

⚡ CT6904A / CT6904A-1

AC/DC CURRENT SENSOR

Maximum rating 500A, ultra-high-stability, high-accuracy, wideband DC to 4MHz/2MHz, high-CMRR, high-performance fluxgate technology, pass-through type



Features

- 5 ppm linearity
- 10 ppm offset
- Voltage output
- CT coil structure for broadband and superior frequency characteristics
- Built-in machined solid aluminum shield for excellent noise resistance (high CMRR)
- Aperture $\phi 32$ mm for cables and bus-bars
- The Power Analyzer PW8001 automatically recognizes the current sensor's information (phase shift data, sensor model name, rated current, serial number) when connected.

Applications

- Measurement of loss in high-frequency reactors
- Automotive (e.g. xEV inverter motors)
- Efficiency measurement of high-efficiency energy converters
- Analysis of industrial inverter motors
- Calibration of shunt resistors
- Measurement of minute superimposed current in battery systems
- For feedback control in medical devices (MRI,CT, X-ray)

Specification highlights	Symbol	Unit	Min.	Typ.	Max.
Nominal primary DC current	IPN DC	A	-500		500
Nominal primary AC current	IPN AC	Arms			500
Measurement range	IPM	A	-550		550
Nominal output voltage	V _{out}	V	-2		2
Primary / secondary ratio	Ratio	V/A	0.004	0.004	0.004
Linearity error	ϵ_L	ppm		± 5	
Offset error	ϵ_O	ppm		± 10	
Bandwidth (± 3 dB)	f	MHz		CT6904A: 4 CT6904A-1: 2	
Withstand voltage (1mA, 50/60Hz for 1minute)	U _d	kV			7.4
Power supply voltages	U _c	V	± 11.5		± 12.5
Operating temperature range	TA	°C	-10		50
Output cable length	L _{cab}	m		CT6904A : 3m CT6904A-1: 10m	

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⚡ **Electrical specifications at T_A = 23°C ± 5°C, supply voltage (by using external PSU) = ±12 V unless otherwise stated**

Parameter	Symbol	Unit	Min.	Typ.	Max.	Comment
Nominal primary DC current	I _{PN} DC	A	-500		500	Refer to "Figure 1. Frequency derating"
Nominal primary AC current	I _{PN} AC	Arms			500	Refer to "Figure 1. Frequency derating"
Measurement range	I _{PM}	A	-550		550	Refer to "Figure 1. Frequency derating"
Maximum input current	I _{MAX}	A _{peak}	-1000		1000	Not exceeding derating curve shown in Figure 1 However, it is allowable for up to 20 ms at 40°C or less
Nominal output voltage	V _{out}	V	-2		2	
Primary/secondary ratio	Ratio	V/A	0.004	0.004	0.004	
Bandwidth (-3dB) CT6904A CT6904A-1	f	MHz		4 2		Refer to "Figure 2. Frequency characteristics"
Output resistance		Ω	40	50	60	
Input impedance		mΩ		2.5		100 kHz
Linearity error	ε _L	ppm		±5		Refer to "Figure 3. Linearity error characteristics"
Offset error	ε _O	ppm		±10		
Output noise	noise	μVrms			300	Measurement bandwidth: DC to 1MHz
Effects of temperature Amplitude sensitivity Offset voltage Phase		ppm of reading/°C ppm of full scale/°C ±°/°C	-20 -1 -0.01		20 1 0.01	Within the range of -10°C to 18°C or 28°C to 50°C
Effects of magnetization		mA			5	Input equivalent, after 500A DC is inputted
Common mode rejection ratio 50/60 Hz 100 kHz	CMRR	dB	140 120			(Effect on output voltage/common-mode voltage) Refer to "Figure 4. CMRR characteristics"
Effects of conductor position 50/60 Hz 100 kHz		% of reading	-0.01 -0.2		0.01 0.2	When wire of outer diameter 10 mm is used Refer to Figure 5. Effects of conductor position (typical) at 100 kHz
Effects of external magnetic field		mA			50	Input equivalent, under a magnetic field of 400 A/m, DC
					50	Input equivalent, under a magnetic field of 400 A/m, 60 Hz
Effects of radiated radio-frequency electromagnetic field		% of full scale			0.5	10 V/m
Effects of conducted radio-frequency electromagnetic field		% of full scale			0.2	10 V
Fluxgate excitation frequency	f _{Exc}	kHz		10.4		
Power supply voltages	U _c	V	±11.5		±12.5	
Positive current consumption	I _{ps}	mA			400	DC + 500 A with ±12 V
Negative current consumption	I _{ns}	mA			-400	DC - 500 A with ±12 V

