SCAPS
scanner application software

DSD-2-O Manual

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1 Introduction

Figure 1: DSD-2-O

1.1 Safety

Operational safety:

The goods supplied by SCAPS GmbH are designed to control a laser scanner system. The machine builder is solely responsible for strictly complying with all applicable and relevant country-specific safety regulations regarding installation and operation of the system.

The goods delivered by SCAPS GmbH must not take over any emergency stop and other safety relevant functions!

The Machinery Directive (2006/42/EC) does not apply to the products supplied by SCAPS GmbH, as there are no mechanical moving parts. Furthermore, no safety function according to the mentioned definition is realized via the USC and DSC/DSD modules.

Laser Safety:

Laser radiation can affect a person's health or otherwise cause irreparable damage. Compliance with all relevant laser safety regulations must be ensured prior to installation and operation.

Safe turn on procedure to avoid uncontrolled laser emission. Turn off procedure conversely (4 to 1), unless otherwise needed by the device.
1.   Scanner controller
2.   Peripheral devices
3.   Scan system

4. Laser

Electrical Safety/EMC:

The product is supplied without an enclosure. The machine builder is solely responsible for the strict compliance with all relevant country-specific safety regulations for the integration and operation of the delivered goods.

The Low Voltage Directive (2014/35/EU) does not apply to the products supplied by SCAPS GmbH, as the voltage supply of all products is below the 75 V direct current (DC) limit. Therefore, these fall outside the scope of the Low Voltage Directive.

The EMC Directive (2014/30/EU) does not apply to the products supplied by SCAPS GmbH, as these are not intended for the end user (person without knowledge of EMC) and are not otherwise made available on the market.

Wiring:

For any wiring, data or power cable connecting and disconnecting, make sure that all devices are turned off and the wires do not carry any voltage!

All cables should be only as long as needed to minimize coupling capacitance and coupling inductance. Especially unshielded cables should be as short as possible. Avoid ground loops.

Avoid long drain wires for the connection of the cable shield.

For differential data signals as for the scan head (XY2-100) and encoder (MOTF), also connect the ground wires.

Power supplies, GND, Shield:

All power sources should be grounded, the potential difference of all power supplies should be below ±5 V. Advice: Use the same ground potential for all used devices if not otherwise needed (GND, Opto_GND, Laser_GND).

PE, shield and power supply: Refer to the manual of the power supply, respectively device manufacturer and stick to them exactly. Connect PE, used cable shields and ground potentials to the same potential if the electrical specifications allow this. Relevant country-specific safety regulations regarding installation and operation of the system must be checked.

Recommendation for shielded cables: Connect one side of the shielded cable to GND to avoid ground loops. For the 25-pin scanner or 37-pin Laser, I/O cable, this can be done with the solder jumper on the bottom side on the USC card (PE to GND, SJ 1 – to SJ 4) – please check the respective manual.

If needed for EMC issues it is also possible to connect both sides of the cable shield, this decision has to be taken by the machine builder and cannot be answered in general.

1.2 Overview

The DSD-2-O is the second generation of a hardware module for building up digital driver based scanning systems. Due to the full digital approach and its small size, very compact and innovative solutions can be realized. The DSD-2-O is designed to control the EL-10-42-OF lens module from Optotune.
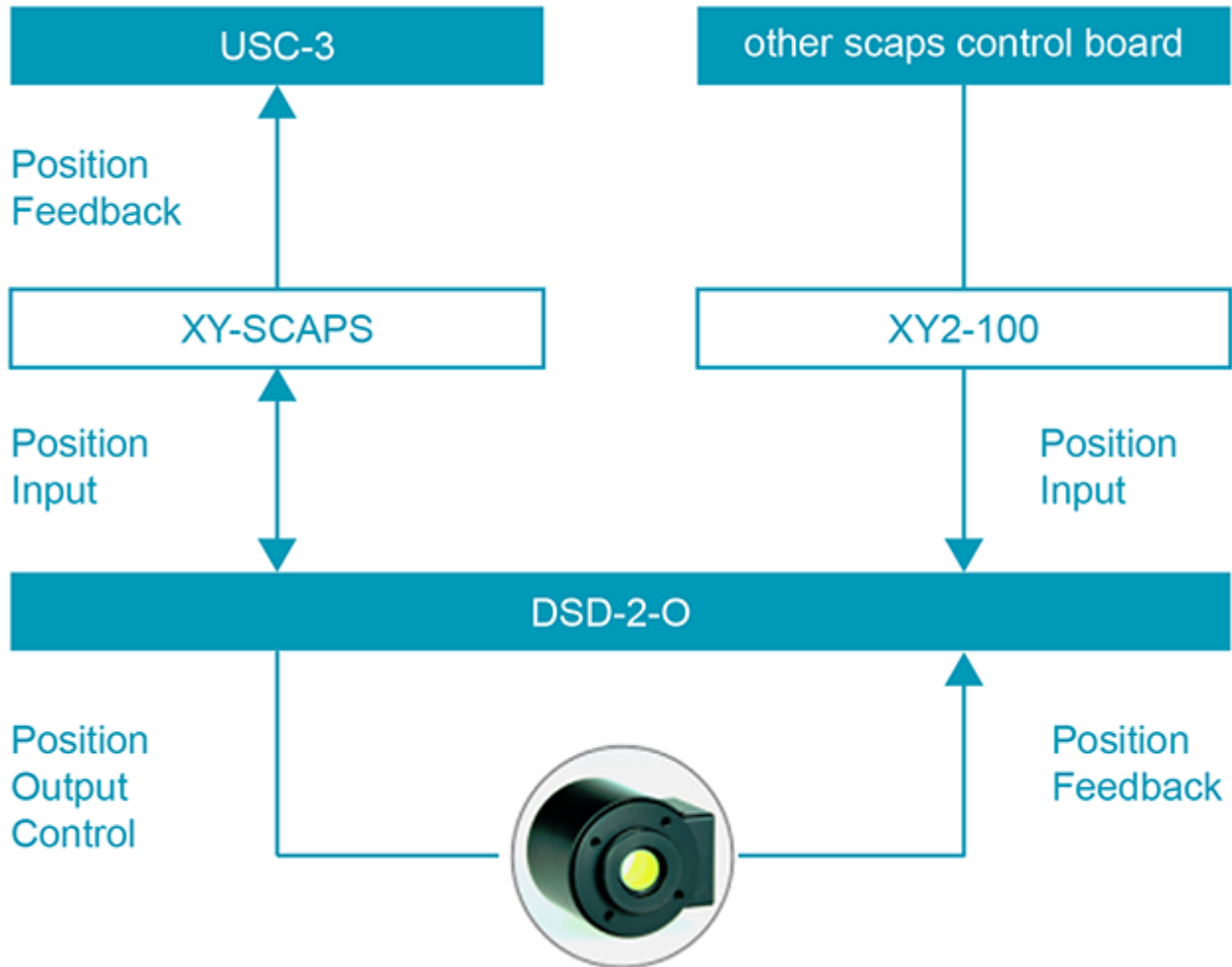
1.3 Position within the system

Figure 2: Position of DSD-2-O within the system

2 DSD licenses

There are two licenses for the DSD:

- **DSD**: This is a base license. This license is necessary to operate the DSD with the XY-SCAPS interface. In combination with a USC-3 card, no further license is required.

- **XY2-100**: This is an additional license, which allows to use the DSD with the XY2-100 protocol, which most scanner control cards are using. In combination with the DSD base license, this license allows to use the DSD with any scanner card using the XY2-100 protocol.

