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Netzer VLX-247 Hollow Shaft Rotary Encoder Kit Encoder

Netzer VLX-247 Hollow Shaft Rotary Encoder Kit Encoder User Guide

Contents

Netzer
Precision Position Sensors

Netzer VLX-247 Hollow Shaft Rotary Encoder Kit Encoder

VLX Encoders Introduction

Designed to meet the requirements of the most demanding applications

The VLX series of Electric Encoders™ are a line of encoders designed for high accuracy motion control for industrial, automation and robotic applications.

These encoders are based on capacitive technology which have been developed and improved for over 20 years by Netzer Precision Position Sensors.

The VLX encoders are characterized by the following features that sets them apart from other similar encoders:

- Low profile (<10.7 mm)
- Hollow shaft (Stator / Rotor)
- No bearings or other contact elements
- High resolution and excellent precision
- Immunity to magnetic fields
- High tolerance to temperature extremes, shock, moisture, EMI, RFI
- Very low weight
- Holistic signal generation and sensing
- Digital interfaces for absolute position

The holistic structure of the VLX Electric Encoder™ makes it unique. Its output reading is the averaged outcome of the entire circumference area of the rotor. This inherent design characteristic provides the VLX encoder with outstanding precision as well as a tolerant mechanical mounting.

The absence of components such as ball bearings, flexible couplers, glass discs, light sources & detectors, along with very low power consumption, enables the VLX encoders to deliver virtually failure-free performance.

VLX-247

VLX-170

VLX-100

VLX-60

VLX-140

VLX-80
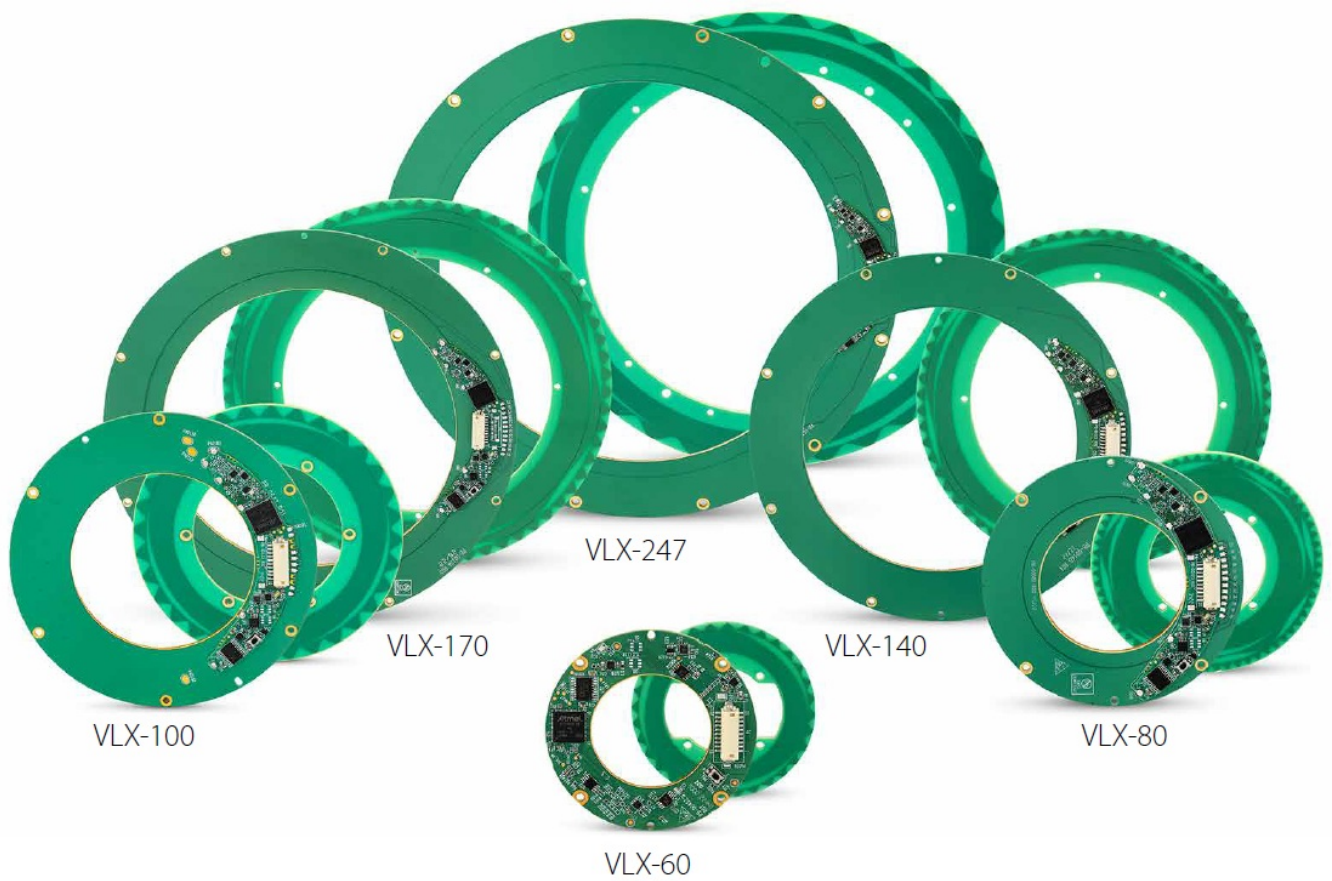
Technical Specifications

General

Angular resolution	18-20 bit
Nominal position accuracy	±0.010° / ±0.006°
Maximum operational speed	4,000 rpm
Measurement range	Single turn, unlimited
Built In Test BIT	Optional
Rotation direction	Adjustable CW/CCW*

* Default same direction from bottom side of the encoder

Mechanical

Allowable mounting eccentricity	±0.1 mm
Allowable axial mounting tolerance	±0.3 mm
Rotor inertia	876,053 gr · mm2
Total weight	220 gr
Outer Ø / Inner Ø / Height	247 / 171 / 10.7 mm
Material (stator / rotor)	PCB (FR4)
Nominal air gap (stator, rotor)	1 mm

Electrical

Supply voltage	5V ± 5%
Current consumption	~90 mA
Interconnection	Connector: DF13A-10P -1.25H
Communication	SSi, BiSS-C
Output code	Binary
Serial output	Differential RS-422
Clock frequency	0.1- 5.0 MHz
Position update rate	35 kHz (Optional – up to 375 kHz)

Environmental

EMC	IEC 6100-6-2, IEC 6100-6-4
Operating temperature	-40°C to +85°C
Storage temperature	-40°C to +85°C
Relative humidity	98% Non-condensing
Shock endurance / functional	100g 6msec saw-tooth per IEC 60068-2-27:2009
Vibration functional	20g @ 10 to 2000 Hz sweep per IEC 60068-2-6
Protection	IP 40

Ordering Code

| VLX | - | 247 | - | S | G | - | C | H | - | n | n | n |

VLX Product Line

Outer Diameter

Output

S	SSi
I	BiSS

Resolution

Code	Bit	CPR
G	18	262,144
H	19	524,288
I	20	1,048,578

EA	Extended Accuracy
nnn	Custom

Interconnection

H	Horizontal (Connector)
V	Vertical (Connector)

C	Connector

Mechanical Drawings

1 mm
recommended air gap between the rotor lower surface and any body made of conductive material within the functional zone – to preven parasitic capacitance

The functional zone is within the ring between radii 94.25 and 113.75 on both the stator and the rotor

