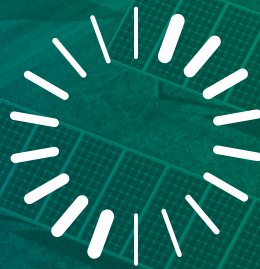




Life Energy Motion

Leading technologies for renewables energies applications

solar



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Leading the world in electrical measurement

A leading company in electrical measurement, LEM engineers the best solutions for energy and mobility, ensuring that our customers' systems are optimized, reliable and safe.

Our 1,500 employees in more than 15 countries transform technology potential into powerful answers. We develop and recruit the best global talents, working at the forefront of mega trends such as renewable energy, mobility, automation and digitization.

With innovative electrical solutions, we are helping our customers and society accelerate the transition to a sustainable future.

Solar energy

Convert solar energy directly into electricity, is one of the products of modern science and technology progress. At the same time, as a kind of favorite clean and green energy, it will significantly reduce the carbon emissions produced by traditional energy consumption which will have a negative impact on the natural environment. By 2050, the generated power by solar will occupy 25% in the global power system to make resisting the most serious catastrophic warming be possible. LEM actively dedicates to the construction of solar generated power stations, by supplying very high technology sensors and solutions to make the solar inverter and related appliances working more efficient, reliable, more affordable, and smarter.

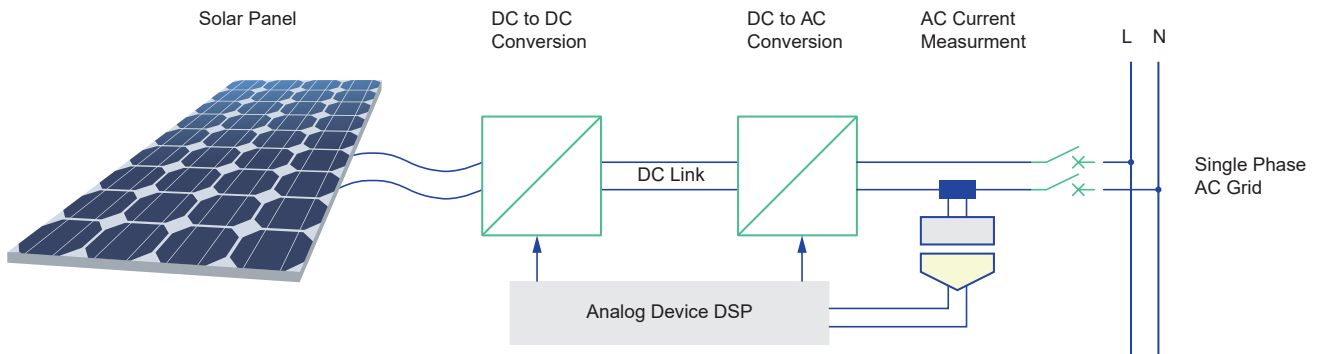
Technological innovation

Technological innovation will accelerate the arrival of the grid-parity and reduce the overall cost of PV system. LEM has already identified the challenge on cost pressure and prepares cost-effective solutions ready to help customers to deal with in all kinds of application.

Rapid development of residential solar market will make everyone use clean energy, and benefit from it. LEM has already accelerated its product development to help inverter suppliers succeeded in the intense market competition.



Solar Power Infrastructure



String vs Centralized PV systems

Two major types of PV system are dominant on the market, String inverter for small and medium power and Centralized inverter for big power



String inverter

String inverter can be directly connected to PV string(s) and used for indoor and outdoor hanging installation, is able to deliver a power to a single-phase or three-phase grid between a few kilowatts and hundreds of kilowatts

String inverters have the following features:

- High protection grade design, more for IP65
- Combiner box is NOT needed
- Wide input dc voltage range
- MPPT control is more sophisticated
- High efficiency
- Flexible configuration to adapt various application scenarios



