CSM High-Voltage Measurement Systems

Safe Measurements in High-Voltage Environments

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Improve Efficiency - Increase Range - Ensure Safety

The mobility of the future will be characterized by different powertrain concepts: Battery electric or hybrid as well as fuel cell drives. What they all have in common are on-board voltages in the high-voltage range that significantly exceed the voltages of traditional drive technologies. This places special safety requirements on the measurement technology in order not to endanger the system and the user. A secure measurement chain from sensor to data acquisition must be implemented.

A long vehicle range and a comprehensive charging infrastructure are essential prerequisites for acceptance of the new forms of mobility. To achieve this, innovative components and entire powertrains must be designed efficiently and continuously optimized.

Therefore, extensive tests and analyses are carried out on the test bench and in road testing. Temperatures, currents, voltages and power have essential roles in the development of efficient powertrains and must be measured at many stages of development. However, vibrations, humidity, strains and other data must also be acquired reliably and safely.

In addition, emerging standards and regulations for the uniform and safe design of vehicles must be complied with, making further measurements necessary.

With the extensive CSM HV measurement portfolio, all necessary measurements for the development of the mobility of the future can be carried out safely, precisely and easily.

Highlights

- Extensive product range for HV-safe and precise detection of
  - Currents
  - HV voltages
  - Powers
  - Temperatures
  - Accelerations
  - Strains
  - Vibrations, humidity, and other measured values
- HV-safe measurements from sensor to data acquisition
- HV-safe use of conventional sensor technology
- Installation close to the measurement point for minimization of interferences
- Use on the test bench and in-vehicle
- Tested HV safety per EN 61010
- Robust housing with IP67 protection on most modules
- High operating temperature range from -40 °C to +120 °C for most modules
- Easy combination of HV-safe and conventional measurement modules
- CAN-, EtherCAT®- (ECAT) and/or XCP-on-Ethernet communication

Acquisition of Many Measured Values - also in the HV Environment

CSM offers a complete HV-safe measurement technology product range for the development of electric and hybrid vehicles from one source!

With HV-safe measurement technology, all relevant measured variables can be easily and reliably acquired.

HV Breakout Modules are used for the synchronous measurement of current, voltage and power directly in HV power cables or bus bars of the vehicle's electrical system.

Conventional sensors from the low-voltage environment can be used with other HV measurement modules for temperature, strain, vibration and many other variables. This makes the application extremely simple.

The HV measurement modules can also be combined with CSM standard measurement technology and interface with the same software tools. This allows flexible measurement chains to be set up for extensive measurements.

Flexible Use - On the Test Bench and in Vehicles

Thanks to the compact design with IP67 protection and operating temperature ranges from -40 °C to +120 °C, most of the HV modules can be mounted directly on the vehicle and in confined spaces close to the measurement points. This reduces signal interference, which further increases the precision of the measurement results. In addition, mounting close to the sensor increases safety by reducing the risk of sensor cables chafing at HV potential.

The HV modules for a 19“ rack design are also very compact. They are particularly suitable for high channel counts, for example for precise temperature measurement of individual cells in HV batteries, and when the modules can be installed in a trunk, truck or passenger compartment.

Due to their robust design, operation in a wide temperature range and very low temperature drift, the measurement modules are also ideal for use in test benches and in climate test chambers. This means that HV components can be measured first on the test bench and later in the vehicle using the same measurement technology, assuring confidence in result throughout the development process.

CSM Xplained - Measuring in HV environments

You can also obtain important information about measurements under HV conditions in our web seminar - with many references to legal framework conditions and requirements.

www.csm.de/xplained-hv

Safety for Systems and Users

CSM Safety Concept

CSM's HV measurement prodcuts meet high safety requirements. Part of the safety concept is a type test of the complete system consisting of both measurement modules and sensor cables by our accredited test laboratory. In addition, each measurement module is subjected to a routine test in accordance with the EN 61010 safety standard before delivery. A corresponding test report as well as a calibration certificate is issued for this purpose.

With these tests and in connection with the corresponding unit-tested sensor cables, the safety of the user is ensured throughout the measurement chain - from the sensor to the data acquisition (data logger, laptop, etc.). When using standard sensors, these must be securely and properly installed and contacted in the HV environment.

Safety Features

- HV-safe measurement modules and Breakout Modules and their specially developed sensor cables with safe connectors for attaching the sensor to the module
- Galvanically isolated, reinforced isolation according to EN 61010 between:
  - the individual measurement channels
  - measurement channels and power supply
  - measurement channels and communcation (CAN and/or EtherCAT®)
  - Measurement channels and housing
- Galvanically isolated, channel-wise adjustable sensor supply with reinforced isolation according to EN 61010
- Approved for use in areas with pollution degree 4 (HV MiniModules and HV Breakout Modules)
- Partial potting of the module components: It is possible to repair the modules
- Additional ground connection for connection to the body ground
- Use of sensors and specially developed HV-safe sensor cables with integrated fully insulated connector concept

The CSM Safety Concept includes the following standard-compliant tests

- Type testing according to safety standard EN 61010 by an accredited test laboratory
- Routine testing of the measurement modules according to safety standard EN 61010
- EMC (CE) test
- Shock and vibration test
- Protection class test (IP65/IP67)

HV Isolation Testing Station

The high hazard potential of measurements taken in HV environments requires increased safety awareness, and often special training. The safety for life and health of the user is the top priority. CSM therefore recommends that the HV isolation of measurement modules is tested regularly to ensure operational safety at all times - especially if the modules are exposed to strong external influences during use.

We will gladly perform the necessary tests and calibrations for you in our in-house test laboratory as part of your preventative maintenance process.

For testing directly at the user's premises, we have developed the HV isolation testing station, consisting of PC-based isolation test software, the isolation tester, a „self-test adapter" and accessories.

High-voltage Safe Measurement Modules

The comprehensive product range allows the reliable acquisition of many measurement values in the HV environment.

Measurement Value	Sensors	Measurement Modules	Page
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▸ Humidity ▸ Vibration ▸ Acceleration ▸ Flow rate ▸ much more	Traditional sensors used in HV environment	HV AD modules with (optional) sensor excitation	18
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HV Breakout Modules

Measurement of Inner Conductor Current, Shield Current and Voltage

The HV Breakout Modules (BM) have been specially designed for safe measurement applications on HV voltage cables. Currents and voltages are measured directly and the raw data is acquired with up to 2 MHz per channel. Current and voltage are tapped synchronously - a basic requirement for precise power calculations.

