HV Breakout Module

Type 3.3 | 3.3C

Product description

The **High Voltage Breakout Module (HV BM) 3.3** has been designed for three phase measurements of currents and voltages of high-voltage carrying cables. Three phase currents and the corresponding phase-to-phase voltages can be measured simultaneously in one module.

The voltages U_{12}, U_{23} and U_{31} are measured directly. The three currents are measured by individual shunt modules. These shunt modules are equipped with a temperature sensor and a calibration data memory for live temperature compensation.

The **HV BM 3.3** is installed into the HV cables by feeding the cables through cable glands into the interior of the module and connecting them with ring terminals. The **HV BM 3.3C** variant uses locking connectors instead of cable glands. This version is ideal for use in test stands and can also be integrated into the interlock loop.

The **HV BM 3.3** transmits the measurement data directly via the standard XCP-on-Ethernet protocol with a data rate of up to 2 MHz per measured signal. This protocol is supported by many measurement data acquisition systems in the field of vehicle measurement technology. The module can therefore be connected directly to the computer.

The module is equipped with an integrated XCP-Gateway that can be optionally enabled.

EtherCAT CAN CAN

Key features

- Time-synchronous measurements of 3 phase-to-phase-voltages (U) and 3 phase currents (I) in one module, HV-safe enclosed for:
  - Nominal voltages up to ±1,000 V (measurement range up to ±2,000 V)
  - Currents up to ±1,400 A (peak)
- Gbit/s XCP-on-Ethernet interface, measurement data rate up to 2 MHz per measured signal
- XCP-Gateway option for connecting CSM's CAN and EtherCAT® measurement modules
- Output of RMS values U_{rms} and I_{rms}, active power, apparent power, reactive power and power factor Lambda

The option "XCP-Gateway" allows the direct connection of CSM's EtherCAT® and CAN measurement modules to the **HV BM 3.3** and transmits their data together with the data of the **HV BM 3.3** to the PC via XCP-on-Ethernet.

All measurement modules receive their supply voltage from the **HV BM 3.3**. The configuration is done by CSM's software CSMconfig.

