

HV Breakout Module

Type 1.2+U



Product description

CSM's High Voltage Breakout Module (HV BM) 1.2+U has been specifically designed for single-phase measurement applications on cables carrying high voltage. The HV BM are suited for simultaneous measurement of internal conductor current and voltage. In addition, the voltage of HV+ → PA and HV- → PA are measured, PA = potential equalization. Also RMS values such as U_{rms} and I_{rms} , and as well active power, apparent power, reactive power and power factor can be calculated.

Typical applications are measurements between HV battery and inverter, both to check the symmetry of the supply voltage to PA and to simultaneously characterize a DC consumer and record its interaction with the vehicle electrical system.

The **HV BM 1.2+U** 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 three voltages are measured directly by the **HV BM 1.2+U**. 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+U** outputs the measured data with a maximum data rate of up to 1MHz 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 100Hz. This allows high speed data acquisition via Ethernet and simultaneously data recording via CAN.



Key features

- ▶ Single-phase measurement of 3 x voltage (U) and current (I) in HV applications, HV-safe enclosed for:
 - ▶ Nominal Voltages up to $\pm 1,000V$ (measurement range up to $\pm 2,000V$)
 - ▶ Currents up to $\pm 2,000A$ (peak)
- ▶ Output of voltages and current with up to 1MHz 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 1.2+U
- ▶ Configuration software CSMconfig
- ▶ Documentation
- ▶ Device Description File (*.xml)
- ▶ Accredited calibration certificates for I and 3 x U in accordance with DIN EN ISO/IEC 17025
- ▶ HV isolation test protocol


Maintenance


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


Accessories

- ▶ See "XCP/ECAT Accessories" and "CAN Accessories" datasheets

Technical data

Type designation	HV BM 1.2+U
	
Installation in	separate 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	2 (per side)
Internal conductor cross section	16 mm ² up to 95 mm ²
Cable outer diameter	9 mm up to 25 mm (select suitable cable glands) ¹ → See "cable glands" section
Measurement signals	voltages HV+ → HV-; HV+ → PA; HV- → PA and current
Measurement ranges	
Voltages	±100, ±200, ±500, ±1,000, ±2,000 V ²
Internal conductor current ¹	4 configurable measurement ranges ($I_{\text{meas.}}$) depending on mounted shunt module $I_1 = I_{\text{peak}}, I_2 = I_{\text{rated}}, I_3, I_4$ → See "Shunt modules" section
Internal resolution	16 bit
Internal sampling rate	1 MS/s
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	8 th order Bessel filter, cutoff frequency approx. 250 kHz
SW input filter	6 th 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 or 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	voltages HV+ → HV-; HV+ → PA; HV- → PA; current shunt temperature, module temperature
CAN	Optionally calculated quantities (with activated option Calc.): RMS values for voltage HV+ → HV- and current, active power, apparent power, reactive power and power factor Lambda → Adjustable integration times 10 ms to 10 s

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Measurement deviation ^{5,6}	
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 and 1,000 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. ±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 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 appropriate CAN Interface, 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

Type designation	HV BM 1.2+U
Measurement categories⁹	
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 (device)	approx. 1,700 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+ / HV-power cable	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) max. 3,000 m above sea level (CAT II and CAT III)
Pollution degree	4 ¹⁰
Storage temperature	-40 °C to +125 °C
Conformity	 (in preparation)
Device safety	EN 61010-1:2020+COR1:2022 EN 61010-2-030:2022

¹ Cable glands and shunt module are selected separately.

² The measurement ranges of the voltage 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 2Mbit/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 used on the **HV BM 1.2+U**. 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			
D1 maximum	14 mm	20 mm	25 mm
D1 minimum	9 mm	11 mm	15 mm
D2 maximum	12 mm	17 mm	21 mm

Shunt modules

For the **HV BM 1.2+U** shunt modules with different measurement ranges are available. The shunt modules are selected separately at the time of purchase and are installed permanently. The maximum on-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	±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 [$\mu\Omega$]	500	200	100	50	35



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