Life Energy Motion

Transducers and energy meters in DC grid applications

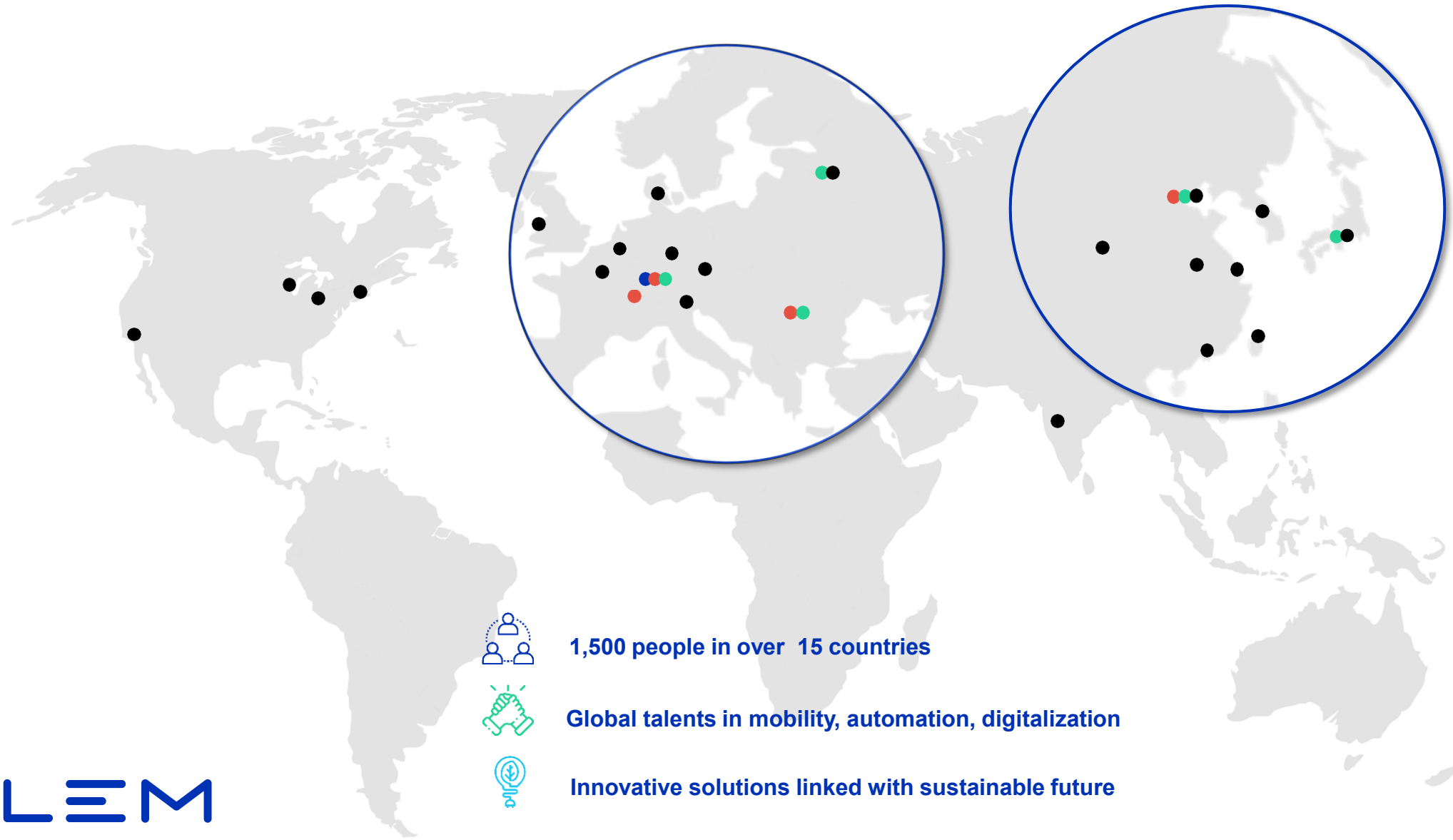
EMN for Smart Electricity Grids 2024-05-16