⚡ **Isolation specifications**

Parameter	Unit	Value	Comment
Rated insulation RMS voltage, basic insulation	V	1000	IEC 61010-1 conditions • over voltage cat III • pollution degree 2
Rated insulation RMS voltage, reinforced insulation	V	1000	
RMS voltage for AC isolation test, 50/60 Hz, 1minute	kV	7.4	Between primary and secondary (and shield) Sensed current: 1 mA
Clearance	mm	20.7	Shortest distance through air
Creepage distance	mm	20.7	Shortest path along device body
Comparative tracking index (CTI)	V	< 250	Performance level category (PLC)= 3
Standards			Safety: EN 61010 EMC: EN 61326

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⚡ Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min.	Typ.	Max.	Comment
Operating environment (altitude)		m			2000	Indoor use, pollution degree 2
Ambient operating temperature range	T _A	°C	-10		50	
Ambient storage temperature range	T _{Ast}	°C	-20		60	
Relative humidity	RH	%			80	Non-condensing
Dust resistance and water resistance	IP20					EN 60529
Measurable conductor diameter	D _{meas}	mm			32	
Dimensions	W H D	mm		139 120 52		Refer to "Figure 6. Dimensions"
Output cable length CT6904A CT6904A-1	L _{cable}	m		3 10		
Mounting hole diameter	D _{mout}	mm		φ 5.2		M5 screw, recommended tightening torque: 1.5 Nm to 2.0 Nm
Weight CT6904A CT6904A-1	m	kg		1.05 1.35		

⚡ Measurement accuracy (total accuracy including uncertainty in calibration system etc.)

Frequency [Hz]	Amplitude		Phase [°]
	[±% of reading]	[±% of full scale]	
DC	0.025	0.007	-
DC < f < 16	0.2	0.02	0.1
16 ≤ f < 45	0.1	0.02	0.1
45 ≤ f ≤ 65	0.02	0.007	0.08
65 < f ≤ 850	0.05	0.007	0.12
850 < f ≤ 1 k	0.1	0.01	0.4
1 k < f ≤ 5 k	0.4	0.02	0.4
5 k < f ≤ 10 k	0.4	0.02	0.08 × f
10 k < f ≤ 50 k	1	0.02	0.08 × f
50 k < f ≤ 100 k	1	0.05	0.08 × f
100 k < f ≤ 300 k	2	0.05	0.08 × f
300 k < f ≤ 1 M	5	0.05	0.08 × f
Frequency range	4 MHz/2 MHz (CT6904A-1) (±3dB typical)		-

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- The variable f in accuracy equations is expressed in kHz.
- Accuracy of amplitude and phase is specified with 110% of full scale input or less and not exceeding derating curve in Figure 1. Accuracy in range of DC < f < 10 Hz are design values.
- Add ±0.01% of reading to amplitude accuracy when input is 100% to 110% of full scale.
- For the CT6904A-1, add the following values to accuracy in the range of 50 kHz < f ≤ 1 MHz.
Amplitude accuracy: ±(0.015 × f [kHz])% of reading
- Combined accuracy with HIOKI power analyzer PW8001 and PW6001 is specified (DC, 45 Hz ≤ f ≤ 65 Hz).
For details of combined accuracy, refer to the instruction manual (<https://www.hioki.com/download/38350>).

⚡ Definition of on accuracy

(total accuracy including uncertainty in calibration system etc.)

Reading (displayed value) error:

Indicates the value displayed by the instrument. Limit values for reading errors are expressed as a percentage of the reading ("% of reading" or "% rdg").

Range error:

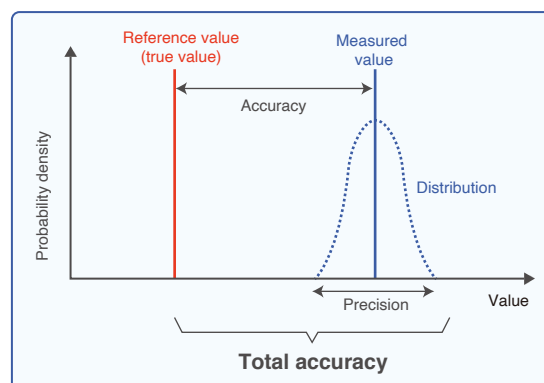
Indicates the instrument's range. Limit values for range errors are expressed as a percentage of the range ("% of range").

