# HV Breakout Module

## Type 1.2+S

## Product description

CSM's **HV Breakout Modules (BM) 1.2+S** have been specifically designed for **single-phase measurement applications** on cables carrying high voltage. They are suited like the HV BM 1.2 for simultaneous evaluation of current and voltage from the inner conductor, and current from the braided shield. 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 measurements between HV battery and inverter. The two-wire HV power cable is to be inserted into the **HV BM 1.2+S** by feeding the cable through a cable gland into the module and connecting by ring terminals.

Voltage is measured directly with the **HV BM 1.2+S**. Current measurements are performed by 2 shunt modules. One for the inner conductor current and one for the shield current. These modules contain, among other things, a temperature sensor and a memory chip for calibration data for automatic online temperature compensation.

The **HV BM 1.2+S** 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 available (with the option "Calc." enabled) and are sent on the CAN bus with a transmission rate of up to 100 Hz. This allows high speed data acquisition via Ethernet and data recording via CAN at the same time.

## 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), current (I) and shield 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)
  - Shield currents up to ±500 A (Peak)
- Output of voltage, current and shield 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
- Simultaneous EtherCAT® and CAN bus communication

## Scope of delivery

- HV Breakout Module 1.2+S
- 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 "ECAT Accessories" and "CAN Accessories" datasheets

## Technical data

| **Type designation** | **HV BM 1.2+S** |
|---|---|
| |  |
| **Technical data valid as of revision** | B031 |
| **Inputs** | separate HV power cables for HV+ and HV-<br>When connecting the HV power cables, please observe the document "Safety Instructions HV Breakout Module". |
| Number of measured phases | 1 |
| Number of cable glands | 2 (per side) |
| Inner conductor cross section | 16 mm² up to 95 mm² |
| Cable outer diameter | 9 mm up to 25 mm (depending on the cable gland used) [1]<br>See section "Cable glands" |
| **Measurement signals** | voltage, current, shield current and instantaneous power |
| Measurement ranges | |
| Voltage | ±100, ±200, ±500, ±1,000, ±2,000 V [2] |
| Inner conductor current, shield current | 4 configurable measurement ranges ($I_{meas.}$) depending on mounted shunt module [1]<br>$I_1 = I_{peak}$, $I_2 = I_{rated}$, $I_3$, $I_4$<br>See section "Shunt modules" |
| Internal resolution | 16 bit |
| Internal sampling rate | 1 MS/s |
| Power calculation | permanently online with 1 MHz |
| Measurement data rate/ sending 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 | 8$^{th}$ order Butterworth filter, cutoff frequency approx. 250 kHz |
| SW input filter | 6$^{th}$ order Butterworth filter,<br>cutoff frequency automatically adjusted to measurement data rate,<br>or selectable for voltage, current and instantaneous power:<br>ECAT: cutoff frequency up to 200 kHz or at sending rate of 1,000 kHz SW-filter switchable<br>CAN: cutoff frequency up to 2 kHz, alternatively mean filter |
| **Output signals** | |
| ECAT and CAN | voltage, current, shield current, instantaneous power,<br>shunt temperatures, module temperature |
| CAN | Optionally calculated quantities:<br>RMS values for voltage and inner conductor current, active power, apparent power, reactive power and power factor Lambda<br><br>→ Adjustable integration times 10 ms to 10 s |

| **Type designation** | **HV BM 1.2+S** |
|---|---|
| |  |
| **Measurement deviation**[5,6] | |
| Voltage | |
| Gain error at 25 °C | typ. ±0.005 % of measured value<br>max. ±0.05 % of measured value |
| Offset and scaling error | typ. ±0.003 % of range<br>max. ±0.02 % of range |
| Gain drift | max. ±20 ppm/K of measured value |
| Zero drift | max. ±10 ppm/K of range |
| Current, shield 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)<br>typ. ±0.05 % of measured value (for shunt module 500 A and 1,000 A)<br>max. ±0.15 % of measured value |
| Offset and scaling error | typ. ±0.02 % of range (valid for all shunt modules)<br>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 configurations permanently 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 configurations permanently 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 1.2+S** |
| **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. 3 W |
| **Housing** | aluminum with HV designation (RAL 2003) |
| Protection class[10] | IP67 |
| Ground connection | M8 threaded hole |
| Weight | approx. 2,000 g (incl. shunt modules, without cable glands) |
| Dimensions (w × h × d) | approx. 200 × 45 × 168 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 |
| **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)<br>max. 3,000 m above sea level (CAT II and CAT III) |
| Pollution degree | 4[10] |
| Storage temperature | -40 °C to +125 °C |
| **Conformity** | CE (in preperation) |
| **Device safety** | EN 61010-1:2020+COR1:2022, EN 61010-2-030:2022 |

[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] 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

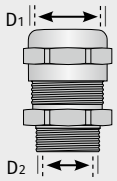
[9] Further information can be found in the Technical Information document "Measurement Categories for CSM HV Measurement Modules".

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

[11] Optionally available in other variants.

## Cable glands

Depending on the cable outer diameters, different cable glands must be adapted to the **HV BM 1.2+S**. 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** |
|---|---|---|---|
|  |  |  |  |
| 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 current measurement

For the **HV BM 1.2+S**, CSM offers shunt modules with different measurement ranges. The shunt modules are selected separately and are installed permanently. Shunt modules from ±50 A up to ±250 A are available for shield current measurements and shunt modules from ±50 A up to ±1,000 A are available for inner conductor current measurements. 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.

| **Measurement of** | **inner conductor current and shield current** | | | **only inner conductor current** | |
|---|---|---|---|---|---|
| **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 |

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