

# MCS - Modular Control System

## User Manual



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# 1 Manufacturer Declarations

## 1.1 Declaration of Conformity

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# Declaration of Conformity

according to ISO/IEC 17050-1:2004

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Manufacturer: SmarAct GmbH  
Manufacturer's Address: Schütte-Lanz-Straße 9  
26135 Oldenburg, Germany



**The manufacturer hereby declares that the product**

Product name: MCS  
Model Numbers: MCS-xxx  
Product Options: all

**complies – if installed in a compatible chassis from SmarAct – with the following European directives:**

2006/95/EC Low-voltage Directive  
2004/108/EC EMC Directive

**The applied standards certifying the conformity are listed below:**

**Electromagnetic Emission:** EN61000-6-3:2011, EN55011:2011

**Electromagnetic Immunity:** EN61000-6-1:2007

**Safety (Low Voltage Directive):** EN61010-1:2001

December 20, 2012  
Oldenburg, Germany

  
Axel Kortschack  
Managing Director

## 1.2 Warnings and Safety Instructions

Please note the following warnings and safety instructions carefully when using the product.

### 1.2.1 Danger - Hazardous Voltage

The MCS controller described in this manual is capable of generating high output currents at high voltages. They may cause serious or even lethal injury if used improperly.

- Do never touch any part that might be connected to an output with a high voltage.
- Do not connect products from other manufacturers to the output connectors.

Output connectors with dangerous signals are labelled with the following symbol:



Please note that the Sensor Modules connected to these connectors have pins with a high voltage, too.

### 1.2.2 Caution - Installation Instructions

The MCS controller must be installed horizontally with 3cm air circulation area behind the ventilator. Insufficient air flow can cause overheating, which can result in a limited functionality of the controller.

### 1.2.3 Caution - Connecting Instructions

The system is NOT hot-pluggable. Always make sure to power down the device before connecting or disconnecting any plugs! The only exception to this are the USB or Ethernet cables which may be removed or attached during operation. Note though that when removing the USB cable, all positioners will be stopped immediately as a safety precaution.

## 2 Introduction

This document is a user manual for the SmarAct Modular Control System (MCS). The MCS is designed to drive piezo based stepping actuators from SmarAct GmbH.

Each MCS control system consists of a main controller, an optional sensor module and an optional hand control module.

- **MCS main controller**

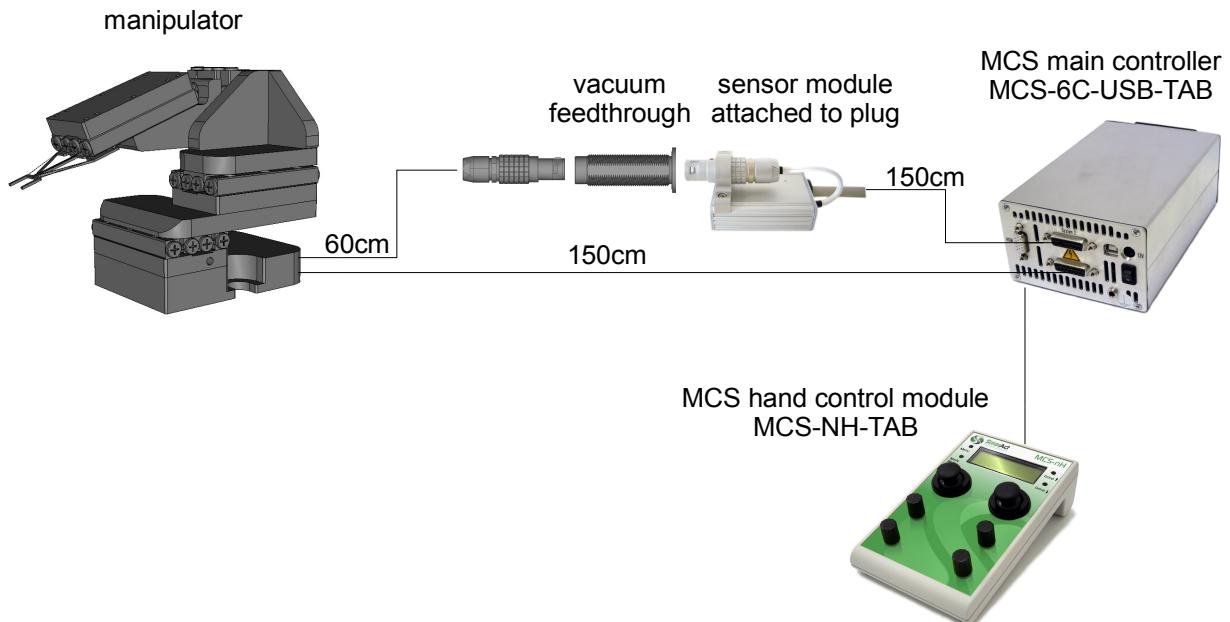
The main controller has the following tasks:

- process commands from the hand control module or from the PC
- read in the sensor data from the integrated position sensors (via sensor module)
- perform closed-loop position control
- drive the positioners

- **Sensor Module:** The positioners may be equipped with integrated sensors to perform closed-loop positioning control. For this, a sensor module preprocesses the sensor data and delivers the data digitised to the main controller. The sensor module is already on the main controller when it is a single-channel controller.

- **Hand Control Module:** The MCS offers easy and ready-to-go control by joysticks and control knobs - without the need of complex installation procedures. Please refer to the user manual of the three-channel MCS-3H-TAB hand control module or the N-channel MCS-NH-TAG hand control module.

Below please find a typical configuration with a six-channel controller, a three-channel sensor module, which is mounted to a plug as well as a hand control module.





Each MCS controller is equipped with one of the following three interfaces:

- **USB Interface Module:** The MCS may be controlled by software running on a PC. For this, we deliver the system with a graphical control program (PrecisionToolCommander), as well as a flexible and well documented Dynamic Link Library and Linux library, which you can integrate into your own software for your specific needs. For those who like to use LabVIEW, we provide ready-to-use VIs based on the DLL.
- **RS-232 Interface Module:** The MCS may be controlled by software running on a PC or controller via an RS-232 interface.
- **Network Interface Module:** The MCS may be controlled by software running on a PC. For this, we deliver the system with a graphical control program (PrecisionToolCommander), as well as a flexible and well documented Dynamic Link Library and Linux library, which you can integrate into your own software for your specific needs. For those who like to use LabVIEW, we provide ready-to-use VIs based on the DLL.

For more information on the available software please refer to the ***MCS Software Installation*** documentation that is in the main directory of the CD.

## 2.1 MCS Main Controller

### 2.1.1 Model and Connector Overview

There are many different types of controllers available. They differ by the type and number of driver boards, the integration of a hand control module as well as the computer interface and the housing. Each option has its own set of connectors.

Order Code	Description	connectors
<b>Controller Type (required)</b>		
MCS	MCS controller	
<b>Drivers (required, combinations possible)</b>		
-1CS, 1CM	1 stick-slip channel, integrated sensor module	1x D-SUB-15 female
-1CCS, 1CCM	1 stick-slip channel, high current, integrated sensor module	1x D-SUB-15 female
-1ES, 1EM	1 stick-slip / 0V channel, integrated sensor module	1x D-SUB-15 female
-1ECS, 1ECM	1 stick-slip / 0V channel, high current, integrated sensor module	1x D-SUB-15 female
-3C, -6C, -9C, ...	3 / 6 / 9 / ... stick-slip channels	1x, 2x, 3, ... D-SUB-15 female
-3CC, -6CC, -9CC, ...	3 / 6 / 9 / ... stick-slip channels, high current	1x, 2x, 3, ... D-SUB-15 female
-3E, -6E, -9E, ...	3 / 6 / 9 / ... stick-slip / 0V channels	1x, 2x, 3, ... D-SUB-15 female
-3EC, -6EC, -9EC, ...	3 / 6 / 9 / ... stick-slip / 0V channels, high current	1x, 2x, 3, ... D-SUB-15 female
-3P, -6P, -9P, ...	3 / 6 / 9 / ... Picoslide channels	1x, 2x, 3, ... D-SUB-25 female
<b>Hand Control Module (optional)</b>		
-3H	Internal Hand Control Module	--
<b>Interface (optional)</b>		
-USB	USB interface	USB socket, type B
-IUSB	internal USB interface (only at DIN connector)	---
-RS232	RS-232 interface	D-SUB-9 male
-ETH	Ethernet interface	RJ45 socket
-3/6/9...DU	direct voltage input	D-SUB-25 female

### Housing (required)

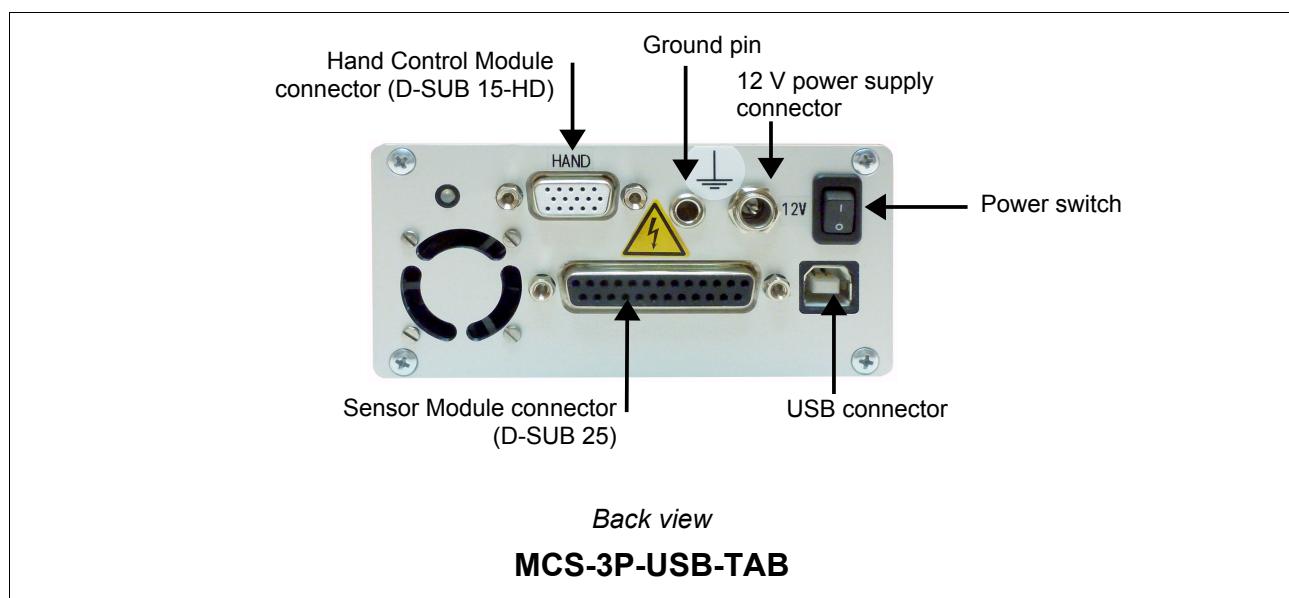
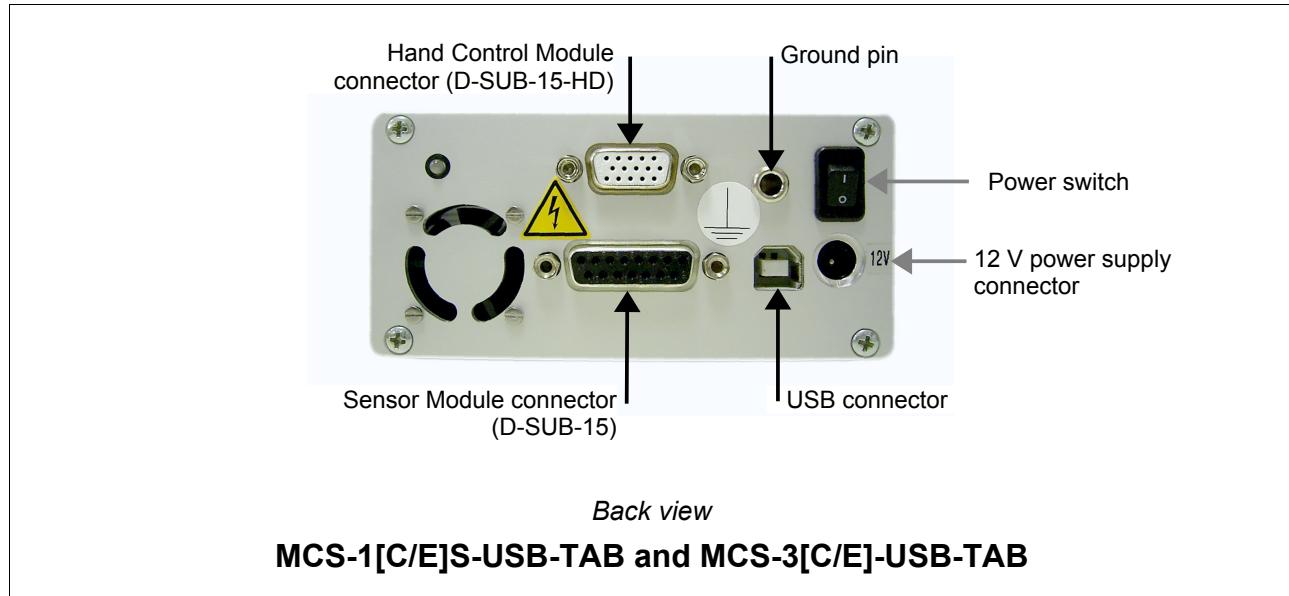
-OEM	OEM board	DIN C/3 connector
-MOD	19" rack module, 3U high	DIN C/3 connector
-TAB	Table-top housing	

