

MCS - Modular Control System

User Manual



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1 Manufacturer Declarations

1.1 Declaration of Conformity

Declaration of Conformity

according to ISO/IEC 17050-1:2004

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 Information, Warnings and Safety Instructions

Please read the following information, warnings and safety instructions carefully before using the product.

1.2.1 Information – Intended Use

The SmarAct MCS controllers are designed to drive the SmarAct positioners only. Please do never connect any other equipment than SmarAct positioners to the MCS controller outputs.

The MCS controllers are laboratory equipment designed according to the DIN EN 61010. The MCS controllers meet the following minimum specifications for safe operation:

- Indoor use only
- Altitude up to 2000 m
- Temperature range from 5 °C up to 40 °C
- Maximum relative humidity 80 % up to 31 °C, decreasing linearly to 50 % relative humidity at 40 °C
- Degree of pollution: 2

Please use the provided power supply only. This is required to meet all design specifications.

1.2.2 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. Therefore, the equipment should only be operated by personnel, which is adequately trained and educated to prevent any improper use. Please follow general accident prevention rules.

- 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.
- Do never use equipment that is damaged in any way.
- The MCS controller contains no user serviceable parts. Never open the case. Procedures which require opening the case must only be carried out by authorized, qualified and trained personnel.

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



Note: The Sensor Modules connected to these connectors have pins with a high voltage, too.

1.2.3 Caution – Unpacking

Please be careful when unpacking the MCS controller. Inspect the MCS controller for signs of damage and only use equipment, which shows no signs of damage. In case of any damage, contact

SmarAct for replacement. Please save all packing materials in case you would like to transport or ship the product again.

1.2.4 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.

If you are using an OEM version of a MCS controller, the controller board must be installed in such a way, that free air convection can be achieved. Insufficient ventilation will cause overheating and premature failure. Therefore forced air cooling, for example in a rack with a fan, is preferred. Make sure that no part of the MCS OEM controller board other than the required connectors can be touched after final installation. Please take care to meet all applicable requirements concerning electrical equipment in your regulatory domain.

Please avoid touching any circuit components, pins or PCB traces, as these components are ESD-sensitive devices. Touch the OEM boards on their edges only during handling and installation. Discharge any static charge on your body by touching a grounded object prior to the handling of the MCS controller board. If not installed, place the MCS controller boards only on conductive surfaces, such as ESD-safe transport containers (envelopes or foam).

Only apply power to the MCS OEM controller board if it is installed in the intended housing. Never apply power to a MCS OEM controller board if any other part than the required connectors can be touched.

1.2.5 Caution – Connecting Instructions

Do never use any other connecting cables than the connecting gear, that you obtained from SmarAct. Never use any third party adapters or cables. This can cause failure or malfunction.

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: When removing the USB cable, all positioners will be stopped immediately as a safety precaution.

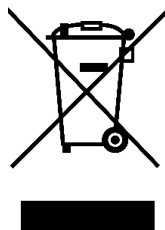
1.2.6 Caution – Disposal of Old Equipment

According to the EU directive 2002/96/EC, as of August, 13, 2005, electrical and electronic equipment may not be disposed of in the member states of the European Union with other wastes.

SmarAct respects the manufacturer's product responsibility and will take care of environmentally correct disposal of old SmarAct products free of charge.

To dispose of old SmarAct equipment, you can return it to SmarAct to the following address postage-free:

SmarAct GmbH
Schuette-Lanz-Strasse 9
26135 Oldenburg, Germany



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.

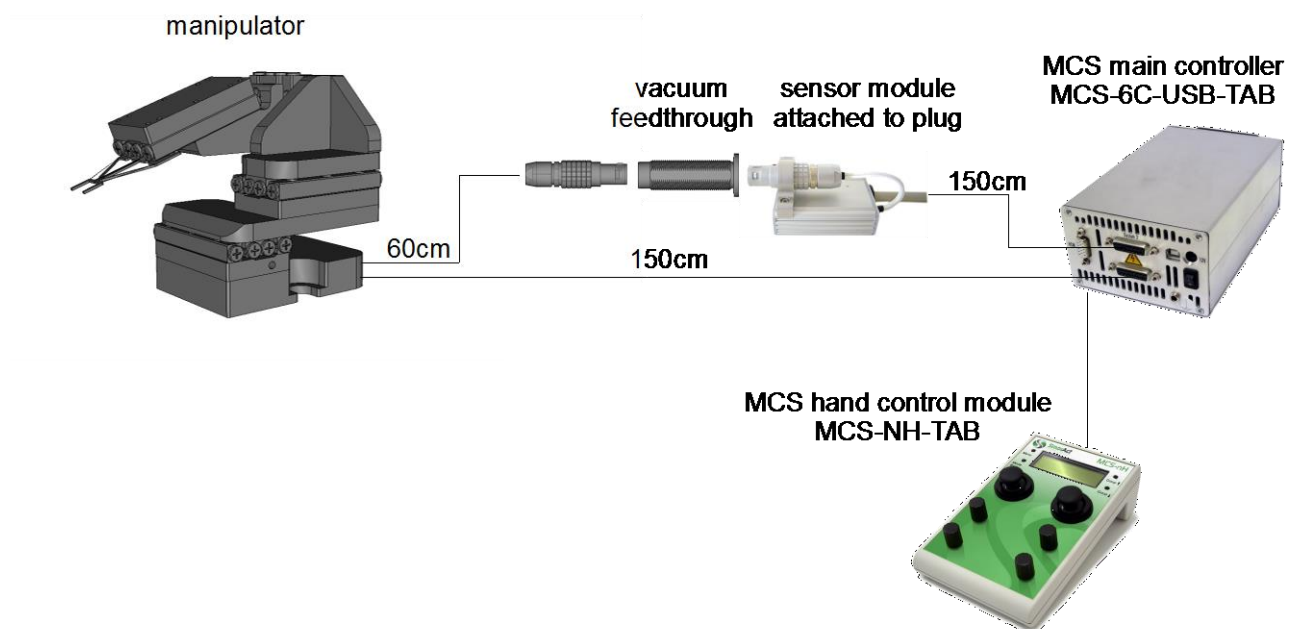
Each MCS control system consists of a main controller, an optional sensor module and an optional hand control module.

- **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 digitized to the main controller. The sensor module may already be integrated in the main controller when it is a single-channel controller.
- **MCS Sensor Reader (Optional):** The MCS Sensor Reader enables to read out the position of SmarAct positioners with a frequency of up to 8 kHz.
- **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-TAB 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 and 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.
- **RS-232 Interface Module:** The MCS may be controlled by software running on a PC or controller via an RS-232 interface.

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.