Full scale (rated current) error:

Indicates the rated current. Limit values for full-scale errors are expressed as a percentage of full scale ("% of full scale" or "% f.s.").

Calibration:

The accuracy of HIOKI products includes all factors that affect the measurement results, such as calibration system errors, ambient temperature, and secular change, as "uncertainty".







HIOKI is accredited as an official ISO/IEC 17025 calibrator.

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⚡ Specific accuracy calculation example

How to measure the current of **DC 300 A** of a conductor with a diameter of $\phi 30$ mm or less with high accuracy.
Guaranteed specifications at $T_A = 23^\circ\text{C} \pm 5^\circ\text{C}$

Measuring instrument configuration	CT6904A,CT6904A-1	CT9555	L9217 + 9704	DM7276
External view				
Range (connection)	500 A (2 V)	Front OUTPUT terminal (BNC terminal)	✓	10 V
Output voltage	300 A \times 2 V / 500 A = 1.2 V			-
Error (reading)	0.025%	-	-	0.0009%
Error (full scale)	0.007%	-	-	12 μV
Total error	$1.2 \text{ V} \times (0.025 + 0.0009)\% + 2 \text{ V} \times 0.007\% + (12 \times 10^{-6}) \text{ V} = 0.0004628 \text{ V}$			
Total error (input equivalent)	$0.0004628 \text{ V} / 2 \text{ V} \times 500 \text{ A} = 0.1157 \text{ A}$			
Error range	300 A \pm 0.1157 A \rightarrow 299.8843 A to 300.1157 A			

⚡ Definition of linearity error

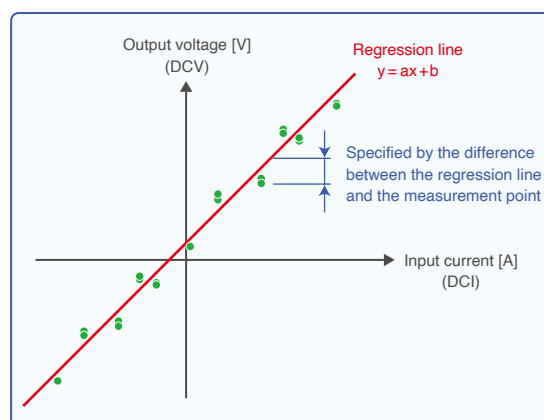
Linearity error ϵ_L :

Indicates that the output (current or voltage) changes linearly in response to the input current.

A regression line is attained by measuring the output voltage in the sequence below in 100 A intervals:

+500 A \rightarrow 0 A \rightarrow -500 A \rightarrow 0 A \rightarrow +500 A

It is defined as the difference between the regression line calculated from the above measurements and the measurement points.



⚡ Definition of offset error

Offset error ϵ_O :

Specified by the ratio of the average value (μ) of the measured values of the offset voltage and the rated current (I_{max}) of each current sensor.

$$\epsilon_O = \mu / I_{max} \text{ [ppm]}$$

⚡ Definition of amplitude error

Amplitude error ϵ_G :

An index showing the degree of flatness of the frequency characteristics of gain.

DC error is defined as (linearity error + offset error).

AC error is defined as deviation from the 55 Hz measurement point.

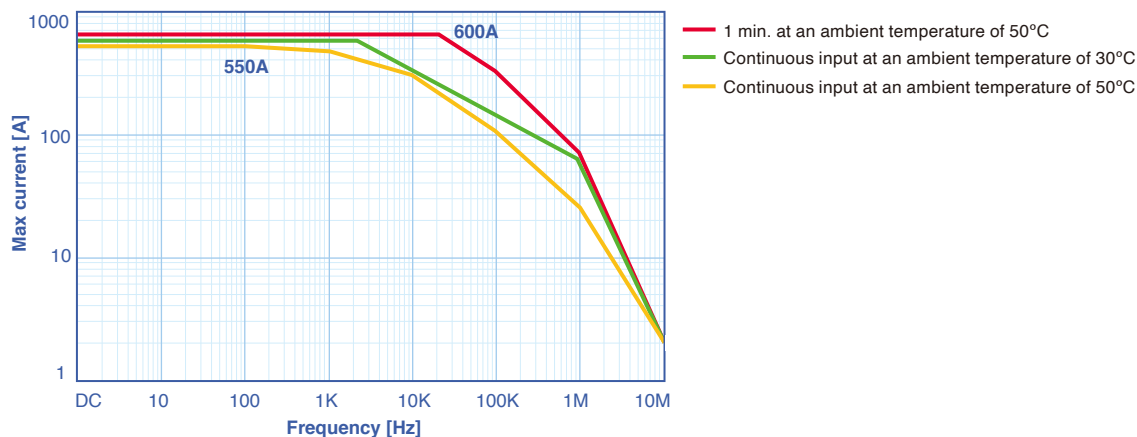
$$\epsilon_{DC} = \epsilon_L + \epsilon_O \text{ [ppm]}$$

