HV Breakout Module

Type 1.2

Product description

The **HV Breakout Module (BM) 1.2** was specially designed by CSM to simultaneously measure the inner conductor current and voltage in the HV vehicle electrical system (DC). Also RMS values such as U_{rms} and I_{rms}, active power, apparent power, reactive power and power factor can be calculated.

The two HV cables are fed through cable glands into the **HV BM 1.2** and are connected there. Typical applications are measurements between HV battery and inverter.

Voltage is measured directly with the **HV BM 1.2**. Current measurement is performed by a shunt module. This module contains, among other things, a temperature sensor and a memory chip for calibration data for automatic online temperature compensation.

The **HV BM 1.2** outputs the measured data with a maximum data rate of up to 1 MHz via EtherCAT® interface and simultaneously with a data rate of up to 10 kHz via the additional CAN interface. This allows high speed data acquisition via Ethernet and simultaneously data recording via CAN. The calculated quantities (with the option "Calc." enabled) are sent on the CAN bus with a transmission rate of up to 100 Hz.

Maintenance

- HV isolation at least every 12 months, scope of testing according to EN 61010
- Calibration every 12 months recommended

Key features

- Single-phase measurement of voltage (U) and current (I) in HV applications, HV-safe enclosed for:
  - Nominal Voltages up to ±1,000 V (measurement range up to ±2,000 V)
  - Currents up to ±2,000 A (peak)
- Output of voltage and current with up to 1 MHz measurement data rate
- Output of RMS values U_{rms} and I_{rms}, active power, apparent power, reactive power and power factor

Scope of delivery

- HV Breakout Module 1.2
- Configuration software CSMconfig
- Documentation
- Device Description File (*.xml)
- Calibration certificates for I and U in accordance with DIN EN ISO/IEC 17025
- HV isolation test protocol

Accessories

- See data sheets "XCP/ECAT Accessories" and "CAN Accessories"

Technical data

Type designation	**HV BM 1.2**
	
Technical data valid as of revision	F031
Installation [1] **in**	separate HV power cables for HV+ and HV-
Number of measured phases	1
Number of cable glands	2 per side
Cross section of inner conductor	16 mm² up to 95 mm²
Cable outer diameter	9 mm up to 25 mm (select the appropriate cable gland) [2] → *See "cable glands" section*
Measurement signals	voltage, current and instantaneous power
Measurement ranges	
Voltage	±100, ±200, ±500, ±1,000, ±2,000 V [3]
Inner conductor current	4 configurable measurement ranges ($I_{meas.}$) depending on mounted shunt module [2] $I_1 = I_{peak}$, $I_2 = I_{rated}$, I_3, I_4 → *See "Shunt modules" section*
Internal resolution	16 bit
Internal sampling rate	1 MS/s
Calculation of instantaneous power	permanently online with 1 MHz
Measurement data rate/ sending rate	
ECAT	1, 2, 5, 10, 20, 50, 100, 200, 500, 1,000 kHz [4]
CAN	1, 2, 5, 10, 20, 50, 100, 200, 500 Hz, 1, 2, 5, 10 kHz [5]
HW input filter	8th order Bessel low-pass-filter, cutoff frequency approx. 250 kHz
SW filter	
ECAT Options for SW filter, adjustable per channel	▶ Off, only for sending rate of 1,000 kHz ▶ 6th order Butterworth low-pass-filter, range: 10 Hz to 200 kHz: ▶ automatically adjusted on sending rate or ▶ user-selectable cutoff frequency
CAN Options for SW filter, adjustable per channel	▶ Off, only at a sending rate of 10 kHz ▶ 6th order Butterworth low-pass-filter, range: 0.1 Hz to 2 kHz: ▶ automatically adjusted based on sending rate or ▶ user-selectable cutoff frequency ▶ Average value per sending interval