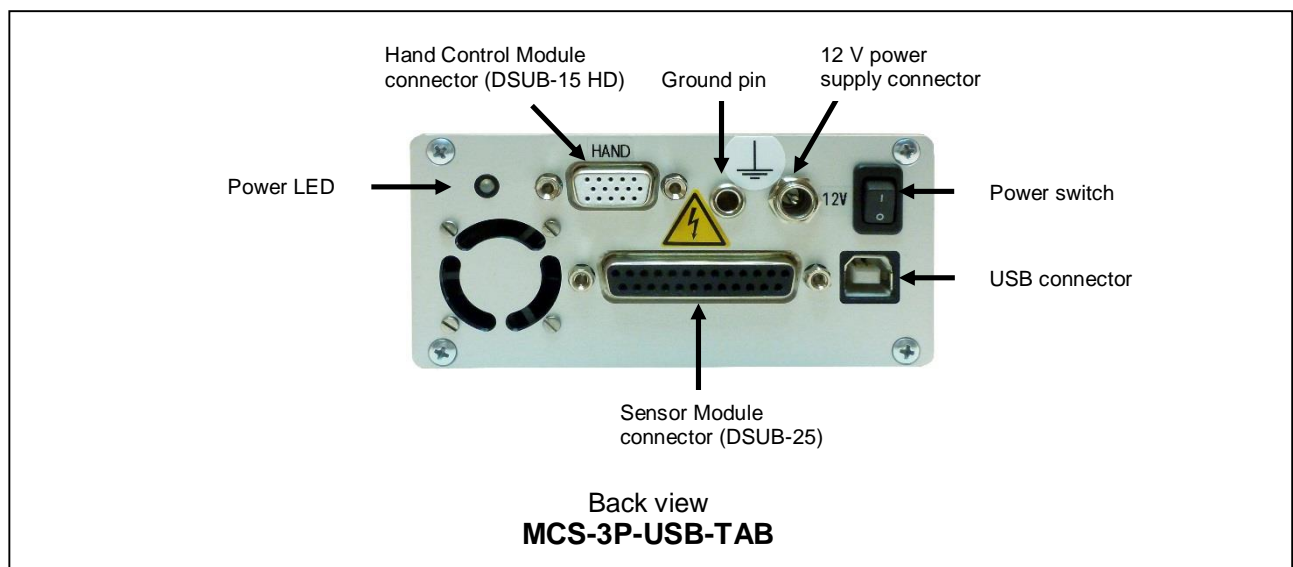
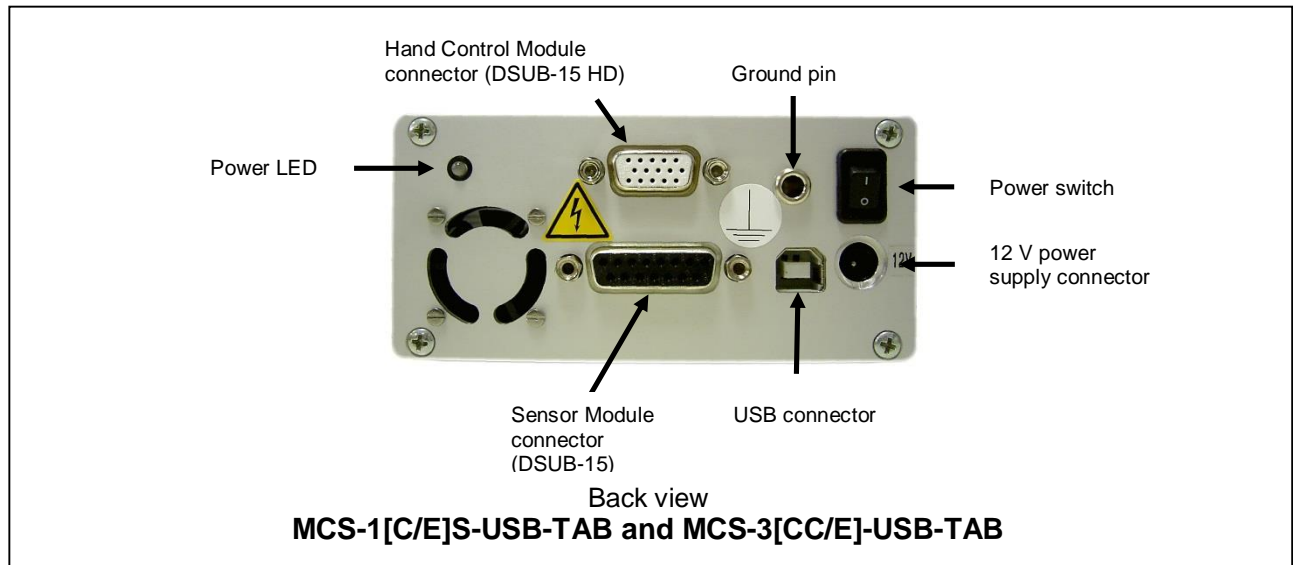
| Order Code | Description | connectors |
|--|---|--|
| Controller Type (required) | | |
| MCS | MCS controller | |
| Drivers (required, combinations possible) | | |
| -1CS, 1CM | 1 stick-slip channel, integrated sensor module | 1x D-SUB-15 female |
| -1CCS, 1CCM | 1 stick-slip channel, high current, integrated sensor module | 1x D-SUB-15 female |
| -1C | 1 stick-slip channel | 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 |
| -3F, -6F, -9F, ... | 3 / 6 / 9 / ... Endeffector channels | 3x, 6x, 9x, ... LEMO ECA.0B.306 sockets |
| -3P, -6P, -9P, ... | 3 / 6 / 9 / ... Picoslide channels | 1x, 2x, 3, ... D-SUB-25 female |
| Hand Control Module (optional) | | |
| -3H | Internal Hand Control Module | -- |
| Interface (optional) | | |
| -USB | USB interface | USB socket, type B |
| -IUSB | internal USB interface (only at DIN connector) | --- |
| -RS232 | RS-232 interface | D-SUB-9 male |

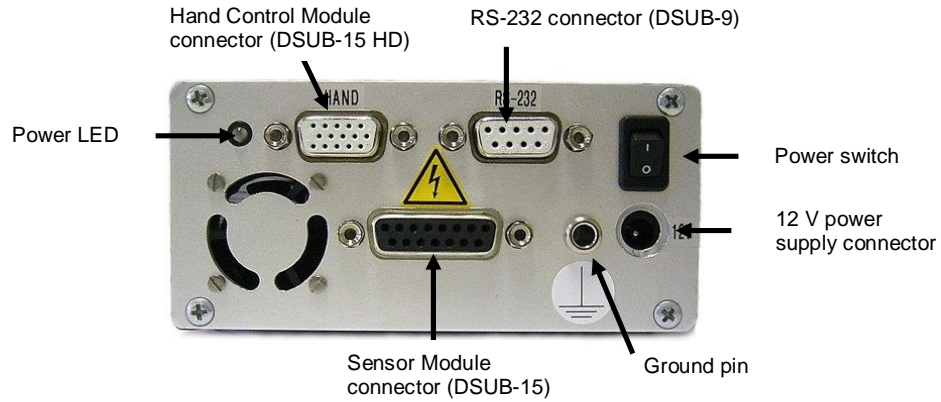
| -ETH | Ethernet interface | RJ45 socket |
|----------------------------|---|---|
| -3/6/9...DU | direct voltage input | D-SUB-25 female |
| Housing (required) | | |
| -OEM | OEM board | DIN C/3 connector |
| -MOD | 19" rack module, 3U high | DIN C/3 connector |
| -TAB | Table-top housing | |
| Order 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 controllers with housing and without integrated hand control module | hand control module interface: 1x D-SUB-15-HD female |
| MCS-xxx-xxx-MOD without 3H | | |
| -1ES, 1EM | 1 stick-slip / 0V channel, integrated sensor module | 1x D-SUB-15 female |

2.1.2 Exemplary Connector Arrangement

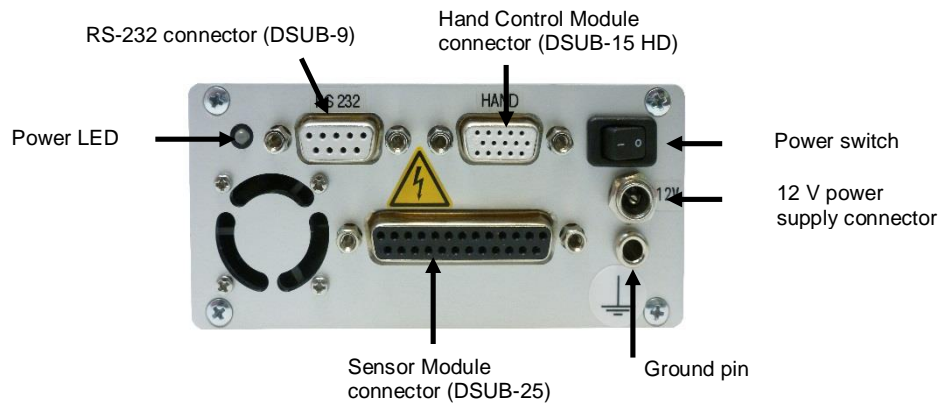
Below there are some examples for the connector arrangement:

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.