$$\epsilon_{GAC} = \frac{\text{Gain}(f) - \text{Gain}(55 \text{ Hz})}{\text{Gain}(55 \text{ Hz})} \times 100 \text{ [%]}$$

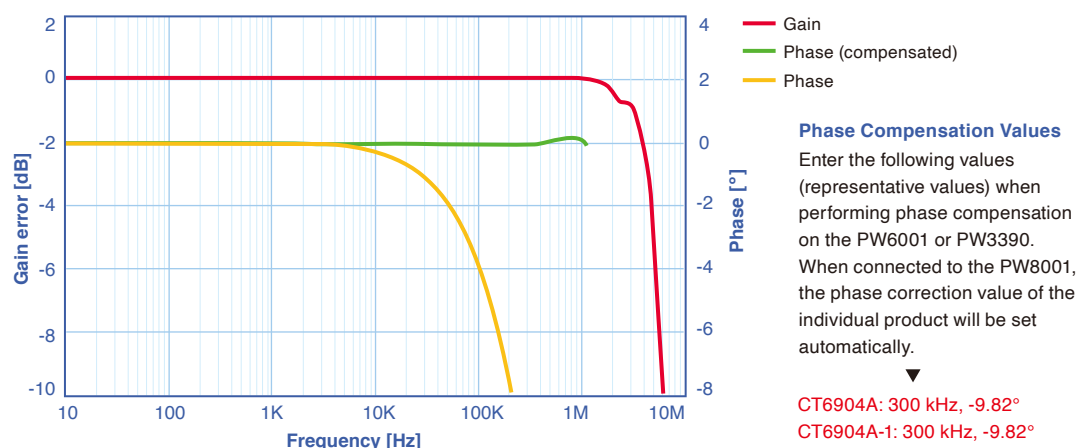
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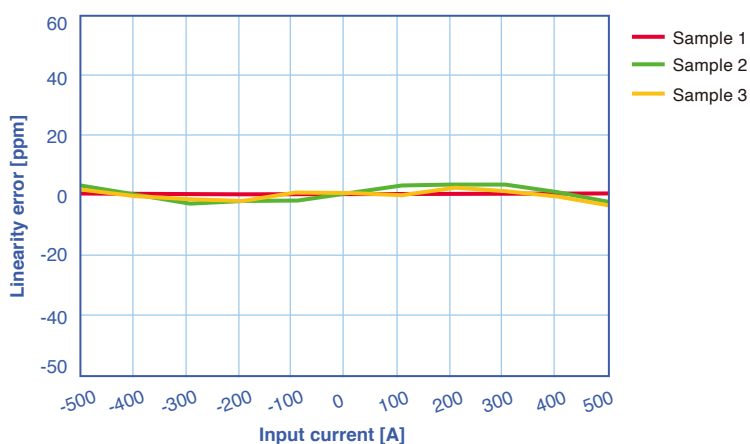
⚡ Figure 1. Frequency derating



⚡ Figure 2. Frequency characteristics



⚡ Figure 3. Linearity error characteristics



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Figure 4. CMRR characteristics

