HV BM Split Modules

Product Description

HV BM Split modules are designed for simultaneous current and voltage measurements ranging from DC to high-speed AC. The exact and high-voltage safe measurement of current and voltage in the electrical drive train or the electrical auxiliary consumers is an essential requirement when developing, testing and analyzing electric vehicles. However, the installation space available in new electric vehicle models is constantly shrinking so that sometimes even the compact **HV Breakout modules** can no longer be installed

With this space issue in mind, CSM has developed **HV BM Split modules** for measurements on HV voltage-carrying cables in confined spaces, for example for measurements between HV battery and inverter. This measurement solution consists of several individual units: an **HV SBM_I** current tap, a breakout box containing the shunt module, an **HV SBM_U,** voltage tap, a breakout box for conneting the finally the **HV SAM**, a module in which the signals of the two taps are processed.

For small currents up to 10 A or 50 A, there is an even smaller **HV SBM_I/U,** equipped with a built-in shunt module and potential tap. This saves valuable space at the measuring point and allows the precise and HV-safe recording of current and voltage providing the means for a flexible arrangement of the measurement components. Current and voltage taps are available with HV-safe housings designed for connecting HV cables either with ring terminals or with PowerLok connectors. It is also possible to work without housing, as the shunt module is available in an open version, equipped with holes for M8 screws for connecting the HV power cable or installation in busbars. The HV potential can be transmitted to the **HV SAM** for voltage measurement using a high-voltage safe measurementing cable. The current measurement is performed via the **HV SBM_I**, which provides a temperature sensor and memory for calibration data for automatic online temperature compensation.

Keyfeatures

- Easy mounting in confined spaces thanks to very compact sizes and separation of tap and measurement module.
- Single-phase voltage (U) and current (I) measurements in HV applications, HV-save insulated for:
  - rated 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 measurement data rates up to 1 MHz
- Output of the RMS values U_{RMS} and I_{RMS}, active power, apparent power, reactive power and power factor Lambda
- Simultaneous EtherCAT® and CAN bus communication