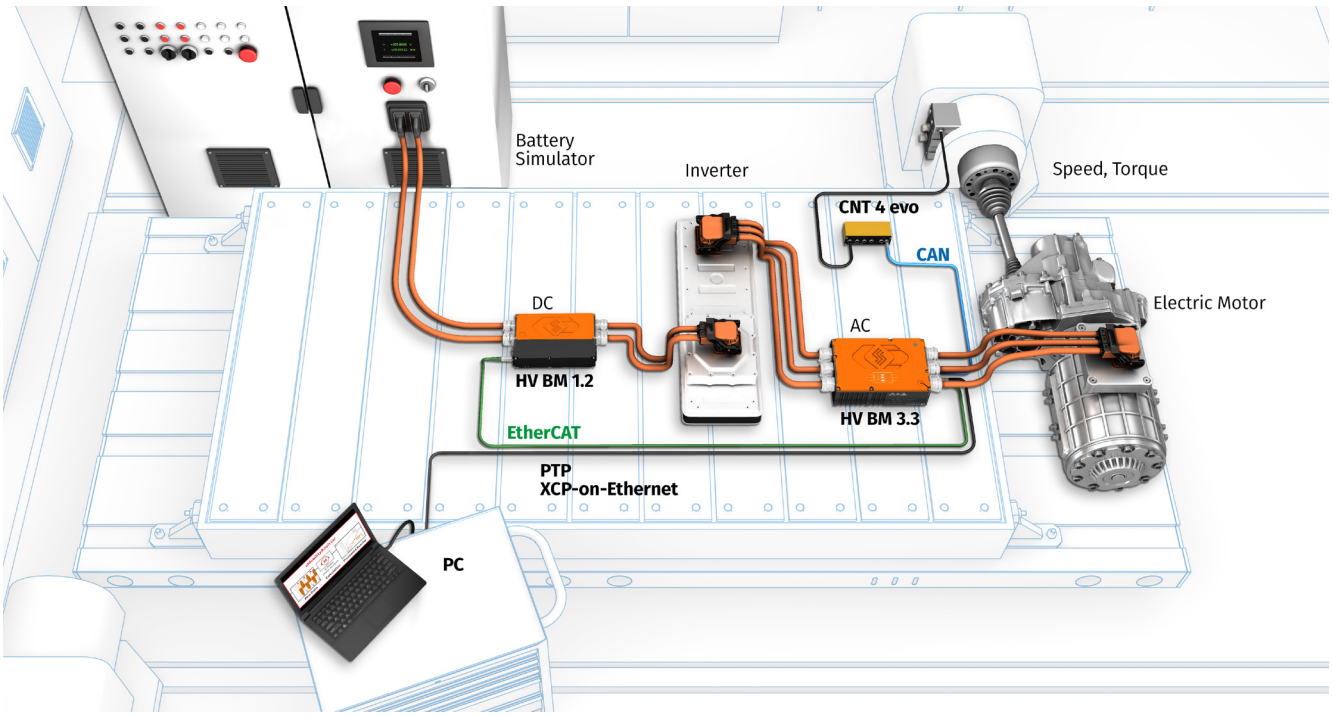


Fig. 1-1: Power and efficiency measurements on a test bench

Fig. 1-1 shows a typical measurement setup for power and efficiency measurements on a test bench. This setup can be used in a similar form for measurements in vehicle as well. Three phase measurements with just a single device and direct connection in the HV-cables provide significant advantages in terms of cost and space.

For example, it is possible to measure the efficiency of powertrains and inverters with minimal effort, interference-free and with high precision.

The efficiency calculations are performed with the eMobility Analyzer, which is part of the software vMeasure and CANape from Vector Informatik.

The RMS values of voltages and currents are calculated directly by the **HV BM 3.3** when the option "Calc." is set. Furthermore, active, apparent and reactive power (using the two-wattmeter-method) and the power factor lambda are calculated too.

This significantly reduces the load on the measurement computer where the data is saved and further calculations can be performed, such as efficiency calculations using the eMobility Analyzer, which is included in Vector's software vMeasure or CANape

Scope of delivery

- HV Breakout Module 3.3 | 3.3C
- Configuration software CSMconfig
- Documentation
- Calibration certificates for I and U in accordance with DIN EN ISO/IEC 17025
- HV isolation test protocol

Maintenance

- HV isolation test at least every 12 months, see EN 61010 for scope of testing
- Calibration every 12 months recommended

Accessories

- See "ECAT Accessories" and "CAN Accessories" datasheets

Technical data

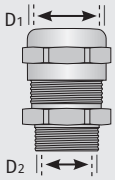
Type designation	HV BM 3.3	HV BM 3.3C
Technical data valid as of revision	A433	
		