Outline: Measuring DC Energy & Current

- LEM at a Glance
- LEM DC energy meters and current transducers for DC energy distribution
- For EV charging in combination with static storage and distributed resources & other applications
- Overview of existing products
- Status of standardization efforts
- Energ metering
- DC transducers

LEM at a Glance

Headquarters in Geneva, Switzerland, a strong presence in Europe & China



LEM Headquarters
- Switzerland

R&D centers
- France
- Switzerland
- Bulgaria
- China

Production plants
- Bulgaria
- China
- Japan
- Malaysia
- Switzerland

Sales

1,500 people in over 15 countries

Global talents in mobility, automation, digitalization

Innovative solutions linked with sustainable future

Our Applications

LEM sensors and solutions play a key role in 6 areas

Motor control

HC16

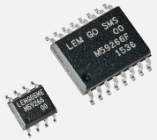
HOB

LF

HAH3DR

Power conversion

LWSR



GO

HMSR

Electrical safety

CDSR

CDT x2

Battery management

HBCT

CAB 1500

HSBBV

Current monitoring

HTRS

ART

Energy metering

Fluxgate transducers; Voltage transducers

EM4TII

DCBM

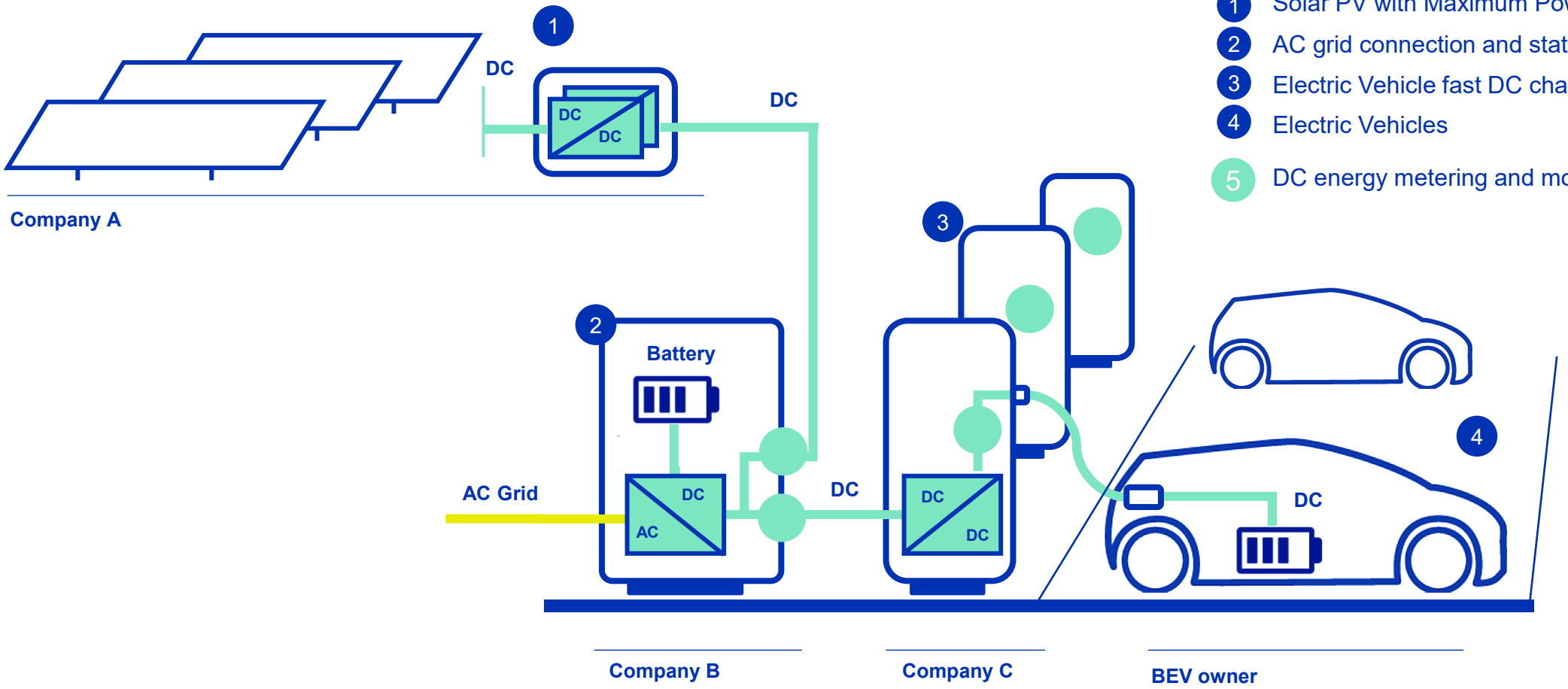
Member of:

LEM DC Energy Meters

For EV charging in combination with static storage and distributed resources & other applications

Smart energy hubs with Distributed Energy Resources

EV charging infrastructure in combination with static storage and DER as an example of DC microgrid

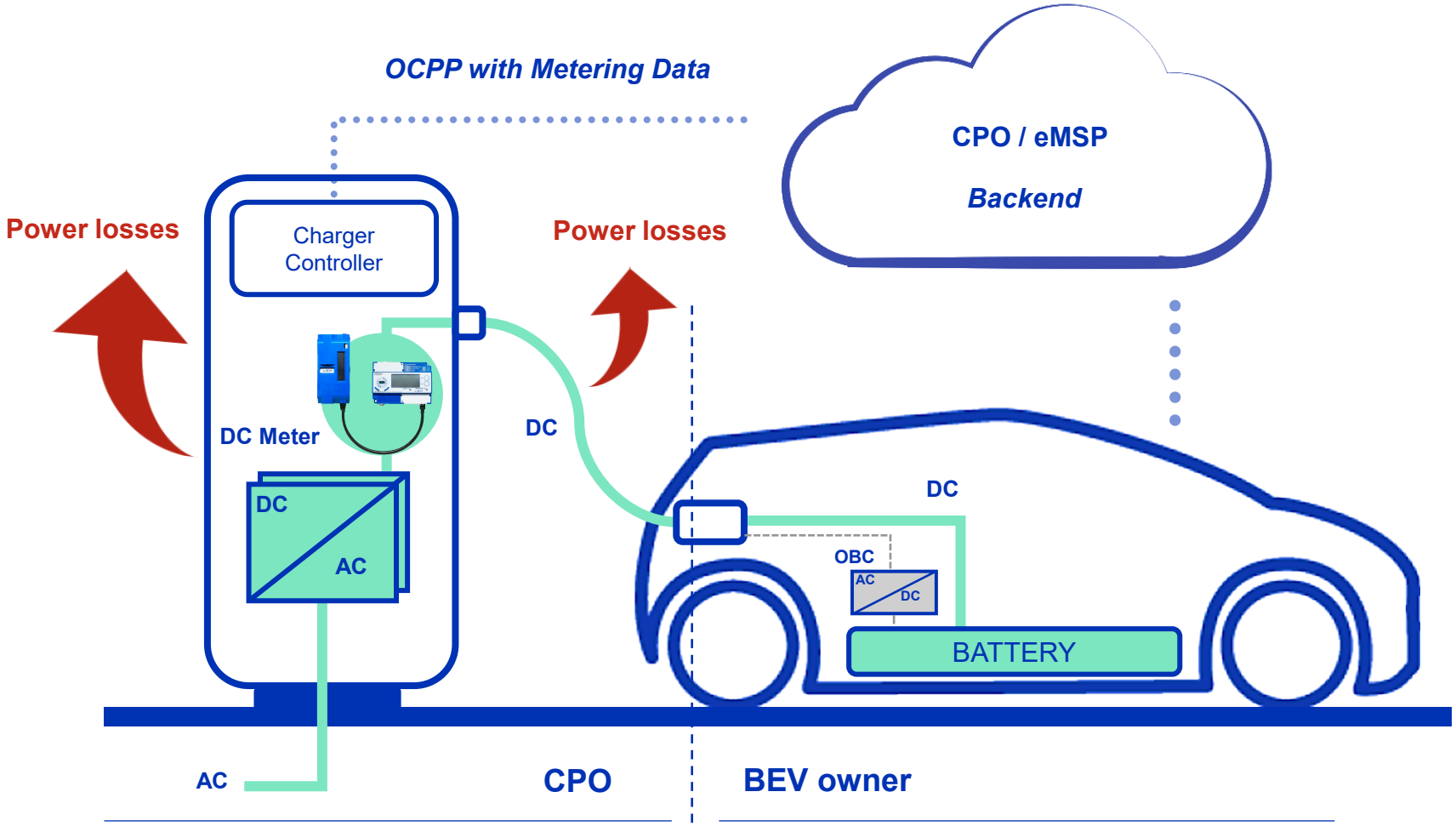


