Closed-Loop Tip-Tilt Mirror-Mounts

INTRODUCTION

SmarAct's motorized Tip-Tilt Mirror-Mounts with integrated sensors may be used with the MCS2 controller with active position control. The closed-loop operation allows to move the mirror to defined and reproducible angular positions even between power-cycles of the controller.
This user guide describes the required calibration and referencing procedure for mirror-mounts to ensure precise and repeatable position control. Note that this guide covers the general concept but not the details of the programming. A corresponding **programming example** for mirror-mounts is installed with the software development kit (SDK) of the *MCS2 software installer*.

Please refer to the *SmarAct Positioner Manual*, *MCS2 User Manual* and *MCS2 Programmer's Guide* documents for more information about the hardware components and setup as well as the general concepts and the programming of the MCS2 device.

SETUP

Mirror-mounts feature two actuators which allow tip and tilt adjustments of the mirror position. For the position feedback two sensors are attached to the mirror-mount. One actuator and one sensor each are wired to a connector. Therefore two connectors must be attached to two channels of the MCS2 sensor module. Note that the sensor module must support I-sensor positioners in order to use closed-loop mirror-mounts.

Configuration

To setup the controller, the correct positioner type must be configured to both channels. Currently, the following mirror-mount positioner types are supported by the MCS2:

- **CT018/AT001 (607)** for *STT25.4I*-types
- **CT041/AT001 (608)** for *STT50.8I*-types

The configuration of the MCS2 controller may be done with the *MCS2 Service Tool*, a *MCS2 Hand Control Module* or with a customer-developed software. Please refer to the *MCS2 Service Tool Manual*, *MCS2 Hand Control Manual* and *MCS2 Programmer's Guide* for more information.

Calibration and Referencing

Since the position sensor works on an incremental basis, a referencing sequence must be executed after each power-up of the controller to establish an absolute position reference. For this the mechanical end stops are used. The end stops must be calibrated *once* in order to be used as a position reference.

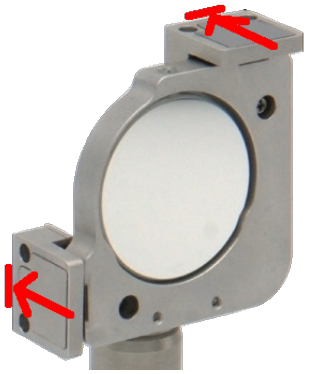

Figure 1. *Correct direction for End Stop Referencing and Calibration routines*

For mirror-mounts the inner end stop must be used for the calibration and referencing (see Figure 1). To achieve this, the *safe direction* property must be set to **"backward direction"**.

The calibration and referencing routines require no special mechanical setup and may be performed in-place. Make sure that the movements don't interfere with your setup.

CAUTION
As a safety precaution, make sure that the mirror-mount may be moved over it's entire range without damaging other equipment.
Also keep in mind that e.g. a laser beam may be deflected in angles unusual to normal operation. In such cases it is recommended to disable the laser during the calibration and referencing procedure.

Due to geometric effects, moving one axis of a mirror-mount may influence the end stop position of the other. This can lead to ambiguous reference positions. To overcome this, a special command sequence must be observed for the calibration and referencing of the two channels of a mirror-mount. This is described in the following sections.

END STOP CALIBRATION

The end stop must be calibrated **once** in the following cases, before it can be used as a reference:

- the mechanical setup has changed (a mirror-mount has been connected to a channel the first time)
- the positioner type has changed
- the safe direction has changed

If nothing has changed, it is not necessary to run the calibration on each initialization or power-up.
The calibration routine moves one axis of the mirror-mount with the configured *move velocity* and *acceleration* in the configured *safe direction* until an end stop is detected. The sensor signals are then used to determine the exact end stop position. This position is saved on the controller and is used later by the referencing sequence to establish an absolute position reference.
It is recommended to perform the calibration under the same conditions as the referencing is performed later.
As mentioned before, moving one axis of a mirror-mount may influence the end stop position of the other. This effect can be eliminated by a three-step calibration:

1. Move one axis (A) to an approximately known position (by using the referencing sequences) to provide reproducible conditions for the second axis.
2. Calibrate and reference the second axis (B).
3. After referencing the second axis, it's now known position may be used to provide reproducible conditions for the calibration of the first axis (A). Calibrate the first axis (A) finally.

Calibration Procedure
The recommended procedure for *calibrating* both axes (A and B) is as follows:

1. Calibrate Channel A
2. Reference Channel A
3. Calibrate Channel B
4. Reference Channel B
5. Calibrate Channel A again
6. Reference Channel A again

END STOP REFERENCING

The referencing sequence must be executed **after each power-up** to establish an absolute position reference. For end stop referenced positioners the physical measuring scale is defined such that the zero position lies near the mechanical end stop that is used for referencing.
The sequence moves one axis of the mirror-mount with the configured *move velocity* and *acceleration* in the configured *safe direction* until an end stop is detected. Once the positioner has found the mechanical end stop it will move a short distance away from the end stop to find the exact reference using the position that was determined while calibrating the end stop. Here the scale of the channel is set to zero.
Note that it is possible to define an offset to the zero position by setting the *logical scale offset* property. This may be used e.g. to shift the logical zero position to the middle of the movement range of the mirror-mount.

Referencing Procedure
The recommended procedure for *referencing* both axes (A and B) is as follows:

1. Reference Channel A
2. Reference Channel B
3. Reference Channel A again

After this, both axes are referenced and may be commanded to move to reproducible absolute positions.

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