

Current Measurement for Electric Vehicle Charger Test

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Current Probe Connections in Electric Vehicle Chargers





PEM Flexible, Clip-Around AC Current Probes Rogowski Coil with Analog Integrator



Current Sensitivity (S):	200mV/A to 0.02mV/A
Current Range:	±30A to ±300kA
Frequency Range:	0.03Hz to 50MHz
Amplitude Accuracy:	~±1%
Phase Shift:	< 1°at mid-range
Insertion Impedance:	~рН
Operating Temp (coil):	-20°C to +100°C (can be wider range)
Sensitivity Temp Coeff:	-150ppm/°C to -200ppm/°C

After Analog Integration

$$V(t) = \int k \cdot \frac{dI(t)}{dt} \cdot dt = k \cdot k'I(t) = S \cdot I(t)$$

S = Sensitivity

Source: PEM



Current Probe Connections in Electric Vehicle Chargers PEM CWT Rogowski Coils





PEM AC Current Probes CWT Mini50HF





Ch2 - CWTMini50HF/3 /B/1/100/2 - 10mV/A, peak current 600A (10A/div)

Ch3 - Voltage close to the coil - 100V/div

Current Sensitivity (S):	10mV/A	5mV/A
Current Range:	±0.6kA	±1.2kA
Noise (primary current):	1.5Ар-р	ЗАр-р
Frequency Range (LF):	12Hz	6Hz
(HF):	50MHz	50MHz
Coil Lengths:	100mm or 2	200mm
Coil Cross-section:	3.5mm	



Ch1 - (2GHz) Co-axial shunt (100A/div) Ch2 - CWTMini50HF/3/B/1/100/2 - 10mV/A, peak current 600A (100A/div)

Source: PEM



Current Probe Connections in Electric Vehicle Chargers PEM CWT Mini50HF





PEM AC Current Probes with Tailored Frequency Response

CMC Common-Mode AC Current Probe

Optimized to provide a High S/N for the high frequency current generated by the Variable Speed Drive Voltage Spikes.

CWT MiniHF 85kHz AC Current Probe Optimized for 85kHz (under development).

Current Sensitivity (S):	200mV/A	100mV/A	50mV/A	Current Sensitivity (S):	20mV/A
Current Range:	±37.5A	±75A	±150A	Current Range:	±300A
Frequency Range (LF):	19kHz	6kHz	1.9kHz	Frequency Range (LF):	530Hz
(HF):	11MHz	13MHz	14MHz	(HF):	30MHz
Coil Lengths:	1000mm (a	also 500mr	n, 700mm)	Amplitude Accuracy (85kHz)	±0.5%



Source: PEM



±1°

Current Probe Connections in Electric Vehicle Chargers <u>Tailored Frequency Response (CMC, CWT MiniHF 85kHz)</u>





DaniSense Zero Flux, Fluxgate Current Transducers



If $\phi_i = \phi_1$ (zero flux in the magnetic toroid), Ni = I and i = I/N ($N \sim 200$ to 5000). If there is no power lost in the Current Transducer, $I^2 R' \sim i^2 R_B$, $I^2 R' \sim \frac{I^2}{N^2} R_B$ or $R' \sim \frac{R_B}{N^2}$ For $R_B \sim 10$ hm, $N \sim 1000$, $R' \sim 1\mu$ ohm. For $I \sim 1000$ A, $N \sim 1000$, $Power \sim 1$ W

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DaniSense Zero Flux,

Fluxgate Current Transducers

Product Range Overview

Output	Product		Primary Current (Arms)					
Туре	Family	50	200	600	1000	2000	5000	10000
	DS series							
	DQ series							
	DC series							
Current	DM series							
	DL series							
	DR series							
	DS series							
Valtaga	DM series							
voltage	DL series							
	DR series							
DC series	DQ series	DS series	S	DM series	DL series	DAM/ÉRE 2		DR series

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DaniSense Zero Flux,

Fluxgate Current Transducers

	DS200ID	DS1200ID-CD3000
Current Ratio, N	500	1500
Current Range	±370A	±1500
Output Signal	2mA/A	0.666mA/A
Zero Offset (equiv. primary)	< ±6mA	< ±18mA
Zero Offset Stability (equiv. primary)	< ±0.06mA/month	< ±0.15mA/month
Offset Change, Magnetic Field (equiv. primary)	$< \pm 3$ mA/mT ⁽¹⁾	< ±3mA/mT ⁽¹⁾
Amplitude Error, dc to 5kHz	< ±0.01%	< 0.01% ⁽²⁾
Phase Error, dc to 5kHz	< ±0.1 degree	$< \pm 0.1 \text{ degree}^{(2)}$
Calibration Winding	-	$3000 \text{ turns}^{(2)} \\ 500mA \cdot 3000t = 1500A \cdot t$
Case Type	Al (ES Shield)	Al (ES Shield)
Aperture	27.6mm (~1.1")	45mm (~1.77")
Calibration Winding Case Type Aperture	- Al (ES Shield) 27.6mm (~1.1")	$3000 \text{ turns}^{(2)}$ $500mA \cdot 3000t = 1500A \cdot t$ Al (ES Shield) $45mm (~1.77")$

(1) A current of 500A generates a field of 1mT at a radius of 0.1m (~4").

(2) Calibration Winding Option limits AC operation to 1kHz



DS200ID Amplitude and Phase v. Primary Current Frequency



Current and Voltage Probe Connections in Electric Vehicle Chargers, Danisense Current Transducers





Bergoz IPCT DC-AC High Resolution Current Transducer



IPCT-0100mA-82 Amplitude v. Frequency



Current Range	±1mA to ±5000mA		
Output Signal, $V(t)$	10V/mA to 2mV/mA		
Zero Offset	Adjustable, 20 turn pot.		
Offset Change, Magnetic Field (equiv. primary)	500µA/mT ⁽¹⁾		
Frequency Response (LF) (HF)	dc 150 Hz to 2.5kHz (-3dB)		
Noise (equiv. primary)	1μArms/√ <i>Hz</i> to 50μArms/√ <i>Hz</i>		
Recovery after overload (1000x)	< 10ms		
Case Type	Plastic, shielded aperture		
Aperture	82mm (3.2")		
(1) A current of 500A generates a field of 1mT at a radius of			

0.1m (~4").

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Current Probe Connections in Electric Vehicle Chargers Bergoz IPCT





GMW CPC Clip-on DC-AC Coreless Current Probes

For System diagnostics and long term monitoring, Current Probes with no magnetic core.

No hysteresis, no damage from primary current overload with recovery to linear operation within 10 μ S of primary current within range. The CPC Current Probe can be used to monitor the "low current" recovery after a high current overload.

8mV/A to 1mV/A
±250A to ±2000A
dc to 75kHz (-3dB)
< ±1%
< 0.2% of range for $40 \text{mT}^{(1)}$
< 2µs
< pH
-40°C to +100°C
Sealed, NEMA 5
27mm (1.06")
< 30g (1 oz)
3.5V to 5.5V, <85mA, USB Port







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(1) A current of 10kA generates a field of 40mT at a radius of 0.05m (~2").

Current Probe Connections in Electric Vehicle Chargers GMW CPC DC-AC Current Probes





Senis

Three-Component AC Magnetic Field Transducer





Field Measurement Points in Electric Vehicle Chargers





Thank You

Questions?

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