HV Breakout-Module

Type 1.1

Product description

CSM's **High Voltage Breakout Modules** (**HV BM**) 1.1 have been specifically designed for **single-phase measurement applications** on cables carrying high voltage. They are suited for simultaneous measurement of internal conductor current, voltage and instantaneous power. Also RMS values such as U_{rms} and I_{rms}, active power, apparent power, reactive power and power factor can be calculated.

Typical applications are for example measurements between HV battery and inverter. The two-wire HV power cable is connected inside the **HV BM 1.1** with ring terminals to M8 bolts and cable glands are used for sealing.

Voltage is measured directly in the **HV BM 1.1** and the current measurement is done with a built-in 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 1.1** 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. The calculated quantities are optionally available (with the option "Calc." enabled) and are sent with a transmission rate of up to 100 Hz. This allows high speed data acquisition simultaneously via Ethernet and data recording via CAN.

Maintenance

▶ HV isolation at least every 12 months, see EN 61010 for scope of testing

▶ Calibration every 12 months recommended

Key features

▶ Single-phase measurement of voltage (U) and current (I) in HV applications, HV-safe enclosure
  ▶ Nominal voltages up to ±1,000 V (measurement range up to ±2,000 V)
  ▶ Currents up to ±500 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 λ
▶ Simultaneous EtherCAT® and CAN bus communication

Scope of delivery

▶ HV Breakout-Module 1.1
▶ Configuration software CSMconfig
▶ Documentation
▶ Device Description File (*.xml)
▶ Calibration certificate for I and U in accordance with DIN EN ISO/IEC 17025
▶ HV isolation test protocol

Accessories

▶ See "ECAT Accessories" and "CAN Accessories" datasheets

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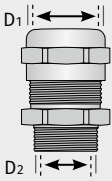Innovative Measurement and Data Technology

Technical data

Type designation	HV BM 1.1
Technical data valid as of revision	F031
Installation in	two-wire HV power cables for HV+ and HV- When connecting the HV power cables, please observe the document "Safety Instructions HV Breakout Module".
Number of measured phases	1
Number of cable glands	1 (per side)
Internal conductor cross section	2 × 2.5 mm² up to 2 × 25 mm²
Cable outer diameter	9 mm up to 25 mm (depending on the cable gland used) [1] See "Cable glands" section
Measurement signals	voltage, current and instantaneous power
Measurement ranges	
Voltage	±100, ±200, ±500, ±1,000, ±2,000 V [2]
Internal conductor current[1]	four configurable measurement ranges ($I_{meas.}$) depending on mounted shunt module $I_1 = I_{peak}$, $I_2 = I_{rated}$, I_3, I_4 See "Shunt modules" section
Internal resolution	16 bit
Internal sampling rate	1 MS/s
Power calculation	permanently online with 1 MHz
Measurement data rate/ send rate	
ECAT	1, 2, 5, 10, 20, 50, 100, 200, 500, 1,000 kHz [3]
CAN	1, 2, 5, 10, 20, 50, 100, 200, 500 Hz, 1, 2, 5, 10 kHz [4]
HW input filter	8th order Bessel filter, cutoff frequency approx. 250 kHz
SW input filter	6th order Butterworth filter, cutoff frequency: automatically adjusted to measurement data rate or selectable for voltage, current and instantaneous power ECAT: cutoff frequency up to 200 kHz, at sending rate of 1,000 kHz SW-filter switchable CAN: cutoff frequency up to 2 kHz, alternatively mean filter
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

Type designation	HV BM 1.1
Measurement deviation [5]	
Voltage	
Gain error at 25 °C [6]	typ. ±0.005 % of measured value max. ±0.05 % of measured value
Offset and scaling error [6]	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 [6]	typ. ±0.03 % of measured value (valid for shunt modules 50 A, 125 A, 250 A) max. ±0.15 % of measured value
Offset and scaling error [6]	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 [7]	for measurements in HV environments [8]
Nominal voltages (unipolar & bipolar)	up to ±1,000 V
Routine test	HV-isolation test [8]
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 configuration stored in the module
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 CSMcan Interface, data transfer "free running"
Configuration	via CAN bus using CSMconfig, settings and configuration stored in the module
LED indicators	
ECAT	Status, Link Activity IN, Link Activity OUT
CAN	Power, Status
Measurement channel	Configuration, Operation

Type designation	HV BM 1.1
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	aluminium with HV designation (RAL 2003)
Protection class	IP67 [10]
Ground connection	M8 threaded hole
Weight	approx. 1,200 g (incl. shunt module, without cable glands)
Dimensions (w × h × d)	approx. 200 × 45 × 120 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
Power HV+/HV- cables	cable glands with shielding taps
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 [10]
Storage temperature	-40 °C to +120 °C
Conformity	CE
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 1.1**. Only suitable combinations (cables + cable glands) ensure the tightness of the housing. The cable glands are selected separately. The following types are currently available:

Type	9/14	11/20	15/25
D_1 ↔ D_2 ↔			
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**, CSM offers shunt modules with different measurement ranges. 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. 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
Peak current I_{peak} [A]	±100	±250	±500
Measurement ranges I_1, I_2, I_3, I_4 [A]	±100, ±50, ±25, ±10	±250, ±125, ±50, ±25	±500, ±250, ±125, ±50
Resolution at I_{peak} [mA/digit]	3	7	15
Resistance [µΩ]	500	200	100

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

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

[3] 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.

[4] 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.

[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] 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.

[7] Please read the CSM document "Safety Instructions HV Breakout Module"!

[8] According to EN 61010-1:2020+COR1:2022 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.

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