HV Breakout-Modules Type 1.x

User Guide

Innovative Measurement and Data Technology

Copyright

Product disposal/recycling

If this symbol (crossed-out wheeled bin) appears on the device, this means that the European Directive 2012/19/EU applies to this device.

The correct disposal of old equipment will protect the environment and people from possible negative consequences.

Become familiar with local regulations for separate collection of electrical and electronic equipment.

Follow local regulations and do not dispose of old equipment with household waste.

Contents

1 Introduction

1.1 About this user guide

This user guide contains contain important information on how to mount, install, and configure the following HV Breakout Modules:

- HV BM 1.1 as of hardware revision E
- HV BM 1.2 as of hardware revision D

Please read the entire document carefully before installation and initial operation.

1.2 Symbols and writing conventions

Symbol/note	Meaning	Example of application
☞	User instruction	☞ Click on **OK** to confirm the entry.
⇨	Result of an action	⇨ The following dialog opens:
→	Cross reference to external information source(s)	→ *CSMconfig Online Help, section "Menu commands"*
→	Text highlighted in blue (with or without arrow) refers to a link/cross reference within the document.	→ Chapter 4.3.2.4 "Ground connection" ☞ Continue with chapter 5.4.3.4 "Creating a new configuration.
i	This pictogram refers to important notes or additional information on a specific topic.	**i** CSM offers a mounting kit for devices in standard housings. For further information please contact our sales department.
Options | Interface	**Menu selection** Menu items, options and buttons are highlighted in bold. The vertical bar "|" separates the menu from the menu command. The example on the right means: Click on the **Options** menu and select **Interface.**	☞ Select **Options | Interface**.
(→ **Options | Interface**)	A menu option integrated into the text.	The CAN interface is selected via the **Interface** dialog (→ **Options | Interface**).

Tab. 1-1: Symbols and writing conventions

1.3 List of abbreviations

Abbreviation	Meaning
ASAM	**A**ssociation for **S**tandardization of **A**utomation and **M**easuring Systems: registered association coordinating the development of technical standards → *asam.net*
CAN	**C**ontroller **A**rea **N**etwork: serial bus system developed by Bosch for networking ECUs in vehicles
CoE	**C**ANopen **o**ver EtherCAT®: protocol for use of the CANopen family of profiles over EtherCAT®
DAQ	**D**ata **A**c**Q**uisition), e.g. DAQ software
ECAT	**E**ther**CAT**®: an Ethernet-based field bus system developed by Beckhoff company and the EtherCAT® Technology Group → *ethercat.org*
EMC	**E**lectro**M**agnetic **C**ompatibility
ESD	**E**lectro**S**tatic **D**ischarge
HV	In terms of automotive engineering, **H**igh **V**oltage is used to specify the following voltage ranges: ▸ Alternating voltage (AC) greater than 30 V and up to 1000 V ▸ Direct voltage (DC) greater than 60 V and up to 1500 V
HV BM	HV Breakout Module
MC Tool	**M**easurement & **C**alibration Tool
OBC	**O**n-**B**oard **C**harger: charging unit in an electric vehicle used for charging the vehicle battery
STG	**ST**rain **G**auge
TEDS	**T**ransducer **E**lectronic **D**ata**S**heet: sensor with integrated memory for electronic data sheet
XCP	Universal Measurement and Calibration Protocol → *asam.net*

Tab. 1-2: List of abbreviations

1.4 Warning

A warning indicates specifically or potentially dangerous situations. Failure to follow a warning could result in injury or death to persons and/or damage to property.

This guide contains warnings that the user must observe to ensure safe operation and to prevent injury to persons and damage to property.

Warning design

A warning sign consists of the following components:

- Warning symbol
- Signal word
- Source/type of hazard
- Possible consequences of non-compliance
- Measures to avert the hazard

Warning symbols

Symbol	Meaning
	General risk This symbol indicates a general hazard.
	High voltage! This symbol indicates a risk due to hazardous electrical voltage.
	Hot surface! This symbol indicates a possible risk of burns from hot surfaces.

Tab. 1-3: Warning signs

Signal words

Signal word	Meaning
WARNING	... indicates a potential hazard. Failure to follow this warning may result in serious injury, or possibly death.
CAUTION	... indicates a potential hazard. Failure to follow this warning may result in minor injuries.

Tab. 1-4: Signal words

If several potential hazards originate from one source of danger, then the warning (signal word/symbol) that indicates the greatest potential hazard is used. For example, a warning indicating danger to life or serious injury may also indicate the potential risk of property damage.

1.5 Directive

A directive contains important information about the product described in the guide. Failure to observe a directive may result in malfunction and/or damage to property and material. A directive is indicated by the blue symbol and the signal word **NOTE**.

Example

NOTE!	
	This symbol indicates important information. Failure to observe this information can impair the function or result in damage to the measurement module. ☞ Read the information carefully.

Symbols

Symbol	Meaning
	This symbol indicates important information. Failure to observe this information can impair the function or result in damage to the measurement module.
	Wear suitable safety gloves.
	Disconnect the device before starting to work.

Tab. 1-5: Symbols used in mandatory signs

1.6 Legal disclaimer

This guide and other documents are part of the product and contain important information for its safe and efficient use. To maintain the high quality level the product is continuously being developed, which may result in the product's technical details changing at short notice. As a result, the contents of this documentation may differ from the technical specifications of the product. No claims against the manufacturer can therefore be derived from the contents of the product documentation.

The manufacturer is not liable for technical or editorial errors or missing information.

No liability for damage resulting from improper use of the product and/or non-observance of the product documentation is assumed.

→ Chapter 2 "Safety Instructions"

1.7 Warranty and exclusion of warranty

The warranty covers the safety and functionality of the product within the warranty period. Excluded from the warranty are claims based on possible consequential damages caused by malfunction or non-function of the product.

The warranty shall become invalid if

- the product is handled improperly
- prescribed maintenance intervals are not observed
- the product is modified
- the user does not observe the product documentation
- the product is operated with accessories or parts which are not explicitly approved for operation by the manufacturer

1.8 ESD Information

The manufacturer of the product declares that the HV Breakout Modules HV BM 1.1 and HV BM 1.2 comply with the requirements of EU Directive 2014/30/EU.

NOTE!	
	Electronic components can be damaged or destroyed by electrostatic discharge (ESD). ☞ Make sure that no electrostatic discharge occurs via the internal contacts of the inputs. ☞ Avoid electrostatic discharge when handling or installing sensors.

2 Safety Instructions

2.1 General safety instructions

The measurement modules may only be used in a technically faultless condition and in accordance with their intended use. Please observe the safety instructions in this chapter and in the document "Safety Instructions HV Breakout Module Type 1.1 | 1.2 | 1.2+S" to avoid user hazards and/or damage to the measurement modules.

WARNING!	
	HV Breakout Modules (HV BM) are used in high-voltage applications. **Improper use poses risks such as life-threatening electrical shocks and fire hazards.** ☞ Only use qualified and trained personnel (observe local guidelines/ regulations). ☞ Observe safety instructions.

WARNING!	
	The orange lid of the device housing can be removed to mount or dismount the HV power cables. For safety reasons, the HV measurement module must only be operated with the lid fitted. **Operating the HV measurement module without the lid poses a risk of life-threatening electrical shock.** ☞ Before removing the lid, make sure that the HV power cables are de-energized. ☞ Only connect HV power cables with ring terminals approved by the manufacturer. ☞ Only operate the HV measurement module with the lid mounted. ☞ It is particularly important that lid and cable glands are properly mounted in order to ensure the tightness of the housing. → Chapter 5 "Installing the HV Power Cables"

WARNING!	
	The measurement module must be connected to the vehicle's potential equalization or protective earth (PE) in order to ensure user safety. **In the event of a fault, there is danger to life due to high-voltage potential if this connection is not established.** ☞ Connect the measurement module to vehicle's potential equalization or PE using a suitable ground cable. ☞ Only use qualified and trained personnel. → Chapter 4.3.2.4 "Ground connection"

WARNING!

The internal temperature of the measurement module and the temperature of the shunts must not exceed +120 °C. The shunts can heat up considerably during operation under high load. The maximum temperature can also be exceeded when no measurements are performed but the module is integrated into a loaded circuit (e.g. when charging a vehicle battery).

- As soon as the temperature of a shunt exceeds +120 °C, the HV Breakout Module sends the error code "0x8001" instead of the measured values for U and I.
- The error message "THERMAL_OVERLOAD" generated from the DBC/A2L file is displayed in the application.
- These messages remain valid until the temperature of all shunts drops below 115 °C again.

Exceeding the specified temperature impairs the operational safety of the HV Breakout Module and can lead to life-threatening electrical shocks and fire.

Installation & Thermal Dissipation

☞ Dissipate the heat generated by attaching the module on a suitable mounting surface.

☞ Choose a sufficiently large cable cross-section to minimize heating due to in-line losses.

Electrical Connection

☞ Tighten the nuts of the ring terminals to the specified torque to keep the contact resistance low.

→ Chapter 5.1.2 "Tightening torques"

Operation & Monitoring

☞ Monitor the internal temperature of the module and the shunt temperatures continuously to prevent overheating.

→ *CSMconfig online help "How to use HV Breakout Modules" and "File format 'DBC' (CAN Signal Database)"*

☞ Reduce or interrupt the current flow in case of excessive temperature to prevent further heating.

WARNING!

When using HV power cables made of aluminum in combination with ring terminals for HV power cables made of copper, the contact resistance between the two components increases.

This can lead to a massive increase in temperature and in the worst case to the development of fire.

☞ Use ring terminals for copper cables only in combination with HV power cables made of copper!

CAUTION!

The shunts integrated in the measurement module can heat up significantly during operation under high load.

Touching the surface of the module may cause serious burns.

☞ Let the measurement module cool down before handling, especially before removing the orange-colored lid.

☞ Wear appropriate safety gloves.

NOTE!

The isolation barrier can be damaged due to aging, overvoltage, bipolar voltage, incorrect operating temperature and mechanical wear.

Periodical tests of the reinforced insulation every 12 months are required.

If there is reason to assume that the isolation might be defective, an HV isolation test should be carried out immediately before putting the device in operation again.

- ☞ To ensure the proper functioning and the electrical safety of the measurement module, make sure that a high-voltage isolation test is carried out at least every 12 months.
- ☞ If damage to the isolation barrier is suspected, a high-voltage isolation test must be performed before the system is put back into operation.
- ☞ Operate the measurement module only within the specified operating conditions.

NOTE!

The interface cables and connection cables of the measurement modules have shields, which are connected to potential equalization or PE. The housings of the measurement modules are also connected to potential equalization or PE. It is therefore important that housings and the shields are at the same potential. Otherwise, measurement results will be falsified or measure modules destroyed.

- ☞ Make sure that no differences in potential occur when mounting the device.
- ☞ Isolate the measurement module from the mounting location, if required.