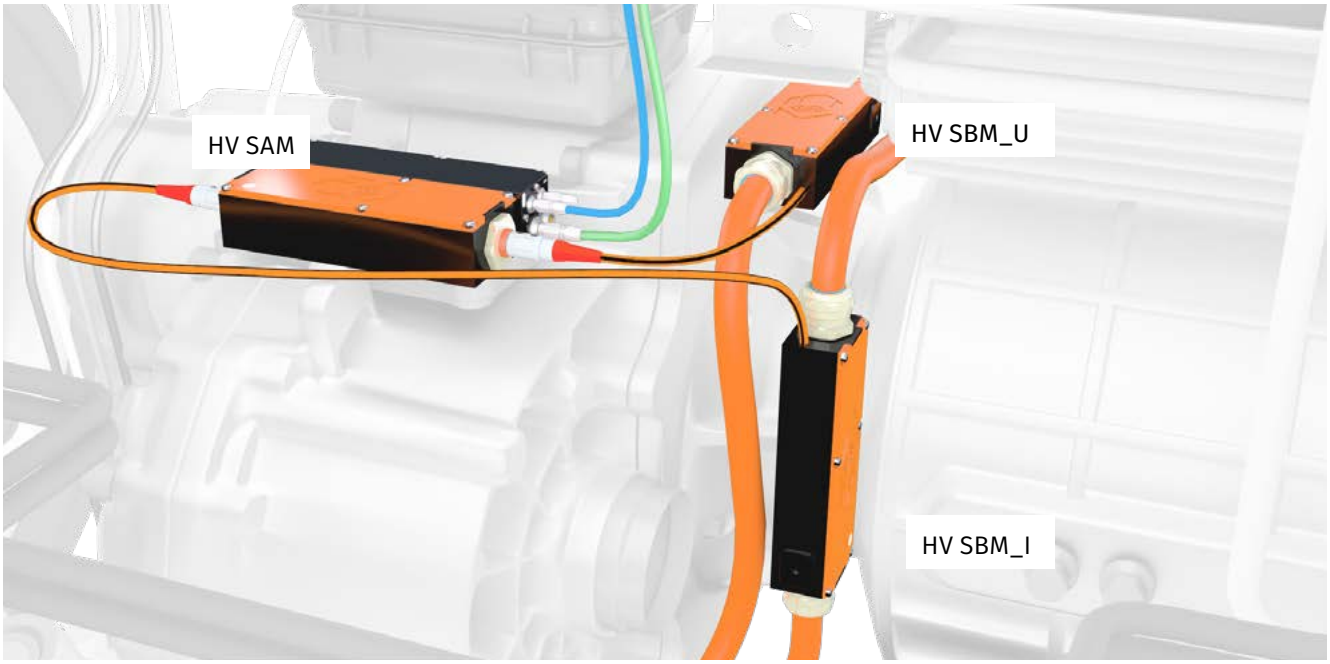


Fig. 1-1: Modular mounting of the measurement technology components

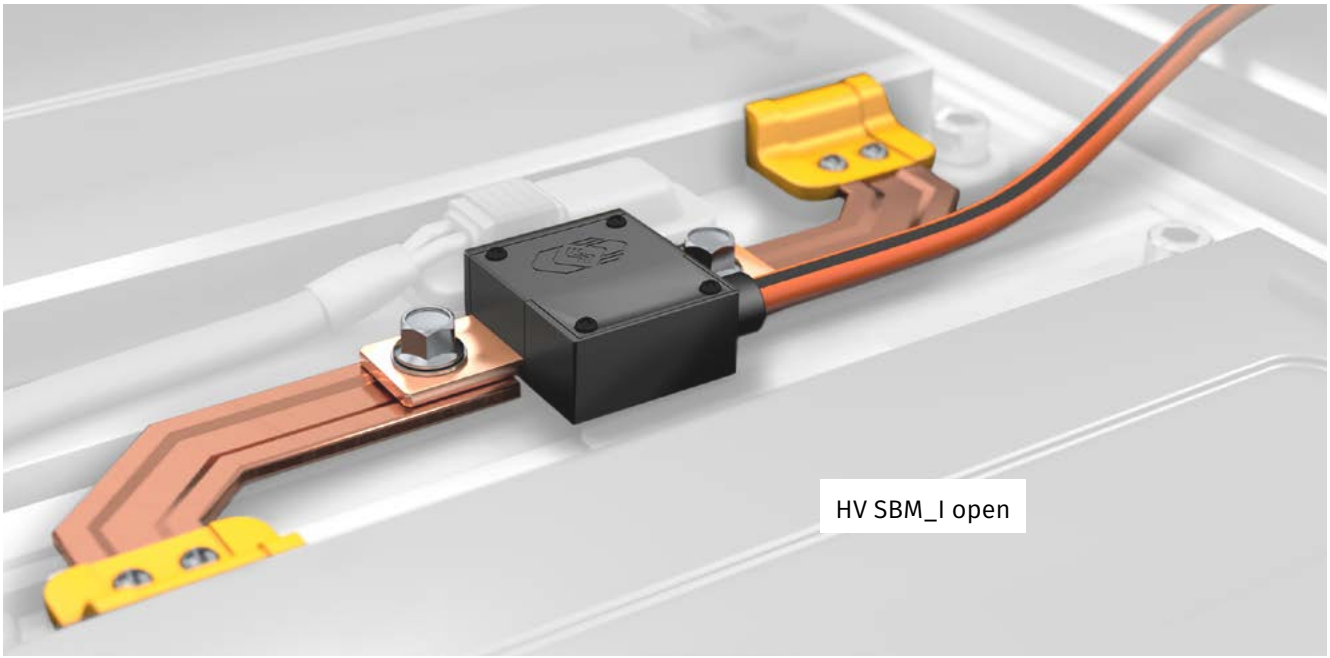


Fig. 1-2: Integration of an HV SBM_I open into a busbar

Shipping content

- HV BM Split Modules (HV Split Breakout Module or HV Split Acquisition Module)
- Configuration software CSMconfig
- Documentation
- Device Description File (*.xml)
- Calibration certificate in accordance with DIN EN ISO/IEC 17025 (I), calibration certificate (U)
- Test protocols for HV insulation test

Maintenance

- HV isolation test at least every 12 months, see EN 61010 for scope of test
- Calibration every 12 months recommended
- HV SAM and HV SBM_I or HV SBM_I/U as well as HV SBM_I open must be calibrated together.