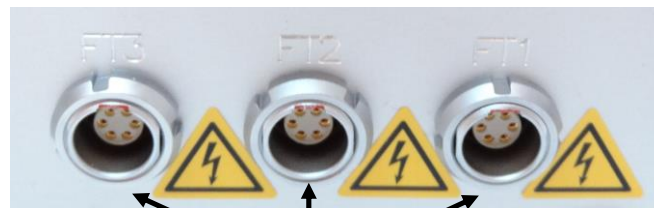




Back view
MCS-3P-USB-TAB



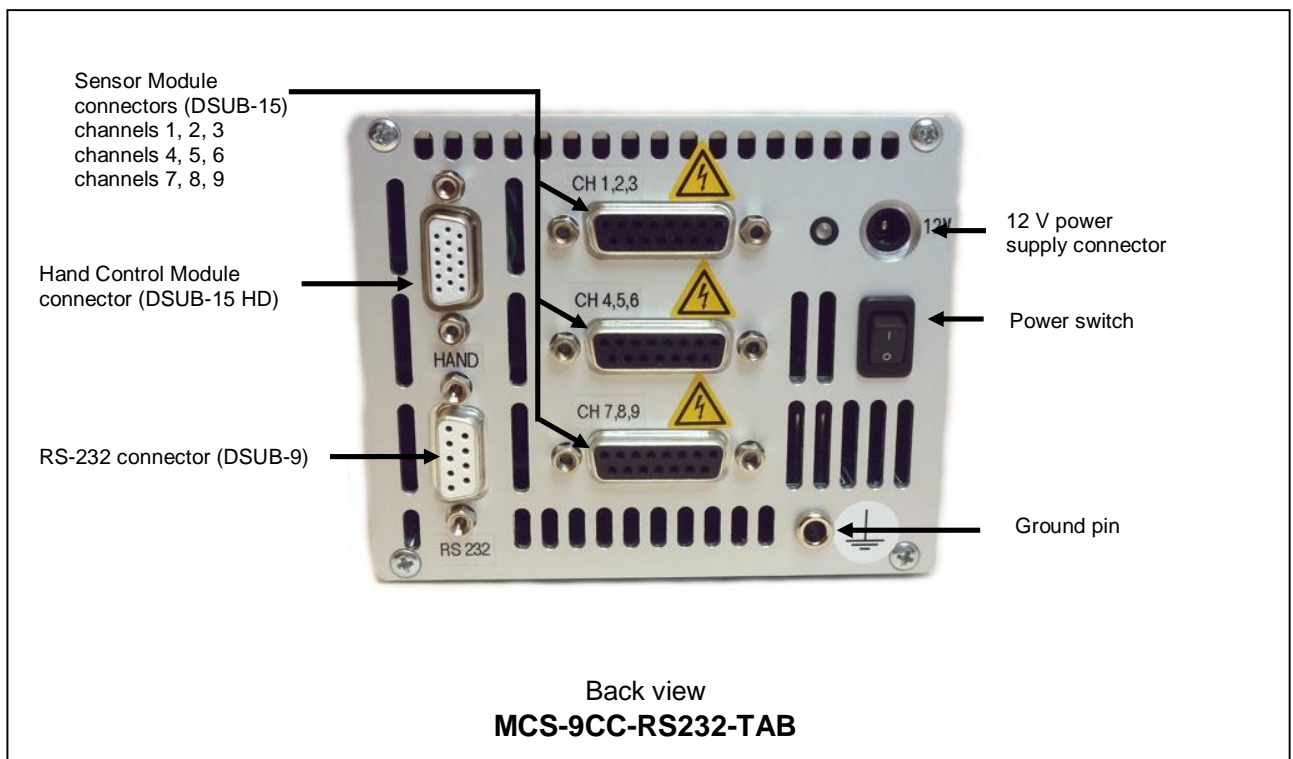
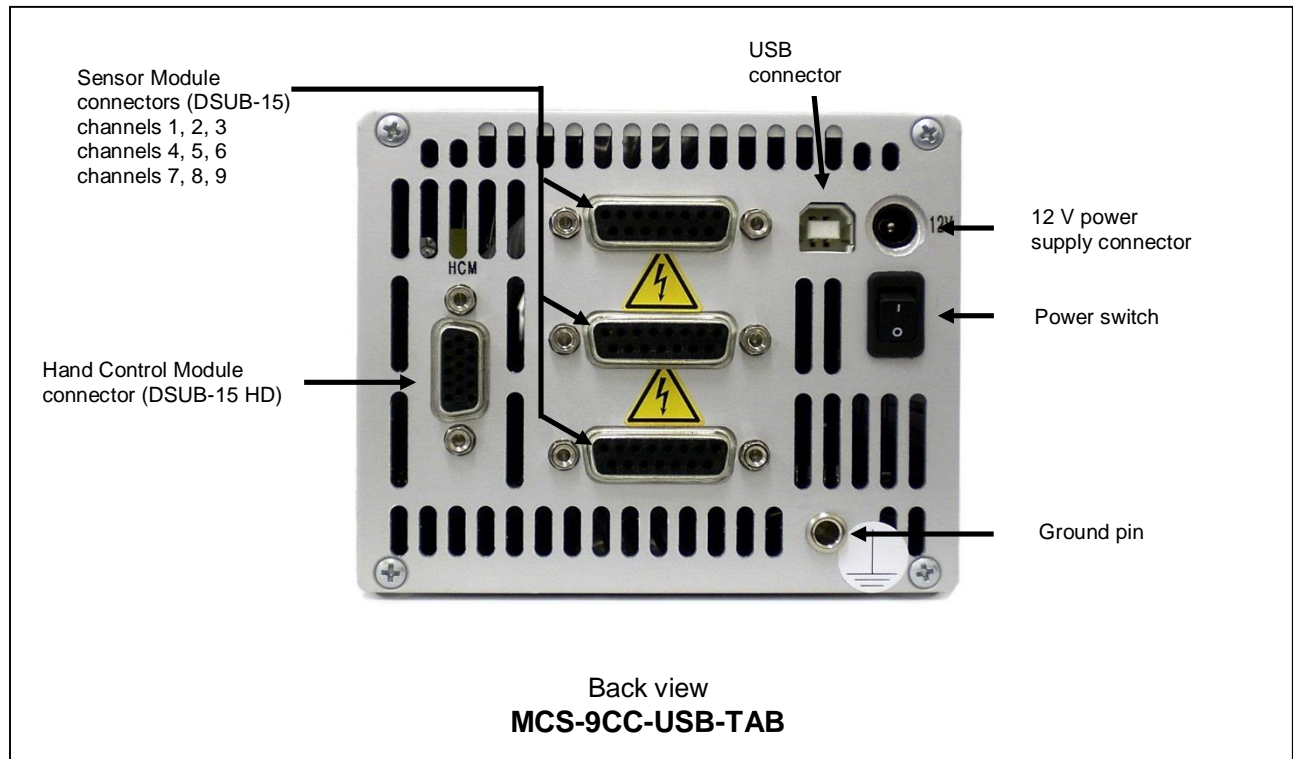
Back view
MCS-3P-RS232-TAB



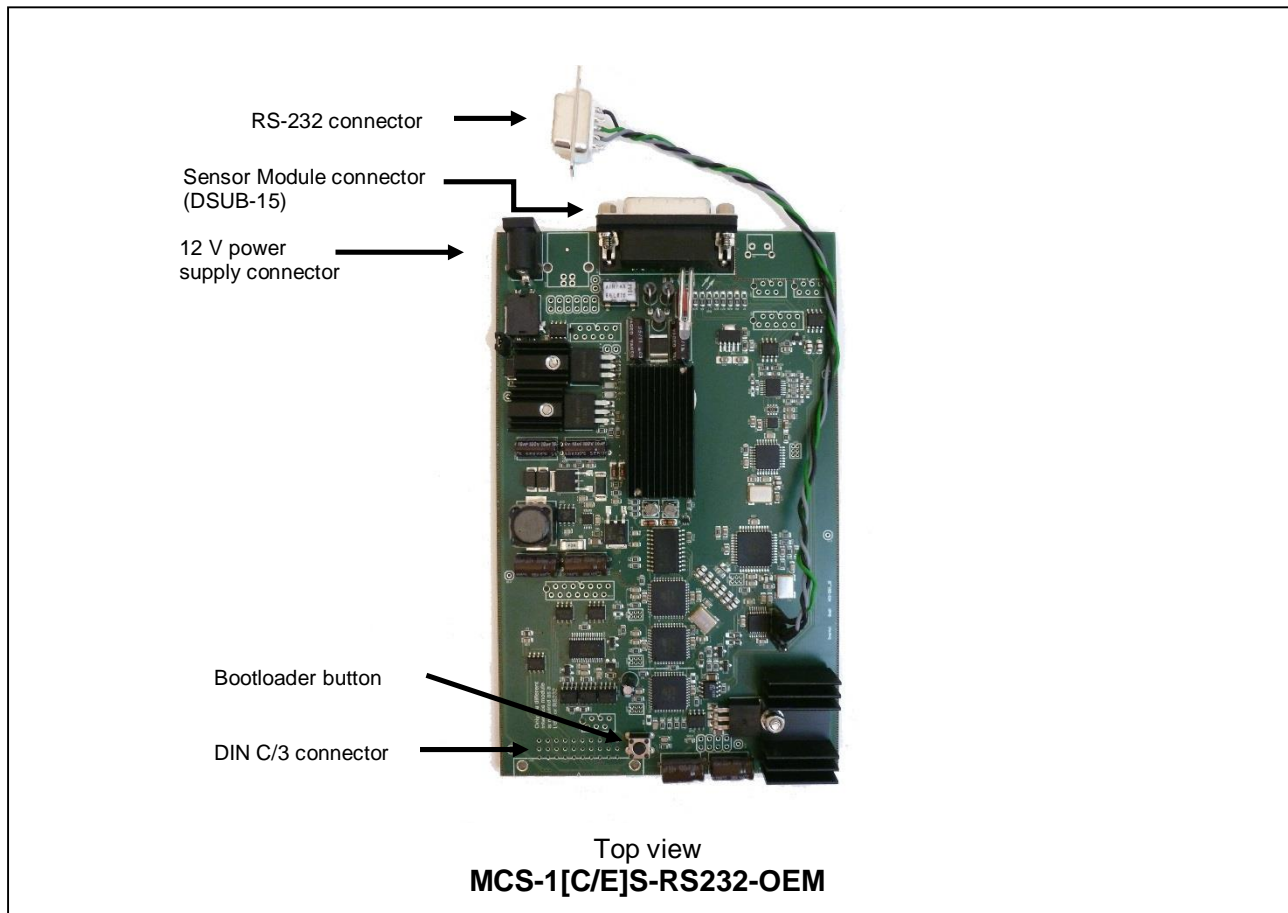
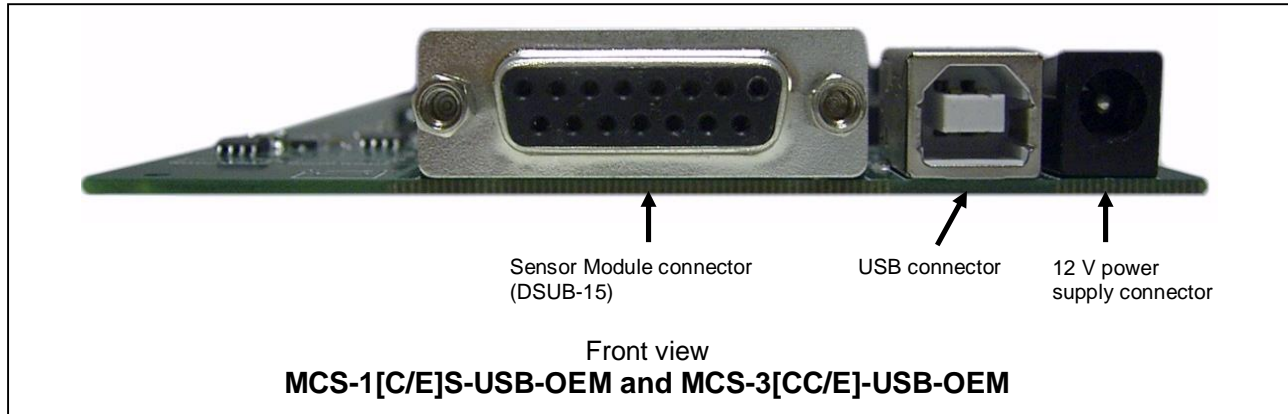
3x LEMO ECA.0B.306 sockets
for FemtoTools Endeffectors

