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Delivery Note No. L1101100354		lin. positioners	
Customer no.	10622	Date	31.10.2011
Your message	09.08.2011	Contact person	Martina Schütt +49 - 441 - 800879/0
Your order no.	PO#6981337		

Dear Mr. Matlis,

we thank you for your order and we deliver under our Terms of Sale and Delivery:

Pos.	Item	Description	Serial No.	Quantity
1.	SLC-1780-S-HV	Positioner with 51 mm travel, crossed roller guideway and integrated sensor (appr. 1 nm resolution), HV compatible (10e-6 mbar)		4 pcs.
2.	SLC-24120-S-HV	Positioner with 83 mm travel, crossed roller guideway and integrated sensor (appr. 1 nm resolution), HV-compatible (10e-6 mbar)		1 pcs.
3.	ALL-CON-15	Pair of D-SUB-15 plugs (atmosphere: standard, vacuum: PEEK), assembly of the cables		5 pcs.
4.	MCS-6C-IDH -RS232	MCS control system for up to six positioners or grippers, with operating controls in separate hand control module and cable (150cm) - AC adapter (12V) - RS-232 cable - user manual - CD with documentation (ASCII command set)		1 pcs.
5.	MCS-3S-DS15	MCS Sensor Module, D-SUB-15 connectors to connect up to three positioners with nanosensors		2 pcs.
6.	CABLES	Cable lengths Proposal: Positioner - Feedthrough: 80 cm Feedthrough - Sensor Module: 30 cm Sensor Module - Controller: 10 m		1

Delivery terms: DDU LBNL (INCOTERMS)

Page 2 of invoice no. RE101100354:

for Lawrence Berkeley National Laboratory - Accounts Payable Dept. - 1 Cyclotron RD - MS 971-AP - CA 94720 BERKELEY

Pos.	Item	Description	Quantity	Unit Price [€]	Total Price [€]
6.	CABLES	Cable lengths Proposal: Positioner - Feedtrough: 80 cm Feedthrough - Sensor Module: 30 cm Sensor Module - Controller: 10 m	1	50.00	50.00
7.	PACKSHIP-US	packing and shipping (United States, uninsured)	1	170.00	170.00
				Total net amount	€ 14,195.00
				VAT 0%	€ 0.00*
				Total gross amount	€ 14,195.00
				Corresponds to	USD 20,429.44

at exchange rate of 1 € = 1,439200 USD

The exchange rate at the date of payment is authoritative.

Country of origin:	GERMANY	* Steuerfreie Lieferung gem. § 4 Nr1 a i. V. m. § 6 UStG (tax free export)
HS commodity code	9012.90.00 00	
Payment term:	30 days net	
Delivery date:	31.10.2011	
Delivery terms:	DDU LBNL (INCOTERMS)	
Dispatch type:	(Nicht angegeben)	
Delivery address:	UC Lawrence Berkeley Lab for the US Dept. of Energy Mr. Mark Coleman 1 Cyclotron RD - Bldg. 69 PO#6981337 CA 94720 BERKELEY VEREINIGTE STAATEN VON AMERIKA	

All prices are quoted in Euros and are exclusive of any and all taxes, custom charges and bank charges, which shall be the sole responsibility of the customer. Technical details are subject to change without notice. Errors and omissions excepted.

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Lawerence Berkeley National Laboratory
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 Mrs. Helen S Yatar
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Invoice No. RE101100354

lin. positioners

Delivey note	LI101100354, Keine Eintragung...	Date	31.10.2011
Customer no.	10622	Contact person	Martina Schütt
Your message	09.08.2011		+49 - 441 - 800879/0
Your order no.	PO#6981337		

Dear Mrs. H. Yatar,

we thank you for your order and invoice under our Terms of Sale and Delivery:

Pos.	Item	Description	Quantity	Unit Price [€]	Total Price [€]
1.	SLC-1780-S-HV	Positioner with 51 mm travel, crossed roller guideway and integrated sensor (appr. 1 nm resolution), HV compatible (10e-6 mbar)	4 pcs.	1,535.00	6,140.00
2.	SLC-24120-S-HV	Positioner with 83 mm travel, crossed roller guideway and integrated sensor (appr. 1 nm resolution), HV-compatible (10e-6 mbar)	1 pcs.	1,565.00	1,565.00
3.	ALL-CON-15	Pair of D-SUB-15 plugs (atmosphere: standard, vacuum: PEEK), assembly of the cables	5 pcs.	360.00	1,800.00
4.	MCS-6C-IDH -RS232	MCS control system for up to six positioners or grippers, with operating controls in separate hand control module and cable (150cm) - AC adapter (12V) - RS-232 cable - user manual - CD with documentation (ASCII command set)	1 pcs.	3,570.00	3,570.00
5.	MCS-3S-DS15	MCS Sensor Module, D-SUB-15 connectors to connect up to three positioners with nanosensors	2 pcs.	450.00	900.00
Intermediate sum of total prices				€	13,975.00



Modular Control System

User Manual

MCS-6C-IDH, RS-232 Interface

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1 Manufacturer Declarations

1.1 Declaration of Conformity

Declaration of Conformity

according to ISO/ IEC Guide 22 and EN 45014

Manufacturer: SmarAct GmbH
Manufacturer's Address: Flötenstraße 70
26125 Oldenburg, Germany



The manufacturer hereby declares that the product

Product name: MCS
Model Numbers: MCS-D; MCS-I; MCS-H; MCS-S
Product Options: all

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

73/23/EEC Low-voltage Directive
89/336/EEC EMC Directive

The applied standards certifying the conformity are listed below:

Electromagnetic Emission: EN61000-6-3, EN55011

Electromagnetic Immunity: EN61000-6-1

Safety (Low Voltage Directive): EN61010-1

November 15, 2008
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 is the USB cable. It may be safely removed or attached during operation. Note though that when removing the USB cable, all positioners will be stopped immediately as a safety precaution.



Calibration



A calibration routine on the controller is used to increase the accuracy of the position calculation.

Calibration must be done once for each channel

- if the **mechanical setup is changed**, i. e. if different or new positioners are connected to different channels,
- or if a **sensor type is changed**.

Safety Precaution: During the calibration the positioner will perform a movement in the range of up to several mm. Sensor types that are referenced via mechanical end stops (e.g. "M", linear positioners with micro sensor) are even moved to the end stop as part of the calibration routine. As a safety precaution, make sure that the positioner has enough freedom to move without damaging other equipment.

Calibration Routine: The calibration can be started on the hand control module or via a PC.

On the **hand control module** follow the following procedure:

- Ensure, that the calibration routine is not issued while the positioner is near a mechanical end stop. Otherwise the calibration might fail and lead to unexpected behavior when using the closed-loop control mode.
- Enter the main menu (top left button next to the display),
- Select "Sensor Options",
- Select "Calibrate",
- Select one of the "Calibrate" menu entries (depending on the channel).
- Press the "Start" button to start the calibration routine. The status will change to "Calibrating". The calibration takes a few seconds to complete. If finished, the status will return to "Stopped". The calibration data is saved and will be used on future power-ups.

Alternatively, the following **programs** can be started from a **PC** after connecting the controller:

- **USB devices:** MCSCalibrator or MCSConfiguration in the Tools folder of the CD
- **RS-232 devices:** RS232Test or MCSConfiguration in the Tools folder of the CD

The calibration data is saved to non-volatile memory immediately. Therefore, if the mechanical setup and the sensor types are unchanged, it is not necessary to issue the calibration routine on each power up. Note though that newly connected positioners have to be calibrated in order to ensure proper operation.

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.

The MCS controller provides the following features:

- **Driver Module:** With the MCS described in this manual you can control up to six positioners.
- **Sensor Module:** The positioners may be equipped with integrated sensors to perform closed-loop positioning control.
- **Hand Control Module:** The MCS offers easy and ready-to-go control by the joysticks and control knobs - without the need of complex installation procedures.
- **RS-232 Interface Module:** The MCS may also be controlled by software running on a PC or controller. Please refer to the *MCS RS-232 Interface Documentation* for more information on how to communicate with the MCS controller via an RS-232 connection.

Please note that this manual has been provided for information only and that the products described are subject to change without notice.