Accessories

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

Technical data

HV Split Acquisition Modul (HV SAM 1.1)

The **HV SAM 1.1** is a measurement module and provides two inputs, one for current and one for voltage. By separating the tapping from the measurement module, the latter no longer has to be integrated directly at the point of measurement.

Type designation	**HV SAM 1.1**
	
Inputs	2 analog inputs (voltage, current)
Measurement ranges	
Voltage	±100, ±200, ±500, ±1,000 V, ±2,000 V [1]
Current [2]	four adjustable measurement ranges (I_{Meas}) depending on the shunt installed $I_1 = I_{Peak}$, $I_2 = I_{Rated}$, I_3, I_4 → *See section "HV Split Breakout Modules (HV SBM)"*
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	8th order Bessel filter, threshold frequency approx. 250 kHz
SW input filter	Switchable 6th order Butterworth filter, Threshold frequency automatically adjusted to the measurement data rate, Can also be specified individually for voltage, current and power: Threshold frequency up to 200 kHz (ECAT) Output rate of up to 2 kHz, additional average value filter
Output signals	
ECAT	Voltage, current, instantaneous power
CAN	Voltage, current, shunt temperature, module temperature Optionally calculated quantities: RMS values for voltage and current, active power, apparent power and reactive power, power factor Lambda → Adjustable integration times 10 ms to 10 s
Field of application [5]	For measurements in HV environments [6] For details, please refer to the applicable document: "Technical Information: Fields of application for CSM High-Voltage Measurement Modules".
Nominal voltage (unipolar & bipolar)	up to 1,000 V DC
Routine test [7]	An isolation test [8] has to be performed at least once every 12 months.
EtherCAT® interface	Ethernet 100 Base-TX, 100 Mbit/sEtherCAT® slave controller, synchronization via Distributed Clocks or Sync Manager 3
Configuration	with CSMconfig via XCP-Gateway or EtherCAT® master software via CANopen over EtherCAT® (CoE), settings and configurations stored in the device
CAN interfaces	CAN 2.0B (active), High Speed (ISO 11898-2:2016), 125 Kbit/s to 1 Mbit/s, up to 2 Mbit/s with CSMcan interface, data transfer free running
Configuration	via CAN bus with CSMconfig, settings and configuration data stored in the device

Type designation	HV SAM 1.1
LED indicators	
ECAT	Status, Link Activity IN, Link Activity OUT
CAN	Power, status
Measurement channel	Configuration, operation
Measurement categories [7]	
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 (RAL2003)
Protection class	IP67
Ground connection	M8 threaded hole
Weight	approx. 1,200 g
Dimensions (W × H × D)	approx. 200 × 45 × 120 mm
Connectors	
EtherCAT® IN	LEMO 1B, 8-pole, code L
EtherCAT® OUT	LEMO 1B, 8-pole, code A
CAN [8]	LEMO 0B, 5-pole, code G
Signal input 1 (HV SBM_I)	LEMO Redel 2P, 8-pole, code E
Signal input 2 (HV SBM_U or K912)	LEMO Redel 2P, 8-pole, code D
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
Storage temperature	-40 °C to +120 °C
Conformity	CE
Safety	EN 61010-1:2020+COR1:2022 EN 61010-2-030:2022

[1] For the measurement of transient overvoltages, the measurement range has been dimensioned to ±2,000 V.

[2] The HV SBM is selected separately, as are the cable glands.

[3] All measurement data rates can be configured via the XCP-Gateway. A standard EtherCAT® master supports a maximum measurement data rate of 10 kHz/channel.

[4] A CAN interface with 2 MBit/s is required to be able to use a measurement data rate of 10 kHz for all measurement signals.

[5] In addition, be sure to observe CSM document "Safety Instructions Split Breakout Module | PG Series"!

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

[7] For further information, please refer to the Technical Information "Measurement Categories for CSM HV Measurement Modules".

[8] Optionally available in other variants.

[1] For the measurement of transient overvoltages, the measurement range has been dimensioned to ±2,000 V.

HV Split Breakout Module (HV SBM)

The **HV SBM** are used for tapping the current and the potentials HV+ and HV-. These signals are measured directly and transmitted to the HV SAM using shielded cables. The housing versions of the **HV SBM** are available with cable gland and connection via ring terminals as well as with a PL500 plug-in system. For measurement in busbars there is an open version which is more compact and allows direct connection via M8 bores.