License	Function
None	No operation possible
DSD	Operation with USC-3
DSD + XY2-100	Operation with any XY2-100 scanner card

1: Overview of available DSD license combinations

3 Main features and specifications

Main features:

- Automatic tuning for the lens
- Error detection
- Heater control circuit
- XY2-100 and XY-SCAPS interface
- Tracking delay about 1.5 ms

Main specification	Value
Dimension total (with connectors)	80 mm x 67 mm x 40 mm
Dimension base plate (with mounting holes)	80 mm x 67 mm
Weight	175 g
Main DSD power supply	15 - 24 V (24 V recommended), max. 2 A
Max power output	15 W
Max current output	1 A
Max total power consumption	< 30 W
Response time (80% step height)	~8 ms
Tracking delay time	~1.5 ms

Table 2: DSD-2-O main specifications
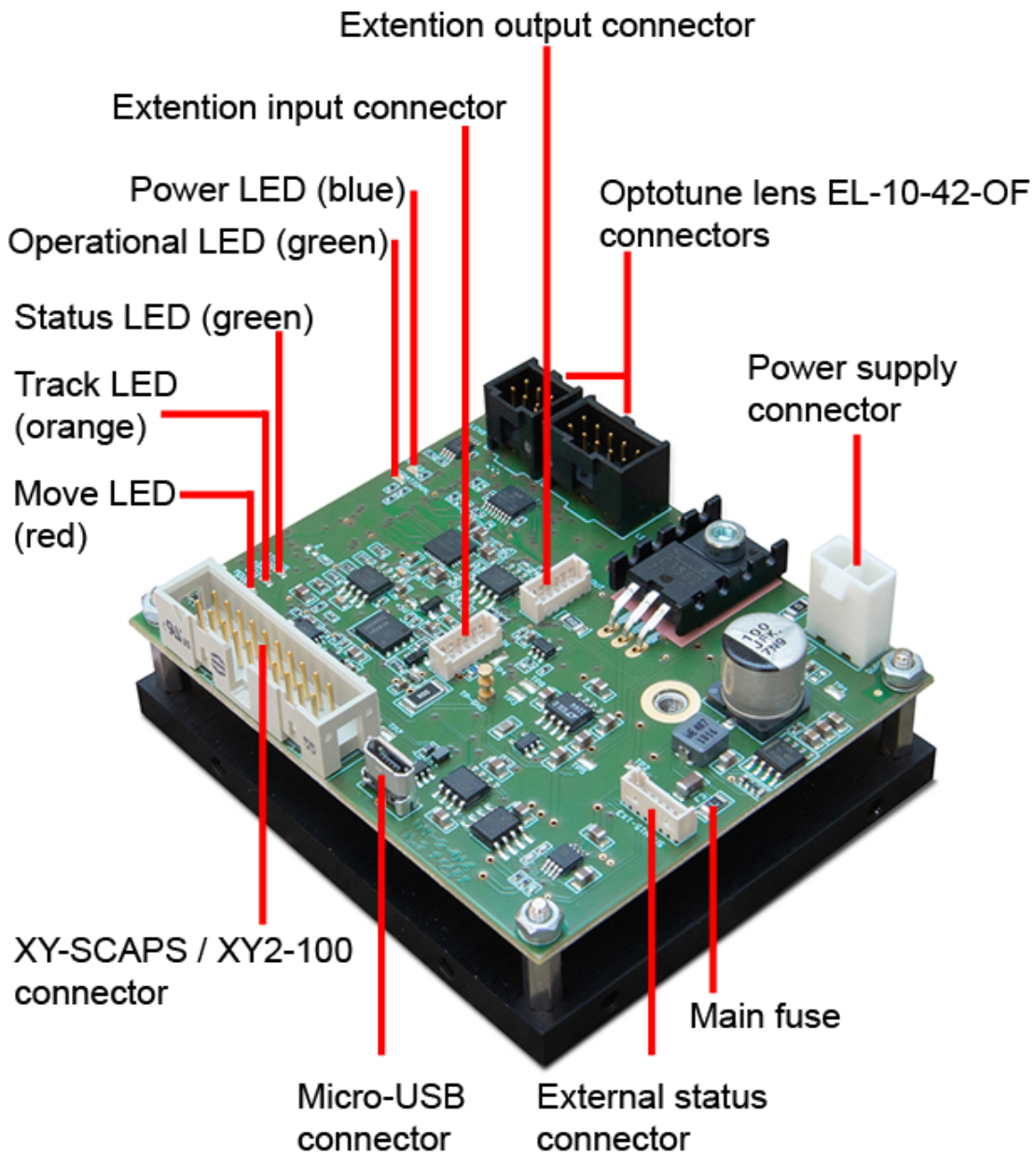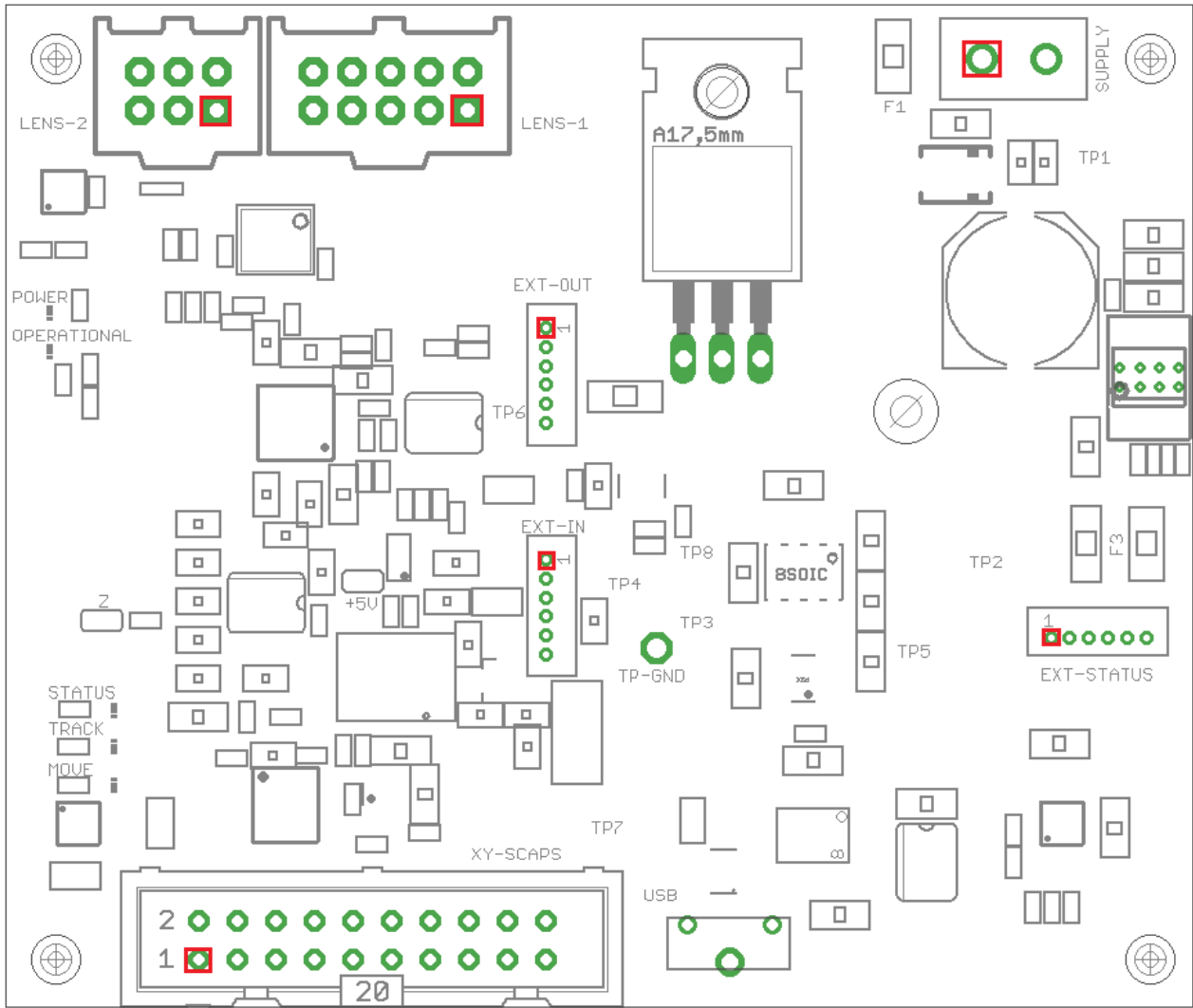
4 Board and connectors

Figure 3: DSD-2-O board overview

Figure 4: Visualization of every pin 1 (red square)