3 System Setup

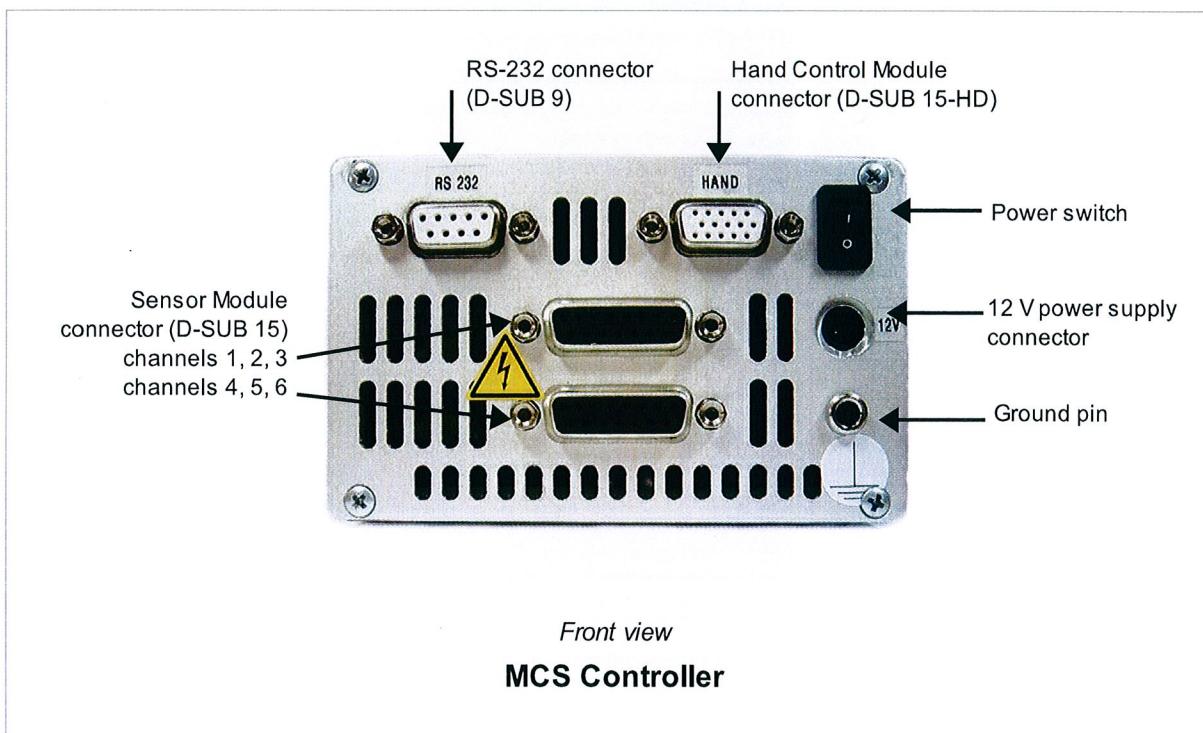
3.1 Controller Components

3.1.1 MCS Controller

The MCS controller is the component

- that drives the positioners
- that processes the sensor data from the integrated position sensors
- that performs closed-loop position control
- that processes commands from the operation controls
- that processes commands from a PC or embedded controller (proprietary software).

The figure below shows the connectors of the MCS controller.



3.2 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).
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 labelled, their labels must match.

3. If the cables from the 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 labelled, their labels must match.
4. If the Sensor Modules are delivered in a separate housing, connect the **positioners** to flat cable and MMCX connectors or the D-SUB 15 pin female connectors of the **Sensor Modules**. If the connectors are labelled, 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. Connect the **MCS controller** with help of the enclosed **RS-232** cable to the **PC or controller**, from which the MCS controller will receive commands.
8. If desired, connect the **ground potential of the mechanical system setup** to the ground pin of the **MCS controller**. This is especially interesting for applications in scanning electron microscopes where the ground potential of the system setup should be equivalent to the ground potential of the controllers.
9. Power up the controller by switching the **power switch** to the "on" position (1).

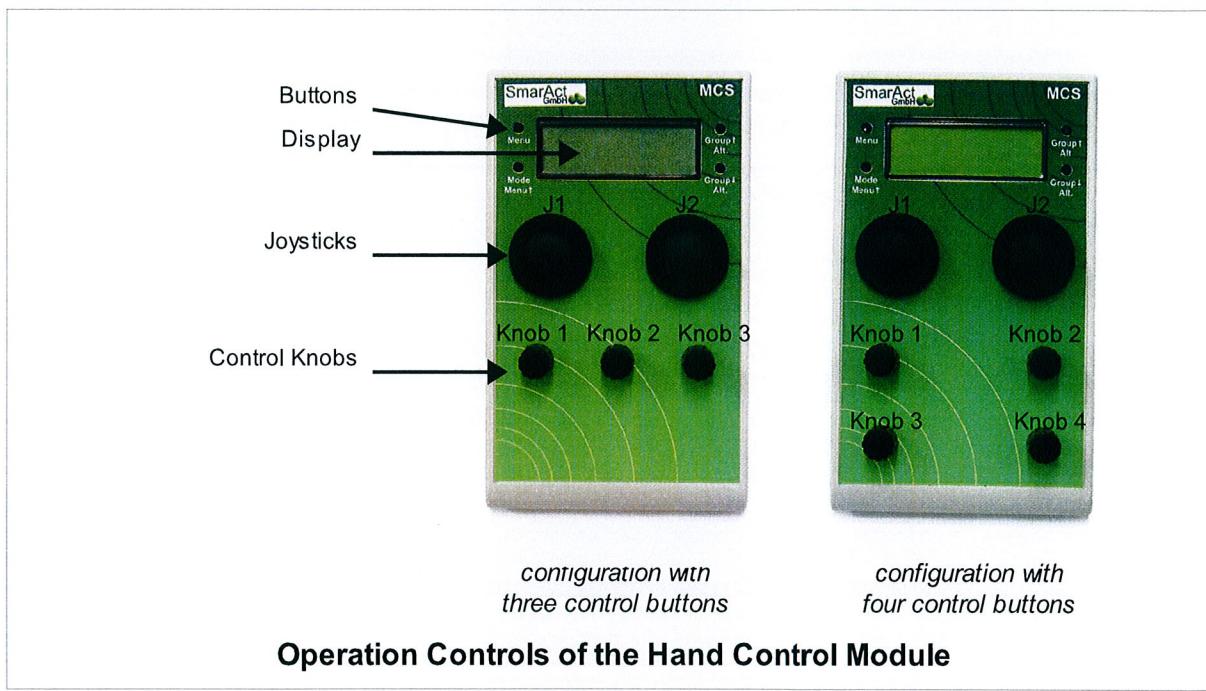
4 Hand Control Module

The Hand Control Module gives you direct control of your positioning system without having to setup a complex control software system. The device may be configured in many ways to suit your needs. However, SmarAct will preconfigure the device for you, so in most cases there will be no need to change the configuration.

After power up, the device is ready to be used and you may start using your positioning system immediately. This section describes how to control your positioning system with the Hand Control Module and how to reconfigure it if you wish to do so.

4.1 General

The device offers two joysticks and three or four control knobs to control the positioners, as well as a display and four buttons to configure the device. The actual number of control knobs depends on the connected system configuration.



Operation Controls of the Hand Control Module

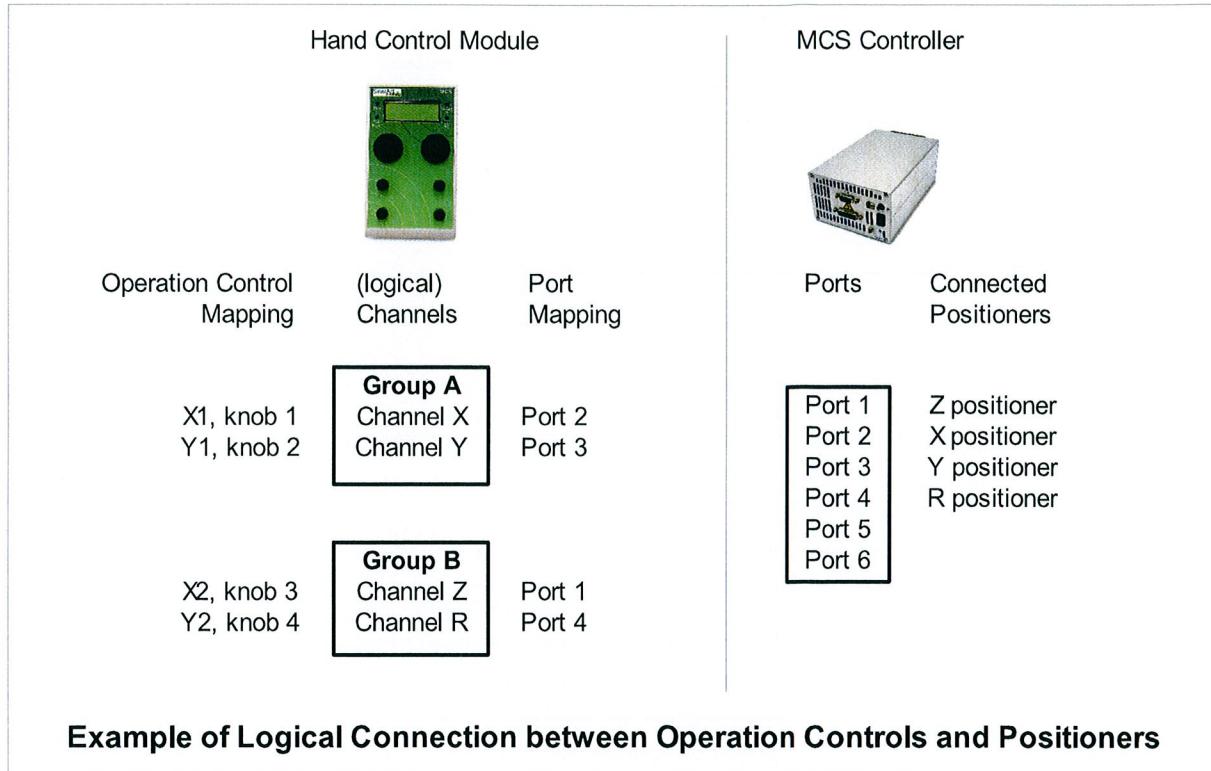
The operation of the device is divided into two modes: the *normal operation mode* and the *menu mode*. In the normal operation mode the device controls are used to control your positioning system. When controlling systems with many positioners (four or more) you may want to divide them into separate groups. The joysticks and knobs may be used to control the positioners of one group. You can use the "Group Up" and "Group Down" buttons next to the display to cycle through the different groups. The "Mode" button lets you select different control modes for each positioner. See section "Normal Operation Mode" for more information on how to control your system.

The "Menu" button enters and exits the menu mode. In this mode the device controls are used to navigate through the menus and sub menus. See section "Menu Mode" for more information.

