HV BM-Split evo

Product Description

The new series of separate HV breakout modules, **HV BM-Split evo**, is designed to simultaneously measure direct current and voltage (DC) in the HV vehicle electrical system. There are variants for HV cables with Al and Cu conductors.

The precise, high-voltage safe measurement of current and voltage in the electric drive train or the electrical auxiliary consumers is an essential task in the development, testing and analysis of electric vehicles. However, the available installation space in newly developed electric vehicles is getting smaller and smaller, so that sometimes even the compact **HV BM** can no longer be installed.

CSM has developed the **HV BM-Split evo** in response to the space problem. This system consists of separate units that are installed according to the available space:

- **HV SAM1 evo**, a measurement module in which the signals from U and I are acquired, processed and output via CAN or EtherCAT
- **HV SBM_I evo**, a breakout box for an HV cable using a shunt module for measuring the current and tapping the potential of HV-.
- **HV SBM_U evo**, a breakout box for an HV cable with tapping of the potential of HV+.

Throughout this document we use **HV SBM evo** for the two variants of the breakout boxes **HV SBM_I evo** and **HV SBM_U evo**. **HV SBML evo** stands for both **HV SBML_I evo** and **HV SBML_U evo**. **HV SBM(L)_I evo** means validity for both variants **HV SBM_I evo** and **HV SBML_I evo**. **HV SBM(L)_U evo** means validity for both variants **HV SBM_U evo** and **HV SBML_U evo**. **HV SBM(L) evo** stands for all four variants of these breakout boxes.

Key features

- Simple installation, flexible use of the installation space due to separation of taps and measuring module.
- Single-phase voltage (U) and current (I) measurements in HV environments, HV-safe isolated 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 with "Option Calculated Channels" license
- Simultaneous EtherCAT® and CAN bus communication

HV SAM1 evo together with **HV SBML_I evo** and **HV SBML_U evo** are used to accommodate the significantly larger ring terminals of Al conductors. The braided shields of the HV cables are isolated and conducted through the **HV SBM(L)_I evo** and **HV SBM(L)_U evo** breakout boxes.
Alternatively, the HV potential can be routed to the **HV SBM(L)_I evo** for voltage measurement using the HV-safe sensor cable K917. The current measurement is done with the shunt module that is in the **HV SBM(L)_I evo**. It includes a temperature sensor and memory for calibration data for automatic online temperature compensation.

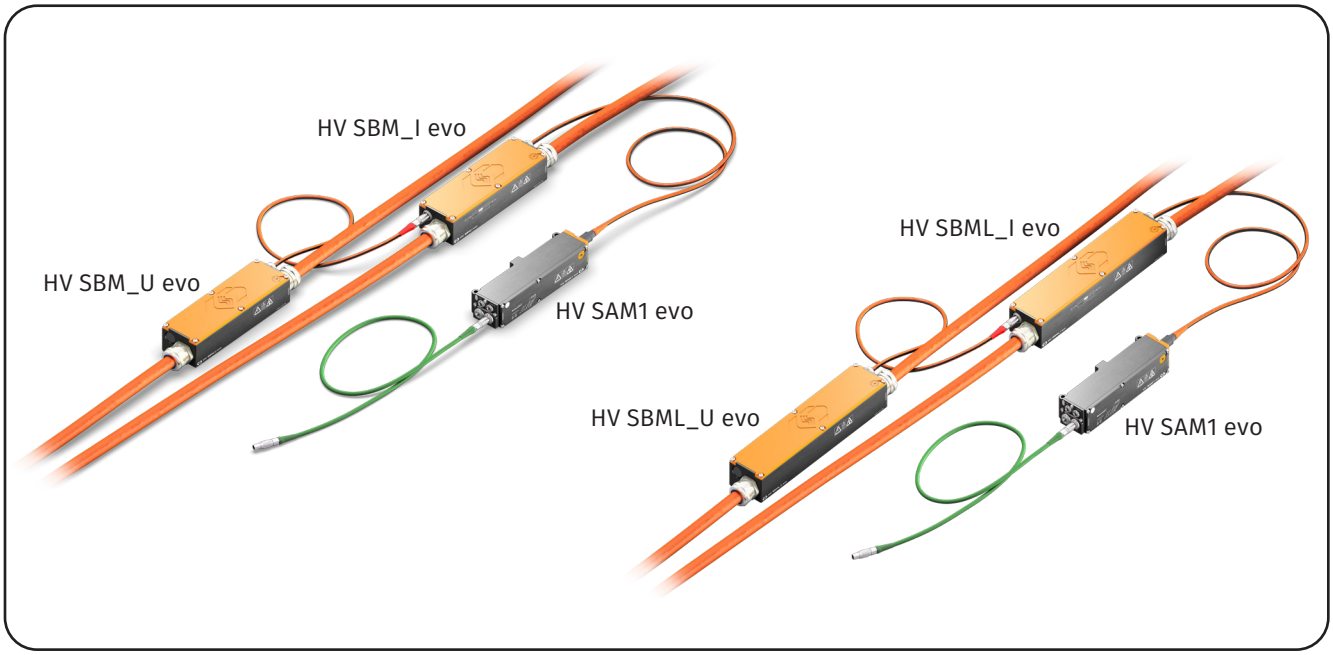


Fig. 1: Overview: Installation of HV BM-Split evo with HV cables with inner conductor of aluminum or copper. The HV cables might have braided shields.