Stator dimensions

Rotor dimensions
$\varnothing$ 227.50 ±0.10

$\varnothing$ 171.45 ±0.10

$\varnothing$ 247.65 ±0.10

$\varnothing$ 188.50 ±0.10

$\varnothing$ 4.1 $^{+0.05}_{0}$ THRU
$\oplus$ 0.05

$\varnothing$ 3.4 THRU typ.12
for M3 screws
$\oplus$ 0.05 +

4.1 $^{+0.05}_{0}$ X 4.8 THRU
$\oplus$ 0.05

$\varnothing$ 4.1 $^{+0.05}_{0}$ THRU
$\oplus$ 0.05

$\varnothing$ 179.40
Rotor mounting PCD
$\odot$ 0.1 A

4.1 $^{+0.05}_{0}$ X 4.8 THRU
$\oplus$ 0.05

A

$\varnothing$ 240
Stator mounting PCD

$\varnothing$ 3.4 THRU typ.12
for M3 screws
$\oplus$ 0.05

7 $^{+1}_{0}$ stator height
include cable and connector

2.4 ±0.24 (10%)
stator PCB thickness

2.4 ±0.24 (10%)
rotor PCB thickness

1 ±0.30
air gap between PCBs

Unless otherwise specified
Dimensions are in: mm Surface finish: N6

Linear tolerances
0.5-4.9: ±0.05 mm   5-30: ±0.1 mm
31-120: ±0.15 mm   121-400: ±0.2 mm

Mechanical Interface Control Drawing

Encoder's stator

Encoder's rotor

M4 dowel pins

Customer's shaft

Customer's base
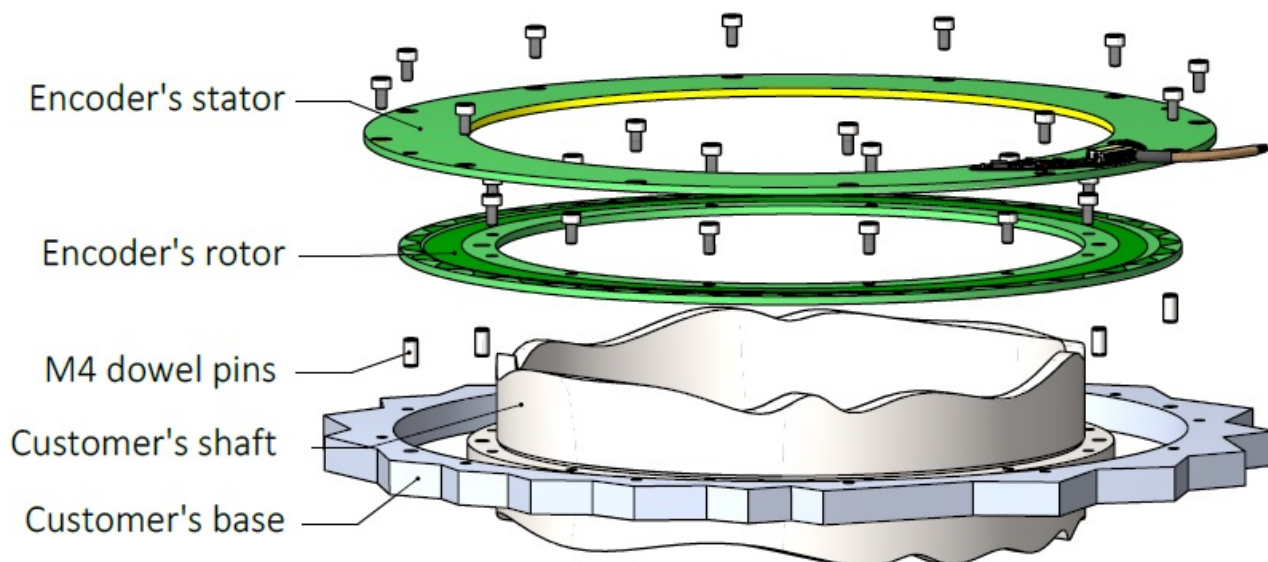
Customer interface, exploded view
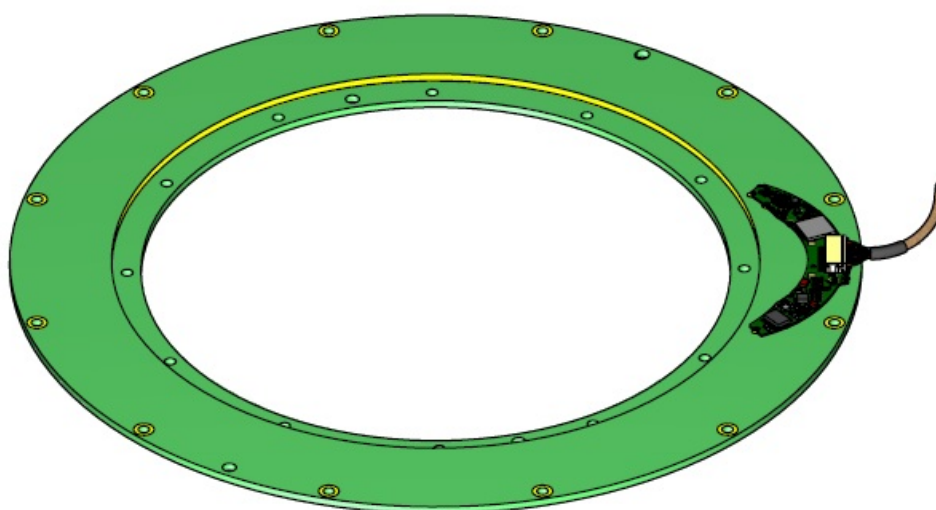
Encoder general view

Accessories cables (optional)

SSi / BiSS	Remarks
CB-00088-250	AWG30, 250 mm
CB-00088-500	AWG30, 500 mm
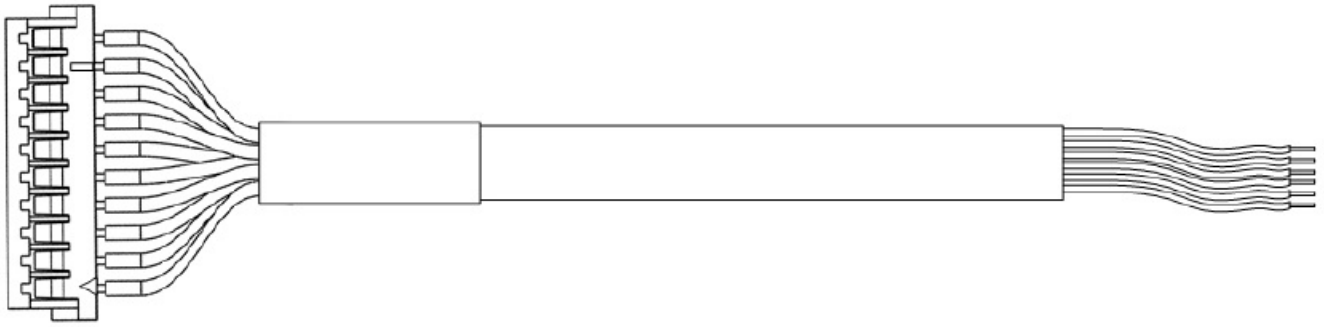
Storage and Handling

Storage temperature: -40°C to +85 °C
Humidity: Up to 98% non-condensing

ESD Protection
As usual for electronic circuits, during product handling do not touch electronic circuits, wires, connectors or sensors without suitable ESD protection. The integrator/operator shall use ESD equipment to avoid the risk of circuit damage.

**ATTENTION** OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES

Product Overview

Overview
The VLX-247 absolute position Electric Encoder™ is a rotary position sensor developed for demanding applications. Currently it performs in a broad range of robotic ,automation and industrial applications.
The Electric Encoder™ non-contact technology provides accurate position measurement through the modulation of an electric field.
The VLX-247 Electric Encoder™ is a kit-encoder, i.e., its rotor and stator are separate.

