HV BM-Split evo

Product Description

The current series of separate HV Breakout Modules, **HV BM-Split evo**, is designed to simultaneously measure current and voltage on the DC-side of the HV vehicle's electrial 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 of the electrical auxiliary units is an essential task in the development, testing and analysis of electric vehicles. However, the installation space available in newly developed electric vehicles is becoming increasingly limited, which means that sometimes even the compact HV BM can no longer be installed.

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

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

For HV cables made of aluminum, significantly larger ring terminals must be used, which do not fit into the above breakout boxes. Longer versions are available for this purpose: the **HV SBML_I evo** and **HV SBML_U evo**.

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 2 MHz
- Optional output of the RMS values U_{RMS} and I_{RMS}, active power, apparent power, reactive power and power factor Lambda

The shields of the HV cables are routed through the breakout boxes in an insolated manner.

A shunt module is installed in the breakout boxes for current measurement. Among other things, it contains a temperature sensor and memory for calibration data for automatic online temperature compensation. The voltage and current signals are sent to the HV SAM1 evo where they are processed and digitalized.

Instead of using breakout boxes to tap the potential of HV+, it can alternatively be tapped with the HV-safe measuring cable K917 and routed to the **HV SBM(L)_I evo.**

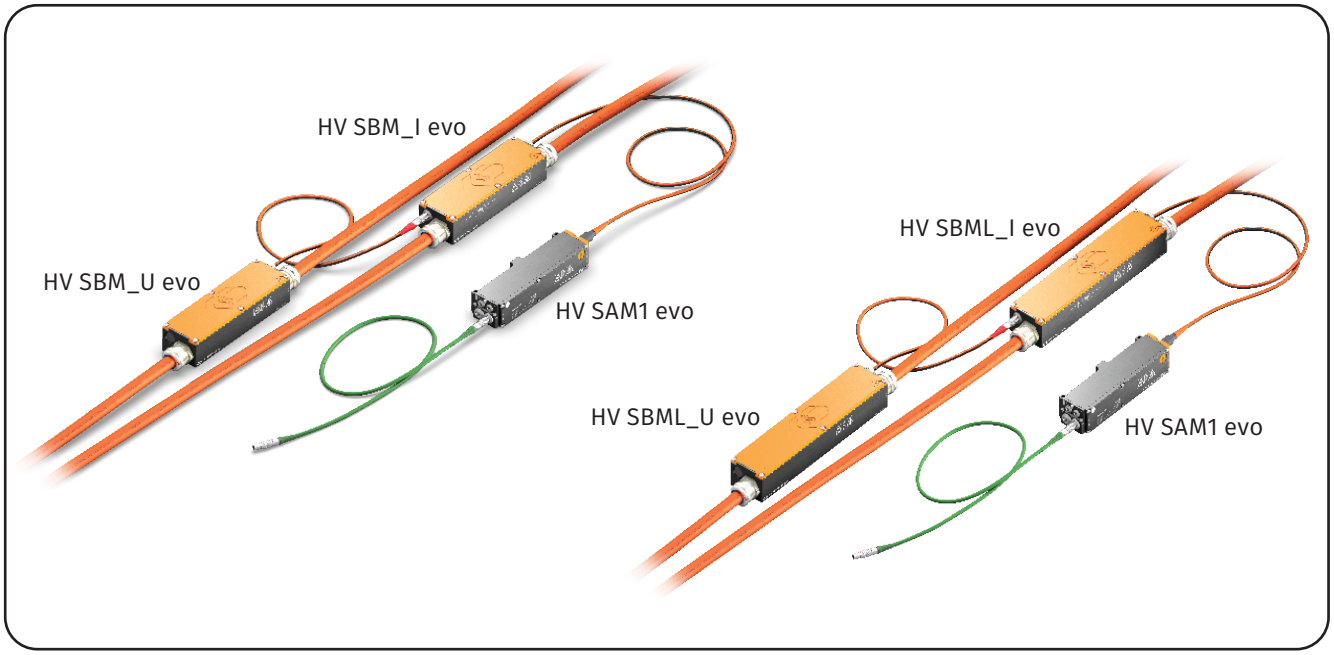


Fig. 1: Overview: Installation of HV BM-Split evo with HV cables, which might be shielded, with inner conductor of aluminum or copper.