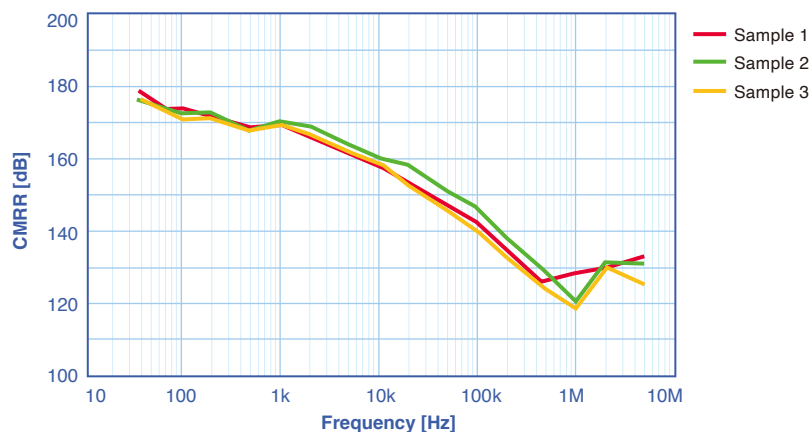
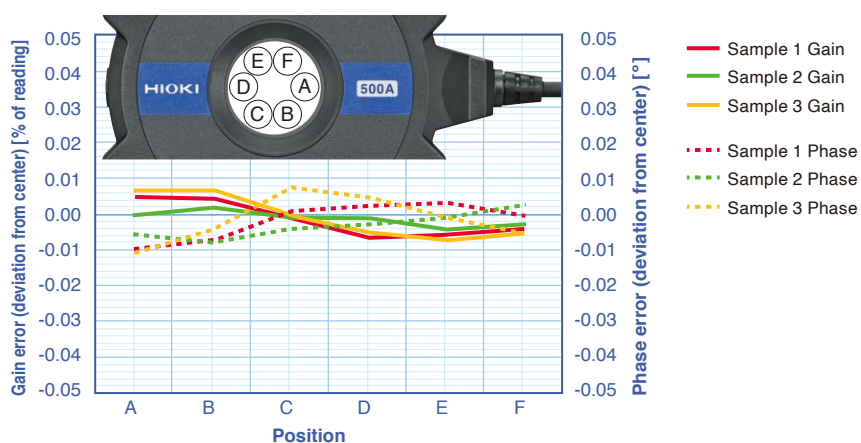


Figure 5. Effects of conductor position (typical) at 100 kHz



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Figure 6. Dimensions

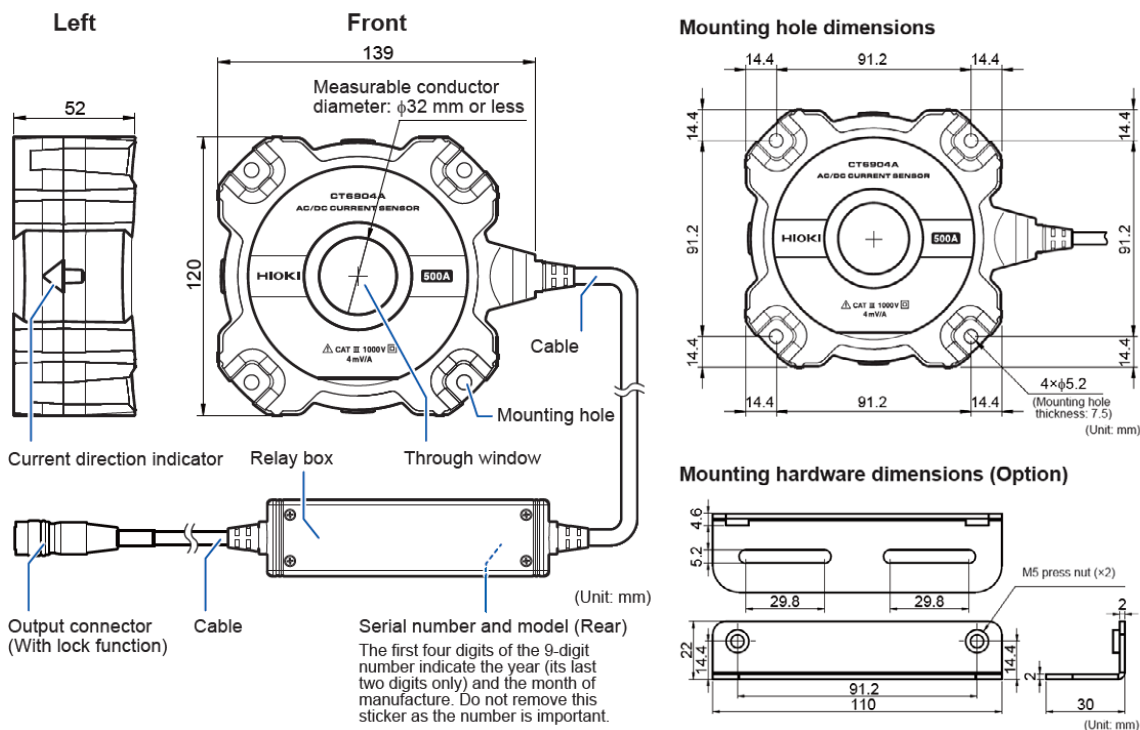
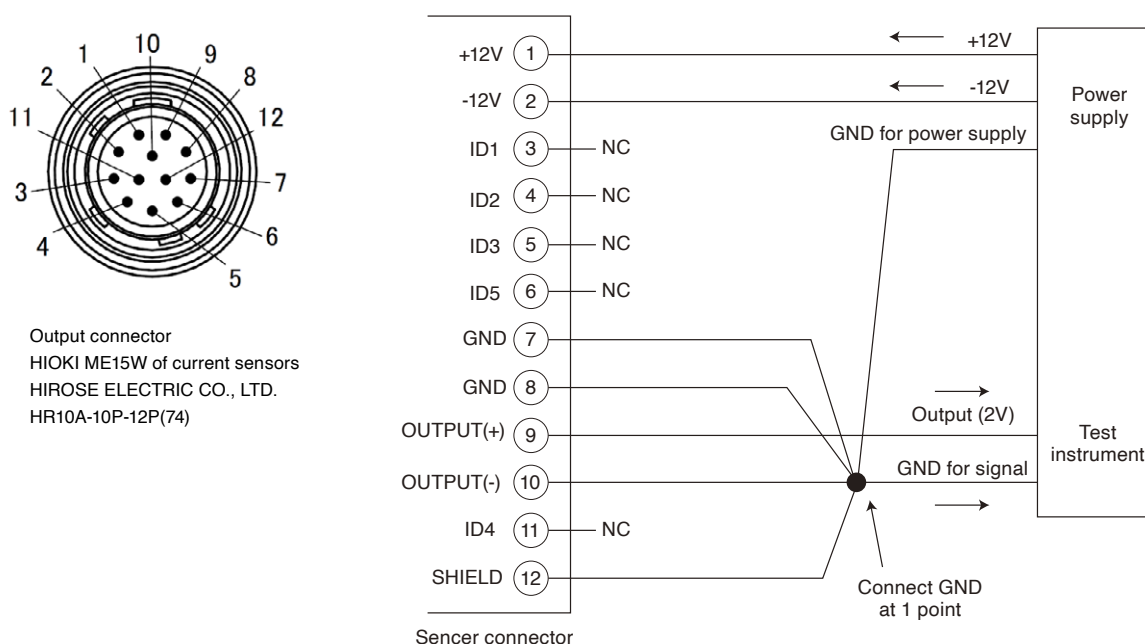