Inputs	separate HV power cables for each phase	PowerLok Connector PL300
	When connecting the HV power cables, please observe the document "HV breakout module safety instructions".	
Number of measured phases	3	
Number of cable glands [1]	3 (per side)	-
Conductor cross section	16 mm² to 95 mm² (depending on the cable glands and the ring terminals used)	PowerLok PL300 Connector for 70 mm² cables
Cable outer diameter	9 mm to 25 mm (depending on the cable gland used) [1] *See section "Cable glands"*	
Measurement signals	3 x voltage and 3 x current	
Measurement ranges		
Voltage	±200, ±500, ±1,000, ±2,000 V [2]	
Conductor current	4 configurable measurement ranges ($I_{meas.}$) depending on the shunt module [1] used $I_1 = I_{peak}$, $I_2 = I_{rated}$, I_3, I_4 → *See section "Shunt modules"*	
Internal resolution	16 bit	
Internal sampling rate	2 MS/s	
Measurement data rate/ sending rate		
XCP-on-Ethernet	1, 2, 5, 10, 20, 50, 100, 200, 500, 1,000, 2,000 kHz	
CAN	1, 2, 5, 10, 20, 50, 100, 200, 500 Hz, 1, 2, 5 kHz [3]	
HW input filter	9th order Bessel filter, cutoff frequency approx. 500 kHz	
SW input filter	6th order Butterworth filter, cutoff frequency: automatically adjusted to measurement data rate or selectable for voltage and current XCP-on-Ethernet: cutoff frequency up to 300 kHz or at sending rate of 1,000 kHz SW-filter switchable, at sending rate of 2,000 kHz always without SW-filter CAN: cutoff frequency up to 2 kHz, alternatively mean filter	
Output signals		
XCP-on-Ethernet/CAN	voltage, current, shunt temperature, module temperature Optionally calculated quantities [4] (with activated option Calc.): RMS values of voltages and currents, active power, apparent power, reactive power and power factor Lambda → Adjustable integration times 10 ms to 10 s	

Type designation	HV BM 3.3	HV BM 3.3C
Measurement deviation[5]		
Voltage		
Gain error at 25 °C	typ. ±0.005 % of measured value max. ±0.05 % of measured value	
Offset and scaling error	typ. ±0.003 % of range max. ±0.02 % of range	
Gain drift	max. ±20 ppm/K of measured value	
Zero drift	max. ±10 ppm/K of range	
Current	online calculation with stored calibration data, with temperature compensation	
Gain error at 25 °C	typ. ±0.03 % of measured value (for shunt module 50 A, 125 A, 250 A) typ. ±0.05 % of measured value (for shunt module 500 A) typ. ±0.08 % of measured value (for shunt module 800 A) max. ±0.15 % of measured value	
Offset and scaling error	typ. ±0.02 % of range (valid for all shunt modules) max. ±0.05 % of range	
Gain drift	max. ±35 ppm/K of measured value	
Zero drift	max. ±20 ppm/K of range	
Fields of application[6]	for measurements in HV environments[7]	
Nominal voltage (unipolar & bipolar)	up to ±1,000 V	
Routine test[8]	HV-isolation test[7]	
XCP-on-Ethernet- interface		
Physical Layer	Ethernet 1000 Base-TX, 1000 Mbit/s	
Protocol	XCP on UDP/IP	
Configuration	via CSMconfig, settings and configurations stored in the device	
CAN Interface	CAN 2.0B (active), High Speed (ISO 11898-2:2016), 125 kbit/s to max. 1 Mbit/s, up to 2 Mbit/s with suitable CAN-interface, data transfer free running, for output of measurement values	
Configuration	via CAN bus using CSMconfig, settings and configurations stored in the device	
XCP-Gateway (option)		
EtherCAT® interface	1 EtherCAT® interface for conneting CSM ECAT measurement modules	
Physical Layer	Ethernet 100 Base-TX, 100 Mbit/s	
Protocol	EtherCAT®, synchronization via Distributed Clock	
CAN interface	CAN 2.0B (active), High Speed (ISO 11898-2:2016), 125 kbit/s to max. 1 Mbit/s, for the connection of CSM CAN measurement modules	
PTP (option)	Supports synchronization using "Precision Time Protocol" (PTP) between HV BM 3.3 or HV BM 3.3C and CSM/3rd party hardware supporting the IEEE 1588 standard or IEEE 802.1AS standard.	
Power supply		
Minimum	7 V DC (-10 %)	
Maximum	30 V DC (+10 %)	
Power consumption	typ. 3.9 W	

