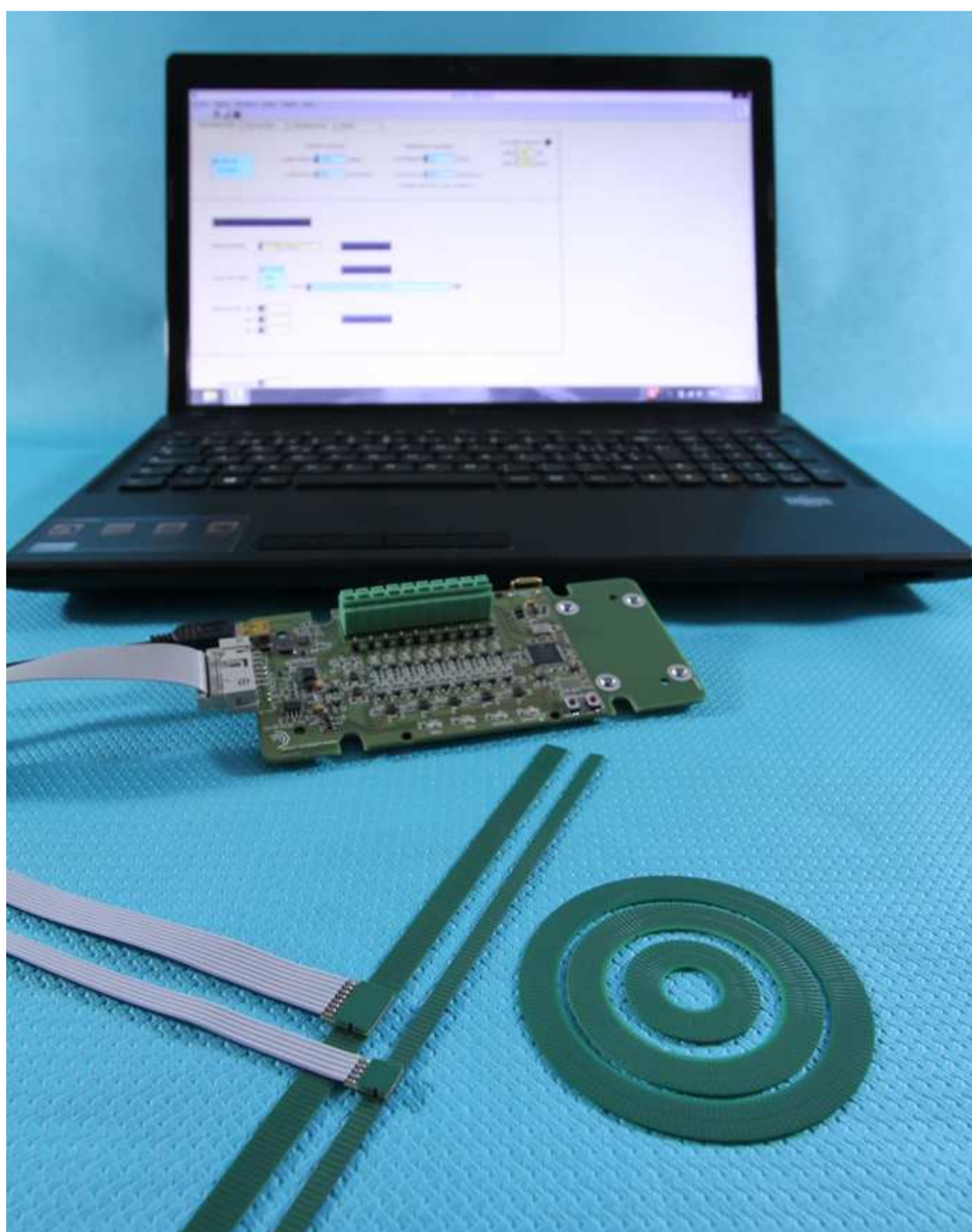


User Manual for ASSIST Evaluation & Programming Tool EPT002



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1. Introduction

The ASSIST Evaluation & Programming Tool (EPT) consists of:

- ASSIST Software
- Interface Board
- One or more POSIC encoders
- One or more scales, codewheels or gears

The EPT allows you to:

- Configure an encoder
- Operate an encoder
- Program a configuration in an encoder
- Linearize an encoder
- Analyze in case of a problem with an encoder

The three most frequent questions about the EPT are :

Q: Should I program the configuration in the encoder's memory?

A: No, in ASSIST you can define a configuration and operate the encoder without programming it. Only for standalone operation (without ASSIST), the encoder must be programmed.

Q: How many times can I program an encoder?

A: An encoder can be programmed only one time. It is not possible to re-program an encoder.

Q: Should I linearize the encoder?

A: No, it is not necessary to linearize the encoder, this depends on the linearity requirement of your application. You can use POSIC encoders with very different types of targets: linear scales, codewheels and ferromagnetic gears. Each target has its own material and shape and therefore has a different characteristic non-linearity. The linearization procedure allows to compensate the characteristic non-linearity. More detailed information is given in Section 6.5.

2. Hardware

2.1 Contents

The contents of the Evaluation & Programming Tool EPT is shown in Figure 1 and Table 1.

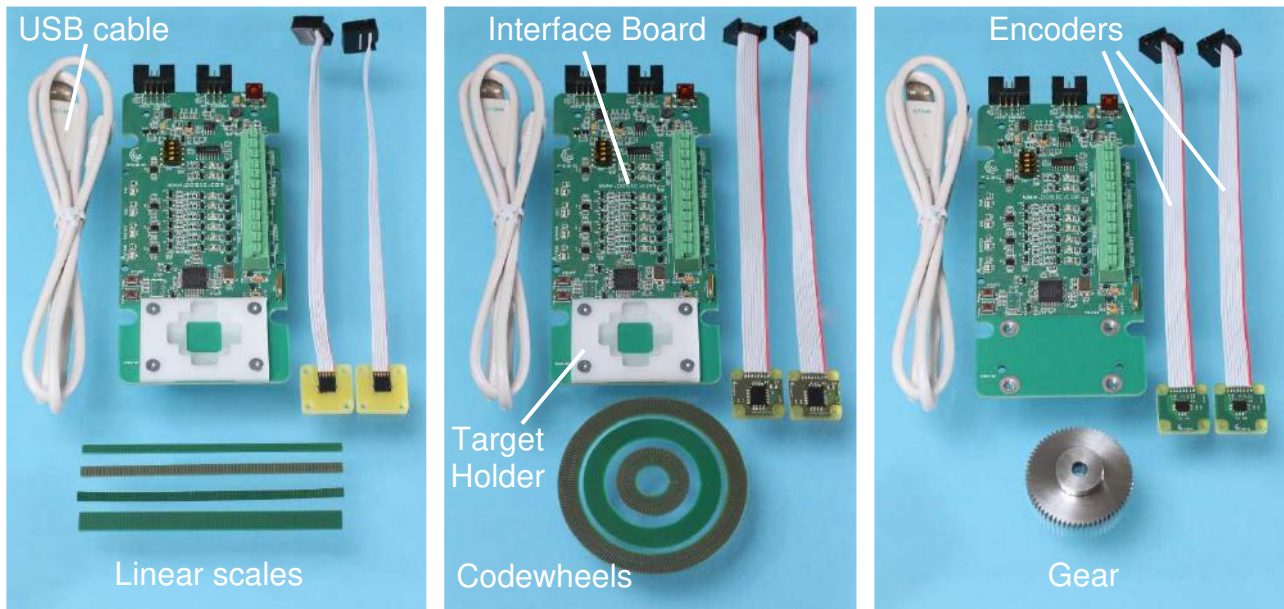


Figure 1 Examples of the Evaluation and Programming Tool EPT002 for an ID1102L with linear scales (left), for an IT5602C with codewheels (center) and for an ID4501G with a ferromagnetic gear (right).

For the AP9200L and AP9201L encoders, a Module Driver Board MDB001 must be connected between the ASSIST Interface Board and the encoder, see Figure 2.

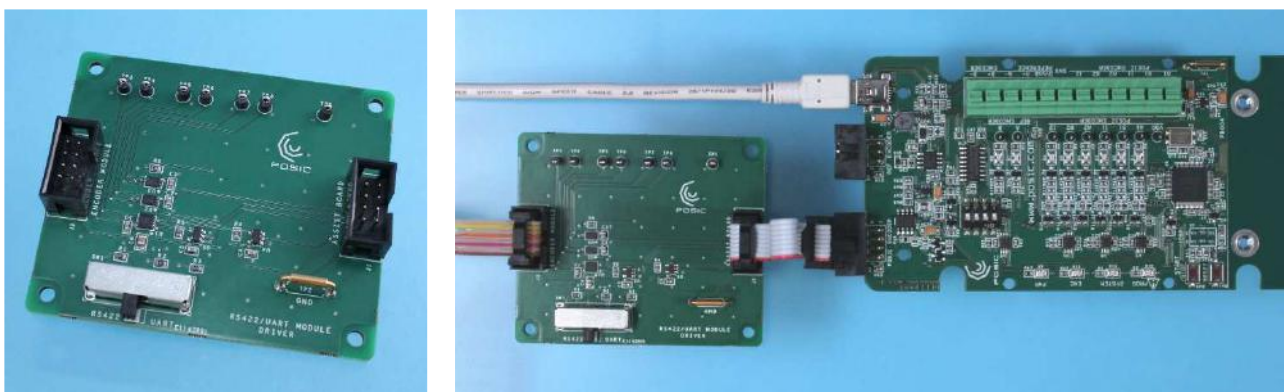


Figure 2 Module Driver Board MDB001 (left) and connection of the Module Driver Board between ASSIST Interface Board and encoder.

Table 1 Targets included in the EPT as a function of the selected encoder-type.

Encoder	Targets	Target Holder
ID1102L	TPLS01, TPLS02, TFLS01, TPLD03, ~100 mm each	Yes
ID4501L		
IT3402L	TPLD03, ~100 mm	
IT5602L		
AP3403L	TPLA08, TPLA16, TPLA32, ~100 mm each	
AP5603L		
AP9200L		
AP9201L		
ID1102C	TPCD05-064, TPCD06-128, TPCD07-180	
ID4501C		
IT3402C		
IT3403C		
IT5602C		
ID1102G	Ferromagnetic gear module 0.5, 64 teeth	No
ID4501G		

2.2 Interface Board

The most important elements on the Interface Board are shown in Figure 3. The schematics are given in Annex 5.

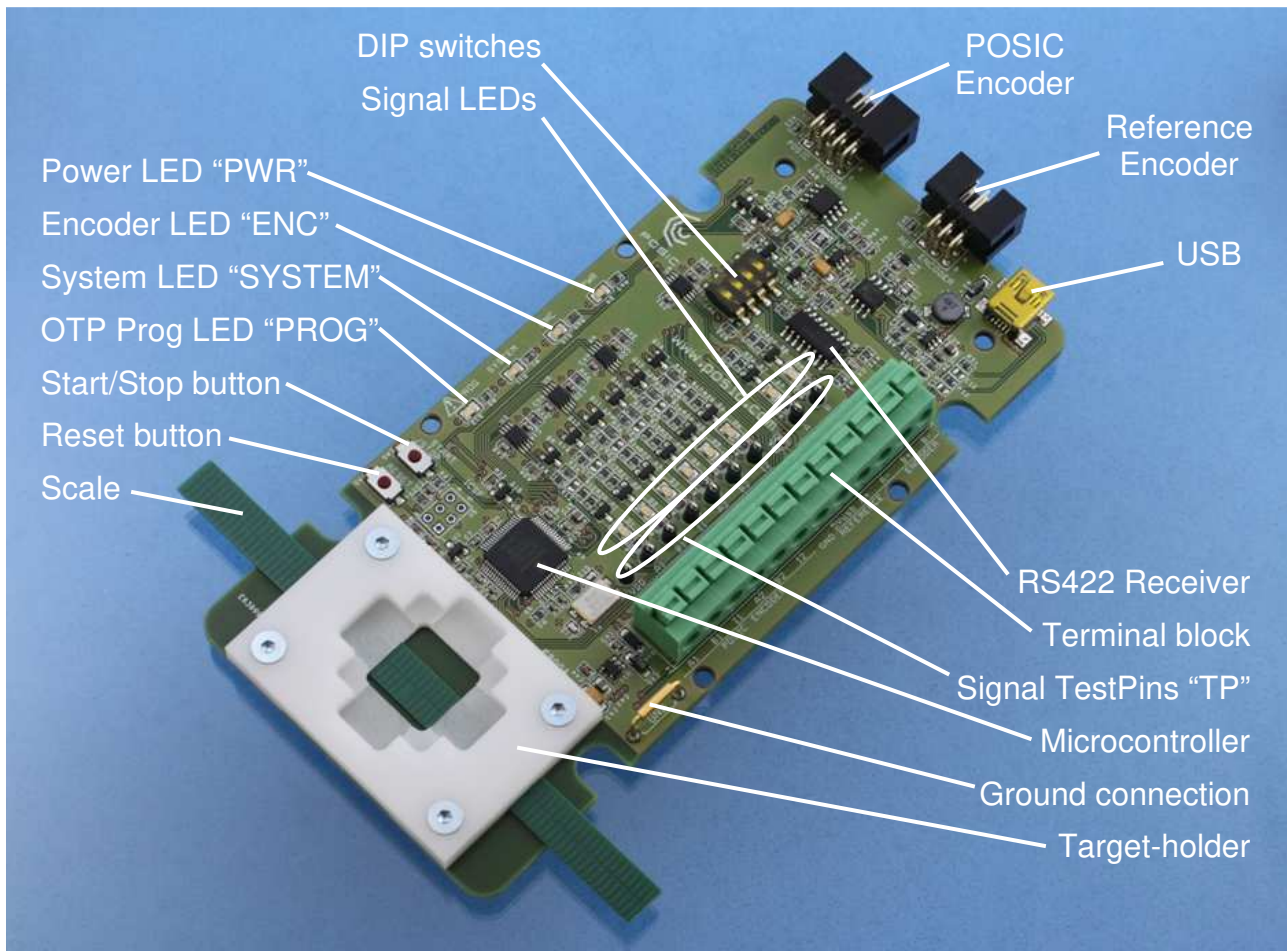


Figure 3 The Interface Board.

2.3 Target-Holder

The Target-holder is the white plastic part shown in Figure 3. It allows to position the encoder and the target in approximately the right positions: the encoder is aligned to track with copper stripes on the scale or the codewheel. When the encoder-holder, on which the encoder is assembled, is gently pressed into the target-holder, the airgap is approximately 0.2 – 0.3 mm. The Target-holder allows to verify if the encoder is functional, however, it is not intended for accurate measurement of linearity, repeatability, accuracy etc.

2.4 Codewheels

For rotary incremental encoders, the target is codewheel TPCD05-64 (Figure 4) with 64 periods, compatible to ID4501C, ID1102C, IT3402C, IT3403C and IT5602C.

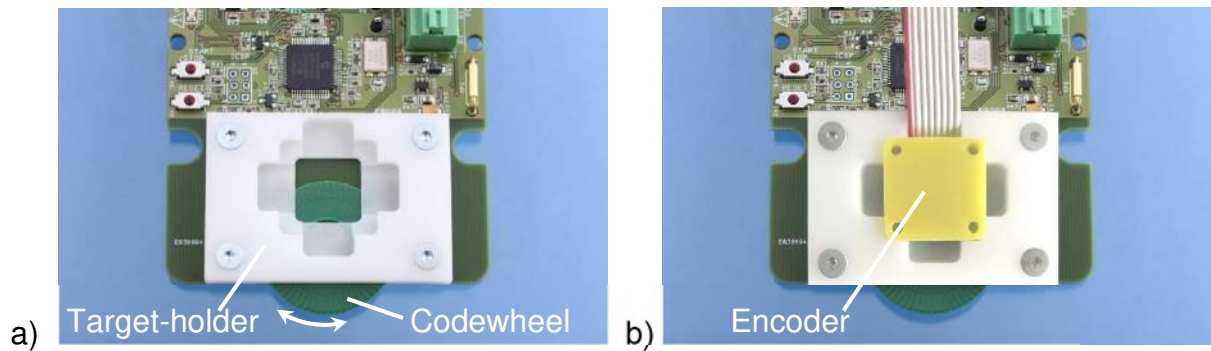


Figure 4 a) Target-holder with codewheel TPCD05-064. b) Placement of the encoder in the target-holder.

2.5 Incremental linear scales

For linear incremental encoders, the target is a 100 mm long 2-track linear scale TPLD03 (Figure 5), compatible to ID4501L, ID1102L, IT3402L and IT5602L. For the encoders ID4501L and ID1102L, the scale may or may not contain an index. For the encoders IT3402L and IT5602C, the scale contains an index, which is the special period shown in Figure 5. If the scale has an index, the encoder and the scale should be oriented as shown in Figure 5.

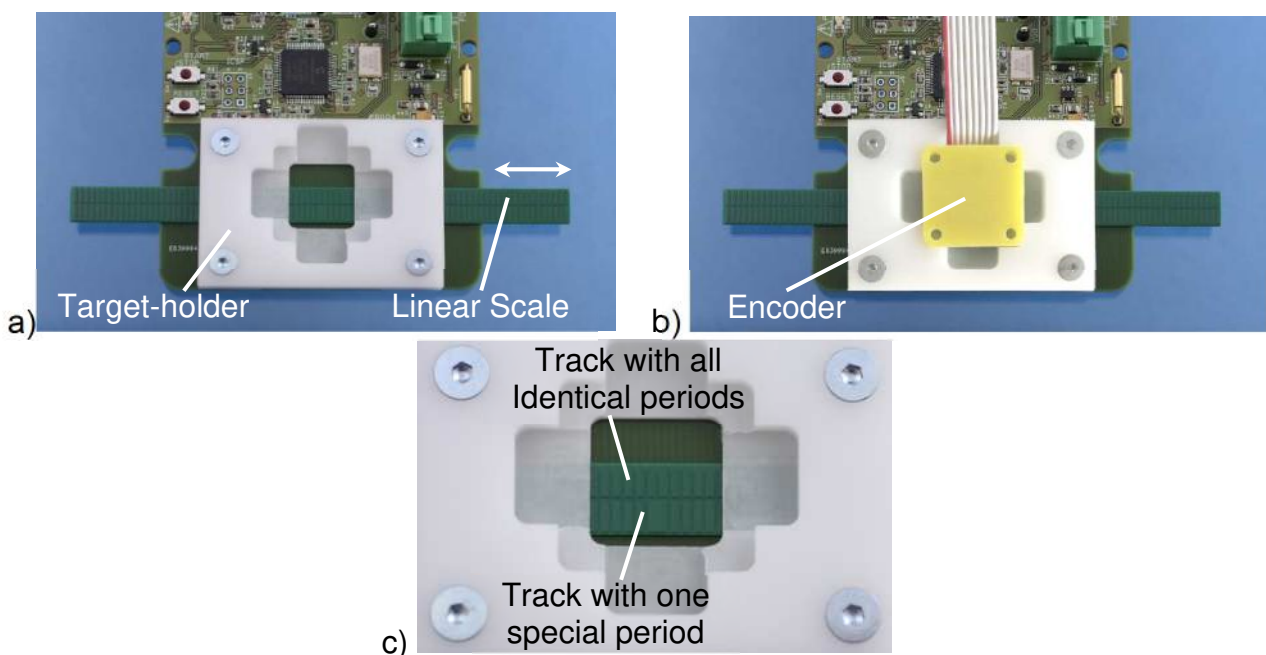


Figure 5 a) Target-holder with linear scale TPLD03. b) Placement of the encoder in the target-holder c) Orientation of the 2-track scale TPLD03 in the target-holder.

2.6 Absolute linear scales

For linear absolute encoders, the targets are 100 mm long 2-track linear scales TPLA08, TPLA16 and TPLA32, compatible to AP3403L and AP5603L. The TPLA scales have two different period-lengths. Track 1 has period-length 1.2 mm and Track 2 has a longer period-length. The encoder and the scale must be oriented as shown in Figure 6.

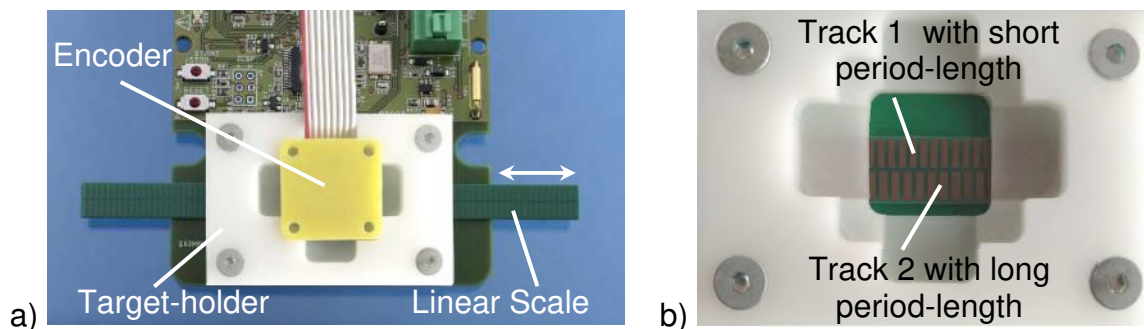


Figure 6 a) Target-holder with absolute linear scale and placement of the encoder in the target-holder. b) Orientation of the 2-track absolute linear scale TPLA08 inside the target-holder.

2.7 LEDs

The status of the LEDs in Figure 3 are explained in Table 2.

Table 2 Status of the different LEDs during operation of the Interface Board.

Status	LED name and color				
	PWR orange	ENC orange	SYSTEM orange	PROG yellow	Signal LEDs 1-8 red
No supply	off	off	off	off	off
Supply to Interface Board	on	off	off	off	off
Supply to Encoder	on	on	off	off	on/off
Encoder in communication- or measurement-mode	on	on	off or blinking	off	on/off
Encoder in OTP programming mode	on	on	on	on	on/off
Firmware upgrade, see Section 5.2	on	off	off	blinking	off

3. Operation without ASSIST Software

For evaluation and demonstration purposes with incremental encoders with A quad B outputs, the Interface Board can be operated without the ASSIST software as described in the sequence below and illustrated in Figure 7.

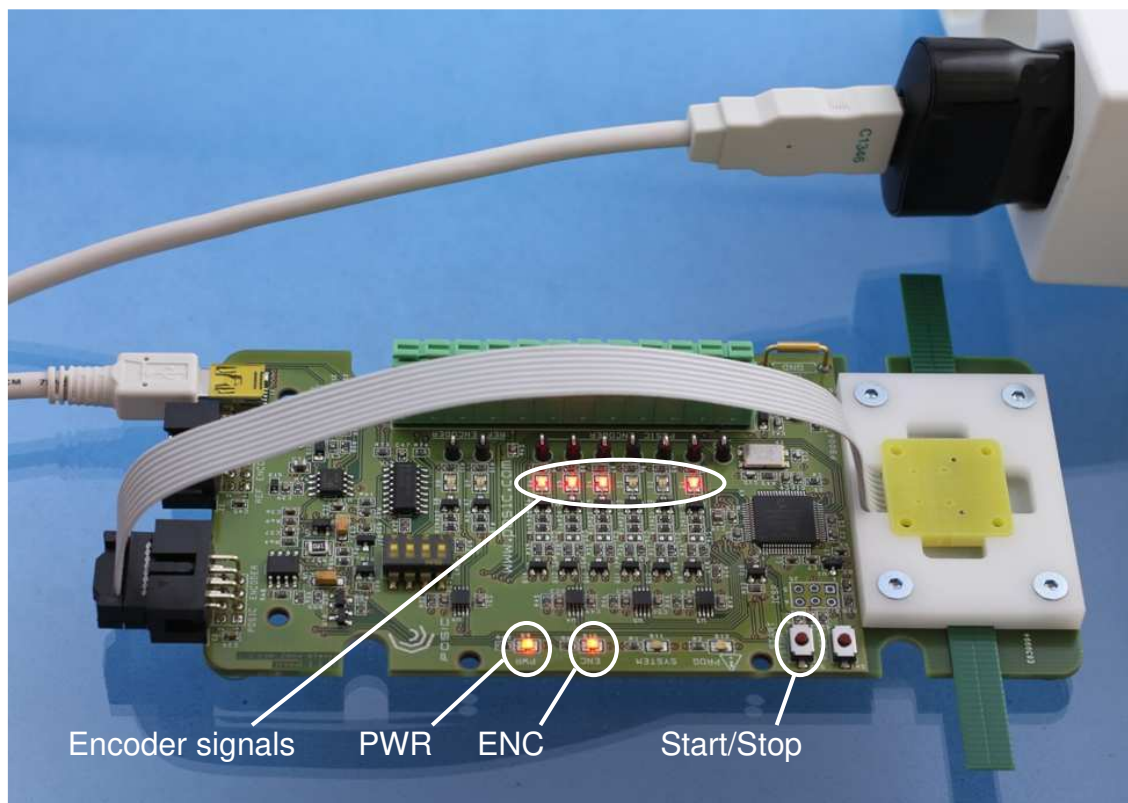


Figure 7 Operation of the Interface Board without the ASSIST software.

Operation without the ASSIST software:

- 1) Connect the USB-cable to a mains-to-USB converter.
- 2) Place the encoder in front of the target and move the target gently. The A quad B encoder output signals are displayed by the Signal LEDs and can be measured on the Signal TestPins (see also Figure 3)

The “Start/Stop” button toggles the encoder on/off.

The encoder operates according to the configuration programmed into its OTP memory. If the OTP memory has not been programmed, the default configuration will be used (max speed = 01 and interpolation = 07, see datasheet of the encoder).

4. Initial Software installation

The ASSIST software has been developed for operation on a PC with a MicroSoft Windows™ 10 operating system and can be downloaded from the POSIC website. Access to the download page is granted upon purchase of the Evaluation and Programming Tool EPT002.

If ASSIST Version 02.00.00 or later is already installed on your PC, you can skip this Chapter and upgrade according to Chapter 5.