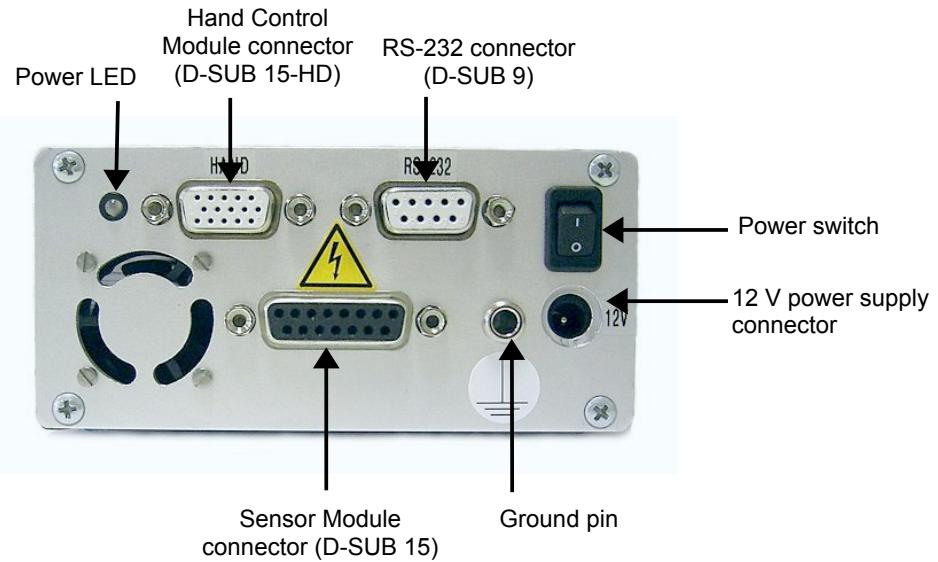
Order Code	Description	connectors
MCS-xxx-xxx-TAB	MCS controller in table-top housing	power supply connector
MCS-xxx-xxx-OEM	MCS OEM controller without housing	
MCS-xxx-xxx-TAB	MCS controller in table-top housing	ground pin: banana jack
MCS-xxx-xxx-TAB MCS-xxx-xxx-MOD without 3H	MCS controllers with housing and without integrated hand control module	hand control module interface: 1x D-SUB-15-HD female
-1ES, 1EM	1 stick-slip / 0V channel, integrated sensor module	1x D-SUB-15 female

### 2.1.2 Exemplary Connector Arrangement

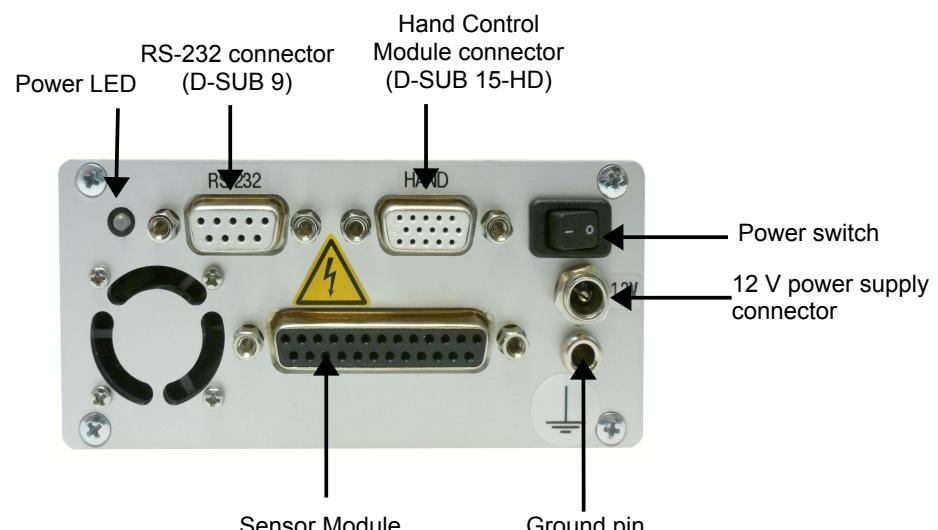
Below there are some examples for the connector arrangement:

The single-channel and three-channel controllers in table-top housings show all main connectors. Depending on the driver board and the computer interface the arrangement is a bit different.





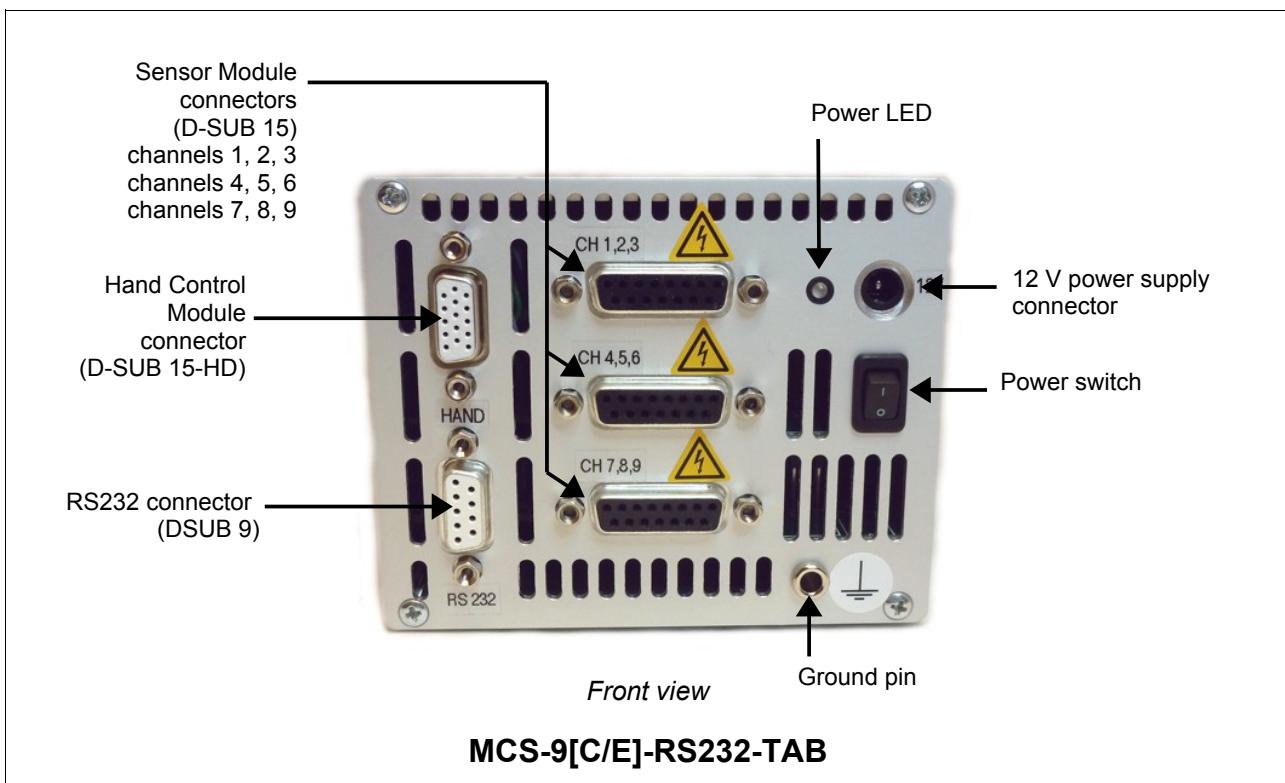
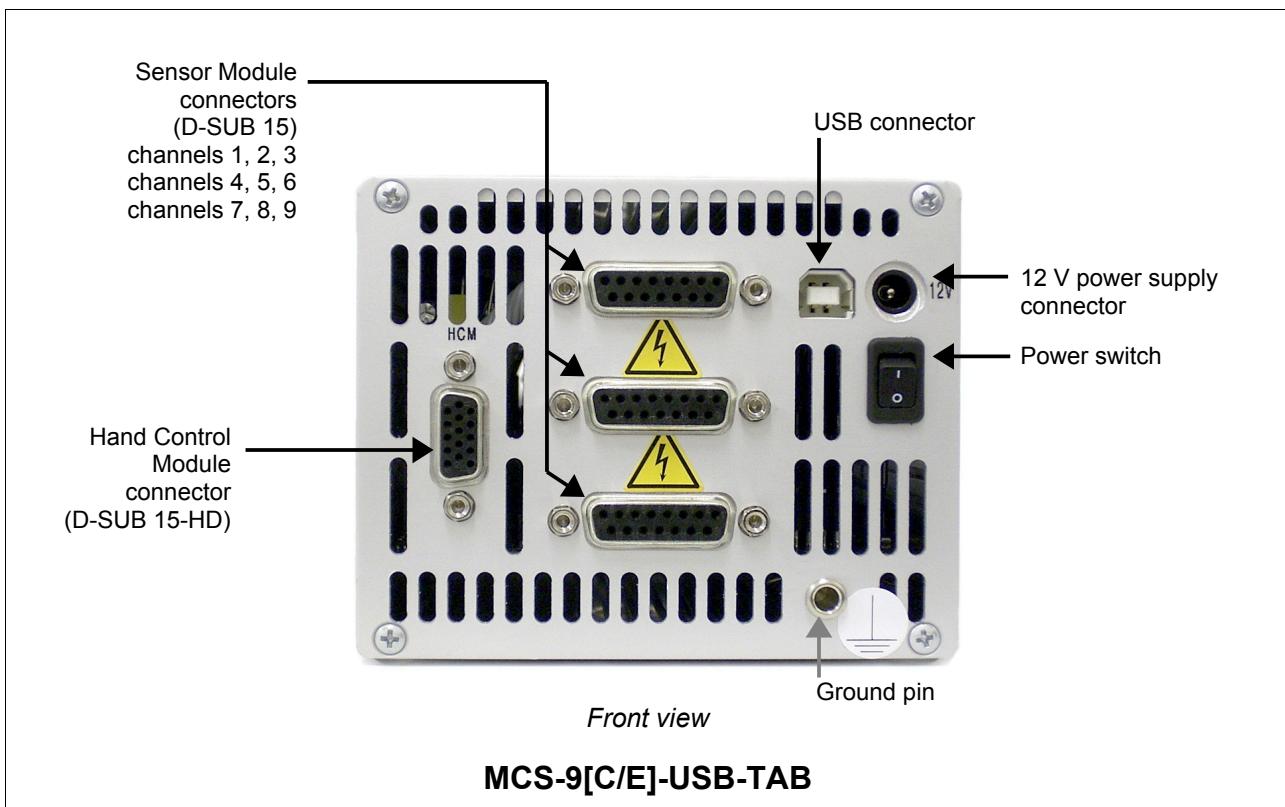
**MCS-1[C/E]S-RS232-TAB and MCS-3[C/E]-RS232-TAB**