2.2 Obligations of the operator

- The operator has to make sure that only qualified and authorized personnel are responsible for handling the product. This applies to installation and operation.
- In addition to the product's technical documentation, the operator may also have to provide operating instructions in accordance with the Occupational Safety and Health Act [1] and the Ordinance on the Use of Working Materials [1].

2.3 Intended use

- HV BM 1.1 and HV BM 1.2 were developed for measuring voltages and currents in high-voltage environments.
- These measurement modules may only be used under the operating conditions which are defined in the specific product's datasheet. Product safety cannot be ensured if the product is used in any other way.
- Observe the electrical safety regulations applicable at the operating site as well as the laws and regulations on occupational safety.
- Read the technical documentation accompanying the measurement module(s) and follow the instructions contained therein.
- The calibration and HV isolation testing of measurement modules may only be performed by authorized calibration laboratories (e.g. CSM calibration laboratory).
- Repair work must only be carried out by the manufacturer.
- The operator bears full responsibility if this device is used in any way which does not comply with the intended use.

1 Outside the jurisdiction of this Act or this Ordinance, the relevant country-specific directives and ordinances applicable at the product's operating site have to be observed.

3 Product Description

3.1 Overview

NOTE!	
	HV Breakout Modules have been optimized to be operated with the lid mounted and the HV power cables connected. Fault-free operation is only possible when the lid is mounted and the HV power cables are properly mounted. ☞ Only operate HV Breakout Modules when the lid is mounted and the HV power cables are connected.

Further information

→ *Further information can be found on our website in section **Products | HV Breakout Modules** and in the following documents:*

- → *Datasheet "HV Breakout Module Type 1.1"*
- → *Datasheet "HV Breakout Module Type 1.2"*
- → *Safety Instructions "HV Breakout Module Type 1.1 | 1.2 | 1.2+S"*
- → *Technical Information "Measurement Categories for CSM HV Measurement Modules"*
- → *Technical Information "Deviation of Measurement"*

3.2 Connections and components

The LED indicators of HV Breakout Modules ⑤, ⑥, ⑦ are integrated into the front of the module housing.[2] The sockets for EtherCAT® ②/④ and CAN ⑪ are integrated in the left side of the housing. Two cable glands ① for installing the HV power cables are integrated into the left and right side of the housing.

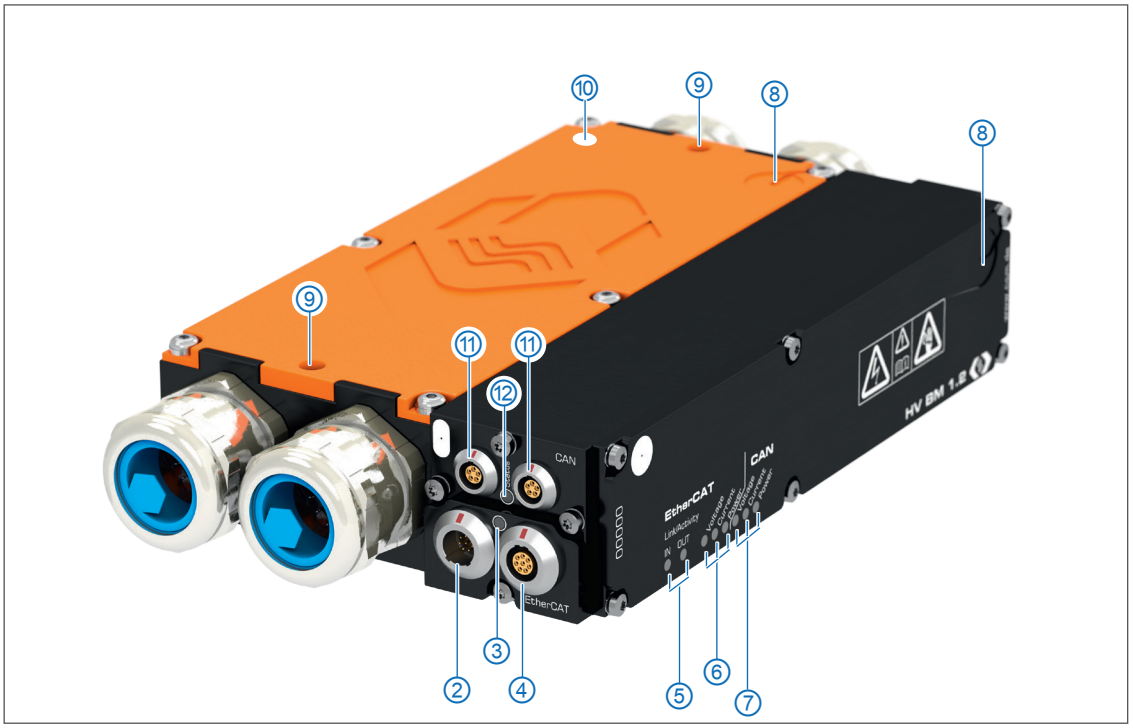


Fig. 3-1: HV BM 1.2, connections and LED indicators

1. Cable glands
2. EtherCAT® **IN** socket (chapter 4.3.2.2 "EtherCAT® IN socket")
3. EtherCAT® bus Status LED indicator (chapter 3.3.1 "EtherCAT® bus Status LED indicator")
4. EtherCAT® **OUT** socket (chapter 4.3.2.3 "EtherCAT® OUT socket")
5. EtherCAT® bus Link/Activity LED indicators **IN** and **OUT** (chapter 3.3.3 "EtherCAT® bus Link/Activity LED indicators IN and OUT")
6. EtherCAT® bus measurement channel LED indicators (chapter 3.3.4 "Measurement channel LED indicators")
7. CAN bus measurement channel LED indicators (chapter 3.3.4 "Measurement channel LED indicators")
8. Ventilation opening with GORE™ membrane and label
9. Bores for M6 threaded bolts
10. Contact surfaces for measuring the resistance of potential equalization or protective earth (PE) to lid
11. CAN sockets (chapter 4.3.2.1 "CAN sockets")
12. CAN bus LED indicator (chapter 3.3.2 "CAN bus LED indicator")

2 The connections shown in Fig. 3-1 apply to module version HV BM 1.2. The HV BM 1.1 is only equipped with one cable gland per side ① and does not have bores for threaded bolts ⑨.

Rear side of the housing

- Type labels of measurement module and shunt module (chapter 6.1 "Type labels")
- DIN EN ISO/IEC 17025 calibration labels and high-voltage isolation test label (chapter 6.2 "Maintenance services")

Others

- Four M4 threaded holes designed for mounting the measurement module are located in the base of the module housing.
- M8 threaded hole in the right-hand side of the housing for connecting the ground cable.[3]

→ Chapter 4.3.2.4 "Ground connection"

3.3 Functional description of LED indicators

3.3.1 EtherCAT® bus Status LED indicator

The two-color status LED (Fig. 3-1, ③) is lit red for a few seconds after the module is switched on and then turns off. [4]

LED		Meaning
Color	Status	
–	off	Measurement module not connected or power supply switched off
green	flashing	50 % on, 50 % off: Device is in status PRE-OPERATIONAL.[5]
green	flashing	20 % on, 80 % off: Device is in status SAFE-OPERATIONAL.[6]
green	permanently lit	Device is in status OPERATIONAL.[7]
red	flashing	Configuration error
red	permanently lit	Measurement module is switched on or connection to power supply has been established, but there is no Ethernet communication.
green/red	flashing	New firmware is downloaded and activated.

Tab. 3-1: Status LED indicator

3 Older hardware revisions of the HV BM 1.1 and HV BM 1.2 module versions are equipped with an M6 threaded hole.
4 Status designations according to Beckhoff and EtherCAT® Technology Group EtherCAT® standard.
5 Status PRE-OPERATIONAL: Configuration/setting of the values for the measurement range
6 Status PRE-OPERATIONAL: Check the measurement range configuration and confirm if the set values are correct. If the measurement range is invalid, the measurement module remains in PRE-OPERATIONAL status.
7 Status PRE-OPERATIONAL: The module is in measurement operation.

3.3.2 CAN bus LED indicator

The LED indicator (Fig. 3-1, ⑫) between the two CAN sockets indicates the operating status of the measurement module.

LED		Meaning
Color	**Status**	
–	off	Measurement module not connected or power supply switched off
green	permanently lit	Normal operation
red	permanently lit	Measurement module is in idle mode, either because the configuration software has stopped data acquisition (no error), or because there is a CAN bus or configuration problem.
red	flashing	The measurement module has been selected via the configuration software and is in idle mode.
green/red	flashing	New firmware is downloaded and activated.

Tab. 3-2: CAN bus LED indicator

3.3.3 EtherCAT® bus Link/Activity LED indicators IN and OUT

The LED indicators for the sockets **IN** and **OUT** (Fig. 3-1, ⑤) are lit or are flashing if the measurement module is electrically connected to an XCP-Gateway or if data is being transferred.

LED		Meaning
Color	**Status**	
green	permanently lit	LED **IN**: Ethernet connection to an upstream module or gateway in the ECAT chain has been established. LED **OUT**: Ethernet connection to a downstream module or gateway in the ECAT chain has been established. No data is transferred.
green	flashing	Ethernet connection is active, i.e. data transfer is in progress.
-	off	No measurement module or XCP-Gateway connected.

Tab. 3-3: LED indicators **IN/OUT**

3.3.4 Measurement channel LED indicators

The measurement channel LED indicators (Fig. 3-1, ⑥ and ⑦) show the status of the corresponding measurement channel. There are separate LED indicators for access via CAN bus or EtherCAT® bus. The measurement channels are arranged as follows (left to right):

1. **Voltage**: Voltage measurement status
2. **Current**: Status of current measurement
3. **Power**: Status of the calculation of the instantaneous power[8]

After switching-on the HV BM 1.x module, all measurement channel LED indicators are lit red, indicating the start-up process. Once the module has initialized itself and no errors were detected, the LED indicators fade out.

After self-initialization, the device checks for the connected shunt module. Meanwhile the LED indicators of the channels for current measurement (**Current**) are lit red. If the shunt module has been successfully identified, the measurement channel LEDs turn off again.

The measurement ranges have to be **configured identically** on the ECAT and the CAN side to send data simultaneously via CAN and ECAT, otherwise only the module side that was configured last will send measurement values. The module side configured first no longer sends measured values, but a defined error value. This is indicated on the module by the LED indicator of the measurement channel which is **permanently lit in red**.

i	For information on how to configure CSM measurement modules, please refer to the CSMconfig online help.