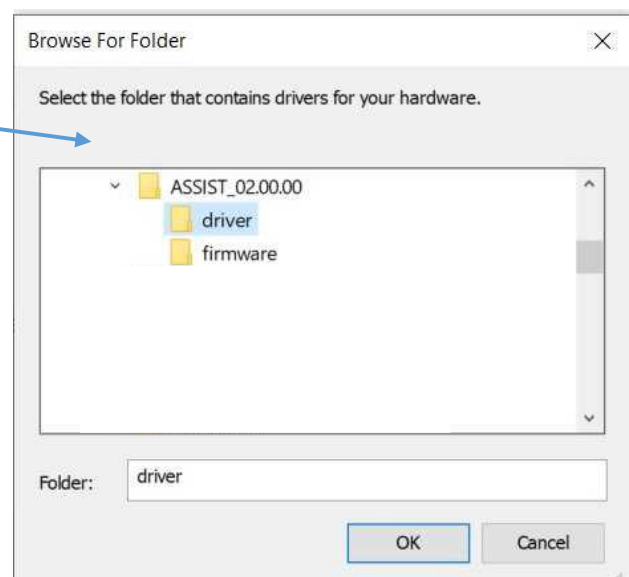
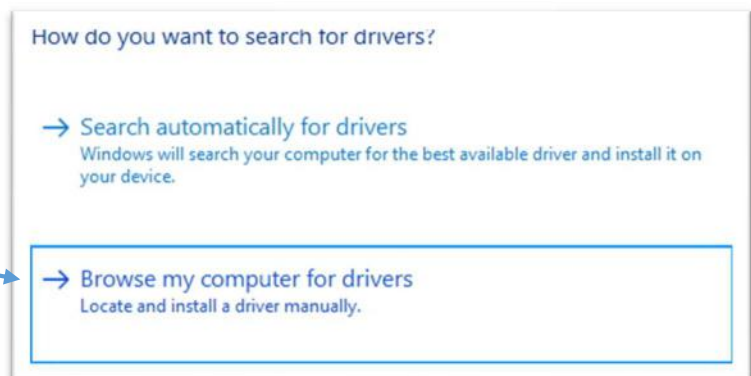
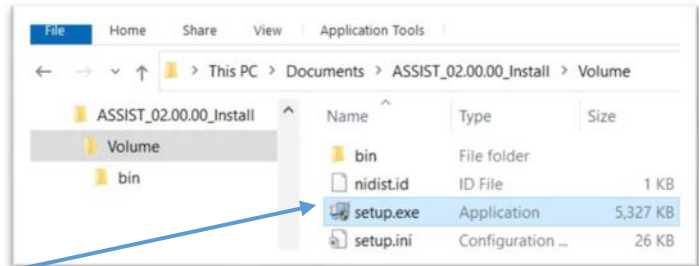
ASSIST installation

- 1) Download and unzip the file ASSIST_xx.xx.xx_Install.zip
- 2) Go to the directory \ASSIST_xx.xx.xx_Install\Volume\
- 3) Launch “setup.exe”, a wizard installs ASSIST
- 4) Connect the ASSIST Interface Board with the USB cable to your PC
- 5) A pop-up window should appear, select “Browse my computer for drivers”.

If no pop-up window appears, see Section 5.3

- 6) Browse to the directory “ASSIST_xx.xx.xx” and select “driver”
- 7) Go to the directory \ASSIST_xx.xx.xx\
- 8) The ASSIST software is started by executing “Posic.exe” (it is recommended to create a shortcut on your desktop)

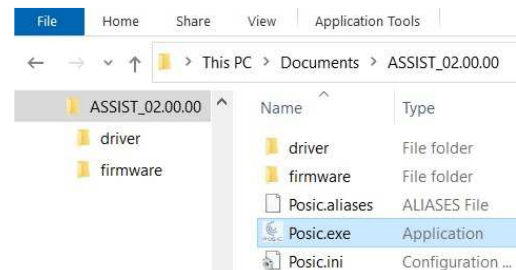
xx.xx.xx designates the version of the ASSIST software and may for example be: 02.00.00



5. Upgrade

5.1 ASSIST Software upgrade

- 1) Download and unzip ASSIST_xx.xx.xx.zip
- 2) Copy the directory ASSIST_xx.xx.xx to the desired location in your PC. It is not necessary to carry out an installation-procedure or to re-boot your PC.
- 3) In the directory ASSIST_xx.xx.xx launch the application Posic.exe (it is recommended to create a shortcut on your desktop)



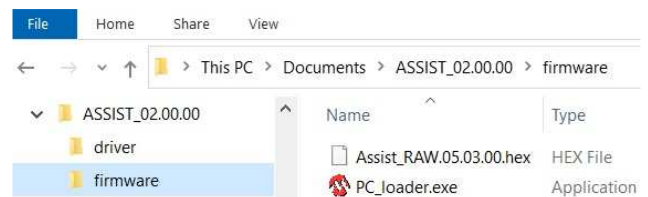
xx.xx.xx designates the version of the ASSIST software and may for example be: 02.00.00

5.2 Interface Board Firmware upgrade

This Section describes how to load firmware into the Flash memory of the dsPIC33 on the Interface Board of the Evaluation & Programming Tool EPT002.

Hard- and software requirements

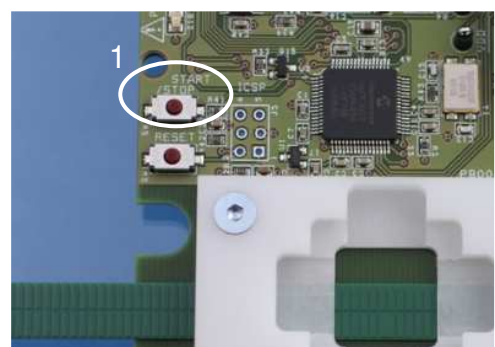
- ASSIST Interface Board
- Executable PC_loader.exe from Microchip™
- Hexadecimal firmware code from POSIC (in the image to the right: Assist_RAW_05.03.00.hex)

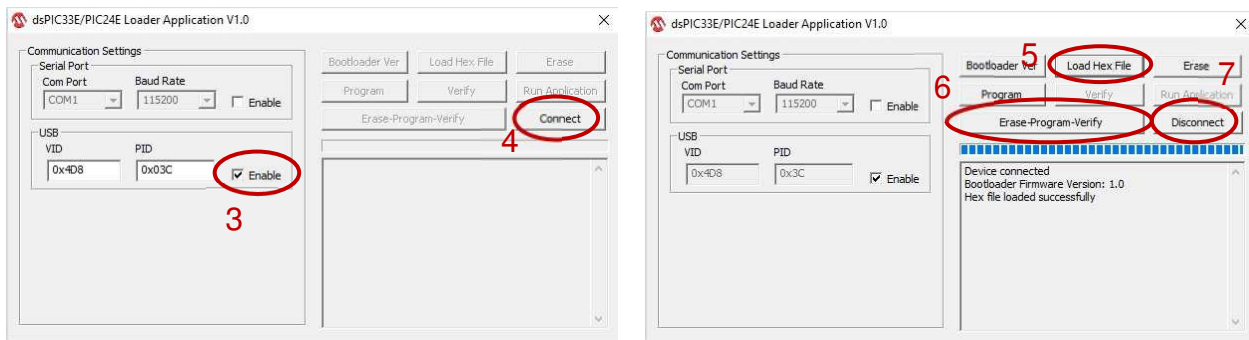


Both files are available in the ASSIST-software in the directory “firmware”

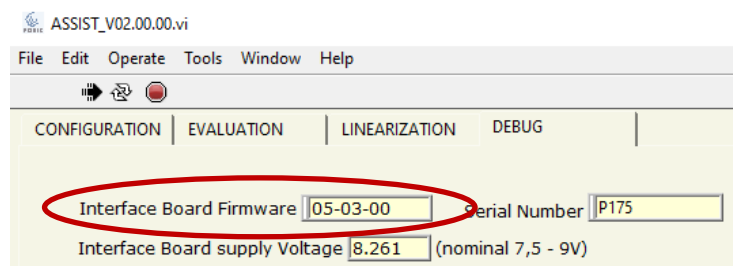
Load Firmware

- 1) Connect the Interface Board to the PC with the USB cable while holding the START/STOP button on the Interface Board pressed. Once connected, release the START/STOP button
- 2) Start PC_loader.exe
- 3) Enable the USB connection
- 4) Press Connect





- 5) Load Hex File and select the appropriate .hex file in the pop-up menu
- 6) Erase-Program-Verify and wait until these commands have been completed
- 7) Disconnect
- 8) Launch ASSIST and verify in the Debug window that the correct version of the firmware has been loaded



5.3 USB Driver

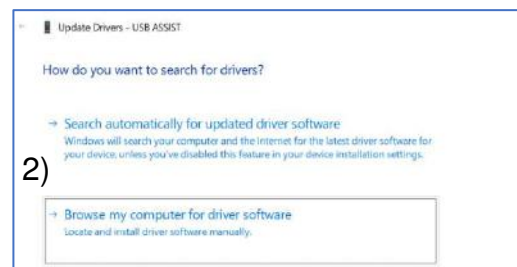
If the USB-driver has not been installed or if the USB-communication with the Interface Board is not working correctly, open the Device Manager.

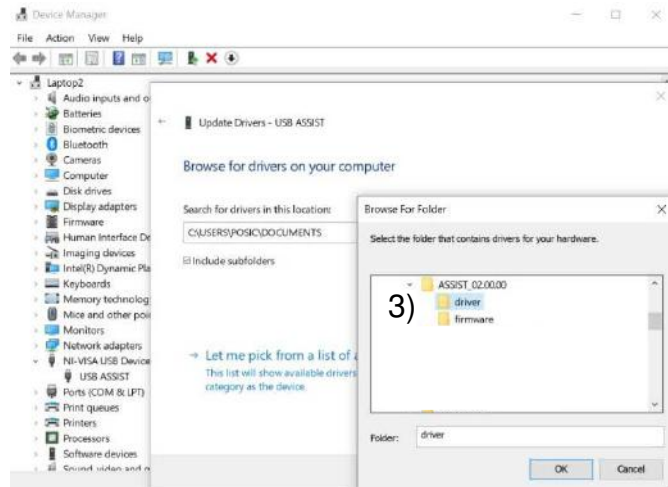
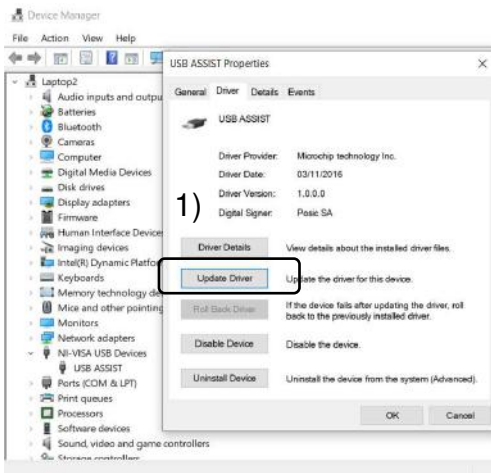
- If the Device Manager list contains NI VISA USB Devices, then continue with Section 5.3.1 NI VISA USB Device.
- If the Device Manager list does not contain NI VISA USB Devices, then continue with Section 5.3.2 USB Input Device.

5.3.1 NI VISA USB Device

In the Device Manager select “NI-VISA USB Devices” (the Interface Board must be connected). If the driver does not correspond to the one in the image below, it is recommended to carry out the following steps:

- 1) Update Driver
- 2) Browse my computer for driver software
- 3) Select “Driver” from the “ASSIST” directory

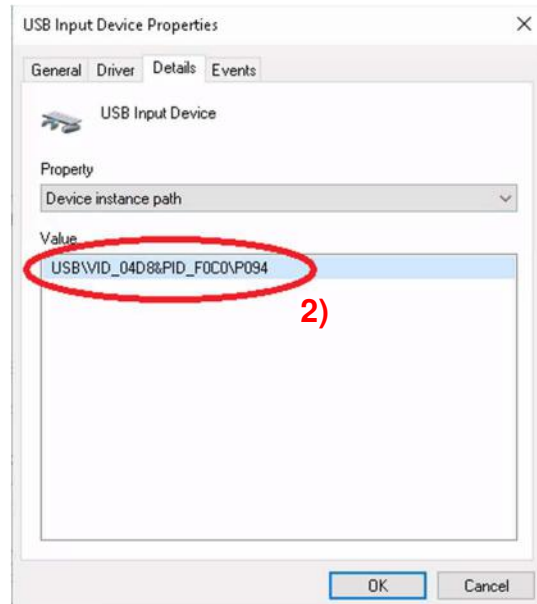
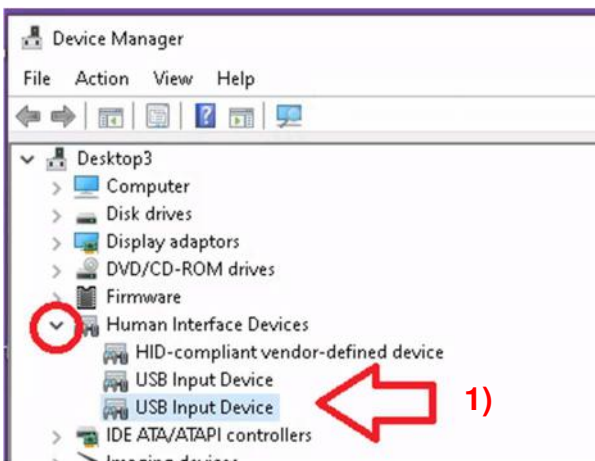




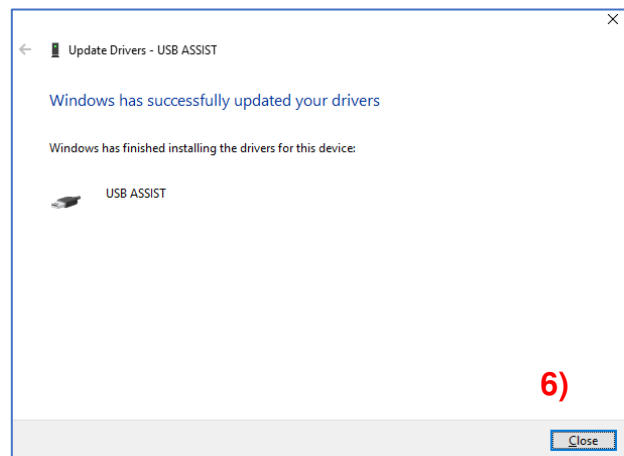
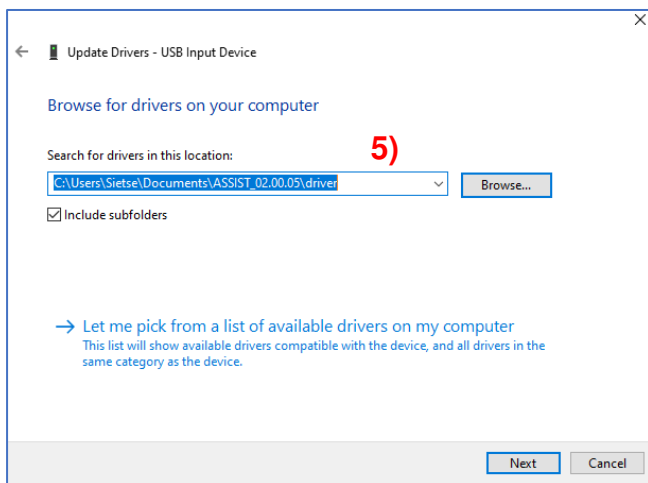
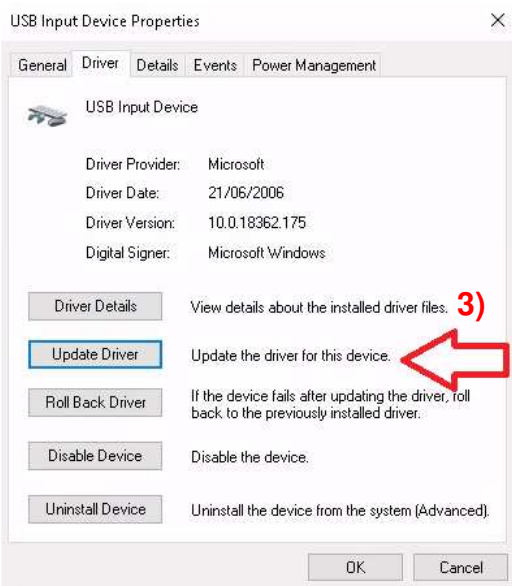
5.3.2 USB Input Device

In the Device Manager select “Human Interface Devices” (the Interface Board must be connected).

- 1) Select a USB Input Device, click on “Properties”, select “Details” select the property “Device instance path”
- 2) If “Value” = USB\VID_04D8&PID_F0C0, continue with 3), else go back to 1) and select another USB Input Device



- 3) In USB Input Device Properties select “Driver” and click on “Update Driver”
- 4) Select “Browse my computer for driver software”
- 5) Browse to the ASSIST-directory, select the “driver”-directory and press “Next”
- 6) Complete the driver installation by clicking “Close”



6. ASSIST software user guide

The ASSIST software consists of four windows that can be selected by means of four tabs as shown in Figure 8.



Figure 8 Four tabs to select one of the four windows Configuration, Evaluation, Linearization or Debug.

6.1 Configuration

ASSIST starts up in the Configuration window. Initially an hourglass will be visible, during which the USB-connection with the Interface Board is established. Depending on the number of USB-ports and their use, it may take several (tens of) seconds to establish the USB-connection. As long as the USB-connection has not been established, the ASSIST software remains inactive.

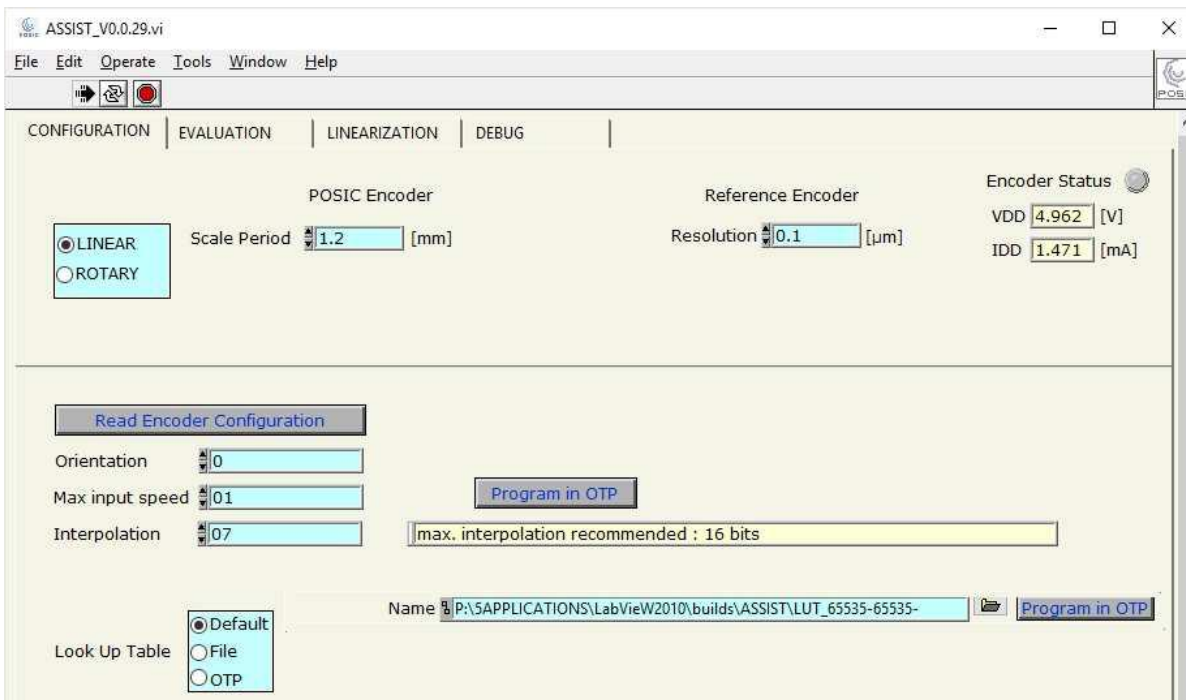


Figure 9 Configuration window for incremental encoders of types ID and IT.

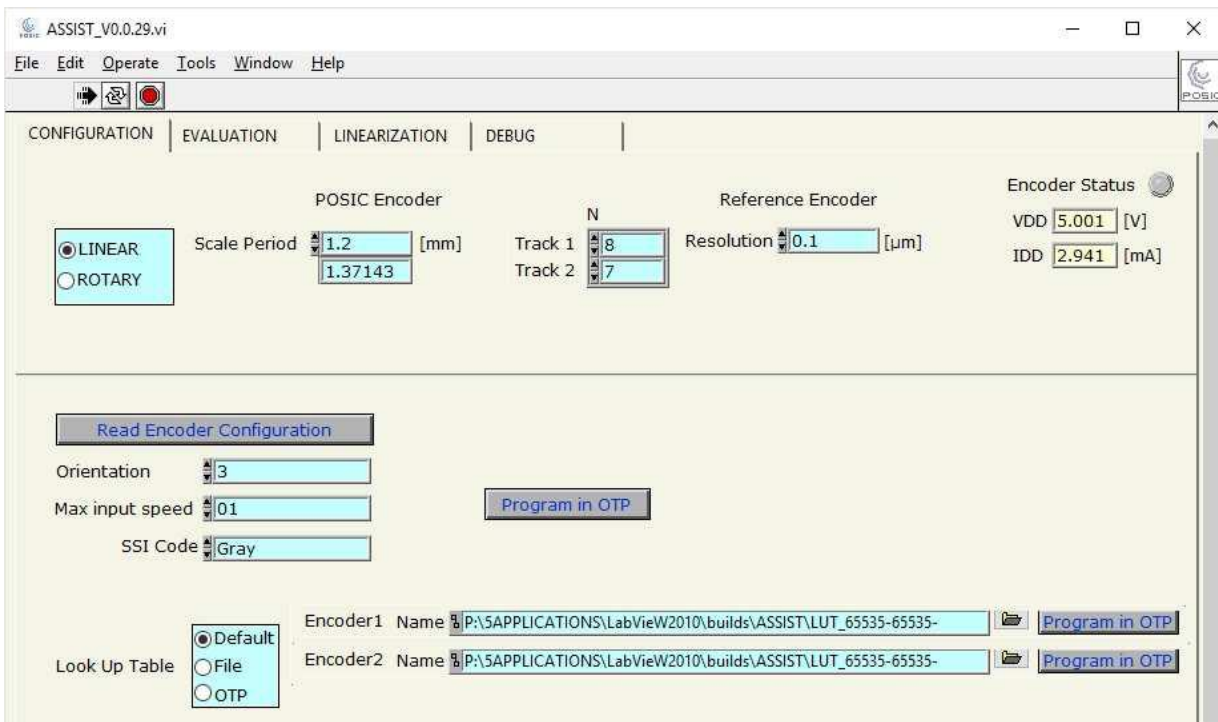


Figure 10 Configuration window for absolute encoders AP3403 and AP5603.

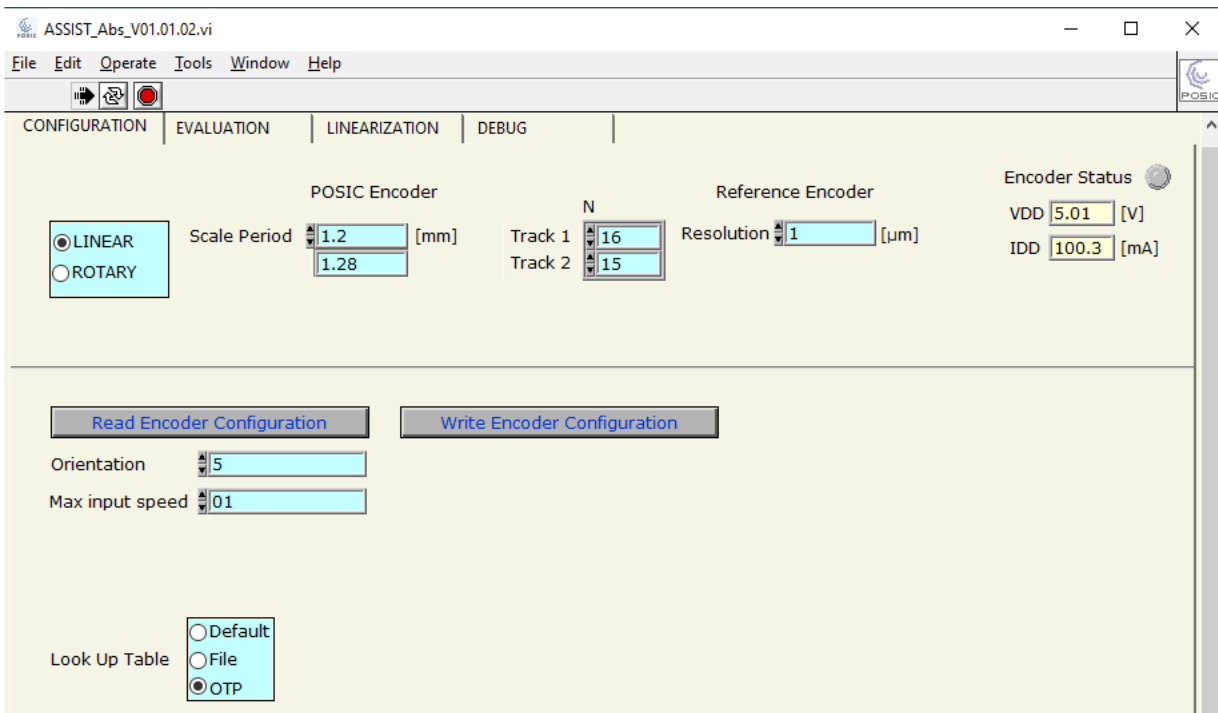
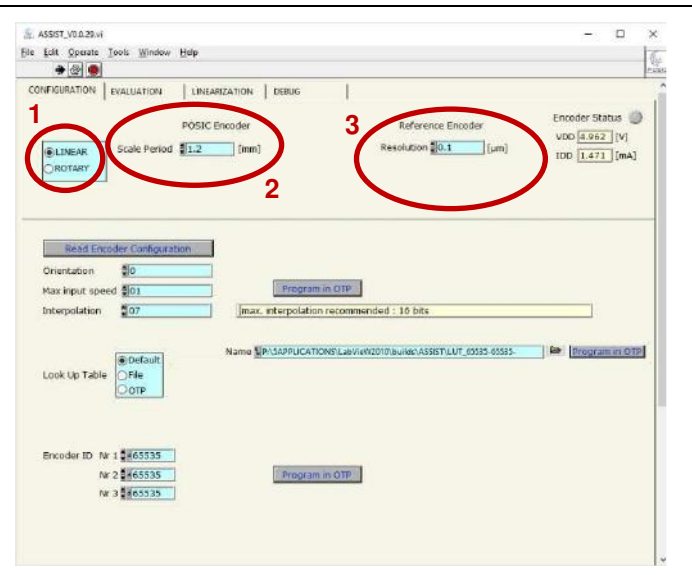


Figure 11 Configuration window for absolute encoders AP9200 and AP9201.

The top-half of the configuration window defines the measurement configuration (Section 6.1.1 and 6.1.2), whereas the lower part defines the POSIC-encoder configuration (Section 6.1.3).

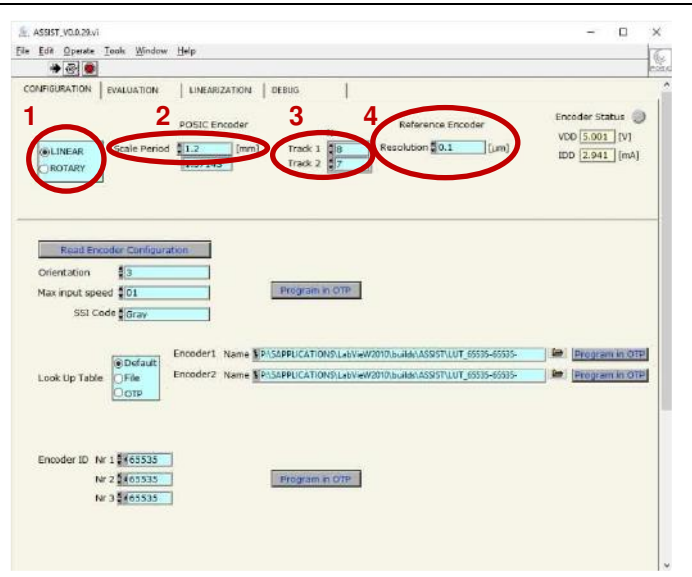
6.1.1 Measurement configuration for incremental encoders

- 1) Select whether the system is linear or rotary.
- 2) Define the target of the POSIC encoder. Linear: scale period length (1.2 or 1.28 mm). Rotary: codewheel number of periods (standard codewheel: 64).
- 3) Define resolution of the Reference encoder. Linear: step size (e.g. 0.1 um). Rotary: increments / revolution (e.g. 16'384 incr/rev if the encoder resolution is 14 bits = 4'096 CPR).