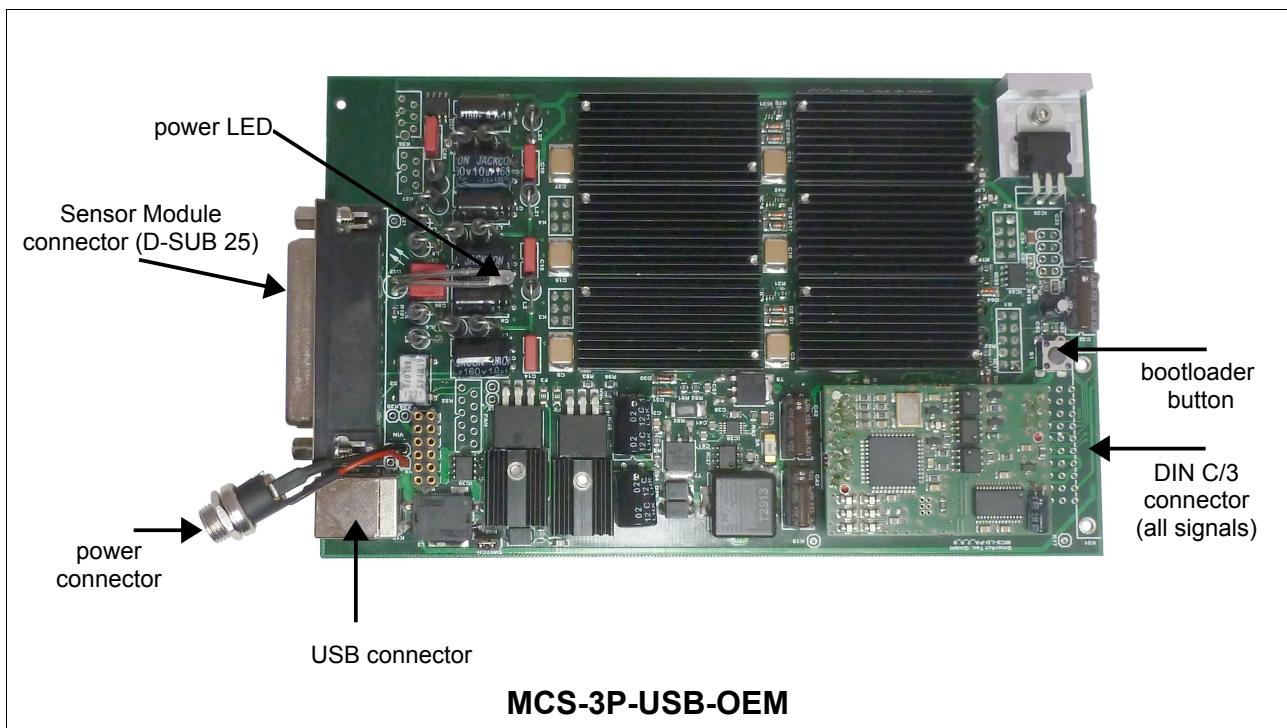
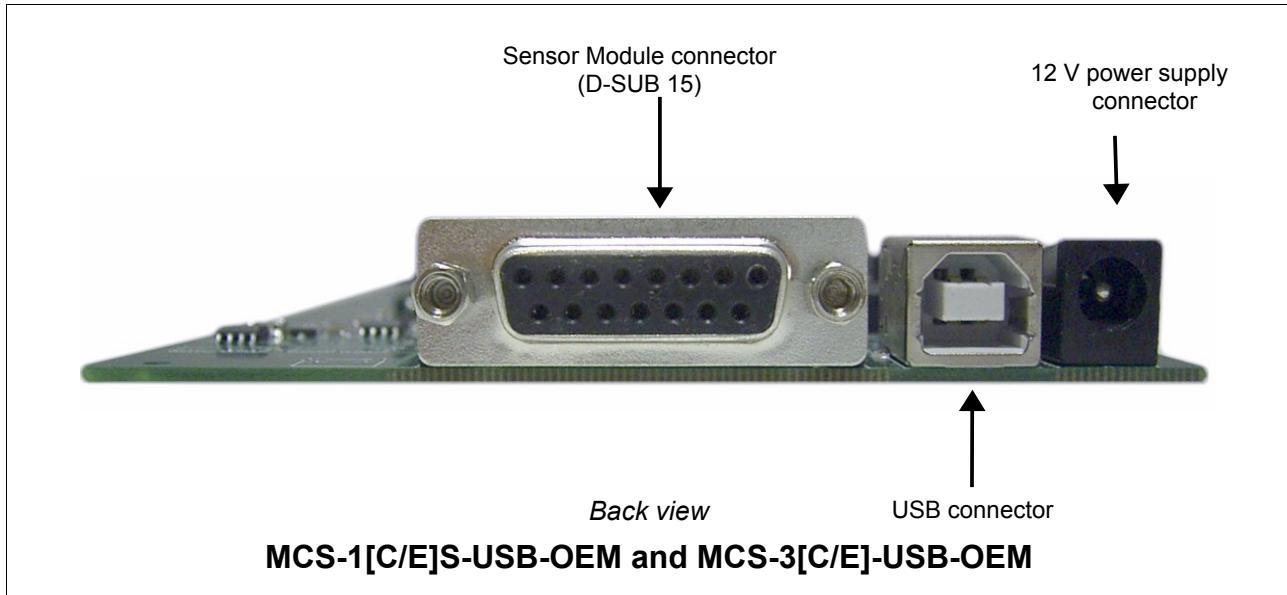
*Back view*

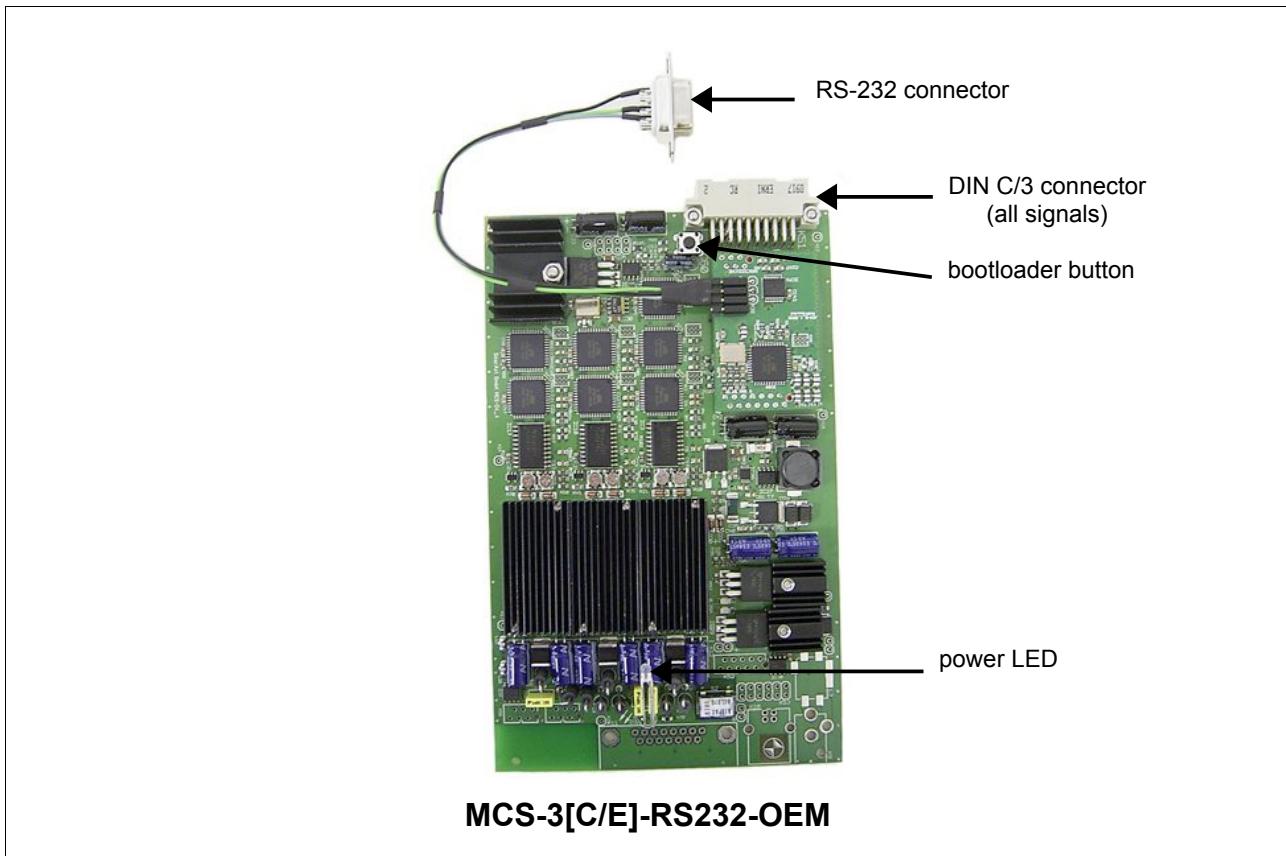
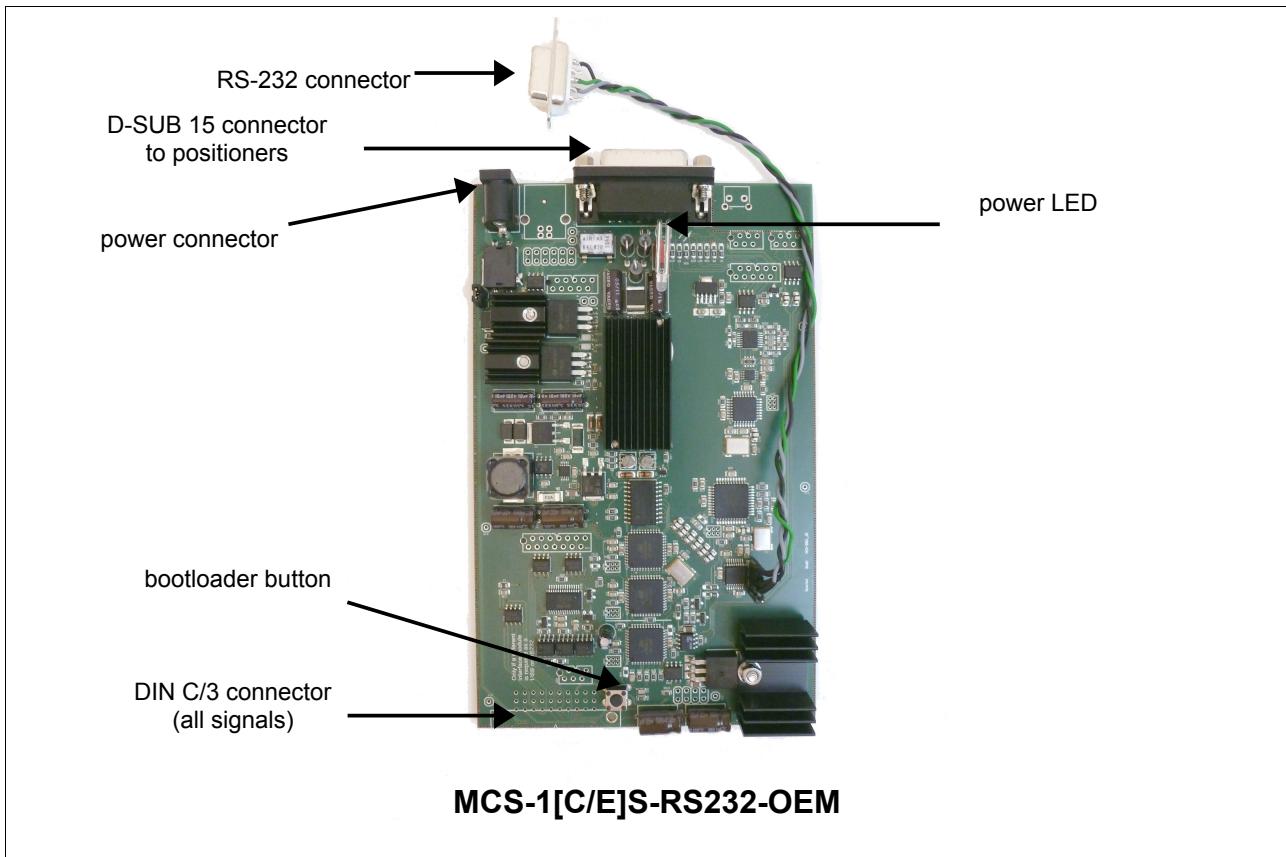
**MCS-3P-RS232-TAB**

Controllers with 6, 9, 12, 15, etc. channels that are delivered in a table-top housing have the same connectors as the controllers above but are equipped with additional D-SUB-15 connectors to the sensor modules.