LED		Meaning
Color	**Status**	
–	off	Normal operation or measurement module not connected or power supply switched off
red	permanently lit	Error while checking for the shunt module (**Current** LEDs)
		The configurations stored in the measurement module on the CAN or EtherCAT® side differ from each other (all three LEDs of the corresponding side)
red	flashing	50 % red 50 % off: disabled channel selected via configuration software
		80 % red 20 % off measured value is out of the measurement range
green	flashing	Channel selected via the configuration software (single LED)
		Module selected via the configuration software (all three LEDs on the corresponding side, i.e. CAN or ECAT)

Tab. 3-4: Measurement channel LED indicators

8 The flash codes of the LED correspond to the flash codes of the **Current** LED (Tab. 3-4).

4 Mounting and Installation

For trouble-free operation and a long product service life, the requirements for mounting and installation specified in this chapter must be observed.

4.1 Before mounting

HV Breakout Modules are equipped with two GORE™ membranes (Fig. 4-1), which are required for pressure compensation. To ensure the breathing function of the membranes, the ventilation openings in the front of the housing ① or in the lid of the housing ② must never be blocked/covered or permanently covered with water or other liquids. There is then a risk of condensation collecting inside the housing and damaging the measurement module.

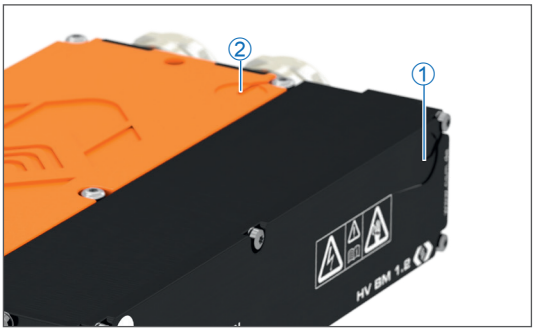


Fig. 4-1: HV BM 1.2, ventilation openings in the housing

NOTE!
The GORE™ membranes are required for pressure compensation. ☞ When mounting the module, make sure that the ventilation opening for the GORE™ membrane is not obstructed or permanently covered by water or other liquids.

NOTE!
Trouble-free operation and electrical safety can only be ensured if the measurement module is correctly installed. ☞ Ensure correct installation. ☞ Operate the measurement module exclusively within the specified operating environment. → *Datasheets "HV Breakout Module Type 1.1" and "HV Breakout Module Type 1.2"*

4.2 Mounting the HV Breakout Module

NOTE!
Strong magnetic fields, such as those induced by permanent magnets, may impair the trouble-free operation of the measurement module. ☞ Make sure that the mounting position of the measurement module is free from strong magnetic fields.

Requirements

- When choosing the mounting position, make sure that the ventilation opening of the GORE™ membrane is not obstructed or covered by liquids.
- Make sure that the mounting site allows for sufficient space to connect and disconnect the cables without clamping or pinching them.
- Avoid mounting locations where the module would be subjected to continuous strong vibrations and/or shocks.

Required parts/material

- four M5 screws[9] or two M6 threaded bolts (HV BM 1.2 only, Fig. 3-1, ⑨)

Mounting the measurement module

☞ Fasten the measurement module at the mounting position.

Please contact our support for the appropriate drill hole diagrams.

NOTE!
Mechanical modifications to the housing (e.g. by drilling additional holes) can destroy the measuring module or impair its function. Doing so would also invalidate the warranty. ☞ Never drill any holes in the housing. ☞ Observe mounting instructions.

9 The depth of the thread in the module housing is 6 mm. The screw length must be chosen according to the thickness of the mounting material.

4.3 Installing HV BM 1.1/HV BM 1.2

4.3.1 Before installation

NOTE!	
	Trouble-free operation and electrical safety can only be ensured if the measurement module is correctly installed. ☞ Make sure that the device is correctly installed. ☞ Operate the measurement module only within the specified operating environment. → *Datasheets "HV Breakout Module Type 1.1" and "HV Breakout Module Type 1.2"*

NOTE!	
	The isolation barrier can be damaged due to aging, overvoltage, high temperature and mechanical wear. ☞ If a damaged isolation barrier is suspected, perform an isolation test immediately. Do not put the device in operation or continue to use it under any circumstances.

i	Vector provides cables for the connection of ECAT and CAN modules. → *"XCP/ECAT Accessories for CSM measurement modules" and "CAN Accessories for CSM measurement modules"* For further details please contact the Vector sales department.

i	Vector provides maintenance and repair services for HV BM measurement modules. → Chapter 6.2 "Maintenance services"

4.3.2 Connectors

HV BM 1.1 and HV BM 1.2 are equipped with an EtherCAT® and a CAN interface. The sockets are located in the left side of the housing.

i	The measurement module's power supply can be provided either via the EtherCAT® **IN** socket or the CAN sockets. The supply voltage fed to CAN is not provided to the EtherCAT® sockets and vice versa. Banana plugs of the interface cable, which are not in use, do not need to be isolated. The supply lines of the two CAN sockets are connected to each other. The same applies to the two EtherCAT® sockets.

The HV power cables are led through cable glands into the inside of the module and connected there.

→ Chapter 5 "Installing the HV Power Cables"

For safety reasons, the measurement module must be connected to the vehicle's potential equalization or protective earth (PE) on the test bench via the threaded hole in the right side of the housing.

→ Chapter 4.3.2.4 "Ground connection"

4.3.2.1 CAN sockets

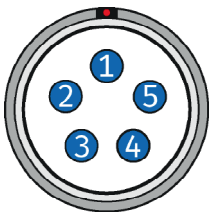
WARNING!
The behavior of the CAN bus can be influenced by connecting a CAN bus measurement module to an existing CAN bus system. **Improper use of a CAN bus system may cause life-threatening situations and material damage.** ☞ Always connect CAN bus measurement modules to a separate CAN bus system (measurement bus). ☞ Only use qualified and trained personnel.

The CAN connectors can be used for both CAN signals and power supply. The interface cable connects the measurement module to the data acquisition system (PC or data logger) and (if required) to the power supply.

NOTE!
Be particularly careful when connecting third-party devices to a CAN measurement bus with HV Breakout Modules. ☞ Ensure that the configuration settings are compatible with all devices (same CAN bit rate, different CAN identifiers). ☞ Only use qualified and trained personnel.

LEMO-0B sockets are used by default for the CAN connections. To have the device equipped with different sockets, please contact the Vector sales department. To connect a cable to this socket, the following plug with plug insert is required:

- **FGG.0B.305.CLA xxxxx** [10]

	Pin	Signal	Description
	1	Power +	Power supply, plus
	2	Power GND	Power supply, ground
	3	CAN_H	CAN high
	4	CAN_L	CAN low
	5	CAN_GND	CAN ground
	Housing	Shield	Cable shield

Tab. 4-1: Plug (front view) for CAN socket: pin assignment

The CAN sockets for CAN signals and power supply are connected in parallel and have identical pin assignments. This enables simple cabling with only one cable between two measurement modules. At the end of the measurement chain, a CAN termination resistor is plugged into the open CAN socket.

10 "xxxxx" is a placeholder here. The actual designation depends on the diameter of the cable that is actually being used.

4.3.2.2 EtherCAT® IN socket

The measurement module is connected to the XCP-Gateway (alternatively to an EtherCAT® master) or to an upstream EtherCAT® measurement module via the EtherCAT® **IN** socket. EtherCAT® measurement modules receive their power supply from the XCP-Gateway, i.e. via the same cable connection.

A LEMO-1B socket is used by default for the ECAT connection. For connecting a cable to this socket the following plug is required:

- **FGL.1B.308.CLL xxxxx** [11]

	Pin	Signal	Description
	1	Power +	Power supply, plus
	2	Power GND	Power supply, ground
	3	RX -	Ethernet: Receive data, minus
	4	TX -	Ethernet: Transmit data, minus
	5	RX +	Ethernet: Receive data, plus
	6	Power GND	Power supply, ground
	7	Power +	Power supply, plus
	8	TX +	Ethernet: Transmit data, plus
	Housing	Shield	Cable shield

Tab. 4-2: Plug (front view) for EtherCAT® **IN** socket: pin assignment

NOTE!

The power supply is looped through from the **IN** socket to the **OUT** socket. Thus, a signal at a specific pin of the **IN** socket is also available at the **OUT** socket.

4.3.2.3 EtherCAT® OUT socket

The **OUT** socket is used for daisy-chaining the EtherCAT® measurement modules. A LEMO-1B socket is used by default for the ECAT connection. To connect a cable to this socket, the following plug with plug insert is required:

- **FGA.1B.308.CLA xxxxx** [11]

	Pin	Signal	Description
	1	Power +	Power supply, plus
	2	Power +	Power supply, plus
	3	Power GND	Power supply, ground
	4	RX +	Ethernet: Receive data, plus
	5	TX -	Ethernet: Transmit data, minus
	6	RX -	Ethernet: Receive data, minus
	7	Power GND	Power supply, ground
	8	TX +	Ethernet: Transmit data, plus
	Housing	Shield	Cable shield

Tab. 4-3: Plug (front view) for EtherCAT® **OUT** socket: pin assignment

11 "xxxxx" is a placeholder here. The actual designation depends on the diameter of the cable that is actually being used.

4.3.2.4 Ground connection

WARNING!	
	The measurement module has to be connected to the vehicle's potential equalization or protective earth (PE) in order to ensure user safety. **In the event of a fault, there is danger to life due to high-voltage potential if this connection is not established.** ☞ Connect the measurement module to vehicle's potential equalization or PE using a suitable ground cable. ☞ Only use qualified and trained personnel.

The HV Breakout Module has to be connected to the vehicle's potential equalization or protective earth (PE) in order to ensure user safety. The cross section of a ground cable depends on the cross section of the HV power cable used. When selecting the ground cable cross-section, observe the recommendations according to DIN VDE 0100-540[12].

NOTE!	
	The M8 threaded mounting hole is designed to connect the device to the vehicle's potential equalization or to protective earth (PE) on a test bench. ☞ Use the threaded hole only for connecting the module to the vehicle's potential equalization or protective earth (PE).

Required parts/materials

NOTE!	
	The cross-section of the ground cable or ground strap has to be sufficiently large to be able to divert the currents from the HV power cables in the event of a fault. ☞ Observe relevant standards and regulations.

- suitable ground cable (not included in the scope of delivery)
- M8 screw[13] plus washer

4.3.2.5 Connecting the connection cables

Cables of various lengths are available for connection to the data acquisition system and the power supply, as well as for daisy-chaining the measurement modules.

→ *"XCP/ECAT Accessories for CSM measurement modules" and "CAN Accessories for CSM measurement modules"*

CAN bus

- K176-xxxx or K85-0060: cable for connection to PC/power supply via CAN interface:
- K70-xxxx: cable for connecting/linking CAN measurement modules
- K72-0250: cable with intermediate supply voltage feed for connecting/interlinking CAN measurement modules

EtherCAT® bus

- K420-xxxx: cable for connecting an XCP-Gateway basic/pro to a PC and power supply

12 In other countries, the applicable standards/directives are to be observed.
13 The screw length depends on the thickness of the material being used.