Centralized inverter

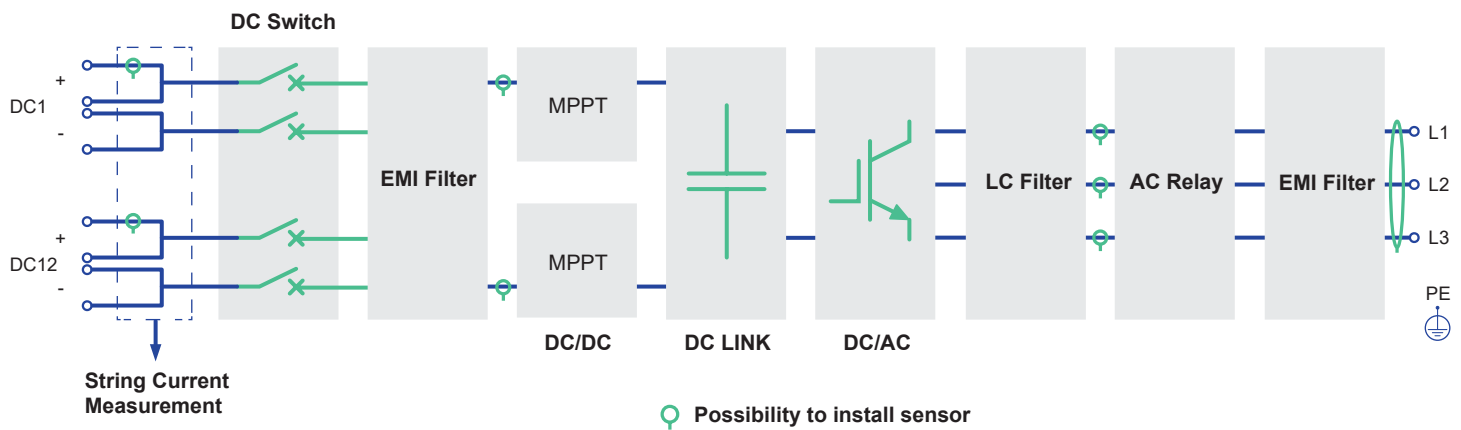
Centralized inverter has a direct current (dc) from photovoltaic combiner box and converts into alternative current (ac) with single power stage. Therefore, the centralized inverter power is relatively large, typically no less than 500kW for single unit, can also be applied to the application for large ground power station and large commercial roof

Centralized inverters have the following features:

- Facilitate maintenance and energy management
- Power density is high while the cost is low
- High-level security for power station
- Capable of power factor adjustment and low voltage ride through function

LEM solution for string inverters

Typical three phase string inverter structure



String inverter normally measures the current in four places to secure the normal operation:

Four places:

- PV array current measurement
- MPPT (Maximum Power Point Tracking) circuit current measurement
- Inverter output alternative current measurement
- Inverter residual current measurement


PV array current measurement is aimed to monitor each array current status during its operation to check whether PV array is working normally or not

Features for PV array current measurement:

- Multi-channels current to be measured, typically string inverters has 2,4,8,16 or 24-channels
- High precise current sensor is not needed
- Current range for each array typically is less than 30Adc
- Inverter residual current measurement

To use MPPT control to ensure the system running at maximum power output condition Measurable current range for DC/DC boost circuit (MPPT circuit) is 10-30A RMS for each MPPT unit, in which will be best choice with open loop current sensor

Sensors specifications

Sensor	HLSR	GO	HMSR
			
Technology	Hall O/L	Hall O/L	Hall O/L
ASIC Inside	Yes, HG2	Yes, HG2 Orion	Yes, HG2 Orion
Integrated Primary	Yes	Yes	Yes
Footprint	DIP	SMD, SOIC 8&SOIC 16	SMD, Compatible with SOIC 16
1500Vdc PV Application	Yes	No	Yes
Withstand surge current capability	10kA 8/20us	10kA,8/20us	20kA.8/20us
OCD function	N/A	Yes (SOIC 16 only)	Yes
Measurable range	+/-300Apk	+/-75Apk	+/- 75Apk

The core control in solar inverter is to generate a pure sinewave current to flow into the grid, which is regards as high-quality energy feed to the grid. Therefore, the current measurement solution in AC side shall be capable of these features:

Features:

- High precise measurement: less than 1%
- Fast response time: less than 1us
- Low offset voltage and current
- Good performance on the temperature drift

