

About the Subject:

Clamp-on Instruments

Current and Power Measurements without breaking the circuit

Since the introduction of the world's first digital AC/DC clamp-on ammeter in 1982, LEM has continued to provide innovative test and measurement solutions encompassing current measurement from 5 mA to 3000 A. The comprehensive product range includes:

- Flexible and solid core current probes
- Current Clamps
- Multimeter Clamps
- Power and Power Quality Clamps
- PC Software for data logging and analysis

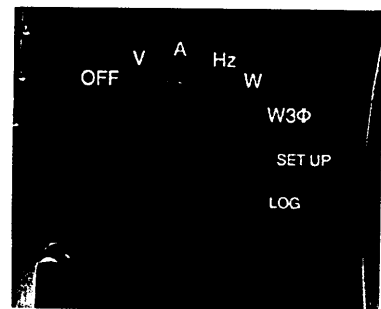
The traditional method of inserting a shunt resistor for current measurement has many disadvantages including the need to break in to the circuit with the associated safety and time penalties and the need for additional calibration equipment. Fundamental to most of the products in the LEM range of Clamps is the use of Hall Effect for current measurement.

In addition to high accuracy non intrusive current measurement, Hall Effect clamps provide the user with clear advantages over other technologies including:

- AC and DC current measurement for complex waveforms
- Low frequency and high current capability

Wide range of applications

The high measuring accuracy, versatility and safety features of the LEM clamp-ons and probes provide total solutions for applications in the service, installation and maintenance of machines and industrial plant. The broad range of instruments ensures the right product for the job from basic AC current measurement through to harmonics analysis and data logging.



Safety and ease of use

All LEM products whatever the level of functionality have been designed for ease of use and safety. They conform to the latest international safety and EMC standards. Safety features include tactile barriers and special jaw designs to provide the user with confidence when making measurements in hazardous voltage areas. Conformance to EMC standards ensures high reliability through reduced susceptibility to electromagnetic interference.

The Hall effect provides galvanic isolation (Fig. right)

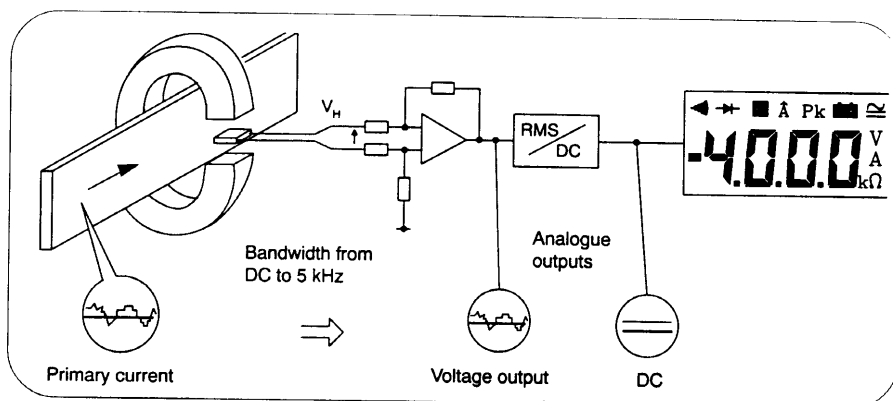
Measuring the magnetic field generated around the live conductor provides a fast and safe measuring method. At the heart of the clamp-on instrument/probe there is a Hall effect sensor located in the jaw's air gap. The Hall effect discovered by Edward H. Hall in 1879 occurs when the element, a current carrying wafer is placed in a perpendicular magnetic field. Lorentz forces drive the charge carriers in the wafer towards the opposite edges of the element depending on their polarity. The resulting Hall voltage, which is directly proportional to the control current and the magnetic flux, is measured across these edges. The magnetic flux density is proportional to the current in the conductor. Processing the Hall voltage gives a reliable method for measuring ac, dc and ac and dc currents flowing in the conductor.

Advanced magnetic circuit design

The magnetic circuit formed by the two jaw halves and the air gap, concentrates



the magnetic field generated by the conductor at the Hall effect sensor. The overall geometry of the measuring jaws and the air gap have been designed such that the position of the cable in the measuring jaw has little effect on accuracy. The magnetic properties of the jaws tolerate overload current of up to 10,000 A and the advanced design ensures low residual magnetism minimising the need for instrument zeroing when making DC measurements. Furthermore, the magnetic circuit and the electronics have been designed to minimise electromagnetic interference, and therefore fields from conductors outside the jaw assembly have little effect on the instrument reading.

