 kHz: 110 dB or greater	50/60 Hz: 100 dB or greater 100 kHz: 80 dB typical	50 Hz/60 Hz: 80 dB or greater
	Temperature coefficient	0.01%/°C		0.005 %/°C
	Voltage input method	Photoisolated input, resistor voltage division	Isolated input, resistor voltage division	Isolated input, resistor voltage division
	Current input method	Isolated input from current sensor		Isolated input from current sensor
Current input	External current sensor input	Yes (ME15W)	Yes (ME15W, BNC)	Yes (ME15W)
	Power supplied to external current sensor	Yes		Yes
	Current sensor phase shift calculation	Yes (auto)		Yes (auto)
Voltage input	Maximum input voltage	1000 V, ±2000 V peak	1000 V AC, 1500 V DC, ±2000 V peak	1000 V AC, 1500 V DC, ±2000 V peak
	Maximum rated line-to-ground voltage	600 V CAT III 1000 V CAT II	600 V AC/1000 V DC CAT III 1000 V AC/1500 V DC CAT II	AC 600 V/DC 1000 V CAT III AC 1000 V/DC 1500 V CAT II
Analysis/calculation	Efficiency and loss calculations	Yes (Max.4 each for efficiency and loss, auto*3)		Yes (Max.4 each for efficiency and loss)
	Motor analysis Number of channels Input format	Yes*4 Max. 4 motors Analog DC, frequency, pulse		Yes*4 Maximum 2 motors Analog DC, frequency, pulse
	Torque meter correction	Zero correction, nonlinear correction, friction correction		Zero correction, nonlinear correction, friction correction
	Harmonics measurement Max. analysis order Synchronization frequency range	Yes (8, for each channel) 500th 0.1 Hz to 1.5 MHz	Yes (8, for each channel) 500th 0.1 Hz to 1 MHz	Yes (4 for each channel) 500th 0.1 Hz to 600 kHz
	IEC harmonics measurement	Yes		-
	IEC flicker measurement	Yes		-
	FFT spectrum analysis	Yes(DC to 6 MHz)	Yes (DC to 1 MHz)	-
	User-defined calculations	Yes		Yes
	Delta conversion	Yes (Δ-Y, Y-Δ)		Yes (Δ-Y, Y-Δ)
	D/A output	Yes*4 20 ch (waveform output, analog output)		Yes*4 16ch (waveform output, analog output)
Display	Display	10.1" WXGA TFT color LCD		10.1" WXGA TFT color LCD
	Touch screen	Yes		Yes
Interface	External storage media	USB 3.0		USB 3.0
	LAN (100BASE-TX, 1000BASE-T)	Yes		Yes
	GP-IB	Yes		-
	RS-232C	Yes (maximum 115,200 bps)		-
	External control	Yes		Yes
	Synchronization of multiple instruments	Yes (up to 4 instruments)		Yes (up to 8 instruments)
	Optical link	Yes*4		-
	CAN or CAN FD	Yes *4		Yes
	Dimensions, weight (W×H×D)	430 mm × 221 mm × 361 mm (16.93 in.× 8.70 in. × 14.21 in.), 14 kg (493.84 oz.)		361 mm× 176 mm × 135 mm (14.21 in.× 6.93 in.× 5.31 in.) 4.6 kg (162.26 oz.)

*1: ±(% of reading + % of range) *2: 6 ranges, based on sensor *3: The position of terms set on the input and output sides is switched depending on the sign of the measured values.
*4: Sold separately

Model No. (Order code)

PW8001

Model	Number of channels	Motor analysis	Waveform and D/A output	CAN or CAN FD interface	Optical link interface
PW8001-01	1 to 8 channels, specify U7001 or U7005 when placing an order (mixed available)	-	-	-	-
PW8001-02		-	Yes	-	-
PW8001-03		-	-	Yes	-
PW8001-04		-	-	-	Yes
PW8001-05		-	Yes	-	Yes
PW8001-06		-	-	Yes	Yes
PW8001-11		Yes	-	-	-
PW8001-12		Yes	Yes	-	-
PW8001-13	U7001 U7005	Yes	-	Yes	-
PW8001-14		Yes	-	-	Yes
PW8001-15		Yes	Yes	-	Yes
PW8001-16		Yes	-	Yes	Yes
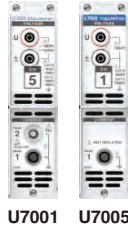
PW4001