4.2 Terminology

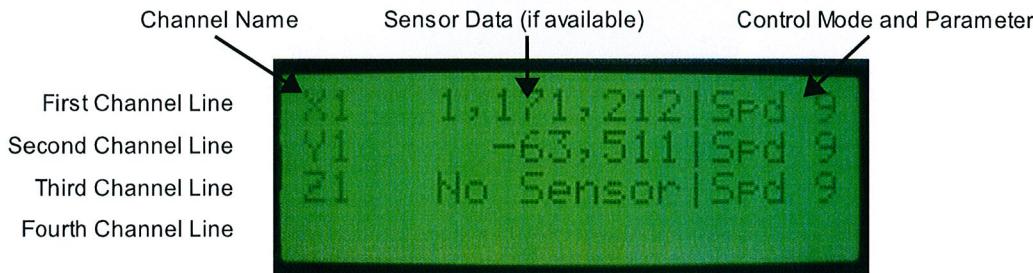
There are some terms that help to understand some basic concepts, especially if you want to adjust the configuration of the device to fit your own needs. Some of these terms are described here.

- **Port** - A port represents a physical signal output pin of the MCS. Each positioner or end effector is connected to a port of the control electronics. Each port has a specific type (positioner or end effector). Positioners may only be connected to positioner ports and end effectors may only be connected to end effector ports. The number of available ports and their types are static properties of the MCS and depend on the hardware you purchased. In a typical case of a complete system the connections from positioners and end effectors to the ports of the MCS are fix and cannot be changed.
- **Channel** - A channel is a logical representation of a positioner or an end effector. During the configuration of the Hand Control Module you may define several channels to control your system. Each channel gets mapped to a port and thus to a positioner or end effector. You may then control your system by setting control parameters for each channel and giving movement commands.
- **Channel Type** - Channels actually do not have a type themselves, since this is a port property. The term "channel type" refers to the type of the port that the channel is currently mapped to.
- **Group** - A group represents a manipulator that is assembled out of several positioners and/or end effectors. A group acts as a "container" for up to four channels. While in normal operation the display shows all the information you need to control the channels of one group, the *current group*. If more than one group is defined you may change the current group by using the "Group Up"/"Group Down" buttons next to the display.
- **Symbols and Names** - Each group may be given a separate *group symbol*, being a single character which is used in the display to refer to that group. The same applies to channels, which are given a *channel symbol*. A *channel name* consists of two characters and is the combination of the channel symbol and the group symbol that the channel is in. In normal operation the channel names are displayed at the beginning of each line.
- **Control Mode** - Each channel may be independently configured with a control mode. The control mode affects the way the positioners or end effectors will behave when turning knobs or moving joysticks to control the system. Each control mode has several parameters that may easily be changed to adjust the behavior of the channels. See section "Control Modes" for more information.



4.3 Normal Operation Mode

On power-up, the device initializes itself and then switches to normal operation. In this mode the display shows information for all channels of the current group. The display is organized in lines (*channel lines*) where each line displays information for one channel. The number of channel lines shown in the display depends on the number of channels that are defined within the current group.



Sample Display Setup in Normal Operation

4.3.1 Channel Lines

The first two characters of each channel line show the channel name consisting of the channel symbol and the group symbol. The contents of the rest of the line depend on the type of the channel, the current control mode of the channel and whether there is sensor data available or not. The different control modes are described in more detail below. Note that the channel name may be changed via the menu (see section "Configuration Menu").

For positioners with integrated sensors, linear position data is displayed in nanometers and rotary position data is displayed in micro degrees.

4.3.2 Control Modes

In normal operation the joysticks and the knobs are used to control positioners and end effectors. Typically, each knob is used to control one positioner or end effector. Which knob corresponds to which depends on the device configuration. The joysticks may also be freely mapped to certain channels.

Turning a knob or moving a joystick will perform a movement. The type of the movement depends on the control mode that is currently configured for the channel. Each channel may be configured with its own control mode independently. The direction of the movement depends on the direction you turned the knob or moved the joystick and also on the invert configuration of the knob or joystick (see section "Configuring Channels").

To change the control mode of a channel press and hold the "Mode" button next to the display (bottom left). The text "Mode adjust" will appear in the display as long as this button is pressed. In this state, instead of moving the positioners, the knobs are used to change the control modes of the corresponding channels. By turning the knobs you may cycle through the available control modes in both directions.

Each control mode has its own parameters. Generally, the parameters of a control mode for a channel may be changed by pressing the corresponding knob. This brings up an arrow indicating the parameter change state. See the following sections for a detailed description of the control modes and their parameter settings.

4.3.3 Control Modes for Positioners

There are four different modes to control positioners:

- Simple Control Mode
- Advanced Control Mode
- Scan Control Mode
- Closed-Loop Control Mode

Note: The Closed-Loop Control Mode is not available to channels that have no sensor.

Hint: When entering the parameter change state the corresponding channel is implicitly stopped. This may be useful to abort a movement.

Simple Control Mode

In this mode a positioner is moved according to its current *speed level*. The speed level is a generic number ranging from 1 (slowest) to 17 (fastest) and the positioner will perform stepping movements. When turning a knob the positioner will perform bursts of steps. Moving a joystick will lead to a continuous movement until released.

Display

The current speed level of a channel is displayed on the right side of the channel line. If there is sensor data available it will be displayed in the left side of the channel line, otherwise "No Sensor" will be displayed.

Example channel line display without sensor: "A1 No Sensor | Spd 9"
Example channel display line with sensor: "A1 -1,675,756 | Spd 9"

Changing the Speed Level

To change the speed level press the knob corresponding to the channel. An arrow will appear next to the speed level display indicating the parameter change state. In this state the knob is used to adjust the speed level. Turning the knob right will increase the speed level, turning it left will decrease it. Pressing the knob will hide the arrow and exit the parameter change state.

Advanced Control Mode

The Advanced Control Mode is also used for stepping movements. However, in this mode you have more control over the parameters that the steps are performed with. You may adjust amplitude and frequency separately as well as the number of steps that are performed per burst.

The *Frequency* parameter is given in Hz and ranges from 5Hz to 18,500Hz. The *Amplitude* parameter is given as a 12-bit value and ranges from 100 to 4,095. A 0 would correspond to 0 Volts, 4,095 corresponds to 100 Volts. The *Steps* parameter ranges from 1 to 9,000.

Turning a knob will perform a burst of steps with the given parameters.

Moving a joystick will lead to a continuous movement until released. The range of frequencies (and therefore the sensitivity of the joystick) is controlled by the *Steps* parameter. A higher value will result in a coarser movement. The step width remains related to the *Amplitude* parameter. Note that the *Frequency* parameter has no influence when you control the positioner with the joystick.

Display

If there is sensor data available it will be displayed on the left side of the channel line and the *Steps* parameter on the right side (indicated by an 'S'). In this case the *Amplitude* ('A') and *Frequency* ('F') parameters are hidden. If there is no sensor data available all three parameters will be displayed in the channel line.

Example channel line display without sensor: "A1F10000 | A4095 | S1000"

Example channel display line with sensor: "A1 13,286,430 | S1000"

Changing Parameters

To change the parameters press the knob corresponding to the channel. Sensor data (if available) is hidden and all parameters are displayed along with an arrow symbol indicating the parameter currently being edited. Turning the knob will increase resp. decrease the current parameter.

To change the current parameter press and hold the knob. The arrow will change to a left/right arrow symbol. Turning the knob in this state (while pressed) will change the current parameter.

Pressing and releasing the knob without having changed the current parameter will exit the parameter change state.

Scan Control Mode

This mode is exclusively used for scanning movements. No steps will be performed. In this mode you have control over the deflection of the piezo element of the positioner. The current deflection is given as a 12-bit value ranging from 0 to 4,095. Turning a knob or moving a joystick will perform a scanning movement of a certain increment. The increment parameter may be adjusted.

When reaching a boundary (0 or 4,095) the positioner will stop. In this state a scan movement instruction in the direction of the boundary will have no effect. If you wish to move the positioner further in this direction you must switch to one of the other control modes.

Display

The current deflection of the piezo element of the positioner is displayed on the right side of the channel line (given as a 12-bit value). If there is sensor data available it will be displayed in the left side of the channel line, otherwise the increment parameter will be displayed.

Example channel line display without sensor: "A1 ΔV 100 | V2047"

Example channel display line with sensor: "A1 -62,095 | V2047"

Changing the Increment Parameter

To change the increment parameter press the knob corresponding to the channel. Sensor data (if available) is hidden and the increment parameter is displayed along with an arrow symbol indicating the parameter change state. In this state the knob is used to adjust the increment parameter. Turning the knob right will increase the increment, turning it left will decrease it. Pressing the knob will hide the arrow and exit the parameter change state.

Closed-Loop Control Mode

This mode is only available to positioners that are equipped with an integrated sensor. If so you may instruct the positioner to travel a certain (relative) distance. The joysticks can not be used to control positioners in this mode. Turning a knob will move the positioner by the configured increment.

The increment parameter depends on the type of the positioner that is configured for a channel (see section "Configuring Channels"). Linear increments range from 1nm to 5mm. Rotary increments range from 1μ° to 90°.

Display

The current increment is displayed on the right side of the channel line. The sensor data is displayed in the left side of the channel line.

Example channel display line (linear): "A1 -4,462,339 | 100μm"

Example channel display line (rotary): "A1 36,195,735 | 2m°"

Changing the Increment Parameter

To change the increment parameter press the knob corresponding to the channel. An arrow will appear next to the increment display indicating the parameter change state. In this state the knob is used to adjust the increment. Turning the knob right will increase the increment, turning it left will decrease it. Pressing the knob will hide the arrow and exit the parameter change state.