6.1.2 Measurement configuration for absolute encoders

- 1) Select whether the system is linear or rotary.
- 2) Define the scale period-length of Track 1 (1.2 mm for POSIC standard absolute scales)
- 3) Define the number of periods for tracks 1 and 2 (e.g. 8 and 7 for TPLA08, see Figure 13). The period-length of Track 2 is calculated automatically.
- 4) Define the resolution of the Reference encoder. Linear: AB state length (e.g. 0.1 um).



6.1.3 Encoder configuration

When the ASSIST software is started and each time a new encoder is connected, the Read Encoder Configuration button  must be pressed, so that ASSIST reads the encoder configuration stored in the encoder's OTP memory.

The configuration defined in the Configuration window is used when the encoder is operated in the Evaluation window or in the Linearization window. So as long as the encoder is used with the ASSIST software, it is recommended not to program the configuration in the encoder's OTP memory.

The AP9200/9201 encoders have an embedded microcontroller and can be programmed more than once. For these encoders "Write encoder configuration" should be pressed after a specific configuration has been selected.

6.1.3.1 Orientation

The orientation of the encoder with respect to the target can be set according to Table 1 of the datasheet, see Figure 12 or Figure 13.

6.1.3.2 Maximum Speed

The Maximum Speed of the encoder can be set according to Table 2 of the datasheet, see Figure 12 or Figure 13.

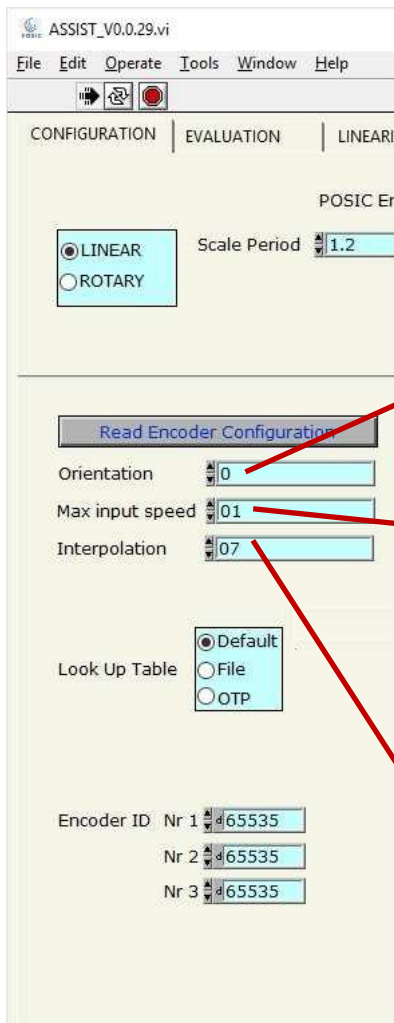
6.1.3.3 Interpolation

For incremental encoders, the Interpolation of the encoder can be set according to Table 3 of the datasheet, see Figure 12.

Please note that the values in Table 3 of the datasheet are rounded values. The exact value is $P/(2^{CC})$ with P = Period-length ($P = 1.2$ mm for TPLS01 and TPLD03, $P = 1.28$ mm for TPLS02)

For absolute encoders, the resolution is fixed:

- 14 bit per scale-period for AP3403 and AP5603
- 16 bit per scale-period for AP9200 and AP9201



Ordering information
 Ordering code: ID4501L-ABBCCD-EEEE-F-GGG-HH
 A Orientation Table 1
 BB Maximum speed Table 2
 CC Resolution Table 3
 D Look-Up Table Table 4
 EEEEE Linear scale Table 5
 F Encoder holder Table 6
 GGG Cable Table 7
 HH Connector Table 8

Table 1: Orientation. Arrows indicate direction of movement of the scale with rising edge A prior to B.

A	Orientation
0	Not progr.
1	0°
4	90°
5	180°
6	270°

Table 2: Maximum speed

BB	Scale period		Max value CC
	1.20	1.28	
00	Not programmed		
01	0.014	0.015	16
02	0.029	0.031	16
03	0.058	0.062	16
04	0.11	0.12	15
05	0.23	0.25	14
06	0.46	0.5	13
07	0.93	1	12
08	1.8	2	11
09	3.7	4	10
21	7.5	8	09
22	15	16	08
23	30	32	07

Table 3: Resolution

CC	CPP	Scale period		Max value BB	Maximum airgap* (mm)
		1.20 um	1.28 um		
00	Not programmed				
03	2	150	160	23	0.6
04	4	75	80	23	0.6
05	8	37.5	40	23	0.6

ID4501L

06	16	18.75	20	23	0.6
07	32	9.38	10	23	0.6
08	64	4.69	5	22	0.5
09	128	2.34	2.5	21	0.5
10	256	1.17	1.25	09	0.4
11	512	0.59	0.63	08	0.4
12	1'024	0.29	0.31	07	0.3
13	2'048	0.15	0.16	06	0.3
14	4'096	0.079	0.078	05	0.2
15	8'192	0.037	0.039	04	0.2
16	16'384	0.018	0.020	03	0.2

* Recommended airgap = 0.2 mm. Sequence of A and B transitions is correct up to Maximum Airgap, but encoding specifications may be out of range.

Table 4: Look-Up Table (LUT)

D	Look-Up Table programmed in OTP
0	Not programmed
1	LUT according to scale, to be specified
8	Custom LUT, to be specified
9	Default LUT (no scale specified)

Table 5: Linear scale (see Fig. 4)

EEEE	Scale	Description
00000	-	No scale
01xxx	TPLS01	Cut to length xxx mm (5 – 205 mm)
02xxx	TPLS02	Cut to length xxx mm (5 – 550 mm)

Table 6: Encoder holder

F	Encoder holder
0	No holder
A	Holder type A (Fig. 7)

Table 7: Cable

GGG	Cable
000	No cable
0xx	Flat ribbon cable, length xx cm

Table 8: Connector

HH	Connector
00	No connector
04	8-pin connector DIN 41651 (Fig. 7)

Figure 12 In the Configuration window, the parameters Orientation, Maximum Speed and Interpolation can be found in the datasheets in tables 1, 2 and 3 respectively.

Ordering information

Ordering code: AP5603L-ABBCCD-EEEE-F-GGG-HH

A Orientation Table 1
 BB Maximum speed Table 2
 CC SSI code Table 3
 D Look-Up Table Table 4
 EEEF Linear scale Table 5
 F Encoder holder Table 6
 GGG Cable Table 7
 HH Connector Table 8

Table 1: Orientation. Arrows indicate direction of movement of the scale with increasing position.

A	Orientation
0	Not programmed (default 0°)
3	0°
5	180°

Table 2: Maximum speed

D	Max speed (m/s)*	Typical delay (ms)
00	Not programmed (default 0.005 m/s)	
01	0.005	30
02	0.010	15
03	0.021	8
04	0.043	4
05	0.086	2
06	0.17	1
07	0.34	0.5
08	0.69	0.25
20	5.5	0 at const. speed
27	11.0	0 at const. speed

*Max speed valid at 25°C, temp. derating in specs, page 2.
 Lower Max speed leads to lower position-noise.

Table 3: SSI Code

CC	SSI Code
00	Not programmed (default Gray)
01	Binary
02	Gray

Table 4: Look-Up Table (LUT)

D	Look-Up Table programmed in OTP
0	Not programmed
1	LUT according to scale, to be specified
8	Custom LUT, to be specified
9	Default LUT, no scale specified

Table 5: Linear scale

EEEE	N1	N2	Max absolute range (mm)	Total scale length (mm)
0000			No scale	
08xxx	8	7	9.6	537.6
16xxx	16	15	19.2	537.6

Track 1 (Fig 4) has period 1.2 mm and is absolute over N1 periods. Track 2 has N2 periods. The scale is made of FR4-material and can be cut to the desired length xxx mm. Complete scale: xxx = 538.

Table 6: Encoder holder

F	Encoder holder
0	No holder
A	Holder A (Fig. 5)

Table 7: Cable

GGG	Cable
000	No cable
0xx	Flat ribbon cable, length xx cm

Max cable length 99 cm

Table 8: Connector

HH	Connector
00	No connector
04	8-pin connector DIN 41651 (Fig. 6)
05	10-pin connector DIN 41651

Figure 13 In the Configuration window, the parameters Orientation, Maximum Speed and SSI Code can be found in the datasheets in tables 1, 2 and 3 respectively.

POSIC Encoder

Scale Period: 1.2 [mm] | 1.28 [mm]

Track 1: 16 | Track 2: 15

Orientation: 3

Max input speed: 01

Look Up Table: Default File OTP

Encoder ID: Nr 1: FFFF | Nr 2: FFFF | Nr 3: FFFF

Ordering information

Ordering code: AP9200L-ABBCCD-EEEE-F-GGG-HH

Table 1: Orientation. Arrows indicate direction of movement of the scale with increasing position.

A	Orientation
3	Not progr. (default 0°)
0	0°
5	180°

Table 2: Maximum speed

BB	Max speed (m/s)*	Typical filter-delay (ms)
00	Not programmed (default 0.014 m/s)	30
01	0.014	30
02	0.029	15
03	0.058	8
04	0.11	4
05	0.23	2
06	0.46	1
07	0.93	0.5
08	1.8	0.25
09	3.7	0.125
21	7.5	0 at const. speed
22	15.0	0 at const. speed

*Max. speed valid at 25°C, temp. derating in specs, page 2. Lower Max speed leads to lower position-noise.

Table 3: Interface

CC	Interface
00	Not programmed (default SSI Binary)
01	SSI, Binary

Table 4: Look-Up Table (LUT)

D	Look-Up Table programmed in OTP
0	Not programmed
1	LUT according to scale specified in Table 5
8	Custom LUT, to be specified

Table 5: Linear scale

EEEE	N1	N2	Max absolute range (mm)	Total scale length (mm)
00000			No scale	
0807	0	7	9.6	18
16027	16	15	19.2	27

The scale is made of FR4-material and can be cut to the desired length.

Table 6: Spacers (distance rings)

F	Spacers
0	No spacers
1	Including 4 spacers

Table 7: Cable

GGG	Flat twisted pair cable
000	No cable
050	Length 50
100	Length 100 cm

Cable temperature range: -20 to 80°C.

Table 8: Connector

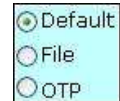
HH	Connector
00	No connector
04	8-pin connector DIN 41651 (Fig. 6)

Figure 14 In the Configuration window, the parameters Orientation and Maximum Speed can be found in the datasheets in tables 1 and 2 respectively. Press “Write Encoder Configuration” in order to activate this configuration.

6.1.3.4 LookUp Table

The encoder contains a LookUp Table (LUT) that can be used to correct the encoder’s non-linearity. One of three options can be selected:

- Default: Default LUT-file stored in the ASSIST software. This LUT is a general-purpose LUT and does not compensate the non-linearity of a specific target.
- File: file selected using a browser. This could e.g. be a “typical LUT” for a specific target or the LUT previously generated in the Linearization window
- OTP: the LUT stored in the encoder’s OTP memory will be used.



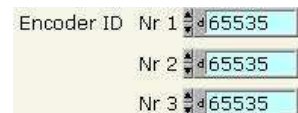
The AP92 encoders are delivered with the standard LUTs for the scale TPLA08. If you use another scale:

- Set N1 and N2 for scale tracks 1 and 2 respectively
- Under LookUp Table select “Default”
- Press “Write Encoder Configuration”

Now the standard LUTs for the selected scale is loaded into the encoder.


6.1.3.5 Encoder ID

The Encoder Identification number consists of three 16-bit numbers. Each number can be programmed to a value between 0 and 65535. The encoder ID has no influence on the encoder operation.

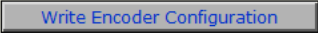


6.1.3.6 RAM and OTP memories for ID, IT and AP3403/5603 encoders

The configuration data (orientation, max speed and interpolation) and LUT defined in the Configuration window will be loaded in the encoder's RAM memory when the encoder is started in the Evaluation or in the Linearization window.

The configuration data (orientation, max speed and interpolation) and LUT defined in the Configuration window can be programmed in the encoder's OTP memory by pressing . The OTP memory is non-volatile: any data programmed into the encoder's OTP memory is permanently stored and cannot be re-programmed or erased. Therefore it is recommended during evaluation and prototyping not to program the OTP memory, but rather to operate the encoder with its configuration and LUT in RAM.

6.1.3.7 Memories for AP9200 and AP9201 encoders

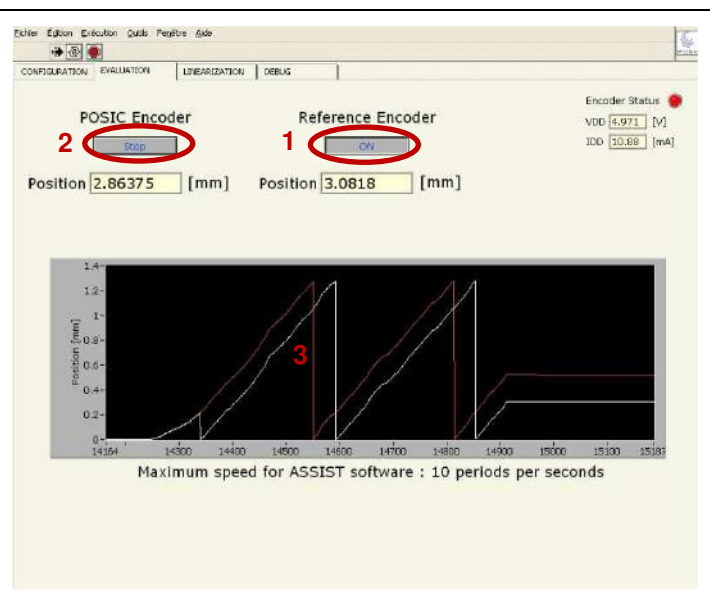
In the encoders AP9200 and AP9201, the configuration is not stored in the OTP (One Time Programmable) memory of the encoder-chip, but rather in the non-volatile memory of the microcontroller that is located on the backside of the encoder module. As the microcontroller's non-volatile memory can be programmed repeatedly, the configuration and LUT are always directly written into the non-volatile memory when  is pressed or when the encoder is activated in the Evaluation window or in the Linearization window.

6.2 Evaluation of incremental encoders

The evaluation window allows you to:

- check whether the POSIC- and Reference-encoder are working correctly
- operate the POSIC- (and Reference-) encoder in a closed-loop control system by using POSIC encoder signals available on the Interface Board.

- 1) The reference encoder (if available) can be activated by pressing the ON/OFF button prior to starting the POSIC encoder.
- 2) The POSIC encoder can be started and stopped by pressing the Start/Stop button.
- 3) The graph displays the POSIC encoder position (white) and the Reference encoder position (red) as a function of time.



The vertical scale in the Evaluation window is automatically adjusted to one period-length. In the example above, a codewheel with 64 periods is used, each period corresponds to $360^\circ/64 = 5.625^\circ$.

The maximum speed in the evaluation window is 10 periods per second. This limitation depends on your PC's performance and other software running in parallel to ASSIST. Above 10 periods per second, the measured position may be wrong.

6.3 Multiple Index

POSIC's ID-encoders (ID1102, ID4501) have a "multiple index". This means that the index pulse is repeated one or more times per target-period. How often the Index pulse is repeated depends on the interpolation factor and is explained in the table below and in Figure 15.

Table 3 Distance between Index pulses as a function of the Interpolation factor.

Interpolation	Distance between Index-pulses	Linear scale, period 1.28 mm	Codewheel, 64 periods
3	1 period	1.28 mm	5.625°
4	1 period	1.28 mm	5.625°
5	1 period	1.28 mm	5.625°
6	1 period	1.28 mm	5.625°
7	1 period	1.28 mm	5.625°
8	1 period	1.28 mm	5.625°
9	1 period	1.28 mm	5.625°
10	1 period	1.28 mm	5.625°
11	1/2 period	0.64 mm	2.813°
12	1/4 period	0.32 mm	1.406°
13	1/8 period	0.16 mm	0.703°
14	1/16 period	0.08 mm	0.352°
15	1/32 period	0.04 mm	0.176°
16	1/64 period	0.02 mm	0.088°

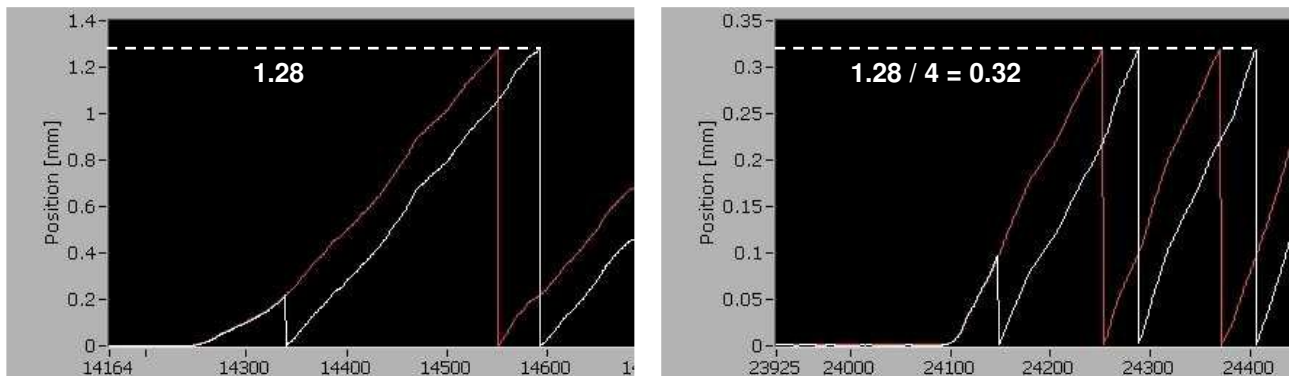


Figure 15 Graph in Evaluation window with a linear scale with period 1.28 mm with interpolation 10 bit (left) and 12 bit (right).

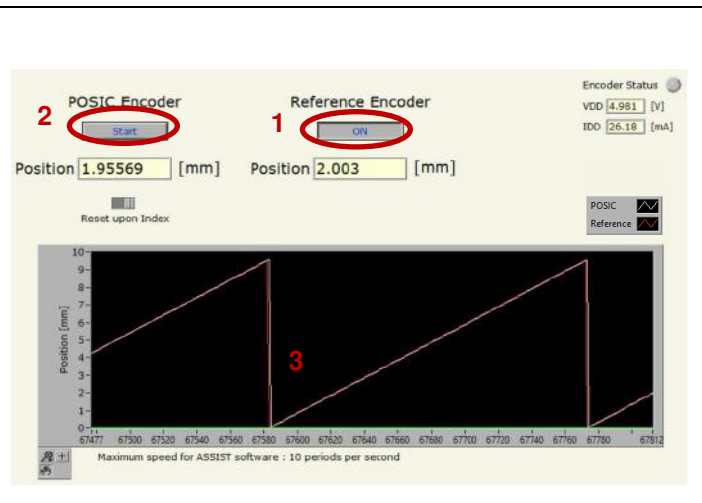
6.4 Evaluation of absolute encoders

The evaluation window allows you to:

- check whether the POSIC- and Reference-encoder are working correctly
- Check the position of the two tracks and the calculated absolute position
- operate the POSIC- (and Reference-) encoder in a closed-loop control system by using POSIC encoder signals available on the Interface Board.

6.4.1 Absolute signal only

- 1) The reference encoder (if available) can be activated by pressing the ON/OFF button prior to starting the POSIC encoder.
- 2) The POSIC encoder can be started and stopped by pressing the Start/Stop button.
- 3) The graph displays the POSIC encoder position (white) and the Reference encoder position (red) as a function of time.



6.4.2 Absolute and two incremental signals

- 1) Scroll down the Evaluation window
- 2) The POSIC encoder can be started and stopped by pressing the ADC Read Start/Stop button.
- 3) Set Z = 0 (Z = zero-compensation, can be modified while measuring)
- 4) APZ = zero-position (can be modified while measuring)
- 5) The measured positions of Encoders 1 and 2 are displayed.
- 6) The absolute position, calculated from Encoders 1 and 2, is shown.
- 7) The graph displays the measured position of encoder 1 (white, ip1), encoder 2 (red) and the calculated absolute position (green).



Measurement with TPLA08: N1 = 8 and N2 = 7

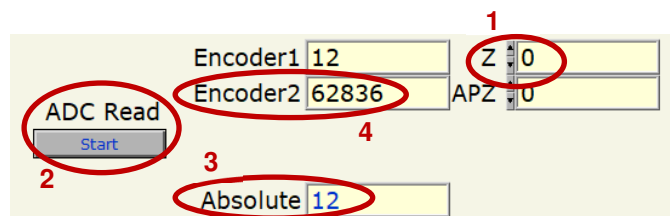
6.4.3 Adjustment of Z for AP3403L and AP5603L encoders

Prior to adjustment of Z, the encoder should be linearized (Annex 3).

For stable measurement values, set Max speed to 01 in the Configuration window.

- 1) Set Z = 0
- 2) Press Start ADC Read
- 3) Move the encoder/scale to position approximately 0 mm and stop the movement
- 4) Read the value of Encoder 2. This is a 16-bit value between 0 and 65'536
- 5) Set Z = 65'536 – measured value of Encoder 2

Example: Encoder 1 = 12 (close to zero). If Encoder 2 = 62'836, then $Z = 65'536 - 62'836 = 2'700$



Measurement with TPLA08: N1 = 8 and N2 = 7

The vertical scale with “ADC Read” counts from 0 to 65'536 per period:

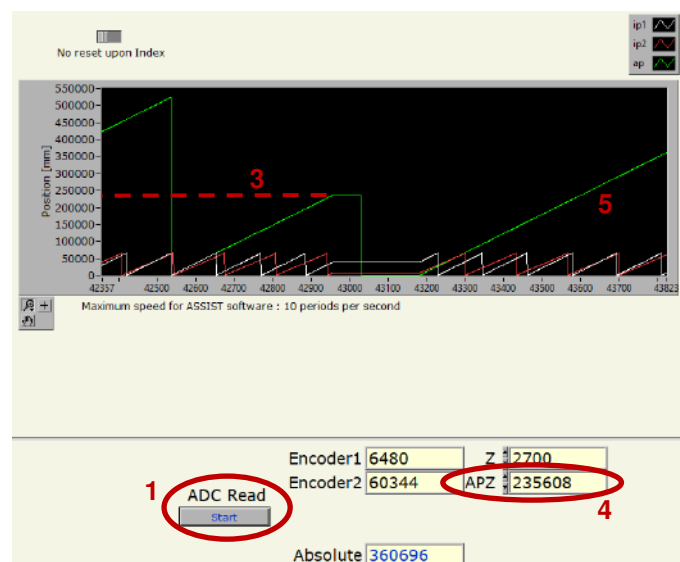
- With scale TPLA08 (stroke of 8 periods): $8 \times 65'536 = 524'288$
- With scale TPLA16 (stroke of 16 periods): $16 \times 65'536 = 1'048'576$
- With scale TPLA32 (stroke of 32 periods): $32 \times 65'536 = 2'097'152$

If it is difficult or impossible to calculate Z in your setup, you can apply the following rule: if jumps occur, add or subtract the value 2800 to Z for TPLA08, add or subtract 1400 for TPLA16, add or subtract 700 for TPLA32.

6.4.4 Adjustment of APZ for AP3403L and AP5603L encoders

Prior to adjustment of APZ, the encoder should be linearized (Annex 3) and the value of Z must be adjusted (Section 6.4.3).

- 1) Press ADC Read
- 2) Move the encoder/scale to where you want to have the zero-position
- 3) Read the absolute value
- 4) Set APZ = absolute value (in this case 235'608)
- 5) Continue measurement with new zero-position



Measurement with TPLA08: N1 = 8 and N2 = 7

6.4.5 Adjustment of Z for AP9200 and AP9201 encoders

Prior to adjustment of Z, the encoder should be linearized (Annex 3) or a standard LUT should be activated (Section 6.1.3.4).

<ol style="list-style-type: none"> 1) Press Reset 2) Press Start POSIC Encoder 3) Move the encoder/scale to position approx. 0 mm (in this case 0.0116 mm) and stop the movement 4) Press Set Z while keeping the scale/encoder at the same position until the measurement (several seconds) has been completed. 	<p>Measurement with TPLA16: N1 = 16, N2 = 15</p>
--	--

6.4.6 Adjustment of Zero-Position for AP9200 and AP9201 encoders

Prior to adjustment of the zero-position, Z must be set (Section 6.4.5) and the encoder should be linearized (Annex 3) or a standard LUT should be activated (Section 6.1.3.4).

<ol style="list-style-type: none"> 1) Press Start POSIC Encoder 2) Move the encoder/scale to where you want to have the zero-position 3) Press Set zero pos. 4) Continue measurement with new zero-position 	<p>Measurement with TPLA08: N1 = 8, N2 = 7</p>
---	--

6.4.7 Jump in absolute position signal

The calculated absolute value may show jumps as shown in Figure 16. There may be one or more root causes for these jumps:

- Incorrect value of Z: adjust Z according to Section 6.4.3 or 6.4.5
- Too high Non-linearity:
 - o Reduce the airgap (smaller airgap leads to lower non-linearity, best results at airgap approx. 0.2 mm)
 - o linearize the encoder (Annex 3) or activate a standard LUT (only for AP92 encoders, Section 6.1.3.4)

- Too high noise:
 - o reduce the airgap (smaller airgap leads to lower noise, best results at airgap approx. 0.2 mm)
 - o Set Max speed BB to a lower value (Section 6.1.3.2)

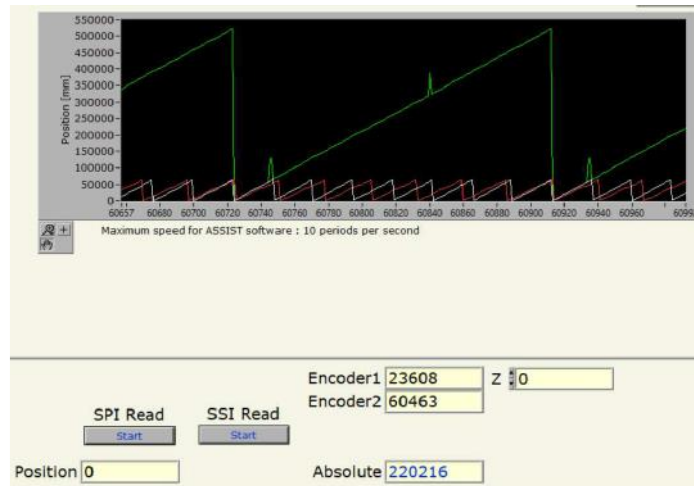


Figure 16 Jumps in the calculated absolute position may originate from a non-optimal LUT or from a wrong value of Z.

6.5 Linearization

As stated in Chapter 1, it is not necessary to linearize the encoder, this depends on the linearity requirement of your application. You can use POSIC encoders with very different types of targets: linear scales, codewheels and ferromagnetic gears. Each target has its own material and shape and therefore has a different characteristic non-linearity. The linearization procedure allows to compensate the characteristic non-linearity. The table below provides some typical values for non-linearity with and without linearization.