1. Solar PV with Maximum Power Point Traking
2. AC grid connection and static battery storage
3. Electric Vehicle fast DC chargers
4. Electric Vehicles
5. DC energy metering and monitoring

DC charging & Energy metering

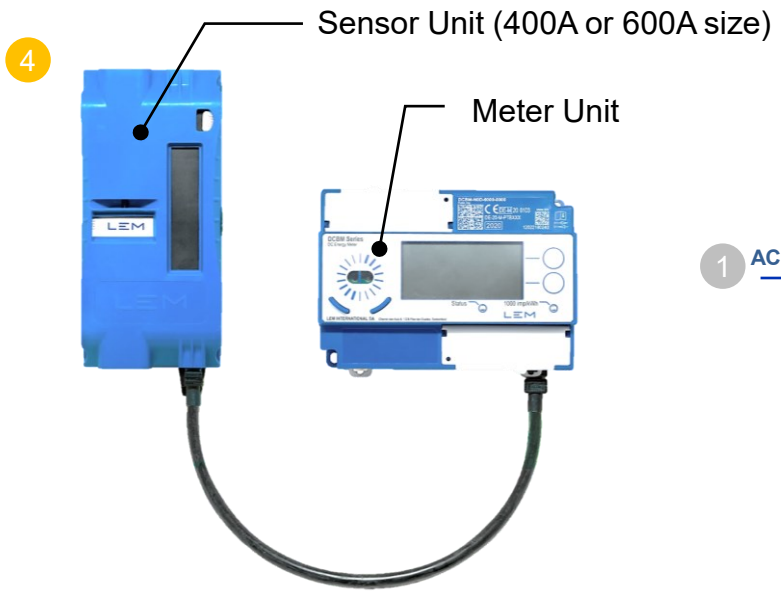
Why do we need energy metering in EV fast chargers ?