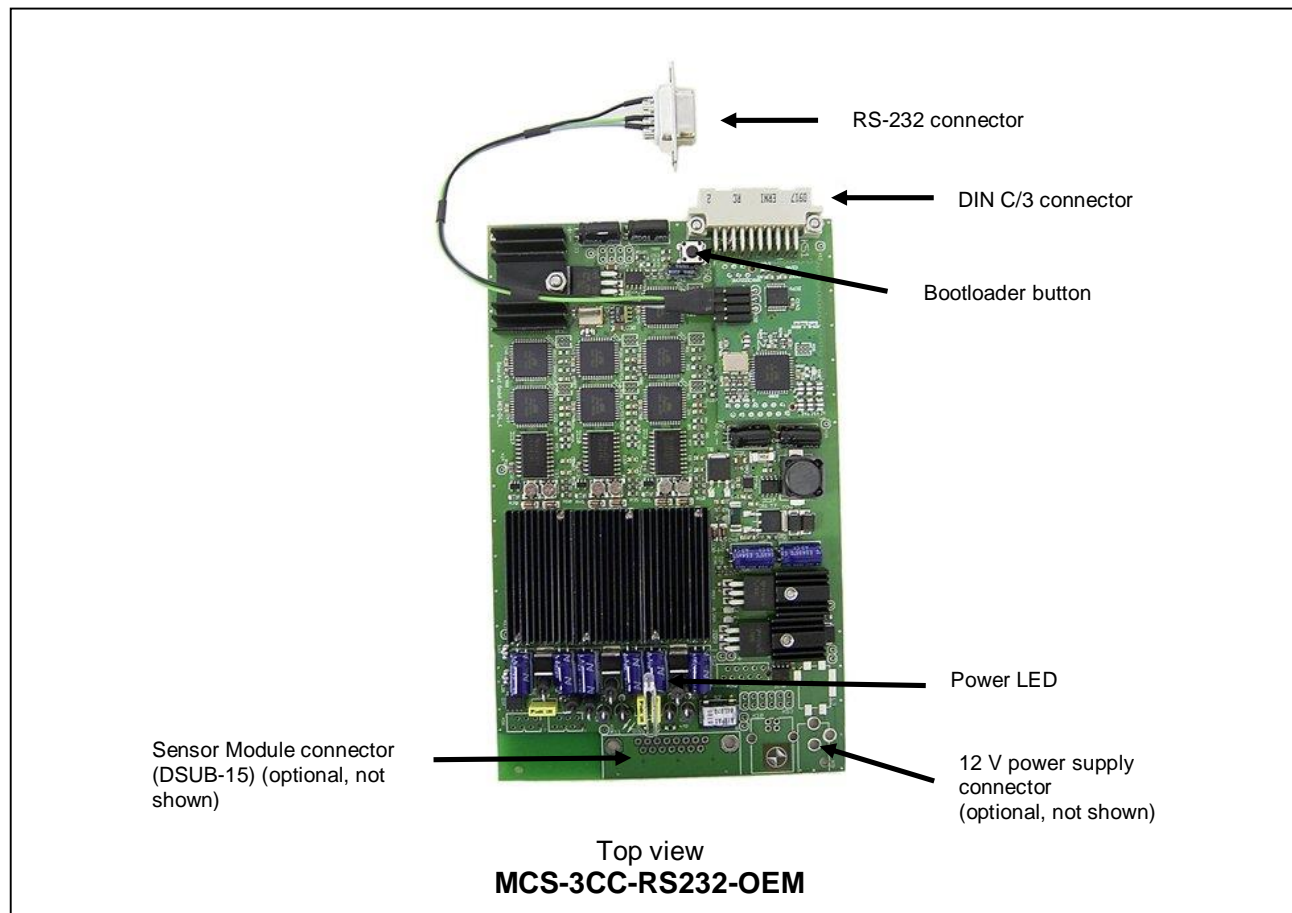
Back view (partial)
MCS-[...]-3F-[...]-TAB

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.