Highlights

- Measurement of voltage (U), current (I) and shield current in HV applications
  - For working voltages up to ±1,000 V (measuring range up to ±2,000 V)
  - Currents up to ±1,000 A (nominal), ±2,000 A (peak)
  - Shield currents up to ±250 A (nominal value), ±500 A (peak)
  - Synchronous tapping of current and voltage
- Simultaneous EtherCAT® and CAN bus communication or direct output of measured values via XCP-on-Ethernet (depending on module type)
- Output of voltage, current and if applicable instantaneous power with up to 1 MHz measurement data rate each (directly via XCP-on-Ethernet up to 2 MHz)
- Optional calculation of power and RMS values directly in the module and output via XCP-on-Ethernet and CAN (output depends on module type)

Fig. 1: HV BM 1.2C on the test bench. The module can be connected directly to the HV power cables via the PL500 plug-in system.

The sensors and measurement electronics of the HV Breakout Modules are well shielded and are housed together in a compact enclosure. This eliminates the need for sensor cables between the measurement point and the modules, which could trap interference and thus falsify the measurement signal.

With the various connection options (via ring terminals or PowerLok connector), the HV BM can be easily installed into the HV cables on test benches and in test vehicles. The HV BM feature an integrated shielding concept - eliminating the need for tedious additional work to manage the continuity of the cable shield.

The robust design (IP 67 and operating temperature range -40 °C to +120 °C) also allows mobile use in harsh road tests. This means that the same measurement system can be used on the test bench and validation in the road test.

Designation	Phases	Measurement of					Cable Connection	Data Output
		Inner Conductor Current	Shield Current	Voltage	Instan-taneous Power	Power and RMS values		
HV BM 1.1	1	✓		✓	✓	✓ (Output via CAN)	1 ring terminal (per side)	EtherCAT® and CAN
HV BM 1.2	1	✓		✓	✓	✓ (Output via CAN)	1 ring terminal (per side)	EtherCAT® and CAN
HV BM 1.2C	1	✓		✓	✓	✓ (Output via CAN)	PL500 connectors	EtherCAT® and CAN
HV BM 1.2+S	1	✓	✓	✓	✓	✓ (Output via CAN)	3 ring terminal (per side)	EtherCAT® and CAN
HV BM 3.1	3	✓		✓	✓		Phoenix terminals	EtherCAT® and CAN
HV BM 3.3	3	✓		✓		✓	3 ring terminal (per side)	XCP-on-Ethernet and CAN
HV BM 3.3C	3	✓		✓		✓	PL300 connectors	XCP-on-Ethernet and CAN

With the **Option Calculated Channels** active, apparent and reactive power, power factor and the RMS values for current and voltage are calculated directly in the module from the sampled measured values.

Depending on the module type, the RMS and power values are transmitted directly to the DAQ computer or a data logger via CAN and XCP-on-Ethernet as separate measurement channels.

This allows power calculations to be carried out without the use of special hardware and software.

- Standard availability
  - Instantaneous power p
    (for HV BM 1.1 / HV BM 1.2 / HV SAM 1.1 / HV BM 3.1)
- With option Calc.
  - Active power P in W
  - Apparent power S in VA
  - Reactive power Q in var
  - Power factor λ
  - RMS voltage U_{RMS} in V
  - RMS current I_{RMS} in A

HV BM Split evo

Measurement of Current and Voltage

The HV BM Split evo use the proven technology of the HV Breakout Modules for fast and precise measurement of internal conductor current, voltage and power and allow you to measure these variables in areas with limited space for measurement equipment.

They are used when there is not enough space to install the HV Breakout Modules. The HV SBML evo variants are used for measurements on HV aluminum cables.

Highlights

- Measurement of voltage (U) and current (I) in HV applications with little space for the installation of the measurement technology.
  - For working voltages up to ±1,000 V (measurement range up to ±2,000 V)
  - Currents up to ±1,000 A (nominal), ±2,000 A (peak)
  - Synchronous tapping of current and voltage
- Simultaneous EtherCAT® and CAN bus communication
- Output of voltage, current and instantaneous power with up to 1 MHz measurement data rate each
- Optional output of RMS values of current and voltage as well as active, reactive and apparent power and power factor via CAN bus

For flexible installation of the measurement technology in tight spaces, the HV BM Split evo consist of three components:

- Breakout boxes for current measurement
- Breakout boxes or cables for voltage tapping
- Measurement modules for the acquisition of the current and voltage values

The HV Split Breakout Modules evo (HV SBM evo) provide a HV-safe enclosure around the measurement point and are connected to an input of the HV Split Acquisition Module 1 evo (HV SAM1 evo) with shielded, HV-safe sensor cables, per the CSM HV Safety Concept.

The “split” design allows the individual current and voltage measurement points to be taken where necessary and their signals sent to the HV SAM1 evo where space is available.

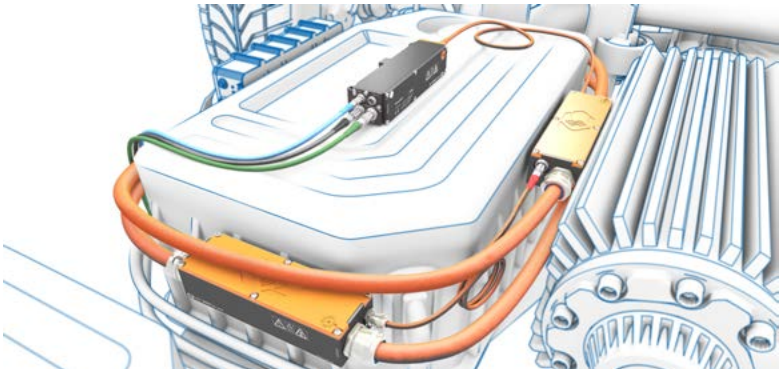


Fig. 2: Measurement of current and voltage with HV BM Split evo in the vehicle electrical system.

Voltage Measurement with HV AD Measurement Modules

HV voltages can also be directly measured with HV-safe measurement modules and appropriate sensor cables. For this purpose, the voltage is simply tapped directly with a HV-safe sensor cable.

The measurement modules are available both as compact and robust MiniModule variants and as 19-inch rack modules.

CAN Measurement Modules

HV AD4 evo XW20 and HV AD4 XW20

- Four analog inputs with galvanic isolation per channel
- Measurement data rate up to 20 kHz per channel
- Measurement range up to ±1,000 V (extended up to ±2,000 V)
- Measurement range adjustable per channel
- Measurement categories (MiniModul version):
  - CAT 0: 1,000 V
  - CAT II: 600 V
  - CAT III: 300 V

ECAT Measurement Module

HV AD4 XW1000

- Four analog inputs with galvanic isolation per channel
- Measurement data rate up to a MHz per channel
- Measurement range up to ±1,000 V (extended up to ±2,000 V)
- Measurement range adjustable per channel
- Measurement categories (MiniModul version):
  - CAT 0: 1,000 V
  - CAT II: 600 V
  - CAT III: 300 V

XCP Measurement Module

HV AD4 XW4000

- Four analog inputs with galvanic isolation per channel
- Measurement data rate up to 4 MHz per channel
- Measurement range up to ±1,000 V (extended up to ±2,000 V)
- GBit/s XCP-on-Ethernet interface for direct connection to the DAQ system
- XCP Gateway option for connection of other CSM EtherCAT® measurement modules