4.1 Power connector

SUPPLY connector	Part number
Connector type	WE 64900211122
Mating connector	WE 649002013322
Mating crimp	WE 64900513722

Table 3: SUPPLY connector part numbers

Pin description	SUPPLY connector
Vsupply (15 - 24 V)	pin 1
GND	pin 2

Table 4: SUPPLY connector assignment

4.2 XY-SCAPS / XY2-100 connector

XY-SCAPS connector	Part number
Connector type	HA 09185206324 / WE 61202021621

Table 5: XY-SCAPS connector part numbers

Pin description	XY-SCAPS connector
CLK-	pin 1
CLK+	pin 2
SYNC-	pin 3
SYNC+	pin 4
N.C.	pin 5
N.C.	pin 6
N.C.	pin 7
N.C.	pin 8
Z-	pin 9
Z+	pin 10
N.C.	pin 11
N.C.	pin 12
N.C.	pin 13
N.C.	pin 14
STAT_Z-	pin 15
STAT_Z+	pin 16
N.C.	pin 17
GND	pin 18
GND	pin 19
GND	pin 20

Table 6: DSD-2-O XY-SCAPS connector assignment

⚠️ WARNING *N.C.: Do not connect!*

4.3 External inputs

EXT-INPUT connector	Part number
Connector type	WE 653006114822 / AM 10114829-10106LF
Mating connector	WE 653002113322 / AM 10114826-00006LF
Mating crimp	WE 65300113722 / AM 10114827-001LF

Table 7: EXT-INPUT connector part numbers

EXT-INPUT connector assignment:

Name	pin number	Description
Input 1	pin 1	Reserved for future use
Input 2	pin 2	Reserved for future use

Name	pin number	Description
Input 3	pin 3	Reserved for future use
Input 4	pin 4	Reserved for future use
Input 5	pin 5	Reserved for future use
GND	pin 6	Ground

Table 8: EXT-INPUT connector assignment

4.4 External outputs

EXT-OUTPUT connector	Part number
Connector type	WE 653006114822 / AM 10114829-10106LF
Mating connector	WE 653002113322 / AM 10114826-00006LF
Mating crimp	WE 65300113722 / AM 10114827-001LF
Max. output voltage	5.0 V
Max. output current	25 mA each

Table 9: EXT-OUTPUT connector part numbers

EXT-OUTPUT connector assignment:

Name	pin number	Description
Temperature reached	pin 1	• low: lens temperature is over 46° • high: lens temperature is below 46°
Temperature in range	pin 2	• low: lens temperature is below 46° or over 50° • high: lens temperature is between 46° and 50°
Error	pin 3	• low: lens temperature reading is working • high: lens temperature reading failure
Lens control	pin 4	• low: lens control is inactive • high: lens control is active
Output 5	pin 5	Reserved for future use
GND	pin 6	Ground

Table 10: EXT-OUTPUT connector assignment

4.5 External status

EXT-STATUS connector	Part number
Connector type	WE 653006114822 / AM 10114829-10106LF
Mating connector	WE 653002113322 / AM 10114826-00006LF
Mating crimp	WE 65300113722 / AM 10114827-001LF
Max. output voltage	5.0 V
Max. output current	20 mA each

Table 11: EXT-STATUS connector part numbers

EXT-STATUS connector assignment:

Name	pin number	Description
MOVE	pin 1	Lens is moving
TRACK	pin 2	Lens control active - Tracking
OPERATIONAL	pin 3	Operation - DSD system is working properly
STATUS	pin 4	Status, blinking with 1 Hz – Status OK
3V3	pin 5	Internal voltage (3.3V, not TTL)
GND	pin 6	Ground

Table 12: EXT-STATUS connector assignment

4.6 Optotune lens connectors

Use the lens cable (delivered by Optotune) to connect the EL-10-42-OF lens with the DSD-2-O board.

4.7 LED indicators

LED name	LED color	Description
POWER	blue	Power good LED for the supply voltage of the DSD system
OPERATIONAL	green	Operation LED – DSD system is working properly
TRACK	yellow	Lens control active LED - Tracking
MOVE	red	Lens is moving LED
STATUS	green	Status LED, blinking with 1 Hz – Status OK

Table 13: LED indicators

4.8 Micro-USB

Standard micro-USB connector. The maximal cable length with standard cables is 5 meters.

USB version: USB 2.0

4.9 Fuse

Fuse	Current	Vendor	Series	Part number
Main power fuse	2 A	Schurter Inc.	USI 1206	3413.0219.22

Table 14: Main power fuse

4.10 Bottom plate

Figure 5: Bottom plate

There are two M3 threads on each side and four M3 threads on top of the plate (45mm x 45mm) to mount the plate to a laser system. The 2.5mm holes are for the mounting of the driver boards onto the bottom plate.

The height of the driver board mounted on this bottom plate is 40mm.

5 Hardware setup

Power supply:

For this setup the DSD board requires the following power supply: Main DSD power supply: 15 - 24 V (24 V recommended), max. 2 A

Optotune lens connectors:

Use the lens cable (delivered by Optotune) to connect the lens EL-10-42-OF with the DSD-2-O board (on the 6-pin and 10-pin connector).

XYS-USB adapter:

The XYS-USB adapter is only needed for calibration or to check the movement of the lens. Therefore, connect the XYS-USB adapter to the XY-SCAPS / XY2-100 input connector and to an USB port of the computer. The driver will be loaded automatically by Windows Update (internet access required).

6 XY2-100 connection

Connect the DSD-2-O and USC-3 controller card as shown in table below. Use the standard scanner output connector for the DSD and the XY-scan head.

Pin description	XY-SCAPS connector DSD-2-O	USC-3 Scanner 25 pin connector
CLK-	pin 1	pin 1
CLK+	pin 2	pin 14
SYNC-	pin 3	pin 2
SYNC+	pin 4	pin 15
Z-	pin 9	pin 5
Z+	pin 10	pin 18
STAT_Z-	pin 15	pin 8
STAT_Z+	pin 16	pin 21
GND	pin 18, 19, 20	pin 11, 23, 24

Table 15: XY-SCAPS with USC-3 connection

Use the same CLK and SYNC signals for the XY scan head and the DSD system with an appropriate adapter cable (Y-cable).

A standard XY-scan head needs signals for CLK±, SYNC±, X±, Y±, STATUS± and GND.

Make sure that the scan head and the USC have the same ground potential, to avoid damages caused by ESD.
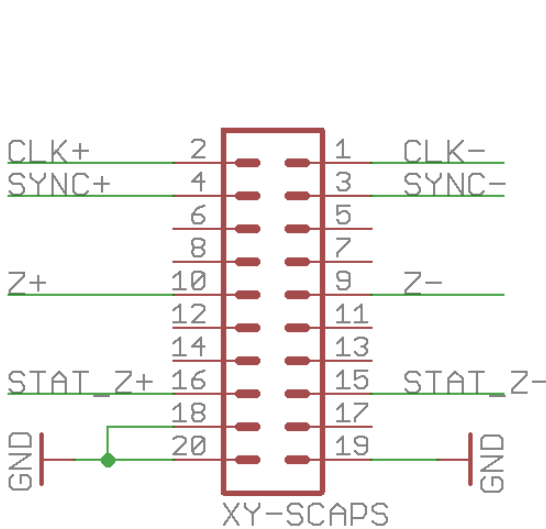
Figure 5: DSD-2-O XY-SCAPS - 20 pin assignment
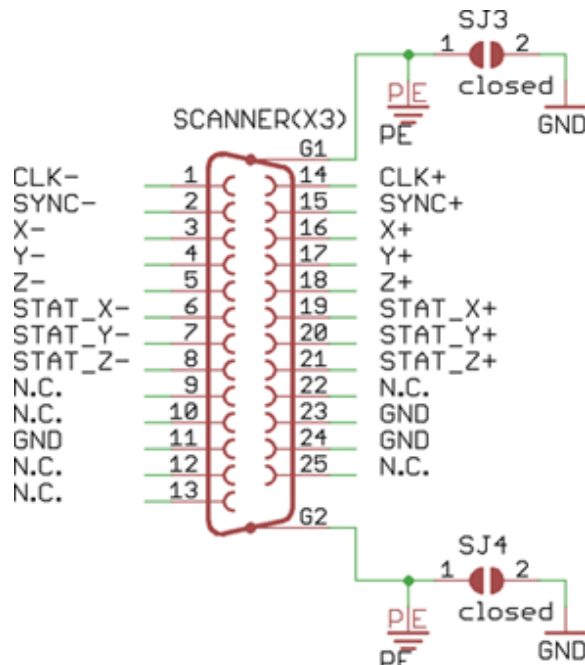
Figure 5: USC-3 Scanner - 25 pin assignment

For the general use of the DSD system without USC card, connect the following signals of the XY2-100 interface to the DSD-2-O.