Table 4 Typical non-linearity (NL) of POSIC encoders with and without linearization.

Target	NL without linearization	NL with linearization
Any linear scale	40 um	10 um
Codewheel TPCD07-128 outer diameter 53 mm	0.12°	0.03°
Gear module 0.5, 100 teeth	0.3°	0.07°

Table 5 and Figure 17 until Figure 19 provide an overview of the three linearization-methods, which are explained in detail in Annex 1 until Annex 3. The Automatic linearization method is the most efficient one, because it does not require manual adjustment (method Manual) and does not require the preparation and transfer of a measurement file (method File).

Table 5 Linearization methods.

Linearization method	Measurement reference	Scale movement	Data Acquisition system	Information
Manual	Microscrew or caliper	Manual with fixed precise steps	ASSIST Interface Board	Figure 17 Annex 1
File	Reference encoder	Motorized or manual	External DAQ system with two A quad B + Index interfaces	Figure 18 Annex 2
Automatic	Reference encoder	Motorized or manual	ASSIST Interface Board	Figure 19 Annex 3

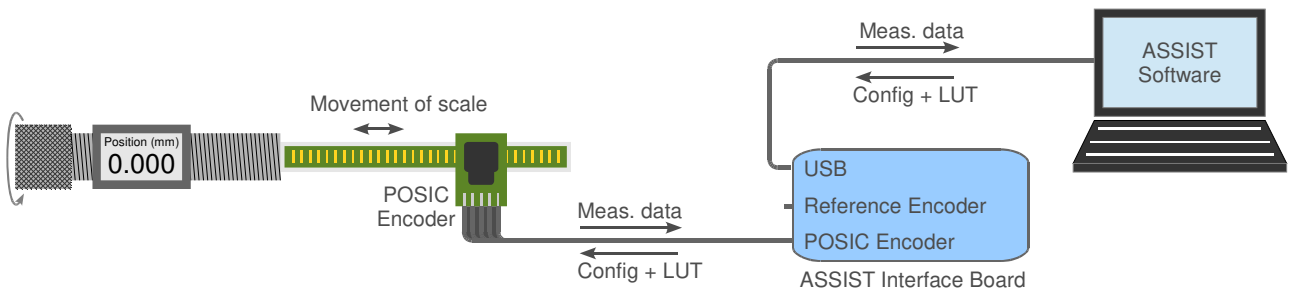


Figure 17 Linearization method “Manual”. The scale is manually adjusted to different positions (e.g. with a microscrew or a stepper-motor with fixed steps). Measurement and configuration take place via the ASSIST Interface Board. Detailed explanation in Annex 1.

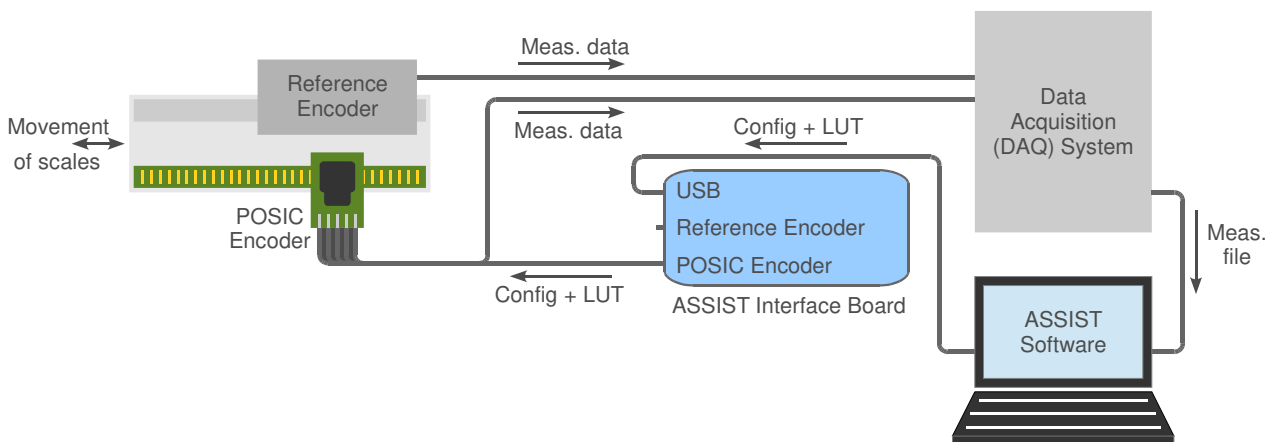


Figure 18 Linearization method “File”. Configuration of the POSIC encoder takes place via the ASSIST Interface Board. POSIC- and Reference encoders are measured

by the customer's DAQ system. Measurement data are transferred to ASSIST by means of a measurement file. Detailed explanation in Annex 2.

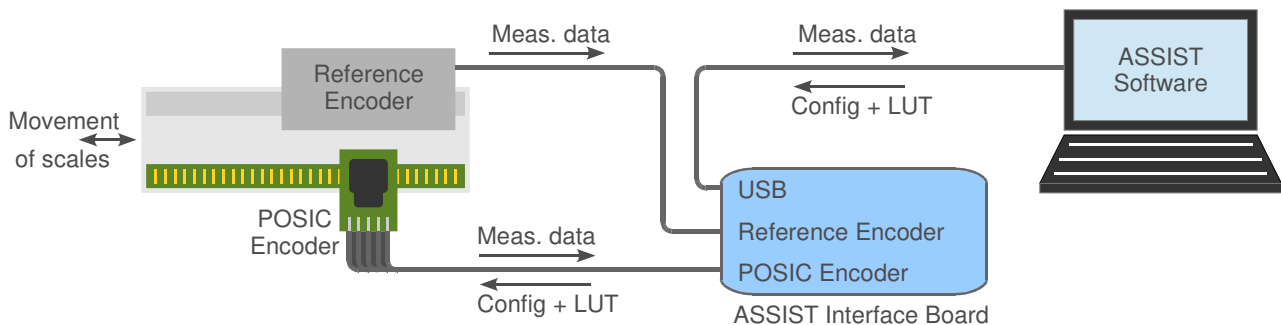


Figure 19 Linearization method “Automatic”. The scales of the POSIC- and the reference-encoders are moved by means of a drive system. Measurement and configuration take place via the ASSIST Interface Board. Detailed explanation in Annex 3.

Recommendations for linearization

- Minimum range The absolute minimum range is one period: one copper-strip of a scale or codewheel or one tooth of a gear. It is recommended to linearize over multiple periods, the LUT will be calculated using the average values, thus reducing the influence of noise or target errors. For a linear application it is recommended to linearize over the complete range or at least over the range where the highest linearity is required. For a rotary application it is recommended to linearize over one full rotation (in order to take into account a potential runout)
- Maximum range For a linear application: length of scale with a margin of 2 complete scale-periods at each end of the scale. For a rotary application: one complete rotation of the codewheel or gear
- Direction of movement During the linearization, the target must move in only one direction with respect to the encoder. This is a precaution to avoid potential problems with the hysteresis of the reference encoder. Changes in direction during the linearization are not allowed
- Maximum speed It is recommended to stay at least a factor 10 below the maximum speed (lowest of the reference- and POSIC-encoder) in order to avoid effects due to bandwidth limitations. For the method “automatic”, the maximum speed is given in Annex 3.
- Linearity of reference encoder The result of the linearization will by definition not be better than the linearity of the reference encoder. It is recommended to use a reference encoder with a linearity that is at least 10 times higher than the desired linearity of the POSIC encoder after linearization.

6.6 Debug

The Debug window is shown in Figure 20 and allows you to check whether the Interface Board and the encoder are working correctly.

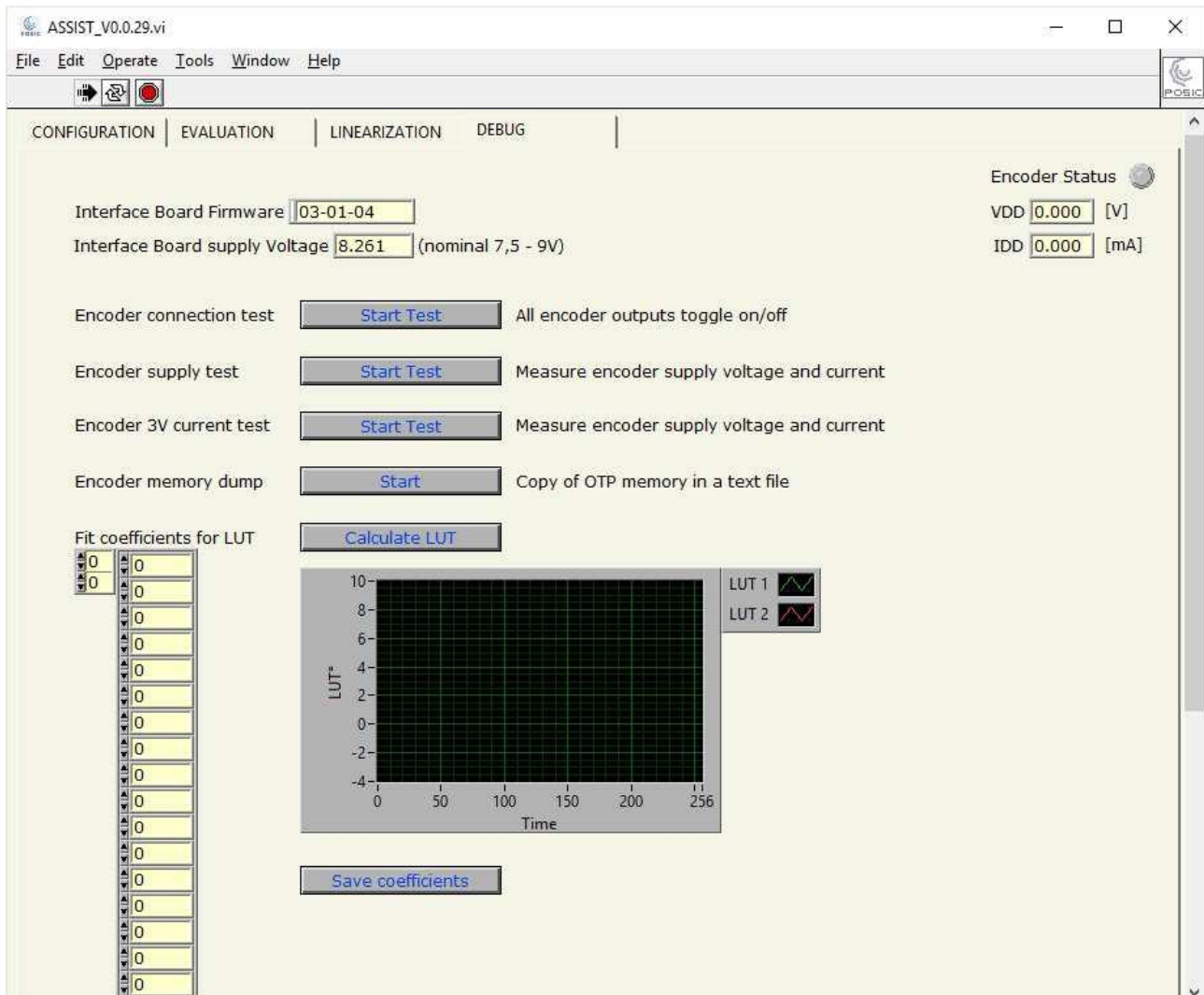


Figure 20 The Debug window.

6.6.1 Interface Board Firmware

The Interface Board Firmware is the firmware in the dsPIC microcontroller (see Figure 3).

6.6.2 Interface Board Supply Voltage

The Interface Board receives a 5V USB supply voltage. The USB supply voltage is boosted to the Interface Board Supply Voltage with a level between 7.5 and 9 V (Annex 4). The Interface Board Supply Voltage is measured when the board is powered-up (it is not continuously measured) and displayed in the Debug window.

6.6.3 Encoder connection test

The encoder connection test allows you to check whether all electrical connections (supply and outputs) are correct. The test is activated by pressing the “Start Test” button and stopped by pressing the “Stop Test” button.

When the connection test is active, the outputs toggle on and off with a frequency between 50 and 100 kHz. This means that all connected signal LEDs on the interface Board are on (Figure 3 in Section 2.2) and that a 50 – 100 kHz frequency can be observed on an oscilloscope connected to the Signal Test Pins (TP), see Figure 3. If the LEDs are not toggling correctly, see Annex 8 on Connection to SSI controller.

LEDs that are not connected to the encoder’s outputs are continuously on (emitting light) during this test.

6.6.4 Encoder supply test

The encoder supply test allows you to check whether the encoder supply voltage and current are correct. The test is activated by pressing the “Start Test” and stopped by pressing the “Stop Test” button.

During this test, the encoder is activated, its output signals can be observed/measured on the Interface Board and the supply voltage and current are measured continuously and displayed at the top right side of the window.

6.6.5 Encoder 3V current test

The encoder 3V current test measures the encoder supply current while applying a 3V supply voltage. At a supply voltage of 3V, the encoder is not working and therefore the current should be below 0.3 mA for ID encoders and below 0.5 mA for IT and AP encoders. If the current is above these values, the encoder is damaged and will probably not function correctly.

6.6.6 Encoder memory dump

The encoder memory dump writes the contents of the encoder’s OTP memory in a text file, the name of which has to be specified in a dialog-box that pops up after Encoder memory dump has been activated. This function might be required for technical support by a POSIC-specialist.

6.6.7 Fit coefficients for LUT

The LUT is calculated from the data measured in the Linearization window by means of an 8th order sine-fit. The coefficients of this sine-fit are displayed in the list. The sequence from top to bottom is: offset, 1st order amplitude, 1st order phase, 2nd order amplitude, 2nd order phase 8th order amplitude, 8th order phase.

After the linearization measurement in the linearization window, the fit coefficients are calculated and listed in the Debug window and the LUT is displayed in the graph, see Figure 21, right graph.

If fit coefficients are filled out or modified and subsequently “Calculate LUT” is pressed, the new LUT is displayed in the graph and a dialog box appears that allows you to store the

calculated LUT in a text file. The newly calculated LUT will subsequently be used in the Linearization window when “Measure RAM LUT” is used.

By pressing “Save coefficients”, the coefficients listed in the table are stored in a text-file.

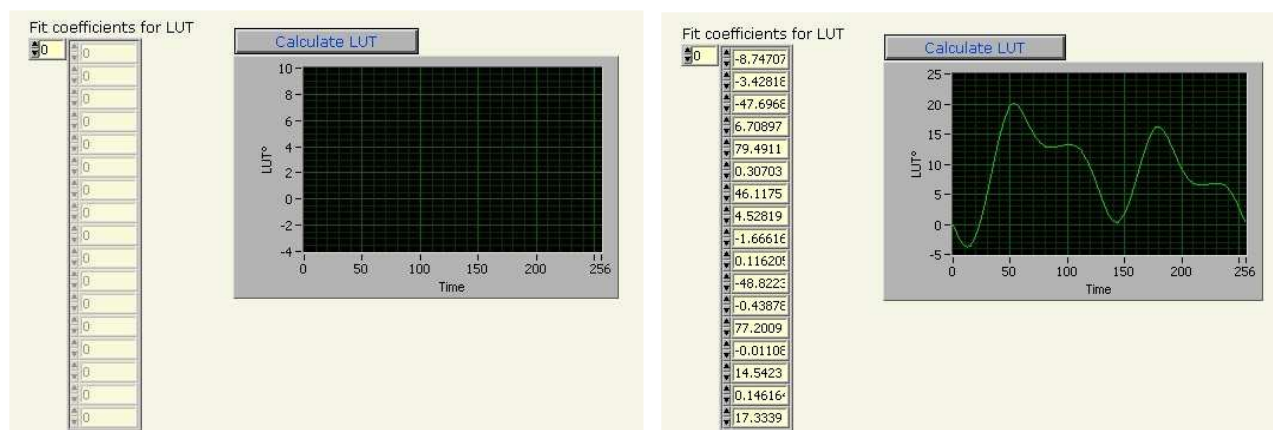


Figure 21 Fit coefficients for LUT prior to linearization (left) and after “Measure Default LUT” (right).

6.7 Encoder operating modes

The 4 modes in which the encoder can be operated using ASSIST are listed in Table 6.

Table 6 Operating modes of the encoder.

Mode	Description	In/outputs
Communication mode	2-wire serial communication to read data from the encoder and to store configuration data and LUT in the encoder’s RAM (volatile memory)	A = clock (input) B = data (bidirectional)
Measurement mode	Encoder measures incremental position and outputs via ABI interface	A, B, I incremental encoder output signals
Programming mode	2-wire serial communication to program configuration data and LUT in OTP (One Time Programmable non-volatile memory)	A = clock (input) B = data (bidirectional)
Connection test mode	All outputs toggle on/off	A, B, I toggle on/off (all outputs)

The Communication mode is employed in the following cases:

- Configuration Window, Read Encoder Configuration (read data from encoder)
- Evaluation Window, Start (send configuration data and LUT to encoder prior to entering into the Measurement mode)
- Linearization Window, Measure Default LUT and Measure RAM LUT (send configuration data and LUT to encoder prior to entering into the Measurement mode)

The Measurement mode is employed in the following cases:

- Evaluation Window, Start (after encoder has been configured)

- Linearization Window, Measure Default LUT and Measure RAM LUT (after encoder has been configured)
- Debug window, Encoder supply test

The Programming mode is employed in the following cases:

- Configuration window, “Program in OTP” of the encoder configuration, the LUT or the EncoderID
- Linearization window, “Program LUT in OTP”

The Connection test mode is employed in the following cases:

- Debug window, encoder connection test

6.8 Encoder RAM and OTP memories

This section applies to all POSIC encoders, except for the encoder AP9200 and AP9201.

The encoder’s configuration data and LUT can be stored in RAM (Random Access Memory). The RAM is volatile: any data written into the encoder’s RAM will be lost when the encoder-power is turned off.

The encoder’s configuration data and LUT can be stored in OTP memory (One Time Programmable). The OTP memory is non-volatile: any data programmed into the encoder’s OTP memory is permanently stored and cannot be re-programmed or erased. Therefore each OTP programming sequence is preceded by a dialog-box with a warning that OTP programming is irreversible and asking a confirmation to continue.

When the encoder is operated using ASSIST, it is typically operated using RAM data (the contents of OTP memory, whether programmed or not, is ignored).

When the encoder is operated without ASSIST, it is always operated using OTP data.

Non-programmed OTP memory contains all ones. A non-programmed 16-bit number has therefore the hexadecimal value FFFF = decimal value $2^{16} - 1 = 65'535$ (see Encoder ID, Figure 9).

6.9 Encoder status

At the top right side of each window, the encoder status is displayed (see Figure 22):

- Indicator showing whether the encoder is on or off.
- Encoder supply voltage (VDD)
- Encoder supply current (IDD)

The supply voltage and current are measured when the encoder is started up and when it goes from one operating mode to another (e.g. from communication mode to measurement mode).

When the encoder indicator is off, the encoder can be disconnected (replaced by another encoder). While the indicator is on, the encoder should not be disconnected.

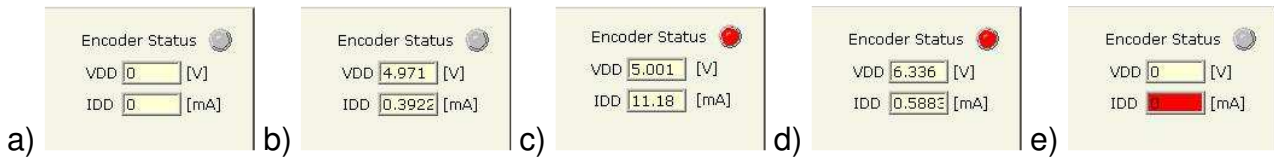


Figure 22 Zoom-in of the top right side of all ASSIST windows showing the supply status of the encoder. a) Encoder has not been activated yet. b) Encoder has been activated, but is not powered at this moment. c) Encoder is working. d) OTP Programming ongoing. e) Short-circuit detected, encoder has been turned off.

The typical supply voltage and current levels are listed in Table 7.

Table 7 Encoder supply voltage and current levels in different operation modes. Current IDD is measured with no load on the encoder outputs.

Mode	VDD	IDD	Comment
Communication	5 V	< 8 mA	
Measurement	5 V	8 – 15 mA	ID encoders
		20 – 40 mA	IT and AP encoders
OTP Programming	6 - 6.5 V	< 10 mA	
Short circuit*	< 5 V	> 50 mA	Encoder automatically turned off**

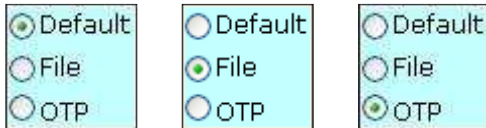
* When the current measured during startup of the encoder is well above the typical level, it is assumed that a short-circuit has occurred between supply and ground or between an output and ground. In this case, the supply to the encoder is cut off and the IDD indicator turns red. The short-circuit should be eliminated before turning the encoder on again.

**When the Interface Board is connected to a low-power USB connection (typically on a USB-hub or at the side of a PC-screen with current limited to 100 mA), the current drawn during the short-circuit may exceed the maximum current of the USB-connection and supply to the Interface Board may be cut off. In that case, the ASSIST software may be halted before it has detected the short-circuit. If this happens, disconnect the Interface Board from the PC and close the ASSIST software. Eliminate the short-circuit, re-connect the Interface Board and re-start the ASSIST software.

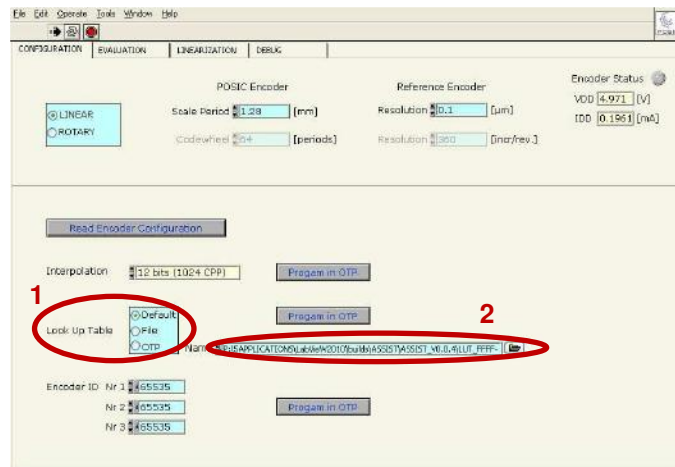
6.10 Operate encoder with Default LUT or LUT from file or OTP

This mode of operation is useful if the encoder has already been linearized and has to be operated e.g. in a closed-loop system with a controller. Please make sure that the POSIC and the Reference-encoder have been correctly configured prior to launching the procedure explained below.

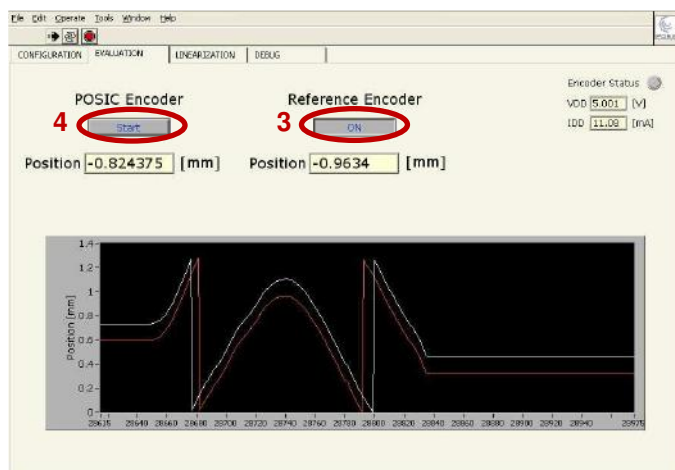
- 1) Select the appropriate LookUp Table: Default, File or OTP.



- 2) If "File" is selected, use the browser to select the LUT file.
The selected LUT will be uploaded in the RAM LUT.



- 3) If desired, turn on the reference encoder.
- 4) Start the POSIC encoder.
The POSIC and reference encoder remain working until the POSIC encoder is stopped. During operation, the results are continuously displayed in the graph and the encoder output signals can be measured on the Interface Board.

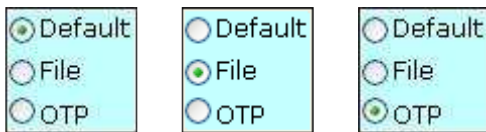


After step 4, you can connect the A, B and I outputs of the encoder to another system (a counter, a controller or other equipment) using the Signal Test Pins or the Terminal Block, see Figure 3 in Section 2.2.

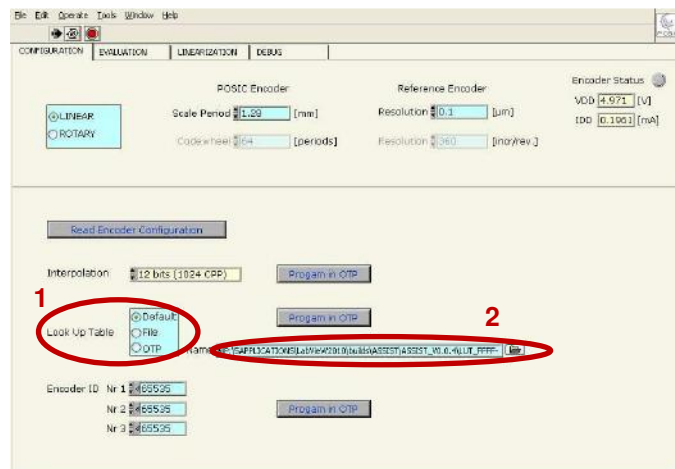
6.11 Measure linearity with Default LUT or LUT from file or OTP

This mode of operation is useful if the linearity of the encoder has to be measured repeatedly or if a "general purpose" LUT has to be tested with several encoders. Prior to executing the steps in the table below, please make sure that the POSIC encoder (and the reference encoder if applicable) has been configured correctly in the configuration window (Section 6.1).

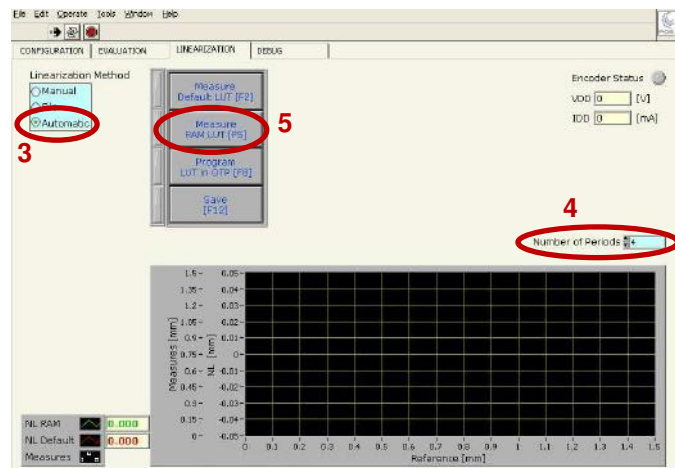
- 1) Select the appropriate LookUp Table: Default, File or OTP.