- K400-xxxx: cable for connecting EtherCAT® measurement module and the XCP-Gateway and for linking EtherCAT® measurement modules
- K410.1-xxxx: cable with intermediate supply voltage feed for connecting EtherCAT® measurement module and an XCP-Gateway and for linking EtherCAT® measurement modules

i	The K420-xxxx cable can also be used to connect an HV BM 1.x directly to a data acquisition system (PC). This requires that data acquisition software supporting EtherCAT® master operation is installed on the PC.

Connecting the power supply

The HV BM 1.x modules are supplied with power either via the EtherCAT® **IN** socket or the CAN sockets (Fig. 3-1).

	NOTE!
	Depending on the number of measurement modules and the cable lengths in a measurement setup, one or multiple intermediate power supplies may be required. An intermediate supply is also required if more current is required than the power supply connected can provide due to the increased power consumption of the measurement modules.

Minimum power supply voltage

The minimum power supply voltage is the minimum voltage delivered by a power supply. In an automotive application, this is usually the vehicle's on-board supply system (e.g. 12 V for passenger cars). Note that this minimum value is required for proper operation of the module. In a 12 V vehicle electrical system, for example, this value can drop for a short time (from a few milliseconds to a few seconds) during engine start-up to a value below the minimum value specified for a measurement module. During operation, it has to be ensured that the supply voltage applied to the modules of a measurement chain does not drop below the specified minimum value.[14]

Cable lengths

The resistance of a connection cable causes a voltage drop in the cable. The extent of the voltage drop depends on the length of the cable and the current flowing through it. In a supply chain, the required minimum voltage has to be applied to each module at all times.[14]

i	For information on how to configure CSM measurement modules, please refer to the CSMconfig online help.

14 The minimum value specified on the type label of a measurement module has to be observed (chapter 6.1 "Type labels").

5 Installing the HV Power Cables

5.1 Installation notes

WARNING!	
	**Inappropriate handling of the HV measurement module can result in life-threatening electrical shocks.** ☞ Observe all safety-related information for mounting the device. → Chapter 2 "Safety Instructions"

WARNING!	
	During installation, minimum clearances must be maintained between the HV-conducting metal parts in the measurement module (ring terminals, nuts, threaded bolts, and HV power cables) and the lid of the housing as well as the module housing itself. **Failure to maintain these minimum clearances poses a risk of life-threatening electrical shocks.** ☞ When installing the HV power cables, make sure that the following minimum clearances are maintained: ▸ ≥ 1 mm between HV-conducting metal parts and the isolation plate mounted on the inside of the lid ▸ ≥ 3.5 mm between HV-conducting metal parts and non-insulated surfaces on the inside of the lid ▸ ≥ 3.5 mm between HV-conducting metal parts and the inner surfaces of the module housing ☞ Use only lids with fully intact isolation plates.

The ring terminals for the HV power cables are not included in the scope of delivery and must be ordered separately.

WARNING!	
	**If inappropriate ring terminals are used, there is a risk of life-threatening electric shocks and short-circuits.** ☞ Only connect HV power cables equipped with ring terminals approved by the manufacturer. ☞ Observe the minimum clearances between the HV-conducting metal parts and the inside of lid of the housing.

5.1.1 Required tools

- Allen key, size 2.5
- Suitable tools for fitting the cable glands (open-end or socket wrenches), size SW24 (for M20), SW30 (for M25) and SW36 (for M32)
- Ratchet/socket wrench (w. deep nut) or ring wrench (deep cranked), size SW13

NOTE!	
	For mounting the ring terminals of the power cables HV- and HV+ on the threaded bolts of an HV Breakout Module, only use the M8 steel nuts and washers included in the scope of delivery.

5.1.2 Tightening torques

The tightening torque for mounting the ring terminals of the HV+ power cables on the threaded bolts of the copper domes (Fig. 5-4, ②/Fig. 5-5, ②) is always 25 Nm.

For mounting the ring terminals of the HV power cables on the threaded bolts of the shunt modules, the tightening torques specified in Tab. 5-1 apply, depending on the shunt module to be connected.

The tightening torques in Tab. 5-1 apply to:

- HV BM 1.1 as of HW rev. E
- HV BM 1.2 as of HW rev. D

Tightening torques for shunt modules	
Type of module	**Tightening torque**
50 A	5 Nm
125 A	15 Nm
250 A	25 Nm
500 A	
1000 A	

Tab. 5-1: Tightening torques for shunt modules

5.2 Connecting the HV power cables

This chapter describes the installation of single-core HV power cables in module of type HV BM 1.1 and HV BM 1.2.

5.2.1 Connection diagram for HV BM 1.1 and HV BM 1.2

Current and voltage measurement

Fig. 5-1 shows the appropriate connection diagram if current and voltage are to be measured. The current is measured in the **minus path** in order to minimize disturbances of the current measurement. The voltage is measured on the consumer side.

i	▸ The red arrows indicate the technical direction of the current. ▸ The blue arrow indicates the technical direction of the voltage. ▸ For the wiring displayed, the technical current and the technical voltage are output with the correct polarity.

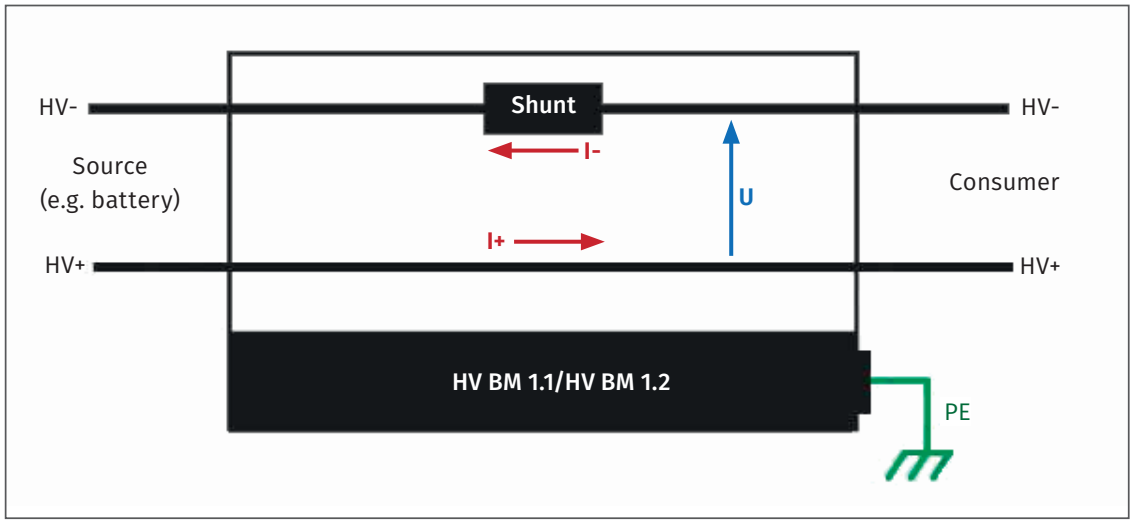


Fig. 5-1: HV BM 1.1 and HV BM 1.2, connection diagram for the measurement of voltage and current

5.2.2 Opening the housing

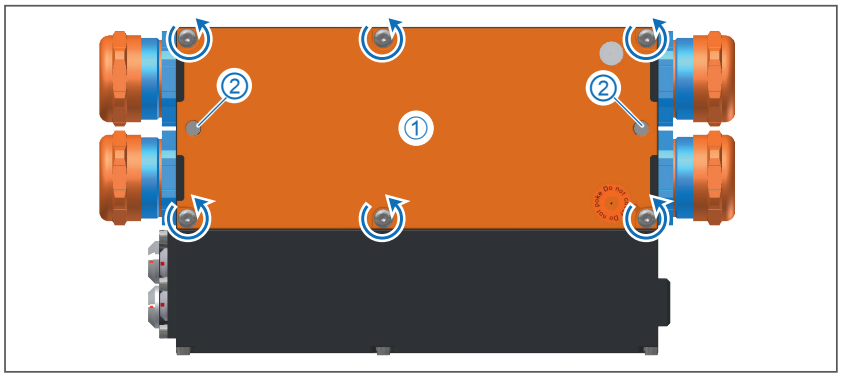


Fig. 5-2: HV BM 1.2, housing closed

☞ Loosen the Allen screws (↻) in the lid of the housing.
☞ If applicable, remove the M6 threaded bolts ②.
☞ Remove the orange-colored lid ① from the housing.

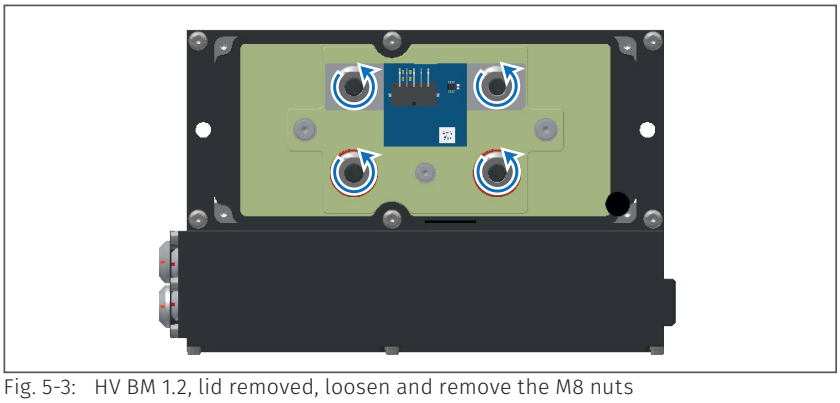


Fig. 5-3: HV BM 1.2, lid removed, loosen and remove the M8 nuts

☞ Loosen and remove the M8 nuts (↻) that have been fitted on the threaded bolts.

5.2.3 Connecting the HV power cables to HV BM 1.1/HV BM 1.2 devices

5.2.3.1 Connections for HV- and HV+ power cables

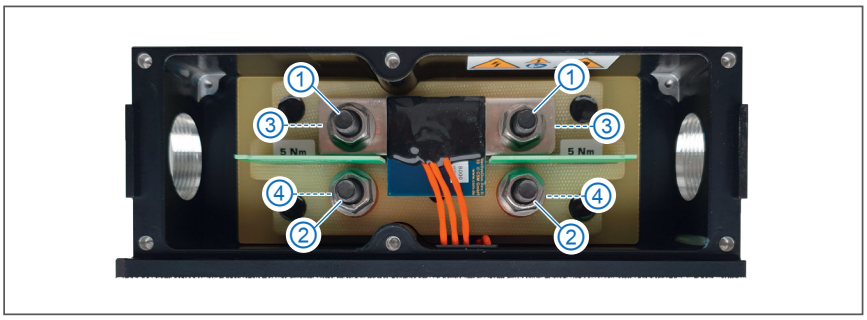


Fig. 5-4: HV BM 1.1 (as of HW rev. D), connections for HV power cables

For mounting the HV power cables, HV BM 1.1 and HV BM 1.2 are equipped with four threaded bolts[15]:

- two for connecting the HV- power cables to the shunt module (Fig. 5-4 / Fig. 5-5 ①)
- two for connecting the HV+ power cables to the busbar (Fig. 5-4 / Fig. 5-5 ②).