1. Encoder stator
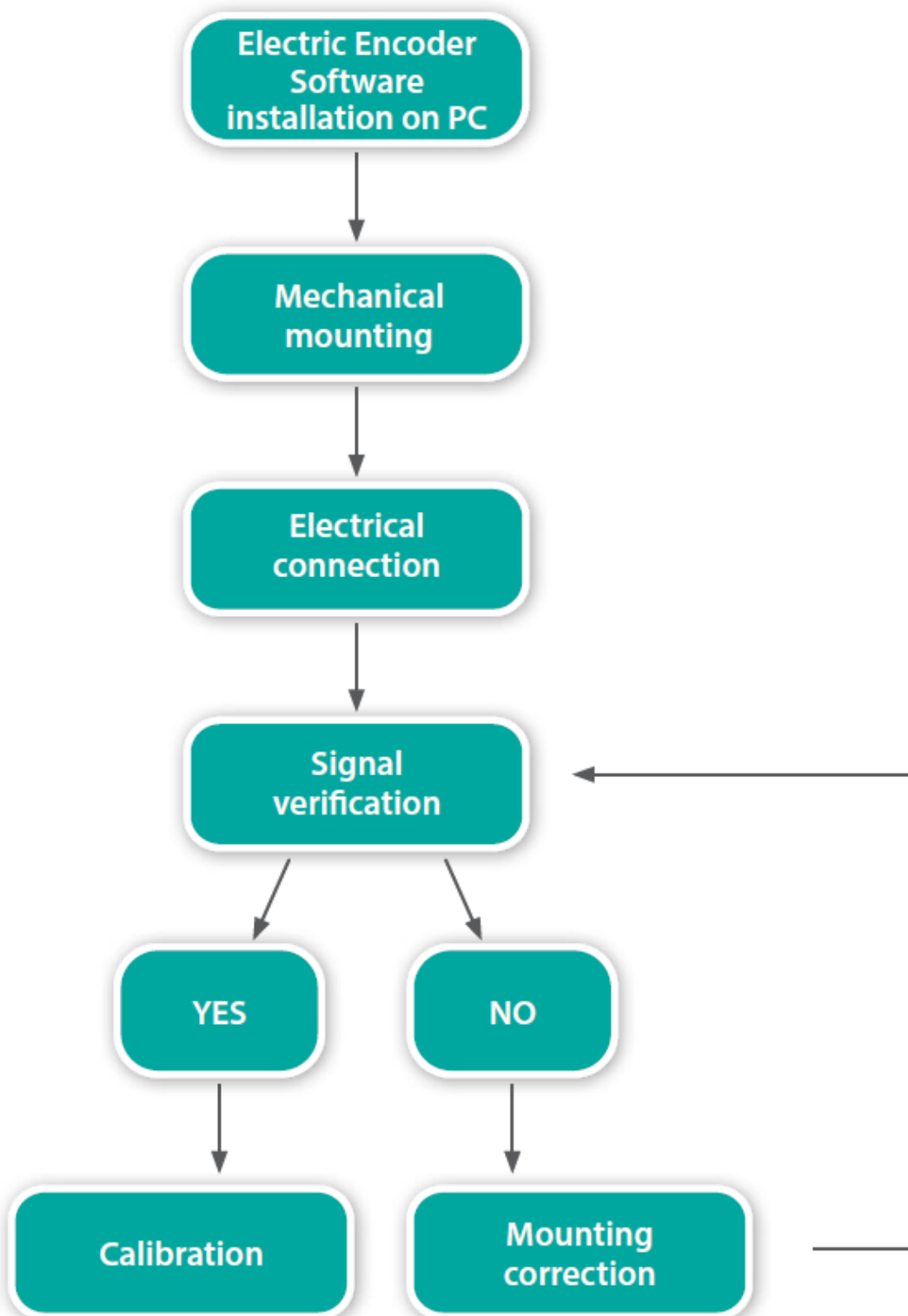2. Encoder rotor
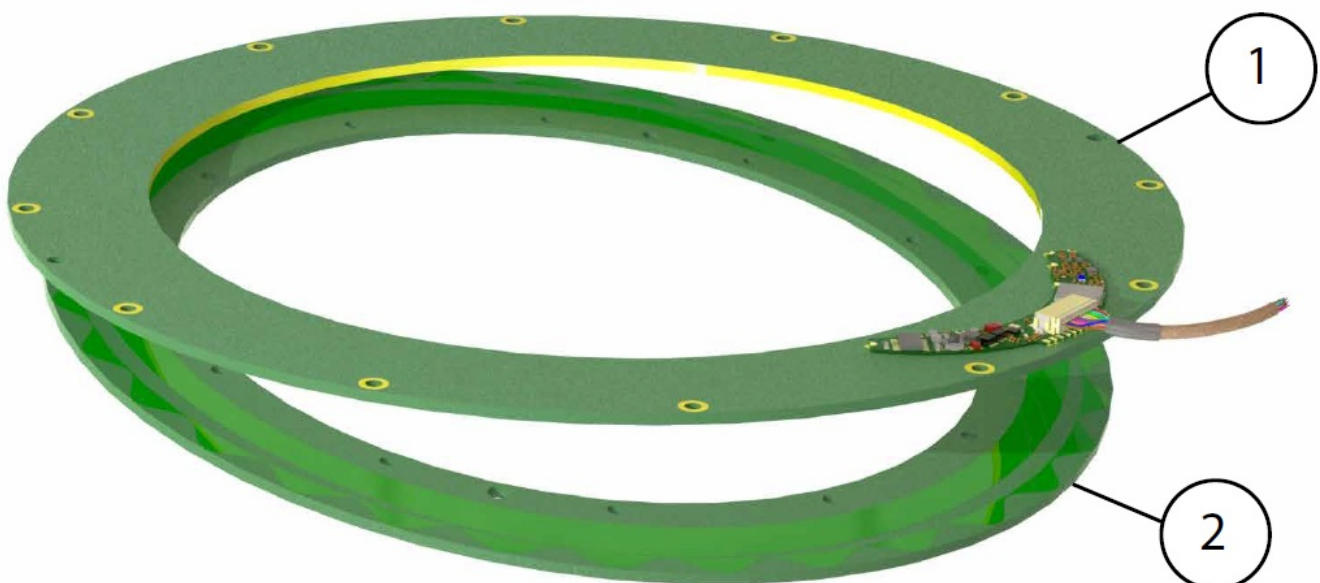
Unpacking – standard order

The package of the standard VLX-247 contains the encoder Stator & Rotor.
Optional accessories:

1. CB-00088-250, 250mm connection harness.
2. CB-00088-500, 500mm connection harness.
3. CNV-00003, RS-422 to USB converter (with USB internal 5V power supply path).
4. NanoMIC-KIT-01, RS-422 to USB converter. Setup & Operational modes via SSi /BiSS interface.
5. DKIT-VLX-247-SG-CH, Mounted SSi encoder on rotary jig, RS-422 to USB converter and cables.
6. DKIT-VLX-247-IG-CH, Mounted BiSS encoder on rotary jig, RS-422 to USB converter and cables.

Installation flow chart

```
        ┌─────────────────────┐
        │  Electric Encoder   │
        │     Software        │
        │  installation on PC │
        └─────────────────────┘
                  │
                  ▼
        ┌─────────────────────┐
        │    Mechanical       │
        │     mounting        │
        └─────────────────────┘
                  │
                  ▼
        ┌─────────────────────┐
        │    Electrical       │
        │    connection       │
        └─────────────────────┘
                  │
                  ▼
        ┌─────────────────────┐ ◄──────────────────┐
        │      Signal         │                    │
        │    verification     │                    │
        └─────────────────────┘                    │
           │              │                         │
           ▼              ▼                         │
       ┌───────┐      ┌───────┐                     │
       │  YES  │      │  NO   │                     │
       └───────┘      └───────┘                     │
           │              │                         │
           ▼              ▼                         │
   ┌─────────────┐  ┌─────────────┐                 │
   │ Calibration │  │  Mounting   │─────────────────┘
   │             │  │ correction  │
   └─────────────┘  └─────────────┘
```

Electric Encoder Software Installation

The Electric Encoder Explorer (EEE) software:

- Verifies correct mounting for an adequate signal amplitude
- Calibration of offsets
- General set up and signal analysis

    This section describes the steps associated with installing the EEE software application.