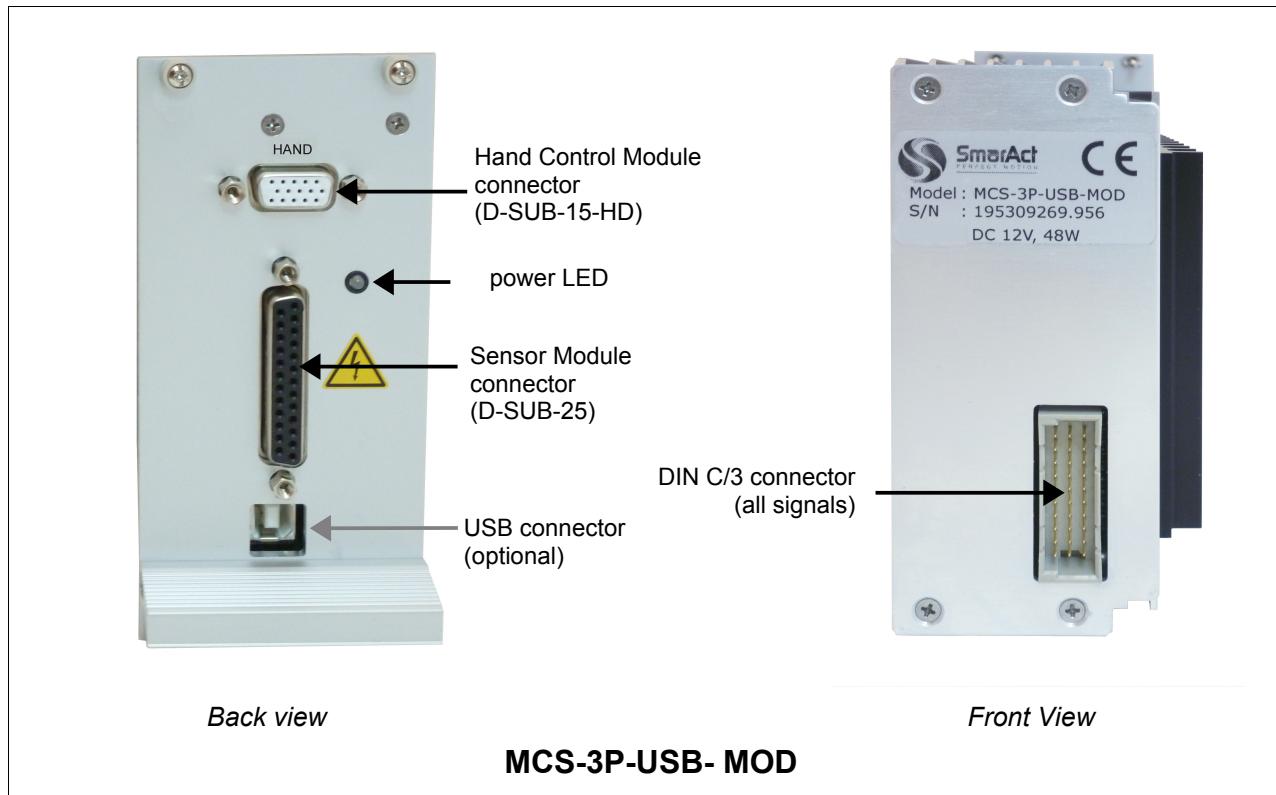
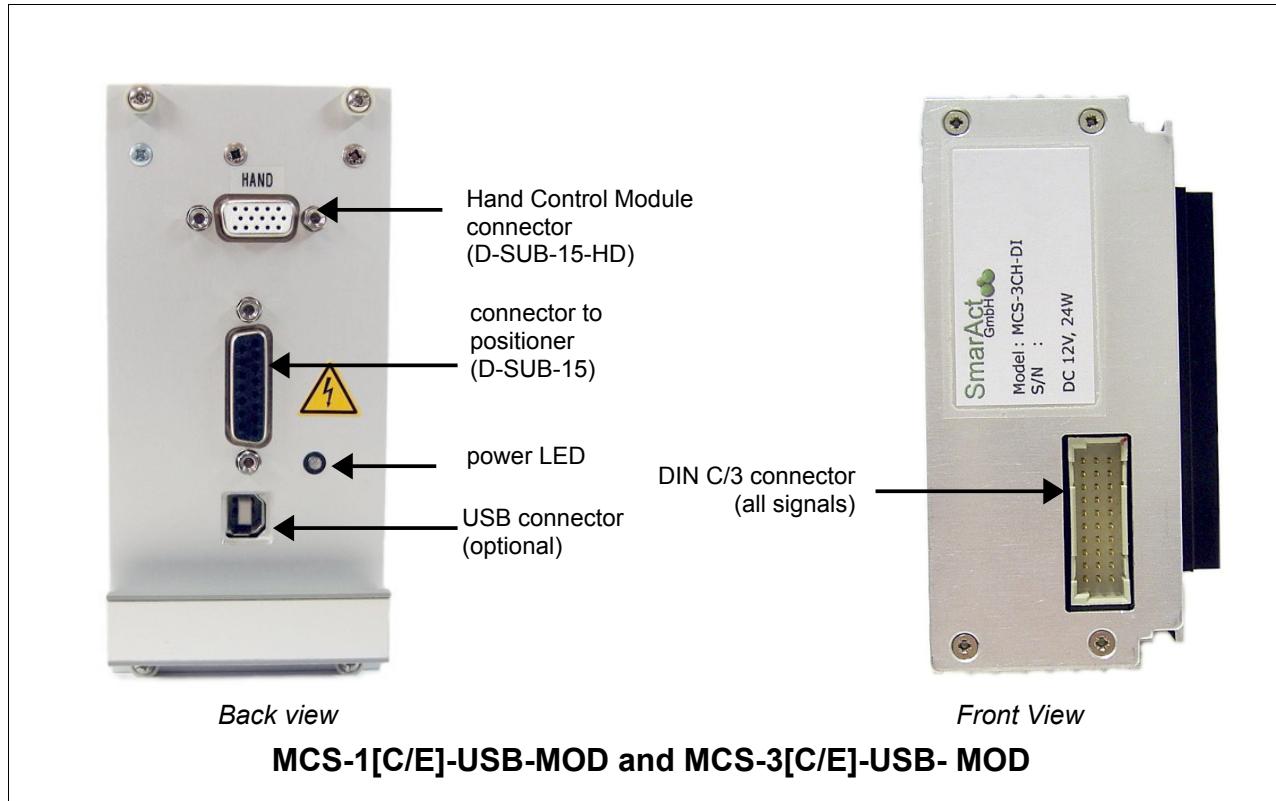


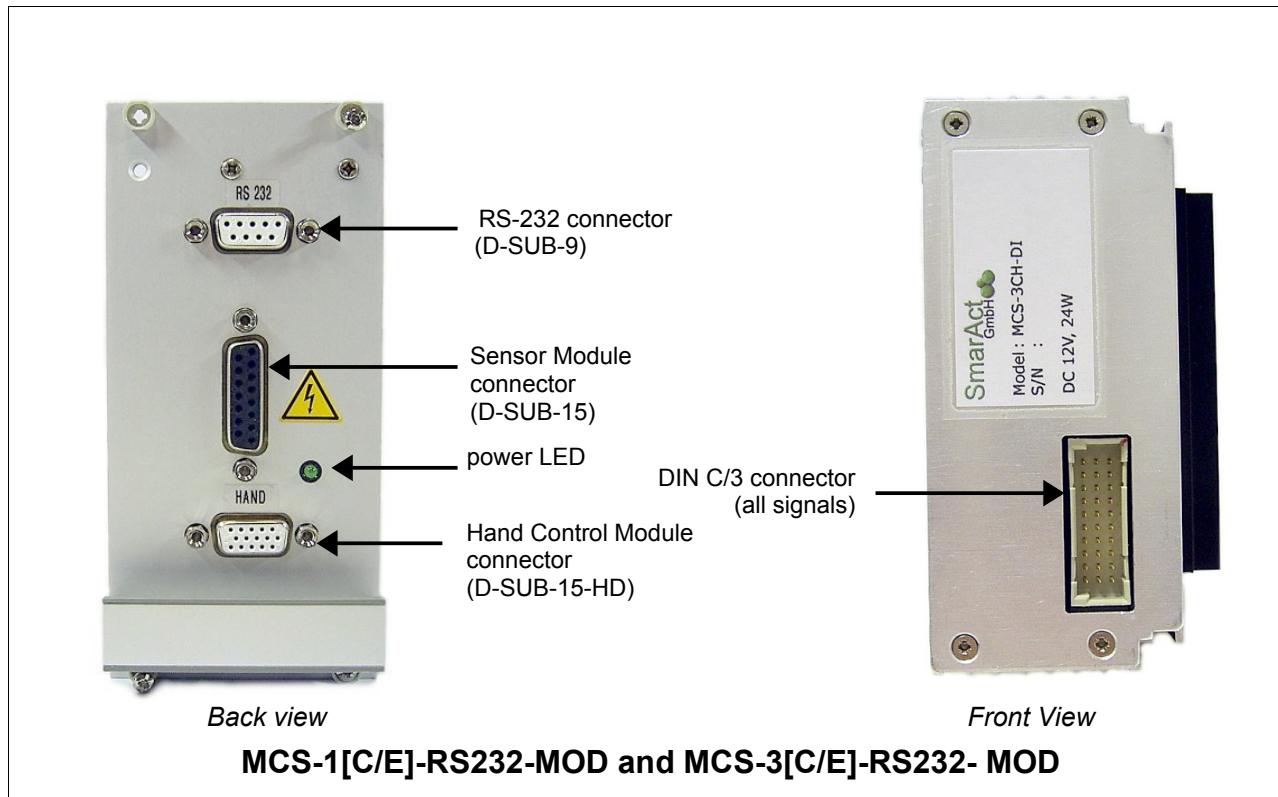
OEM controllers are delivered without housing and with a customer-specific assembly of the connectors.





Rack Modules are prepared for the integration into a SmarAct MCS-RACK-19 chassis. They are connected to the backplane of the chassis via a DIN C/3 connector. The connectors at the front side differ depending on the driver board and the interface.



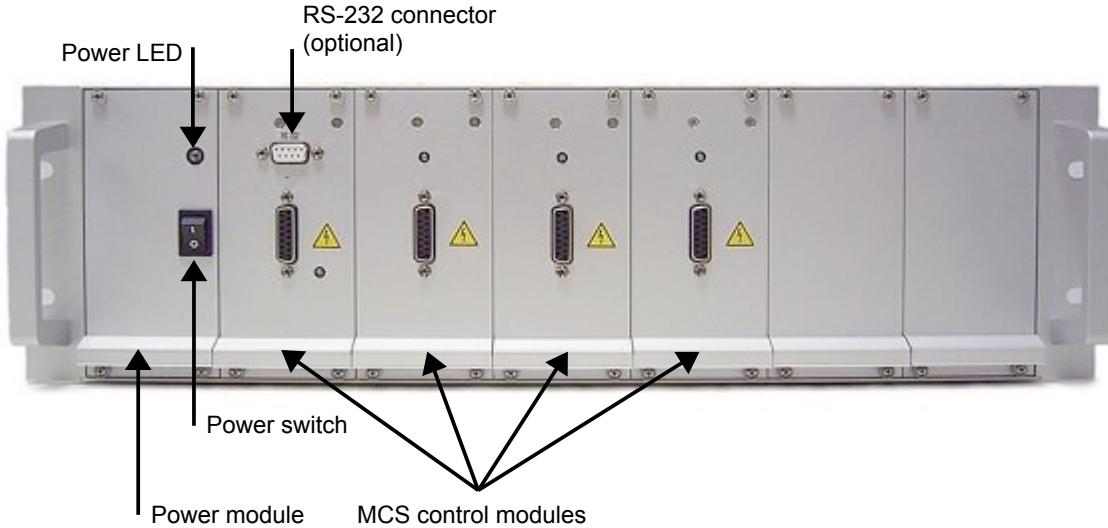


## 2.2 SmarAct Chassis (optional)

MCS controller modules can be inserted in a 19" chassis.

Order Code	Description
MCS-RACK-19	19 inch wide housing

The figure below shows the main components of the SmarAct MCS 19" rack chassis equipped with four MCS controller modules.



**MCS 19" rack chassis (example)**

The 19" SmarAct chassis includes a **power module** with power LED and power switch. The power module comprises of an AC adapter for 230V / 50Hz input and outputs 12V. The power LED indicates that the power supply is switched on.

One **MCS control module** is equipped with either a **USB interface**, an **RS-232 interface** or with an **Ethernet interface** and with this provides the communication interface for the complete controller. All MCS control modules are connected internally via a backplane.

### 2.2.1 Insertion and Removal of Modules

Please follow the following instructions for inserting or removing MCS modules to and from the MCS controller:

1. Make sure that the **power switch** is in the “**off**” position (0).
2. **Remove the line cord.**
3. **Wait one minute** to be sure that all electric circuits are discharged completely.
4. **Unscrew the four screws** at the corner of the module or front cover to be removed.
5. **Remove** the module or front cover.
6. **Insert** the desired module or front cover.
7. **Tighten the four screws** at the corner of the module or front cover.
8. **Plug in the line cord.**

### 2.2.2 Fuses

The chassis is equipped with a slow-blow fuse (see value at housing) in the connector for the line cord. Please follow the following instructions for exchanging the fuse:

9. Make sure that the **power switch** is in the “**off**” position (0).
10. **Remove the line cord.**

11. **Wait one minute** to be sure that all electric circuits are discharged completely.
12. **Take out the fuse carrier and replace the fuse.**
13. **Insert the fuse carrier** again.
14. Plug in the **line cord**.