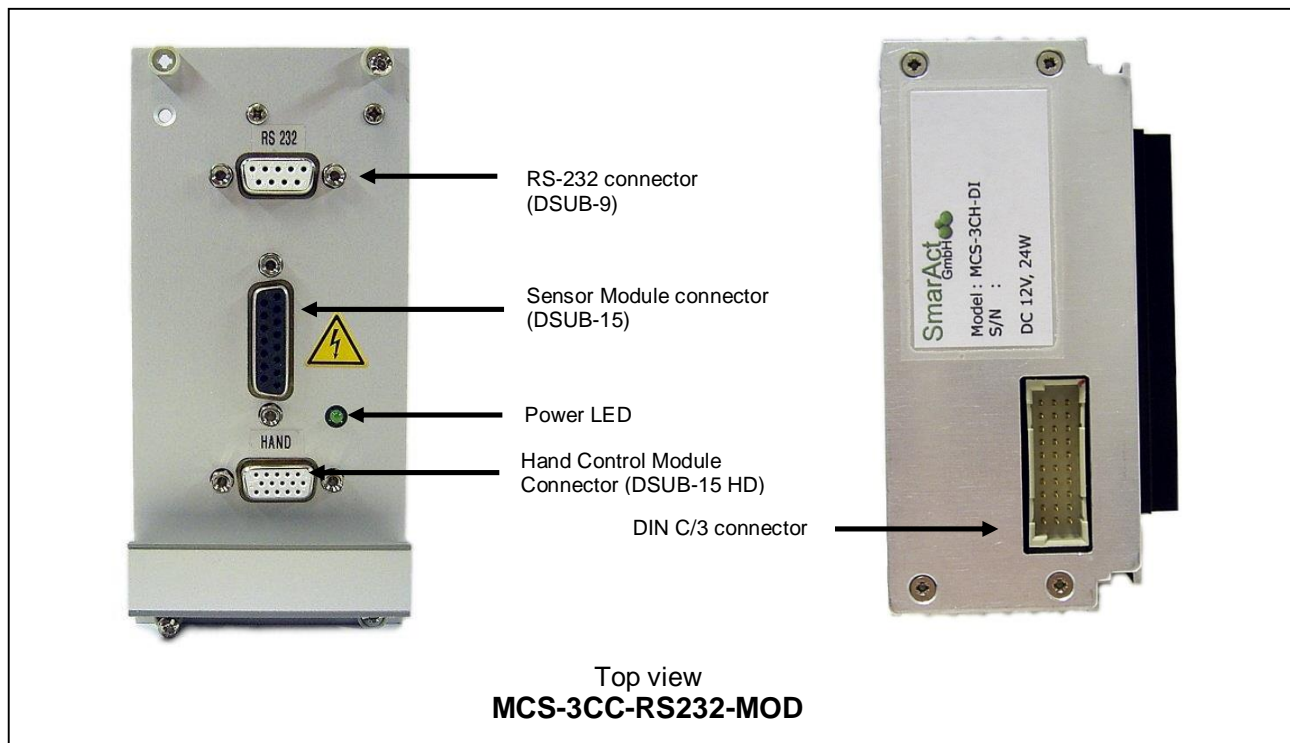
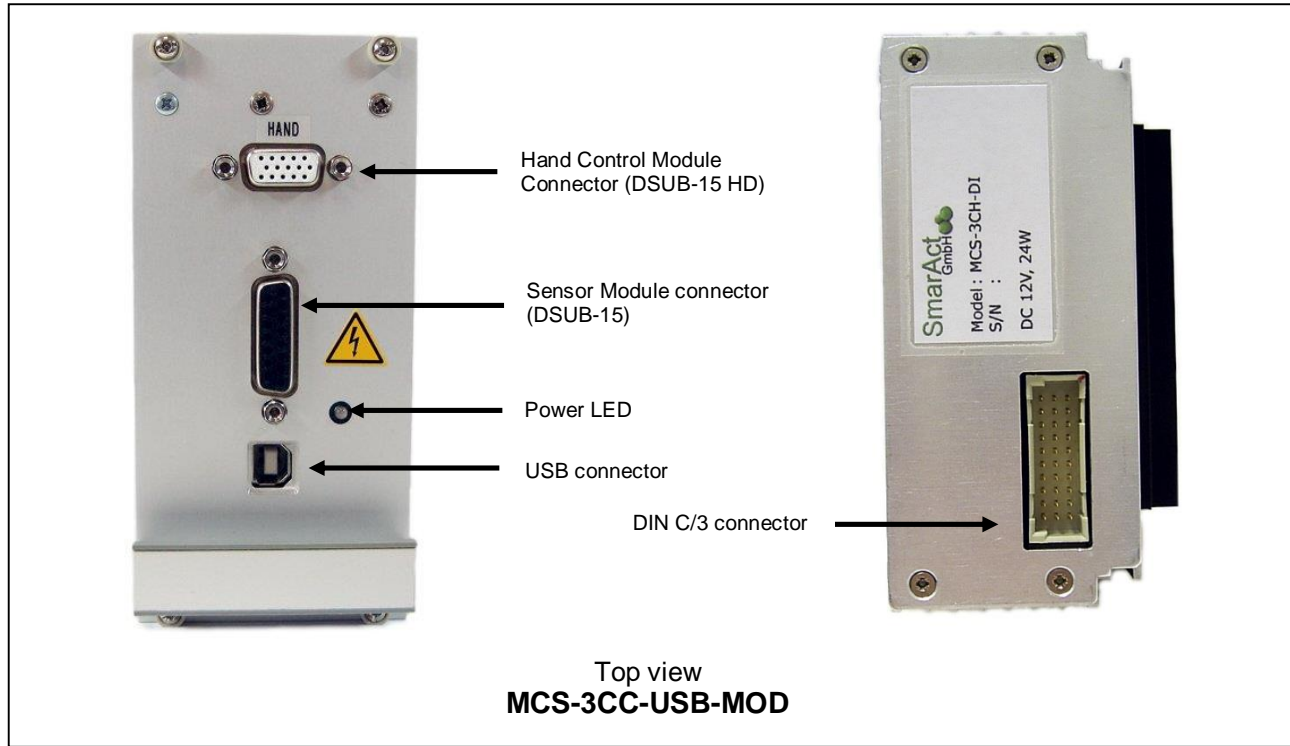


OEM controllers are delivered without housing and with a customer-specific assembly of the connectors.





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.

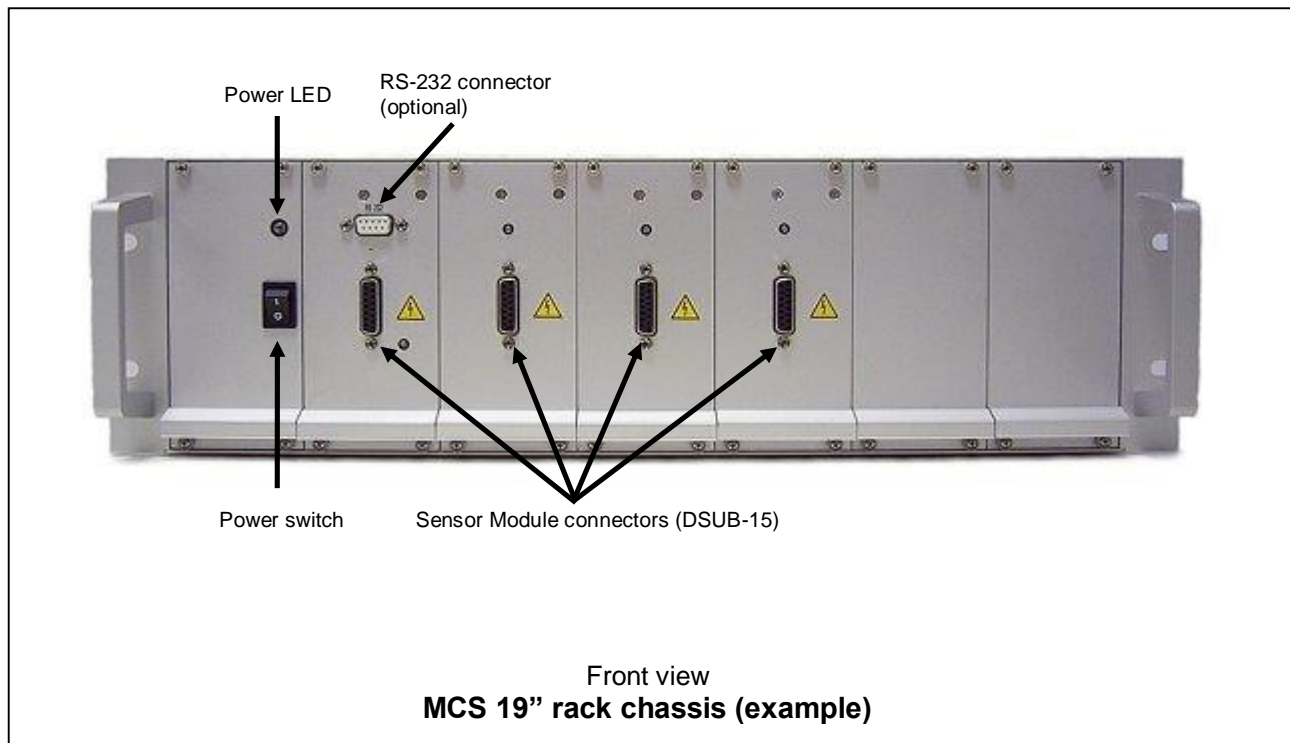


2.2 SmarAct Chassis (optional)

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.



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 digitizes the sensor data. The model depends on the sensor type, the driver type as well as the connector to the positioner.