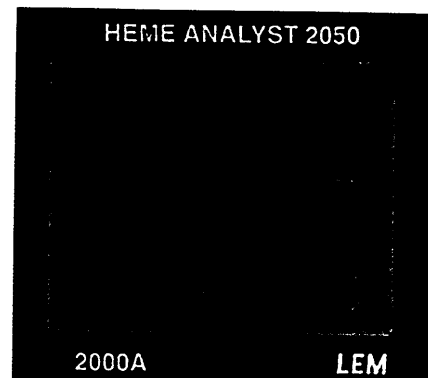


The magnetic circuit and the Hall generator placed in the air gap provide the open-loop LH-Series clamp-on multimeters with a high linearity.

True RMS for reliable measurement (Table)

Modern multimeters basically use 3 types of measuring methods: Mean value, peak value and true RMS measuring. When measuring pure DC or sinusoidal AC, clamp-on multimeters using the different methods show equivalent results. However in the case of ripple currents or even complex distorted currents typically found in power converters, PWM frequency inverters and mains supply circuits, the mean and peak value techniques can result in substantial errors. In these common applications only the true RMS measurement technique employed in most LEM clamp-on instruments provide reliable readings. When measuring AC according to the peak value measuring method the peak

value is measured and multiplied by a 0.707 correction factor while the mean value is multiplied by a 1.111 form factor. Neither give accurate results for non-sinusoidal waveforms.



Comparison of true RMS measurements and those resulting from average-reading or peak-reading methods.

Waveform	Sine	Square	Triangle	Pulse
RMS value	100 A	100 A	100 A	100 A
Value displayed on LH..15, LH..35, LH..40 deviation	100 A 0 %	100 A 0 %	100 A 0 %	100 A 0 %
Average-reading method deviation	100 A 0 %	111 A +11 %	96 A -4 %	68 A -32 %
Peak-reading method deviation	100 A 0 %	71 A -29 %	123 A +23 %	173 A +73 %

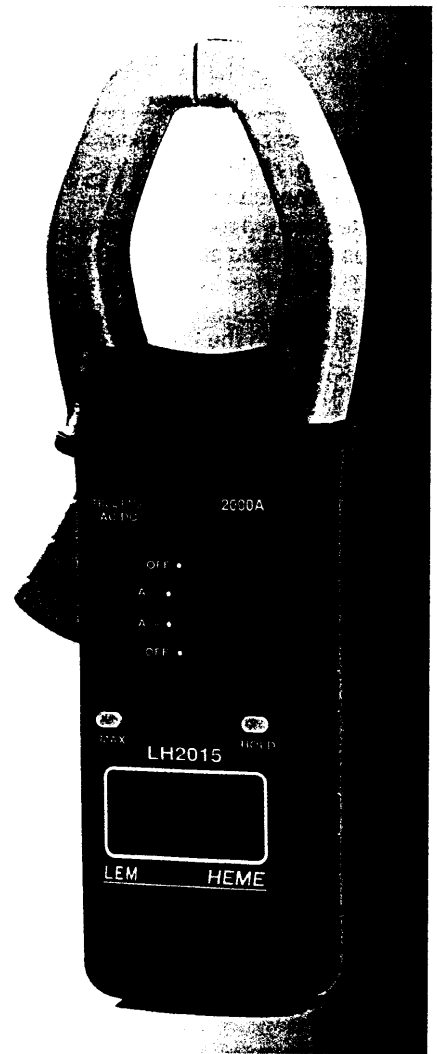
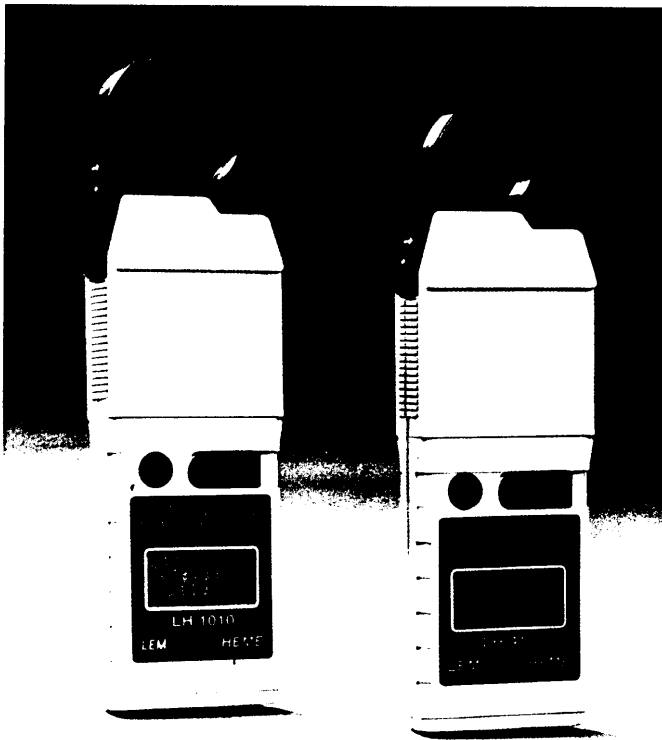
LH Series Clamp-on Ammeters