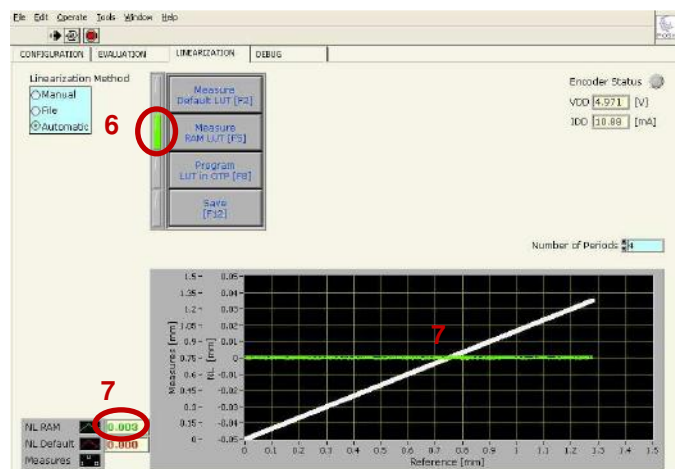
- 2) If "File" is selected, use the browser to select the LUT file.
The selected LUT will be uploaded in the RAM LUT.



- 3) Select Linearization Method Automatic.
- 4) Define number of periods (copper strips on the target) over which the linearity measurement has to be carried out.
- 5) Start the measurement with RAM LUT (do not activate "Measure Default LUT"); it takes a few seconds to upload the encoder configuration and the RAM LUT. Make sure the scale/codewheel does not change direction during the measurement.



- 6) The green sign indicates that the measurement with RAM LUT has been completed.
- 7) The measured position (white) and non-linearity (green) are displayed.



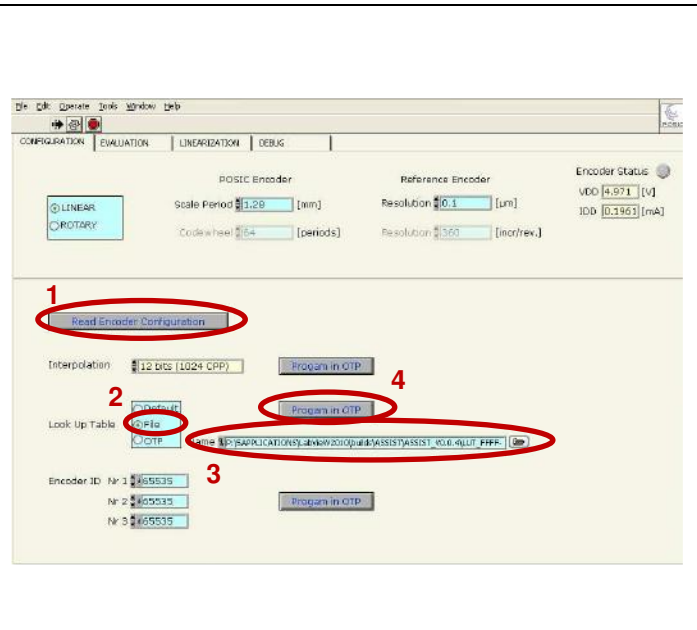
6.12 Program a LUT directly into OTP

This method can be used if a LUT stored in a file has to be programmed into the OTP memory of one or more encoders without any linearity measurement.

- 1) Read Encoder Configuration.
- 2) Select the LookUp Table: File.
- 3) Use browser to specify the filename.
- 4) Program in OTP.

The programming of OTP memory is irreversible, therefore a dialog box will appear to confirm the command.

After completion of the OTP programming, the encoder can be disconnected and another encoder can be connected for programming.



6.13 Export measurement data to spreadsheet

- 1) Right-click in the graph with the measurement that you want to export, see Figure 23
- 2) Select Export
- 3) Select whether you want to export the data to the clipboard (so you can paste it in any application) or to Excel (Excel will be opened with the measurement data in the first worksheet)

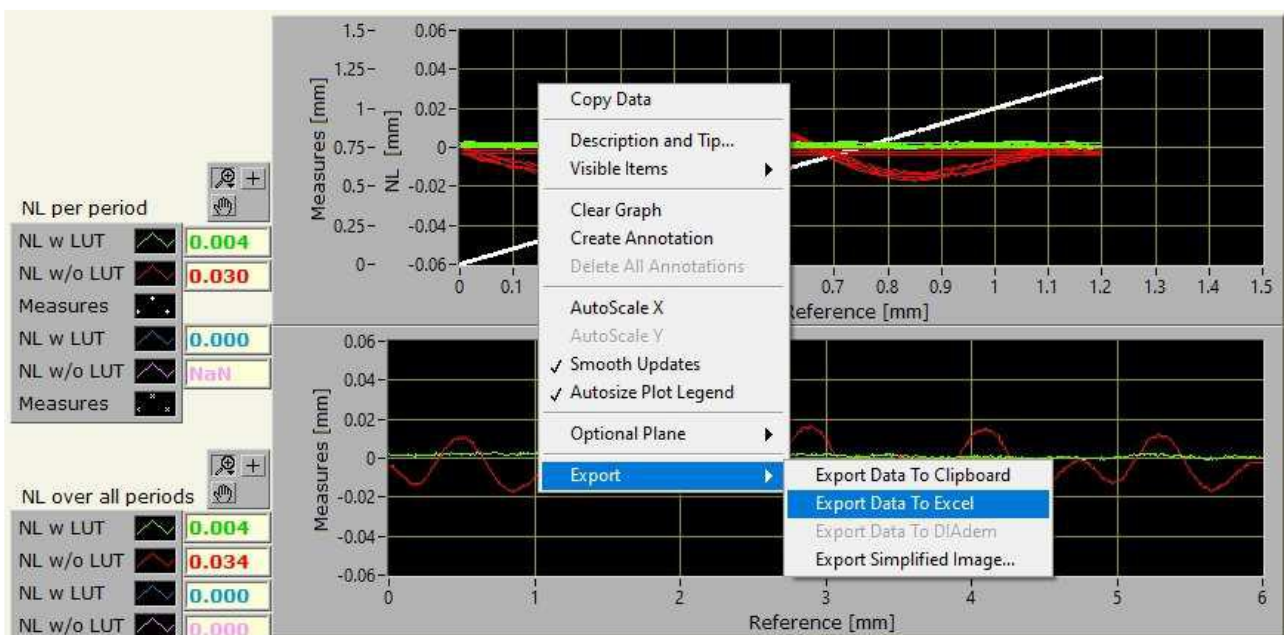


Figure 23 Export measurement data by right-clicking in the graph, selecting Export and then selecting your preferred export destination.

6.14 Zoom in/out

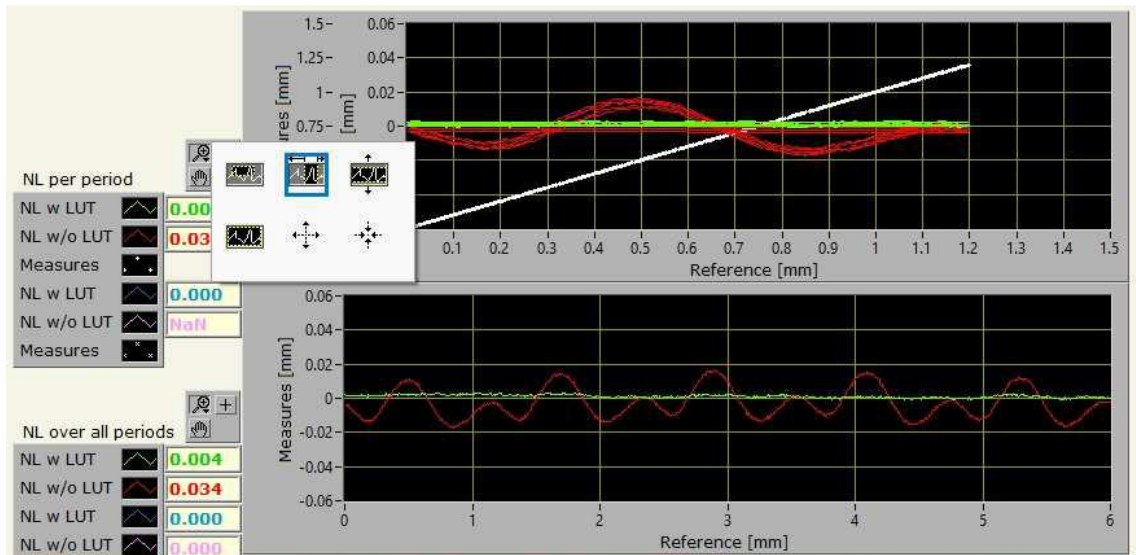


Figure 24 Use the display-tool to the left of each graph to zoom in in/out.

6.15 LUT file format

During the linearization procedure (Annex 1 - Annex 3), the filename proposed for the LUT-file contains the encoder-ID (Section 6.1.3.5 and Figure 9): 65536_65536_65536_ENC1.txt for an encoder in which the Encoder-ID has not been programmed. This is only a recommendation, any other filename may be used. For an AP-encoder, 2 LUT-files are stored with the suggested names ending with _ENC1.txt and _ENC2.txt

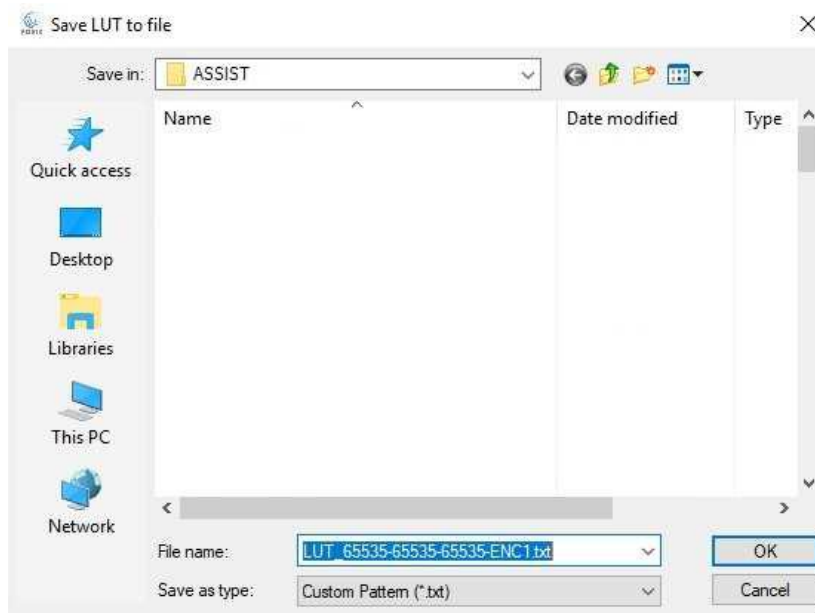


Figure 25 Pop-up window at the end of the linearization procedure asking for the LUT filename.

A LUT file contains the LUT of one encoder and consists of 258 lines: 2 header-lines followed by 256 LUT-values. The LUT-values are expressed in electrical degrees; 360 electrical degrees correspond to one period of a target. An example is shown in Figure 26.

During a Save-operation in the Linearization-window: if an existing filename is used, the values will be overwritten.

```
LUT_65536-65536-65536_ENC1.txt
LUT [deg]
0.57128906250
0.08789062500
-0.39550781250
-0.83496093750
-1.25244140625
-1.64794921875
-2.02148437500
-2.37304687500
-2.70263671875
-3.03222656250
-3.31787109375
-3.58154296875
-3.82324218750
-4.02099609375
-4.21875000000
-4.37255859375
-4.50439453125
...
```

Figure 26 Example of a LUT-file with filename LUT_65536_65536_65536_ENC1.txt. Only the initial 20 values are shown (a complete LUT contains 256 values).

6.16 Result file format

During the linearization procedure (Annex 1 - Annex 3), the filename proposed for the Result-file is Result.dat. This is only a recommendation, any other filename may be used.

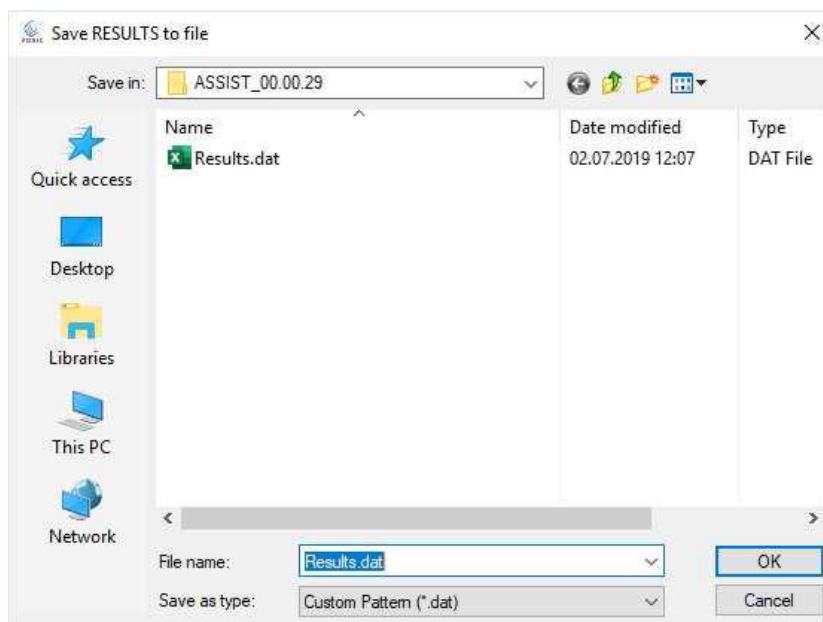


Figure 27 Pop-up window at the end of the linearization procedure asking for the filename for the measurement results.

The Result file contains the identification information and the measurement results of one or more encoders. Each row corresponds to one encoder. The data are stored as text and can easily be imported into a spreadsheet program. An example of a result file is shown in Figure 28.

During a Save-operation in the Linearization-window: if an existing filename is used, the values will be added to the file as the last line (existing data will not be overwritten).

It is recommended to use one result-file per production batch up to several thousand encoders, so that measurement results can easily be analysed using a spreadsheet program.

Encoder ID1	Encoder ID2	Encoder ID3	NL Calibration	NL Control	NL Final	File name	Date	Time	Commentary
			[mm]	[mm]	[mm]		jj.mm.aa	hh.mm.ss	
0	0	0	3.28E-02	7.85E-03	7.86E-03	result.dat	12.12.2013	12:00:08	
0	0	1	4.64E-02	6.30E-03	6.30E-03	result.dat	12.12.2013	17:40:06	
0	0	2	4.92E-02	4.90E-03	4.86E-03	result.dat	13.12.2013	15:50:04	

Figure 28 Example of a Result-file (result.dat) imported into a spreadsheet program.

6.17 Memory Dump file format

In the Debug window, the filename proposed for the Memory Dump contains the encoder-ID (Section 6.1.3.5 and Figure 9): DUMP_65536_65536_65536_ENC1.txt if the encoder-ID has not been programmed. This is only a recommendation, any other filename may be used.

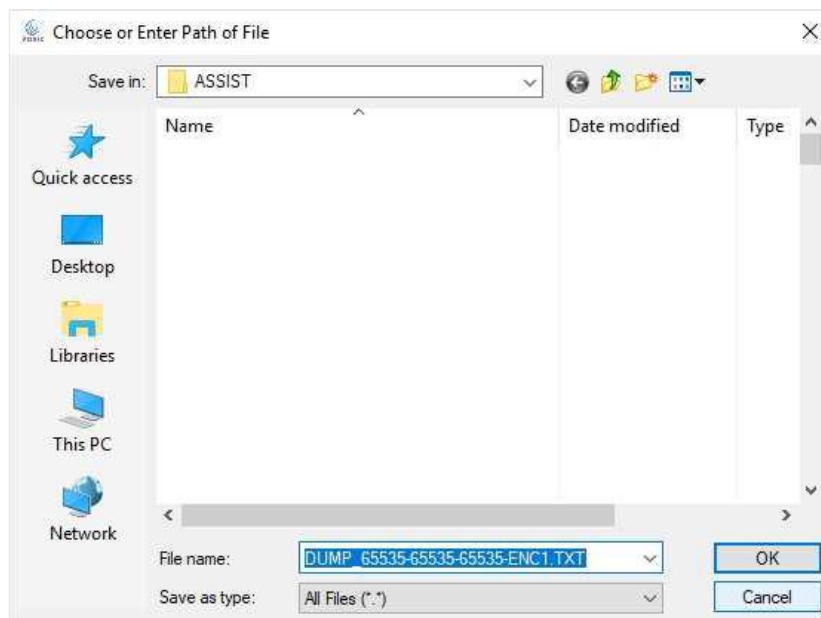


Figure 29 Pop-up window asking for the DUMP filename.

A DUMP file contains the OTP memory of the encoder and consists of 2 columns of 512 lines (for ID encoders) or 1024 lines (for IT and AP encoders).

512	1
513	1
514	0
515	15
516	0
517	74
518	255
519	0
520	255
521	0
522	31
523	0
524	129
525	12
526	16
527	94
528	98
529	24
530	0
531	0
...	

Figure 30 Example of a DUMP-file. Only the initial 20 values are shown (a complete DUMP contains 512 lines).

Annex 1

Manual linearization

The linearization method “Manual” is listed in Table 8 and is most suitable when the scale is moved by means of a manual system with fixed steps. An example with a micro-screw is shown in Figure 31. Instead of a manual micro-screw, a motorized stage could be used.

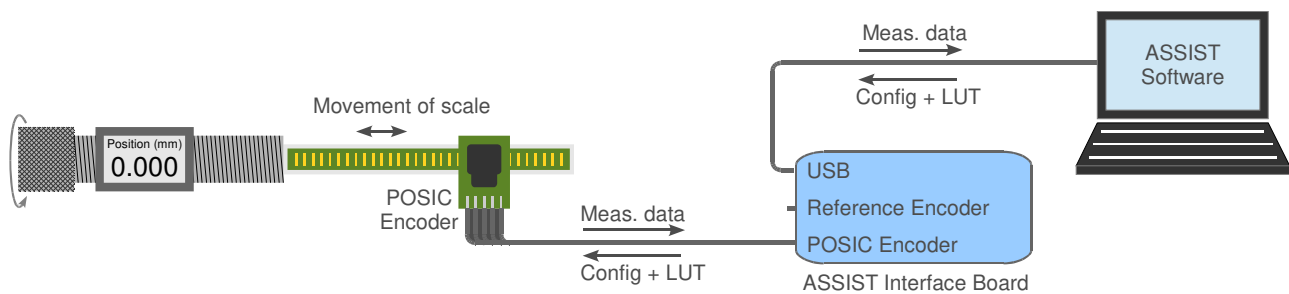


Figure 31 Linearization method “Manual” using a micro-screw to adjust fixed steps.

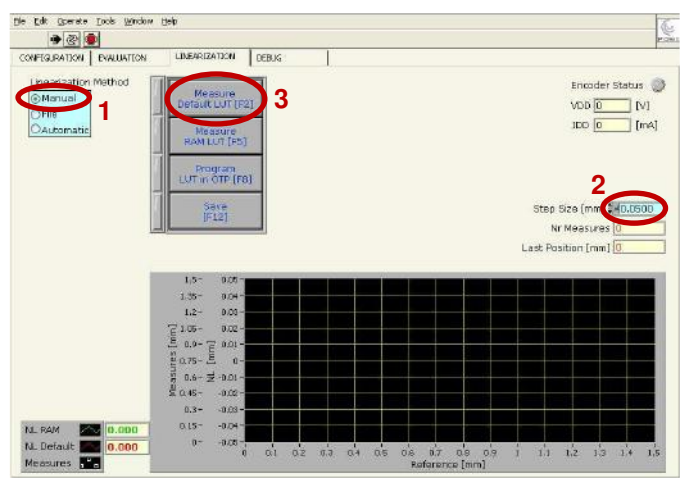
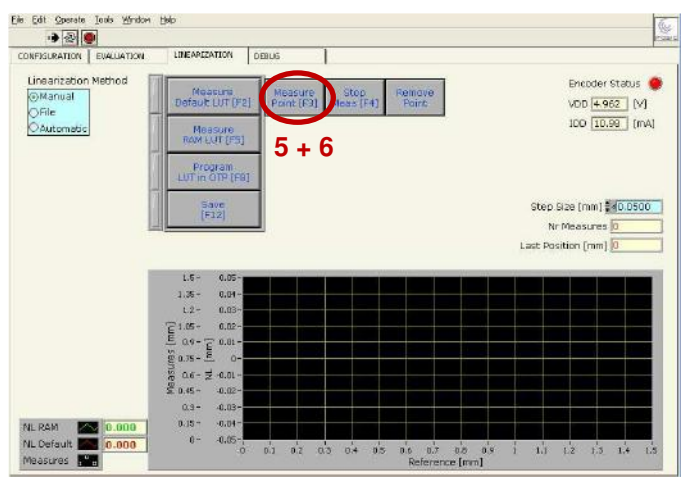
Recommendations:

- Stabilization time between movement and measurement depends on value of BB according to Table 2 on page 4 of the encoder datasheet:

BB	01	02	03	04	05	06	07	> 08
Stabilization Time (ms)	500	250	125	63	32	16	8	5

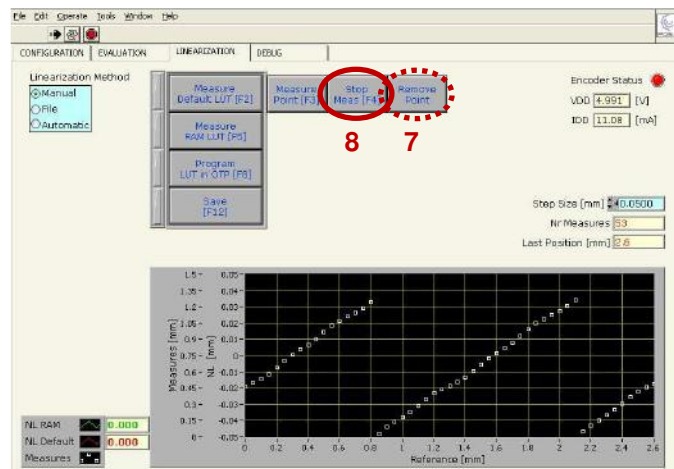
- Resolution of the POSIC encoder: CC = 10 according to Table 3 on page 4 of the encoder datasheet.
- Measurement mode has no influence on this linearization method and may thus be set to Continuous or Triggered.
- Number of linearization-points It is recommended to use at least 20 linearization-points per target-period. For the manual linearization method with a linear scale, this corresponds to a step size of approximately 0.05 mm. The LUT is calculated using an 8th-order polynomial fitting-procedure: additional linearization points above 20 will not significantly improve the resulting LUT.
- Spacing between linearization points For this linearization method, it is required to use equidistant linearization points (e.g. 1.2 mm / 24 points = 0.05 mm between two linearization points). It is not required that the period length is an integer multiple of the linearization point spacing. Example: the combination of period length = 1.2 mm and linearization point spacing = 0.018 mm would be perfectly OK, although their ratio is not an integer number: 66.67.

Table 8 Linearization procedure “Manual”.

<ol style="list-style-type: none"> 1) Select linearization method: Manual. 2) Define step size that will be applied. 3) Start the measurement with Default LUT (it takes a few seconds to upload the encoder configuration and the Default LUT) and move the target until at least one Index-pulse has been observed on the corresponding signal-LED. 	
<ol style="list-style-type: none"> 4) Move the target until at least one index-pulse has been generated. This allows the ASSIST software to know the reference position, which is required to calculate the LUT. 5) Go to the initial position and record the first datapoint by pressing “Measure Point”. A first white datapoint appears in the graph. 6) Move to the second position, record the second datapoint etc. Continue until at least one complete scale-period has been covered. 	

7) If an error occurs, the last datapoint can be eliminated by pressing “Remove Point”.

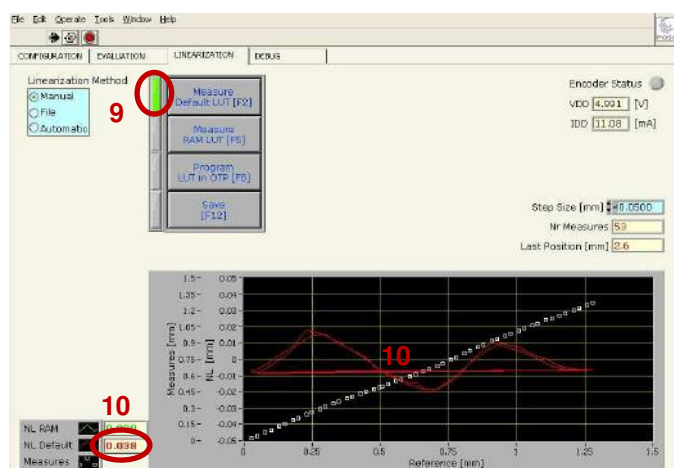
8) When all measurement points have been recorded, Press “Stop Meas”.



9) The green sign indicates that the measurement with Default LUT has been completed.

10) The measured position (white) and non-linearity (red) are displayed.

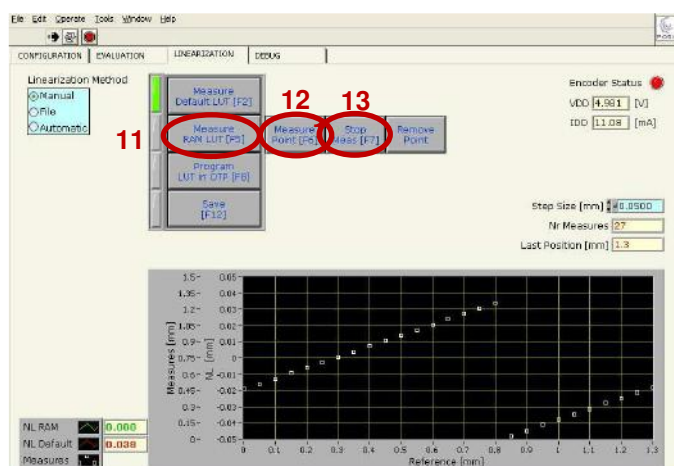
Based on the measurement with Default LUT, a LUT is calculated that compensates the encoder's non-linearity. This LUT is uploaded in RAM memory during the next step.



11) Start the measurement with RAM LUT (it takes a few seconds to upload the encoder configuration and the RAM LUT) and move the scale until at least one Index-pulse has been observed on the corresponding signal-LED.

12) Then carry out the same procedure as in steps 4-6.

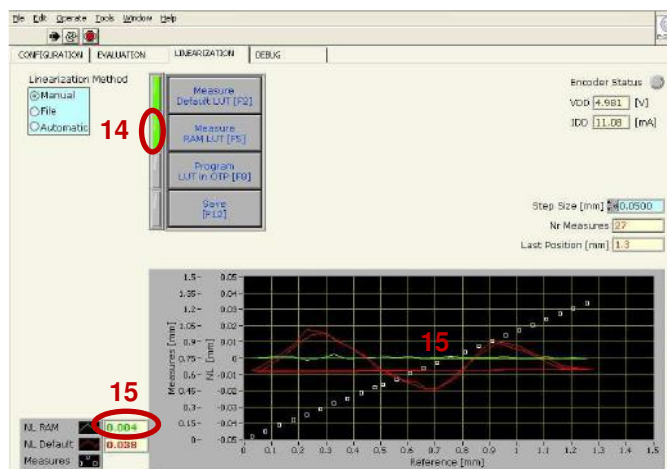
13) When all measurement points have been recorded, Press “Stop Meas”.



14) The green sign indicates that the measurement with RAM LUT has been completed.

15) The measured position (white) and non-linearity (green) are displayed.