Pin description	XY-SCAPS connector
CLK-	pin 1
CLK+	pin 2
SYNC-	pin 3
SYNC+	pin 4
Z-	pin 9
Z+	pin 10
STAT_Z-	pin 15
STAT_Z+	pin 16
GND	pin 18, 19, 20

Table 16: XY2-100 general connection

7 Software

7.1 Installation

- Install latest version of SAMLight
- Install latest version of DSD Setup

7.2 DSD setup dialog
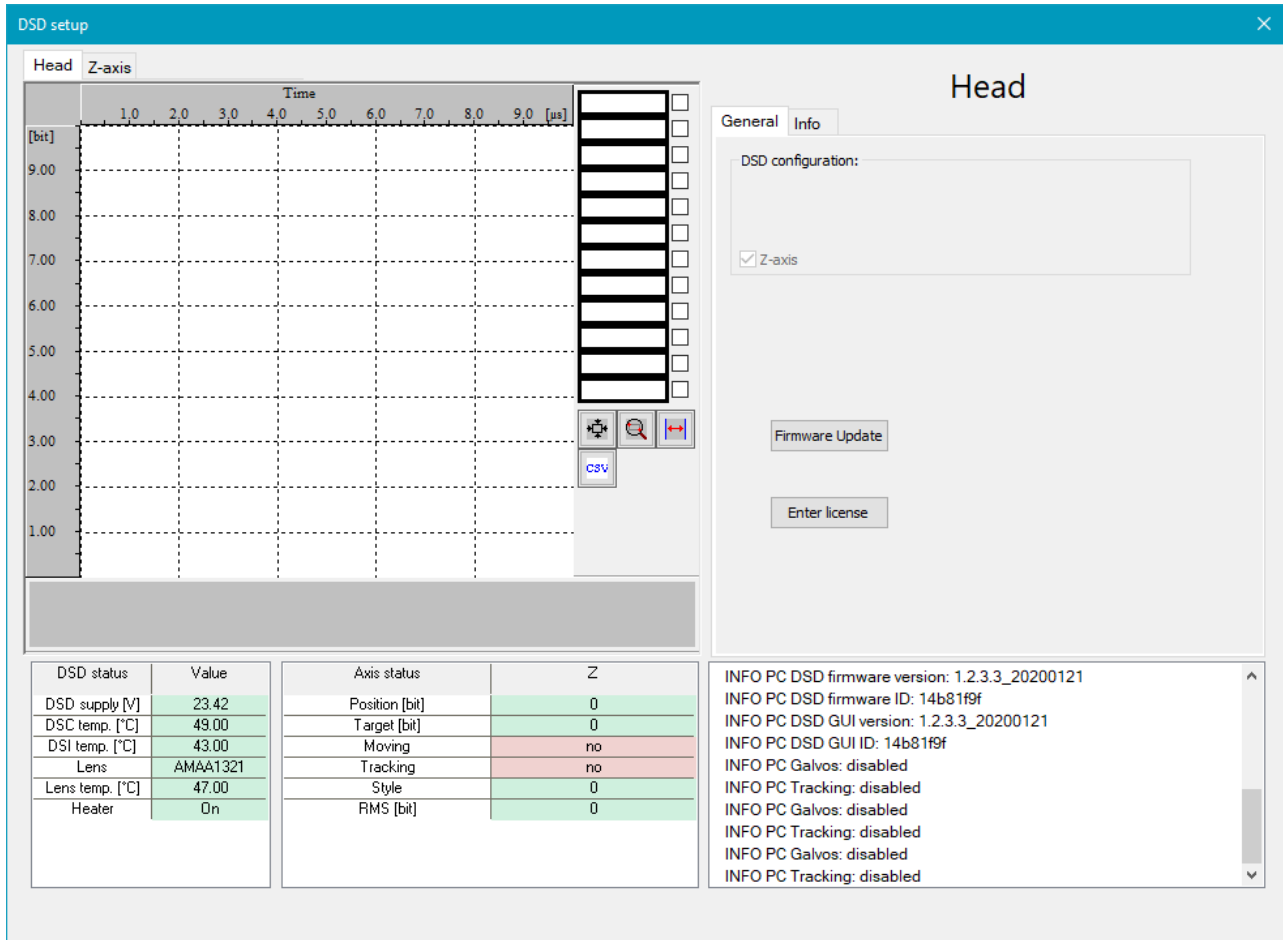
Start the DSD setup with <SCAPS>\tools\sc_dsd.exe.

Figure 6: DSD setup dialog

DSD status and Axis status after startup with XYS-USB adapter:

The DSD status (left bottom) shows several states of the DSD system, as supply voltage, temperature of the board, serial number of the lens and also the temperature of the lens.
The axis status (mid bottom) shows the actual state of the lens, as if the lens is tracking or moving and also the actual position and the target position in bit.

DSD log:

The DSD log (right bottom) shows several information of the DSD. The text is saved to <SCAPS>\system\sc_dsd_log.txt.

7.3 Info

The information page shows various software and hardware information of the DSD system.
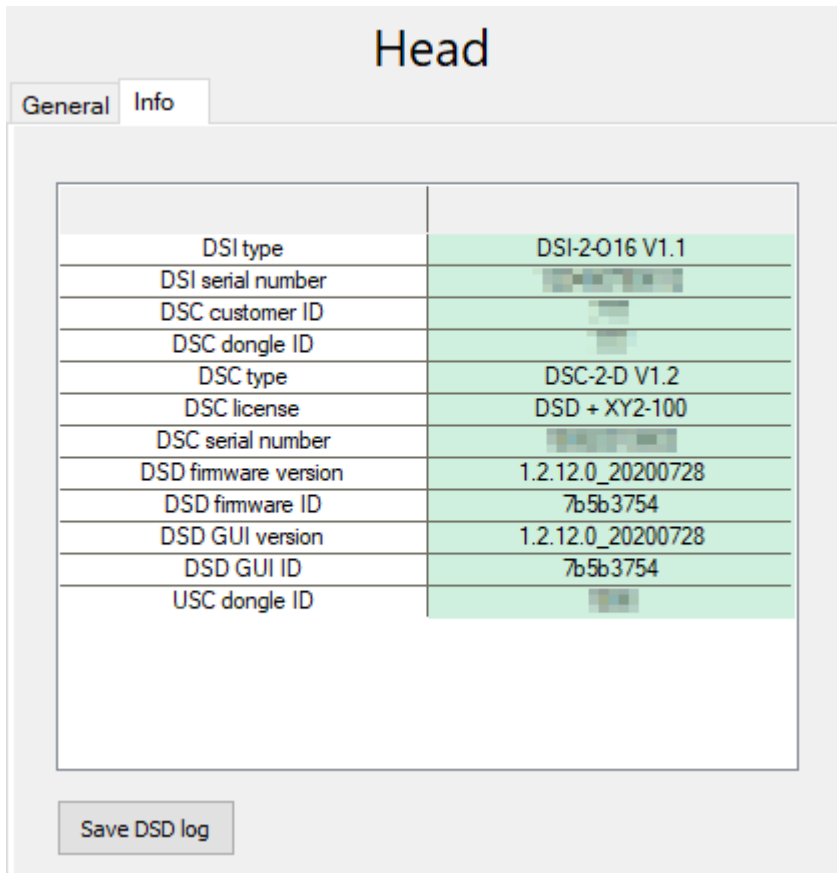
Figure 7: Info page

Save DSD log:

This button saves the DSD log file(s) to the PC at %SCAPS_SAM%
\system\dsd\log\YYYYMMDD_HHMMSS_dsd_log.zip for debugging purpose.