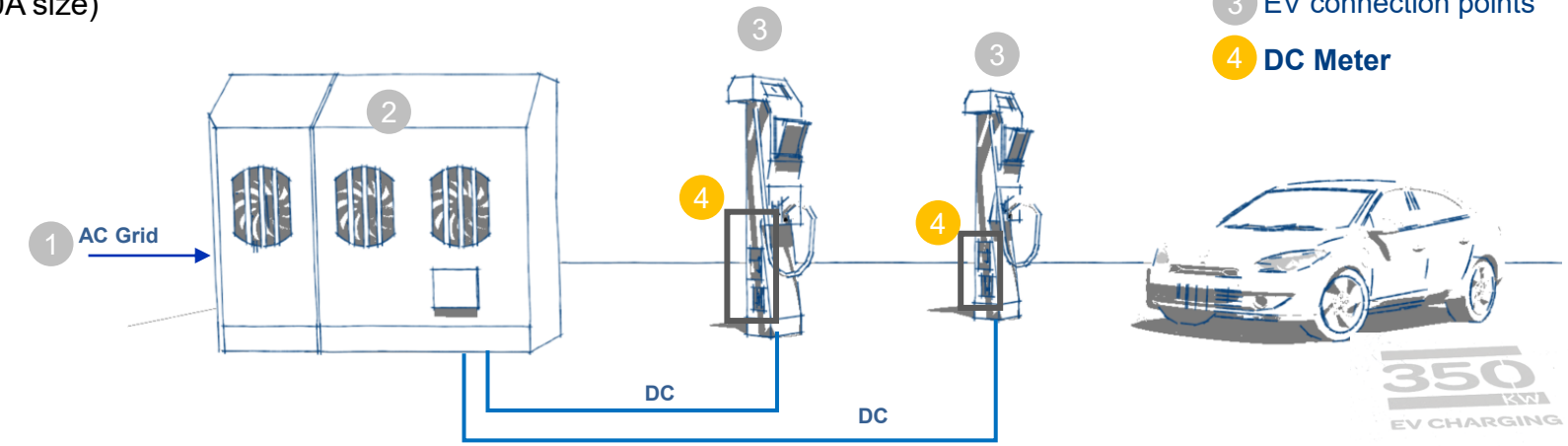
Ensure trust and fairness for end users



DCBM 400/600 – DC Energy Metering

A complete metering solution for DC Fast Charging





1. AC grid
2. Power converters
3. EV connection points
4. **DC Meter**

A Complete DC Meter Solution

- **kWh-based billing in DC fast charging**
- **400 A or 600 A**, **1000 V DC**
- Operating temperature **−40 °C … +85 °C** (accuracy class B)
- **Ethernet HTTP** interface easy to integrate, with **security**
- Certified by **PTB** and **MID (2014/32/EU), UL Recognized**

PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

S.A.F.E. Software Alliance for E-mobility

c UL us

LEM

DCBM400/600 certifications and approvals

Germany – MessEV / MessEG (+ MID)

Module B
DE-20-M-PTB-0075, Revision 2

Module D
DE CSA 22 D 002

UL Recognized

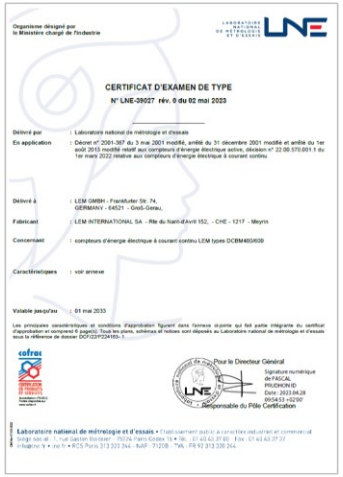
2022-10-18-E330077

MID – 2014/32/EU

Module B
CH-MI003-21039-00

Module D
6030-01644

French regulation



Type examination certificate
N° LNE-39027 rév. 0

Registration for Quality system
N° LNE- 39059 rév. 0

DCBM Family

Portfolio of energy metering solution in EV charging application

DCBM 100

- DC wallbox
- 1000 VDC
- 80 A
- Plug and play
- Cable connection 35mm²
- Operating +80°C
- PTB / MID / LNE / UL

DCBM 400

- DC Fast Charging
- 1000 VDC
- 400 A
- Split design
- Cable loss compensation
- Cable / busbar
- Operating +85°C
- PTB / MID / LNE / UL

DCBM 600

- DC Fast Charging
- 1000 VDC
- 600 A
- Split design
- Cable loss compensation
- Cable / busbar
- Operating +85°C
- PTB / MID / LNE / UL

Combined DC Smart Sensors

Specification summary

Preliminary

Features

- DC Range of operation: 1000 V
- Three sizes: In 100A, 400 A and In 600 A
- Robust current terminals, compliant with busbars and cable lugs
- Current, Voltage, Energy, Temperature measurement
- Bi-directional current measurement
- Accuracy Class B, −40°C to +85°C
- Reinforced insulation at DC: 1000 V, U_{ni} 8 kV
- CAN communication protocol
- Monitoring of current / voltage / temperature / energy
- Auxiliary power supply +5 V DC
- 35 mm-DIN rail and screw mounting
- Sealing of terminals and interfaces
- Accessories: nuts, communication cable, protection cover