LZSR family

Closed Loop Hall technology enlarges measuring range on PCB mounting with +5 V single supply



Features

- 3 proposed ranges 100 – 150 – 200A Nominal
- +5 V single supply
- PCB mounting
- Various integrated options: Reference, Aperture and/or integrated primary conductor, OCD output
- Measuring peak current up to 3 times the nominal value
- Very low offset drift up to 3ppm/K of VREF
- Offset drift 7 times better than previous generation of C/L Hall effect current transducers working with traditional Hall effect chip
- Internal reference voltage provided on a dedicated pin
- Total error at +85°C: 1.4 %
- High performance with a Hall ASIC for closed loop working principle

Sensors specifications

Product Family	LH	CASR/CKSR	LESR/LKSR	LZSR
Technology	Hall C/L	FluxGate	Hall C/L	Hall C/L
Power supply	±12...±15V	+5V	+5V	+5V
Output Type	Current source	Voltage source	Voltage source	Voltage source
Accuracy@50A 25C	0.2%	0.8%	0.5%	0.6%
Response time	0.2us@90% I_{PN}	0.3us@90% I_{PN}	0.3us@90% I_{PN}	2.2us@80% I_{PN}
Offset voltage/current@50A	±0.06 mA	±0.7 mV	±0.725 mV	N/A
Offset voltage/current@100A	N/A	N/A	N/A	±0.75 mV
TCG	±30ppm/K	±40ppm/K	±40ppm/K	±45ppm/K

LEM leakage current measurement for your safety

In fact, residual current is called common mode current caused by parasitic capacitor between the PV panel(s) and power earth, while there has a loop existing between the parasitic capacitor and grid through the PV system during the inverter operates, the common mode voltage coming from high switching of IGBTs will occur a common mode current on the parasitic capacitor and will flow into the grid.

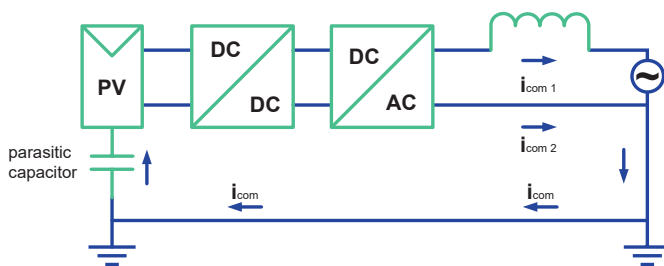


If there is no electrical isolation (including high frequency isolation and low frequency transformer isolation), the common mode current will become large due to the low resistance in the system loop, which will have a safety risk and thus impact the whole system

According to the norms: if the continuous residual current exceeds the following limit, the inverter should stop running and disconnect from the grid within 300ms duration.

- For less than or equal 30kVA inverter, the maximum allowed residual current limit is 300mA_{RMS}
- For 30kVA above inverter, the maximum allowed residual current limit is 10mA/kVA
- Should use a current sensor which complies with Type B standard to guarantee residual current measurement.

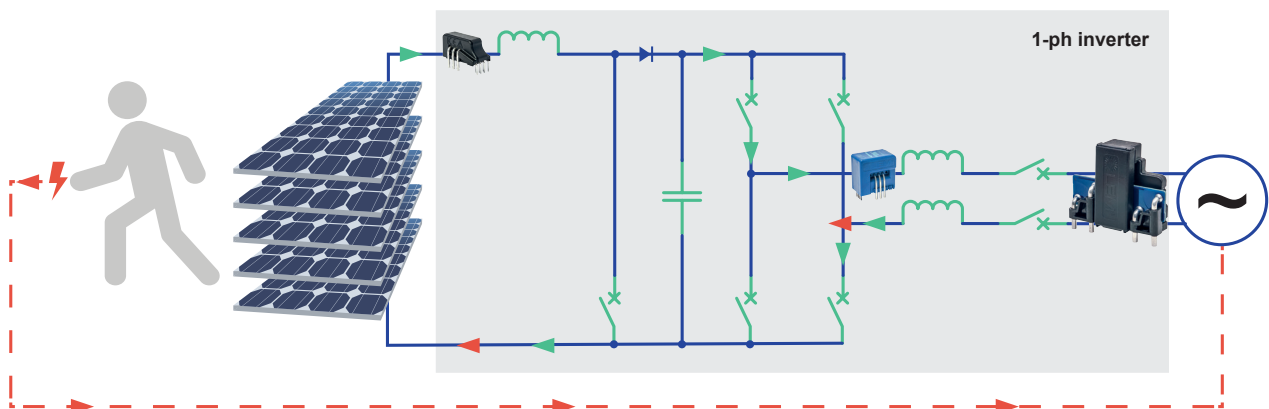
The LDSR is a small residual current sensor, allowing small inverter manufacturers to fulfill IEC62109.