The LH Series of instruments is the most comprehensive range of clamp meters available which conform to CE requirements for safety and electromagnetic compatibility. From the low cost pocket size LH 1010 through to the LH 2040 which has True RMS AC and DC current measurement capability up to 2000 A and analogue outputs for use with oscilloscopes and recorders.

In addition to AC/DC capability, the use of Hall Effect ensures accurate low frequency and high current measurements are possible in a compact

instrument design. Maximum overload currents are much higher than for conventional current transformer designs improving safety and reliability. The LH41/410/1010 and LH2015 meet the requirements for AC/DC current only applications.

The LH10 Series current meters are pocket sized for convenience and ease of use whilst the high current LH 2015 has a large jaw for measurements on bus bars up to 2000 A. The new LH 41 features a 4 A current range for measurements down to 10 mA plus auto zero and auto power off functions.



Product features include:

- Four models with current ranges from 4 A to 2000 A and resolution down to 1 mA
- Hall Effect for accurate AC and DC measurements
- Advanced jaw design ensuring low susceptibility to external conductors and stable zeroing characteristics for DC measurement
- Auto-ranging, display hold and low battery indication
- Max HOLD and TRUE RMS (LH 2015 only).

Model	Maximum conductor	Measurem. mode	True RMS	Ranges	Resolution	Accuracy	Crest Factor	Order No.
LH 41	19 mm Ø	AC, DC	No	4/40 A	1 mA/10 mA	1.3 %±5 dgts	-	LLH0410000
LH 410	19 mm Ø	AC, DC	No	40/400 A	0.01/0.1 A	1.3 %±8 dgts	-	LLH4100000
LH 1010	30 mm Ø	AC, DC	No	400/1000 A	0.1/1 A	1.3 %±5 dgts	-	LLH1010000
LH 2015	50 mm Ø	AC, DC	Yes	400/2000 A	0.1/1 A	1.3 %±3 dgts	Max 6	LLH2015000