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Output signals	
ECAT and CAN	voltage, current, instantaneous power, shunt temperature, module temperature
CAN	Optionally calculated quantities: RMS values for voltage and current, active power, apparent power, reactive power and power factor Lambda → Adjustable integration times 10 ms to 10 s
Measurement deviation [6]	
Voltage	
Gain error at 25 °C [7]	typ. ±0.005 % of measured value max. ±0.05 % of measured value
Offset and scaling error [7]	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 [7]	For shunt module 50 A, 125 A, 250 A general: typ. ±0.03 %, max. ±0.15 % of measured value for shunt module 500 A and 1,000 A up to 600 A: typ. ±0.05 %, max. ±0.15 % of measured value up to 750 A: typ. ±0.25 %, max. ±0.3 % of measured value above 750 A: typ. ±0.3 %, max. ±0.4 % of measured value
Offset and scaling error [7]	typ. ±0.02 % of range (valid for all shunt modules) max. ±0.05 % of range
Gain drift	max. ±25 ppm/K of measured value
Zero drift	max. ±15 ppm/K of range
Fields of application[1]	for measurements in HV environments[8]
Nominal voltages (unipolar & bipolar)	up to ±1,000 V
Routine test	HV isolation test according to EN 61010-2-030
EtherCAT® interface	Ethernet 100 Base-TX, 100 Mbit/s, EtherCAT® slave controller, synchronization via Distributed Clocks or Sync Manager 3
Configuration	with configuration software CSMconfig via XCP-Gateway or EtherCAT® master software via CANopen over EtherCAT® (CoE), 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, data transfer free running
Configuration	via CAN bus using CSMconfig, settings and configurations stored in the device
LED indicators	
ECAT	Status, Link Activity IN, Link Activity OUT
CAN	Power, Status
Measurement channel	Configuration, Operation

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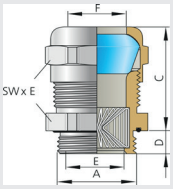
Measurement categories[9]	
CAT 0	1,000 V
CAT II	600 V
CAT III	300 V
Power supply	
Minimum	7 V DC (-10 %)
Maximum	30 V DC (+10 %)
Power consumption	typ. 2.5 W
Housing	aluminum with HV designation (RAL 2003)
Protection class	IP67[10]
Ground connection	M8 threaded hole
Weight (device)	approx. 1,400 g (incl. shunt module, without cable glands)
Dimensions (w × h × d)	approx. 200 × 45 × 135 mm (without cable glands)
Connectors	
EtherCAT®IN	LEMO 1B, 8-pole, code L
EtherCAT®OUT	LEMO 1B, 8-pole, code A
CAN[11]	LEMO 0B, 5-pole, code G
HV power cable	cable glands with shielding taps[12]
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 and CAT III)
Pollution degree	4[10]
Storage temperature	-40 °C to +120 °C
Conformity	
Device safety	EN 61010-1:2020+COR1:2022, +COR1:2023 with EN 61010-2-030:2022

Cable glands

Depending on the cable, different sizes of cable glands have to be used for the **HV BM 1.2**. The tightness of the housing can only be maintained with suitable combinations of cables and cable glands. The cable glands are selected separately. The following sizes are available:[1][2]

Size	**9/14**	**11/20**	**15/25**
			
Cable outer diameter			
max. ∅	14 mm	20 mm	25 mm
min. ∅	9 mm	11 mm	15 mm

Shunt modules

For the **HV BM 1.2** shunt modules with different measurement ranges are available. The shunt modules are selected separately and installed permanently. The maximum operating time depends, among other things, on the ambient temperature and the resulting power loss in the measurement module. The 1,000 A shunt module cannot be operated continuously at rated current. With the other shunt modules, the rated current may not be applied continuously. The temperature of the shunt modules must not exceed +120 °C.

Rated current I_{rated} [A]	**±50**	**±125**	**±250**	**±500**	**±1,000**
Peak current I_{peak} [A]	±100	±250	±500	±1,000	±2,000
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	±2,000, ±1,000, ±500, ±250
Resolution at I_{peak} [mA/digit]	3	7	15	30	60
Resistance [µΩ]	500	200	100	50	35

[1] Please read the CSM document "Safety Instructions HV Breakout Module".

[2] Cable glands and shunt module are selected separately.

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

[4] All measurement data rates are configurable via XCP-Gateway. When configuring via a standard EtherCAT® master, a maximum measurement data rate of 10 kHz/channel is supported.

[5] In order to be able to use a measurement data rate of 10 kHz for all measurement signals, a CAN interface with 2 Mbit/s is required.

[6] The values for current are frequency dependent. For further information on measurement deviations, please refer to the Technical Information "Deviation of Measurement".

[7] The typical value is based on a statistically relevant number of calibrations. It is defined as the limit value below which 70% of all measured deviations lie.

[8] According to EN 61010-1:2020+COR1:2022, +COR1:2023 with EN 61010-2-030:2022.

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

[10] Only if installed correctly. Please follow the assembly instructions in the installation manual.

[11] Optionally available in other variants.

[12] Please regard technical information in "Cable catalog Cable glands" of the company Pflitsch.

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