HV SBM_I and HV SBM_U

Type designation	HV SBM_I	HV SBM_U
		
Inputs	HV- power cable for HV-	HV-power cable for HV+
	When connecting the HV power cables to the HV SBM, be sure to observe the document "Safety Instructions HV Split Breakout Module" valid for the corresponding module version.	
Number of measured phases	1	
Number of cable glands	1 (on each side)	
Cable cross sections	16 mm² to 95 mm²	
Outer cable diameter	9 mm to 25 mm (depending on the cable gland used) *See section "Cable glands"*	
Connectors		
Connecting cable to HV SAM	2 m HV measurement cable with LEMO REDEL 2P, 8-pole, code E	2 m HV measurement cable with LEMO REDEL 2P, 8-pole, code D
HV+/HV- power cable[1]	Current and HV- potential tap	HV+ potential tap
	Connection via ring terminals and cable glands with adapter for shielding[2]	
Ground connection	M8 threaded hole	
Housing	Aluminium with HV designation (RAL2003)	
Protection class	IP67[3]	
Weight	approx. 870 g	approx. 780 g
Dimensions (W × H × D)	approx. 200 × 46 × 55 mm (without cable glands) approx. 264 × 46 × 55 mm (with cable glands)	
Measurement categories[4]		
CAT 0	1,000 V	
CAT II	600 V	
CAT III	300 V	
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[3]	4	
Storage temperature	-40 °C to +120 °C	
Conformity	CE (in preparation)	
Safety	EN 61010-1:2020+COR1:2022, EN 61010-2-030:2022	

[1] The cable glands are to be selected separately.

[2] Version with plug-in connector available on request.

[3] Correct installation provided! Be sure to observe the mounting instructions in the installation manual.

[4] For further information, please refer to the Technical Information "Measurement Categories for CSM HV Measurement Modules".

HV SBM_I/U

Type designation	HV SBM_I/U 10 A	HV SBM_I/U 50 A
		
Inputs	HV- power cable for HV- and HV+	
	When connecting the HV power cables to the HV SBM, be sure to observe the document "Safety Instructions HV Split Breakout Module" valid for the corresponding module version.	
Number of measured phases	1	
Number of cable glands	1 (on each side)	
Cable cross sections	6 mm²	
Outer cable diameter	9 mm to 14 mm HV+ and HV- in common cable sheath 2 x 4 mm HV+ and HV- in seperated cable sheaths 2 x 5 mm HV+ and HV- in seperated cable sheaths 2 x 6 mm HV+ and HV- in seperated cable sheaths	
Connectors		
Connecting cable to HV SAM	Current: 2 m HV measurement cable with LEMO REDEL 2P, 8-pole, code E Voltage: 2 m HV measurement cable with LEMO REDEL 2P, 8-pole, code D	
HV+/HV- power cable	Current and HV- /HV+ potential tap Connection via Phoenix-clamp	
Ground connection	M8 threaded hole	
Housing	Aluminium with HV designation (RAL2003)	
Protection class	IP67[1]	
Weight	approx. 510 (without cable gland)	
Dimensions (W × H × D)	approx. 120 × 36 × 39 mm (without cable glands, without mounting eyelet) approx. 146 × 36 × 39 mm (without cable glands, with mounting eyelet) approx. 181 × 36 × 39 mm (with cable glands, with mounting eyelet)	
Measurement categories[2]		
CAT 0	1,000 V	
CAT II	600 V	
CAT III	300 V	
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[1]	4	
Storage temperature	-40 °C to +120 °C	
Conformity	CE (in preparation)	
Safety	EN 61010-1:2020+COR1:2022 EN 61010-2-030:2022	

[1] Correct installation provided! Be sure to observe the mounting instructions in the installation manual.

[2] For further information, please refer to the Technical Information "Measurement Categories for CSM HV Measurement Modules".