### 2.2.3 Proprietary Chassis

Alternatively to using a SmarAct chassis, the MCS modules may also be inserted in a proprietary chassis.

MCS modules must not be used without a suitable chassis. The chassis must ensure free air convection and a protection of the user against the used voltages.

For operation MCS control modules must be connected to a fitting power supply:

- Voltage: 12V DC  
The power supply must be voltage-regulated.
- Current: the current / power as specified on the label must be provided. This is typically 2A or 4A for each MCS control module. For safety reasons the current must be limited.

## 2.3 MCS Sensor Module

For positioners with integrated sensors a sensor module is required that digitises the sensor data. The type depends on the sensor type, the driver type as well as the connector to the positioner.

Order Code	Description	Connectors
<b>Controller Type</b>		
MCS	MCS controller	
<b>Sensor Type</b>		
-1S, -2S, -3S	Nanosensor with 2 / 3 channels	1, 2, 3 connectors
-1M, -2M, -3M	Microsensor with 2 / 3 channels	1, 2, 3 connectors
<b>Driver Type</b>		
-EP	for stick-slip positioners (E or C)	D-SUB-15 plug on cable
-ES	for stick-slip positioners (E or C)	D-SUB-15 socket
-PP	for Picoslide positioners (P)	D-SUB-25 plug on cable
<b>Positioner Connector Type</b>		
-SDS15		DSUB 15 sockets
-BLE1B10G		LEMO 1B board sockets, 10 pins, EPG
-BLE1B14G		LEMO 1B board sockets, 14 pins, EPG
-LEMO1B		LEMO 1B plug, 14 pins, FGJ
-LEMO2B	for stick-slip positioners (E or C)	LEMO 2B plug, 32 pins, FGJ
-LEMO2B	for Picoslide positioners (P)	LEMO 2B plug, 32 pins, FGK
-LEMO2K		LEMO 2K plug, 32 pins, FGJ
<b>Housing Type</b>		
-OEM	OEM board	
-TAB	Table-top housing	
-TBM	Table-top housing with mounting holes	
---	mounted to Lemo plug	

The most common sensor modules are shown below:

Order Code	Description
MCS-3S-EP-SDS15-TAB	- 3 channels
MCS-3M-EP-SDS15-TAB	- D-SUB-15 plugs
MCS-3S-PP-SDS15-TAB	
MCS-3S-EP-LEMO2B	- 3 channels
MCS-3S-PP-LEMO2B	- directly mounted to one
MCS-3S-EP-LEMO2K	Lemo plug (size 2B, 32 pins)
	
MCS-3S-EP-LEMO1B	- 3 channels
MCS-3S-PP-LEMO1B	- directly mounted to three Lemo plugs (size 1B, 14 pins)
	
MCS-3S-EP-BLE1B10G-TABM	- 3 channels
	- Lemo plugs (size 1B, 10 pins)
	

## 2.4 MCS Hand Control Module

An external hand control module can be connected to the main controller with the cable that is delivered with the system. Please refer to one of the separate documents for the operation description.

Order Code	Description
MCS-3H-TAB	Hand Control Module for three channels
MCS-NH-TAB	Hand Control Module for N channels



## 2.5 Connecting Cables

Please follow the following instructions for connecting all cables to the MCS controller:

1. Make sure that the **power switch** is in the “**off**” position (0) or that the MCS control module is not supplied with power, respectively.
2. Connect the **Sensor Modules**, which may be integrated into the manipulator base plate, to the D-SUB 15 pin female connector(s) of the **MCS controller**. If the connectors are labeled, their labels must match.
3. If the cables from the positioners or Sensor Modules are delivered with feedthroughs, **install the feedthroughs** at a flange of the vacuum chamber and connect the matching connectors to both sides of the feedthrough. If the connectors are labeled, their labels must match.
4. If the Sensor Modules are delivered in a **separate housing**, connect the positioners to the D-SUB 15 pin female connectors of the Sensor Modules. If the connectors are labeled, their labels must match.
5. If the Hand Control Module is delivered in a separate housing, connect the **Hand Control Module** to the D-SUB 15 pin high-density female connector of the **MCS controller** by using the enclosed cable.
6. Connect the **power supply**, which has been delivered with the controller, to the power supply connector of the **MCS controller**.

7. If desired, connect the **ground potential of the mechanical system setup** to the ground pin of the **MCS controller**. This is recommended for applications in scanning electron microscopes where the ground potential of the system setup should be equivalent to the ground potential of the controllers.
8. Connect the **MCS controller** with one of the following cables:
  - **RS-232** cable to the PC or controller, from which the MCS controller will receive commands.
  - **USB** cable to the PC, on which the software will be installed.
  - **Ethernet** cable to the Ethernet switch or PC, on which the software is installed.
9. Power up the controller by switching the **power switch** to the "on" position (1).

## 3 Technical Data

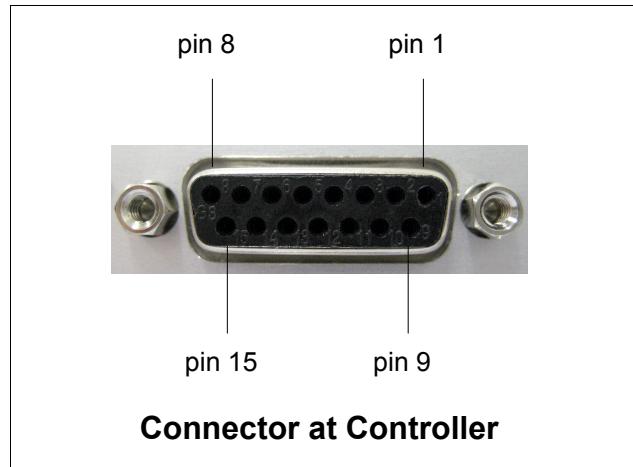
### 3.1 Power Supply

The MCS controller is supplied by a 12V power supply. Please use the power supply that has been shipped with the MCS controller and that matches the current and power rating, which is specified on the label of the controller (typically on underside or back side).

### 3.2 MCS Main Controller Connectors

#### 3.2.1 D-SUB-15 Connector at Single-Channel Controller MCS-1C/E...

The MCS controller provides a female DSUB15 connector to stick-slip positioners - either directly or via an MCS sensor module.



The pin assignment of each DSUB connector is as follows:

Pin	Signal	Function
1	HV-OUT	Positioner driving signal
2	d.n.c.	DO NOT CONNECT
3	d.n.c.	DO NOT CONNECT
4	S-GND	Ground for sensor
5	S-SIN+	U1/sin+ signal from sensor
6	S-COS+	U2/cos+ signal from sensor
7	S-REF+	U0/reference+ signal from sensor
8	d.n.c.	DO NOT CONNECT
9	HV-GND	Ground for positioner driving signal
10	S-SCL	SCL for I <sup>2</sup> C bus, sensor programming
11	S-SDA	SDA for I <sup>2</sup> C bus, sensor programming
12	S-SIN-	U1/sin- signal from sensor
13	S-COS-	U2/cos- signal from sensor
14	S-REF-	U0/reference- signal from sensor
15	S-3.3V	Power supply for sensor, 3.3V DC

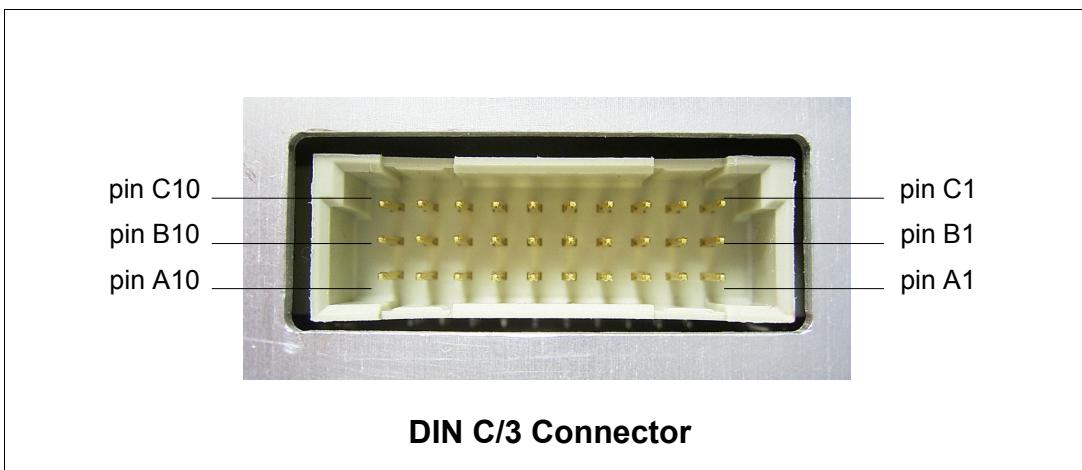
The positioner driving signals are specified as follows:

Driving Signal (HV-OUT-x)	Value	Unit
Output voltage range	0 to 100	V
Average current per channel	200	mA
Peak current per channel, < 10 µs, max. speed	20	A
Signal	sawtooth (step mode), constant (scan mode)	

### 3.2.2 DIN Connector at Single-Channel Stick-Slip Controller MCS-1xx-...-MOD/TAB

Most signals to and from an MCS OEM controller board or an MCS rack controller module can be transmitted with the male DIN plug type C/3. This includes

- the power supply,
- the positioner driving signals,
- the USB connection,
- an emergency stop signal.



The pin assignment is as follows:

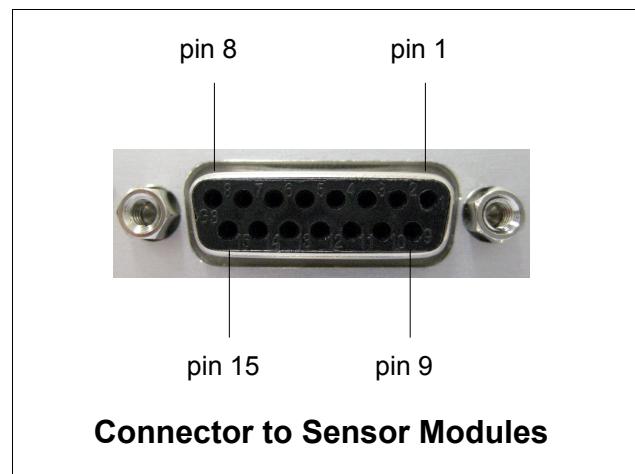
Pin	Signal	Function
A1	d.n.c.	DO NOT CONNECT
A2	d.n.c.	DO NOT CONNECT
A3	SM-D+	RS-485 D- signal from an external Sensor Module
A4	HCM-MOSI	Hand Control Module: SPI communication: master out - slave in
A5	HCM-HS2	Hand Control Module: SPI communication: hand shake
A6	HCM-HS1	Hand Control Module: SPI communication: hand shake
A7	USB-DAT-	USB data -
A8	d.n.c.	DO NOT CONNECT
A9	MCS-12V	Power supply for MCS controller, 12V DC
A10	MCS-GND	Ground for MCS controller
B1	d.n.c.	DO NOT CONNECT
B2	SM-D-	RS-485 D- signal from Sensor Module
B3	MCS-GND	Ground for MCS controller
B4	HCM-SCLK	Hand Control Module: SPI communication: serial clock
B5	HCM-5V	Power supply for Hand Control Module, 5V DC
B6	EMERG-STP	Emergency stop (stop all movements when pulled low)
B7	USB-DAT+	USB data +
B8	d.n.c.	DO NOT CONNECT
B9	MCS-12V	Power supply for MCS controller, 12V DC
B10	MCS-GND	Ground for MCS controller
C1	HV-OUT	Positioner driving signal
C2	HV-GND	Ground for positioner driving signals
C3	SM-5V	Power supply for Sensor Module, 5V DC
C4	HCM-SS	Hand Control Module: SPI communication: slave select
C5	HCM-MISO	Hand Control Module: SPI communication: master in - slave out
C6	d.n.c.	DO NOT CONNECT
C7	USB-GND	Ground for USB
C8	USB-5V	Power supply for USB, 5V DC
C9	MCS-12V	Power supply for MCS controller, 12V DC
C10	MCS-GND	Ground for MCS controller

The positioner driving signals are specified as follows:

Driving Signal (HV-OUT-x)	Value	Unit
Output voltage range	0 to 100	V
Average current per channel	200	mA
Peak current per channel, < 10 µs, max. speed	20	A
Signal	sawtooth (step mode), constant (scan mode)	

### 3.2.3 D-SUB-15 Connector at Three-Channel Stick-Slip Controller MCS-3CE...

The MCS controller provides a female DSUB15 connector to stick-slip positioners - either directly or via an MCS sensor module.