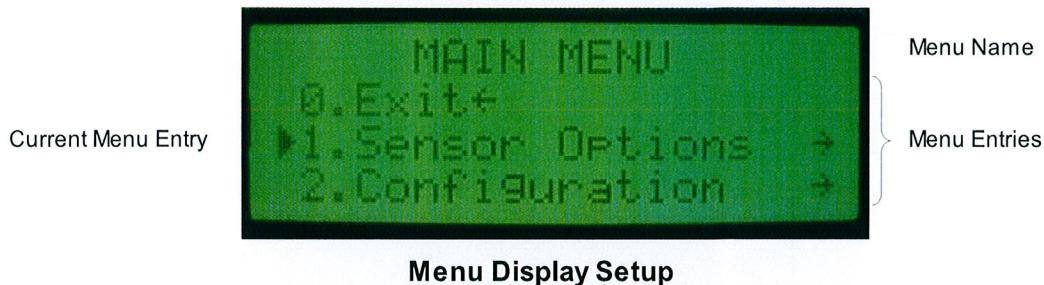
Hold Time

The Closed-Loop Mode has a global parameter that affects all channels equally. The *hold time* represents the time (in seconds) that a target position is actively held after reaching it. To adjust this parameter, enter the main menu (top left button next to the display), select "Sensor Options" and scroll to the "CL Hold Time" entry. A value of 0s will simply stop the positioner once the target is reached. Other values will cause the positioner to hold the position, potentially compensating for drift effects and the like. If set to infinite, the positioner will only stop holding the position on an explicit stop (pressing the knob) or by performing other movements in different control modes.

Note that this option also affects the "Find Reference" function (see section "Reference Marks").

4.4 Menu Mode

The menu mode is used to configure the Hand Control Module and to execute special commands, e.g. finding reference marks of positioners with sensors. To enter the menu mode press the "Menu" button next to the display (top left). To exit the menu mode press this button again or select the exit menu entry of the main menu.



Menu Display Setup

The navigation through the menu and sub menus follows a simple scheme. The first line of the display shows the name of the current menu. The rest of the lines display the menu entries.

Turning any knob will cycle through the entries in a scrolling manner. The solid arrow on the left side indicates the current menu entry (always the middle line). Pressing any knob will select the current menu entry.

A small arrow on the right side of a menu entry indicates that a sub menu will be entered if the entry is selected. To exit a sub menu select the "Exit" menu entry.

To speed up menu navigation you may use the buttons on the left side of the display. The "Menu Up" button (bottom left) will exit the current menu and navigate one hierarchy level upwards. Doing so in the main menu will exit the menu mode and has the same effect as pressing the "Menu" button (top left). The "Menu" button always exits the menu mode immediately.

The joysticks have no function while in menu mode.

The "Alt." buttons on the right side of the display have context dependent functions. See section "Advanced Features" for more information.

4.4.1 Sensor Options Menu

The Sensor Options menu lets you execute special commands and select options that relate to position sensors that are integrated into your positioners. Note that if your positioning system is not equipped with sensors this menu entry will not appear.

In this menu the following entries are available:

- Zero All: Selecting this entry will cause all positioners to set their current position as their zero position.
- Zero Channel: Instead of zeroing all channels, this entry will enter a sub menu where you can select one or more specific channels to zero.
- Find Ref. All: This will cause all positioners to move to their reference marks. You may specify a special sequence that defines in which order the positioners move to their marks. See section "Reference Marks" for more information.
- Find Ref. Ch: This entry will enter a sub menu where you can select one or more specific channels to move to their reference marks.

- Configure Refs: To configure the sequence in which positioners move to their reference marks when issuing the “Find Ref. All” command you would normally use the Channel Settings menu for each channel. The “Configure Refs” sub menu allows you to configure all channels within one menu. See the section below for more information.
- Calibrate All: This will cause all channels to calibrate their sensors. See section “Sensor Calibration” for more information.
- Calibrate Ch: This entry will enter a sub menu where you can select one or more specific channels to calibrate.
- CL Hold Time: This entry is used to set the Closed-Loop Hold Time parameter. See section “Closed-Loop Control Mode” for more information.
- Mode: Specifies the sensor mode. The available modes are “Disabled”, “Enabled” and “Powersave”. See section “Sensor Modes” for more information.

Configure Reference Marks Menu

When issuing the “Find Ref. All” command from the Sensor Options menu all positioners will move to their reference marks in a special sequence (see section “Reference Marks”). The Configure Reference Marks sub menu lets you configure this sequence for all channels and also their initial search direction (safe direction).

For each positioner channel that supports this feature there will be a menu entry with the name of the channel, its current reference order index and its safe direction. To alter the settings for a channel, navigate to the according menu entry. Press and hold a knob. The arrow will change to a left/right arrow symbol. Turning the knob in this state (while pressed) will move the menu cursor to the reference order index or the safe direction. Releasing the knob on a parameter will allow you to edit the parameter by turning the knob. To exit the edit mode move the menu cursor to the left again or press the “Menu Up” button next to the display (bottom left). This will return to normal menu navigation.

4.4.2 Configuration Menu

Even though the devices are shipped preconfigured, you may want to do some adjustments to the configuration or set it up for a different manipulator system. This section describes how to configure the Hand Control Module.

There are several memory slots that you may use to save and load different configurations (Main menu, “Load Config” / “Save Config”). The first slot is the default slot and will automatically be loaded when the device is powered up.

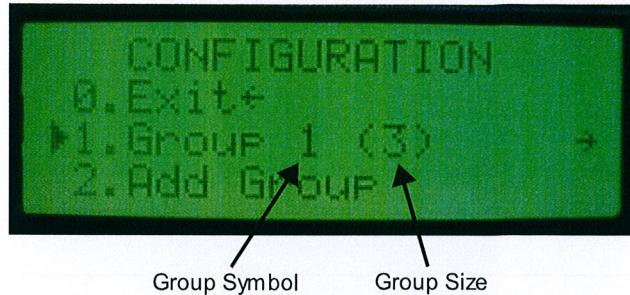
Note that changes made to the configuration of the device take immediate effect, but will not be saved to a memory slot automatically. If you power down the device before saving the new configuration to a slot the changes will be lost.

To start configuring the device enter the main menu by pressing the “Menu” button and select the “Configuration” menu entry.

Setting up Groups and Channels

Configuration Menu

The Configuration menu will let you manage up to nine different channel groups. Each group has a configurable symbol that will be displayed when referring to that group and each group can hold up to four channels.



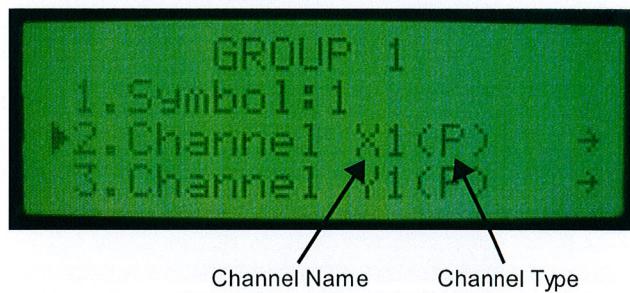
The menu will display a list of currently defined groups using their group symbols. The number in brackets behind each group shows the current size of the group, i.e. the number of channels that are in the group.

To add a new group simply select the "Add Group" menu entry. A new menu entry for the group will be added to the menu. Newly created groups are initially empty. If no groups are currently defined, then only the "Exit" and "Add Group" menu entries are available.

To configure a group simply select its menu entry. This will bring you to the Group menu. There you will also be able to remove the group from the configuration.

Group Menu

The Group menu will let you manage up to four channels for the selected group. Each channel has a configurable symbol. A channel is referred to by its channel name consisting of its channel symbol and the group symbol of the group that its in. If you change the group symbol all channel names in the group will change accordingly.



The menu will display a list of currently defined channels within the selected group using their channel names. Within the menu mode channels are displayed with an additional symbol in brackets behind the channel name. This symbol indicates the channel type, thus the type of the port that the channel is currently mapped to. A 'P' marks a positioner channel, an 'E' marks an end effector channel.

To change the group symbol select the "Symbol" menu entry. This will bring up a blinking cursor. In this mode you may select a different symbol by turning a knob. Once satisfied, press a knob again to make the changes take effect. To abort the symbol editing press the "Menu Up" button next to the display (bottom left).

To add a new channel to the group select the "Add Channel" menu entry. A new menu entry for the channel will be added to the menu. If no channels are currently defined in the group, then only the "Exit", "Symbol", "Add Channel" and "Remove Group" menu entries are available.

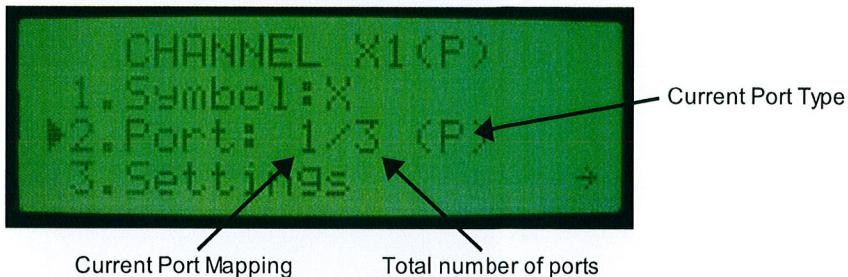
Note: For devices with less than four knobs, group sizes of four are not recommended.

To configure a channel simply select its menu entry. This will bring you to the Channel menu. There you will also be able to remove the channel from the group.