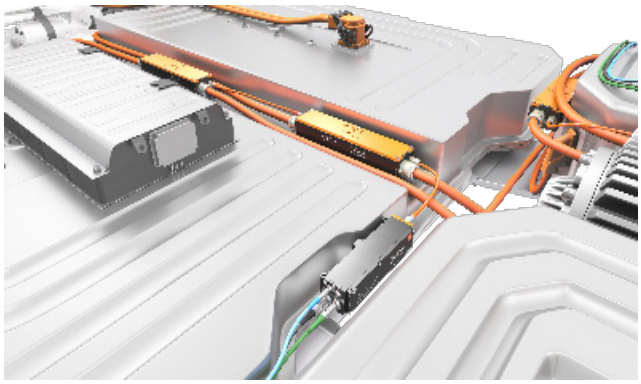


Fig. 2 and fig. 3: Flexible installation of measurement technology components

Scope of delivery

- HV BM-Split evo modules according to order
- Configuration software CSMconfig
- Documentation
- Device Description File (*.xml)
- Calibration certificates for I and U in accordance with DIN EN ISO/IEC 17025
- Test protocols for HV isolation test

Maintenance

- HV isolation test at least every 12 months, see EN 61010 for scope of test
- Calibration every 12 months recommended
- HV SAM1 evo and HV SBM(L)_I evo must be calibrated together.

Accessories

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

Technical data

HV Split Acquisition Module (HV SAM1 evo)

The **HV SAM1 evo** is a measurement module that receives two inputs, one for current and one for voltage. By separating the measurement point from the acquisition module **HV SAM1 evo** can be places where space is available.

Type designation	**HV SAM1 evo**
	
Inputs	1 x voltage signal, 1 x current signal
Measurement ranges	
Voltage	±100, ±200, ±500, ±1,000 V, ±2,000 V [1]
Current [2]	4 adjustable measurement ranges (I_{Meas}) depending on the shunt module installed in the corresponding HV SBM(L)_I evo $I_1 = I_{Peak}$, $I_2 = I_{Rated}$, I_3, I_4
Internal resolution	16 bit
Internal sampling rate	2 MS/s
Measurement data rate/ sending rate	
ECAT	1, 2, 5, 10, 20, 50, 100, 200, 500, 1,000 , 2,000 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, 3 dB cutoff frequency approx. 450 kHz in the measurement range ±2 kV ... ±200 V, at ±100 V approx. 350 kHz
SW filter options per channel ECAT Options for SW filter at a sending rate up to 1,000 kHz, adjustable per channel	No SW filter at a sending rate of 2,000 kHz, options: ▶ Off, only for sending rate of 1,000 kHz ▶ 6th order Butterworth filter, range: 10 Hz to 300 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 filter, range: 0,1 Hz to 2 kHz: ▶ automatically adjusted on sending rate or ▶ user-selectable cutoff frequency ▶ Average value per sending interval
Output signals	
ECAT and CAN	Voltage, current, temperatures of shunt and HV SAM1 evo
CAN	With "Option Calculated Channels" license output of 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

Type designation	**HV SAM1 evo**
Field of application[5]	For measurements in HV environments[6]
Nominal voltage (unipolar & bipolar)	up to 1,000 V DC
Routine test	HV-isolation test[6]
EtherCAT® interface	Ethernet 100 Base-TX, 100 Mbit/s EtherCAT® 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 appropriate CAN interface, data transfer free running
Configuration	via CAN bus with CSMconfig, settings and configuration data stored in the device
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. 2.3 W
Housing	aluminum with HV designation (RAL2003)
Protection class	IP67
Ground connection	M8 threaded hole
Weight (device)	approx. 700 g
Dimensions (W × H × D)	226 × 45 × 63 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	LEMO Redel SP, 13-pole, code N

Type designation	HV SAM1 evo
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 (in preparation)
Safety	EN 61010-1:2020+COR1:2022, +COR2:2023 EN 61010-2-030:2022

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

[2] See section "Shunt modules", page 8

[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's document "Safety Instructions for HV BM-Split evo".

[6] In accordance with EN 61010-1:2020+COR1:2022, +COR2:2023, 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.