Figure 7. Pin assignment (when not using the sensor units CT9555, CT9556, or CT9557)



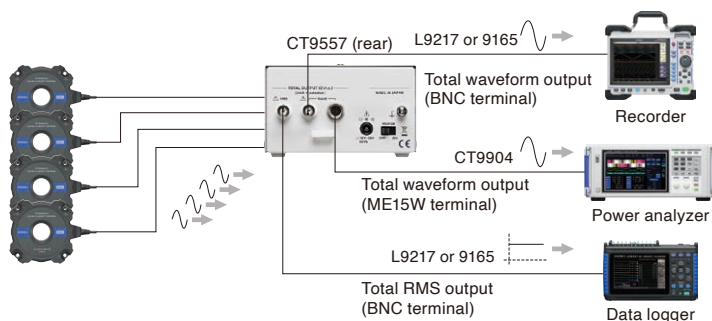
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Figure 8. Options and main combination



The CT9557 not only functions as a 4-channel power supply, but can also output additive waveform and RMS output from up to four input waveforms.



CT9904 CONNECTION CABLE
 ME15W (12 pin) terminal - ME15W (12 pin) terminal
 The CT9904 is the cable for the CT9557 addition output and POWER ANALYZER PW8001/PW6001/PW3390 connection.

CT9902 EXTENSION CABLE
 ME15W (12 pin) terminal - ME15W (12 pin) terminal
 The CT9902 can be used to extend a current sensor's cable by 5m. Up two of these cables can be used for a maximum extension of 10 m.
 *When using the CT9902, an additional accuracy needs to be added. For details, see the sensor's user manual.

Links

1. Web site https://www.hioki.com/global/products/current-probes/high-precision/id_471292
2. Accuracy calculation tools
 PW8001, PW6001, PW3390: <https://hioki-cierto.com/gl/fm50bha8wk/>

Files and information such as the Power Analyzer accuracy calculation tools are updated regularly. Instead of downloading them once and using them for a long time, download them from the download link just before using them.

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