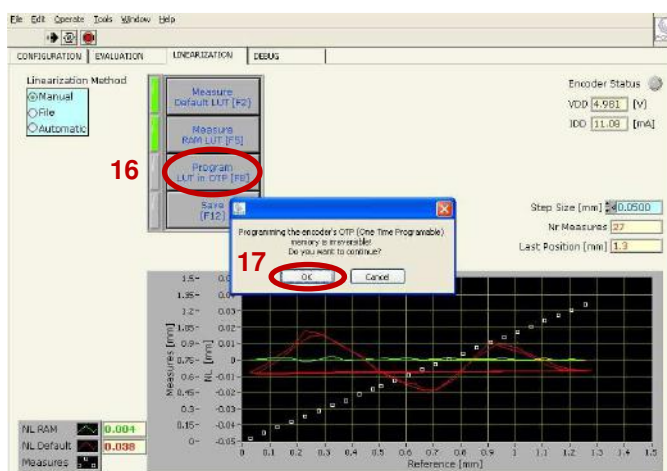
If the linearity with RAM LUT is OK, continue with the next step; if the result is not OK, check your measurement setup and re-start with step 1.



If you do not intend to operate the encoder standalone, programming the LUT is not required, go to step 19.

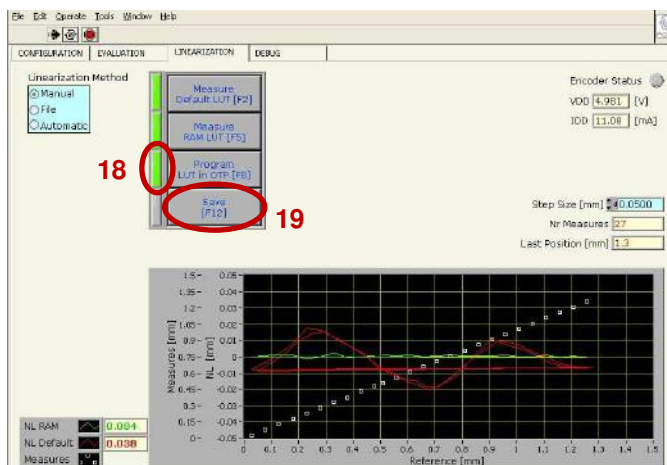
16) Program the LUT in the encoder's OTP memory (One Time Programmable).

17) The programming of OTP memory is irreversible, therefore a dialog box will appear to confirm the command.



18) Wait until the box to the left of the command "Program LUT in OTP" turns green, which means that the OTP programming has been completed successfully.

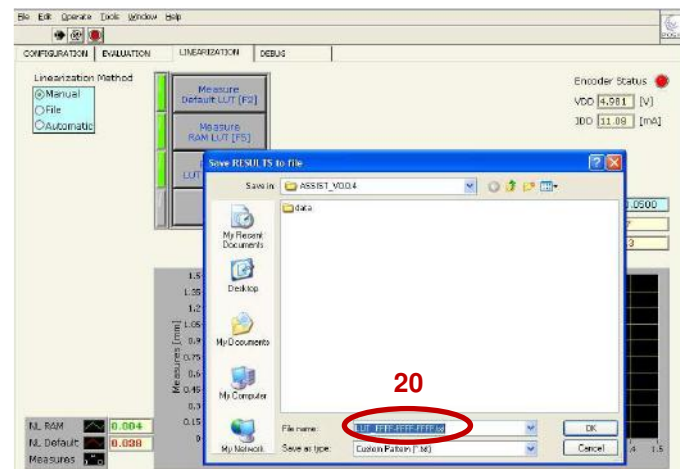
19) Save the measurement data and the LUT in two files on your PC.



20) A first a dialog box appears that asks you to specify the LUT file.

Each LUT is stored in a separate file, the suggested filename contains the encoder ID (three 16-bit hexadecimal numbers) and has the suffix .txt.

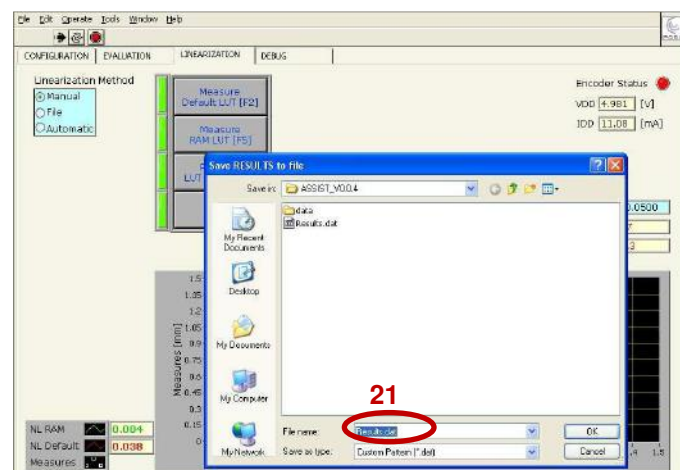
Details about the LUT file in Section 6.15.



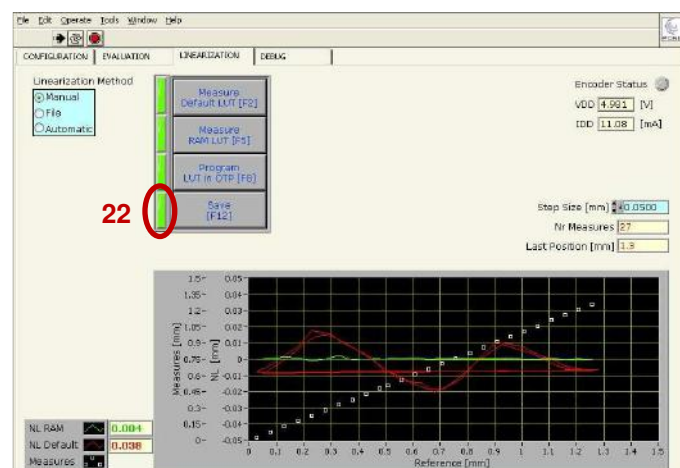
21) A second dialog box appears that asks you to specify the file in which the measurement results are stored.

The results are stored in a line that is added to the file Results.dat.

Details about the results file in Section 6.16.



22) The complete linearization, including storage in the encoder's OTP memory and storage of the linearization results on your PC has been completed.



Annex 2

Linearization with external DAQ system

The linearization method “File” is listed in Table 9 and is most suitable when an external DAQ system is used. A reference encoder and a data acquisition system with two ABI-interfaces (other than the ASSIST Interface Board) are required. The linearization data are transferred from the DAQ system into the ASSIST software by means of a measurement data file (Meas. file in Figure 32).

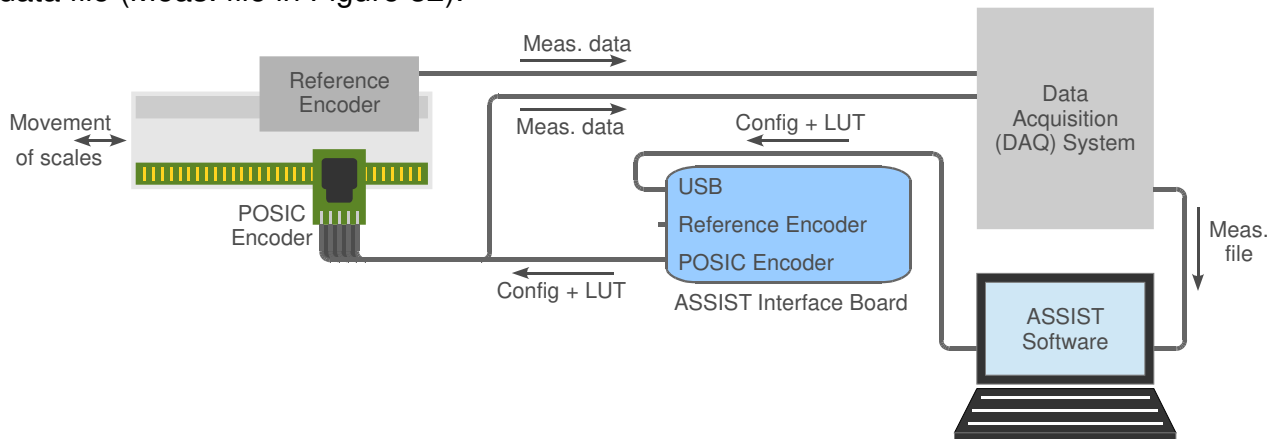


Figure 32 Linearization method “File” using an external DAQ system.

“Measurement mode” has no influence on this linearization method and may thus be set to Continuous or Triggered.

In the “File” method, the POSIC and the Reference encoders are measured in parallel using a DAQ system with two A quad B interfaces (not the Interface Board). The measured data has to be converted into a tab-separated text file with two columns, the first column containing the reference position in mm and the second column containing the POSIC encoder position in mm (see Figure 33). The Assist software asks for this data file in a dialog box in order to calculate the LUT and to display the measurement data in the graph. The POSIC encoder position must be reset to zero at each rising edge of the Index-pulse. The reference encoder position should not be reset to zero during the measurement.

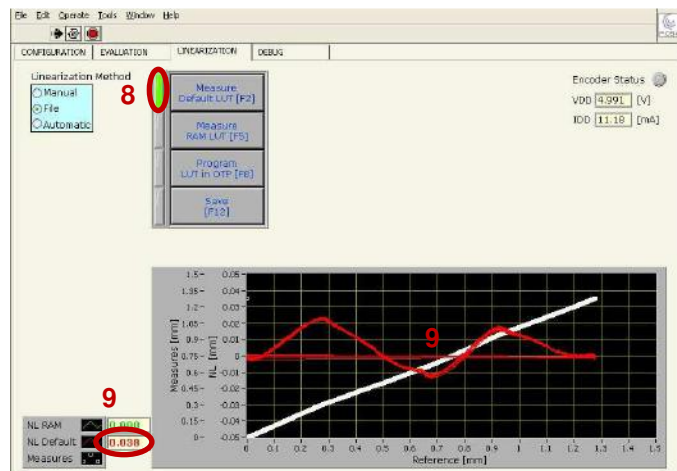
2.923712	0.3184
2.936015	0.3302
2.948600	0.3422
2.962975	0.3545
2.975995	0.3665
2.988247	0.3785
3.003565	0.3902
3.016359	0.4025
3.030359	0.4143
3.046360	0.4263
3.060330	0.4383
3.074860	0.4503
3.086988	0.4623

Figure 33 Example of the measurement data file: the left column is the reference- and the right column is the POSIC-encoder. The values are tab-separated. The encoder positions are in mm.

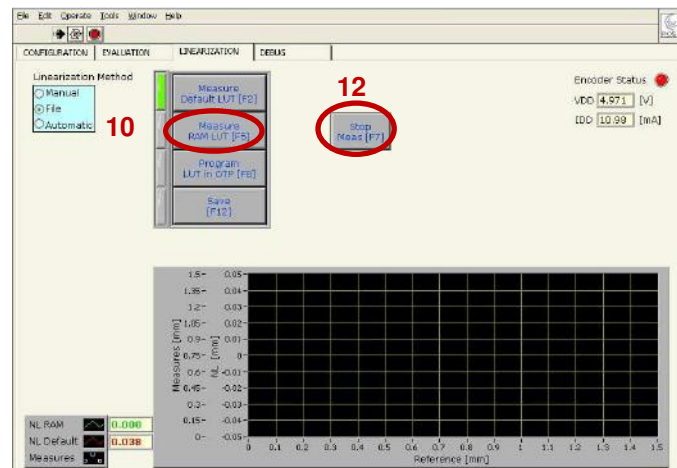
Table 9 Linearization procedure “File”.

<ol style="list-style-type: none"> 1) Select linearization method: File. 2) Start the measurement with Default LUT (it takes a few seconds to upload the encoder configuration and the Default LUT). 	
<ol style="list-style-type: none"> 3) Move the target over the measurement range. 4) Stop the POSIC encoder when the linearity measurement has been completed. 	
<ol style="list-style-type: none"> 5) A dialog box appears that asks for the file containing the measurement data. This dialog box will be completed in step 7. 6) Convert the measurement results into a text file with two columns containing the reference encoder and POSIC encoder positions in mm, see Figure 33. 7) Fill in the measurement results filename in the dialog box. 	

- 8) The Default LUT measurement has been completed when the green indicator turns on.
- 9) The position (white) and non-linearity (red) measured with the Default LUT are displayed.



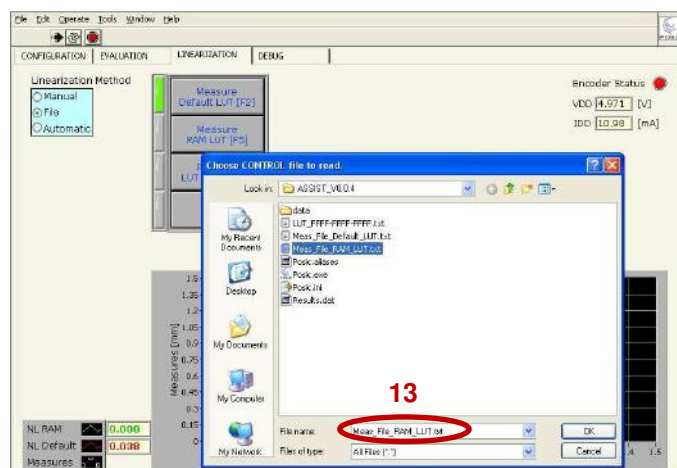
- 10) Start the measurement with RAM LUT. Fill in the file generated in steps 2-4 and press OK (it takes a few seconds to upload the encoder configuration and the RAM LUT).



- 11) Move the target over the measurement range.
- 12) Stop the POSIC encoder when the linearity measurement has been completed.

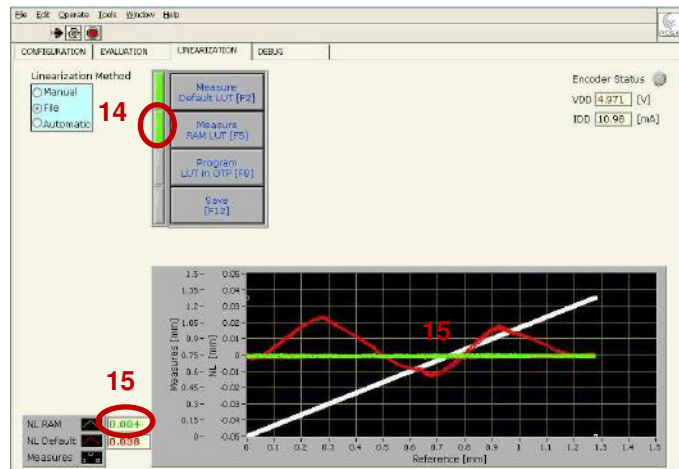
Convert the measurement results into a text file as in step 6.

- 13) After step 12 a dialog box appears that asks for the file containing the measurement data. Fill in the file generated in steps 10-12 and press OK.



14) The RAM LUT measurement has been completed when the green indicator turns on.

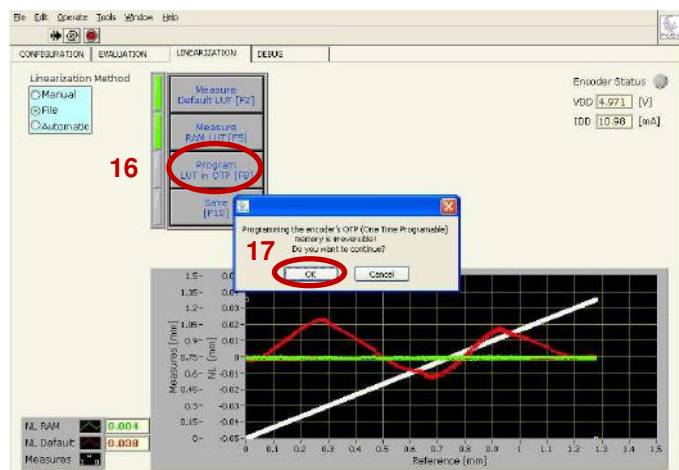
15) The position (white) and non-linearity (green) measured with the RAM LUT are displayed.



If you do not intend to operate the encoder standalone, programming the LUT is not required, go to step 19.

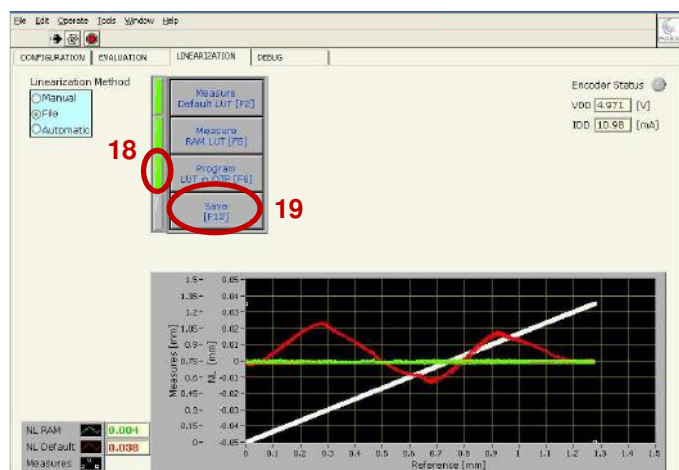
16) Program the LUT in the encoder's OTP memory (One Time Programmable).

17) The programming of OTP memory is irreversible, therefore a dialog box will appear to confirm the command.



18) Wait until the box to the left of the command "Program LUT in OTP" turns green, which means that the OTP programming has been completed successfully .

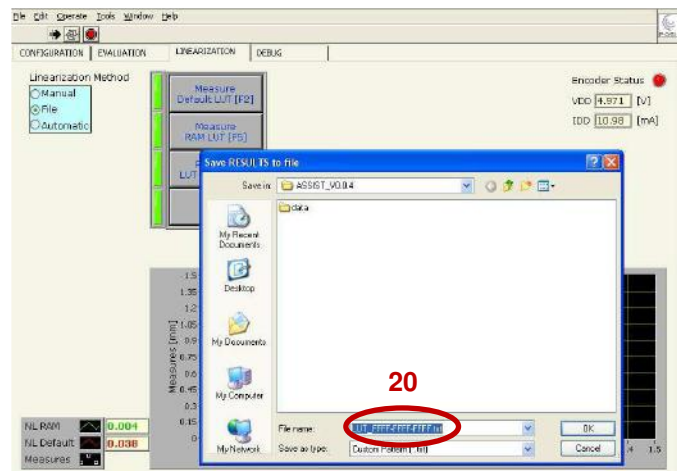
19) Save the measurement data and the LUT in two files on your PC.



20) A first a dialog box appears that asks you to specify the LUT file.

Each LUT is stored in a separate file, the suggested filename contains the encoder ID (three 16-bit hexadecimal numbers) and has the suffix .txt.

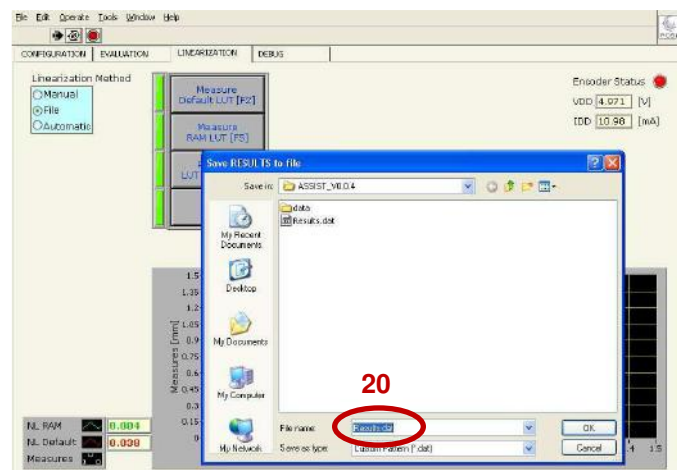
Details about the LUT file in Section 6.15.



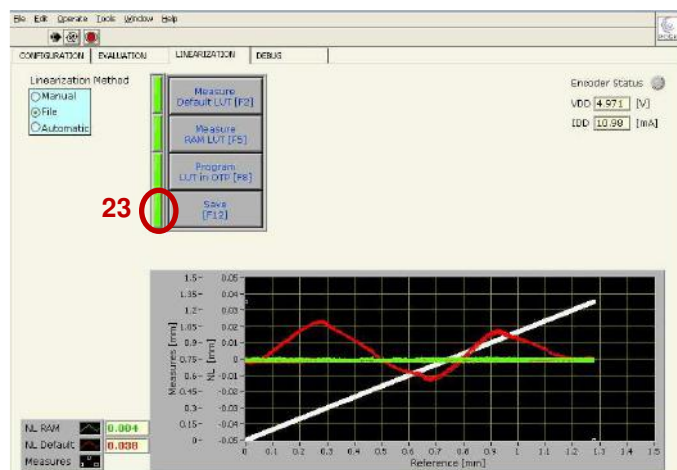
21) A second dialog box appears that asks you to specify the file in which the measurement results are stored.

The results are stored in a line that is added to the file Results.dat.

Details about the results file in Section 6.16.



23) The complete linearization, including storage in the encoder's OTP memory and storage of the linearization results on your PC has been completed.



Annex 3

Automatic linearization

The linearization method “Automatic” is listed in Table 10 and is most suitable when the scale is moved by means of a drive system (can also be moved manually) and no external DAQ system is used. A reference encoder is required. The method is shown in Figure 34.

This linearization method is illustrated in Table 10 for an ID-encoder, however, the method is applicable to all POSIC’s ID- IT- and AP-encoders. In the case of AP-encoders with a 2-track Nonius system, the linearization is carried out for both scale-tracks at the same time.

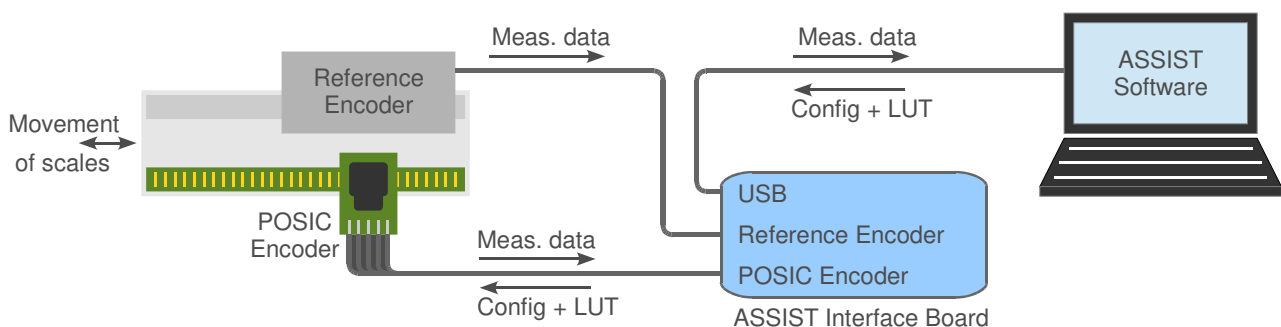


Figure 34 Linearization method “Automatic”.

The requirements and recommendations for this method are:

- A reference encoder with A and B outputs is required and must be connected to the Interface Board as explained in Annex 5.
- During measurement, the scale must be moving in one direction.
- For rotary encoders, the linearization measurement should preferably be carried out over one full rotation.
- For linear encoders, the linearization measurement should preferably be carried out over the part of the scale where the best linearity must be obtained.
- The best linearization results are obtained if the movement is as smooth as possible and has a fairly constant speed.
- The speed during linearization should be at least 60x lower than the adjusted value for Max Speed BB according to table 2 on page 4 of the encoder datasheet (e.g. if for an ID1102L encoder the code BB = 07 and Max Speed = 1 m/s, the speed during linearization should be less than 16.7 mm/s). For high-precision linearization, it is recommended to limit the speed during linearization to 600x lower than Max Speed BB.

Linearization should be carried out with values for Max Speed BB and Resolution CC that are optimal for a good linearization according to the recommendations above. The values BB and CC used during linearization are completely independent of the values used during operation in the application.

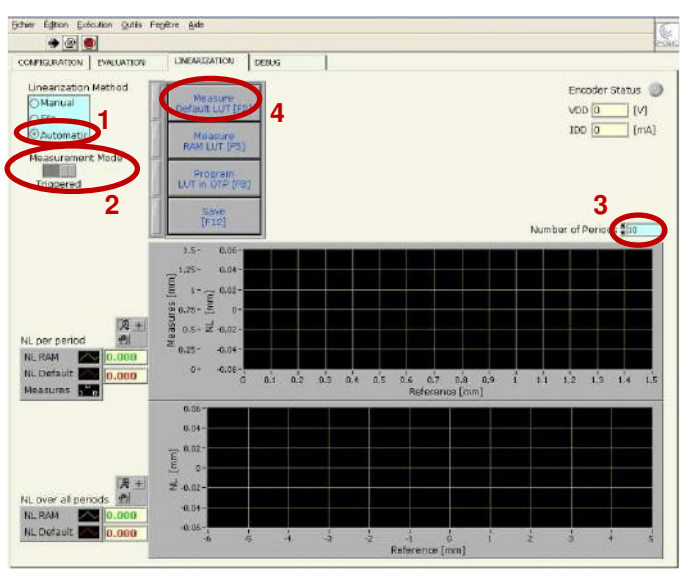
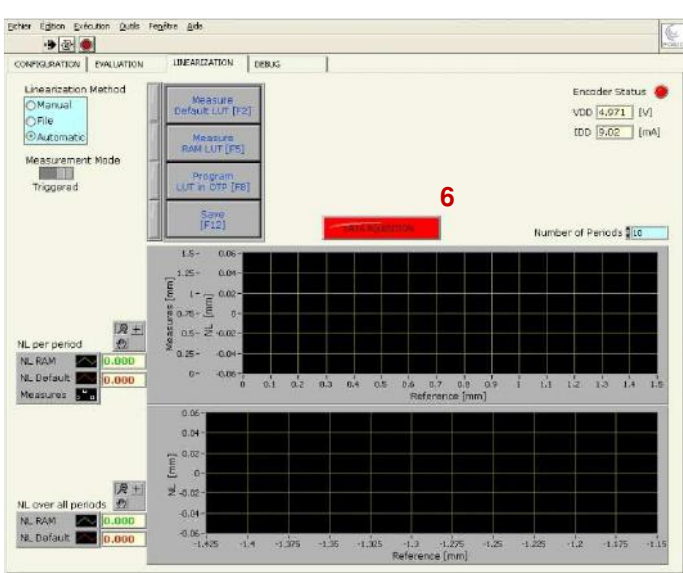
The switch “Measurement mode” allows you to choose between two different measurement modes:

- 1) Continuous: data acquisition of POSIC and Reference encoders continuously with a repetition rate that is typically 10 ms, but that depends on the speed of your PC, other programs running on your PC etc. This method is recommended for linearization with resolution $CC > 8$
- 2) Triggered: data acquisition of POSIC and Reference encoders triggered by the rising and falling edges of the A and B signals of the POSIC encoder. This method is recommended for linearization with resolution $CC < 8$

The Continuous mode shows the data in the graph (white lines in Table 8) during the measurement, whereas the Triggered mode shows the measured data only when the measurement has been completed.