Current Measurement with CSM Current Sensors

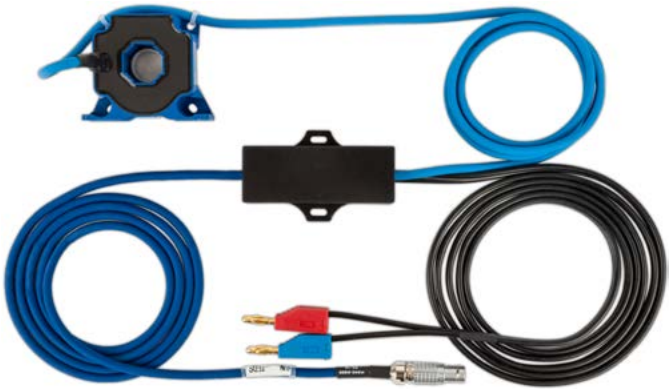
Currents can be acquired with CSM current sensors in combination with CSM measurement modules. With the ECAT measurement modules, the acquired data can be synchronously integrated into the measurement chain.

An adapter cable also allows these current sensors to be used with CSM's CAN-based Minimodules.

CSM LEM Sensor Package

The CSM LEM sensor packages in combination with the CSM standard modules AD4 ECAT enable the safe and highly accurate measurement of typical currents occurring in HV applications.

The very high sampling rate and the extremely good synronization of the CSM measurement modules for the acquisition of HV voltage and current allow a highly accurate power calculation.



- For the highly accurate measurement of currents
- Up to ±1,000 A (700 A RMS continuous)
- For signal frequencies up to 200 kHz
- TEDS support according to IEEE 1451.4 standard

CSM Current Clamp

The CSM Current Clamps are suitable for high-precision measurements of currents up to ±1,000 A with signal frequencies up to 1 MHz. Different variants are available for rated currents from ±20 A to ±1,000 A.

The current clamp can be quickly and easily attached to power cables to be measured. The integrated supply module contains the leads for the necessary supply voltage. This allows a flexible application.

Likewise, galvanic isolation between the test setup and the measurement equipment is ensured - making the CSM Current Clamps also suitable for applications in 48 V on-board power supplies and HV environments.

- Current measurements up to ±1,000 A also in HV environments
- Signal frequencies up to 1 MHz
- TEDS support according to IEEE 1451.4 standard
- Fast installation due to integrated, automotive-grade supply module with easy connection to CSM measurement technology

Temperature Measurement

Temperatures play an important role in the electric powertrain. They directly influence the performance, lifetime and safety of components such as HV batteries. Accordingly, they must be reliably acquired at many stages of development on various components - CSM offers a range of options for this.

Temperature Measurement with Sensors from the Low-voltage Environment

With HV-safe sensor cables and CSM HV measurement-modules, sensors from the low-voltage environment can also be used for temperature measurement.

Thermocouples

The measurement modules have NiCr-Ni temperature inputs (type K) for simple and reliable temperature measurements.

HV TH4 evo

- Four measuring inputs via 8-pin Redel-multi-connector, galvanically isolated
- Measurement categories
  - CAT II: 600 V
  - CAT III: 300 V

HV TH8 evo

- Eight measurement inputs via two HV-safe sensor cables using 8-pin Redel multi-connectors, galvanically isolated

RTD Sensors

The HV PT measurement modules allow high-precision temperature measurements with PT100 and PT1000 resistance sensors installed in the HV environment.

HV PT2

- Two measurement inputs via via HV-safe sensor cable using 8-pin Redel multi-connector in 4-wire technology for PT100 or PT1000 sensors
- Reinforced insulation

HV PT8

- Eight measurement inputs via four HV-safe sensor cables using 8-pole Redel multi-connectors in 4-wire technology for PT100 or PT1000 sensors
- Reinforced insulation

HV DTemp Measurement System

Digital Temperature Measurement with up to 512 Measurement Points

The CSM HV DTemp measurement system was developed for the position-accurate, digital and thus interference-free acquisition of up to 512 temperature measurement points with a single cable connection to the HV DTemp-P Central Unit.

Highlights

- Measurement accuracy of the overall system: ±0.1 °C to ±0.25 °C
- Miniaturized, highly accurate, robust sensors which are very immune to interference
- Efficient acquisition of up to 512 temperature measurement points via a single Central Unit
- Temperature sensors can be precisely positioned and flexibly applied, e.g. via an ultra-thin flexible circuit
- Only one connection cable from the HV environment to the CAN bus Central Unit
- HV-safe up to ±1,000 V

Precise knowledge of thermal behavior and temperature profiles is an essential prerequisite for the development of high-performance high-voltage battery systems. For this purpose, temperatures must be measured with several hundred measurement points, even between the cells of the battery.

With the HV DTemp measurement system, such measurements can be easily performed due to the connection via a single digital sensor cable into the HV environment which also allows fot hte decentralized control of up to 512 temperature measurement points.