7.4 Calibration

Calibration process for a new system:

- Load default parameters   Z axis > General > Edit axis > Load defaults > select Optotune EL-10-42-OF > OK
- Calibrate the PD   Z axis > PD > Calibrate PD
- Evaluate the dynamic lens parameters   Z axis > Lens > Autotune
- Enable automatic control after DSD reboot   Z axis > General > Automatic control after DSD reboot
- Save current settings   Z axis > General > Save settings to card
- Close DSD dialog
- Re-power the DSD card

Check calibration and tuning:

- Check the Position Detector (PD)   Z axis > PD > Evaluate PD

- Check the calibration of the PD   Z axis > PD > Check calibration

- Check tuning of the lens dynamics   Z axis > Lens > Ramp, Start
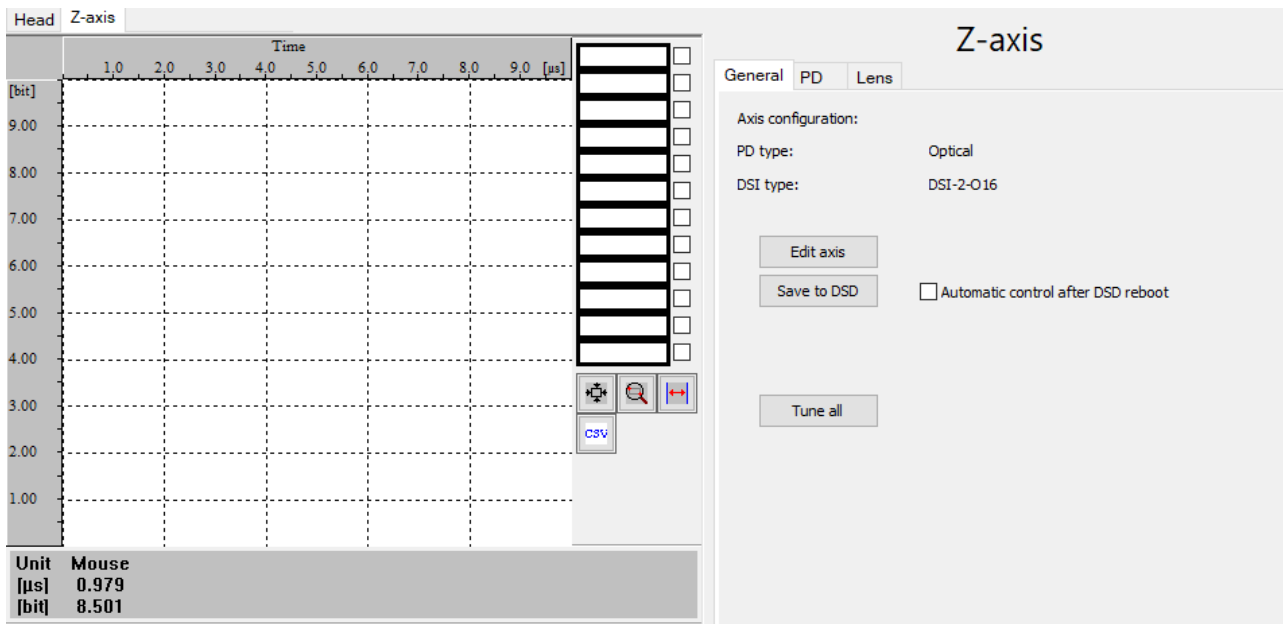
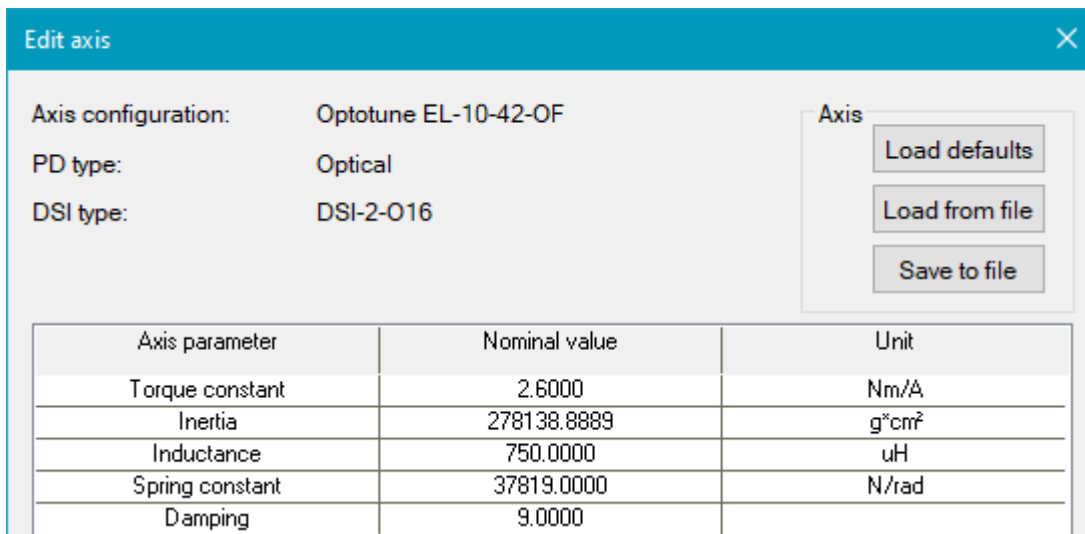## 7.4.1 Load and save parameters

Figure 8: Z axis, General

Edit axis:

Figure 9: Edit axis dialog to load or save parameters

Following functions are available in the edit axis dialog:

- Load default parameters
- Load parameters from file
- Save parameters to file

Save to card:

Saves current settings to the DSD.

Tune All:

This button runs following functions:
- Load defaults
- Evaluate PD
- Calibrate PD
- Autotune Lens

7.4.2 Position detector

Evaluate PD:

First step is to check the position detector of the lens. The LED supply current (LED [mA]) for the position detector will be ramped up to check if it's working correctly.
Beside the LED supply current, the currents of both position detector channels (PD-A [µA] and PD-B [µA]) are displayed as well.
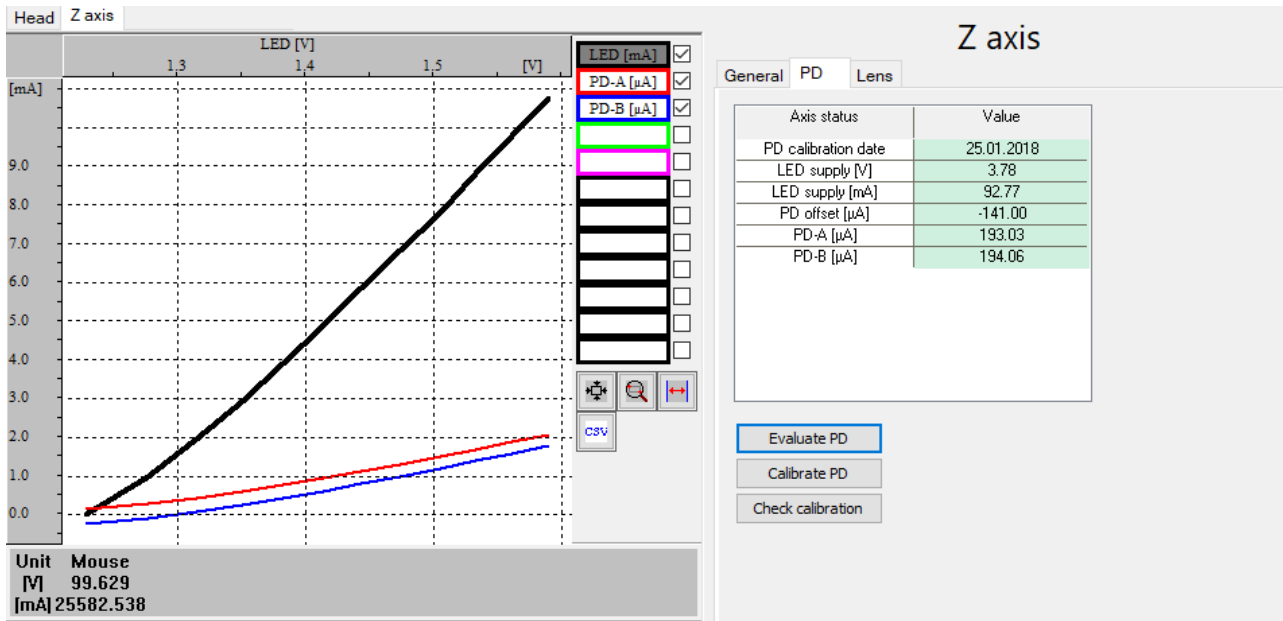
Figure 10: Evaluate PD