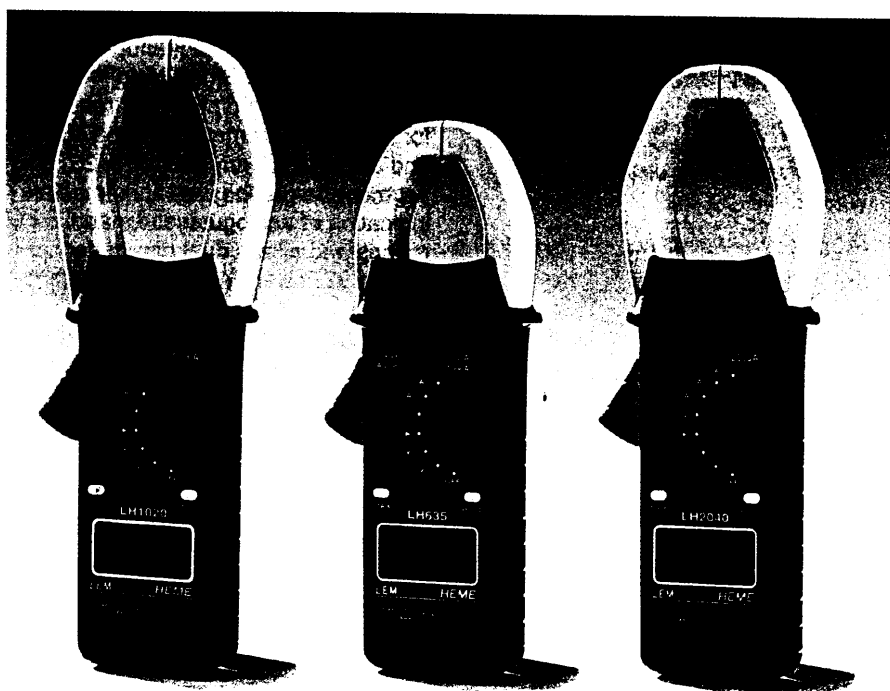
Clamp-on Multimeters

LH Series clamp-on multimeters include full multimeter functionality in addition to high accuracy current measurement. There are a total of eight instruments providing solutions for basic AC current measurement through to high performance AC+DC True RMS applications.

Features of Clamp-on Multimeters

- AC Amps, AC and DC Volts, Ω , Diode and Continuity Test
- Excellent accuracy and low susceptibility to conductor position
- Auto-ranging and auto-zeroing
- Display Hold for convenience in use
- Conformance to IEC1010 and EMC standards

Six of the eight models use the True RMS technique for the accurate measurement of distorted waveforms and the LH 635, LH 1035 and LH..40 Series can cope with Crest Factors as high as 6. True RMS measurements are essential when measuring non-sinusoidal waveforms generated by non linear loads from modern electronics equipment.



Series LH..20

AC current up to 1000 A

Series LH..30

AC/DC current up to 1500 A
Two jaw sizes

Series LH..40

AC and DC current up to 2000 A
Analogue Outputs

	LH1020	LH1025	LH630	LH635	LH1035	LH240	LH1040	LH2040	
Max. conductor size	50 mm \emptyset 25 x 70 mm		35 mm \emptyset 18 x 42 mm		50 mm \emptyset 22 x 62 mm				
Measurement modes	AC	AC, Max	AC, DC	AC, DC, Max	AC, DC, AC + DC, Max				
True RMS measur.	NO	YES	NO	YES	YES	YES	YES	YES	
A ranges (autoranging)	400/1000A		400/600A 400/1000A DC		400/1000A ACrms 400/1500A DC	40/200A AC Pk, DC	400/1000A AC AC Pk, DC	400/2000A AC Pk, DC	
Resolution			100 mA/1 A			10 mA/ 100 mA	100 mA/1 A		
Accuracy	$\pm 1.5\%$ rdg ± 5 dgts (@ 50-60 Hz)		$\pm 1.3\%$ rdg ± 3 dgts (DC and 15 - 400 Hz)	$\pm 1.3\%$ rdg ± 3 dgts (DC and 15Hz-1kHz)	$\pm 1.9\%$ rdg ± 3 dgts (DC and 15 Hz-1 kHz)	$\pm 1.3\%$ rdg ± 3 dgts (DC and 15 Hz-1 kHz)			
Crest Factor	-	4 Max.	-	-	-	6 Max.			
Analogue Output	-	-	-	-	-	5 mV/A	1 mV/A	0.5 mV/A	
Maximum overload	1200 A		10000 A DC, 400000/frequency A AC rms						
V ranges (autoranging)					400 V/600 V				
Ω ranges (autoranging)					400 Ω /4 k Ω				
Diode test	Forward voltage up to 2000 mV								
Order No.	LLH	1020000	1025000	6300000	6350000	1035000	2400000	1040000	2040000

Power Clamps LH 1050/1060

Features Include

- Automatic detection of AC, DC and AC + DC signals
- Accurate Power and Power Factor measurements for distorted waveforms
- Smart Hold™ and Record modes for data analysis
- Integrated 3 Phase Power Capability for balanced loads
- Optional Digital Interface and Windows software for data logging

The LH1050/1060 extend the capabilities of the LH Series instruments into AC/DC power and power quality measurement. In addition to Watts, VA, VAR and Power Factor

readings, the instruments give accurate current, voltage and frequency measurement. The unique Smart Hold™ feature means that a complete set of readings for all seven parameters can be stored and displayed at any instant. A 25 segment bargraph gives an immediate indication of analogue values and ranges and allows dual parameter display in Power Factor and Frequency modes.