Minimum requirements

- Operating system: MS windows 7/ 10, (32 / 64 bit)
- Memory: 4MB minimum
- Communication ports: USB 2
- Windows .NET Framework, V4 minimum

Installing the software

- Run the Electric Encoder™ Explorer file found on Netzer website: Encoder Explorer Software Tools
- After the installation you will see Electric Encoder Explorer software icon on the computer desktop.
- Click on the Electric Encoder Explorer software icon to start.

Mechanical Mounting

Encoder mounting – End-of-Shaft Installation
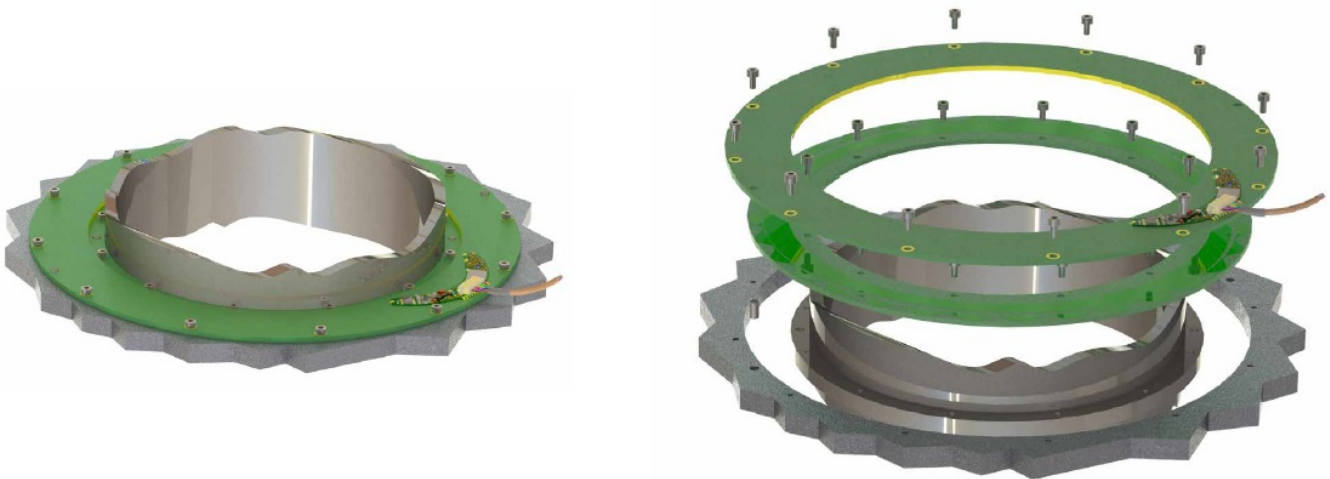
Typical encoder installation uses

- Mounting screws Socket Head Cup Screw 8xM2, 4 each per stator & rotor.
- Mounting dowel pins 4xØ2, 2 each per stator & rotor (not included with the encoder).

Encoder stator / Rotor relative position
For proper performance the air gap should be 1 mm ±0.3 mm

In an optimal mounting, the signal amplitude values generated by the encoder, would be in the middle of the range of the signal plot shown in the Encoder Explorer software (see plot below). This may vary according to the

encoder type.
Verify proper rotor mounting with the Encoder Explorer tools "Signal analyzer" or "Signal verification process."
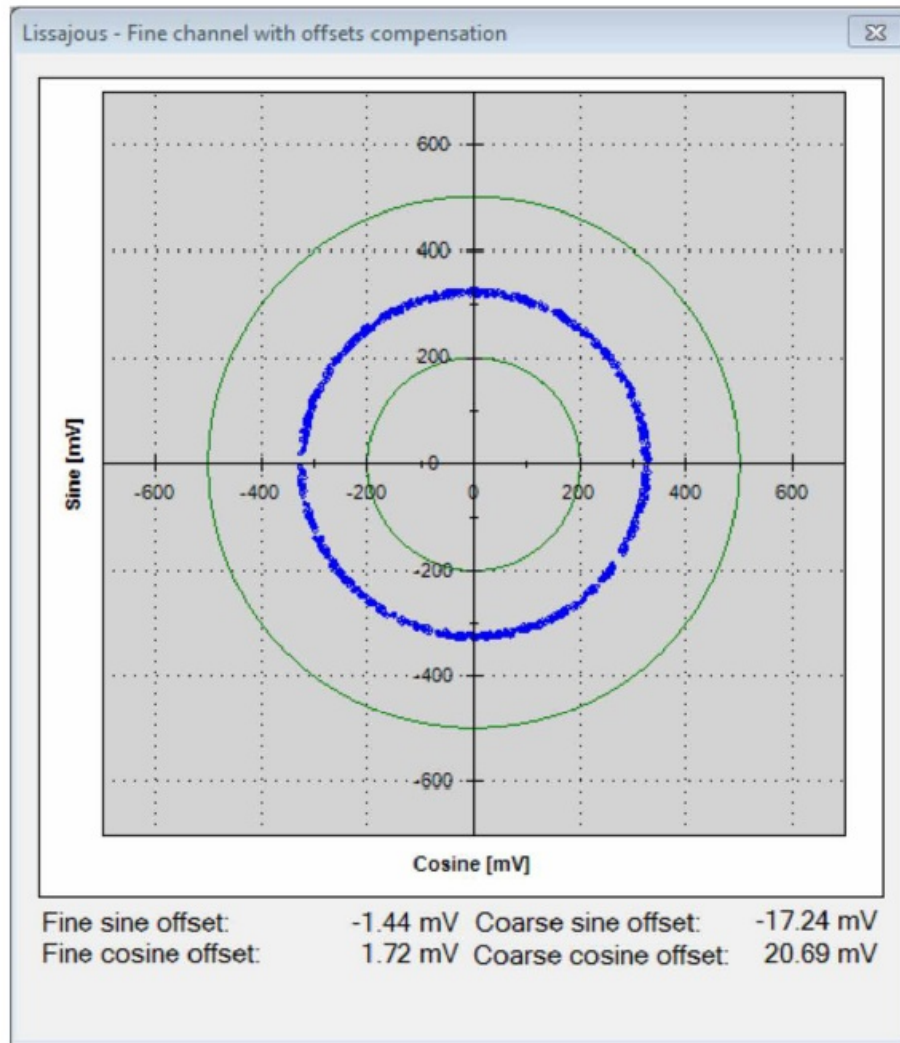
Note: for more information please read section 7

Electrical Connection

This chapter reviews the steps required to electrically connect the encoder with digital interface (SSi or BiSS-C).

Connecting the encoder
The encoder has two operational modes:

Absolute position over SSi or BiSS-C
This is the power-up default mode
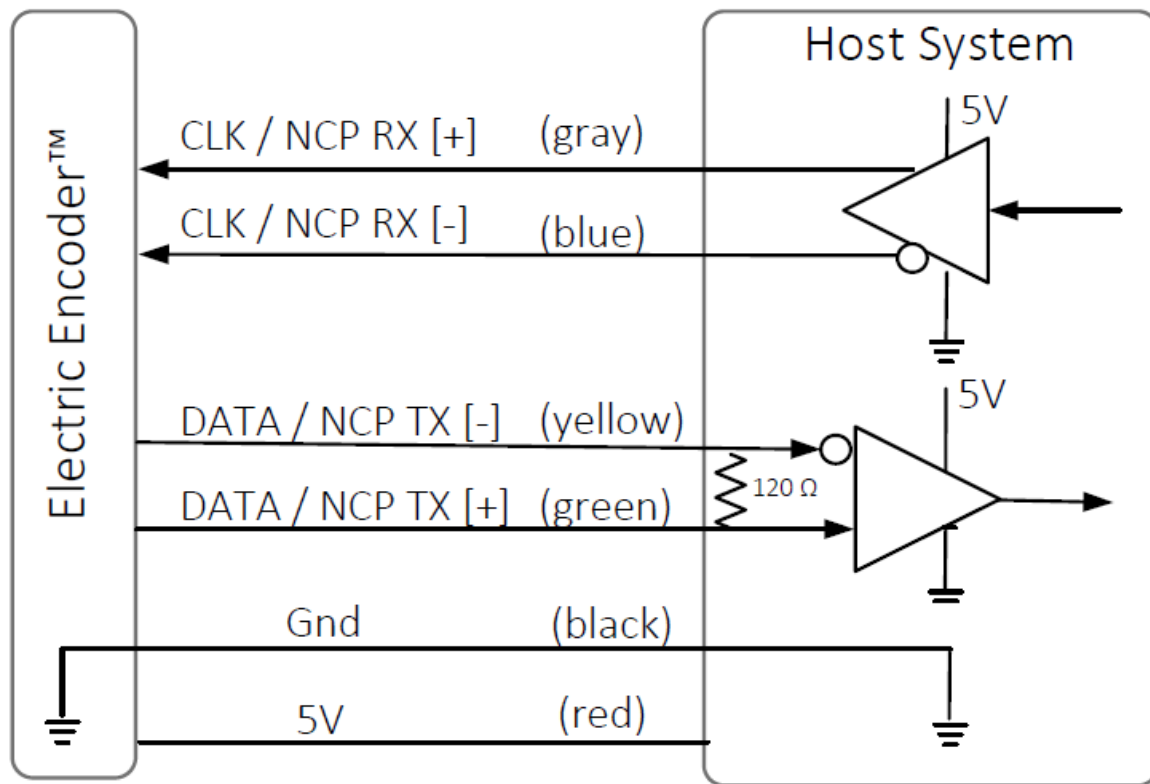
SSi / BiSS output signal parameters

Output code	Binary
Serial output	Differential RS-422
Clock	Differential RS-422
Clock frequency	0.1-5.0 MHz
Position update rate	35 kHz (Optional – up to 375 kHz)

Connector Pinout

Pin No.	SSi / BiSS	Remarks
8	+5V	P.S.
7	GND	GND / RTN
6	Data +	Data / NCP TX
5	Data –	
4	Clock –	Clock / NCP RX
3	Clock +	

Accessory cable (optional) SSi / BiSS interface wires color code

Clock +	Grey	Clock
Clock –	Blue	
Data –	Yellow	Data
Data +	Green	
GND	Black	Ground
+5V	Red	Power supply

Digital SSi Interface

Synchronous Serial Interface (SSi) is a point to point serial interface standard between a master (e.g. controller) and a slave (e.g. sensor) for digital data transmission.
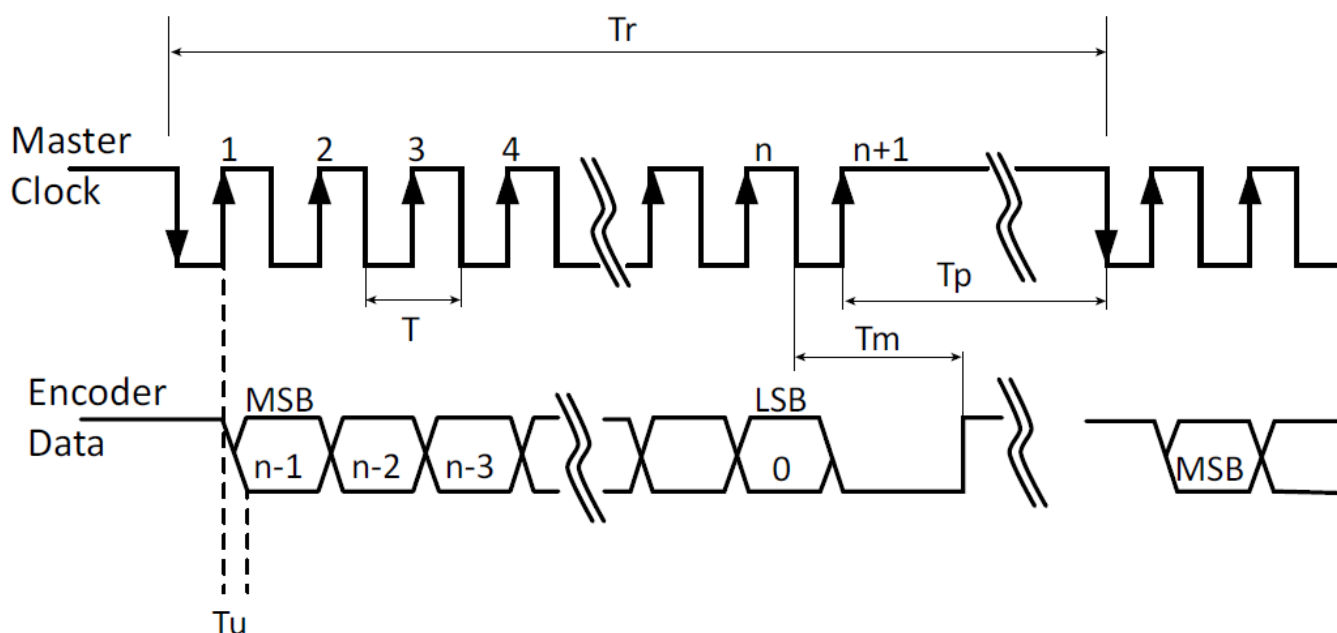
Built In Test option (BIT)

The BIT indicates critical abnormality in the encoder internal signals.

'0' – the internal signals are within the normal limits, '1' – Error

The Part Number of the encoder indicates whether the encoder includes BIT. If no BIT is indicated in the PN, there is no additional error bit.
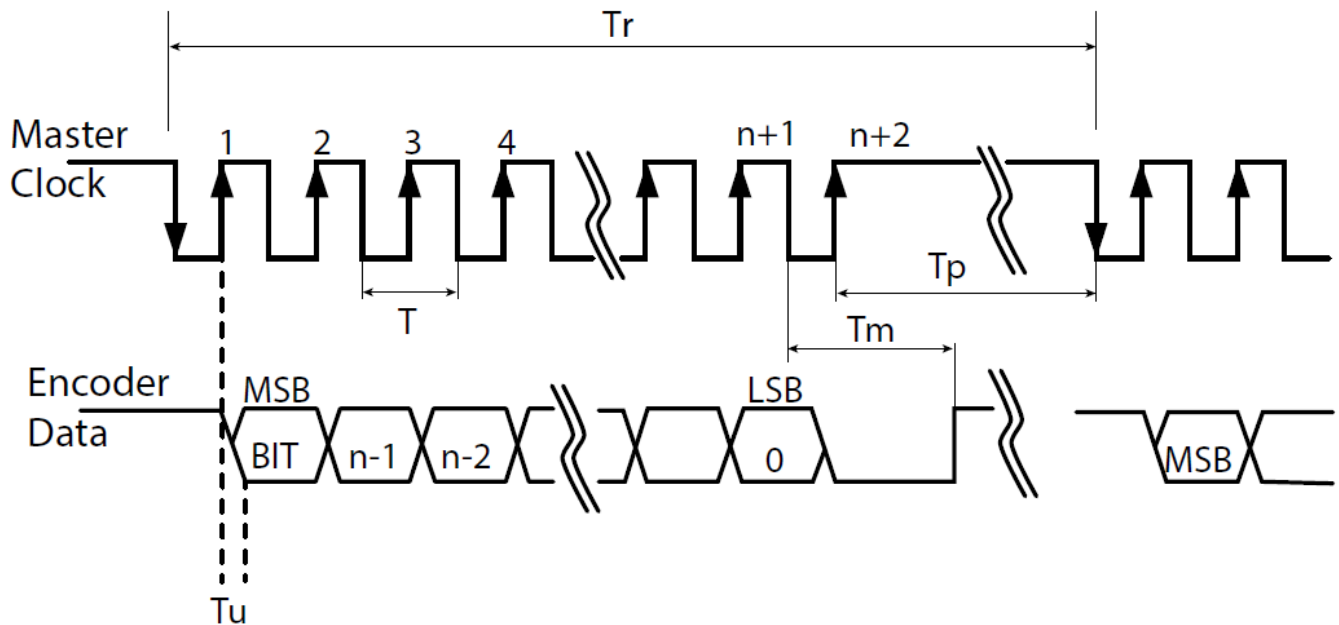
	Description	Recommendations
n	Position resolution	12-20
T	Clock period	
f= 1/T	Clock frequency	0.1-5.0 MHz
Tu	Bit update time	90 nsec
Tp	Pause time	26 – ∞ µsec
Tm	Monoflop time	25 µsec
Tr	Time between 2 adjacent requests	$Tr > n*T+26$ µsec
fr=1/Tr	Data request frequency	

Digital BiSS-C Interface

BiSS – C Interface is unidirectional serial synchronous protocol for digital data transmission where the Encoder acts as "slave" transmits data according to "Master" clock. The BiSS protocol is designed in B mode and C mode (continuous mode). The BiSS-C interface as the SSi is based on RS-422 standards.