Applications

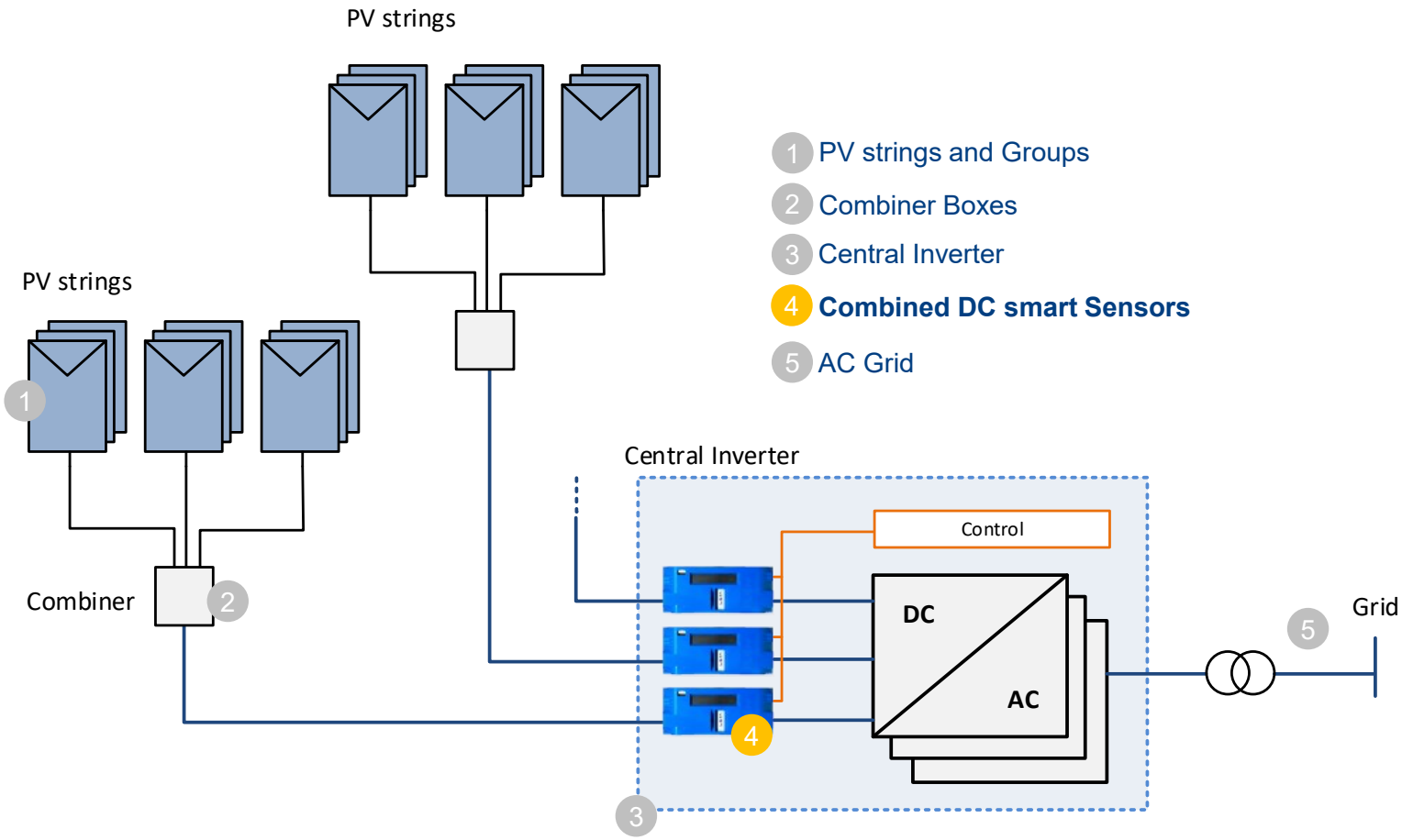
- Energy storage, renewables
- DC grids and energy monitoring
- Electric vehicle charging infrastructure
- Data centers

According to IEC 60688: *U – I – P* transducer with digital output

Combined DC Smart Sensors

PV Application Example

Preliminary



A Robust combined DC measurement

- **400 A or 600 A**, **1000 V DC**
- Operating temperature **-40 °C … +85 °C** (accuracy class B)
- **Robust** system integration, **busbar, cables**
- **CAN** communication
- **Voltage, Current, Temperature, Energy** measurement
- Insulation: U_{ni} 8kV