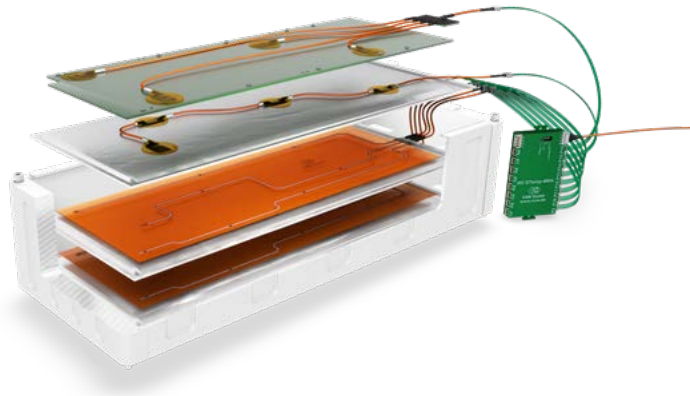
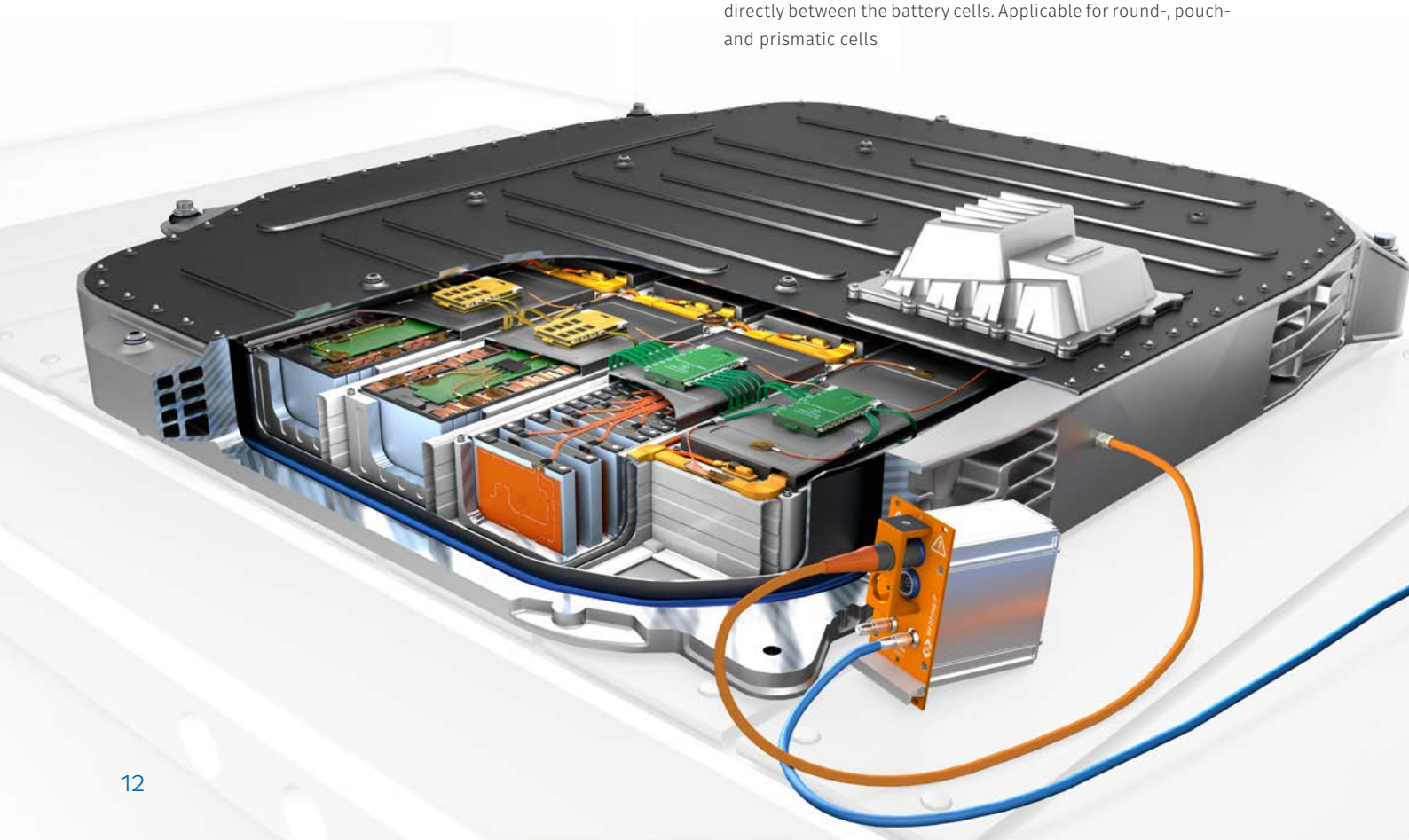
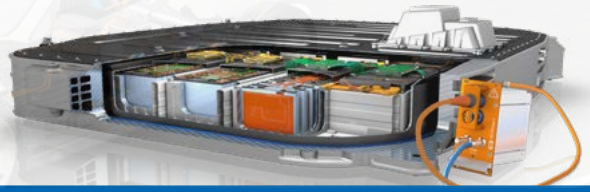


Fig. 3: The very thin HV DTemp IC sensor technology can be installed as individual sensors or on ultra-thin flexible circuits directly between the battery cells. Applicable for round-, pouch- and prismatic cells

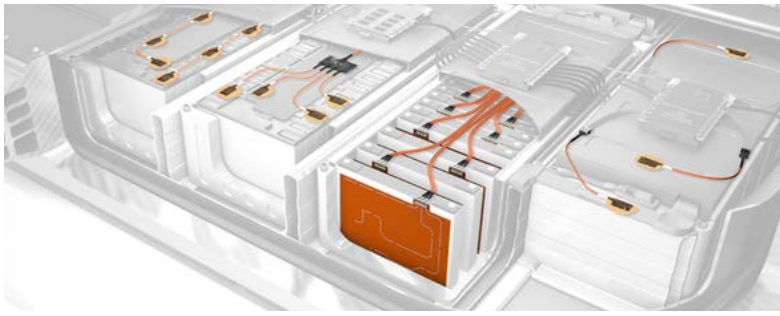




The measurement system consists of three components:

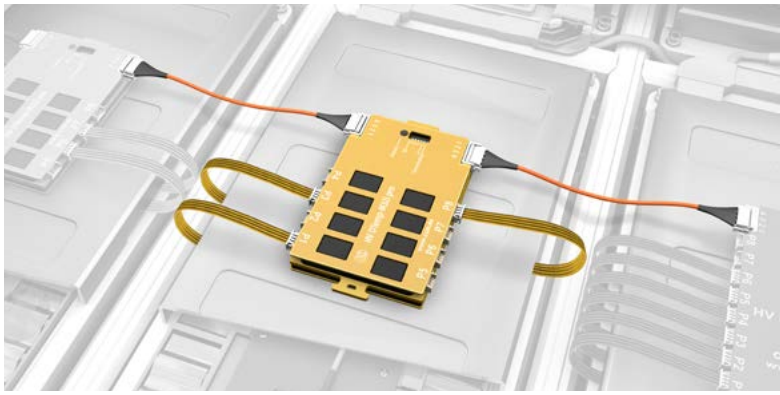
HV DTemp IC Sensors

- Up to four IC temperature sensors are connected together to form an HV DTemp sensor assembly. The sensors are either arranged individually on an ultra-thin flexible circuit or positioned together on one larger flexible circuit.
- The dimensions of the flexible circuit, the amount of sensors and the sensor position can be selected according to the measurement task.



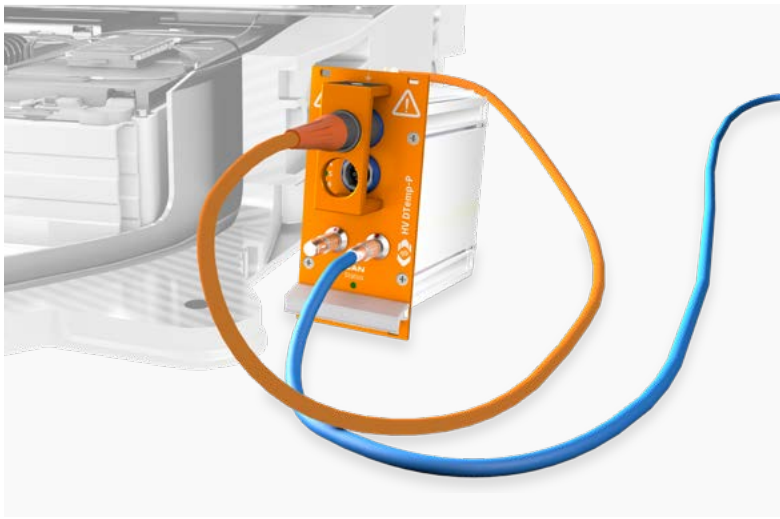
HV DTemp-Mx Controller

- The compact HV DTemp controllers are installed decentrally in the HV environment. They provide the power supply for the temperature sensors and acquire up to 64 temperature signals in parallel.
- The power supply for all HV DTemp Mx Controllers and the transmission of the measured temperature values out of the HV environment are provided via a single HV-safe connection cable.