Model	Number of channels	Motor analysis	Waveform and D/A output	CAN or CAN FD interface	DC power supply operation
PW4001-01	4 ch	-	-	Yes	-
PW4001-02	4 ch	-	Yes	Yes	-
PW4001-03	4 ch	Yes	-	Yes	-
PW4001-04	4 ch	-	-	Yes	Yes
PW4001-05	4 ch	Yes	Yes	Yes	Yes

430 mm (16.93 in.)
221 mm (8.70 in.)
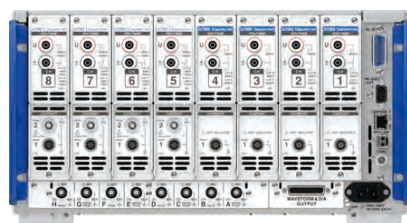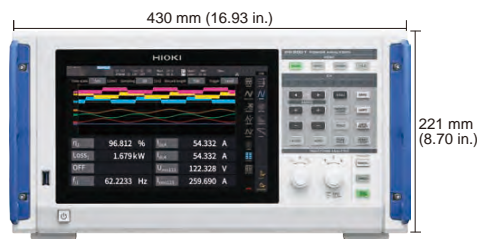
PW8001-15
Four U7001 units installed
Four U7005 units installed

410 mm (16.14 in.)
361 mm (14.21 in.)
176 mm (6.93 in.)
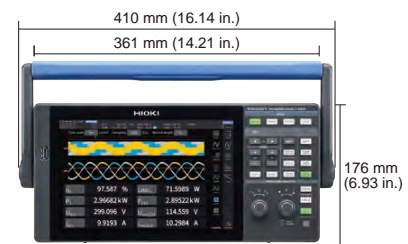
PW4001