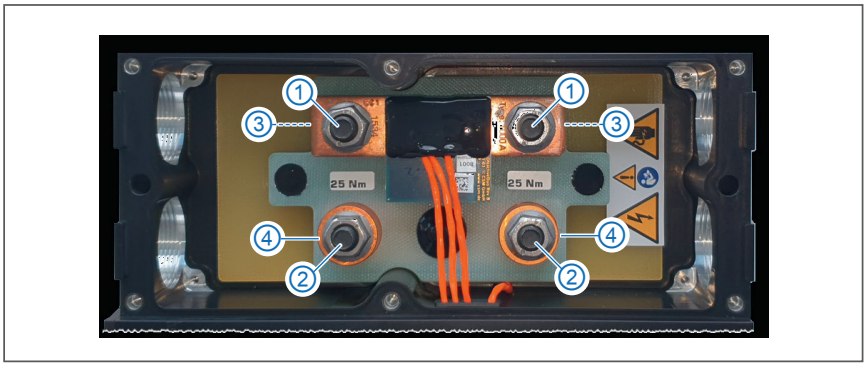


Fig. 5-5: HV BM 1.2 (as of HW rev. E), connections for HV power cables

Mounting the HV- power cables

The ring terminals of the HV- power cables rest on the shunt module, which has been placed on the threaded bolts (Fig. 5-4 / Fig. 5-5, ①) using spacer sleeves (Fig. 5-4 / Fig. 5-5, ③).

→ Chapter 5.2.3.2 "Connecting the HV- power cables to the shunt module"

Mounting the HV+ power cables

The ring terminals of the HV+ power cables are placed on the threaded bolts (Fig. 5-4 / Fig. 5-5, ②) and rest on the copper domes (Fig. 5-4 / Fig. 5-5, ④) of the cable feedthrough.

→ Chapter 5.2.3.3 "Connecting the HV+ power cables on the busbar side"

15 By default, the M8 nuts for mounting the HV power cables are mounted on the threaded bolts.

5.2.3.2 Connecting the HV- power cables to the shunt module

NOTE!	
	The mounting instructions in this chapter refer to module types HV BM 1.1 (as of HW rev. E) and HV BM 1.2 (as of HW rev. D) with frequency-response-optimized shunt modules (as of HW rev. C000).[16] For measurement and shunt modules with older hardware revisions, different mounting instructions apply when connecting the HV power cables. The differences are described in a previous version of this user guide. ☞ Please contact Vector Support if you need this user guide.

When installing the HV power cables on shunt modules with HW revision C000 or later, the shunt module rests on the spacer sleeves regardless of the cross-section of the HV power cables (Fig. 5-6).

The ring terminals are placed on the threaded bolts as shown in Fig. 5-7 and Fig. 5-8 and fastened with M8 nuts and washers.

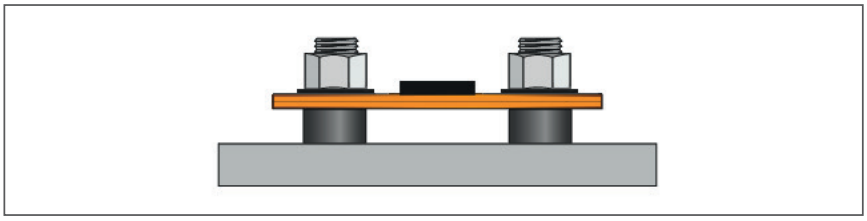


Fig. 5-6: Shunt module (HW rev. C000), HV power cables not connected

☞ Loosen the M8 nuts to mount the HV power cables.

☞ Remove the M8 nuts and washers from the threaded bolts.

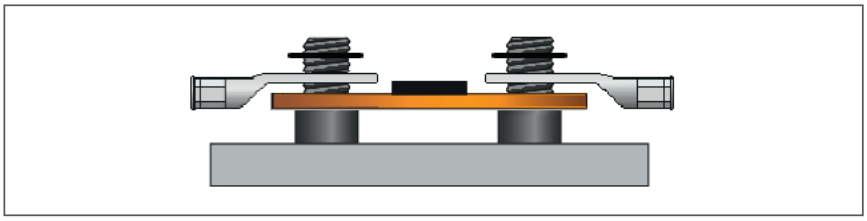


Fig. 5-7: HV- power cables, placing the ring terminals and the washers on the threaded bolts

☞ Place the ring terminals on the threaded bolts as shown in Fig. 5-7.

☞ Place the washers on top.

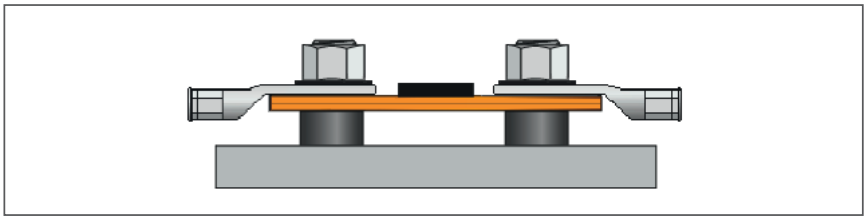


Fig. 5-8: HV- power cables, fasten the ring terminals using the M8 nuts

☞ Fasten the ring terminals with the M8 nuts and tighten to the specified torque (Tab. 5-1).

16 The hardware revision number can be found on the type label of the shunt module (chapter 6.1 "Type labels").

5.2.3.3 Connecting the HV+ power cables on the busbar side

The HV+ power cables are mounted as shown below.

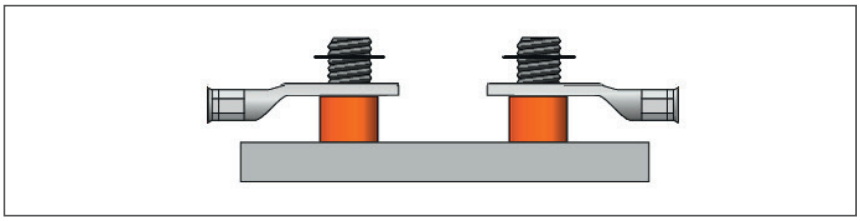


Fig. 5-9: HV+ power cables, place the ring terminals on the copper domes

☞ Place the ring terminals of the HV+ power cables on the copper domes as shown in Fig. 5-9.

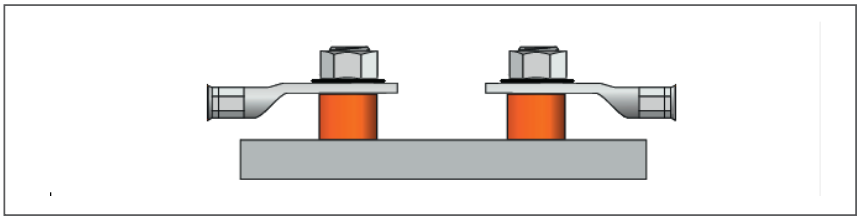


Fig. 5-10: HV+ power cables, fasten the ring terminals with M8 nuts

☞ Place the washers on the ring terminals.

☞ Fasten the ring terminals with the M8 nuts and tighten them with a torque of 25 Nm.

5.2.4 Mounting the cable glands and the lid of the housing

NOTE!	
	To prevent water ingress and condensation, the tightness of the housing has to be ensured. ☞ Check the housing's gasket surface for the orange lid and the gasket in the lid before attaching the lid. Damaged gaskets should be replaced. ☞ Make sure that lid and seal are properly fitted. ☞ Make sure that cable glands and HV power cables are properly mounted.

5.2.4.1 Mounting the cable glands

i	Make sure to slide the components of the cable glands onto the HV power cables *before* crimping the ring terminals. → Chapter 7.1.3 "Preparing the cable glands"

☞ Attach the double nipples of the cable glands with the springs inserted to the housing and fasten them by hand. Make sure that there is full contact between the springs and the stripped shields of the HV power cables.

☞ Screw the pressure screws with the sealing inserts to the double nipples and tighten them by hand.

☞ Tighten the pressure screws and double nipples to the specified torque. Please observe the mounting instructions of the manufacturer at www.pflitsch.de.

5.2.4.2 Mounting the lid of the housing

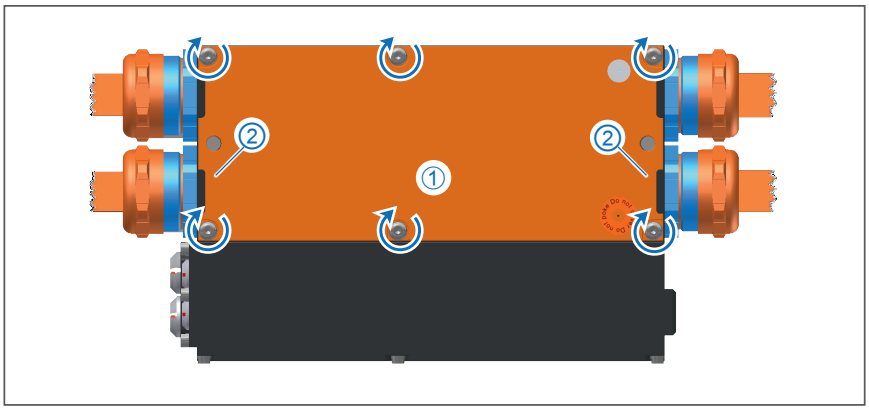


Fig. 5-11: HV BM 1.2, HV power cables and lid mounted

☞ Place the orange lid ① on the housing.

☞ Mount the lid on the housing using the Allen screws (↻).

☞ If applicable, re-mount the M6 threaded bolts ②.

5.3 Connecting the shields using the M3 threaded holes

As an alternative to the connection via cable glands (chapter 5.2.2), the shields can also be connected to the module housing using the four M3 threaded holes (◯)

NOTE!	
	The stripping dimensions of the HV power cables depend on whether the braided shields are connected to the module housing via the cable glands or by using the M3 threaded holes. → Chapter 7.1.5 "Preparing HV power cables for HV BM 1.1 and HV BM 1.2"

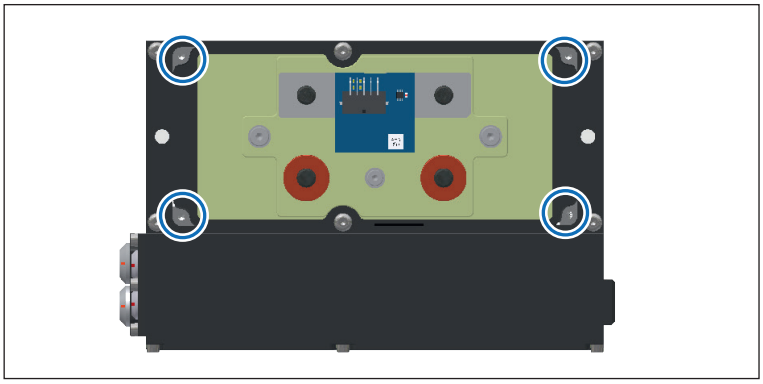


Fig. 5-12: HV BM 1.2, housing open, M3 threaded holes marked

Mounting the HV power cables

☞ Place the ring terminals for the inner conductors on the threaded bolts.