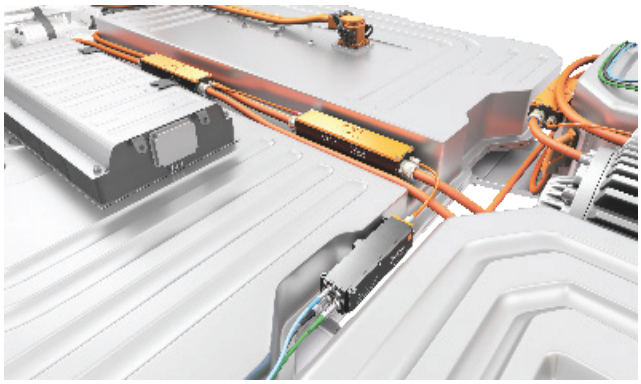


Fig. 2 and fig. 3: Flexible installation of the HV BM-Split evo system.

Scope of delivery

- HV BM-Split evo modules
- Configuration software CSMconfig
- Documentation
- Device Description File (*.xml)
- Calibration certificates for I and U in accordance with DIN EN ISO/IEC 17025 for **HV SAM1 evo** and the shunt module built into the **HV SBM(L)_I evo**
- Test protocols for HV isolation test

Maintenance

- HV isolation test at least every 12 months, according to EN 61010 for scope of test
- Calibration every 12 months recommended

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 and has one analog input each for current and voltage signals. The separation of the tap and measurement module allows it to be placed at a suitable place near the measuring tap.

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	4 adjustable measurement ranges (I_{Meas}) depending on the shunt module [2] 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
Sending rate of measured data	
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 low-pass-filter, 3 dB cutoff frequency approx. 450 kHz in the measurement ranges ±2 kV ... ±200 V, at ±100 V approx. 350 kHz
SW filter	
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 ▶ Off, only for sending rate of 1,000 kHz ▶ 6th order Butterworth low-pass-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 low-pass-filter, range: 0.1 Hz to 2 kHz: ▶ automatically adjusted based 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 license "Option Calculated Channels" 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
Measurement deviation [5]	
Voltage and current cable (DC)	
Gain error at 25 °C	max. ±0.05 % of measured value
Offset and scaling error	max. ±0.02 % of range
Gain drift	max. ±10 ppm/K of measured value
Zero drift	max. ±10 ppm/K of range
Field of application [6]	For measurements in HV environments [7]
Nominal voltage (unipolar & bipolar)	up to 1,000 V DC
Routine test	HV-isolation test according to EN 61010-2-030
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 [8]	
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 [9]
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 [10]	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 [9]
Storage temperature	-40 °C to +120 °C
Conformity	CE for the HV BM-Split evo system
Safety	EN 61010-1:2020+COR1:2022, +COR2:2023 with 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] The values for current differ depending on the frequency. For further information on measurement deviations, please refer to the Technical Information "Deviation of Measurement".

[6] In addition, be sure to observe CSM's document "Safety Instructions for HV BM-Split evo".

[7] In accordance with EN 61010-1:2020+COR1:2022, +COR2:2023 with EN 61010-2-030:2022.

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

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

[10] 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 breakout boxes **HV SBM_I evo** and **HV SBM_U evo** are installed in HV cables made of Cu, while the **HV SBML_I evo** and **HV SBML_U evo** are installed in HV cables made of Al. For this, ring terminals are attached to the inner conductors and shields of the split HV cables with a cross-section of up to 120 mm² and connected to bolts in the breakout boxes, with the shields being insulated.