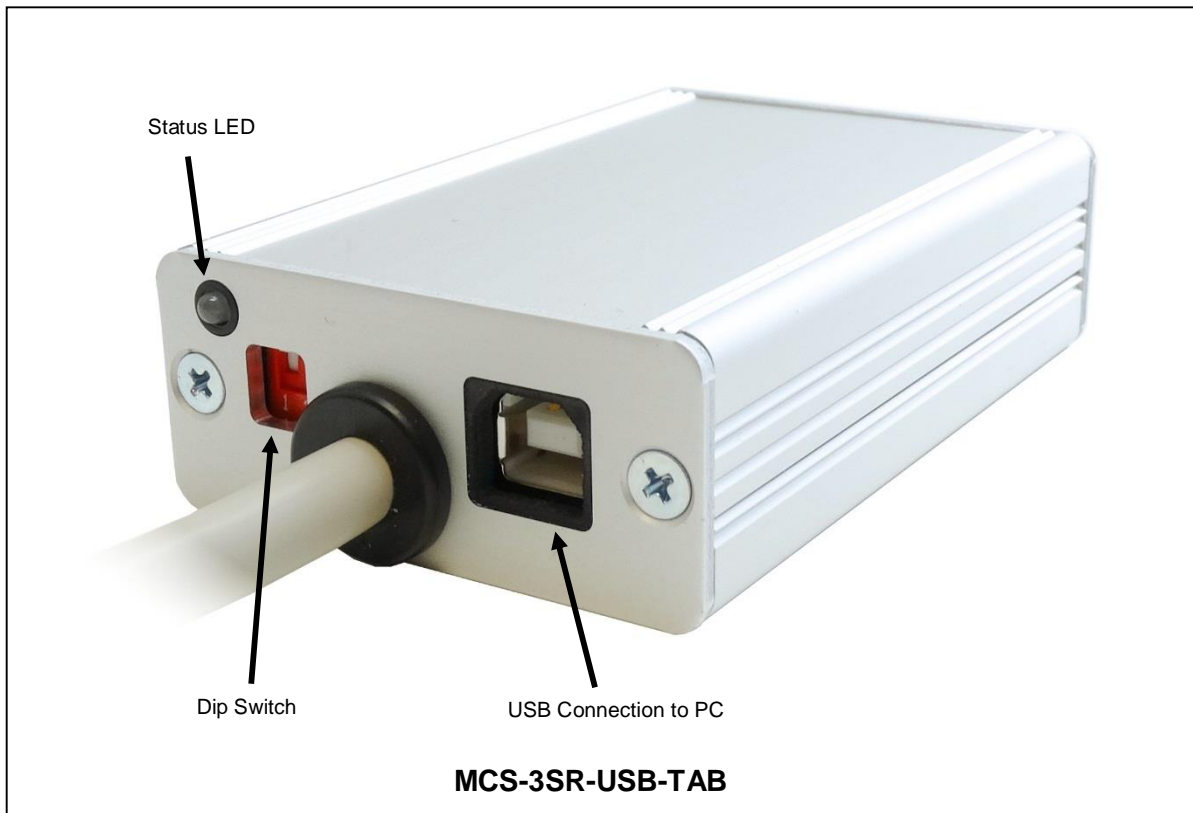
| Order Code | Description | Connectors |
|------------------------|---------------------------------------|-------------------------------------|
| Controller Type | | |
| MCS | MCS controller | |
| Sensor Type | | |
| -1S, -2S, -3S | Nanosensor with 1 / 2 / 3 channels | 1, 2, 3 connectors |
| -1M, -2M, -3M | Microsensor with 1 / 2 / 3 channels | 1, 2, 3 connectors |
| Driver Type | | |
| -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 |
| Connector Type | | |
| -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 |
| -3ADC | ADC input | Coaxial SMB connector |
| Housing Type | | |
| -OEM | OEM board | |
| -TAB | Table-top housing | |
| -TABM | 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 MCS-3M-EP-SDS15-TAB MCS-3S-PP-SDS15-TAB | - 3 channels - D-SUB-15 plugs |  |
| MCS-3S-EP- LEMO2B MCS-3S-PP- LEMO2B MCS-3S-EP- LEMO2K | - 3 channels - directly mounted to one Lemo plug (size 2B, 32 pins) |  |
| MCS-3S-EP- LEMO1B MCS-3S-PP- LEMO1B | - 3 channels - directly mounted to three Lemo plugs (size 1B, 14 pins) |  |
| MCS-3S-EP-BLE1B10G-TABM | - 3 channels - Lemo plugs (size 1B, 10 pins) |  |
| MCS-3S-EP-SDS15-3ADC-TAB | - 3 channels - D-SUB 15 plugs - 3 ADC inputs |  |

2.4 MCS Sensor Reader

The MCS Sensor Reader extracts the raw data stream of the sensor module and provides position data with a bandwidth up to 8 kHz. Using the USB interface of the Sensor Reader the data are accessible.



The Status of the LED and the Dip Switch settings are as follows:



| | |
|--------------|------------------------|
| LED off | Sensor Reader disabled |
| LED blinking | Connection linking |
| LED on | Connection established |

| | |
|--------------|-----------------------------------|
| Dip Switch 0 | On: ADC Signal / Reference Signal |
| Dip Switch 1 | reserved |

Both D-Sub 15 Connectors of the Sensor Reader have the same pinout as described in Chapter 3.2.1.

2.5 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 |
| |  |

2.6 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

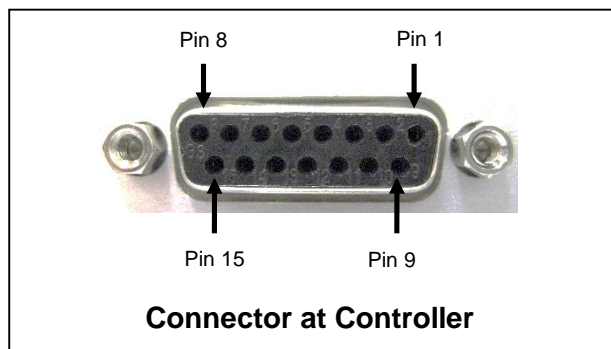
3.1 Power Supply

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 ² C bus, sensor programming |
| 11 | S-SDA | SDA for I ² 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 |

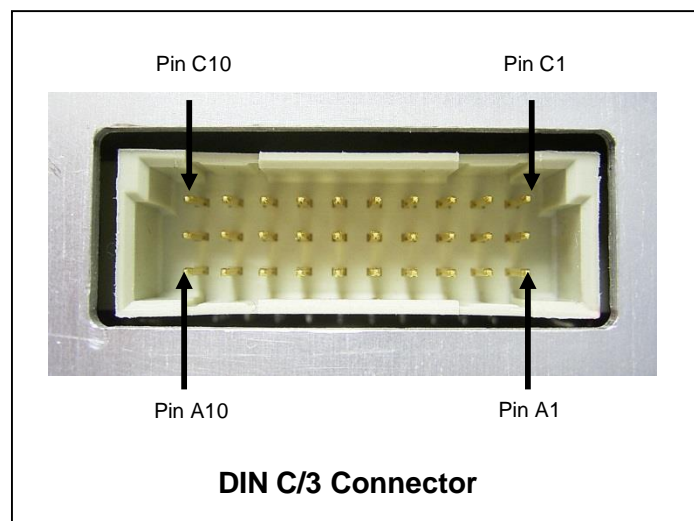
The positioner driving signals are specified as follows:

| 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 μ s, 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:

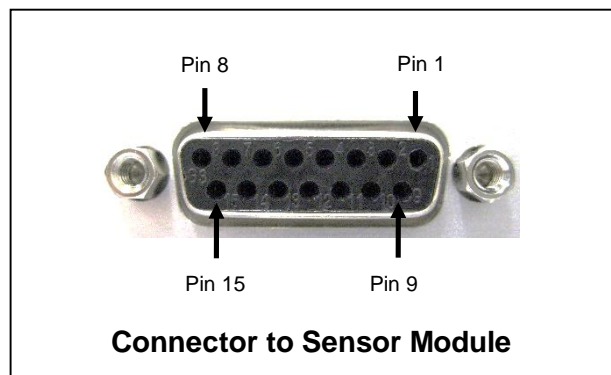
| Pin | Signal | Function |
|-----|-----------|---|
| A1 | d.n.c. | DO NOT CONNECT |
| A2 | d.n.c. | DO NOT CONNECT |
| A3 | SM-D+ | RS-485 D- signal from an external Sensor Module |
| A4 | HCM-MOSI | Hand Control Module: SPI communication: master out - slave in |
| A5 | HCM-HS2 | Hand Control Module: 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 μ s, 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 | d.n.c. | DO NOT CONNECT |
| 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:

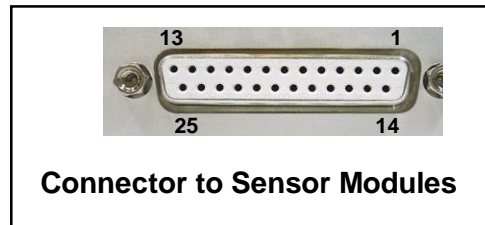
| Driving Signal (HV-OUT-x) | Value | Unit |
|--|---|------|
| Output voltage range | 0 to 100 | V |
| Average current per channel | 200 | mA |
| Peak current per channel, < 10 μ s, max. speed | 20 | A |
| Signal | sawtooth (step mode), constant (scan mode) | |

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.