HV SBM open

Type designation	HV SBM_I open [1]		K912
			
Inputs	HV- power cable		HV+ power cable
	When connecting the HV power cables to the HV SBM, be sure to observe the document "Safety Instructions HV Split Breakout Module" valid for the corresponding module version.		
Number of measured phases	1		
Connection			
Connecting cable to HV SAM	2 m HV measurement cable with LEMO Redel 2P, 8-pole, code E		HV measurement cable with LEMO Redel 2P, 8-pole, code D
HV+/HV- power cable	Connection via M8 bores using ring terminals		Connection via open cable end
Weight	approx. 190 g		approx. 155 g (2 m cable)
Dimensions	① 84 × 20 × 3 mm ② 39 × 41 × 19 mm (W × H × D)		2 m or 3 m available

Measurement categories [2]	
CAT 0	1,000 V
CAT II	600 V
CAT III	300 V

Operating and storage conditions		
Operating temperature range	-40 °C to +120 °C	-40 °C to +125 °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	2	
Storage temperature	-40 °C to +120 °C	-40 °C to +125 °C

Conformity	CE (in preparation)
Safety	EN 61010-1:2020+COR1:2022 EN 61010-2-030:2022

[1] CSM provides HV SBM_I shunts with various measurement ranges. See section "Shunts" for further information.

[2] For further information, please refer to the Technical Information "Measurement Categories for CSM HV Measurement Modules".

Measurement error[1]

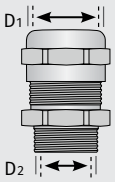
The data (current) in the table below is valid for joint calibration of **HV SAM** and **HV SBM**.

Voltage	
Gain error at 25 °C	max. ±0.05 % of measured value
Offset and scaling error	max. ±0.02 % of range
Gain drift	max. ±20 ppm/K of measured value
Zero drift	max. ±10 ppm/K of range
Current	Online adjustment with stored calibration data, with temperature compensation
Gain error at 25 °C	max. ±0.15 % of measured value
Offset and scaling error	max. ±0.05 % of range
Gain drift	max. ±25 ppm/K of measured value
Zero drift	max. ±15 ppm/K of range

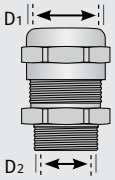
Cable glands

Depending on the outer cable diameter, different types of cable glands have to be used for the **HV SBM** in housing. 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 types are currently available:

HV SBM_I and HV SBM_U (M32)

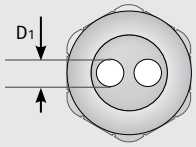
Type	**9/14**	**11/20**	**15/25**
			
Outer cable diameter			
D_1 max.	14 mm	20 mm	25 mm
D_1 min.	9 mm	11 mm	15 mm
D_2 max.	12 mm	17 mm	21 mm

HV SBM_I/U (M20)

Type	**9/14**
	
Outer cable diameter	
D_1 max.	14 mm
D_1 min.	9 mm
D_2 max.	12 mm

[1] The values for current can differ depending on the frequency. For further information on measurement deviations, please refer to the Technical Information "Measurement Deviation".

HV SBM_I/U (M20)

Type	2x4	2x5	2x6
			
D_1 Diameter cable gland	2 x 4 mm	2 x 5 mm	2 x 6 mm

Shunts

CSM offers shunts with a variety of measurement ranges.

For the **HV SBM** in housing. These shunts are selected separately and will be permanently installed in the module housing. **HV SBM_I open** and **HV SBM_I/U** are available with the various measurement ranges as ready potted units equipped with measurement cable.

The maximum operating time depends, among other things, on the ambient temperature and the resulting power loss in the **HV SBM**. This means that the rated current may not be applied continuously without causing the **HV SBM** to overheat. The temperature must not exceed +120 °C. The shunts have 4 configurable measuring ranges (I_{Mess}).

HV SBM_I and HV SBM_I open

Nominal current I_{Rated} [A]	**±125**	**±250**	**±500**	**±1,000**
Peak current I_{Peak} [A]	±250	±500	±1,000	±2,000
Measurement range I_1, I_2, I_3, I_4 [A]	±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]	7	15	30	60
Measurement resistor [µΩ]	200	100	50	35

HV SBM_I/U

Nominal current I_{Rated} [A]	**±10**	**±50**
Peak current I_{Peak} [A]	±25	±100
Measurement range I_1, I_2, I_3, I_4 [A]	±25, ±10, ±5, ±2	±100, ±50, ±25, ±10,
Resolution at I_{Peak} [mA/Digit]	0,76	3
Measurement resistor [µΩ]	2000	500

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