Energy Metering On-board Rolling Stock

Versatile solution, compliant with EN 50463:2017

BOARD

GROUND

LEM

Sensors

TEMA4G

GPS

4G

Insulated DC voltage transducer with current output

Fluxgate DC current transducers with current output

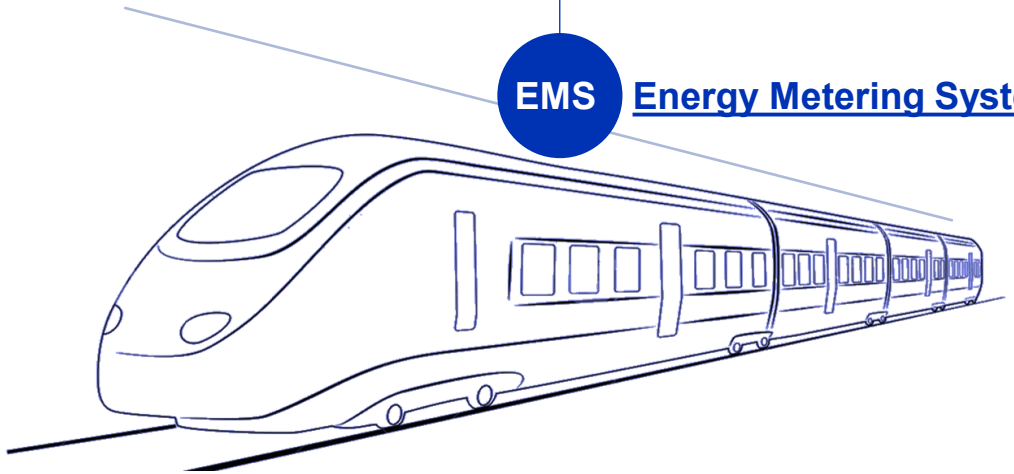
AC input channels for voltage and current

HTTP(S)

Metering data

Service Web Interface

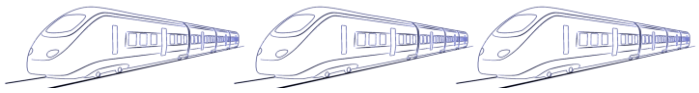
EMS **Energy Metering System**



Data Collecting Systems

Energy billing

Railway companies



TEMA4G Specifications

Embedded energy metering solution for trains

Parameter	TEMA4G
Railway networks	AC and DC
Measurement accuracy	< 0.5R EN50463-2
Connectivity	3G, 4G / GPS
Communication	HTTP(S)
Standards	EN50463:2017, EMC EMV-06
Features	Transmission of CEBD data, Event logs, Power down managment Ethernet service interface

Current transducers for DC energy distribution

Overview of existing products

LEM – the one-stop shop for current sensing

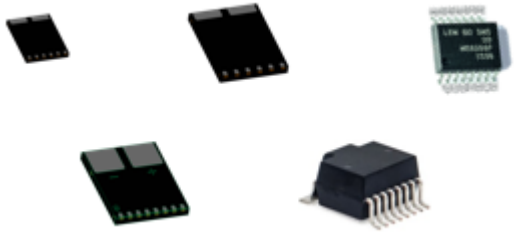
A large variety – most transducers to be combined with power electronics

Very high performance

Closed-loop sensors

Open-loop sensors

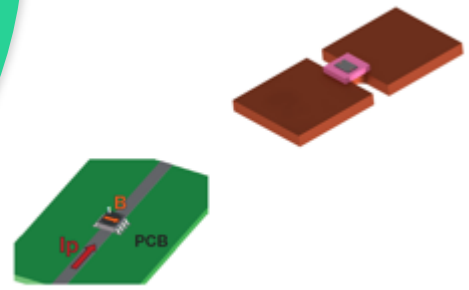
Cost effective and high performance



Small footprint and cost effective

Integrated current sensors

Field sensors



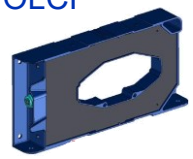
Contactless high measurement range and small footprint

Reference Grade (“HIP”)

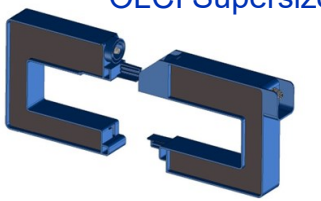
Product overview for Industrial Large Drives