Built In Test option (BIT)

The BIT indicates critical abnormality in the encoder internal signals.
'1' – the internal signals are within the normal limits, '0' – Error
The Part Number of the encoder indicates whether the encoder includes BIT. If no BIT is indicated in the PN, the error bit is always 1.
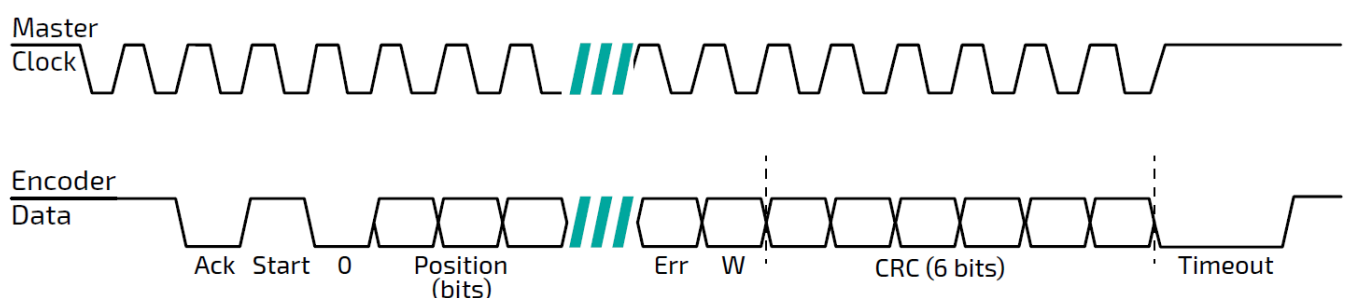
Bit allocation per encoder resolution					Description	Default	Length
17bit	18bit	19bit	20bit				
27	28	29	30	Ack	Period during which the encoder calculates the absolute position, one clock cycle	0	1/clock
26	27	28	29	Start	Encoder signal for "start" data transmit	1	1 bit
25	26	27	28	"0"	"Start" bit follower	0	1 bit
8…24	8…25	8…26	8…27	AP	Absolute Position encoder data		Per resolution
7	7	7	7	Error	BIT (Built In Test option)	1	1 bit
6	6	6	6	Warn.	Warning (non active)	1	1 bit
0…5	0…5	0…5	0…5	CRC	The CRC polynomial for position, error and warning data is: x6 + x1 + x0. It is transmitted MSB first and inverted. The start bit and "0" bit are omitted from the CRC calculation.		6 bits
				Timeout	Elapse between the sequential "start"request cycle's		25 µs

Setup mode over NCP (Netzer Communication Protocol)
This service mode provides access via USB to a PC running Netzer Encoder Explorer application (on MS Windows 7/10). Communication is via Netzer Communication Protocol (NCP) over RS-422 using the same set of wires.
Use the following pin assignment to connect the encoder to a 9-pin D-type connector to the RS-422/USB converter CNV-0003 or the NanoMIC.

Electric encoder interface, D Type 9 pin Female

Description	Color	Function	Pin No
SSi Clock / NCP RX	Gray	Clock / RX +	2
	Blue	Clock / RX −	1
SSi Data / NCP TX	Yellow	Data / TX −	4
	Green	Data / TX +	3
Ground	Black	GND	5
Power supply	Red	+5V	8

Blue Box

or

NanoMIC

Electric Encoder
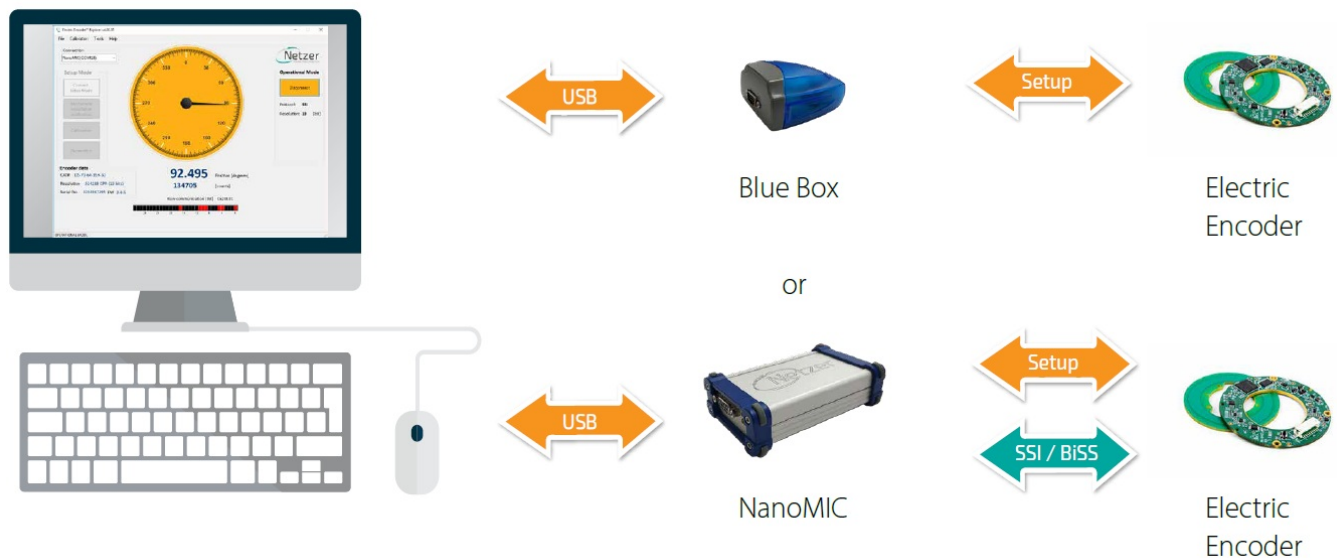
Electric Encoder

Connect Netzer encoder to the converter, connect the converter to the computer and run the Electric Encoder Explorer Software Tool

Electrical connection and grounding
Observe the following grounding consideration:

1. The cable shield electrically floating (unconnected) by default.

2. Make sure the chassis is grounded.

3. It's highly recommended to keep the motor PWM wires electrically shielded and/or kept away from the encoder.

Note: 4.75 to 5.25 VDC power supply required

Signal Verification

Starting the Encoder Explorer
Make sure to complete the following tasks successfully:

- Mechanical Mounting
- Electrical Connection to the encoder
- Encoder Explore Software Installation