LDSR 0.3-TP/SP1 & LDSR 0.3-NP Features:

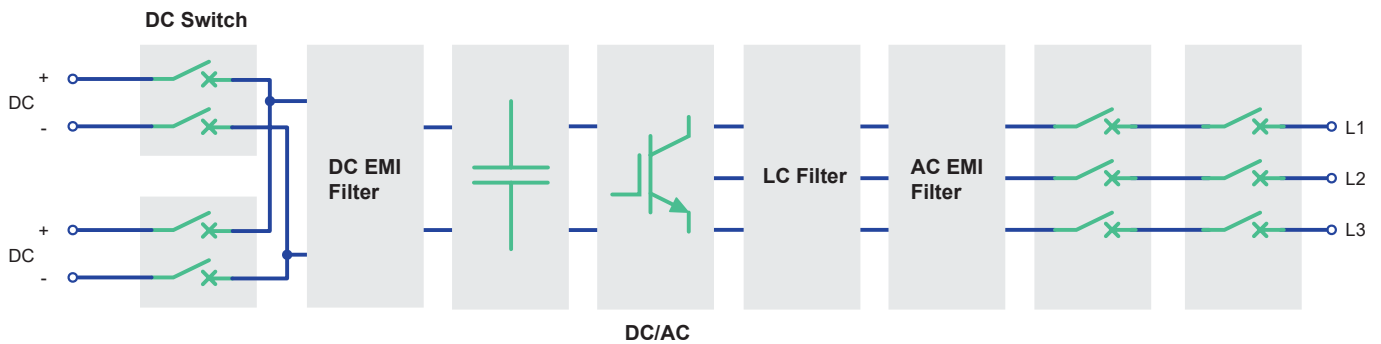
- $I_{PN} = 300 \text{ mA RMS}$
- 2 or 4 primary bars options
- 5% accuracy
- 20 turns test winding
- 35 A max on each primary
- 2 kHz bandwidth
- Small footprint (70% smaller than CTSR)
- Optimized for EN 62109

LDSR inside AC inverters



LEM solution for centralized inverters

Comparing to string inverter, centralized inverter measures current both in DC and AC side more easily, a large range of current sensor can solve all the power measurement problems, become safer and more reliable.



LF 10 Family

Closed Loop with Hall elements integrated into the latest designed LEM ASIC (Cygnus) providing useful additional functions and patented techniques

Features:

- Five series at 200 - 300 - 500 - 1000 – 2000 A nominal
- Compact sizes/variety of mounting topologies (flat or vertical)
- Fully compatible & same technology (Closed Loop Hall) as previous generation LF x05 series
- Higher immunity (510-1010)
- Higher accuracy & response
- -40 to +85°C operation

Sensors specifications

Product Family	LF210/310/510	LF1010	LF2010
			
Technology	C/L Hall cell	C/L Hall cell	C/L Hall cell
Current range	100-500A	1000A	2000A
Insulation	3.5kV	6kV	10kV
Global error @25°C	0.2%	0.2%	0.2%
Overall accuracy (over T°C)	0.2%	0.4%	0.3%
Linearity error	0.05%	0.15%	0.1%
Bandwidth	100 kHz	200 kHz	150 kHz
Delay time (us)	0.5	0.5	0.5
Electrical Offset (mA)	0.15	0.2	0.2
Consumption (mA)	35 + I_s	49 + I_s	85 + I_s

LEM

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