Coreless
+24V (+5V option)

OLCI



OLCI Supersize



Closed-Loop
+/-15V to +/-24V

LA - 100A to 200A

LFx10 - 200A – 1000A

LF2010 - 2000A

LT 4000 - 10000

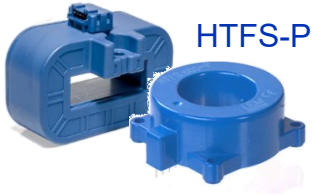
Open-Loop
+5V

HO-NP 40A - 150A

HO-P/S/PW 60A - 700A

HOYS / HOYL 100A - 800A

HTFS-P 200A - 800A



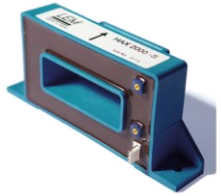
Open-Loop
+/-15V

HTB 50A – 400A

HAS 50A – 600A

HAT 200A - 1500A

HAX 500A - 2500A



HAZ - 4kA to 20kA

50A **250A** **1000A** **2500A** **10,000A**

Standardization

Electricity metering and transducers

DC Energy Metering

Europe & International

- Around 2000: energy meters for railways needed because of infrastructure split-off
- EN 50463 series (1st ed. 2012), later IEC 62888 (2018) – B2B, not covered by the MID
- 2011: “New work item proposal” for IEC 62053-41, Static meters for DC energy
- 2015-12: mandate M/541 from the EU Commission to CENELEC (& CEN & ETSI)
- “to draft new harmonised standards, in support of … Directive 2014/32/EU…, for metering AC and DC electricity supply to the public for road, maritime transport and inland navigation, including on-board metering
- 2021-06: IEC 62053-41 published (also FprEN IEC 62053-41:2021; classes 2, 1, 0.5)
- 2022-01: start of drafting of EN 50470-4, DC meter standard done, waiting for harmonization
- 2023-04: positive assessment of HAS consultant for FprEN 50470-4; later no objections @ vote
- 2023-08: **EN 50470-4 published** (DC meter standard done, waiting for harmonization)
- PMD standard **IEC 61557-12 to include DC; PQ parameter discussion started**
- Parallel efforts in China, the USA (ANSI C12.32 DC meters, C12.33 DC transducers) …

Transducers

IEC 60688

- Current and voltage transducers outputs of 1 A, 5 A, 100 V as well as HV ITs are specified in
- IEC 61869-1…? (many parts)
- ANSI C12.11
- IEC 60688 Electrical measuring transducers for converting AC and DC electrical quantities to analogue or digital signals (may be a future-proof alternative for LV applications)
- Analog output signals can be differential (shielded twisted pair for good immunity):
- voltages centered around 2.5 V
- Span (valley-to-peak): ~8 V – nice dynamic range
- DC power supply: 5V
- The same lines could be used for a pulse density modulation output for even enhanced immunity
- TEDS, the standardized “Transducer Electronic Data Sheet” is available; security could be added as anti-tampering means

DC Transducer issues

No power from the primary side as in AC

- Good current transducers are “closed-loop” types requiring a power supply,
- Power supply for currents above ~100 A:
- Supply voltage: +/− 15 V
- Currents: secondary current + ~100 mA

- Secondary (output) currents are not standardized
- Round numbers of secondary turns are chosen (500, 750, 1000, 1500, 2000, 2500) the nominal secondary current follows from the nominal primary current; ~1 A
- Customers in power electronics chose a burden resistor adapted to their application
- On instruments like power analyzers, multi-range inputs are available

DC protection & power electronics

IEC

SC 23E

- Residual current monitoring

TC 85 JWG 26 (TC 69)

- Residual current monitoring for EVSE IEC 61577-18

Other topics (mostly safety, EMC not mentioned below)

LEM provides transducers for many AC/DC applications

• Power electronics	IEC 62477
• Drives	IEC 61800-5-1
• UPS, power supplies	
• PV inverters	IEC 62109, UL 1741
• Instrument transformers	TC 38, IEC 61869 series

Thank you