The pin assignment is as follows:

Pin	Signal	Function
1	HV-OUT-1	Positioner driving signal, channel 1, 4, 7, ...
2	HV-OUT-2	Positioner driving signal, channel 2, 5, 8, ...
3	HV-OUT-3	Positioner driving signal, channel 3, 6, 9, ...
4	SM-GND	Ground for Sensor Module and sensor
5	SM-D-	RS-485 D- signal from Sensor Module
6	SM-SW2	Switch for sensor, channel 2
7	d.n.c.	DO NOT CONNECT
8	S-3.3V	Power supply for sensor, 3.3V DC
9	HV-GND-1	Ground for positioner driving signal, channel 1, 4, 7, ...
10	HV-GND-2	Ground for positioner driving signal, channel 2, 5, 8, ...
11	HV-GND-3	Ground for positioner driving signal, channel 3, 6, 9, ...
12	SM-D+	RS-485 D+ signal from Sensor Module
13	SM-SW1	Switch for sensor, channel 1
14	SM-SW3	Switch for sensor, channel 3
15	SM-5V	Power supply for Sensor Module, 5V DC
Shielding	SM-GND	Ground for Sensor Module and sensor

The positioner driving signals are specified as follows:

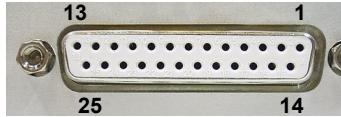
Driving Signal (HV-OUT-x)	Value	Unit
Output voltage range	0 to 100	V
Average current per channel	200	mA
Peak current per channel, < 10 µs, max. speed	20	A
Signal	sawtooth (step mode), constant (scan mode)	

The signals from the sensor module are specified as follows:

Signal from Sensor Module (D+, D-)	Value	Unit
Voltage range	0 to 5	V
Signal	digital, RS-422 protocol	

### 3.2.4 D-SUB-15 Connector at Three-Channel Picoslide Controller MCS-3P...

The MCS controller provides a female DSUB25 connector to Picoslide positioners - either directly or via an MCS sensor module.



**Connector to Sensor Modules**

The pin assignment is as follows:

Pin	Signal	Function
1	HV-OUT-1A	Positioner driving signal A (forward), channel 1, 4, 7, ...
2	HV-OUT-1B	Positioner driving signal B (lift), channel 1, 4, 7, ...
3	HV-OUT-2A	Positioner driving signal A (forward), channel 2, 5, 8, ...
4	HV-OUT-2B	Positioner driving signal B (lift), channel 2, 5, 8, ...
5	HV-OUT-3A	Positioner driving signal A (forward), channel 3, 6, 9, ...
6	HV-OUT-3B	Positioner driving signal B (lift), channel 3, 6, 9, ...
7	SM-GND	Ground for Sensor Module and sensor
8	d.n.c.	DO NOT CONNECT
9	SM-D+	RS-485 D+ signal from Sensor Module
10	d.n.c.	DO NOT CONNECT
11	SM-SW1	Switch for sensor, channel 1
12	SM-SW3	Switch for sensor, channel 3
13	d.n.c.	DO NOT CONNECT
14	HV-GND-1A	Ground for positioner driving signal A, channel 1, 4, 7, ...
15	HV-GND-1B	Ground for positioner driving signal B, channel 1, 4, 7, ...
16	HV-GND-2A	Ground for positioner driving signal A, channel 2, 5, 8, ...
17	HV-GND-2B	Ground for positioner driving signal B, channel 2, 5, 8, ...
18	HV-GND-3A	Ground for positioner driving signal A, channel 3, 6, 9, ...
19	HV-GND-3B	Ground for positioner driving signal B, channel 3, 6, 9, ...
20	d.n.c.	DO NOT CONNECT
21	d.n.c.	DO NOT CONNECT
22	SM-D-	RS-485 D- signal from Sensor Module
23	d.n.c.	DO NOT CONNECT
24	SM-SW2	Switch for sensor, channel 2
25	SM-5V	Power supply for Sensor Module, 5V DC
Shielding	SM-GND	Ground for Sensor Module and sensor

The positioner driving signals are specified as follows:

Driving Signal (HV-OUT-x)	Value	Unit
Output voltage range	0 to 100	V
Average current per channel	200	mA
Peak current per channel, < 10 µs, max. speed	20	A
Signal	sawtooth (step mode), constant (scan mode)	

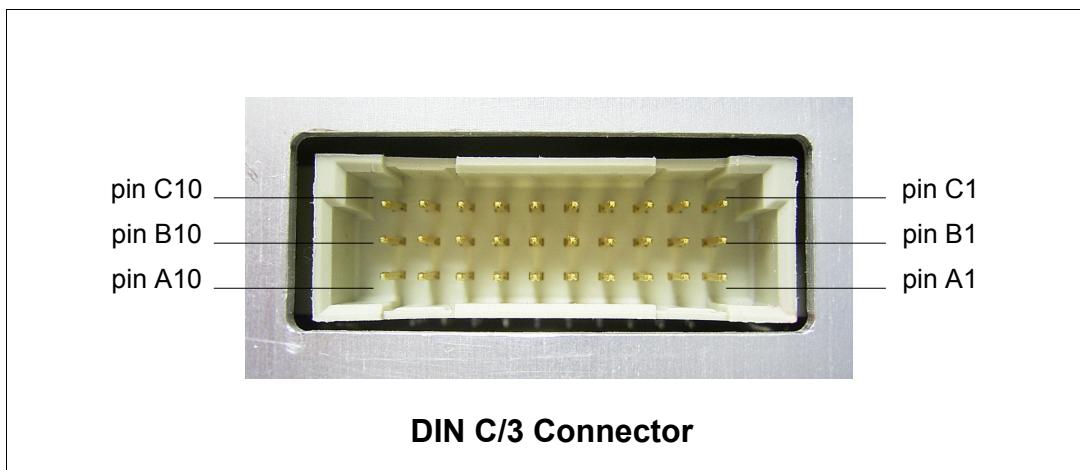
The signals from the sensor module are specified as follows:

Signal from Sensor Module (D+, D-)	Value	Unit
Voltage range	0 to 5	V
Signal	digital, RS-422 protocol	

### 3.2.5 DIN Connector at Three-Channel Controller MCS-3xx-...-MOD/TAB

Most signals to and from an MCS OEM controller board or an MCS rack controller module can be transmitted with the male DIN plug type C/3. This includes

- the power supply,
- the positioner driving signals,
- the USB connection,
- an emergency stop signal.



The pin assignment is as follows:

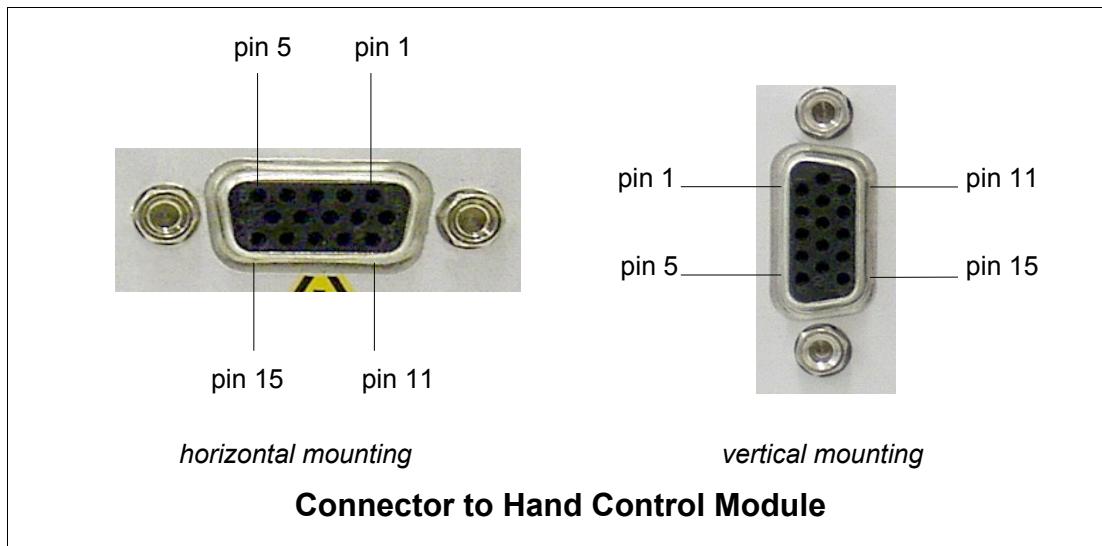
Pin	Signal	Function
A1	HV-OUT-3	Positioner driving signal, channel 3
A2	d.n.c.	DO NOT CONNECT
A3	SM-D+	RS-485 D- signal from Sensor Module
A4	HCM-MOSI	Hand Control Module: SPI communication: master out - slave in
A5	HCM-HS2	Hand Control Module: SPI communication: hand shake
A6	HCM-HS1	Hand Control Module: SPI communication: hand shake
A7	USB-DAT-	USB data -
A8	d.n.c.	DO NOT CONNECT
A9	MCS-12V	Power supply for MCS controller, 12V DC
A10	MCS-GND	Ground for MCS controller
B1	HV-OUT-2	Positioner driving signal, channel 2
B2	SM-D-	RS-485 D- signal from Sensor Module
B3	MCS-GND	Ground for MCS controller
B4	HCM-SCLK	Hand Control Module: SPI communication: serial clock
B5	HCM-5V	Power supply for Hand Control Module, 5V DC
B6	EMERG-STP	Emergency stop (stop all movements when pulled low)
B7	USB-DAT+	USB data +
B8	d.n.c.	DO NOT CONNECT
B9	MCS-12V	Power supply for MCS controller, 12V DC
B10	MCS-GND	Ground for MCS controller
C1	HV-OUT-1	Positioner driving signal, channel 1
C2	HV-GND	Ground for positioner driving signals
C3	SM-5V	Power supply for Sensor Module, 5V DC
C4	HCM-SS	Hand Control Module: SPI communication: slave select
C5	HCM-MISO	Hand Control Module: SPI communication: master in - slave out
C6	d.n.c.	DO NOT CONNECT
C7	USB-GND	Ground for USB
C8	USB-5V	Power supply for USB, 5V DC
C9	MCS-12V	Power supply for MCS controller, 12V DC
C10	MCS-GND	Ground for MCS controller

The positioner driving signals are specified as follows:

Driving Signal (HV-OUT-x)	Value	Unit
Output voltage range	0 to 100	V
Average current per channel	200	mA

### 3.2.6 D-SUB-15-HD Connector to Hand Control Module

For the Hand Control Module the MCS controller provides a female D-SUB 15 pin high-density female connector.

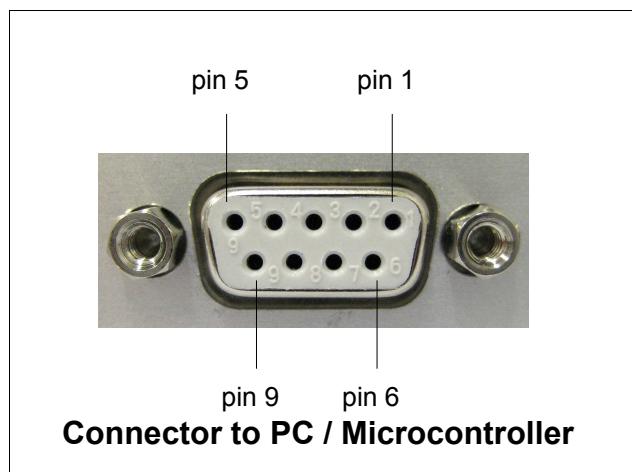


The pin assignment is as follows:

Pin	Signal	Function
1	GND	Ground for Hand Control Module
2	SCLK	SPI communication: serial clock
3	MISO	SPI communication: master in - slave out
4	MOSI	SPI communication: master out - slave in
5	SS	SPI communication: slave select
6	HS1	SPI communication: hand shake
7	HS2	SPI communication: hand shake
8	GND	Ground for electronics
9	5V	power supply for Hand Control Module, 5V DC
10	d.n.c.	DO NOT CONNECT
11	d.n.c.	DO NOT CONNECT
12	d.n.c.	DO NOT CONNECT
13	d.n.c.	DO NOT CONNECT
14	d.n.c.	DO NOT CONNECT
15	d.n.c.	DO NOT CONNECT
Shielding	GND	Ground for Hand Control Module

### 3.2.7 D-SUB-9 Connector for RS-232 Communication

The D-SUB 9 pin female connector at the MCS controller provides a standard RS232 interface to a PC or microcontroller.