☞ Fasten the ring terminals for the inner conductors with the M8 nuts. Observe the tightening torques specified in Tab. 5-1 when tightening the nuts.

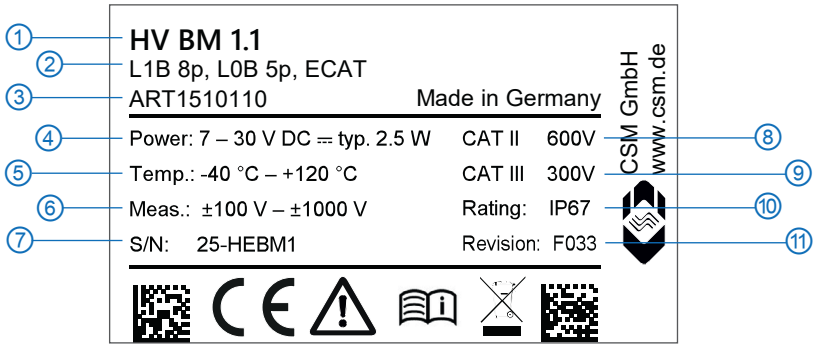
☞ Fasten the ring terminals for the braided shields with the M3 screws and washers.

→ See chapter 5.2 "Connecting the HV power cables".

6 Maintenance and Cleaning

6.1 Type labels

6.1.1 Measurement module

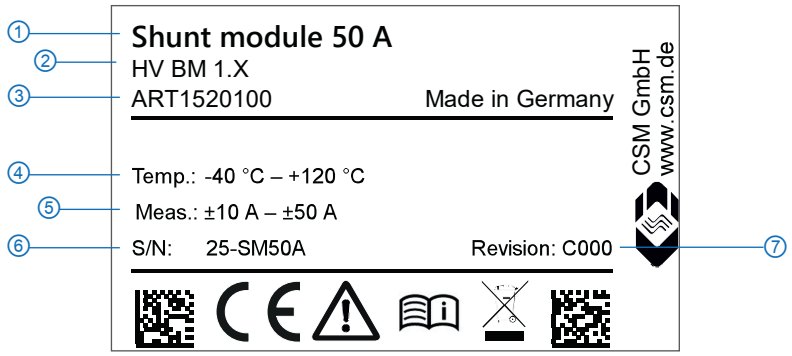


①	HV BM 1.1	Device type
②	L1B 8p, L0B 5p, ECAT	Device details: ▸ L1B 8p - EtherCAT® sockets: LEMO 1B, 8-pole ▸ L0B 5p - CAN sockets: LEMO 0B, 5-pole ▸ ECAT - bus system
③	ART1510110	Part number of the measurement module
④	Power: 7 – 30 V DC, typ. 2.5 W	Power supply range, typical power consumption
⑤	Temp.: -40 °C – +120 °C	Operating temperature range
⑥	Meas.: ±100 V – ±1 kV	Measurement ranges
⑦	S/N: HEBM1	Measurement module serial number
⑧	CAT II: 600 V	Measurement category II [17]
⑨	CAT III: 300 V	Measurement category III [17]
⑩	Rating: IP67	Protection class
⑪	Revision: F033	Hardware revision number

Tab. 6-1: Type label measurement module

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

6.1.2 Shunt module



①	Shunt module 50 A	Shunt type/nominal current of the shunt module
②	ART1520100	Part number
③	Temp.: -40 °C – +120 °C	Operating temperature range
④	Meas.: ±10 A – ±50 A	Measurement ranges
⑤	S/N: 25-SM50A	Serial number of the shunt module
⑥	Revision: C000	Hardware revision number

Tab. 6-2: Type label shunt module

6.2 Maintenance services

The following testing certificates are issued for HV BM 1.x measurement modules:

- DIN EN ISO/IEC 17025 calibration certificates for U and I
- Testing certificate (HV isolation test)

This is documented by corresponding labels attached to the rear or the top side of the module housing.

Fig. 6-1: DIN EN ISO/IEC 17025 calibration label

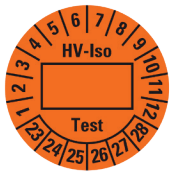


Fig. 6-2: High-voltage isolation test label

NOTE!

An isolation test is required every 12 months in order to ensure the measurement module's operational safety.

☞ Make sure that a high-voltage isolation test according to the latest edition of EN 61010 is carried out at least every 12 months.

To ensure reliability and functionality, a measurement module should be checked at least every 12 months. Vector offers maintenance packages and a repair service for this purpose.

- HV isolation test (functional testing included)
- DIN EN ISO/IEC 17025 calibration (including function test)
- Repair service

Monitoring of calibration due date[18]

The feature for calibration due date monitoring provides the option to specify the period of time for which the calibration of a module is valid (**Calibration interval**). In addition, it is possible to define the period of time during which CSMconfig indicates the impending expiration of the validity of the calibration with recurring messages (**Lead warn time**).

☞ Select **Options | Settings** from the menu.

⇨ The **Program Settings** dialog opens.

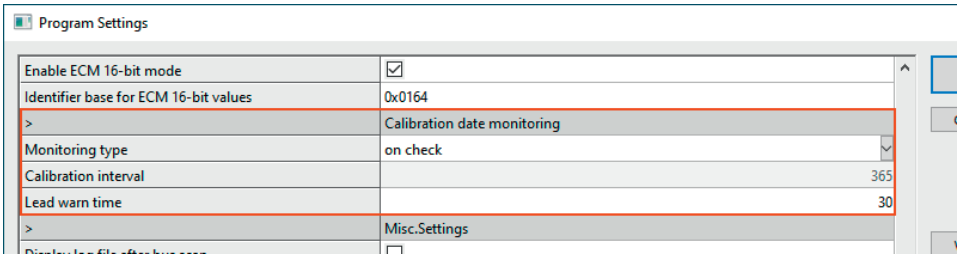


Fig. 6-3: **Program Settings** dialog, **Calibration date monitoring** section

☞ Make the required settings in section **Calibration date monitoring**.

→ *CSMconfig online help, "Program Settings"*

6.3 Cleaning instructions

WARNING!	
	HV Breakout Modules are used in high-voltage applications. **Improper use may result in life-threatening electrical shocks.** ☞ Observe safety instructions.

NOTE!	
	☞ De-energize the measurement module before starting to work.

NOTE!	
	The surface of the housing is sensitive to aggressive cleaning agents, solvents and abrasive media. ☞ Do not use aggressive cleaning agents or solvents to clean the measurement module. ☞ Use only a moist cloth.

18 When monitoring the calibration date, CSMconfig checks the date that has been written to the measurement module during calibration. The calibration date is only available if the measurement module has been calibrated at the CSM calibration laboratory.

7 Appendix

7.1 Preparing HV power cables

7.1.1 General information

The following sections contain information on how to mount HV power cables to the various types of HV Breakout Modules.

	NOTE!
	Vector provides sets of ring terminals for module type HV BM 1.1 (Tab. 7-1), which are designed for the limited space available in the HV Breakout Module and for the dimensions of shielded two-core high-voltage power cables with conductors made of copper in accordance with LV 216-2 Tables A.5.1 and A.5.2. For the module type HV BM 1.2, Vector provides sets of ring terminals (Tab. 7-1) that are designed for the limited space available in the HV Breakout Module and for the dimensions of shielded single-core high-voltage power cables with fine-stranded copper conductors in accordance with LV 216-2 Table A.2.

7.1.2 Components for mounting HV power cables

Cross section	Cable (example)	Ring terminals	Cable gland
2× 6 mm²	Coroflex FHLR2GCB2G 2× 6 mm²	ART1520532 Ring Terminal Set 6 mm² HV BM 1.1	ART1520202 Cable gland set 9/14 HV BM
16 mm²	Coroflex FHLR2GCB2G 16 mm²	ART1520521 Ring Terminal Set 16 mm² HV BM 1.2	ART1520202 Cable gland set 9/14 HV BM
25 mm²	Coroflex FHLR2GCB2G 25 mm²	ART1520522 Ring Terminal Set 25 mm² HV BM 1.2	ART1520202 Cable gland set 9/14 HV BM
35 mm²	Coroflex FHLR2GCB2G 35 mm²	ART1520523 Ring Terminal Set 35 mm² HV BM 1.2	ART1520201 Cable gland set 11/20 HV BM
50 mm²	Coroflex FHLR2GCB2G 50 mm²	ART1520544 Ring Terminal Set 50 mm² HV BM 1.2	ART1520201 Cable gland set 11/20 HV BM
70 mm²	Coroflex FHLR2GCB2G 70 mm²	ART1520545 Ring Terminal Set 70 mm² HV BM 1.2	ART1520201 Cable gland set 11/20 HV BM ART1520200 Cable gland set 15/25 HV BM
95 mm²	Coroflex FHLR2GCB2G 95 mm²	ART1520526 Ring Terminal Set 95 mm² HV BM 1.2	ART1520200 Cable gland set 15/25 HV BM

Tab. 7-1: Components for single- and two-core HV power cables

7.1.3 Preparing the cable glands

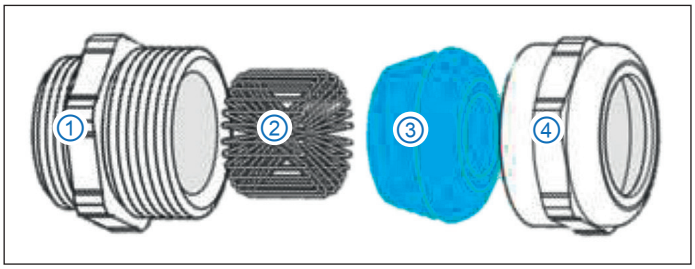


Fig. 7-1: Components of a cable gland with triangular spring 'TRI' contacting the braided shield

1. Double nipple
2. Triangular spring 'TRI'
3. Sealing insert
4. Pressure screw

i	The triangular springs (Fig. 7-1, ③) are needed to establish contact between the braided shield of the HV power cable and the module housing. If no contact between braided shield and housing is required, these springs can be omitted.

The two-part silicone sealing insert[19] with removable inlet has two zones (cable diameter): 1× with inlet and 1× without inlet. Fig. 7-2 shows the sealing insert of a cable gland with the sealing ranges 25 – 20 mm (without inlet) and 20 – 15 mm (with inlet). If necessary, the inlet has to be removed from the sealing insert.