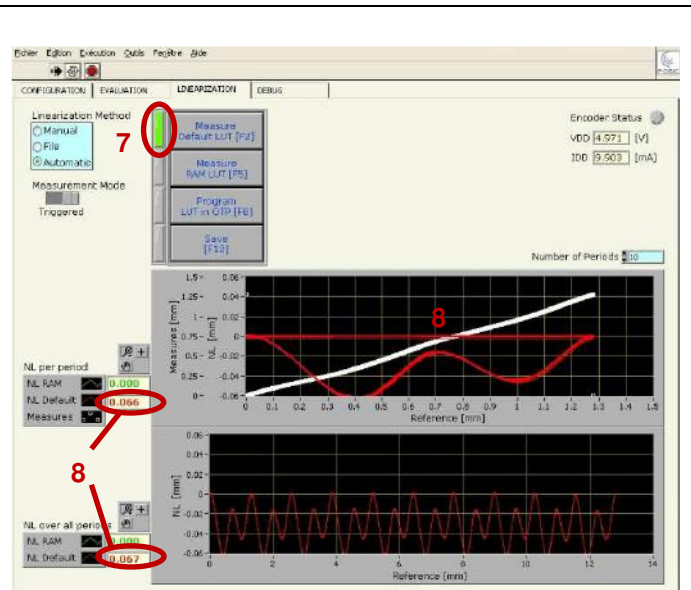
The Triggered mode provides more accurate linearity measurement results, especially at lower interpolation (less than 8 bits). However, the maximum linearization speed for the Triggered mode (especially at high interpolation) is lower than for the Continuous mode.

Table 10 Linearization of incremental encoders using method “Automatic”.

<ol style="list-style-type: none"> 1) Select linearization method: Automatic. 2) Select Measurement Mode: Triggered 3) Define number of periods (copper strips on the target) over which the measurement will be carried out. 4) Start the measurement with Default LUT (it takes a few seconds to upload the encoder configuration and the Default LUT). 	
<ol style="list-style-type: none"> 5) Move the target over the measurement range. 6) During the measurement, the message DATA ACQUISITION is shown, indicating that the measurement is ongoing. <p>In the case of the Measurement Method Continuous, the measurement data are dynamically shown in the graph while the measurement takes place.</p>	

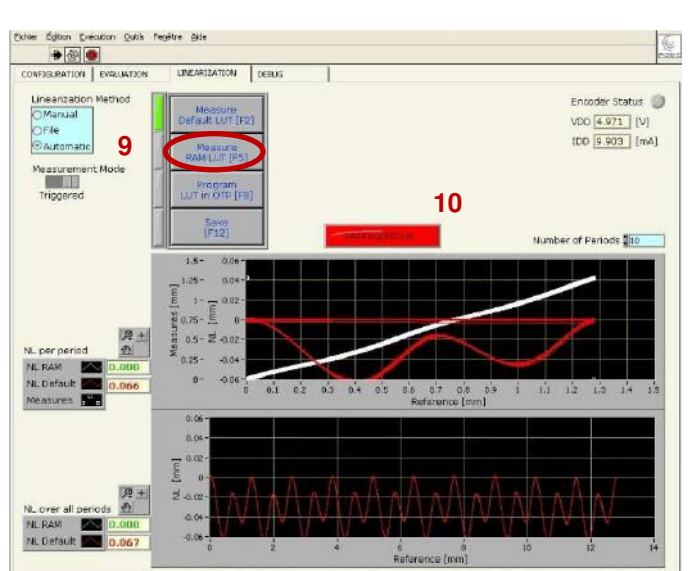
- 7) The green sign indicates that the measurement with Default LUT has been completed.
- 8) The measured position (white) and non-linearity (red) are displayed. The values for the measured non-linearity per period (top graph) and over all periods (bottom graph) are shown.

Based on the measurement with Default LUT, a LUT is calculated that compensates the encoder's non-linearity. This LUT will be uploaded in RAM memory during the next step.



- 9) Start the measurement with RAM LUT (it takes a few seconds to upload the encoder configuration and the RAM LUT).
- 10) During the measurement, the message DATA ACQUISITION is shown, indicating that the measurement is ongoing.

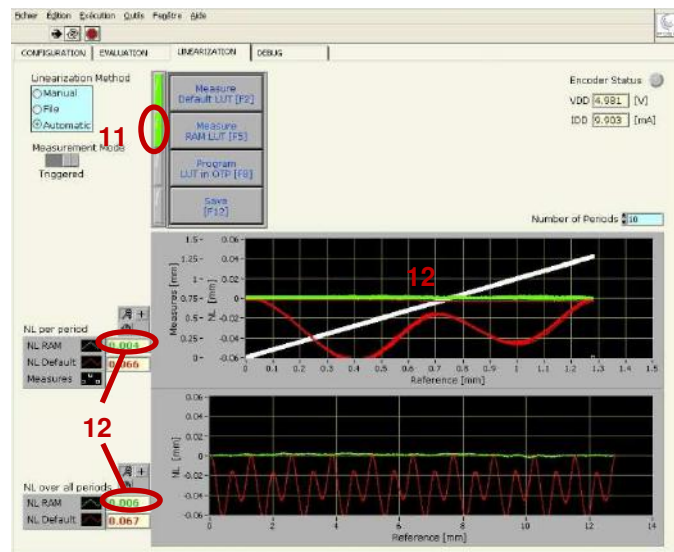
In the case of the Measurement Method Continuous, the measurement data are dynamically shown in the graph while the measurement takes place.



11) The green sign indicates that the measurement with RAM LUT has been completed.

12) The measured position (white) and non-linearity (green) are displayed.

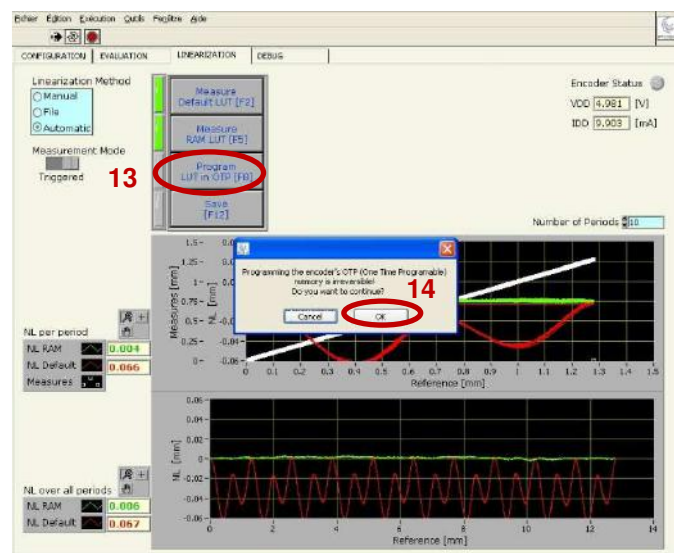
If the linearity with RAM LUT is OK, continue with the next step; if the result is not OK, check your measurement setup and re-start with step 1.



If you do not intend to operate the encoder standalone, programming the LUT is not required, go to step 16.

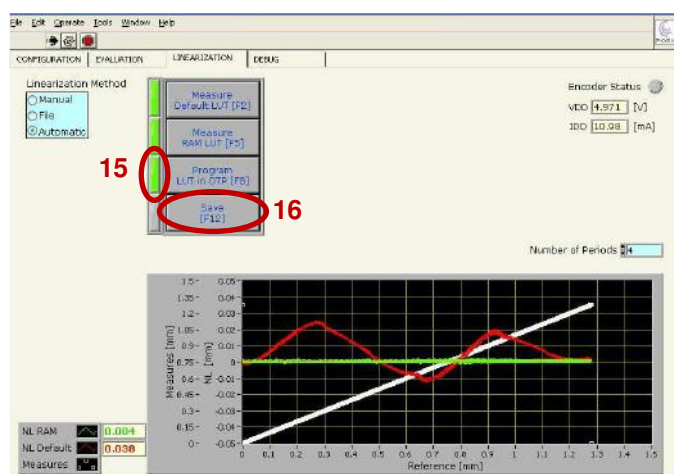
13) Program the LUT in the encoder's OTP memory (One Time Programmable).

14) The programming of OTP memory is irreversible, therefore a dialog box will appear to confirm the command.



15) Wait until the box to the left of the command "Program LUT in OTP" turns green, which means that the OTP programming has been completed successfully.

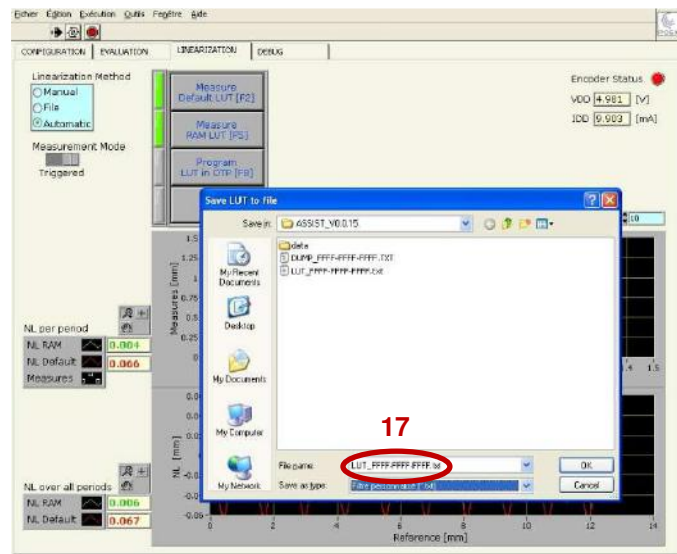
16) Save the measurement data and the LUT in two files on your PC.



17) A first dialog box appears that asks you to specify the LUT file.

Each LUT is stored in a separate file, the suggested filename contains the encoder ID (three 16-bit hexadecimal numbers) and has the suffix .txt.

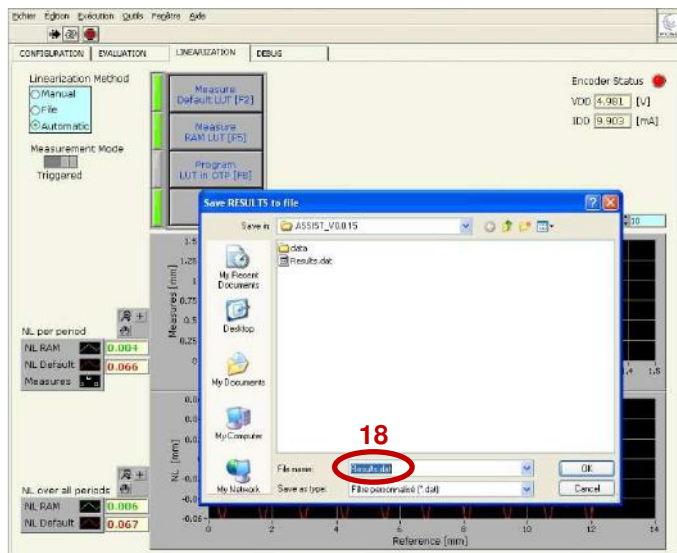
Details about the LUT file in Section 6.15.



18) A second dialog box appears that asks you to specify the file in which the measurement results are stored.

The results are stored in a line that is added to the file Results.dat.

Details about the results file in Section 6.16.



19) The complete linearization, including storage in the encoder's OTP memory and storage of the linearization results on your PC has been completed.

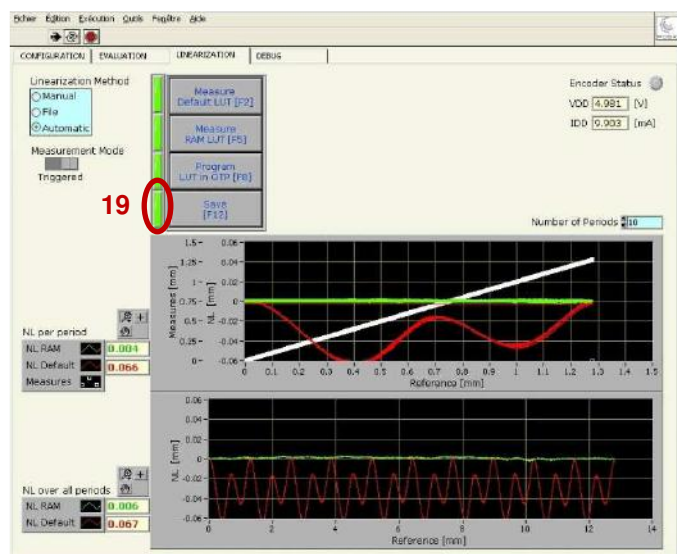
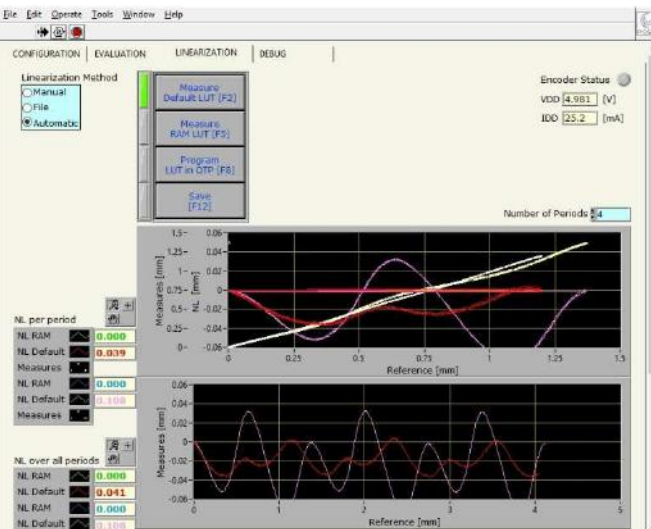
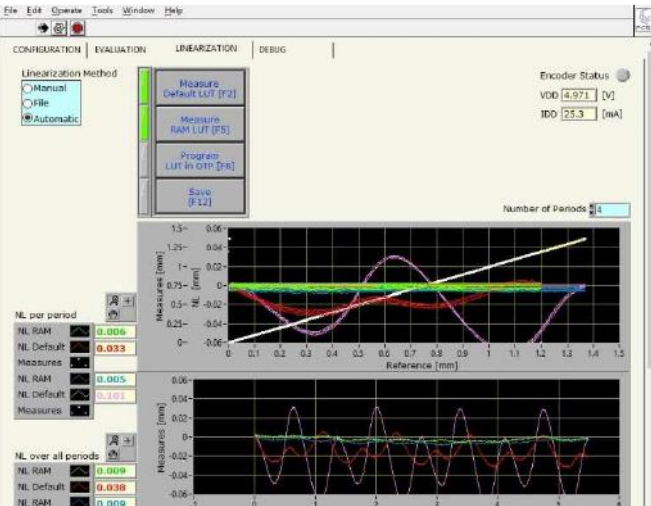


Table 11 Linearization of absolute encoders using method “Automatic”.

<p>The linearization-procedure of absolute encoders is the same as for incremental encoders, see Table 10.</p> <p>The two tracks are measured and linearized in parallel, resulting in 2 graphs and 2 LUTs: one for Track 1 / Encoder 1 and one for Track 2 / Encoder 2.</p> <p>The results after “Measure Default LUT (equivalent to points 7) and 8) in Table 10) is shown in the graph to the right.</p>	
<p>The results after “Measure RAM LUT (equivalent to points 11) and 12) in Table 10) is shown in the graph to the right.</p>	

AP92 encoders have a memory that can be programmed more than once, so after linearization of AP92 encoders, the LUTs are directly written into the encoder’s memory.

Annex 4 Schematics

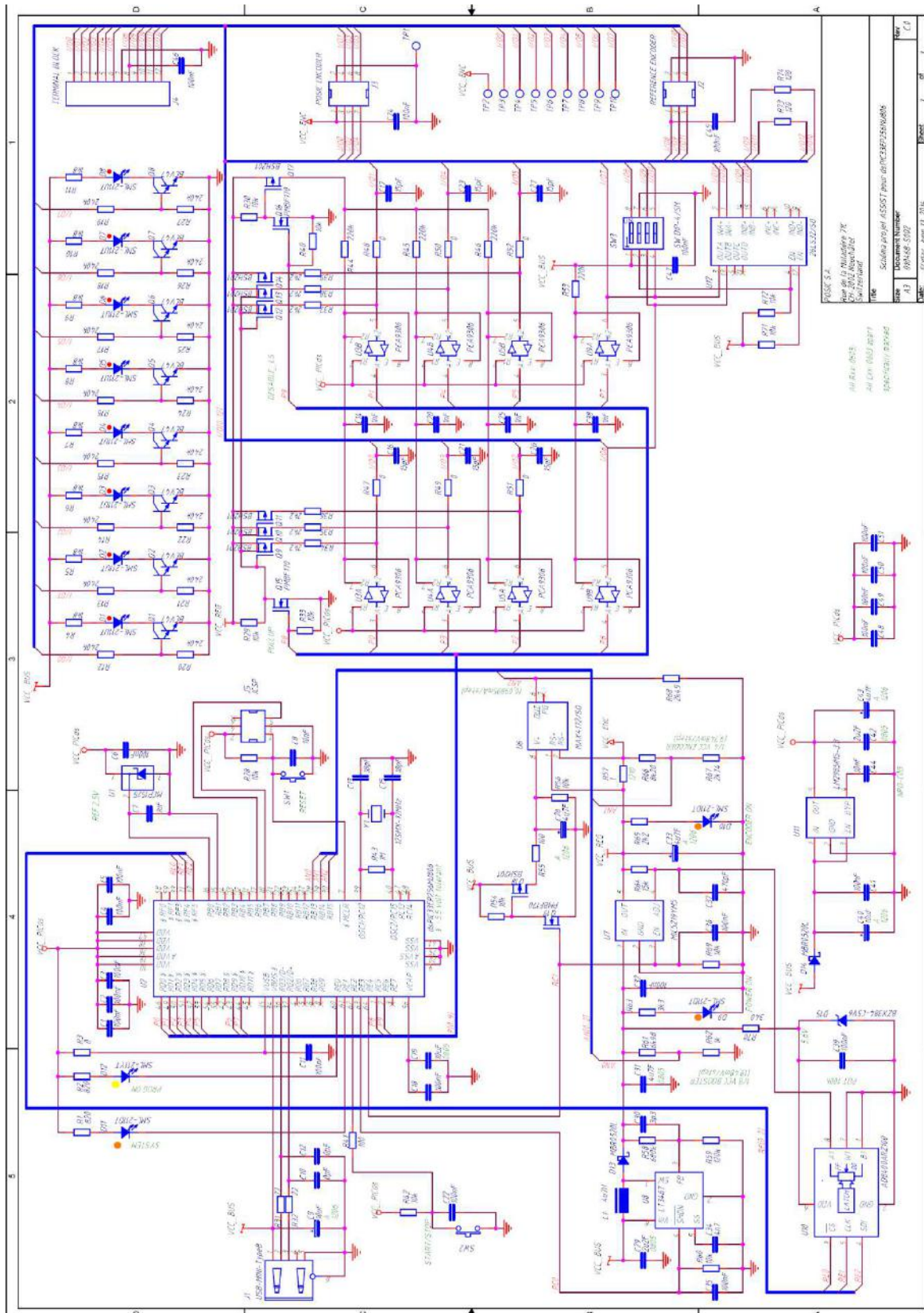


Figure 35 Schematic diagram of the Programming Board.

The schematic diagram of the Interface Board is provided in Figure 35, a short explanation of the different components is given below.

Integrated circuits:

- The microcontroller uC U2 is a dsPIC33EP with two A quad B interfaces and a USB interface. In communication mode, the uC converts the USB-protocol to the serial communication protocol of the encoder. During encoder-operation, the uC reads out the POSIC-encoder (and a reference-encoder) and transfers the data via the USB connection to the PC.
- The booster U8 increases the USB supply voltage to the Board Voltage between 7.5V and 9V.
- The uC-regulator U11 provides a 3.3V supply voltage to the uC.
- The encoder-regulator U7 provides a 5V supply during communication and normal operation and provides a 6.5V supply during OTP-programming of the encoder. The digital potentiometer U10 is controlled by the uC and is used to set the output voltage the encoder-regulator to the correct value.
- The bidirectional level shifters U3, U4, U5, U9 interface between the uC (signal levels 0 - 3.3V) and the encoder (signal levels 0 - 5V or 0 - 6.5V).
- The current measurement chip U6 is used to measure the encoder supply current (Figure 22).
- The RS422 line receiver U12 receives the differential signals from the reference encoder and converts them to single-ended signals than are connected (via level-shifters) to the uC.

Diodes and LEDs:

- The red signal-LEDs D1 – D5 indicate the status of the POSIC encoder signals (IO0 – IO5 = TP3 – TP8) and D6 – D7 indicate the status for the reference encoder signals (IO6 – IO7 = TP9 – TP10).
- The red LED D9 POWER ON (PWR on board) indicates whether the USB power supply is correct.
- The red LED D11 SYSTEM is activated when the uC is reading the POSIC and/or reference encoder.
- The red LED D10 ENCODER ON (ENC on board) indicates whether the encoder is powered.
- The yellow LED D12 PROG ON (PROG on board) indicates that programming of the OTP memory of the encoder is ongoing.
- The reference diode U1 provides a reference voltage to the uC.

Connectors:

- J1 is the USB-connector.
- J2 is the connector for the Reference encoder.
- J3 is the connector for the POSIC encoder.
- J4 is the green terminal-block.
- J5 is used by POSIC to load the code into the uC.

Annex 5

Electrical connections POSIC- and Reference-encoders

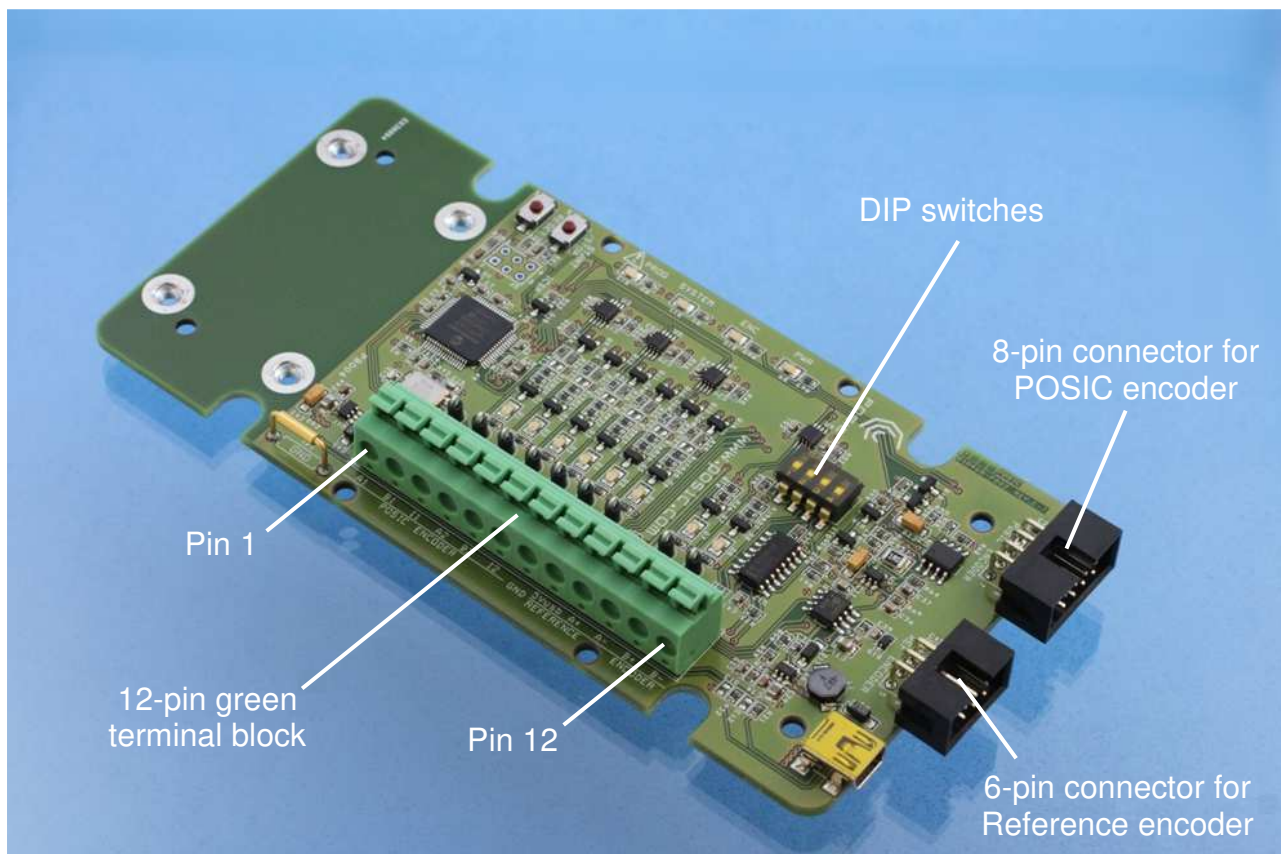


Figure 36 Interface Board with the connectors for POSIC- and Reference-encoder, green terminal block and DIP-switches.

Table 12 Pinout of the 8-pin connector for the POSIC encoder, see Figure 36 and schematics in Figure 35.

Pin nr.	Signal ID and IT encoders	Signal AP encoders	Comment
1	VDD	VDD	POSIC encoder supply voltage
2	GND	GND	Ground
3	A1	Clock1	Signal A or Clock1
4	B1	Data1	Signal B or Data1
5	I1	-	Signal I
6	A2	Clock2	Signal A2 or Clock2
7	B2	Data2	Signal B2 or Data2
8	I2	-	Signal I2

The POSIC Encoder is powered by the Interface Board (see Figure 35) via pin 1 of the 8-pin connector according to Table 9. Do not apply an external supply voltage to the POSIC Encoder while it is connected to the Interface Board. Permanent damage may occur if the POSIC Encoder or the Interface Board are powered otherwise than via the USB-connection. Tables 9 - 11 provide the pinouts of the encoder connectors and the green terminal block. The POSIC Encoder connections are in green, the Reference Encoder connections in red and the GND in blue (common GND between POSIC and Reference Encoders).

Table 13 Pinout of the 6-pin connector for the Reference encoder, see Figure 36 and schematics in Figure 35.

Pin nr.	Signal	All DIP switches off (default)	All DIP switches on
1	5Vusb	Not connected	5V USB supply voltage
2	GND	Ground	
3	A+	Differential signal A, positive	Signal A
4	A-	Differential signal A, negative	Not connected
5	B+	Differential signal B, positive	Signal B
6	B-	Differential signal B, negative	Not connected

Table 14 Pinout of the 12-pin green terminal block, see Figure 36 and schematics in Figure 35.

Pin nr.	Signal	All DIP switches off (default)	All DIP switches on
1	A1 / Clock1	POSIC encoder signal A	
2	B1 / Data1	POSIC encoder signal B	
3	I1	POSIC encoder signal I	
4	A2 / Clock2	POSIC encoder signal A2 (only for IT3402)	
5	B2 /Data2	POSIC encoder signal B2 (only for IT3402)	
6	I2	POSIC encoder signal I2 (only for IT3402)	
7	GND	Ground (common ground for POSIC and reference encoders)	
8	5Vusb	Not connected	Supply for Ref encoder
9	A+	Ref encoder diff signal A, positive	Ref encoder signal A
10	A-	Ref encoder diff signal A, negative	Not connected
11	B+	Ref encoder diff signal B, positive	Ref encoder signal B
12	B-	Ref encoder diff signal B, negative	Not connected

Important: 5Vusb (terminal block pin 8) is NOT the supply for the POSIC encoder
 The POSIC-encoder supply VDD is not available on the green terminal block, it is only available on the POSIC encoder connector (pin 1 in Table 9)
 5Vusb may be used to supply the Reference encoder, see Table 12.

Reference encoder configurations

The DIP switches on the Interface Board allow you to configure the supply of the reference encoder and the type of outputs of the reference encoder according to the table below.