Run the Encoder Explorer tool (EE)
Ensure proper communication with the encoder: (Setup mode by default).
The Encoder position-dial is colored blue when in Setup Mode, either through the NanoMic or the BlueBox (a).
Note that the operational mode is not available through the BlueBox (b).
The Signal amplitude bar indicates whether the signal is within the acceptable tolerance (c) . Note that prior to performing the Signal Verification process the bar could indicate an out of tolerance signal (d).
Encoder data is displayed in the encoder data area (CAT No., Serial No.) (e).
The position dial display responds to shaft rotation (f).
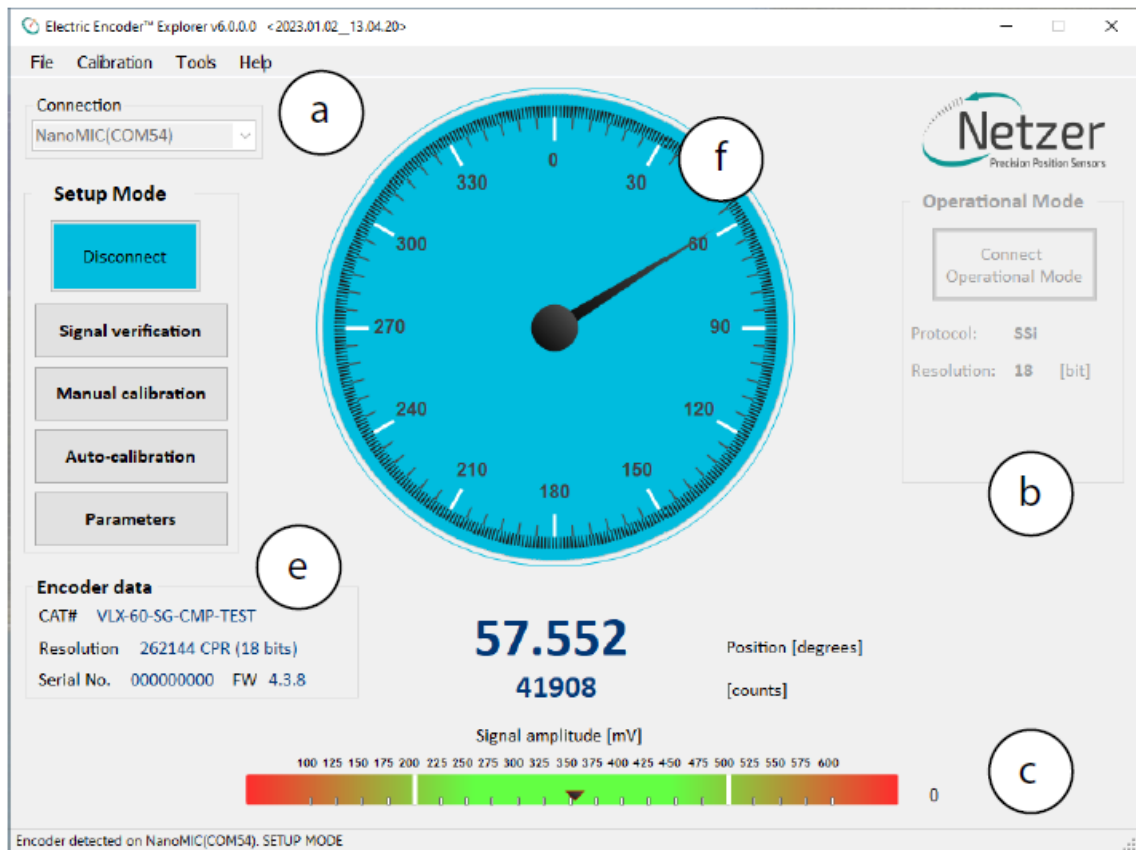
It is important to perform the Signal Verification process prior to the calibration of the encoder to ensure optimal performance.