Fig. 7-2: Cable gland with sealing insert

The following cable glands are available for mounting the HV power cables:

Cable gland type	9/14	11/20	15/25
Pflitsch designation	bg 220ms tri /sc	bg 225ms tri /sc	bg 232ms tri /sc
Sealing range w/o inlet	9 – 14 mm	16 – 20 mm	20 – 25 mm
Sealing range with inlet	—	11 – 16 mm	15 – 20 mm
Connecting thread	M20	M25	M32
Wrench width	SW24	SW30	SW36

Tab. 7-2: Technical data of the cable glands used

The scope of delivery of the **9/14** and **11/20** cable glands includes reducers from M32 to M20 and from M32 to M25.

The tightening torques for double nipples and pressure screws as well as further manufacturer information can be found in the product catalogue at www.pflitsch.de/en.

19 The sealing insert is not available for all cable glands, see Tab. 7-2.

7.1.4 Installation instructions for pressure screw and triangular spring

NOTE!	
	Depending on which HV power cables and cable glands are used, there is a risk of chafing. ☞ Protect the HV power cables with suitable heat-shrink tubing if required.

To ensure proper contact between the braided shield ① and the triangular spring ② in the cable gland (Fig. 7-3), the cable has to be mounted carefully, so that the position of the stripped cable matches that of the triangular spring.[20]

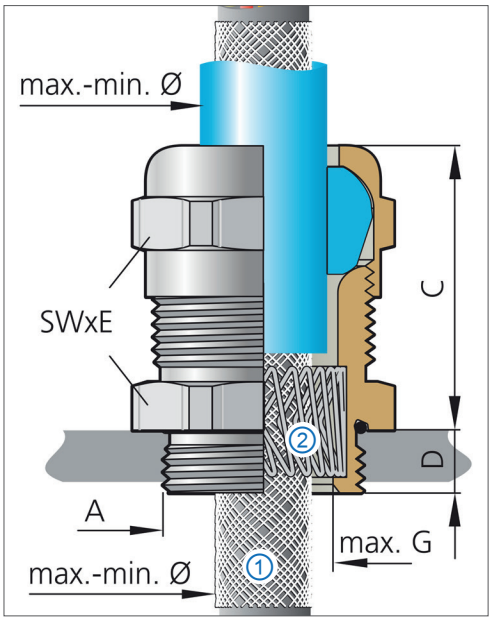


Fig. 7-3: Cable gland (longitudinal section)

i	These springs can be removed if the braided shields are soldered to the feedthrough.

To establish a good electrical connection between module housing and the braided shield of the cable, the triangular spring in the cable gland requires an approx. 10 mm long contact area on the cable shield (Fig. 7-4).

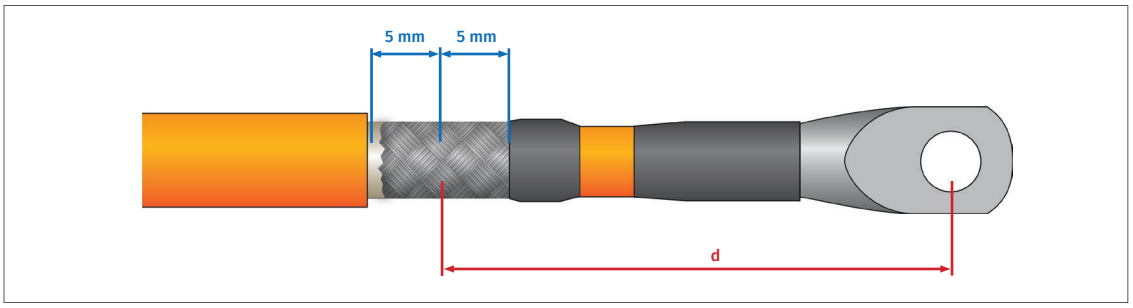


Fig. 7-4: HV power cable, contact area for spring

- without reducer (M32): d = 70 mm
- with reducer (M32 to M25 or M20): d = 74 mm

20 For further information on Pflitsch blueglobe TRI cable glands, see the Pflitsch Cable Gland Catalogue at www.pflitsch.de/en.

If a reducer is used, as shown in the right-hand illustration in Fig. 7-5, the overall length of the cable gland increases by 4 mm, i.e. this increases the distance between the ring terminal and the area of the HV power cable that needs to be stripped to establish contact between the TRI spring and the shielding (Fig. 7-4). This must be kept in mind when preparing an HV power cable.

Fig. 7-5: Cable gland: without reducer (left) and with reducer (right) ①

NOTE!	
	Please note that the use of a reducer increases the overall length of a cable gland. If a reducer from M32 to M25 or M20 is used, the overall length of the cable gland is increased by approx. 4 mm (Fig. 7-4).

7.1.5 Preparing HV power cables for HV BM 1.1 and HV BM 1.2

NOTE!	
	The information in this chapter applies when contacting the braided shields via the cable glands. When the braided shields are connected via the M3 threaded holes, different dimensions for the stripping of the cables apply. → Chapter 7.1.6 "Preparing the HV power cables when connecting the braided shields to the M3 threaded holes"

The data in Tab. 7-3 applies to the assembly of the power cables HV- and HV+ for both module types, i.e., HV BM 1.1 and HV BM 1.2.

Cable cross section	Stripping length of outer sheath	Length of braided shield	Stripping length of inner sheath
2× 6 mm²	75 mm	17 mm	-
35 mm²	65 mm	17 mm	20 mm
50 mm²	62 mm	17 mm	12 mm
70 mm²	55 mm	17 mm	15 mm
95 mm²	55 mm	17 mm	25 mm

Tab. 7-3: Dimensions for the preparation of HV power cables for module types HV BM 1.1 and HV BM 1.2

7.1.5.1 Preparing single- and two-core HV power cables (HV BM 1.2 and HV BM 1.1)

i	The steps 1 to 5 for the installation described below are identical for single-core cables (HV BM 1.2) and two-core cables (HV BM 1.1). The steps 6 to 8 differ depending on whether it is a single-core or a two-core HV power cable.

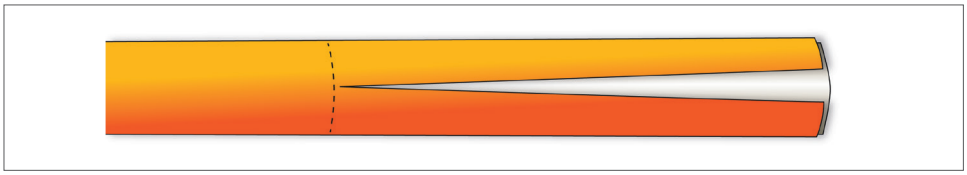


Fig. 7-6: Step 1: Removing the outer sheath

☞ Remove the required length of the outer sheath (Tab. 7-3). Make sure that the braided shield lying underneath will not be damaged.

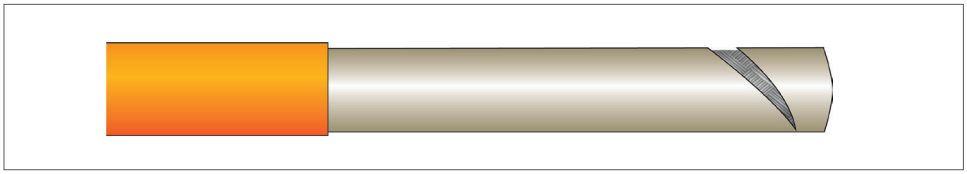


Fig. 7-7: Step 2: Removing the protective foil.

☞ Remove the protective foil from the braided shield.

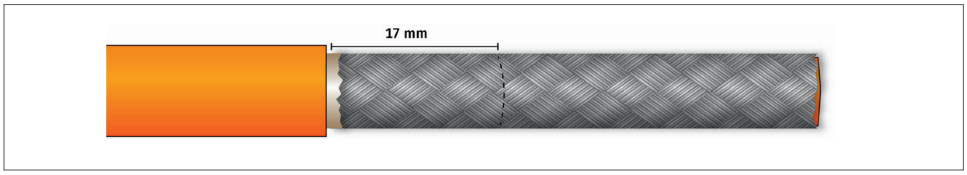


Fig. 7-8: Step 3: Applying the mark on the braided shield

☞ Mark a 17 mm long section on the braided shield.
☞ Remove the remaining braided shield.

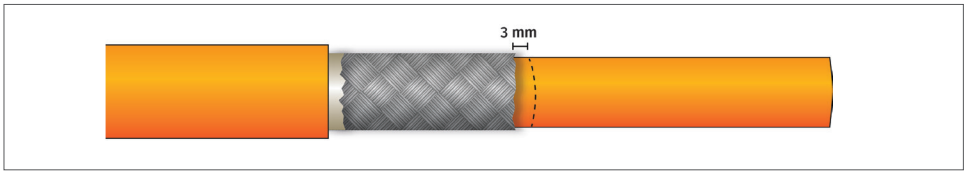


Fig. 7-9: Step 4: Marking the inner sheath

☞ Apply a mark on the inner sheath with a distance of 3 mm to the end of the braided shield.

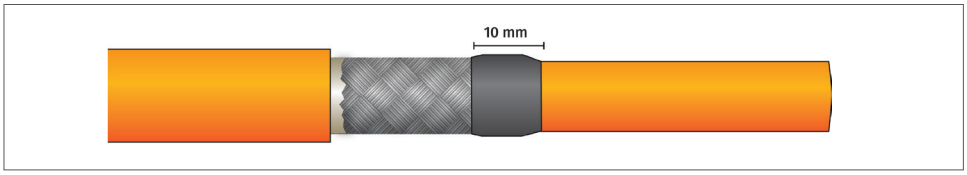


Fig. 7-10: Step 5: Attaching and fixing the heat-shrink tubing

☞ Slide a 10 mm long piece of heat-shrink tubing over the HV power cable up to the mark (Fig. 7-9).
☞ Fix the heat-shrink tubing by applying heat.

7.1.5.1.1 Single-core cable (HV BM 1.2)

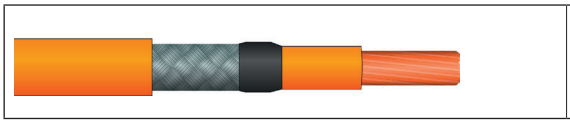


Fig. 7-11: Step 6: Stripping the inner sheath

☞ Remove the inner sheath to the required length (Tab. 7-3).

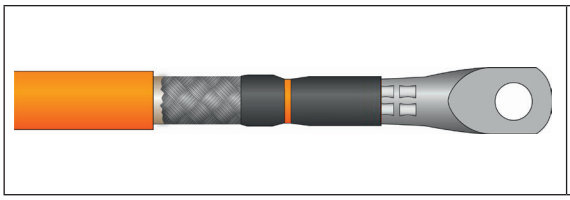


Fig. 7-13: Step 7: Sliding the heat-shrink tubing over the cable and attaching the ring terminal

☞ Slide an approx. 25 mm long piece of heat-shrink tubing over the inner sheath.