HV DTemp-P Central Unit

- Up to eight of the HV DTemp controllers can be operated simultaneously on the HV DTemp-P Central Unit via an internal digital measurement bus
- From the HV DTemp-P Central Unit to the data acquisition system, the temperature measurement values are transmitted via a single digital CAN bus cable, which also contains the power supply for all DTemp components

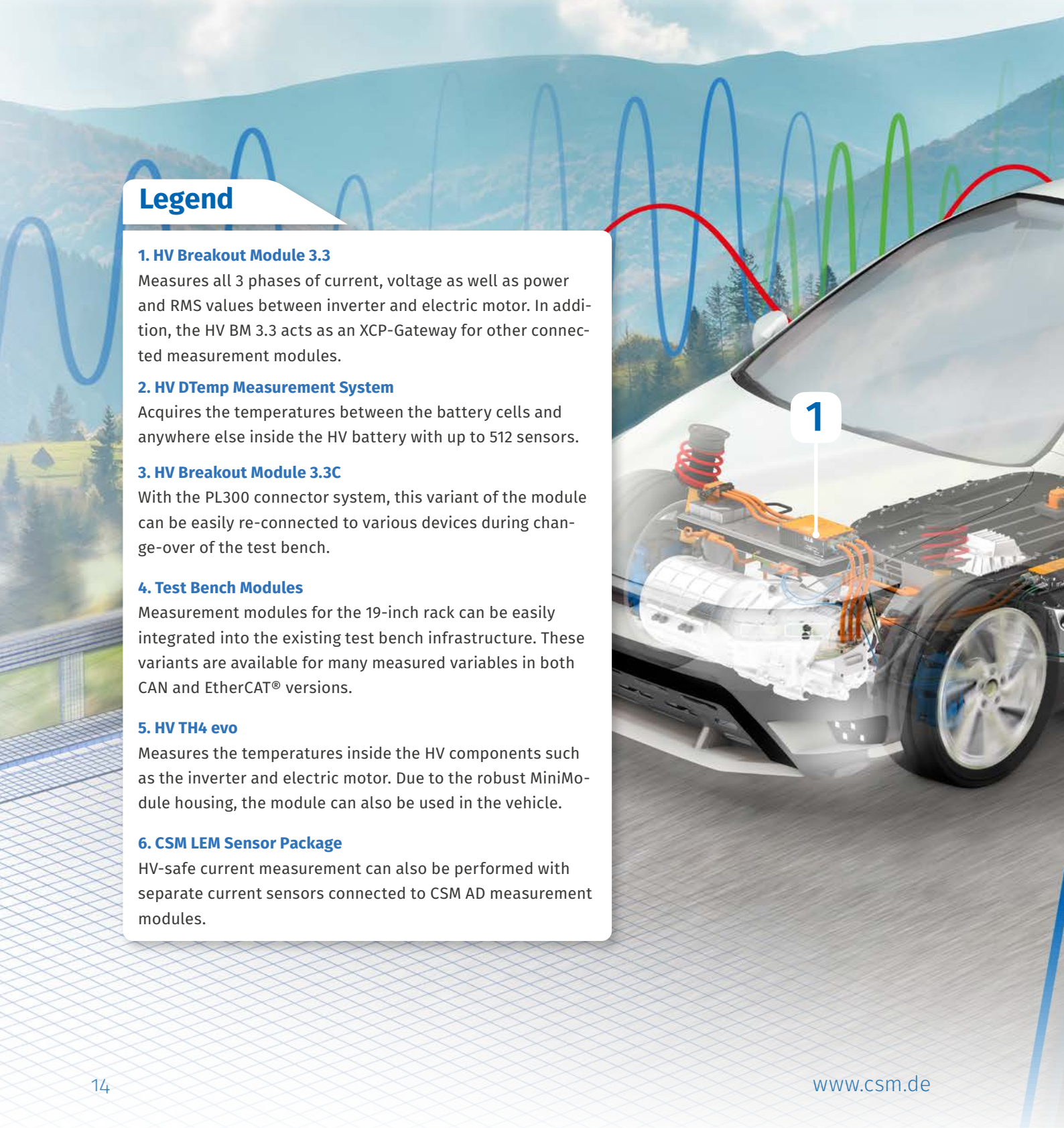


The individual components are combined specifically to a complete measurement system for each application.

Example of Measurements in High-voltage Environments

For the development of electromobility, many measured variables must be safely and reliably acquired under HV conditions - on the test bench and in the vehicle. Using the same measurement technology for different tests saves valuable time and costs, as the measurement technology only needs to be installed once. In addition, the results from different test runs can be compared more easily.

The CSM HV measurement modules can be combined with low-voltage measurement technology in a measurement chain to flexibly find the right tool depending on the measurement task.



Legend

1. HV Breakout Module 3.3
Measures all 3 phases of current, voltage as well as power and RMS values between inverter and electric motor. In addition, the HV BM 3.3 acts as an XCP-Gateway for other connected measurement modules.