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 μ s, max. speed | 20 | A |
| Signal | sawtooth (step mode), constant (scan mode) | |

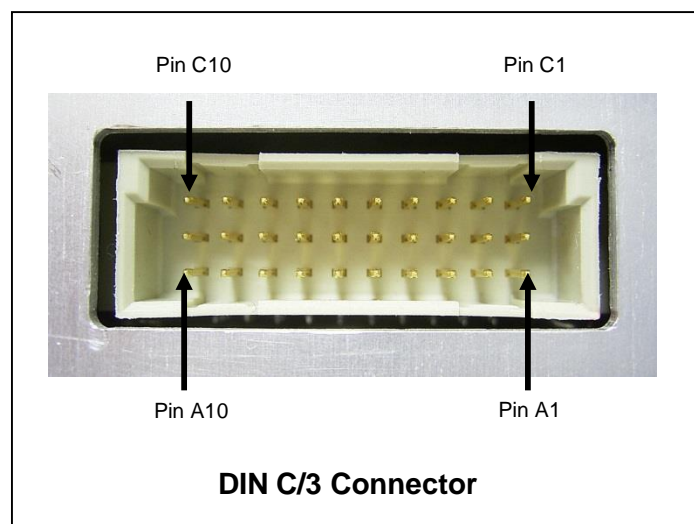
The signals from the sensor module are specified as follows:

| 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:

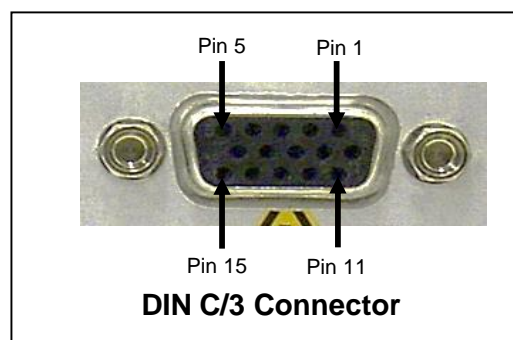
| Pin | Signal | Function |
|-----|-----------|---|
| A1 | HV-OUT-3 | Positioner driving signal, channel 3 |
| A2 | d.n.c. | DO NOT CONNECT |
| A3 | SM-D+ | RS-485 D- signal from Sensor Module |
| A4 | HCM-MOSI | Hand Control Module: SPI communication: master out - slave in |
| A5 | HCM-HS2 | Hand Control 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 |
| Peak current per channel, < 10 μ s, max. speed | 20 | A |
| Signal | sawtooth (step mode), constant (scan mode) | |

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

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

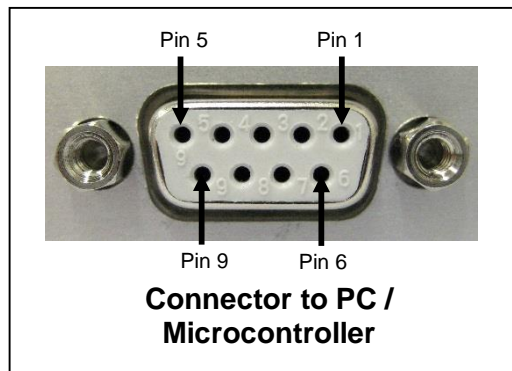


The pin assignment is as follows:

| 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.

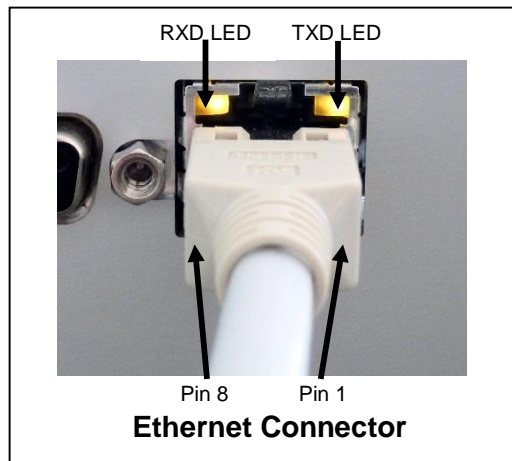


The pin assignment is as follows:

| 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.



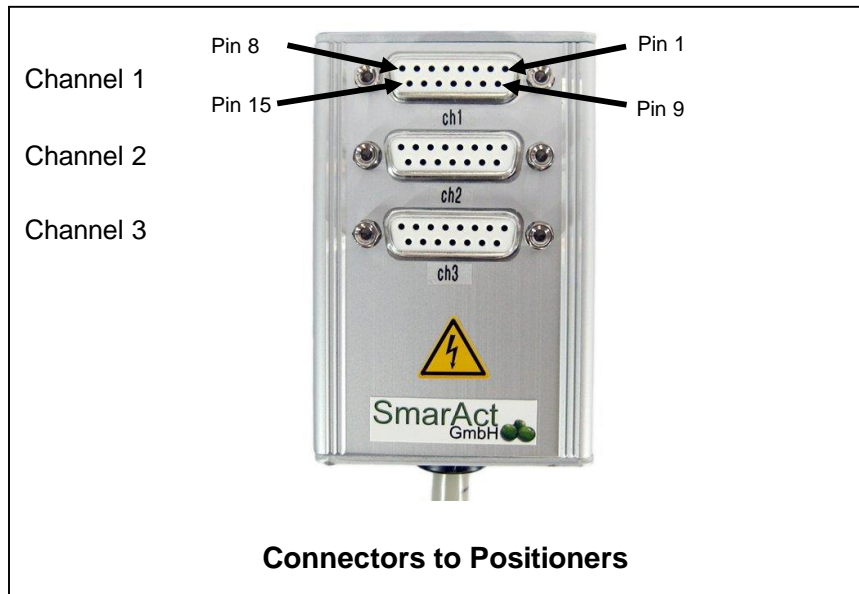
The pin assignment is as follows:

| 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



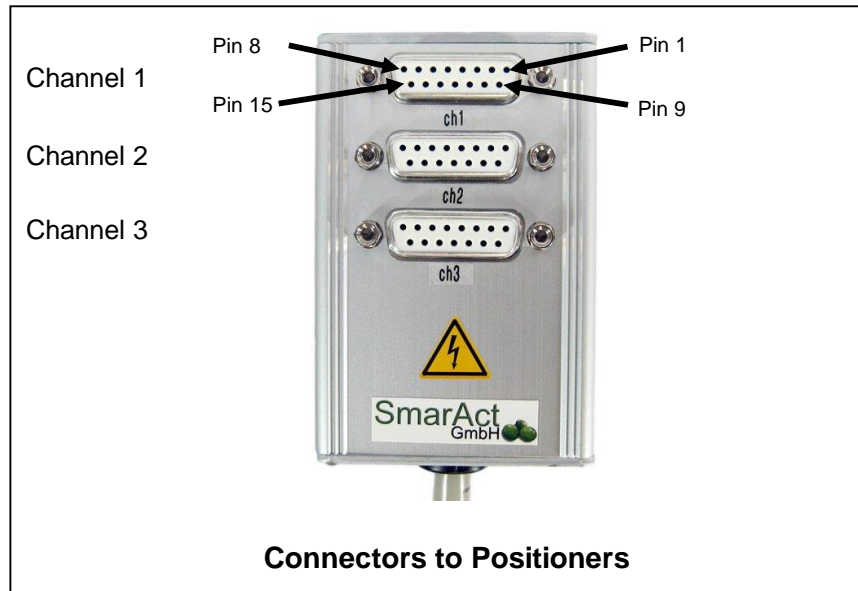
The pin assignment of each D-SUB connector is as follows:

| 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 ² 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 ² C bus, sensor programming |
| | HV-GND-xB | Ground for positioner driving signal B, channel x (Picoslide-lift) |

| | | |
|----|--------|--|
| 11 | S-SDA | SDA for I ² 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 |

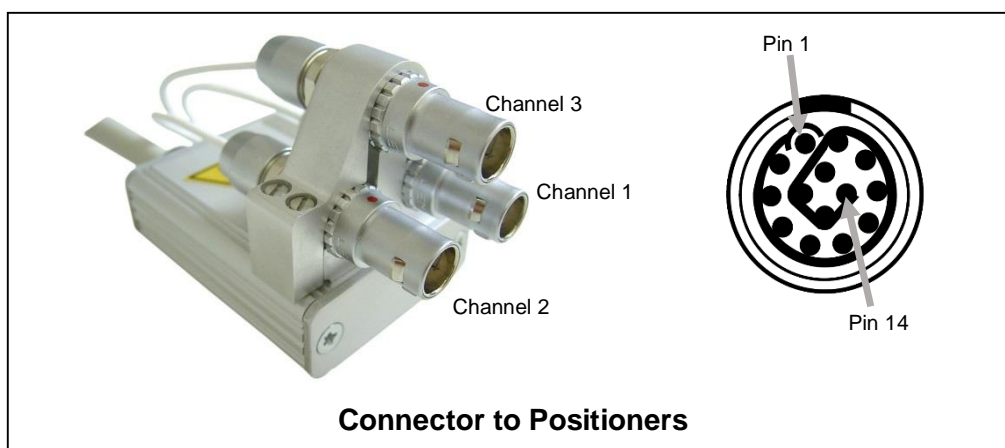
The HV-OUT-x signals are identical to the HV-OUT-x signals from the MCS controller.