Calibrate PD:

As a next step the position detector needs to be calibrated. The Model is fitted to the Position curve. PD-A and PD-B show the currents of the single position detector channels. The curve Model [V] shows the applied voltage for the model of the lens.
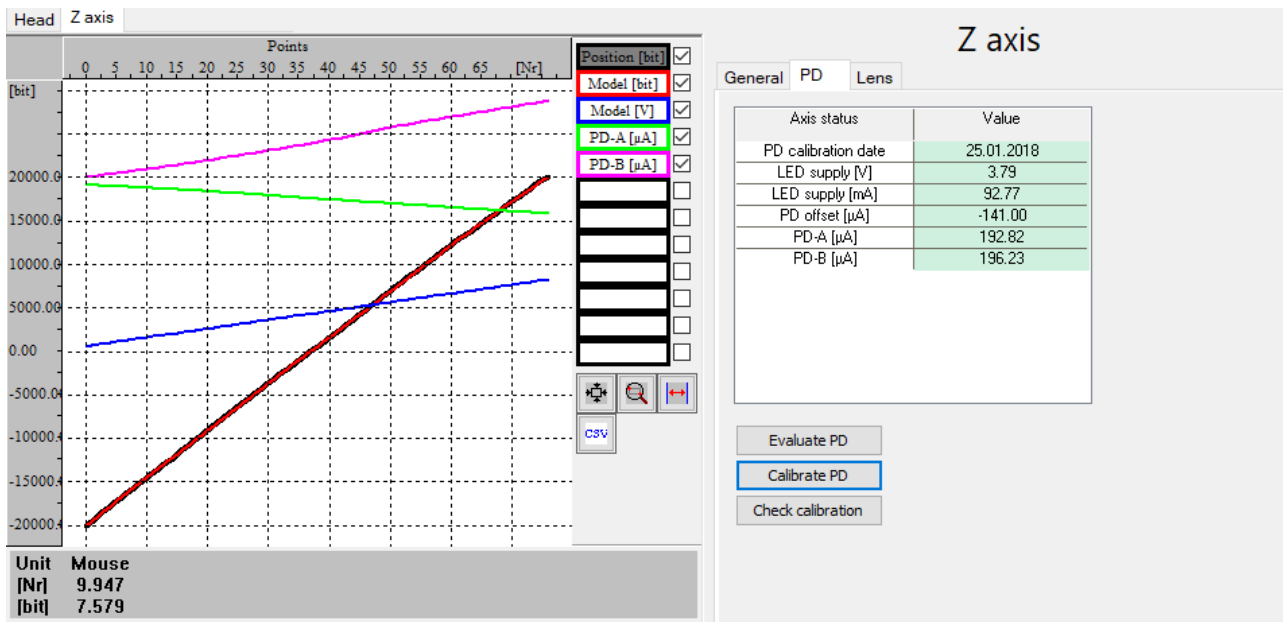

Figure 11: Calibrate PD

Check calibration:

The forward and backward movement of the Position should be symmetrical and also fit to the model curve. Graphs are the same as with Calibrate PD.
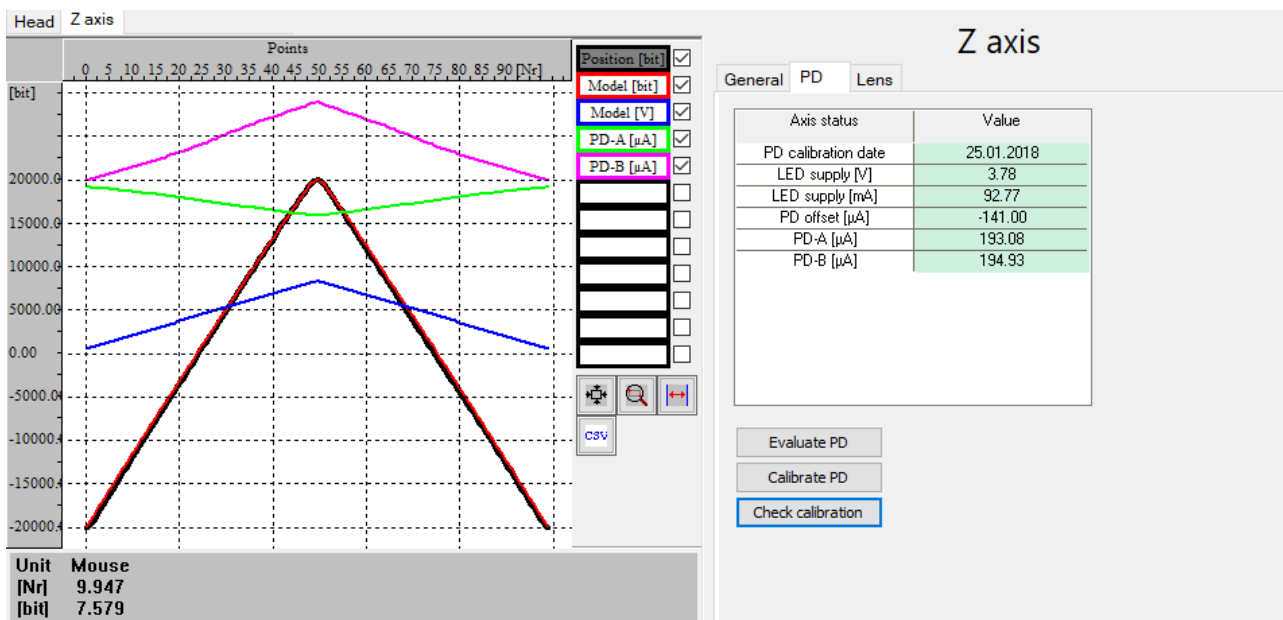

Figure 12: Check calibration

7.4.3 Lens

Autotune Lens:

After the successful calibration of the position detector, the dynamic model parameters have to be adjusted for each lens. The Autotune function will find the right model parameters.
Certain steps are driven to find the right control values. Position is the real position from the lens. The dynamic model parameters are evaluated to get a good match between Model and Position.
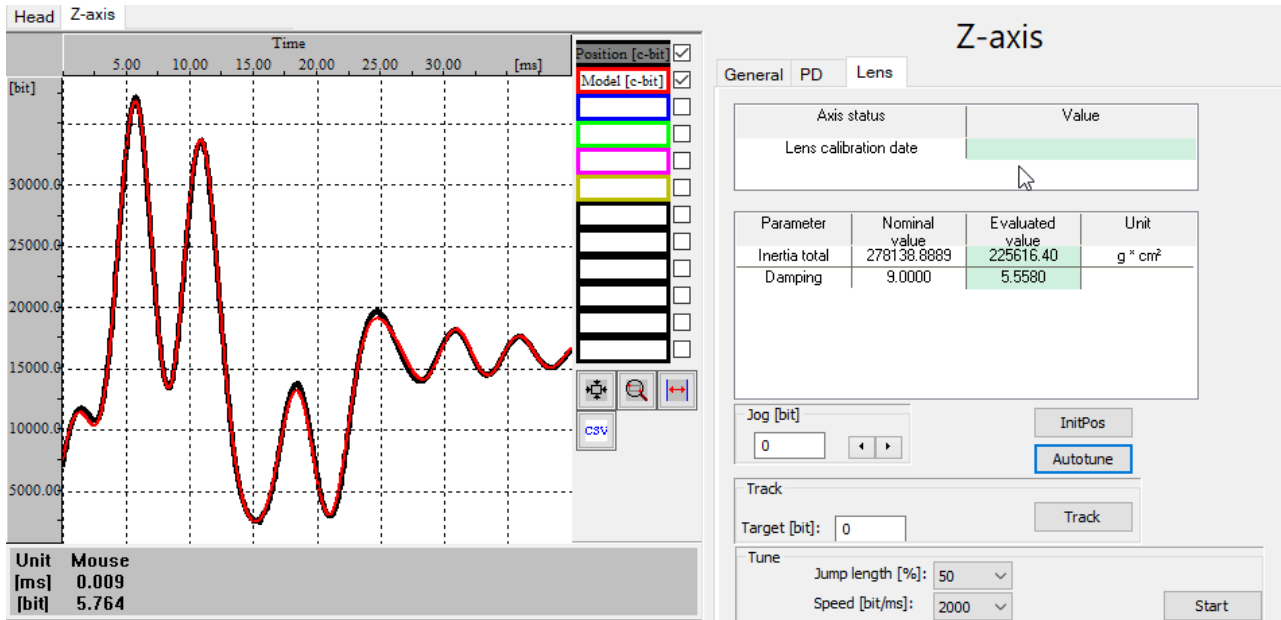After a successful Autotune it is recommended to save the settings.

Figure 13: Autotune Lens

Jog and InitPos:

The jog feature can be used to change the position of a already tracking lens (see Track Lens).
By clicking the button InitPos the position will be initialized and the actual position of the lens is shown within the Axis Status.

Track Lens:

To drive the lens to certain positions the track feature can be used.

Ramp Lens:

To check the calibration different ramps can be driven at different speeds. The button Start / Stop will toggle its state as the lens is moving or not.

Available ramp settings:
- Jump Length [%] of the full field: 1 to 80
- Speed [bit/ms]: 100 to 4000
- Control loop: This checkbox allows to enable or disable the tracking of the real position to the model position.

The next figures show the result of an already tuned lens for a movement of 50 % of the full field with a speed of 2000 bit/ms.
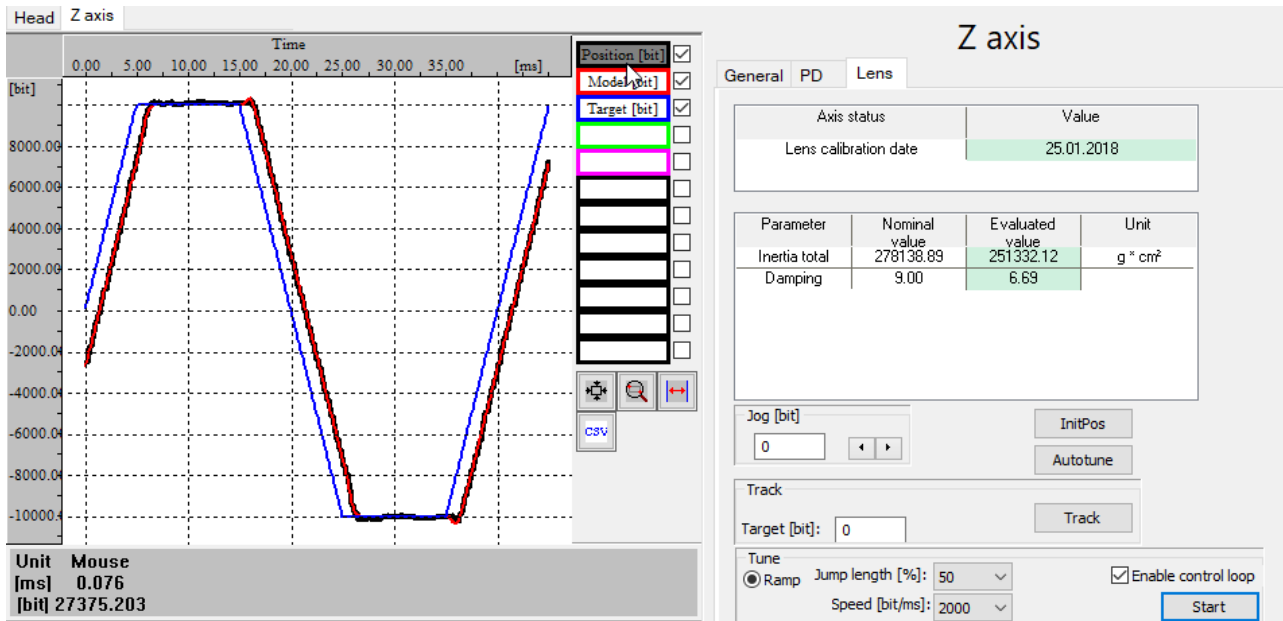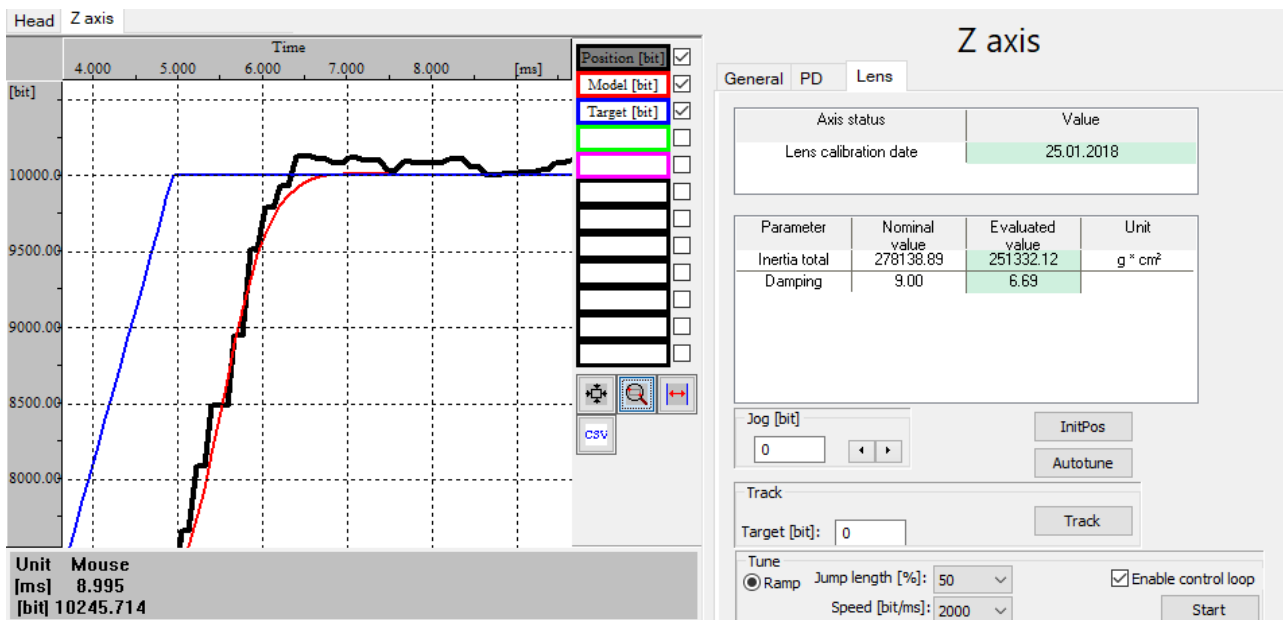
Figure 14: Ramp Lens curve

Figure 15: Ramp Lens curve, zoom

7.4.4 Input mapping

The DSD-2-O default mapping of the XY2-100 signals [bit] is linear to diopter [1/m] (-18000 bit is mapped to -1.8 dpt, 18000 bit is mapped to 1.8 dpt). The non-linear mapping between focus distance [mm] and XY2-100 signals [bit] is usually done in the software of the scanner control card, see Z-Lookup table SAMLight. Alternatively, the "Input Mapping" feature can be used to linearize the XY2-100 signals [bit] to the focus distance [mm] directly in the DSD.