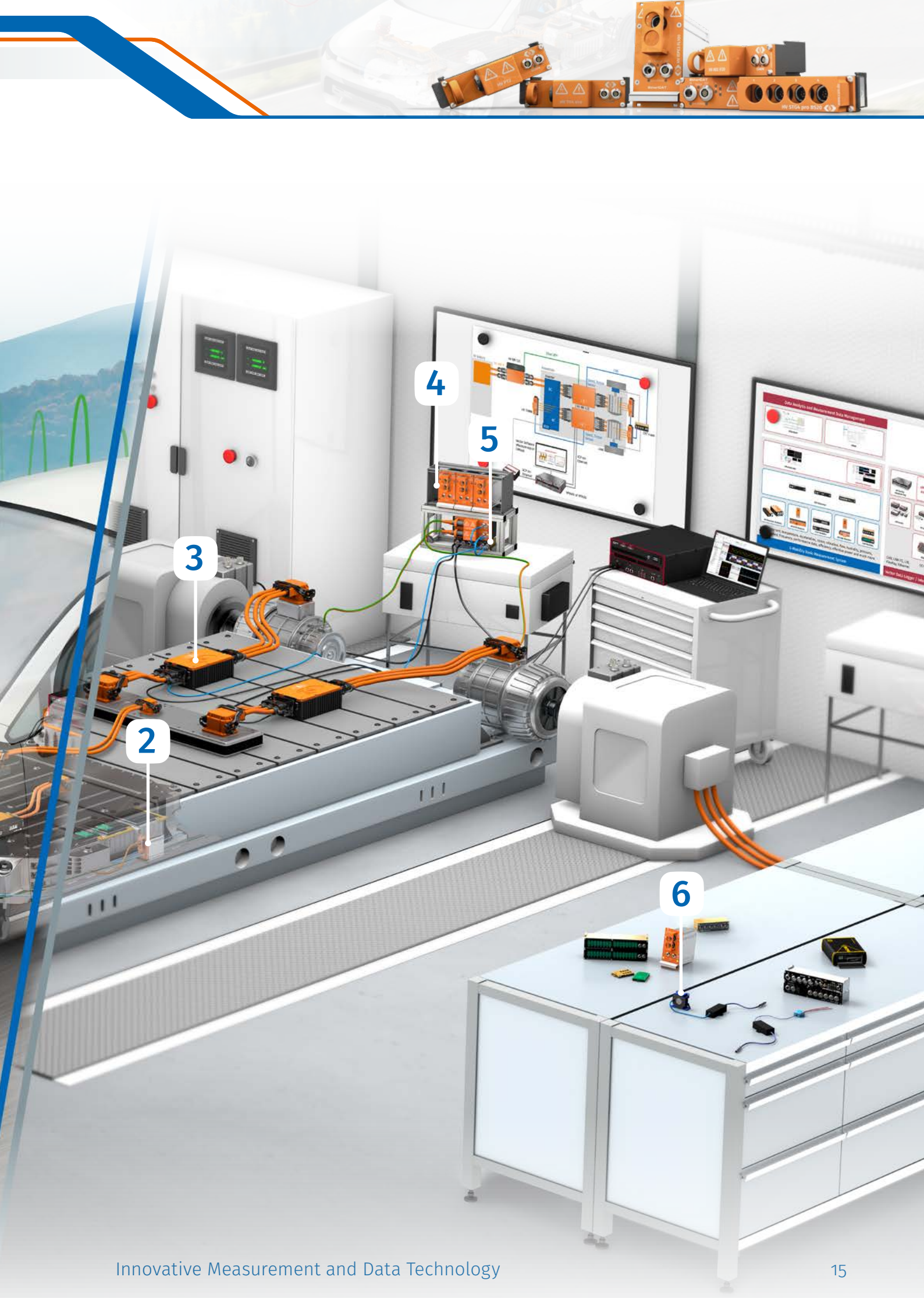
2. HV DTemp Measurement System
Acquires the temperatures between the battery cells and anywhere else inside the HV battery with up to 512 sensors.

3. HV Breakout Module 3.3C
With the PL300 connector system, this variant of the module can be easily re-connected to various devices during change-over of the test bench.

4. Test Bench Modules
Measurement modules for the 19-inch rack can be easily integrated into the existing test bench infrastructure. These variants are available for many measured variables in both CAN and EtherCAT® versions.

5. HV TH4 evo
Measures the temperatures inside the HV components such as the inverter and electric motor. Due to the robust MiniModule housing, the module can also be used in the vehicle.

6. CSM LEM Sensor Package
HV-safe current measurement can also be performed with separate current sensors connected to CSM AD measurement modules.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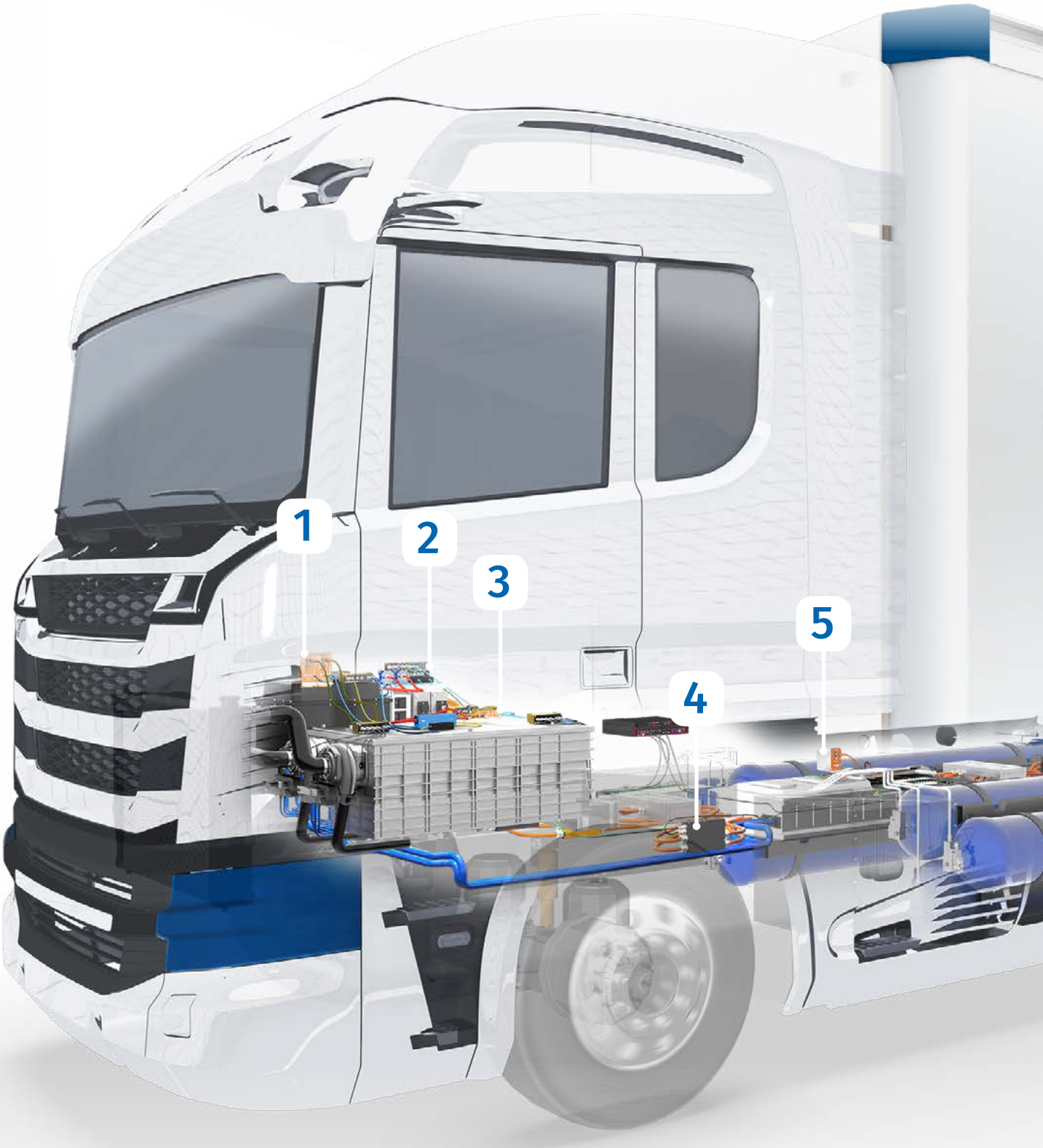
Example ofMeasurements in High-voltage Environments

Not only battery-electric drives will move vehicles in the future - other drive concepts, such as fuel cells, are also playing an important role in mobility.