Configuring Channels

Channel Menu

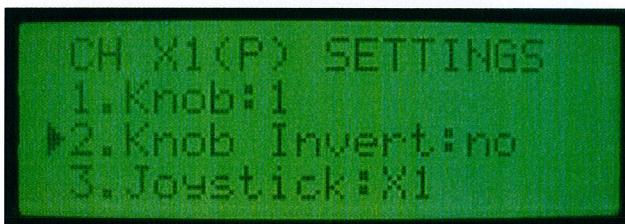
The channel menu lets you configure the properties of the selected channel. The channel symbol is edited in the same way as the group symbol (see above).



The most important setting is the port mapping, i.e. which port the channel is mapped to. This setting defines which positioner or end effector will be controlled if commands are issued to the channel. Selecting the "Port" menu entry will cycle through the available ports of the system. The symbol in brackets indicates the type of the currently selected port. As noted above, a 'P' marks a positioner channel, an 'E' marks an end effector channel. You can test the port mapping immediately by pressing one of the Alt buttons. See section "Advanced Menu Features" below for more information.

To specify further settings of the selected channel select the settings menu entry. The contents of the Channel Settings menu depends on the type of the port that the channel is mapped to.

Channel Settings Menu for Positioners



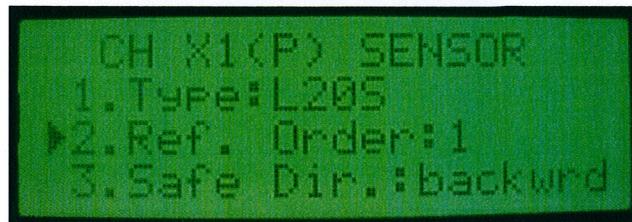
The Channel Settings menu lets you define which knob and joystick should be used to control the channel. Selecting the "Knob" menu entry will cycle through the knobs. The "Joystick" menu entry has the options "X1" (left joystick, horizontal axis), "Y1" (left joystick, vertical axis), "X2" (right joystick, horizontal axis), "Y2" (right joystick, vertical axis) and "none". In the latter case the channel will not be controllable with a joystick.

Sometimes it may also be convenient to invert the movement direction of movement commands. Adjust the settings to your needs.

Note: It is possible to map several channels to the same knob or joystick axis. Doing so will move positioners simultaneously. However, this is not recommended and should be used with care.

If the positioner that the channel is currently mapped to has an integrated sensor there will be an additional sub menu ("Sensor Settings") with some additional options.

Sensor Settings Menu for Positioners



Before using positioners that are equipped with sensors, the device must be told which type of sensor is connected to each channel. The setting affects the position calculation and closed-loop control. The “Type” menu entry lets you cycle through the available sensor types. Currently the following types are available:

Type	Positioner Series	Comment
S	SLCxxxxs, SLxxxxs	linear positioners with nanosensor
SR	SR3610s	rotary positioner with nanosensor
MR	SR1910m	rotary positioner with microsensor
SP	SLCxxxsp, SLxxxxsp	linear positioners with nanosensor, large actuator
SC	SLCxxxsc, SLxxxxsc	linear positioners with nanosensor, distance-coded reference marks
M25	SR1410s	rotary positioner with microsensor
SR20	SR2013s	rotary positioner with nanosensor
M	SLCxxxxm, SLxxxxm	linear positioners with microsensor
GC	SR1910m	rotary positioner with microsensor, no reference mark, end stops
GD	SGO60.5m	goniometer with micro sensor (60.5mm radius)
GE	SGO77.5m	goniometer with micro sensor (77.5mm radius)
RA	SFWxxxxam	rotary positioner with absolute sensory
GF	SR1209m	rotary positioner with microsensor
RB	SR1910m	rotary positioner with microsensor, no reference mark, no end stops (unlimited rotation)
G605S	SGO60.5s	goniometer with nano sensor (60.5mm radius)
G775S	SGO77.5s	goniometer with nano sensor (77.5mm radius)

The “Ref. Order” menu entry defines the reference order index of the channel and the “Safe Dir.” menu entry defines the safe direction. These settings are relevant if you wish to let channels find their reference marks. See section “Reference Marks” for more information.

4.4.3 Advanced Menu Features

When configuring the device in the menu mode the “Alt” (Alternate) buttons next to the display have some additional context dependent functions that you may find useful. These functions are described in the following.

Swapping Groups or Channels

When cycling through several groups with the “Group Up” and “Group Down” buttons while in the normal operation mode, their order is defined by the order in the configuration menu. If you wish to change the order of the groups without having to remove them and set them up again, you may use an “Alt” button in a “Drag ‘n Drop” like fashion to accomplish this:

Say you have three groups A,B and C and want to change their order to A, C and B. Enter the Configuration menu and scroll to the “Group B” menu entry. Press and hold an “Alt” button. You now have “grabbed” group B. A symbol will appear in the top right corner of the display:

- An “x” indicates that the group may not be dropped onto the current menu entry.
- A “!” indicates that a Drag ‘n Drop operation will be executed if the group is dropped onto the current menu entry.

While holding down the “Alt” button you may navigate through the menu normally with the usual controls. Navigate to the “Group C” menu entry. The Drag ‘n Drop symbol will change to a “!”. Release the “Alt” button to “drop” group B and therefore swap the positions of group B and group C. To abort the operation release the “Alt” button while the Drag ‘n Drop symbol shows an “x”.

The same technique may be used to swap the order of channels within a group. Select a group by entering its group menu, grab a channel with an “Alt” button and drop it onto another. This will swap the positions of the channels within the group. This may be useful, since the order of the channels in a group defines the order of their channel lines in the display while in normal operation mode.

You may even swap two channels that are in different groups (grab a channel in one group and drop it onto a channel in another group) or move a channel to a different group (grab a channel in a group and drop it onto another group) provided the target group is able to hold another channel.

Swapping Configuration Slots

Similar to the procedure described above you may swap the contents of configuration slots in the “Load Config” or “Save Config” menu. This might be useful if you have several configurations that you use and temporarily want to make one the default configuration.

To swap two configuration slots, enter either the “Load Config” menu or the “Save Config” menu. Navigate to the first slot you want to swap. Press and hold an “Alt” button. Navigate to the slot you wish to swap and release the button.

Test Settings

When configuring channels in the Channel menu and its sub menus you are able to test the settings you have made without having to leave the menu mode. The following settings support the test feature:

- **Port Mapping (Channel Menu)** - Navigate to the “Port” menu entry in the Channel menu and select the port you wish to map the channel to. Press and hold an “Alt” button. The text “test” will appear instead of the current port mapping. Turning a knob in this state will not navigate through the menu, but instead will execute a small movement on the target port. This makes it easy to identify the desired port.
- **Knob Invert (Channel Settings Menu)** - Similar as to above, holding down an “Alt” key while being on the “Knob Invert” menu entry will let you test the movement inversion of a channel when using a knob. Note that this function ignores the current knob mapping, thus you may turn any knob to test the setting.

- **Joy Invert (Channel Settings Menu)** - Holding down an "Alt" key while being on the "Joy Invert" menu entry will let you test the movement inversion of a channel when using a joystick. Contrary to knob inversion test, you must use the joystick axis which the channel is mapped to in order to test the inversion setting.
- **Safe Direction (Channel Sensor Settings Menu)** - Holding down an "Alt" key while being on the "Safe Dir." menu entry will let you test the initial movement direction of a channel when moving to the reference mark (see section "Reference Marks"). Note that the executed movement direction does not depend on which direction you turn the knob. It will only depend on the safe direction setting.
- **Safe Direction (Configure Reference Marks Menu)** - Same as above.

Caution: When using the test options provided by the "Alt" buttons, the positioners will perform macroscopic movements. Please ensure that no other equipment can be damaged by these test movements.

4.4.4 User Mode vs. Admin Mode

In some situations it might be desirable to restrict the ability to configure the device. For this the device offers an admin mode and a user mode.

- In admin mode (default) the complete functionality as described in the previous sections is available.
- In user mode only the Sensor Options menu is available when entering the menu with the menu button and you cannot change the sensor mode or configure the reference sequence.

To switch between the admin and user modes press and hold the two right buttons next to the display (Group up / Group down) while entering the menu with the menu button (top left). You are then asked to enter a code. Use the knobs to adjust the digits and enter the code "591". This code is fixed and cannot be changed. It is merely to avoid an accidental mode change. Press any knob to complete the mode change. The new mode will be displayed as a short message before the menu is entered.

4.5 Additional Information

4.5.1 Sensor Modes

If your positioners are equipped with integrated sensors, you have the option to chose between three different sensor operation modes: "Disabled", "Enabled" and "Powersave".

If the sensors are permanently supplied with power ("Enabled" mode) they generate heat which may cause the system to drift in case of weak thermal coupling (e.g. inside an SEM). For this, the sensors may be powered down ("Disabled" mode) if sensor data is (temporarily) not needed. Note though that moving a positioner in this mode will invalidate the position information.

The "Powersave" mode handles the power supply of the sensors automatically. Whenever a positioner is actively moving the sensors are enabled to be able to keep track of the current position of the positioner. When it is stopped the sensors are disabled, only checking the current position once in a while, minimizing heat generation.

4.5.2 Reference Marks

Positioners that are equipped with an integrated sensor and a reference mark may be instructed to move to a known physical position (the reference mark). For this, the positioner moves in the initial search direction. If the reference mark is found, the positioner will stop. If a mechanical end stop is detected before the mark is found, the search direction will be reversed. Once the mark is reached, the positioner will hold its position if configured so with the Closed-Loop Hold Time parameter (see "Sensor Options" menu). If set to zero seconds, the positioner will simply stop and wait for further instructions. Otherwise it will hold the reference mark for the configured time.