LH 1060 additional features

- Measurement of Peak voltage and current values
- Measurement of Total Harmonic Distortion (THD), Distortion Factor (DF), Crest Factor (CF), and Ripple
- Digital waveform output for harmonics analysis with Winlog interface and software.

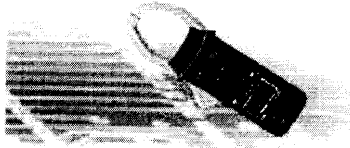


On page 16 more about AC/DC Current Probes

Model	ANALYST 2060	ANALYST 2050	LH 1050	LH 1060	Accuracy	Resolution
Max Conductor Size	60 mm Ø		50 mm Ø			
Measurement modes	AC/DC, AC+DC		AC/DC, AC+DC			
TRMS	●		●		●	
A ranges (autoranging)	40/400/2000 A		400/1000A		±1.5% rdg. ± 5 D	ANALYST-0.01/0.1/1A LH1050-0.1/1A
V ranges (autoranging)	4/40/400/600 V		400/600V		±1% rdg. ± 5 D	ANALYST-0.001/0.01/0.1/1V LH1050-0.1/1V
kW/kVA/kVAR ranges (autoranging)	4/40/400/ 1200 kW/kVA/kVAR		40/400/600 kW/kVA/kVAR		±2.5% rdg. ± 5 D	ANALYST-0.001/0.01/0.1/1kW LH1050-0.01/0.1/1kW
kWh (autoranging)	4,40,400,4000,40000kWh		-		± 3% rdg. ± 5 D	0.001/0.01/0.1/1/10kWh
Frequency	10 Hz-1 kHz		20 Hz-1 kHz		0.5% rdg (40-70Hz)	0.1Hz
Crest factor	1-5		-	1-5	±3% rdg. ±5 D (CF1-3)	0.01
Total harmonic distortion	1-600 %		-	1-600%	± 3% rdg.±5 D	0.1 %
Distortion factor	●	-	-	1-100%	± 3% rdg.±5 D	0.1%
Harmonics bargraph	●	-	-	-		
Ripple	●	2-600%	-	2-600%	± 3% rdg.±5 D	0.1%
Peak, average	●	●	-	●		
REC min, max Av	●	●	●	●		
Memory	8 Screens		1 Data Set			
Digital output	●	●	-	-		
Logging	int/ext 5,000 rdgs	int/ext 2,000 rdgs	external, incl. waveform			
Chart mode	●	●	-	-		
Oscilloscope mode	2/4/20/50ms/div		-	-		
Multi Parameter display	up to 5		Bargraph+digit.			
Back light	●	●	-	-		
3 Phase capability	●	●	●	●		
WinLog compatibility	●	●	●	●		
Maximum overload	10,000 A		10,000 A			
Safety IEC1010	600 V Cat IV		600 V Cat III			
Order No.	LLH2060000	LLH2050000	LLH1050000	LLH1060000		

CLAMP-ONS

CLAMP



Instrument Function	Current Clamps						Multimeter Clamps						Power	
	LH41	LH410	LH1010	LH2015	LH1020	LH1025	LH630	LH635	LH1035	LH240	LH1040	LH2040	LH1050	LH1060
Amps AC	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Amps DC	●	●	●	●			●	●	●	●	●	●	●	●
Volts AC/DC					●	●	●	●	●	●	●	●	●	●
TRMS				AC		AC	AC	AC	AC	AC+DC	AC+DC	AC+DC	AC+DC	AC
Resistance					●	●	●	●	●	●	●	●		
Continuity/Diode Test					●	●	●	●	●	●	●	●		
Frequency													●	●
Power/Power Factor													●	●
Energy														
THD/DF														
Ripple														●
Bargraph													●	●
Multiparameter Display														
Waveform/Chart Display														
Harmonics Display														
Backlight													●	●
Auto Zero	●			●			●	●	●	●	●	●	●	●
Max Hold				●		●		●	●	●	●	●		
Min Max Av													●	●
Logging													ext	e:
Analogue Output										●	●	●		
Digital Output													●	●