Even in these more complex powertrain setups, there are HV environments, such as inside the fuel cell stack, in which measured variables must be acquired in a HV-safe manner.



CSM Application Examples

Many application examples for HV-safe measurements can be found on our website.

Legend

1. HV TH8 evo
Measures HV-safe temperatures in the cooling system of the fuel cell stack. With HV-safe sensor cables, known thermocouples from the low-voltage range can be used.

2. XCP-Gateway
With CSM XCP-Gateways, both HV and conventional, low voltage CAN and ECAT measurement modules can be combined in one measurement chain. In this way, the measurement data from the HV and LV environments flow seamlessly into a single, comprehensive analysis.

3. HV AD2 IF20
Acquires data from standard sensors in conjunction with special HV-safe sensor cables. This allows flow, humidity and pressure to be measured in the stack oxygen supply.

4. HV Breakout Module 1.2
Simultaneously measures current and voltage between the HV distributor and the HV battery in the electric powertrain.

5. HV DTemp Measurement System
Very high channel count of temperature measurement in the HV traction battery

6. Additional HV Breakout Modules
For power and efficiency analyses, additional HV Breakout Modules are inserted into the power cables or busbars of the HV electrical system.

Measurement of Humidity, Vibrations, Accelerations

HV AD Modules with ±20 V Measurement Range and Sensor Excitation

Reliably acquire analog signals on HV components: With the HV AD measurement modules, CSM offers universal measurement technology for sensors with analog voltage outputs or measurements of analog voltages up to ±20 V in the HV environment.

CAN Measurement Modules

HV AD2 evo IF20

- Two measurement HV-Safe sensor cable to IP67 MiniModule (inputs via 8-pin Redel multi-connector)
- Galvanically isolated sensor excitation for standard sensors in HV environment
- Possible measurement ranges from ±1 V to ±20 V
- Measurement data rate up to 20 kHz via CAN
- Reinforced isolation up to 846 V

ECAT Measurement Module

HV AD4 IF1000

- Four measurement inputs via HV-safe sensor cables to IP65 Test Bench Module (8-pin Redel multi-connector)
- Galvanically isolated sensor excitation for standard sensors in HV environment
- Possible measurement ranges up to ±20 V
- Measurement data rate up to 1 MHz
- Reinforced isolation up to 846 V

HV AD Modules with ±90 V Measurement Range

The HV AD modules with ±90 V measurement range are suitable for applications where smaller voltages have to be measured HV-safe and with high resolution.

CAN Measurement Modules

HV AD4 OW20

- Four measurement inputs via HV-Safe sensor cable (8-pin Redel multi-connector, galvanically isolated)
- Measurement ranges from ±5 V to ±90 V
- Measurement range adjustable per channel
- Measurement data rate up to 20 kHz via CAN
- Reinforced isolation
- Measurement categories:
  - CAT 0: 1,000 V
  - CAT II: 600 V
  - CAT III: 300 V

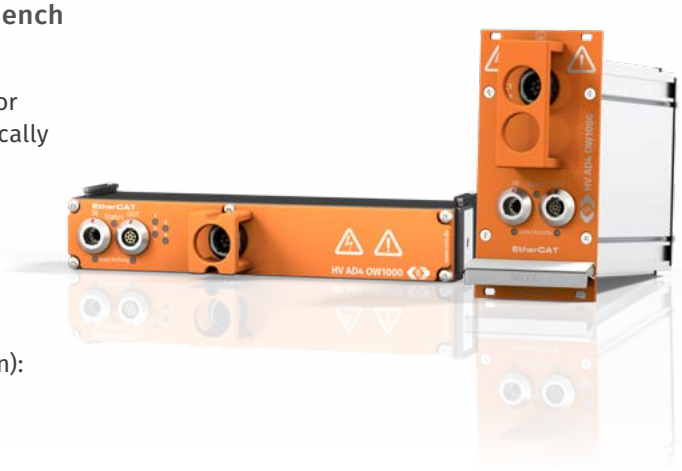
HV AD8 OW20

- Four measurement inputs via HV-Safe sensor cable (8-pin Redel multi-connector, galvanically isolated)
- Measurement ranges from ±5 V to ±90 V
- Measurement range adjustable per channel
- Measurement data rate up to 20 kHz via CAN
- Reinforced isolation

ECAT Measurement Modules

HV AD4 OW1000 (MiniModul and test bench module)

- Four measurement inputs via HV-Safe sensor cable (8-pin Redel multi-connector, galvanically isolated)
- Measurement ranges up to ±90 V
- Measurement range adjustable per channel
- Measurement data rate up to 1 MHz
- Reinforced isolation
- Measurement categories (MiniModul version):
  - CAT 0: 1,000 V
  - CAT II: 600 V
  - CAT III: 300 V



Measurement of accelerations, mechanical stresses and other measurement variables

Measurements with IEPE-Sensors

HV IEPE3 FL100

The HV IEPE3 FL100 offers three analog inputs with a modified sensor supply for the connection of IEPE sensors. This allows standard IEPE sensors from low-voltage applications to be operated safely in the HV environment in conjunction with special sensor cables.

- Support of all common IEPE sensors such as microphones, vibration, torque, etc.
- Three analog inputs with reinforced insulation
- HV-safe sensor supply
- Measurement data rate up to 100 kHz per channel

Measurements with Strain Gauges

HV STG4 pro BS20

The HV STG4 pro BS20 is the high-performer among the HV-safe strain gauge measurement modules: The extended input voltage range enables precise measurements from very low to very high signal voltages.

Thanks to the complete galvanic insulation, half and full bridges as well as standard strain gauge-based sensors from conventional low-voltage applications can be used in conjunction with special sensor cables. This simplifies the application and configuration, since known sensors can be used and HV safety is ensured.

- Four time-synchronous strain gauge inputs with reinforced insulation (galvanically isolated)
- Safe use of standard strain gauge based sensors from low voltage applications in HV environment
- Adjustable supply voltages from 1 to 10 V
- Measurement data rate up to 20 kHz per channel
- Support of full and half bridges in 6- and 4-wire connection
- Precise acquisition due to very small input voltage range
- High noise suppression due to ratiometric measurement principle and configurable software filters

HV-safe Sensor Cables

The specially developed sensor cables for up to four measurement points are optimally matched to the properties of the CSM measurement modules. They are correspondingly safe to touch (when using insulated sensors) and robust.

With their small diameter, they are ideally suited for space-saving applications. Since cables are often exposed to chafing from contact with car body parts, the sensor cables have a blue intermediate sheeth.

If the blue intermediate jacket becomes visible, this indicates that the cables are no longer safe to operate. Depending on the application, cables are available for the HV modules for AD, STG, IEPE, PT and TH and Breakout Modules.