To execute a reference command enter the main menu and select "Sensor Options" → "Find Ref. Ch". This will bring up a list of all available channels with this feature. Select a channel to let the positioner start looking for the reference mark.

Note: The sensor of the positioner must be calibrated in order to be able to find the reference mark (see section below).

The "Find Ref. All" menu entry will let all positioners move to their reference mark at once. A flexible configuration option lets you define in which order the channels will move. Each channel may be configured with a *reference order index* (see section "Sensor Settings Menu"). The system will start moving all positioners to their reference marks that have their indexes set to 1. When these have finished the system will continue with index 2 and so on. Consequently, assigning each channel a different index will move the positioners one after the other. Assigning the same index to all channels will make them move simultaneously. Between these two extremes you have the freedom to chose any combination, e.g. to first move all Z-axes of an multi-manipulator system, then the rest.

You may also set the reference order index to "-" in which case the channel will be omitted when selecting the "Find Ref. All" menu entry.

The *safe direction* option may also be configured for each channel separately and specifies the initial movement direction to search for the reference mark.

Some sensor types (e.g. "M", linear positioners with micro sensor) do not have a physical reference mark. For these positioners the mechanical end stops are used for referencing. Which end stop is used is defined by the configured safe direction.

4.5.3 Sensor Calibration

For positioners with integrated sensors the calibration may be used to increase the accuracy of the position calculation and should be done once for each channel if the mechanical setup changes (different positioners connected to different ports). The calibration data is automatically saved to non-volatile memory. Therefore, if the mechanical setup is unchanged it is not necessary to issue the calibration routine on each power up. Note though that newly connected positioners have to be calibrated in order to ensure proper operation.

Important: The calibration routine takes a few seconds to complete and the positioner will perform a movement in the range of up to several mm, depending on the positioner type. It must be ensured, that the calibration routine is not issued while the positioner is near a mechanical end stop. Otherwise the calibration might fail and lead to unexpected behavior when using the closed-loop control mode. As a safety precaution, also make sure that the positioner has enough freedom to move without damaging other equipment.

To calibrate a sensor, enter the main menu (top left button next to the display) and select "Sensor Options" → "Calibrate Ch". This will bring up a list of all available channels with this feature. Select a channel to let the positioner start the calibration routine.

Sensor types that are referenced via mechanical end stops (s.a.) are also moved to the end stop as part of the calibration routine. Which end stop is used is defined by the configured safe direction.

4.6 FAQ

Q: When I turn the knob in the Closed-Loop Mode nothing happens. Why?

A: If the Closed-Loop Hold Time is deactivated (0 seconds) then the movement increments are always executed relative to the current position of the positioner. With this setting, executing very small increments (e.g. 2nm) might have no effect due to sensor noise, since the target is "immediately" reached and the positioner stopped.

To avoid this behavior, increase the Hold Time via the menu settings. This will cause multiple small increments to accumulate. Thus, the increments are not executed relative to the current position of the actuator, but relative to the last target position.

Q: Why can't I select the Closed-Loop Mode for a channel?

A: The Closed-Loop Mode is only available to channels that have a sensor attached to it. If a sensor is present check if all wires are connected properly and restart the system.

Q: I can hear the positioner doing steps, but apparently it is not moving. How can this be?

A: The positioners must be driven with a certain minimum amplitude in order to function properly. This minimum value may vary from positioner to positioner. Try increasing the amplitude value.

Q: When I move a joystick to control a positioner nothing happens. What's wrong?

A: A channel has to be mapped to a joystick axis for this to work. Check the settings of the channel in the configuration menu.

Another reason might be that the positioner is currently configured for closed-loop control. In this mode it is not possible to control the positioner with a joystick.

5 Technical Data

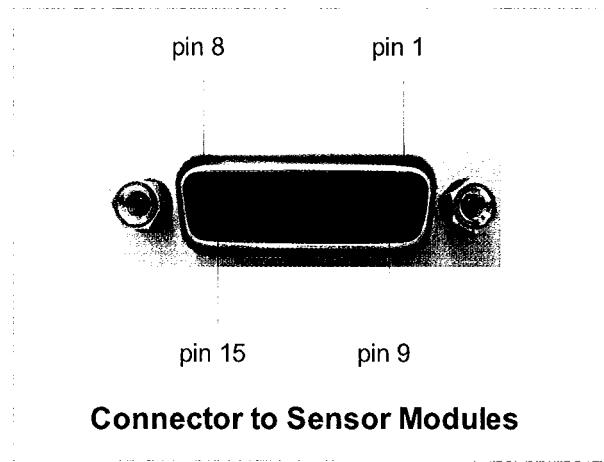
5.1 Power Supply

The MCS controller is supplied by a 12V / 65W power supply. Please use the power supply that has been shipped with the MCS controller.

5.2 Connectors at MCS Controller

5.2.1 Connector to Sensor Modules

The Sensor Module(s), which may be either integrated in the manipulator base plate or in a separate housing, must be connected to the D-SUB 15 pin female connector(s) at the MCS controller.



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	d.n.c.	DO NOT CONNECT
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	d.n.c.	DO NOT CONNECT
14	d.n.c.	DO NOT CONNECT
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:

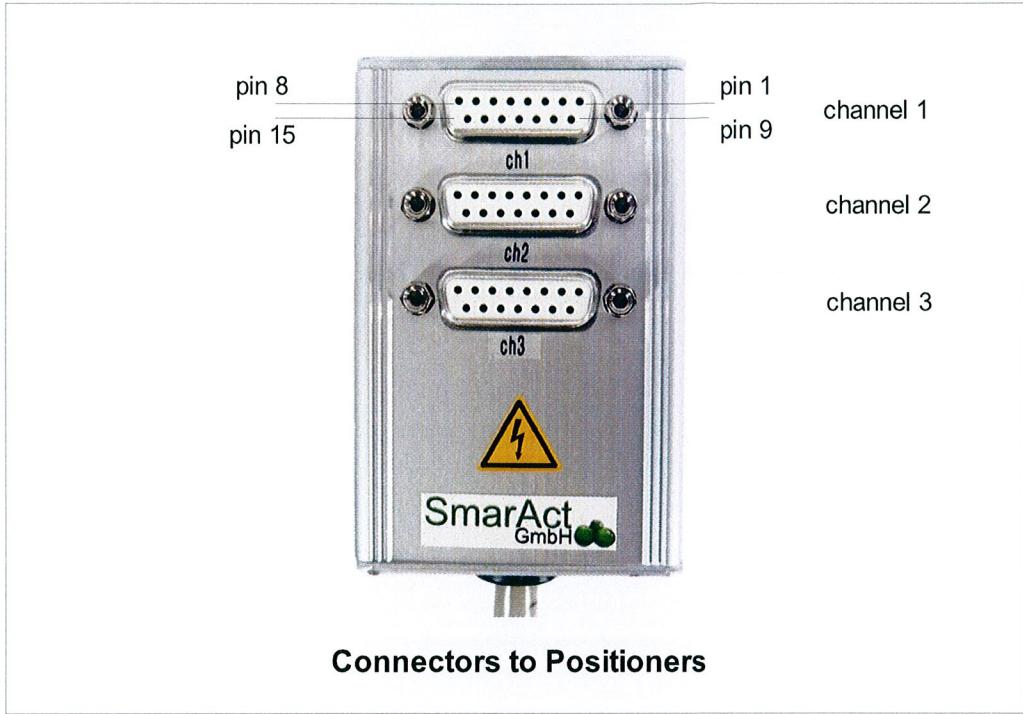
Driving Signal (HV-OUT-x)	Value	Unit
Output voltage range	0 to 100	V
Average current per channel	200	mA
Peak current per channel, < 10 µs, max. speed	20	A
Signal	sawtooth (step mode), constant (scan mode)	

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	

5.3 Connectors at Sensor Module in Standard Housing (optional)

The Sensor Modules may be either integrated in the manipulator base plate or in separate housings. If they are delivered in a standard housing the positioners must be connected to the D-SUB-15 connectors.



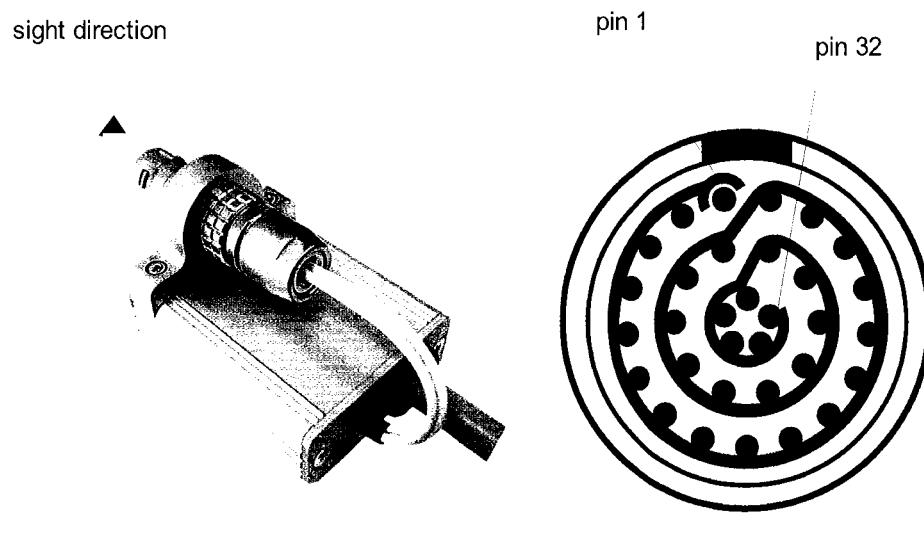
The pin assignment of each DSUB connector is as follows:

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+	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-x	Ground for positioner driving signal, channel x
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-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.