Shunt modules that measure both current and voltage are installed in the **HV SBM_I evo** and **HV SBML_I evo**. Since the shunt module is installed in the HV- cable, the other potential (HV+) must be supplied for voltage measurement. This can be done with the pluggable K917 cable or with **HV SBM_U evo** or **HV SBML_U evo**. These breakout boxes have an outgoing signal cable that can be plugged into **HV SBM_I evo** or **HV SBML_I evo**. The current and voltage signals processed by the shunt module are transmitted to the **HV SAM1 evo** via shielded signal cables.

Type designation	**HV SBM_I evo** **HV SBML_I evo**	**HV SBM_U evo** **HV SBML_U evo**
Installation[1] in shielded or unshielded	HV-power cable for HV-	HV-power cable for HV+
Number of measured phases	1	
Number of cable glands	1 on each side	
Cable cross sections	16 mm² to 120 mm²	
Cable outer diameter	9 mm to 25 mm (select the appropriate cable gland)	
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	Current and HV- potential tap	HV+ potential tap
	Connection via ring terminals and cable glands[2]	
Ground connection	M8 threaded hole	
Fields of application[1]	for measurements in HV environments[3]	
Nominal voltage (unipolar & bipolar)	up to ±1,000 V DC	
Routine test	HV isolation test according to 61010-2-030	
Housing	Aluminum with HV designation (RAL2003)	
Protection class	IP67[4]	
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[5]		
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	4[4]	
Storage temperature	-40 °C to +120 °C	

Type designation	HV SBM_I evo HV SBML_I evo	HV SBM_U evo HV SBML_U evo
Conformity	CE for the HV BM-Split evo system	
Safety	EN 61010-1:2020+COR1:2022, +COR2:2023 with EN 61010-2-030:2022	

[1] Please read the CSM document "Safety Instruction HV BM-Split evo".

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

[3] According to EN 61010-1:2020+COR1:2022, +COR2:2023 with EN 61010-2-030:2022

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

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

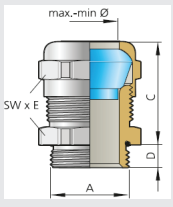
Measurement cable for the voltage

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, lead 2 mm, tinned
Weight	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 für das HV BM-Split evo System
Safety	routine test in accordance with EN 61010

Cable glands

For the **HV SBM(L) evo,** different sizes of cable glands must be selected depending on the outer diameter of the HV cable. Only by using the right combination of HV cable and cable glands can the tightness of the enclosure be ensured. 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

Size	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 "Cable catalog Cable glands" of the company Pflitsch.

Shunt modules

CSM offers shunt modules with different measurement ranges. For the **HV SBM_I evo** and **HV SBML_I evo** these shunt modules are selected separately and will be installed in the module housing. The shunt modules also provide a calibrated measurement input for the HV-voltage.

The maximum operating duration of the current depends, among other things, on the ambient temperature and the power loss generated in the **HV SBM(L)_I evo**. The 1,000 A shunt module cannot be operated continuously at rated current. With the other shunt modules, the rated current may not be applied continuously under certain circumstances. The temperature of the shunt modules must not exceed +120°C. The shunts have 4 configurable measuring ranges (I_{Meas}).

Shunt modules for HV SBM_I evo and HV SBML_I evo

Measurement range					
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
Voltage	±100, ±200, ±500, ±1.000 V, ±2.000 V[1]				
Measurement error[2]					
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				
Current (DC)	Online adjustment with stored calibration data, with temperature compensation				
Gain error at 25 °C	for shunt modules 50 A, 125 A, 250 A max. ±0.15 % of measured value for shunt modules 500 A and 1.000 A up to 600 A: max. ±0,15 % of measured value. up to 750 A: max. ±0.3 % of measured value up to 750 A: max. ±0.4 % of measured value				
Offset and scaling error	max. ±0.05 % of range				
Gain drift	max. ±25 ppm/K of measured value				

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

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

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