For the "Input Mapping" feature following steps have to be done:

- Scanner control software
  - Set up the XY2-100 signals [bit] linear to focus distance [mm] in the software of the scanner control card and note the bit/mm factor.
  - Find the Z mm value in the scanner control software which results in the best focus. Repeat this for different target heights. An example, how this can be done, can be found in the SAMLight manual, Z Lookup Table Calibration.

- DSD Setup:
  - Set the correct bit/mm factor in the Input Mapping tab.
  - Insert the values of target height and of the best marked line for all valid marked target heights in the Input Mapping grid.
  - With 'Max fit order' the desired polynomial fit order can be chosen.
  - After pressing 'Apply': The current input mapping (black curve) is set to the preview of the new input mapping (blue curve) and the measured data is set to the target data.
  - Save current settings (Z axis → General → Save settings to card)

By clicking 'Apply' the measured data is cleared. Before pressing 'Apply', make sure the preview of the new input mapping (blue curve) looks reasonable. If not you can try to reduce the 'Max fit order' and double check the input data.

In the DSD log the current Input Mapping is shown. The default mapping is displayed as 'DSD Input mapping coefficients: [0.00e+00 1.00e+00]'.

In the mm-dpt-plot following information is shown:
- **black curve**: current input mapping
- **red squares**: measurement points
- **blue curve**: new input mapping preview

In figure 16 the moment after inserting the measurement data (bit/mm factor, target values, measured values, Max fit order) but before pressing 'Apply' is shown.
In figure 17 the state after pressing 'Apply' is shown: The current input mapping (black curve) is set to the preview of the new input mapping (blue curve) and the measured data is cleared (the measured data is set to the target data).
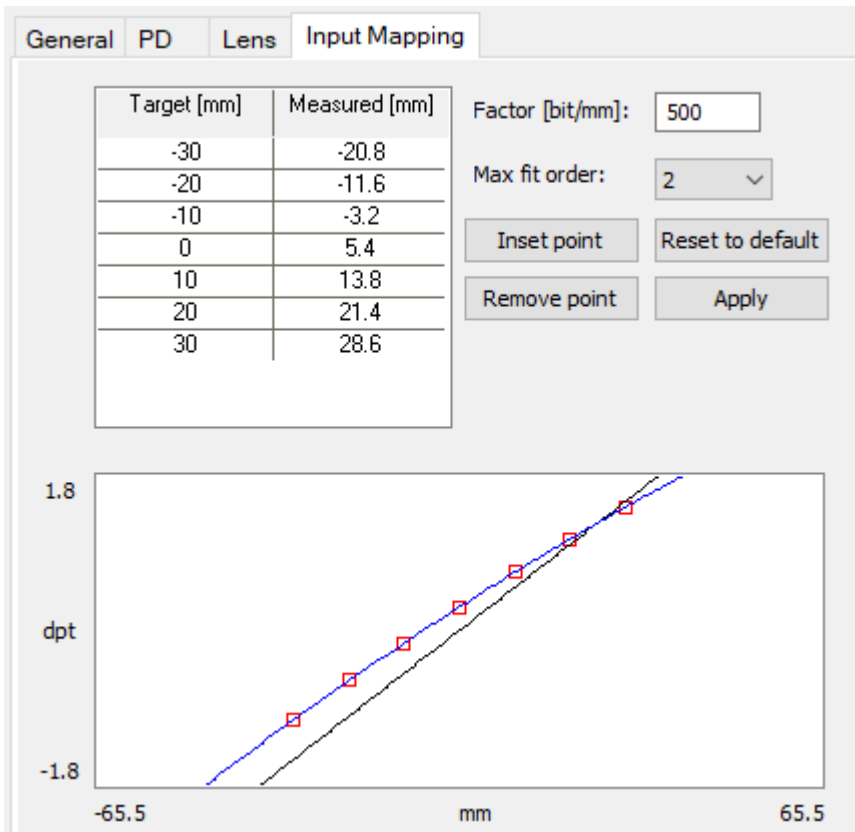
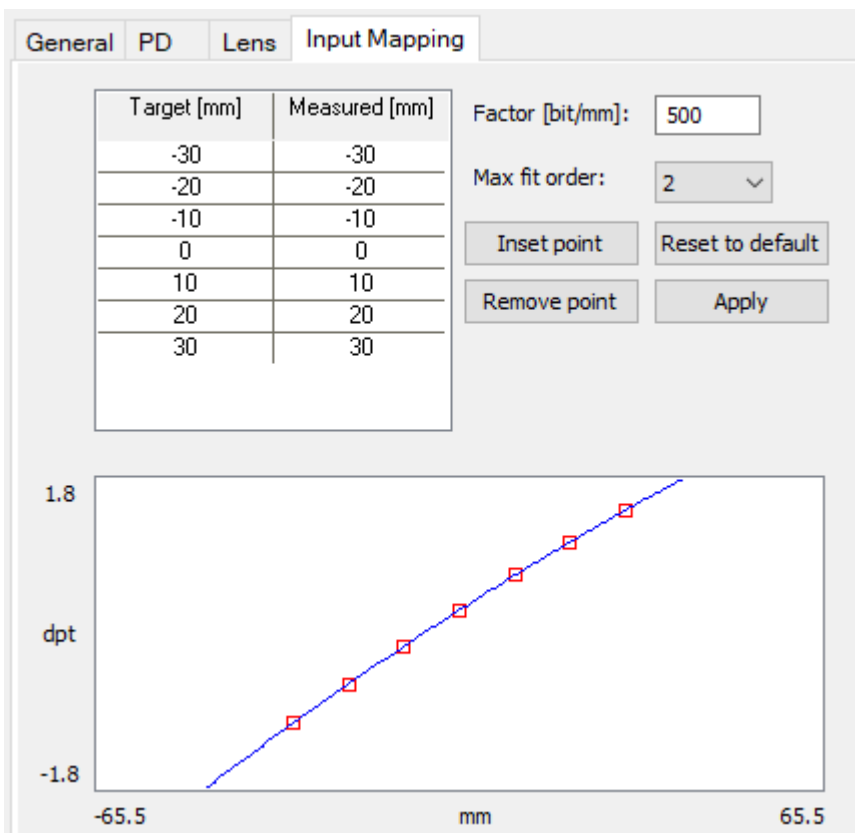**Figure 16: Example of new input mapping preview before clicking 'Apply'**

Figure 17: Example of new input mapping after clicking 'Apply'

7.5 DSD auto startup

Standard startup behaviour after calibration and autotuning:

- Z-axis > General: Enable "Automatic control after DSD reboot" and click "Save to DSD".
- Close the DSD setup software and power off the DSD board.
- Connect XY2-100 signals to the DSD board. Ensure that only valid position signals are sent to the DSD board. As home position of the system the center position of the lens (0 bit) is recommended.
- Power on the DSD board.
- The system heats the lens to 47°C. To ensure that the temperature has settled, the DSD waits until the lens temperature has not left the temperature range between 46°C and 48°C for one minute. This can take up to 10 minutes.
- Then the yellow "track" LED of the DSD lights up. The green "operational" LED changes its status from blinking to steady on and the external output pin 4 "lens control" goes high to indicate that the system is ready.
- To apply a focus shift to the lens send appropriate XY2-100 signals.

> *With a default input mapping the maximum XY2-100 signals are* ±18000 bit. If signals are sent outside of this range, the DSD will keep the lens at the maximum allowed focus shift.

7.6 Z-Lookup table SAMLight

Before the system is ready to mark, the 3D lookup table within SAMLight has to be created.

> *Close the DSD-Setup software before SAMLight is started to avoid communication errors within the DSD-setup.*

The following figure shows a exemplary lookup table for the use with a 160 mm F-Theta lens. The exact values for the focus distance (mm) have to be found with an appropriate calibration test job.

Figure 18: SAMLight - 3D lookup table example

With a 160 mm F-Theta lens, ±1.8 dpt correspond to ±50 mm focus shift.