5.4 Connectors at Sensor Module in Housing at LEMO 2B Plug (optional)

The Sensor Modules may be either integrated in the manipulator base plate or in separate housings. If they are delivered in housings which are attached to LEMO 2B plugs they can be directly connected to the feedthroughs.



Connectors to Positioners

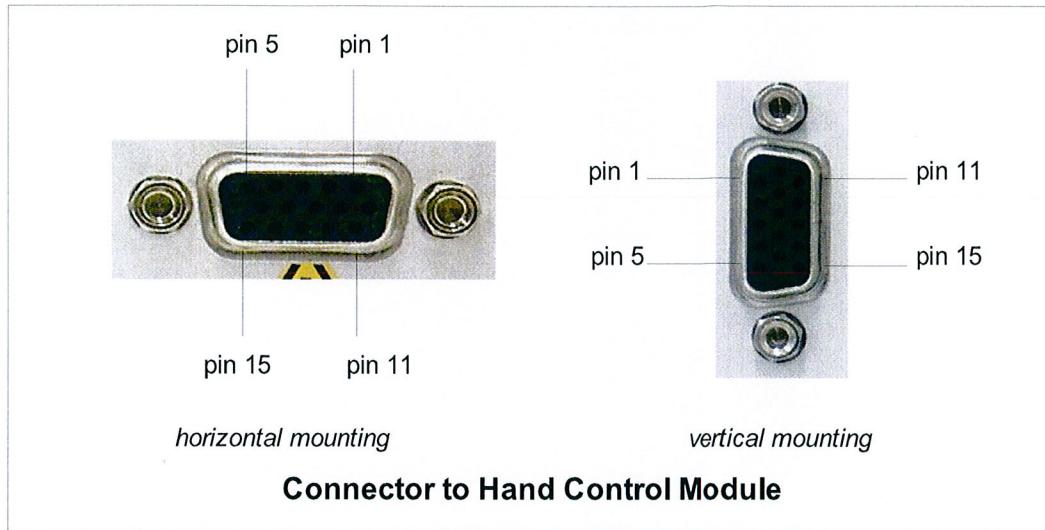
The pin assignment of the LEMO 2B plug is as follows:

Pin	Signal	Function
1	HV-OUT_3	Positioner driving signal, channel 3
2	HV-OUT_2	Positioner driving signal, channel 2
3	HV-GND_2	Ground for positioner driving signal, channel 2
4	HV-GND_1	Ground for positioner driving signal, channel 1
5	HV-OUT_1	Positioner driving signal, channel 1
6	HV-GND_3	Ground for positioner driving signal, channel 3
7	S-GND_3	Ground for sensor, channel 3
8	S-5.0V_3	Power supply for sensor, 5.0V DC, channel 3
9	d.n.c.	DO NOT CONNECT
10	d.n.c.	DO NOT CONNECT
11	S-5.0V_2	Power supply for sensor, 5.0V DC, channel 2
12	S-GND_2	Ground for sensor, channel 2
13	S-REF_-1	U0/reference- signal from sensor, channel 1
14	S-GND_1	Ground for sensor, channel 1
15	S-5.0V_1	Power supply for sensor, 5.0V DC, channel 1
16	S-REF_-3	U0/reference- signal from sensor, channel 3
17	S-REF+_3	U0/reference+ signal from sensor, channel 3
18	S-COS_-3	U2/cos- signal from sensor, channel 3
19	S-COS+_3	U2/cos+ signal from sensor, channel 3
20	S-SIN_-3	U1/sin- signal from sensor, channel 3
21	S-SIN+_3	U1/sin+ signal from sensor, channel 3
22	S-REF_-2	U0/reference- signal from sensor, channel 2
23	S-REF+_2	U0/reference+ signal from sensor, channel 2
24	S-COS_-2	U2/cos- signal from sensor, channel 2
25	S-COS+_2	U2/cos+ signal from sensor, channel 2
26	S-SIN_-2	U1/sin- signal from sensor, channel 2
27	S-SIN+_2	U1/sin+ signal from sensor, channel 2
28	S-REF+_1	U0/reference+ signal from sensor, channel 1
29	S-COS_-1	U2/cos- signal from sensor, channel 1
30	S-COS+_1	U2/cos+ signal from sensor, channel 1
31	S-SIN_-1	U1/sin- signal from sensor, channel 1
32	S-SIN+_1	U1/sin+ signal from sensor, channel 1

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

5.4.1 Connector to Hand Control Module

The Hand Control Module must be connected to the D-SUB 15 pin high-density female connector at the MCS controller.

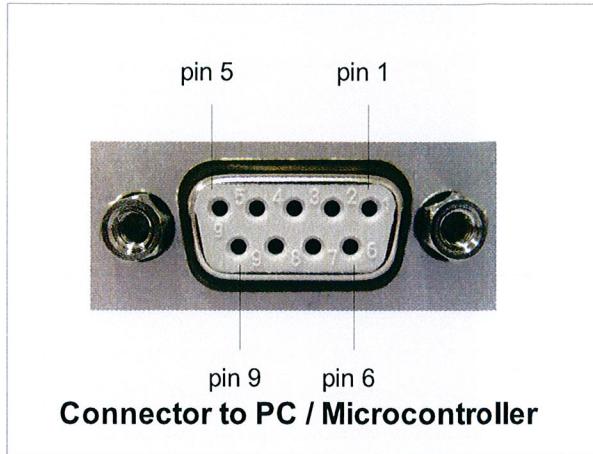


The pin assignment is as follows:

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

5.4.2 Connector to PC or Microcontroller (optional)

The D-SUB 9 pin female connector at the MCS controller provides a standard 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

5.5 Operating Conditions

The MCS controller must be used in normal environmental conditions:

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

6 Positioner - Handling Instructions

SmarAct's positioners are high-precision products which have to be handled with care. There are certain conditions which have to be avoided or taken care of. If there should arise any questions on handling the positioners please contact the SmarAct team.

6.1 Handling

SmarAct positioning systems are precision devices and caution should be used when handling a positioner or manipulator.

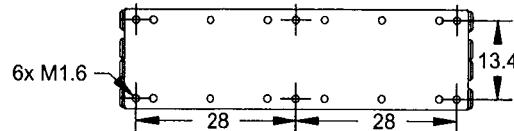
- Generally, caution should be used **to not apply high torques or forces to the slides** with respect to the guides. Therefore, a manipulation system should be held at the base plate when transporting it.
- **Neither the sensor head nor the scale should be touched** since this could affect its operation or damage it. Fingerprints can be removed by wiping carefully with isopropanol-tinctured cotton buds.
- The positioners consist of steel parts that can rust, if touched with bare hands. Therefore, **gloves** should be worn when handling positioners or manipulators. As an additional protection, outer surfaces can be lubricated with **white oil** if the positioners are not applied in vacuum conditions.
- The cables are attached directly at the positioners and **special care** should be taken **not to damage the cables**. For most of the positioner series repairing a cable is very difficult and expensive.

6.2 Mounting

For mounting a device to a manipulation system it is necessary to use screws. There are two common sources of damaging a positioner: Using too long screws and applying too much force and torque to the manipulation system.

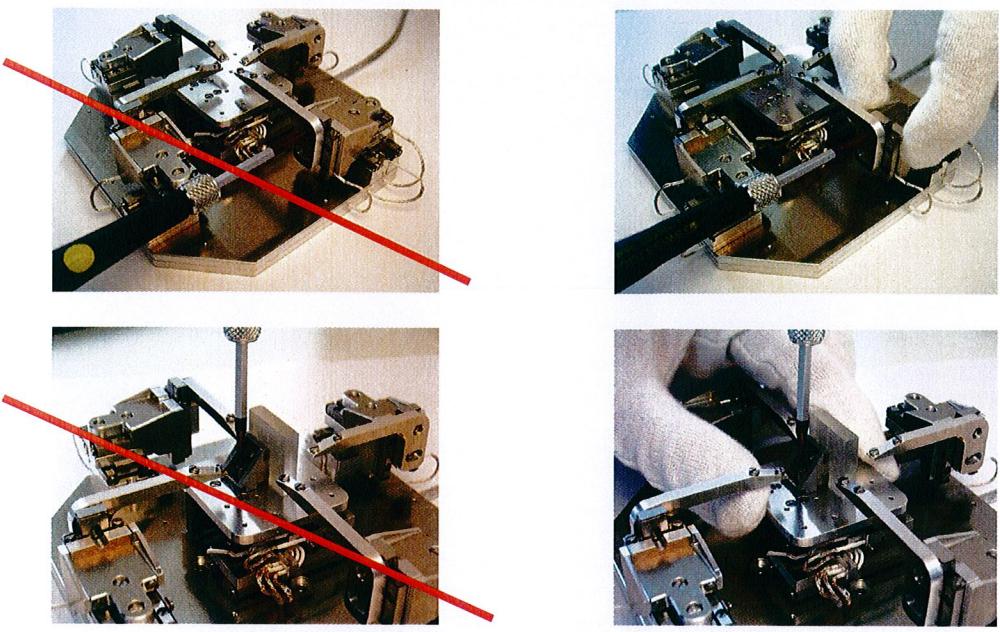
- For some positioners, the **allowable screw-in depths** are quite small. By using too long screws, you may hit internal components and damage the positioner. Therefore, measure the screw length beforehand and shorten the screws, if necessary. The following max. screw-in depths should be respected:

Positioner Series	Maximum Screw-in Depth
SL-15xx	Top side: 1.0mm Bottom side: 1.0mm
SL-20xx	Top side: 1.2mm Bottom side: 1.2mm
SLC-xxxx	Top side: 3.5mm Bottom side: At the sides, marked with cross: 3.5mm No other holes must be used!