HV BM-Split evo

HV SBM_I evo and HV SBM_U evo also HV SBML_I evo and HV SBML_U evo

The **HV SBM(L) evo** are used for tapping the current and the potentials HV+ and HV-. These signals are measured directly and transmitted to the **HV SAM evo** using shielded cables. The HV conductors are connected with ring terminals in the **HV SBM(L) evo** and the braided shields are isolated in the **HV SBM(L) evo**. There are variants for HV conductors with Al and Cu conductors, whereby **HV SBML_I evo** and **HV SBML_U evo** are the extra-long variants designed for the longer ring terminals of Al conductors. **HV SBM_I evo** and **HV SBM_U evo** are large enough to connect HV copper conductors up to 120 mm² cross-section.

Type designation	**HV SBM(L)_I evo**	**HV SBM(L)_U evo**
Installation in shielded or unshielded	HV-power cable for HV-	HV-power cable for HV+
	When connecting the HV power cables to the HV SBM(L) evo, be sure to observe the document "Safety Instructions HV BM-Split evo"	
Number of measured phases	1	
Number of cable glands	2 (1 on each side)	
Cable cross sections	16 mm² to 120 mm²	
Cable outer diameter	9 mm to 25 mm (depending on the cable gland used)	
Connectors		
Connecting cable	2 m HV signal cable to HV SAM1 evo with LEMO REDEL 2P, 13-pole, code N	0,5 m HV signal cable to HV SBM_I evo with LEMO L1E, 1-pole
HV+/HV- power cable [1]	Current and HV- potential tap	HV+ potential tap
	Connection via ring terminals and cable glands	
Ground connection	M8 threaded hole	
Housing	Aluminum with HV designation (RAL2003)	
Protection class	IP67 [2]	
Weight (device)	HV SBM_I evo: 1.2 kg HV SBML_I evo: 1.4 kg	HV SBM_U evo: 1.1 kg HV SBML_U evo: 1.3 kg
Dimensions (W × H × D)	HV SBM_I evo/HV SBM_U evo: 220 × 51 × 69 mm without cable glands 284 × 51 × 69 mm with cable glands HV SBML_I evo/HV SBML_U evo: 310 × 51 × 69 mm without cable glands 374 × 51 × 69 mm with cable glands	
Measurement categories [3]		
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 [2]	4	
Storage temperature	-40 °C to +120 °C	
Conformity	CE (in preparation)	
Safety	EN 61010-1:2020+COR1:2022, +COR2:2023, EN 61010-2-030:2022	

[1] Shunt modules and cable glands are to be selected separately.

[2] Correct installation assumed! Be sure to observe the mounting instructions in the installation manual.

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

Measurement cable for the voltage

Type designation	**K917**
Measuring the potential of	HV+ power cable for HV+
Number of measured phases with HV SAM1 evo	1
Connection	
Connecting cable to HV SBM(L)_I evo	HV measurement cable with LEMO 1E, 1-pole, code N connection via open cable end 2 mm galvanized
Weight (device)	approx. 100 g
Dimensions	1 m length
Operating and storage conditions	
Operating temperature range	-40 °C to +125 °C
Relative humidity	5 % to 95 % (non-condensing)
Storage temperature	-40 °C to +125 °C
Conformity	CE
Safety	EN 61010-1:2020+COR1:2022, +COR2:2023, EN 61010-2-030:2022

Measurement error

The measurement errors for current in the table below are valid for joint calibration of the **HV SAM1_evo** and the **HV SBM(L)_I evo**.

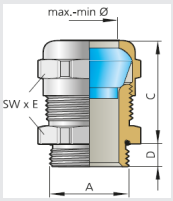
Measurement error[1]	
Voltage (DC)	
Gain error at 25 °C	max. ±0.05 % of measured value
Offset and scaling error	max. ±0.02 % of range
Gain drift	max. ±20 ppm/K of measured value
Zero drift	max. ±10 ppm/K of range
Current (DC)	Online adjustment with stored calibration data, with temperature compensation
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

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

Cable glands

Depending on the cable, different sizes of cable glands have to be used for the **HV SBM(L) evo.** 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 currently available: [1]

Cable glands for HV SBM(L)_I evo and HV SBM(L)_U evo

Type	**5/14**	**11/20**	**15/25**
			
Outer cable diameter			
max. Ø	14 mm	20 mm	25 mm
min. Ø	5 mm	11 mm	15 mm

[1] Please regard technical information in Pflitsch "Cable catalog Cable glands".

Shunt modules

CSM offers shunt modules with a variety of measurement ranges. For the **HV SBM_I evo** and **HV SBML_I evo** these shunt modules are selected separately and will be permanently installed in the module housing.

The maximum operating duration depends on the ambient temperature and the resulting power loss among other things in the **HV SBM(L)_I evo**. This means that the rated current may not be applied continuously without causing the **HV SBM(L)_I evo** to overheat. The temperature must not exceed +120 °C. The five different shunt modules each have four configurable measuring ranges (I_{Meas}).

Shunt modules for HV SBM(L)_I evo

Nominal current I_{Rated} [A]	±50	±125	±250	±500	±1,000
Peak current I_{Peak} [A]	±100	±250	±500	±1,000	±2,000
Measurement range 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
Measurement resistor [µΩ]	500	200	100	50	35

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