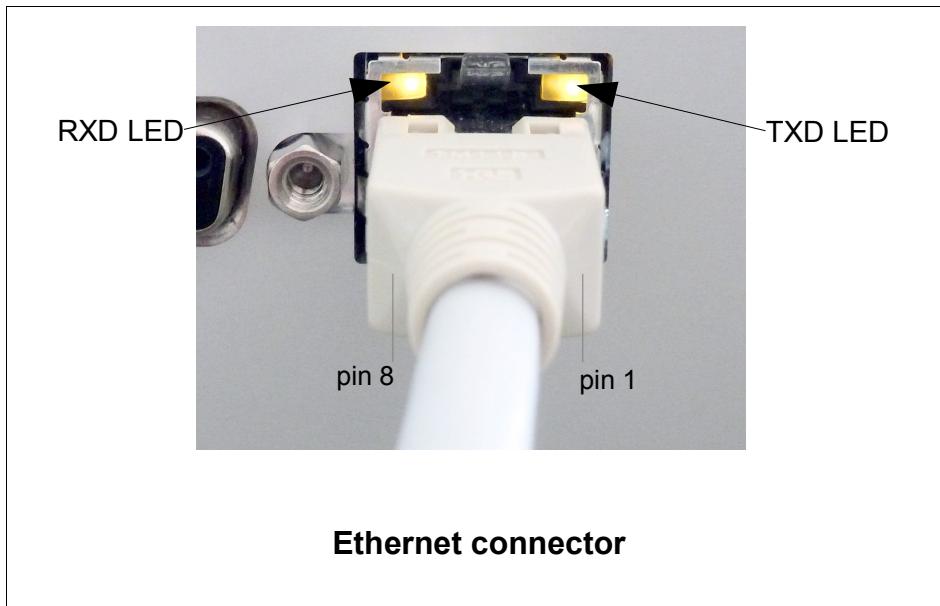


The pin assignment is as follows:

Pin	Signal	Function
1	d.n.c.	DO NOT CONNECT
2	RS-RX	RS-232 communication: MCS to PC
3	RS-TX	RS-232 communication: PC to MCS
4	d.n.c.	DO NOT CONNECT
5	RS-GND	RS-232 communication: ground
6	d.n.c.	DO NOT CONNECT
7	d.n.c.	DO NOT CONNECT
8	d.n.c.	DO NOT CONNECT
9	d.n.c.	DO NOT CONNECT
Shielding	MCS-GND	Ground for MCS controller

### 3.2.8 8P8C Connector for Ethernet Communication

The 8P8C-modular jack connector at the MCS controller provides a standard 10BaseT / 100BaseTX Ethernet interface.



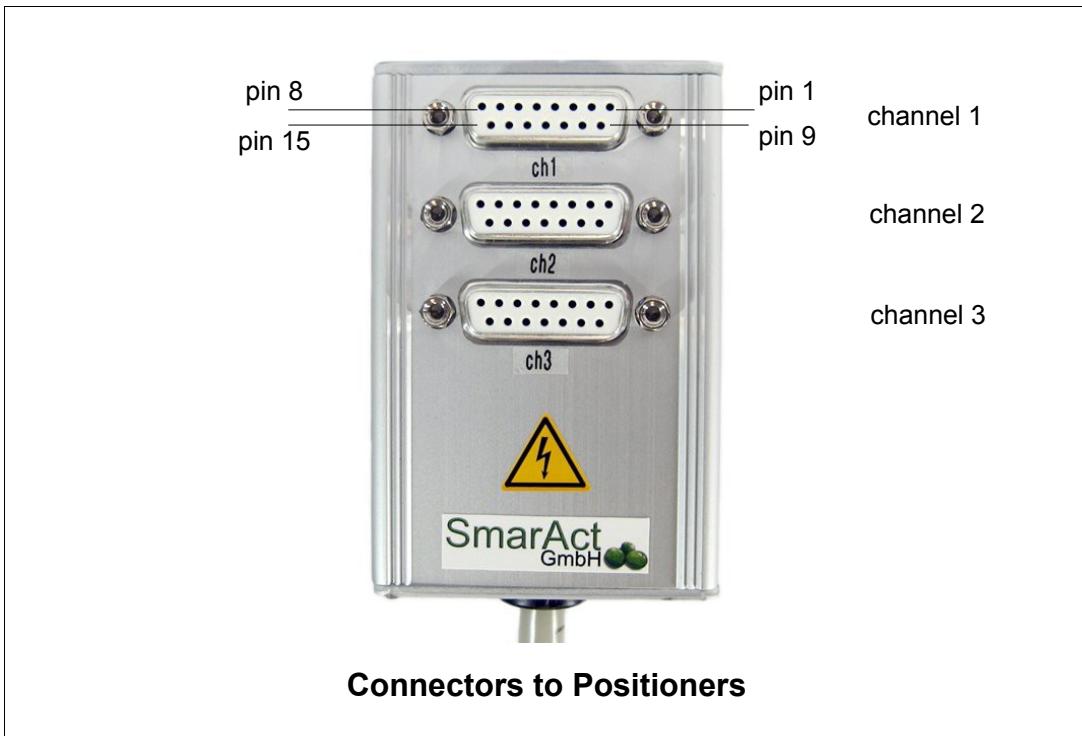
The pin assignment is as follows:

Pin	Signal	Function
1	Tx+	Signal Pair, The differential data is transmitted to the media on the Tx-/Tx+ signal pair
2	Tx-	
3	Rx+	Signal Pair, The differential data from the media is received on the Rx-/Rx+ Signal pair
4	d.n.c.	DO NOT CONNECT
5	d.n.c.	DO NOT CONNECT
6	Rx-	Signal Pair, The differential data from the media is received on the Rx-/Rx+ Signal pair
7	d.n.c.	DO NOT CONNECT
8	d.n.c.	DO NOT CONNECT
Shielding	MCS-GND	Ground for MCS controller

LED Colors	RXD LED	TXD LED
Off	Ethernet connector is not connected	Ethernet connector is not connected
Yellow	Ethernet is connected and no data received	Ethernet is connected and no data transmitted
Green	Data received	Data transmitted

### 3.3 MCS Sensor Module Connectors

#### 3.3.1 D-SUB-15 Connector at Sensor Module MCS-3M-EP-SDS15

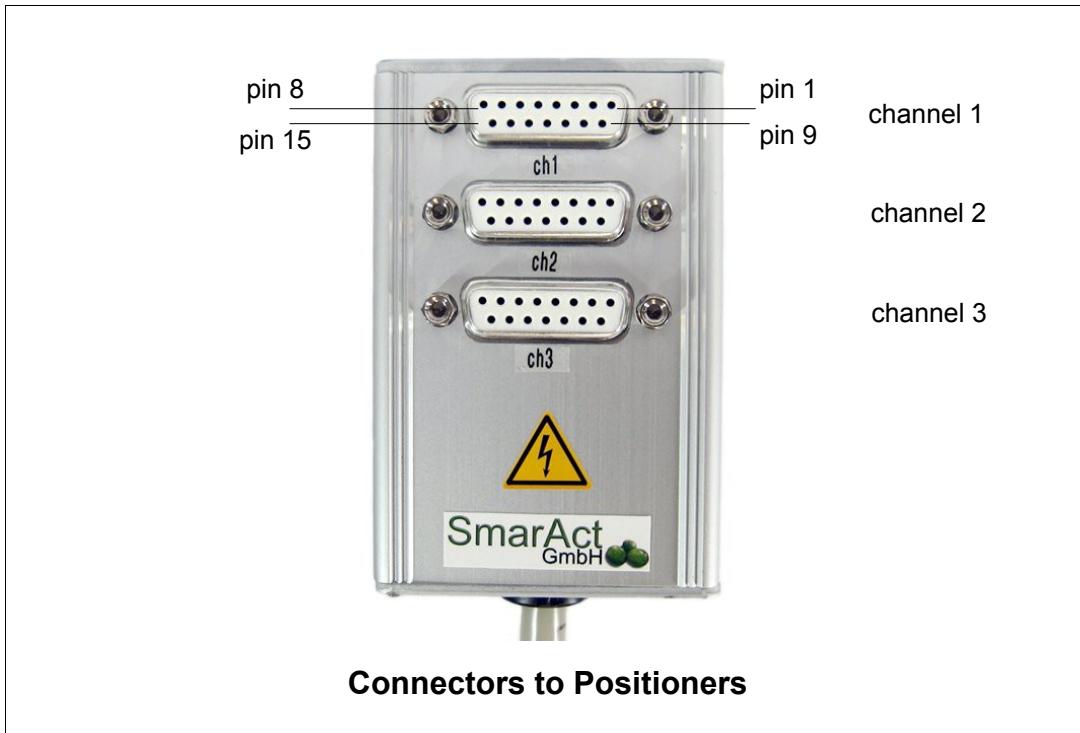


The pin assignment of each D-SUB connector is as follows:

Pin	Signal	Function
1	HV-OUT-x	Positioner driving signal, channel x
2	d.n.c.	DO NOT CONNECT
3	d.n.c.	DO NOT CONNECT
4	S-GND	Ground for sensor
5	S-SIN+	sin signal from sensor
6	S-COS+	cos signal from sensor
7	d.n.c.	DO NOT CONNECT
8	d.n.c.	DO NOT CONNECT
9	HV-GND-x	Ground for positioner driving signal, channel x
10	d.n.c.	DO NOT CONNECT
11	d.n.c.	DO NOT CONNECT
12	d.n.c.	DO NOT CONNECT
13	d.n.c.	DO NOT CONNECT
14	d.n.c.	DO NOT CONNECT
15	S-5.0V	Power supply for sensor, 5.0V DC

The HV-OUT-x signals are identical to the HV-OUT-x signals from the MCS controller.

### **3.3.2 D-SUB-15 Connector at Sensor Module MCS-3S-xx-SDS15-TAB**



The pin assignment of each D-SUB connector is as follows:

Pin	Signal	Function
1	HV-OUT-x	Positioner driving signal, channel x (slip stick)
	HV-OUT-xA	Positioner driving signal A, channel x (Picoslide-forward)
2	d.n.c.	DO NOT CONNECT
	HV-OUT-xB	Positioner driving signal B, channel x (Picoslide-lift)
3	d.n.c.	DO NOT CONNECT
4	S-GND	Ground for sensor
5	S-SIN+	U1/sin+ signal from sensor
6	S-COS+	U2/cos+ signal from sensor
7	S-REF+	U0/reference+ signal from sensor
8	d.n.c.	DO NOT CONNECT
	S-SCL	SCL for I <sup>2</sup> C bus, sensor programming
9	HV-GND-x	Ground for positioner driving signal, channel x (slip stick)
	HV-GND-xA	Ground for positioner driving signal A, channel x (Picoslide-forward)
10	S-SCL	SCL for I <sup>2</sup> C bus, sensor programming
	HV-GND-xB	Ground for positioner driving signal B, channel x (Picoslide-lift)
11	S-SDA	SDA for I <sup>2</sup> C bus, sensor programming
12	S-SIN-	U1/sin- signal from sensor
13	S-COS-	U2/cos- signal from sensor
14	S-REF-	U0/reference- signal from sensor
15	S-3.3V	Power supply for sensor, 3.3V DC

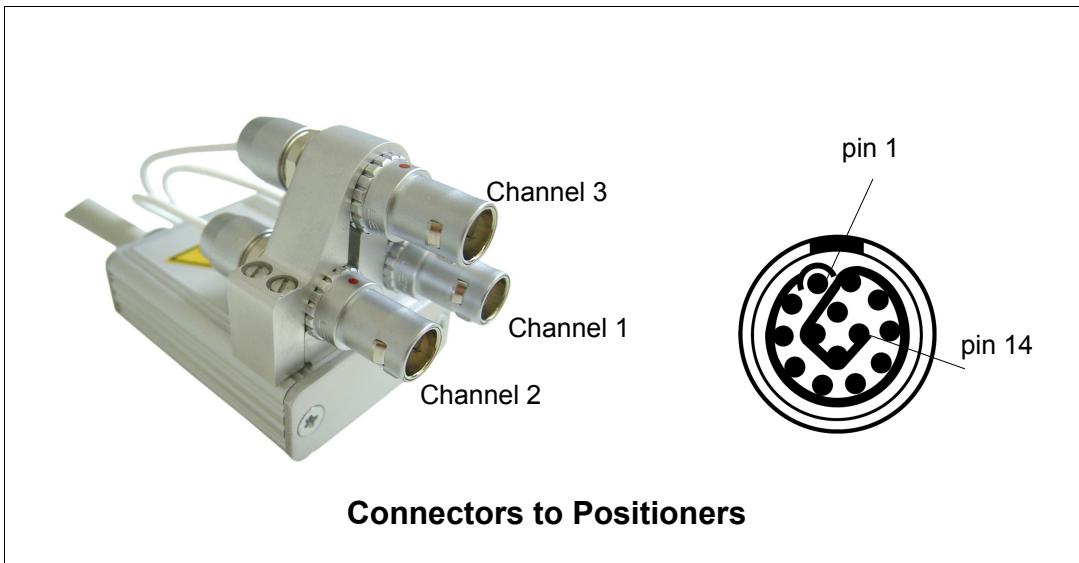
The HV-OUT-x signals are identical to the HV-OUT-x signals from the MCS controller.