Current sensor lineup

Model	Appearance	Rated current	Maximum peak current	Frequency range	Amplitude accuracy 50 Hz/ 60 Hz	Diameter of measurable conductors	Cable length	Automatic phase correction[*1]	Operating temperature
Pass-through types									
CT6862-05		50 A rms	±141 A peak	DC to 1 MHz	±0.05 % rdg ±0.01 % f.s.	φ 24 mm (0.94 in.)	3 m (9.84 ft.)	-	-30°C to 85°C -22°F to 185°F
CT6872		50 A rms	±200 A peak	DC to 10 MHz	±0.03 % rdg ±0.007 % f.s.	φ 24 mm (0.94 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
CT6872-01							10 m (32.81 ft)		
CT6863-05		200 A rms	±565 A peak	DC to 500 kHz	±0.05 % rdg ±0.01 % f.s.	φ 24 mm (0.94 in.)	3 m (9.84 ft.)	-	-30°C to 85°C -22°F to 185°F
CT6873		200 A rms	±350 A peak[*2]	DC to 10 MHz	±0.03 % rdg ±0.007 % f.s.	φ 24 mm (0.94 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
CT6873-01							10 m (32.81 ft)		
CT6875A		500 A rms	±1500 A peak[*2]	DC to 2 MHz	0.04 % rdg ±0.008 % f.s.	φ 36 mm (1.42 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
CT6875A-1				DC to 1.5 MHz			10 m (32.81 ft)		
CT6904A		500 A rms	±1000 A peak[*2]	DC to 4 MHz	±0.02 % rdg ±0.007 % f.s.	φ32 mm (1.26 in.)	3 m (9.84 ft.)	Yes	-10°C to 50°C 14°F to 122°F
CT6904A-1				DC to 2 MHz			10 m (32.81 ft)		
CT6904A-2		800 A rms	±1200 A peak[*2]	DC to 4 MHz	±0.025 % rdg ±0.009 % f.s.	φ32 mm (1.26 in.)	3 m (9.84 ft.)	Yes	-10°C to 50°C 14°F to 122°F
CT6904A-3				DC to 2 MHz			10 m (32.81 ft)		
CT6876A		1000 A rms	±1800 A peak[*2]	DC to 1.5 MHz	0.04 % rdg ±0.008 % f.s.	φ 36 mm (1.42 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
CT6876A-1				DC to 1.2 MHz			10 m (32.81 ft)		
CT6877A		2000 A rms	±3200 A peak[*2]	DC to 1 MHz	0.04 % rdg ±0.008 % f.s.	φ80 mm (3.15 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
CT6877A-1							10 m (32.81 ft)		
Clamp types									
CT6830 NEW		2 A rms	±4.3 A peak	DC to 100 kHz	±0.3 % rdg ±0.05 % f.s.	φ5 mm (0.20 in.)	4 m, 20 cm[*4] (13.12 ft., 7.87 in.)	Yes	-40°C to 85°C (-40°F to 185°F)
CT6831 NEW		20 A rms	±43 A peak	DC to 100 kHz	±0.3 % rdg ±0.01 % f.s.	φ5 mm (0.20 in.)	4 m, 20 cm[*4] (13.12 ft., 7.87 in.)	Yes	-40°C to 85°C (-40°F to 185°F)
CT6833 CT6833-01 NEW		200 A rms	±600 A peak	DC ~ 50 kHz	±0.07% rdg ±0.007% f.s.	φ 20 mm (0.79 in.)	5 m(16.40 ft.) 10 m(32.81 ft.)	Yes	-40 °C to 85 °C (-40°F to 185°F)
CT6834 CT6834-01 NEW		500 A rms	±800 A peak	DC ~ 50 kHz	±0.07% rdg ±0.007% f.s.	φ 20 mm (0.79 in.)	5 m(16.40 ft.) 10 m(32.81 ft.)	Yes	-40 °C to 85 °C (-40°F to 185°F)
9272-05		20 A rms, 200 A rms	±71 Apeak, ±430 Apeak	1 Hz to 100 kHz	±0.3 % rdg ±0.01 % f.s.	φ46 mm (1.81 in.)	3 m (9.84 ft.)	-	0°C to 50°C 32°F to 122°F
CT6841A		20 A rms	±60 A peak[*2]	DC to 2 MHz	±0.2 % rdg ±0.01 % f.s.	φ20 mm (0.79 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
CT6843A		200 A rms	±600 A peak[*2]	DC to 700 kHz	±0.2 % rdg ±0.01 % f.s.	φ20 mm (0.79 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
CT6844A		500 A rms	±800 A peak[*2]	DC to 500 kHz	±0.2 % rdg ±0.01 % f.s.	φ20 mm (0.79 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
CT6845A		500 A rms	±1500 A peak[*2]	DC to 200 kHz	±0.2 % rdg ±0.01 % f.s.	φ50 mm (1.97 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
CT6846A		1000 A rms	±1900 A peak[*2]	DC to 100 kHz	±0.2 % rdg ±0.01 % f.s.	φ50 mm (1.97 in.)	3 m (9.84 ft.)	Yes	-40°C to 85°C -40°F to 185°F
Direct-wired types									
PW9100A-3[*3]		50 A rms	±200 A peak[*2]	DC to 3.5 MHz	±0.02 % rdg ±0.005 % f.s.	M6 screw terminals	3 ch	Yes	0°C to 40°C 32°F to 104°F
PW9100A-4[*3]		50 A rms	±200 A peak[*2]	DC to 3.5 MHz	±0.02 % rdg ±0.005 % f.s.	M6 screw terminals	4 ch	Yes	0°C to 40°C 32°F to 104°F

*1: When using PW8001 *2: Within 20 ms and 40°C (104°F) or less *3: Special specification PW9100A with a rated current of 5A can also be ordered.
*4: Between sensor to multiplexer, Between multiplexer to output connector

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