The benefits at a glance

- Only one cable for up to 4 measurement points:
  - Reduces sources of error and increases safety (chafing, cable breakage, etc.)
- Less cabling effort, reduces costs compared to the use of single cables
- Double insulation: safe to touch, increased electrical and mechanical safety
- Specially developed colored bezels and keying with fully insulated plastic plugs matching the specific CSM measurement module prevents accidental cross-connection: Fire protection class V-0, protection class IP67

Designation	Description
Thermo Sensor Cables	
K940	Surface thermocouple cables for use in HV environments with HV-TH measurement modules; 4 × HV sensor type K, non-insulated measuring tips
K941	Surface thermocouple cables for use in HV environments with HV-TH measurement modules; 4 × HV sensor type K, insulated measuring tips protected with heat shrink tubing
K950	Signal cable for HV PT measurement modules with 2 × HV PT100 sensor
Analog Sensor Cables	
K902	Signal cable for HV AD measurement modules with measurement ranges up to ±90 V, Shielding for suppression of interference signals
K912	Signal cable for HV AD measurement modules with measurement ranges up to ±1,000 V, Shielding for suppression of interference signals
K920	Signal cable for HV AD measurement modules with sensor supply for 2 sensors
K960	Connection cable between a HV IEPE3 FL1000 measurement module and an IEPE sensor (triaxial, uniaxial)
K980	Connection cable between a HV STG measurement module and a strain gauge full / half bridge

In the CAN and ECAT accessories catalogs you will find all suitable connection cables as well as a wide range of connectors and mounting materials.

About us

CSM Computer-Systeme-Messtechnik GmbH

With our innovative technology, we are making the mobility of today and tomorrow safer, more efficient and more sustainable. We, CSM Computer-Systeme-Messtechnik GmbH, are a manufacturer of distributed and robust measurement technology for vehicle development.

From our international offices, we support many industries worldwide with our products in the successful transition to electrified systems. Offering a suitable measurement technology solution – supported by our expert team – is key to our success.

Our portfolio includes conventional and HV-safe measurement modules for the fast and synchronous acquisition of current and voltage, temperatures and many other measured values. We complement these with suitable software, data loggers and a large selection of memory card drives and storage media for industrial use.

As part of the Vector Group and together with our partners, we offer comprehensive and complementary solutions for data acquisition and analysis from a single source..

Measurement Technology for E-Mobility
We accompany you on the way to the future

Service & Support

Do you have special questions or technical requests for the use of the CSM measurement technology? Please contact us, our Service & Support is at your disposal.

Please use our telephone hotline:

+49 711 - 77 964-444

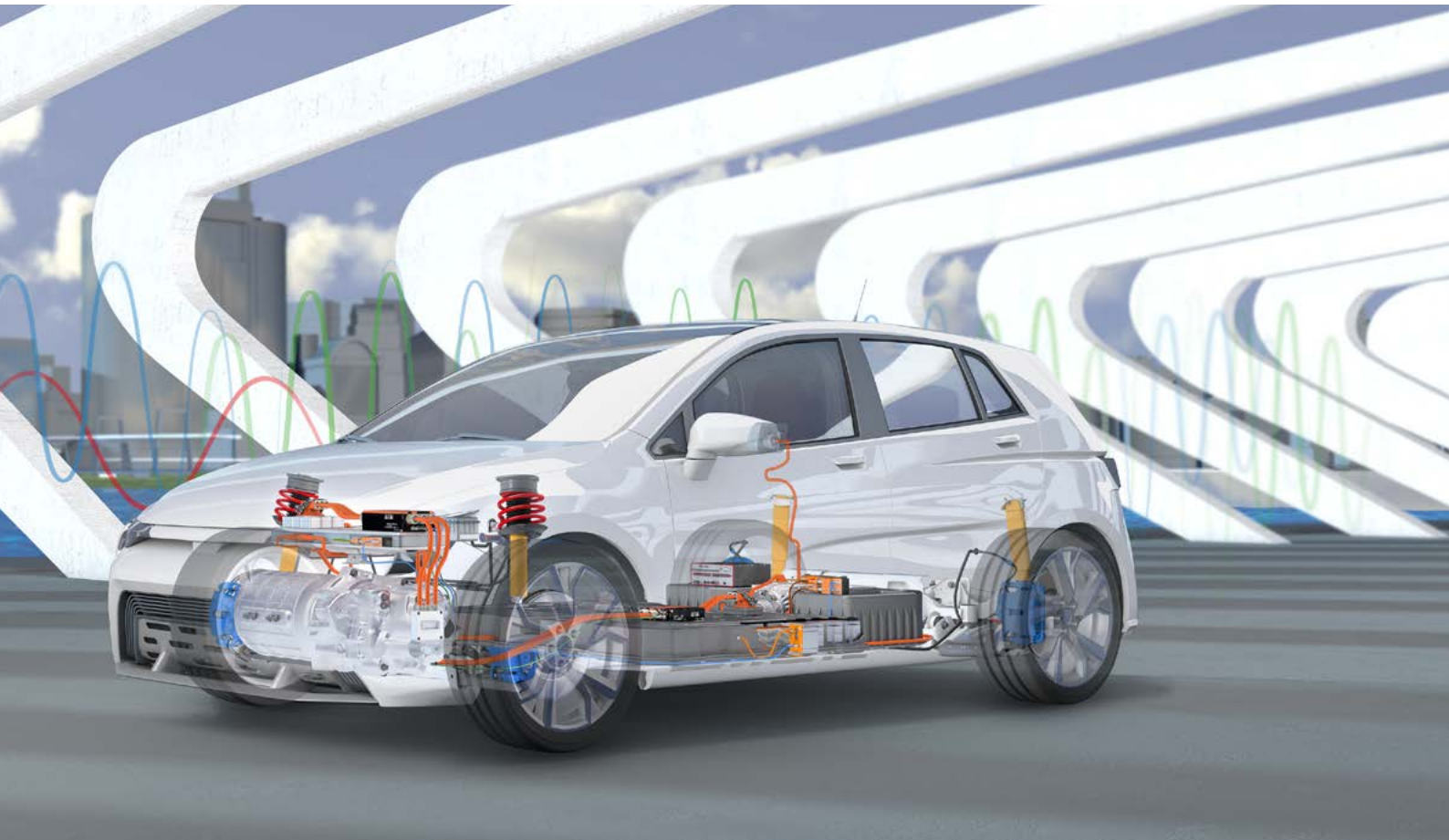
Or contact us via our website: **www.csm.de** under the keyword »Support«.

All Products, Data, and Information at a Glance

Our website **www.csm.de** provides you with further information about the CSM measurement modules and data loggers. Make use of our solutions for the development and testing of passenger cars, commercial and special vehicles, construction and agricultural machinery, cranes, wind turbines, airplanes, ships etc.

- Overview of the entire product portfolio
- Application examples
- Direct download: the latest CSM software versions
- Easy access to data sheets and product information

www.csm.de



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