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 ² C bus, sensor programming |
| 2 | S-SCL | SCL for I ² 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) |

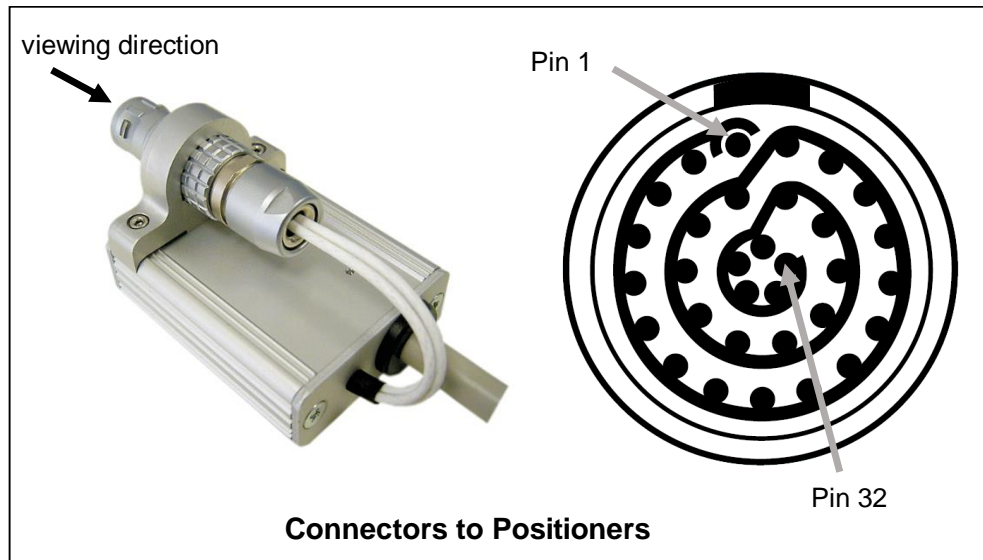
The HV-OUT-x signals are identical to the HV-OUT-x signals from the MCS controller.

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:

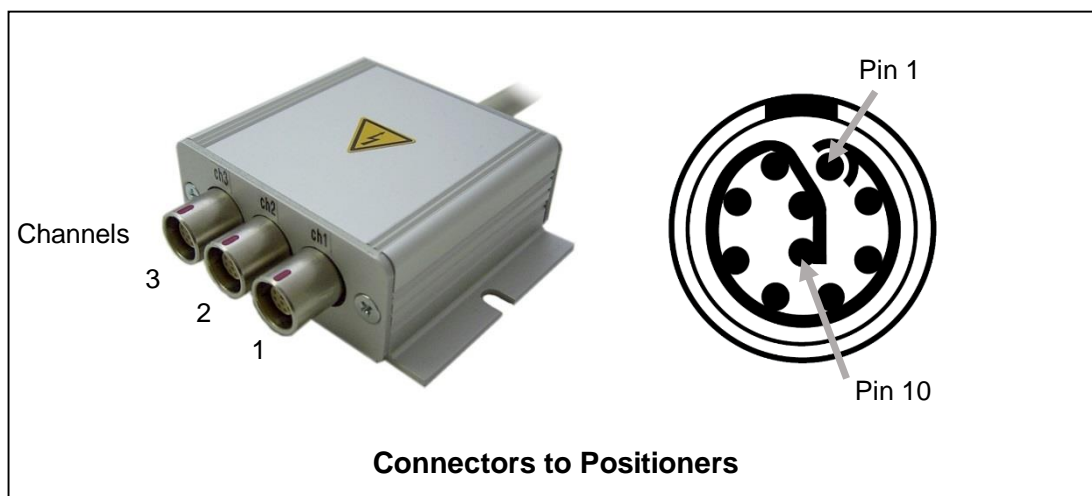
| Pin | Signal | Function |
|-----|----------|--|
| 1 | S-SIN+_1 | U1/sin+ signal from sensor, channel 1 |
| 2 | S-SIN-_1 | U1/sin- signal from sensor, channel 1 |
| 3 | S-COS+_1 | U2/cos+ signal from sensor, channel 1 |
| 4 | S-COS-_1 | U2/cos- signal from sensor, channel 1 |
| 5 | S-REF+_1 | U0/reference+ 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

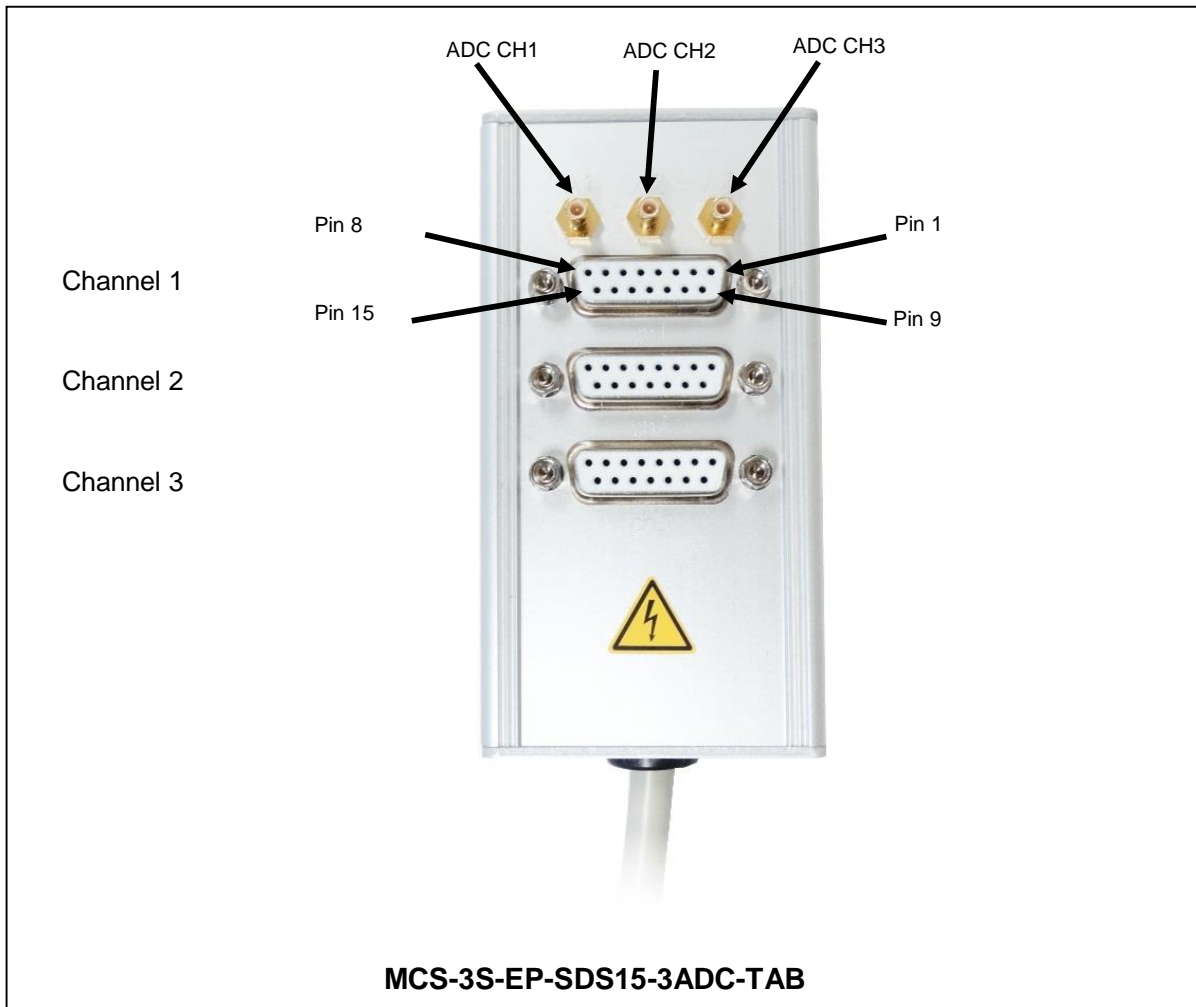


The pin assignment of each D-SUB connector is as follows:

| 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.

3.3.6 SMB connector at MCS-3S-EP-SDS15-3ADC-TAB



Pin Description for ADC CH1 , ADC CH2 , ADC CH3:

| | | |
|--------|------------|-------------------------------|
| Tip | ADC input | The ADC input signal 0 – 3.3V |
| Shield | ADC ground | Ground for ADC input |

The Pin assignment of the D-SUB sockets can be found in section 3.3.2.

3.4 Operating Conditions

The MCS controller must be used in normal environmental conditions:

- Indoor usage only.
- Temperature range MCS controllers with external power supply: 5°C to 40°C
- Temperature range MCS-19" controller with internal power supply: -40°C to 70°C.