Table 15 Configuration of the Reference Encoder by means of the DIP switches.

DIP Switches				Reference encoder supply	Reference encoder outputs
1	2	3	4		
off	off	off	off	External supply	RS422 differential
on	off	off	off	5V USB supply to Ref enc.	RS422 differential
off	on	on	on	External supply	5V TTL single-ended
on	on	on	on	5V USB supply to Ref enc.	5V TTL single-ended

When DIP switch 1 is **off**, the Interface Board does not provide a supply voltage to pin 1 of the Reference Encoder connector.

When DIP switch 1 is **on**, the Interface Board provides the 5V USB supply voltage to pin 1 of the Reference Encoder connector.

When DIP switches 2-4 are **off**, the RS422 line receiver on the Interface Board is enabled. When DIP switches 2-4 are **on**, the RS422 line receiver on the Interface Board is disabled, its inputs are connected to the corresponding outputs, thus allowing single-ended 5V TTL encoder signals to pass to the uC.

Annex 6

In-circuit programming

In-circuit programming is required when the linearization and/or the OTP-programming has to be carried out after the encoder has been permanently connected to a controller (e.g an SMD-encoder soldered on a PCB together with a microcontroller). During in-circuit programming, the Interface Board needs to control the encoder's supply voltage VDD and the pins A, B and I.

If it is possible to disable the 5V encoder-supply and to put the controller in/outputs (A, B, I) in high-impedance state, Figure 37 shows the connections for in-circuit programming.

If it is not possible to disable the 5V encoder-supply or to put the controller in/outputs (A, B, I) in high-impedance state, Figure 38 shows the connections for in-circuit programming.

During OTP-programming, the encoder supply voltage VDD and the voltage on A, B and I are increased to 6.5 V during a relatively short time (few seconds). Series resistors are recommended to protect the controller inputs during encoder-programming. Recommended value for the series resistor $R = 100 - 1000 \Omega$.

For in-circuit programming of 2-channel encoders (e.g. ID1102, ID4501), pins 3, 4 and 5 (A1, B1 and I1) of the 8-pin connector are used as shown in Figure 37 and Figure 38. However, for 3-channel encoders (e.g. IT3402), pins 3, 4, 5, 6, 7 and 8 (A1, B1, I1, A2, B2 and I2) of the 8-pin connector have to be used.

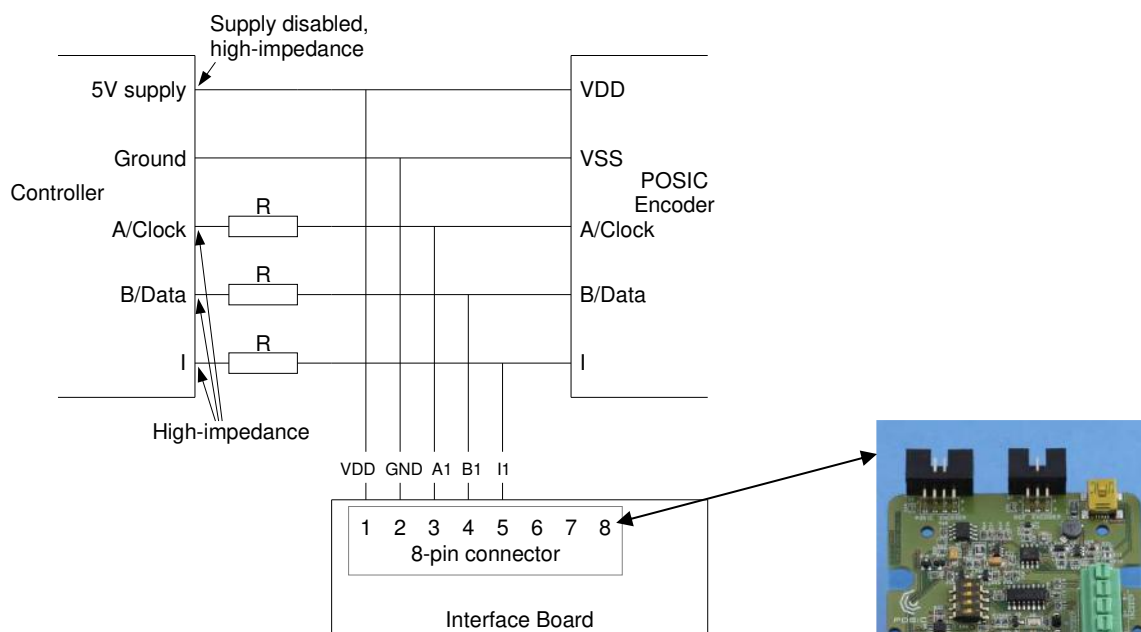


Figure 37 In-circuit programming via the Interface Board while the encoder remains connected to a controller with supply disabled and I/Os in high-impedance state.

In order to avoid problems when the encoder's programming voltage of 6.5 V is applied, series resistors $R = 100 - 1000 \Omega$ are recommended.

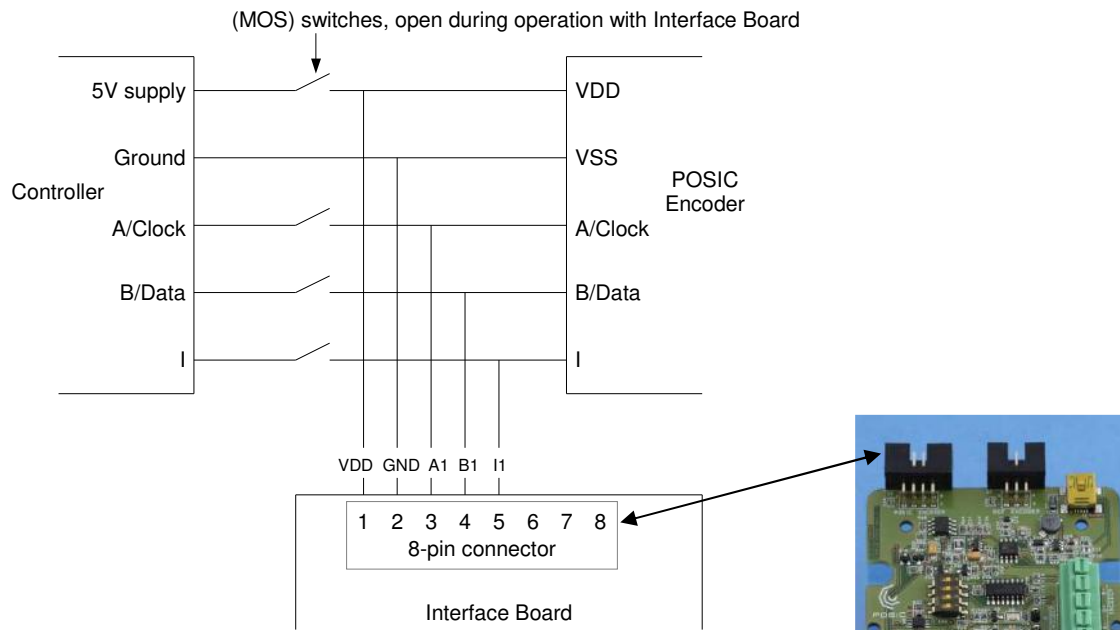


Figure 38 In-circuit programming via the Interface Board while the encoder is disconnected from the controller by means of mechanical switches or MOS switches.

Annex 7

Connection to SSI controller

A POSIC encoder with SSI interface can be configured with the ASSIST software and then be operated (in closed-loop operation) with an SSI controller by following the sequence in Figure 39.

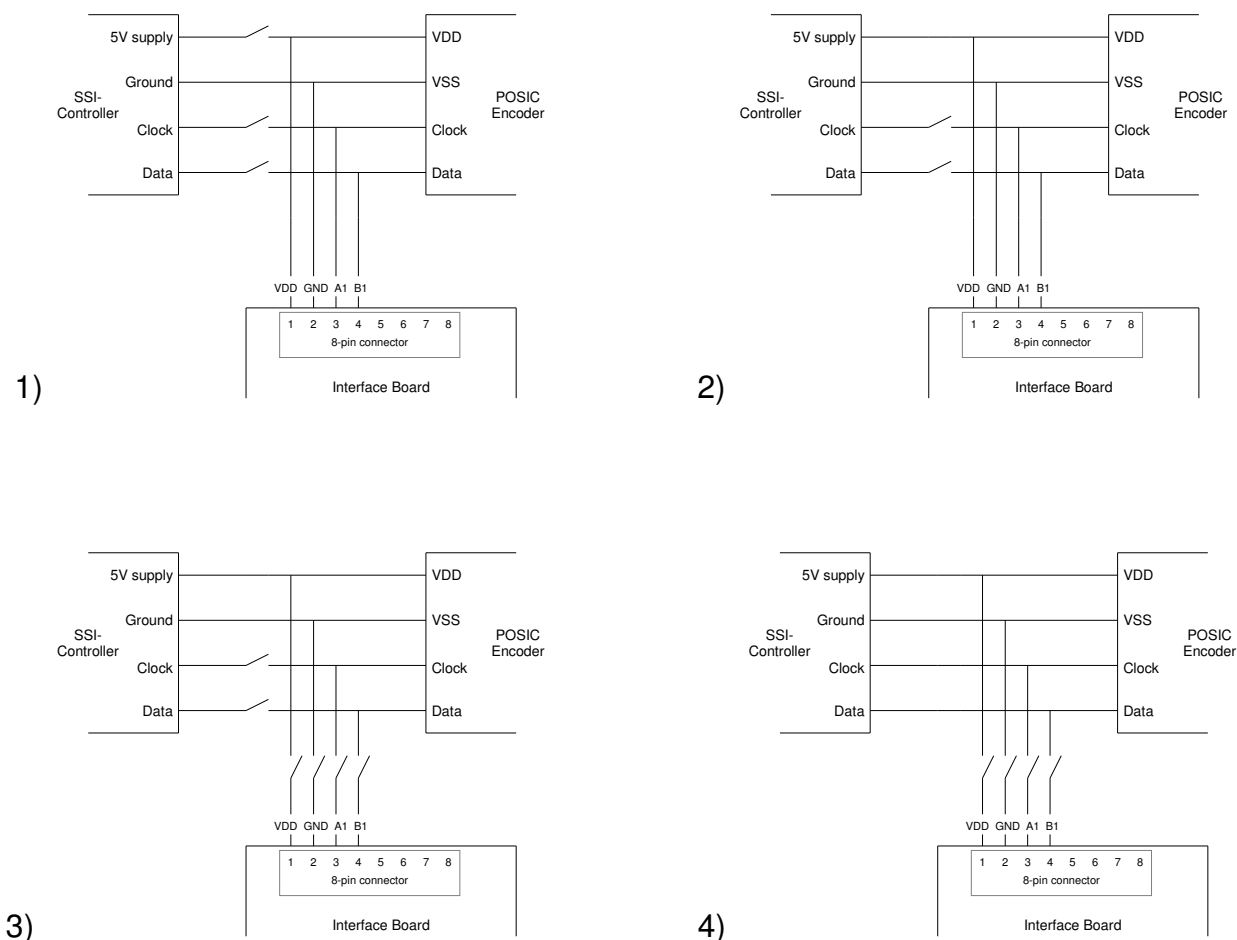


Figure 39 Sequence to configure an AP encoder using ASSIST and then switch to an external SSI controller.

- 1) Connect the encoder to the Interface Board and configure the encoder with the ASSIST software.
- 2) Connect the SSI controller's 5V supply to the encoder (the encoder is now supplied by the ASSIST Interface Board and the SSI controller in parallel).
- 3) Disconnect the Interface Board.
- 4) Connect Clock and Data from the SSI controller to the encoder.

For a 2-chip encoder (e.g. AP5603), this sequence should be applied for sensors 1 and 2 (with VDD1, VDD2, DATA1, DATA2, CLOCK1 and CLOCK2) in parallel.

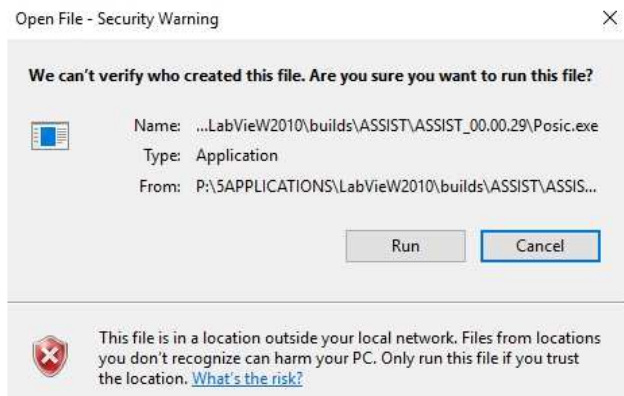
Annex 8 Troubleshooting

USB-connections lost and re-established

- Q:** During “Read Encoder Configuration” or other communication with the encoder, the USB-connection is lost and re-established (USB-connection and –disconnection sounds are heard), then the LabView program does not respond anymore.
- A:** If there is a short-circuit between the encoder-connections, a large current (approx 100 mA) is drawn when the encoder is started. If the USB-cable is connected to a high-current USB connection (typically the USB connectors in a PC, max current 500 mA), the ASSIST software automatically turns off the encoder and provides a warning that a short-circuit has been detected (See Figure 22 in Section 6.9). However, if the USB-cable is connected to a low-current USB connection (typically a USB-hub or a USB-connection at the side of a computer screen, max current 100 mA), the short-circuit current during startup exceeds the USB-current limit and the USB connection is lost (stopped by the PC). Directly after the USB connection has been lost, it is re-established, but the ASSIST-software has not been re-initialized. First the ASSIST software should be stopped and the USB connection unplugged. Then the short-circuit should be eliminated. Finally the USB connection should be established and the ASSIST software re-started.

Warning when launching Posic.exe

- Q:** After launching Posic.exe, the warning shown to the right appears.
- A:** The operating system on your PC does not recognize the publisher of the ASSIST software and therefore generates this warning. Press “Run” and the ASSIST software will start.



Program not responding, impossible to close the window

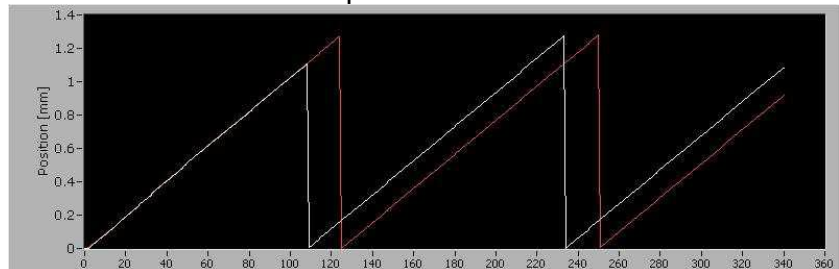
- Q:** The program is not responding and it is not possible to close the window.
- A:** The LabView program has encountered a problem and has to be halted by pressing the stop-button as shown to the right. After pressing the stop-button, the execution of the program has been halted and the window can be closed by pressing the close-button at the right top side.



Evaluation window, POSIC- and Reference-encoder not synchronous

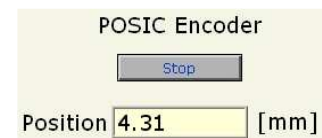
Q: The POSIC- and the Reference encoder are not synchronous. Each time the encoders are activated, the difference between the two encoders (in mm or in degrees) is different.

A: This observation is correct. The POSIC encoder is operated as an incremental encoder with an index-pulse, which appears once every period. The Reference encoder is operated as a purely incremental encoder (if there is an index-pulse, it is ignored). Upon activation of the encoders, the counters for both encoders start at zero, so they are synchronized. As soon as the POSIC-encoder provides an index-pulse, it is reset to zero (in the example at X-value 110). From that moment on, the two encoders are not synchronous anymore. The difference (in mm or angle) between the encoders depends on the start-position. So if the start-position is not always equal, the difference between the two encoders won't be equal either. See also next question/answer.

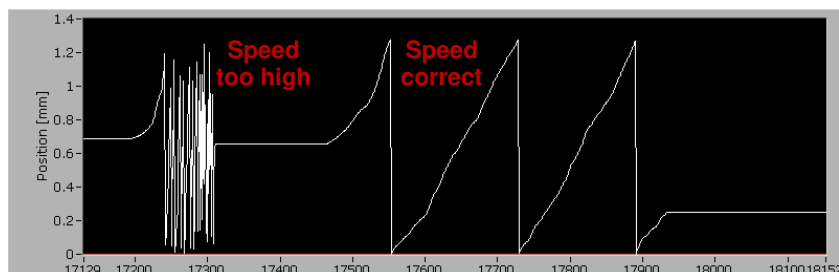


Evaluation window: Position not correct

Q: The position of the POSIC encoder displayed in the Evaluation window is not correct.



A: The POSIC encoder may be operated at very high speeds, but the ASSIST software has a limited acquisition frequency (around 100 position-samples per second, depending on the type of

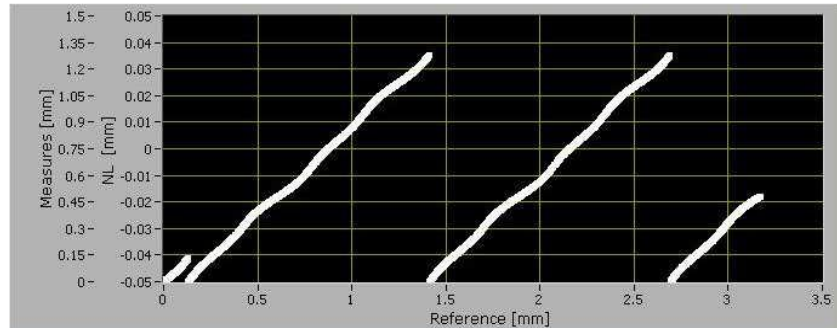


PC, operating system and other software running parallel to ASSIST). If the encoder-speed is higher than 10 periods per second, one or more periods might not be registered correctly and the displayed POSIC encoder position may be wrong. This effect is illustrated in the graph above: at the left side the speed is too high (> 10 periods/second) and the POSIC encoder position may be wrong. At the right side the speed is correct (< 10 periods/second) and the POSIC encoder position is correct. See also previous question/answer.

Linearization window, white measurement curves

Q: During the measurement “Measure Default LUT”, the white curves that are drawn during the measurement seem to be quite non-linear.

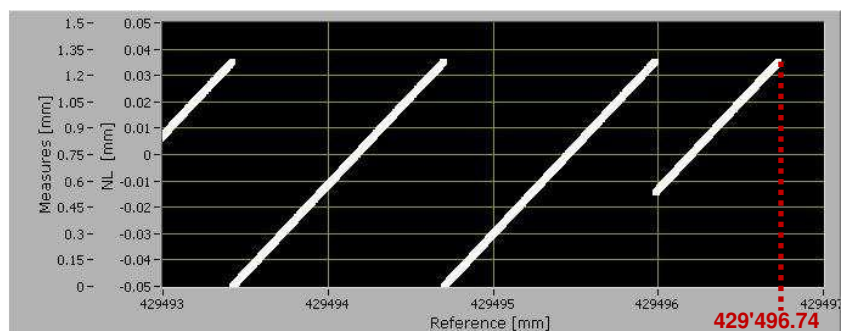
A: The white curves that are drawn during the measurement with Default LUT show indeed a non-linearity that is higher than the actually measured non-linearity. The correct non-linearity is displayed after the measurement has been completed.



Linearization window, automatic linearization method, right-end value of scale

Q: During linearity measurement, the white measurement curves are drawn from right to left and the right-end of the scale is at a very large value.

A: When the encoder is moved in negative direction (of the reference encoder), the measurement starts with the counter at zero and then counts down. As the counter in the Interface Board is a 32-bit counter, it will count down from 2^{32} .

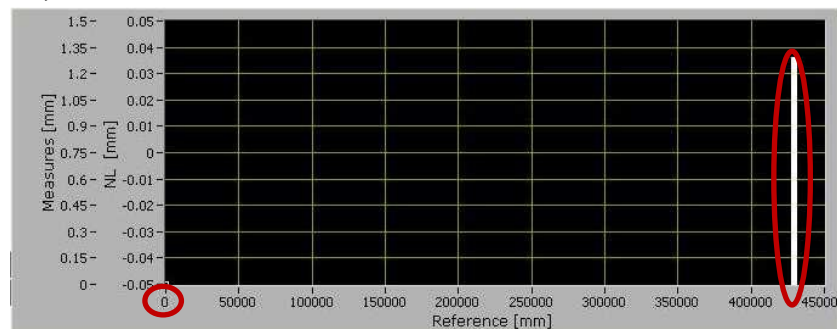


If the reference encoder has a resolution of 0.1 μ m, the maximum value of the counter is 429'496.74 mm. This value will be the right-end of the scale when the movement is in the negative direction.

Linearization window, automatic linearization method, wide scale

Q: During linearity measurement, the white measurement curves are drawn as vertical lines.

A: See previous Q and A. When the counter starts at zero and then moves in the negative direction, the graph shows both the value at zero and at the maximum counter-value.

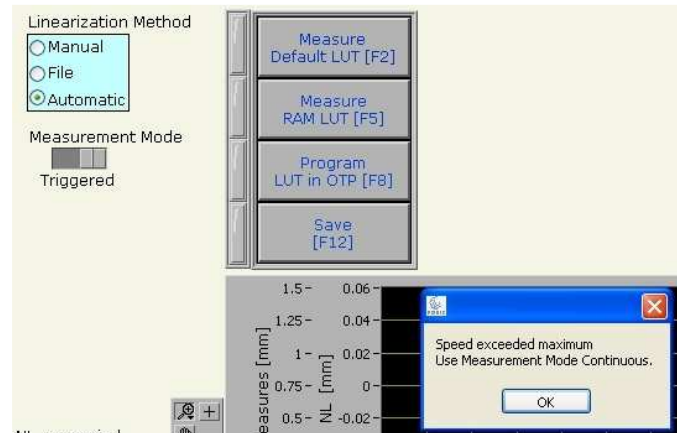


Hence, the graph is automatically scaled to the full 32-bit counter-range and the curves appear as vertical lines. After completion of the measurement, the scale is adapted.

Linearization window, automatic linearization method, speed exceeded maximum

Q: During linearity measurement with Measurement Mode = Triggered, the message “speed exceeded maximum” appears.

A: In Triggered mode, the POSIC encoder and the Reference encoder positions are measured at each transition of the A and B signals of the POSIC encoder. Especially when the interpolation factor of the POSIC encoder is high, it might occur that the ASSIST software is not fast enough to transfer the measured during the measurement. In that case the data acquisition is stopped and the message “speed exceeded maximum” is displayed. This problem can be resolved by 1) measure with a lower speed or 2) use the measurement mode “Continuous” instead of “Triggered”.



Configuration window, modification of parameter

Q: When I change a parameter in the configuration window (e.g. resolution of the reference encoder or number of periods of the codewheel), the value is not taken into account during measurement in the Evaluation and Linearization windows.

A: The values that are typed into boxes (resolution, period length, number of codewheel periods etc) are only taken into account if the value has been completed by an “enter” or if the cursor has been put into another location.

Configuration window, write configuration parameters in RAM

Q: When I change a parameter in the configuration window (e.g. Max input speed or Interpolation), will it be directly written into the encoder’s RAM?

A: No, the configuration and LUT will only be written in the encoder’s RAM when the encoder is started: by pressing “Start” in the Evaluation window or by pressing one of the “Measure” buttons in the Linearization window..

Reference encoder

Q: The reference encoder does not seem to work.

A: Check whether the supply and the signal levels of the reference encoder are defined correctly according to Annex 5.

Debug window, electrical connection test

Q: Some LEDs are toggling on and off, but not all.

A: This behavior is correct, because not all signal LEDs are connected to encoder outputs. Check in Annex 5 which signal LEDs are connected to encoder outputs. The signal LEDs that are not connected to encoder outputs are continuously on (emitting light) during the electrical connection test.

Colors of text boxes

Q: What is the meaning of the colors of the text boxes?

A: The color scheme used in the ASSIST software is as follows:

- Values displayed in a yellow box (5.001) have been read from the encoder or have been measured and cannot be modified by the user.
- Values displayed in a yellow box with up/down arrows (12 bits (1024 CPP)) have been read from the encoder's OTP memory. These values cannot be re-programmed in OTP memory, but can be modified in the encoder's RAM memory.
- Values displayed in a blue box (65535) can be defined (or selected from a list) by the user. In some cases (e.g. Encoder ID, Section 6.1.3.5) these are unprogrammed values read from the encoder's OTP memory. These unprogrammed values can be programmed into the encoder's OTP memory by filling in the right number and pressing the "Program in OTP"-button (Program in OTP).

POSIC Encoder supply connection on green Terminal Block

Q: There is no POSIC Encoder supply connection on the green Terminal Block.

A: The POSIC Encoder supply voltage VDD is provided by the Interface Board. Hence, no external encoder supply is required and therefore there is no encoder supply connection on the green Terminal Block. More detailed information on the schematic diagram in Annex 4 and on the encoder connectors in Annex 5.

Annex 9

Glossary

AP encoder	Absolute Position encoders AP3403 and AP5603
ASSIST	Name of the software that runs on a PC and communicates with the Interface Board
Binary	Binary 1111 1111 = Hexadecimal 0xFF = Decimal 255
Codewheel	Disc or ring containing copper strips that is rotated on front of the encoder in order to measure the rotary position
Decimal	Binary 1111 1111 = Hexadecimal 0xFF = Decimal 255
Default LUT	LUT that corrects electronic non-linearities, but does not correct non-linearities due to the encoder and scale/codewheel.
ENC	Encoder: LED on the Programming Board indicating that the encoder receives its supply voltage
Hexadecimal	Binary 1111 1111 = Hexadecimal 0xFF = Decimal 255
ID encoder	Incremental Dual-channel encoders ID1102 and ID4501
IT encoder	Incremental Triple-channel encoders IT3402, IT3403 and IT502
In-circuit progr.	In-circuit programming of an encoder's OTP memory while the encoder is connected to a controller or other electronic device
LED	Light Emitting Diode. The Programming Board contains red LEDs for the encoder signals, orange LEDs for the power supply and a yellow LED that lights up during OTP programming.
LUT	LookUp Table to linearize the encoder.
OTP	One Time Programmable memory. This non-volatile memory in a POSIC encoder contains the configuration and calibration data and can be programmed only once.
OTP LUT	LUT stored in the encoder's OTP memory
PROG	Programming: warning LED that turns on during (irreversible) programming of the encoder's OTP memory
PWR	Power: LED indicating that the Programming Board is powered via the USB-cable



RAM LUT	LUT calculated (by ASSIST software) from linearity-measurement (carried out by the user) that is stored in RAM for verification purposes. The RAM LUT is stored in volatile memory, which means that the RAM LUT is erased when the encoder supply is turned off.
RESET	Reset of the microcontroller on the Interface Board. This switch should not be used.
Scale	Linear scale or ruler containing copper strips that is linearly moved in front of the encoder in order to measure the linear position
START/STOP	Start/stop button that allows to operate the encoder without PC
SYSTEM	System: LED indicating that the microcontroller is active
Target	Object that moves in front of an encoder. For rotary applications, the target is a codewheel or a gear, for linear applications the target is a linear scale.
USB	Universal Serial Bus. Connection between the PC (with ASSIST software) and the Interface Board. The Interface Board receives its power supply from the PC via the USB.