Type designation	HV BM 3.3	HV BM 3.3C
		
LED indicators		
PWR	Power	
XCP-BM	Link/Activity (PC), Status, Sync, configuration, operation	
XCP-Gateway	Sync, Device	
PC-Connection	Link/Activity (ECAT)	
Measurement categories[8]		
CAT 0	1,000 V	
CAT II	600 V	
CAT III	300 V	
Housing	aluminum with HV designation (RAL 2003)	
Protection clas	IP67[9]	IP67 (mated)
Ground connection	M8 threaded hole	
Weight	2,400 g incl. shunt modules, without cable glands	3,800 g incl. shunt modules
Dimensions (w × h × d)	approx. 295 × 75 × 150 mm	approx. 260 × 85 × 150 mm
Connectors		
PC (Ethernet)	LEMO 1B, 8-pole, code J	
PWR_{IN}	LEMO 0B, 5-pole, code G[10]	
ECAT (EtherCAT®/PWR_{OUT})	LEMO 1B, 8-pole, code A	
CAN (CAN/PWR_{OUT})	LEMO 0B, 5-pole, code G[10]	
Power HV+/HV- cables	cable glands also connecting the braided shields	Amphenol PowerLok connector PL300: PL083X-301-10M8-2 also connecting the braided shields
Interlock	-	LEMO 00, 2-pole, code G
Operating and storage conditions		
Operating temperature range	-40 °C to +120 °C	
Relative humidity	5 % to 95 % (non-condensing)	
Operating altitude	max. 5,000 m above sea level (CAT 0) max. 3,000 m above sea level (CAT II und CAT III)	
Pollution degree	4[9]	
Storage temperature	-40 °C to +125 °C	
Conformity	CE (in preparation)	
Device safety	EN 61010-1:2020+COR1:2022 EN 61010-2-030:2022	

Cable glands

Depending on the cable outer diameters, different cable glands must be adapted to the **HV BM 3.3**. Only suitable combinations (cables + cable glands) ensure the tightness of the housing. The cable glands are selected separately as needed. The following types that contact the braided shield are currently available:

Type	**9/14**	**11/20**	**15/25**
			
Cable outer diameter			
D_1 maximum	14 mm	20 mm	25 mm
D_1 minimum	9 mm	11 mm	15 mm
D_2 maximum	12 mm	17 mm	21 mm

Shunt modules

For the **HV BM 3.3**, CSM offers shunt modules with different measurement ranges. The shunt modules are selected separately and are installed permanently. The maximum operating time depends, among other things, on the ambient temperature and the resulting power loss in the measurement module. Under certain circumstances, the rated current cannot be applied permanently without the shunt module overheating. Its temperature must not exceed +120 °C.

Rated current I_{rated} [A]	**±50**	**±125**	**±250**	**±500**	**±800**
Peak current I_{peak} [A]	±100	±250	±500	±1,000	±1,400
Measurement ranges I_1, I_2, I_3, I_4 [A]	±100, ±50, ±25, ±10	±250, ±125, ±50, ±25	±500, ±250, ±125, ±50	±1,000, ±500, ±250, ±125	±1,400, ±800, ±500, ±250
Resolution at I_{peak} [mA/digit]	3	7	15	30	43

[1] Cable glands and shunt modules are selected separately.

[2] The measurement ranges of the analog inputs are dimensioned for ±2,000 V for acquiring transient overvoltages.

[3] In order to be able to use a measurement data rate of 5 kHz for all measurement signals, a CAN interface with 2 Mbit/s is required.

[4] Further information can be found in the Technical Information document on the subject of "CSM Power Calculation and Vector Power Analysis in comparison".

[5] The values for current can differ depending on the frequency. Further Information can be found in the Technical Information document on the subject of "Deviation of Measurement".

[6] Please read the CSM document "Safety Instruction HV Breakout Module type 3.3" or "Safety Instruction HV Breakout Module type 3.3C"!

[7] According to EN 61010-1:2020+COR1:2022 with EN 61010-2-030:2022

[8] Further Information can be found in the Technical Information document "Measurement Categories for CSM HV Measurement Modules".

[9] Valid for HV BM 3.3: Only if installed correctly. Please follow the assembly instructions in the installation manual.

[10] Optionally available in other variants

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