☞ Attach the ring terminal to the stripped conductor.

☞ Use the crimping pliers to crimp the ring terminal.

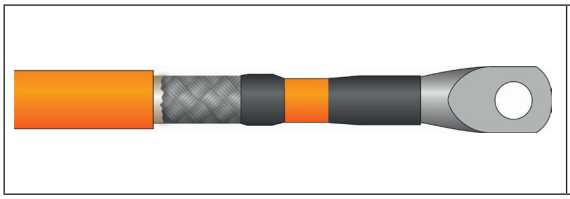


Fig. 7-15: Step 8: Placing/fixing the heat-shrink tubing

☞ Slide the heat-shrink tubing over the crimped end of the ring terminal, so that the end of the ring cable lug is sufficiently covered.

☞ Fix the heat-shrink tubing.

7.1.5.1.2 Two-core cable (HV BM 1.1)

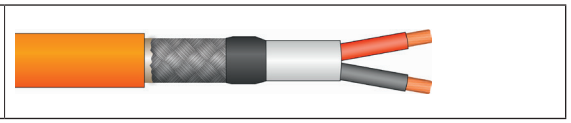


Fig. 7-12: Step 6: Stripping inner sheath/single wires

☞ Strip the inner sheath to 30 mm.

☞ Strip the black and red single wires to 8 mm each.

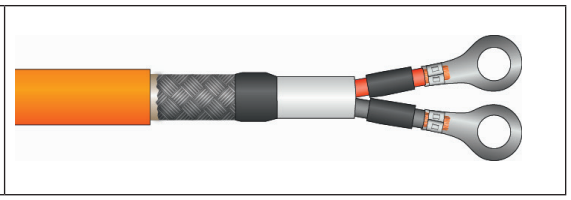


Fig. 7-14: Step 7: Fitting the heat-shrink tubings and attaching the ring terminals

☞ Slide a sufficiently long piece of heat-shrink tubing over each single wire.

☞ Attach the ring terminals to the stripped wires.

☞ Use the crimping pliers to crimp the ring terminals.

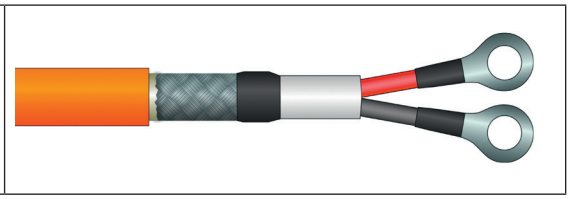


Fig. 7-16: Step 8: Placing/fixing the heat-shrink tubings

☞ Slide the heat-shrink tubings over the crimped ends of the ring terminals so that the crimped ends and the red or black sheath of the individual wires are sufficiently covered.

☞ Fix the heat-shrink tubings.

→ Chapter 5.2 "Connecting the HV power cables"

7.1.6 Preparing the HV power cables when connecting the braided shields to the M3 threaded holes

7.1.6.1 Cable glands

Connecting the braided shields via the M3 threaded holes in the module housing is suitable for the module types HV BM 1.1 and HV BM 1.2.

NOTE!	
	If the braided shields are connected via the M3 threaded holes, the triangular springs have to removed from the cable glands.

→ Fig. 7-1 and chapter 7.1.3 "Preparing the cable glands"

7.1.6.2 Preparing the single-core HV power cables

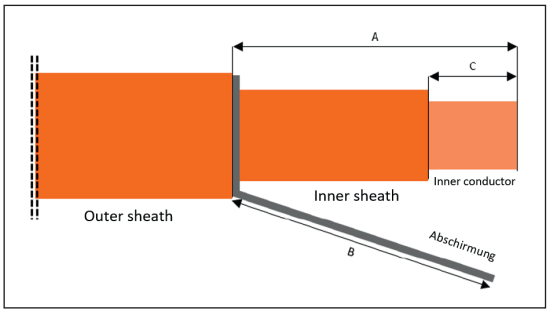


Fig. 7-17: Dimensions for the preparation of single-core HV power cables

Fig. 7-17 shows an example of specifications for the mounting of a single-core HV power cable when the braided shield is connected using the M3 threaded holes. The stripping lengths for **A**, **B** and **C** depend on the cross-sections of the HV power cable being used (Tab. 7-4).

Cable cross section	A – Stripping length of outer sheath	B – Length of braided shield	C – Stripping length of inner sheath
16 mm²	35 mm	30 mm	15 mm
35 mm²	50 mm	40 mm	20 mm
50 mm²	45 mm	40 mm	14 mm
70 mm²	40 mm	40 mm	18 mm
95 mm²	40 mm	40 mm	25 mm

Tab. 7-4: Dimensions for the preparation of single-core HV power cables

Preparing HV power cables (single-core)

- ☞ Remove the outer sheath in the required length (Tab. 7-4, **A**). Make sure that the braided shield lying underneath will not be damaged.
- ☞ Remove the protective foil from the braided shield.
- ☞ Twist the braided shield into a strand and shorten it to the required length (Tab. 7-4, **B**).
- ☞ Remove the inner sheath in the required length (Tab. 7-4, **C**).
- ☞ Attach ring terminals to the stripped inner conductor (inner conductor current measurement) and the strand of braided shield. Observe the orientation of the ring terminals.
- ☞ Crimp the ring terminal (inner conductor).
- ☞ Crimp the ring terminal for the braided shield.

☞ Slide a piece of heat-shrink tubing in the required length onto the strand of braided shield and fix it by applying heat.

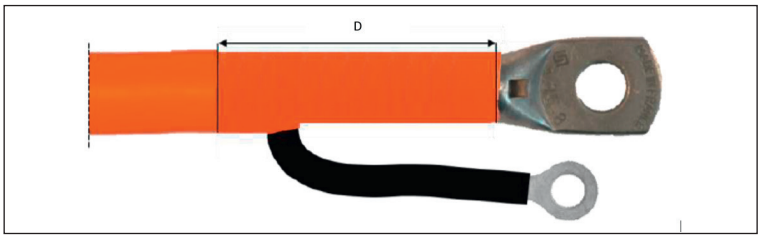


Fig. 7-18: Single-core HV power cable: stripped section (D)

☞ Double-wrap the stripped section on the HV power cable (Fig. 7-18, **D**) with insulating tape.

7.1.6.3 Preparing two-core HV power cables

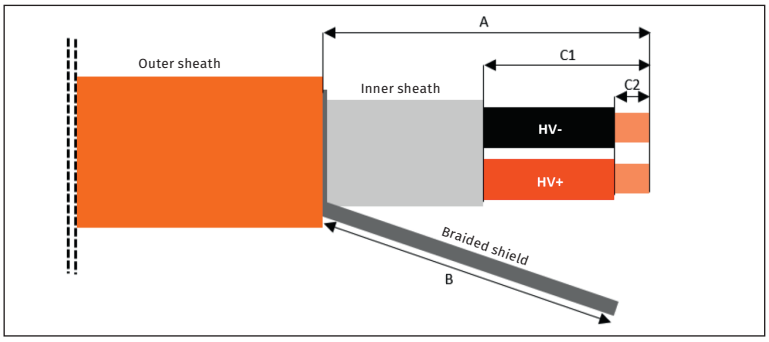


Fig. 7-19: Dimensions for the preparation of two-core HV power cables

Fig. 7-19 shows an example of specifications for the preparation of a two-core HV power cable when the braided shield is connected by using the M3 threaded holes. The stripping lengths for **A**, **B**, **C1** and **C2** depend on the cross-section of the HV power cable being used (Tab. 7-5).

Cable cross section	A – Stripping length of outer sheath	B – Length of braided shield	C1 – Stripping length of inner sheath	C2 – Stripping length of single wires
2× 6 mm²	60 mm	50 mm	30 mm	6 mm

Tab. 7-5: Dimensions for the preparation of two-core HV power cables

Preparing two-core HV power cables

☞ Remove the outer sheath in the required length (Tab. 7-5, **A**). Make sure that the braided shield lying underneath will not be damaged.

☞ Remove the protective foil from the braided shield.

☞ Twist the braided shield into a strand and shorten it to the required length (Tab. 7-5, **B**).

☞ Remove the inner sheath in the required length (Tab. 7-5, **C1**).

☞ Strip the red and black single wires (Tab. 7-5, **C2**).

☞ Attach the ring terminals to the stripped wires.

☞ Crimp the ring terminals.

☞ Slide the heat-shrink tubing in the required length onto the strand of braided shield and fix it.

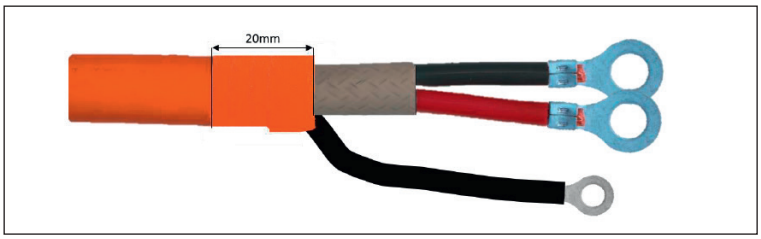


Fig. 7-20: Two-core HV power cable: apply insulating tape to the marked section

☞ Double-wrap the area marked in Fig. 7-20 (approx. 20 mm) on the HV conductor with insulating tape.

7.2 Distance between the threaded bolts used for connecting the shunt module

An HV Breakout Module that is only used temporarily can be removed from the HV power cable and bypassed. The distance between the two threaded bolts on which the shunt module is mounted is 60 mm for all HV Breakout Modules.

This distance is 60 mm for all HV Breakout Modules.

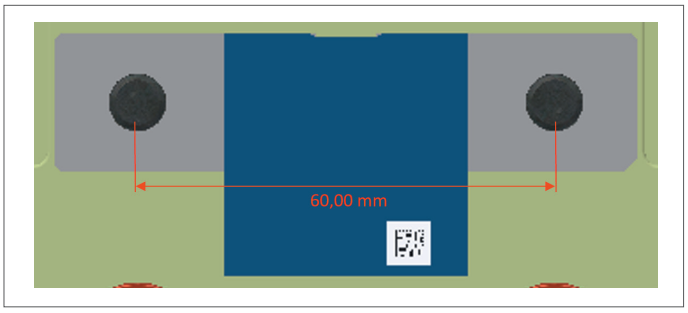


Fig. 7-21: Distance between threaded bolts

7.3 List of figures

7.4 List of tables

CSM GmbH

Raiffeisenstr. 36
70794 Filderstadt
Germany

Technical Questions:
www.csm.de/service-and-support

Sales Contact:
www.vector.com/contact

Part of the Vector Group