SR-36xx	Top side: 2.2mm Bottom side: No holes must be used! Mounting with through holes.
SR-19xx	Top side: 1.5mm Bottom side: No holes must be used! Mounting with through holes.

- The most common source for too high torques is the force of a screwdriver when mounting a device to a positioner or when assembling or disassembling a manipulation system. Therefore, a **manipulation system** should generally **not be disassembled**. If a device shall be mounted to a positioner, please **hold the positioner directly** and not indirectly via any other part which it is connected to. E.g. when mounting something to the Z positioner of an XYZ manipulator hold the Z positioner directly and not the base plate of the manipulator.



NOT THIS WAY: Don't apply a force or torque to *THIS WAY:* Hold the positioner directly when a positioner by holding it indirectly via other mounting devices to it. Minimise the applied positioners.

- When mounting a device to a manipulation system or when mounting the manipulation system to an experimental setup make sure to **screw the parts tightly together**. Again, please do not apply too high forces and torques to the manipulation system.

6.3 Environment

The positioners should be operated

- at **room temperature** (5°C to +40°C)
- in a **dry atmosphere**
- without **high magnetic fields**.

Dusty environments should be avoided. Dust may settle in-between the raceway, the balls or rollers and the slider, which would have an negative effect on the precision. Also the micro or nano position sensor is sensitive to dust on the scale.

Do not drive the positioners **in liquid**, especially not in conductible liquid.

Furthermore, humid environment (e.g. in an incubator) may lead to rust, which may be avoided by using a lubrication.

6.4 Electrical Connection

When **connecting** the positioners to the controllers, please make sure that the **controller is switched off**. Especially positioners with integrated sensors are **not hot-pluggable**.

You can supply driving signals in the range from -20V to 120V. Driving the positioners outside this specification will cause damage of the driving piezo ceramic.

6.5 Maintenance

SmarAct positioners have a **standard lifetime of 10,000m** where they don't require any maintenance, except cleaning after having been touched etc. After that lifetime it may be necessary to grease the positioners (see below).

6.5.1 Cleaning

Positioners can be cleaned with **isopropanol-tinctured cotton buds**. Do not use acetone. If any grease has been removed from the friction surface by the cleaning process, it must be replaced.

6.5.2 Greasing

After the standard lifetime (see above) the max. velocity and the blocking force of a positioner may degrade. It may be necessary to **grease** the surface where the friction element is in contact with the slide:

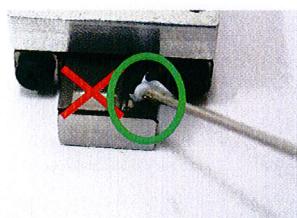
- **Linear positioners** can be greased by applying Fomblin VAC3 UHV grease to the friction surfaces, as shown in the figures below. Please note that neither the sensor head nor the sensor scale must be contaminated with grease.
- **Rotary positioners** cannot be greased because their friction surface is covered.



SL-line: Greasing the friction surface at the inner side of the slide.



SL-line: Greasing the friction surface at the outer side of the slide.



SLC-line: Greasing the friction surface at one side of the slide.

6.6 Frequently asked Questions

The following collection of frequently asked questions (and answers) can provide a first help for the most common questions. If these FAQ cannot solve the problem immediately or in case of any doubt please don't hesitate to contact the SmarAct team.

6.6.1 Positioner Performance

- Q: The **max. velocity** of the positioner drops fast.
A: It may be necessary to grease the positioners. See above: Maintenance - Greasing.
- Q: The positioner seems to **loose steps**.
A: Each step varies a bit from the step before. Since a positioner is making many steps, this error can cumulate to deviations which can clearly be seen. If you want the positioners to move with a high repeatability or high absolute accuracy, you need to use some kind of feedback. Therefore, we offer optical position sensors which can be integrated into the positioners without changing their outer dimensions. In some cases the user has a different kind of feedback, like the image of a microscope, or the intensity of a laser beam etc.
- Q: I can **hear the positioner** doing steps, but apparently it is **not moving**. How can this be?
A1: The positioners must be driven with a certain minimum amplitude in order to function properly. This minimum value may vary from positioner to positioner. Try increasing the amplitude value.
A2: The steps may be smaller than the resolution of the measurement device (microscope etc.). Try increasing the amplitude value.
- Q: The positioner is moving **slower upwards than downwards** when supplied with a **mass**.
A: This is the case even when using the same parameters for the steps: A slip-stick drive is an inertial-friction drive. Its velocity strongly depends on the force it has to apply. It always moves faster in the direction of an external force acting on the positioner. Such an external force is the load which a positioner has to move up and down, for example. To avoid this you might want to use the speed control feature of the MCS controller.
- Q: The positioner has different **blocking forces** at different **frequencies**.
A: This is a normal behaviour of stick-slip-drives.
- Q: Is every **positioner** applicable in **any orientation**?
A: Yes, any positioner can be used horizontally, vertically or at any other angle. Please note that when mounted horizontally the load can be much higher (allowable load) than when mounted non-horizontally (blocking force).

6.6.2 Blockage

- Q: The positioner is **blocked**, i.e. it is **not moving when commands** are given.
A: Please check the following points:
 - If the positioner has reached one of the **mechanical end stops** move it in the **other direction**.
 - Sometimes it helps to **increase the voltage amplitude** in step mode. The amplitude must be higher than a certain threshold, which is normally in the range of up to 50V. This threshold amplitude is different for different positioners.

6.6.3 Sounds

- Q: Why does my **positioner** make some **sound**?
A: This is normal. The sound you hear is the positioner moving with the frequency of the steps.
- Q: Why are the **positioners** making **strange rattling noises** when they are controlled via **joystick**?
A: This is normal. The sound you hear is the update rate of the joystick.
- Q: Why do all **positioners move slightly** when switching the **MCS controller on or off**?
A: The resting potential of the MCS output is 50V. When switching on the MCS controller, the output voltage is increased from 0V to 50V, which causes the deflection. When switching off the MCS controller, the output voltage is decreased from the current value to 0V. In addition, positioners with an integrated nanosensor are performing a scanning movement to detect the mounting direction of the nanosensor.

6.6.4 Sensor

- Q: What happens in **power-save mode**?
A: In power-save mode the nanosensor will be switched off most of the time and switched on every 0.5s to read out the current data. Only when closed-loop movement commands are performed the nanosensor is continuously switched on until the target position is reached.
- Q: The **sensor is not working**.
A: Please check that the sensor mode is set to "enabled" or "power-save mode".

6.6.5 Interference

- Q: When working in an **SEM** I note a **micro vibration** of the actuator.
A: Make sure that you connect the **pin plug of the control unit to the electrical ground of the setup**. When working inside a vacuum chamber of a scanning electron microscope (SEM), it is important that you put the potential of the pin plug to the same potential as the SEM chamber or to a potential that is kept constant.

6.6.6 PC-based Control

- Q: After plugging in the USB cable and **switching on the MCS** I **cannot connect** to it via software.
A: It takes some time (about 3s) before the USB port of the MCS is ready to receive commands.

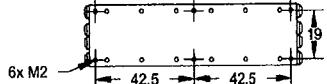


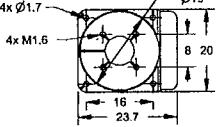
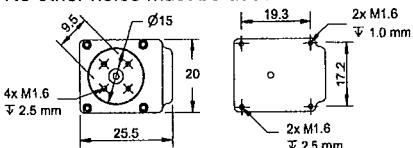
Maximum Screw-in Depths



For some positioners, the allowable screwing depths are quite small. By using too long screws, you may hit the internal components and damage the positioner. Therefore, measure the screw length beforehand and shorten the screws, if necessary.

The following maximum screw-in depths must be respected:

Positioner Series	Maximum Screw-in Depth
SLC-17xx	Top side: 3.5 mm Bottom side: Marked with cross: 3.5 mm No other holes must be used!
	
SLC-24xx	Top side: 3.5 mm Bottom side: Marked with cross: 3.5 mm No other holes must be used!
	
SLL-C12-xx	Carriage: 4x M3 ∇ 3.5 mm Rail: Countersunk through-hole No other holes must be used!
SLL-C15-xx	Carriage: 4x M4 ∇ 4.0 mm Rail: Countersunk through-hole No other holes must be used!

Positioner Series	Maximum Screw-in Depth
SR-19xx	<p>Top side: 1.5 mm</p> <p>Bottom side: No holes must be used!</p> <p>Mounting with through holes.</p> 
SR-20xx	<p>Top side: 1.6 mm</p> <p>Bottom side: Marked with cross: 1.0 mm</p> <p>No other holes must be used!</p> 
SR-2812	<p>Top side: Marked with cross: 4x M2 ∇ 2.5 mm</p> <p>Bottom side: No holes must be used!</p> <p>Mounting with through holes.</p>
SR-36xx	<p>Top side: 2x M3 ∇ 2.5 mm</p> <p>Bottom side: No holes must be used!</p> <p>Mounting with through holes.</p>
SR-57xx	<p>Top side: 2x M3 ∇ 5.0 mm</p> <p>Bottom side: Marked with cross: 3.0 mm</p> <p>No other holes must be used!</p>