For Sensor Modules **MCS-3S-PP-SDS15-TAB** which are connected to MCS-3P (D-SUB 25)

### 3.3.3 14 Pin Lemo-1B Connector at Sensor Module **MCS-3S-xx-LEMO1B**

The MCS3S-xx-LEMO1B sensor module is directly attached to LEMO 1B plugs and can be directly connected to the feedthroughs.

- MCS-3S-EP-LEMO1B is for stick slip positioner
- MCS-3S-PP-LEMO1B is for picoslide positioner



The pin assignment of each DSUB connector is as follows:

Pin	Signal	Function
1	S-SDA	SDA for I <sup>2</sup> C bus, sensor programming
2	S-SCL	SCL for I <sup>2</sup> C bus, sensor programming
3	d.n.c	DO NOT CONNECT
	HV-GND-xB	Ground for positioner driving signal B, channel x (Picoslide-lift)
4	d.n.c.	DO NOT CONNECT
	HV-OUT-xB	Positioner driving signal B, channel x (Picoslide-lift)
5	S-5.0V	Power supply for sensor, 5.0V DC
6	S-REF-	U0/reference- signal from sensor
7	S-REF+	U0/reference+ signal from sensor
8	S-COS-	U2/cos- signal from sensor
9	S-COS+	U2/cos+ signal from sensor
10	S-SIN-	U1/sin- signal from sensor
11	S-SIN+	U1/sin+ signal from sensor
12	S-GND	Ground for sensor
13	HV-GND-x	Ground for positioner driving signal, channel x (slip stick)
	HV-GND-xA	Ground for positioner driving signal A, channel x (Picoslide-forward)
14	HV-OUT-x	Positioner driving signal, channel x (slip stick)
	HV-OUT-xA	Positioner driving signal A, channel x (Picoslide-forward)

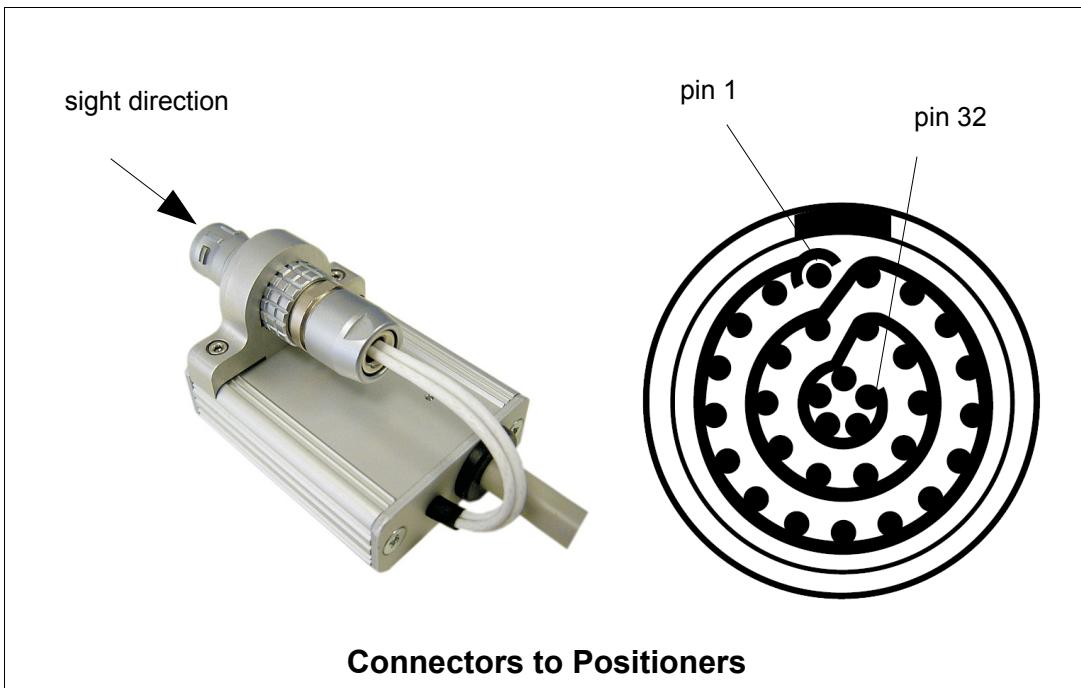
The HV-OUT-x signals are identical to the HV-OUT-x signals from the MCS controller.

For Sensor Modules MCS-3S-PP-LEMO1B which are connected to MCS-3P (D-SUB 25)

### 3.3.4 32 Pin Lemo-2B Connector at Sensor Module MCS-3S-xx-LEMO2B / -LEMO2K

The MCS-3S-xx-LEMO2B / -LEMO2K sensor module is directly attached to a LEMO 2B plug and can be directly connected to the feedthrough.

- MCS-3S-**EP**-LEMO2B is for stick slip positioners, LEMO 2B plugs
- MCS-3S-**EP**-LEMO2K is for stick slip positioners, LEMO 2K plugs
- MCS-3S-**PP**-LEMO2B is for picoslide positioners, LEMO 2B plugs



The pin assignment of the LEMO 2B plug is as follows:

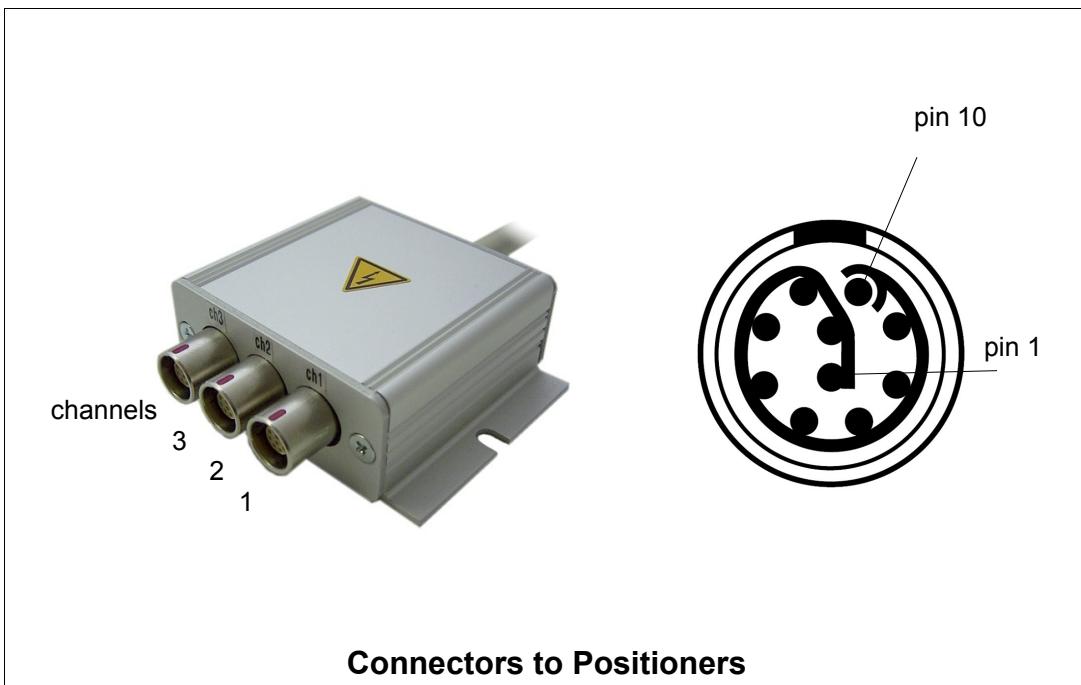
Pin	Signal	Function
1	S-SIN+_1	U1/sin+ signal from sensor, channel 1
2	S-SIN-_1	U1/sin- signal from sensor, channel 1
3	S-COS+_1	U2/cos+ signal from sensor, channel 1
4	S-COS-_1	U2/cos- signal from sensor, channel 1
5	S-REF+_1	U0/reference+ signal from sensor, channel 1
6	S-SIN+_2	U1/sin+ signal from sensor, channel 2
7	S-SIN-_2	U1/sin- signal from sensor, channel 2
8	S-COS+_2	U2/cos+ signal from sensor, channel 2
9	S-COS-_2	U2/cos- signal from sensor, channel 2
10	S-REF+_2	U0/reference+ signal from sensor, channel 2
11	S-REF-_2	U0/reference- signal from sensor, channel 2
12	S-SIN+_3	U1/sin+ signal from sensor, channel 3
13	S-SIN-_3	U1/sin- signal from sensor, channel 3
14	S-COS+_3	U2/cos+ signal from sensor, channel 3
15	S-COS-_3	U2/cos- signal from sensor, channel 3
16	S-REF+_3	U0/reference+ signal from sensor, channel 3
17	S-REF-_3	U0/reference- signal from sensor, channel 3
18	S-5.0V_1	Power supply for sensor, 5.0V DC, channel 1
19	S-GND_1	Ground for sensor, channel 1
	HV-GND-1	Ground for positioner driving signals, channel 1
20	S-REF-_1	U0/reference- signal from sensor, channel 1
21	S-GND_2	Ground for sensor, channel 2
	HV-GND-2	Ground for positioner driving signals, channel 2
22	S-5.0V_2	Power supply for sensor, 5.0V DC, channel 2
23	d.n.c.	DO NOT CONNECT
	S-GND	Ground for sensor
24	d.n.c.	DO NOT CONNECT
	S-GND	Ground for sensor
25	S-5.0V_3	Power supply for sensor, 5.0V DC, channel 3
26	S-GND_3	Ground for sensor, channel 3
	HV-GND-3	Ground for positioner driving signals, channel 3
27	HV-GND_3	Ground for positioner driving signal, channel 3
	HV-OUT-3B	Positioner driving signal B, channel 3 (Picoslide-lift)
28	HV-OUT_1	Positioner driving signal, channel 1

	HV-OUT-1A	Positioner driving signal A, channel 1 (Picoslide-forward)
29	HV-GND_1	Ground for positioner driving signal, channel 1
	HV-OUT-1B	Positioner driving signal B, channel 1 (Picoslide-lift)
30	HV-GND_2	Ground for positioner driving signal, channel 2
	HV-OUT-2B	Positioner driving signal B, channel 2 (Picoslide-lift)
31	HV-OUT_2	Positioner driving signal, channel 2
	HV-OUT-2A	Positioner driving signal A, channel 2 (Picoslide-forward)
32	HV-OUT_3	Positioner driving signal, channel 3
	HV-OUT-3A	Positioner driving signal A, channel 3 (Picoslide-forward)

The HV-OUT-x signals are identical to the HV-OUT-x signals from the MCS controller.

For Sensor Modules MCS-3S-PP-LEMO2B which are connected to MCS-3P (D-SUB 25)

### 3.3.5 10 Pin Lemo-1B Connector at Sensor Module MCS-3S-EP-BLE1B10G-TABM



The pin assignment of each D-SUB connector is as follows:

Pin	Signal	Function
1	S-5.0V	Power supply for sensor, 5.0V DC
2	S-REF-	U0/reference- signal from sensor
3	S-REF+	U0/reference+ signal from sensor
4	S-COS-	U2/cos- signal from sensor
5	S-COS+	U2/cos+ signal from sensor
6	S-SIN-	U1/sin- signal from sensor
7	S-SIN+	U1/sin+ signal from sensor
8	S-GND	Ground for sensor
9	HV-GND-x	Ground for positioner driving signal, channel x
10	HV-OUT-x	Positioner driving signal, channel x

The HV-OUT-x signals are identical to the HV-OUT-x signals from the MCS controller.

### 3.4 Operating Conditions

The MCS controller must be used in normal environmental conditions:

- Indoor usage only.
- Temperature range: 5°C to 40°C.