Signal verification process
The Signal Verification process ensures that the encoder is mounted correctly and provides good signal amplitudes. This is performed by collecting raw data of the fine and coarse channels during rotation.
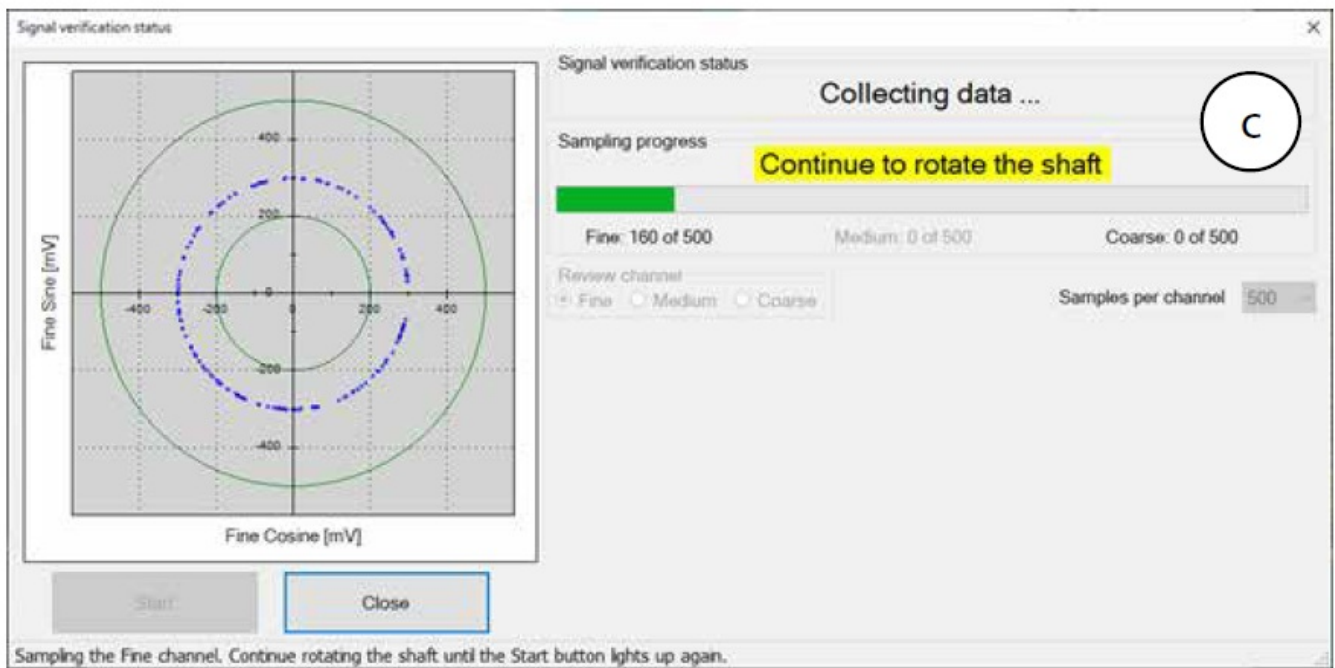
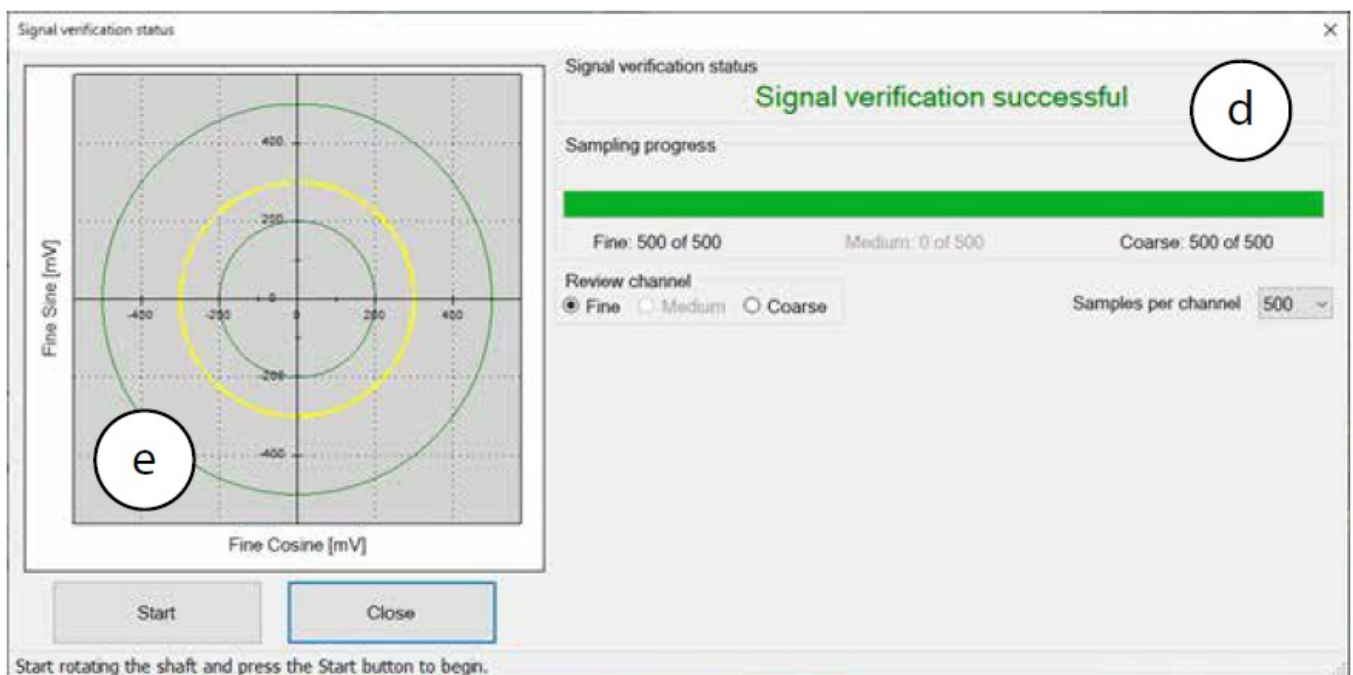Select <Signal Verification> on the main screen (a).
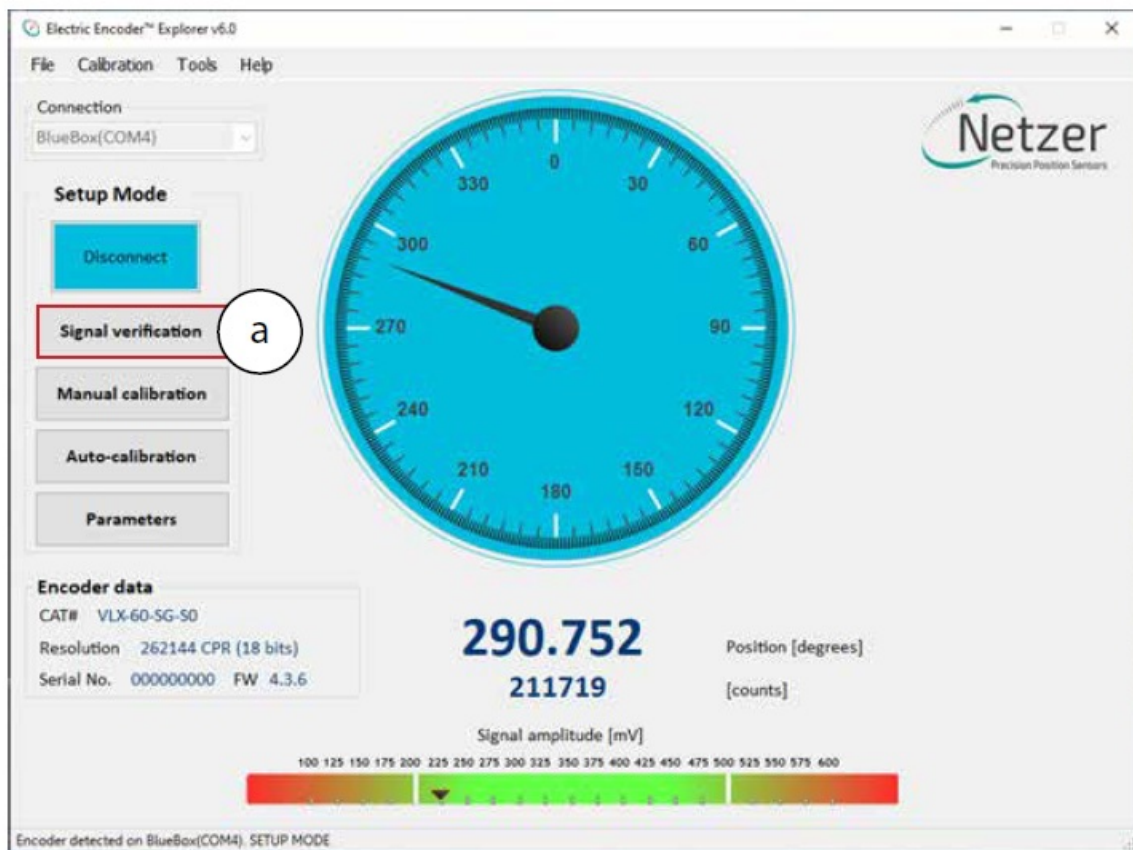
Select <Start> to initiate the process (b).
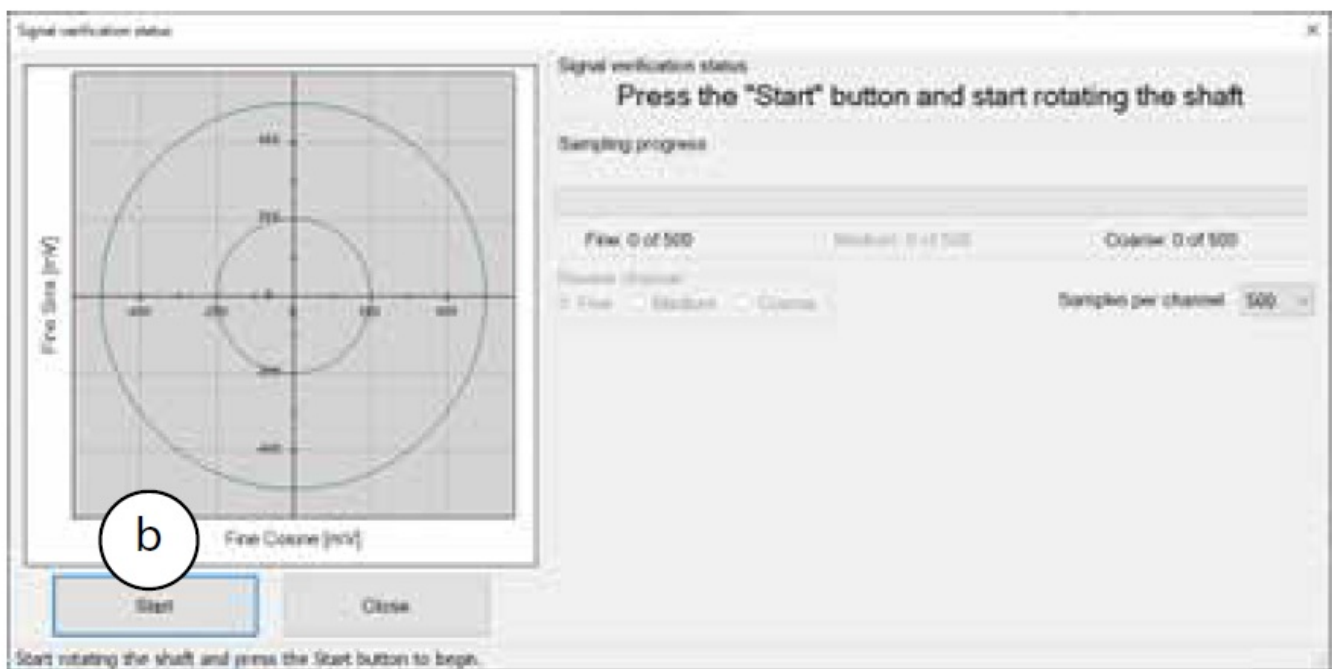
Rotate the shaft in order to collect the fine and coarse channels data (c).

If the process is successful, the status "Signal verification successful" would appear (d).
The 'amplitude circle' would be centered between the two green circles, preferably in the middle of the tolerance (e).

Note however, that mounting the encoder towards the extreme mechanical tolerances might cause the amplitude circle to be offset from the exact middle of the nominal position.
If the signal is out of tolerance the Error notification "Amplitude is lower/higher than the min/max limit of XXX" would appear (g).
In Addition, the status "Signal verification failed – perform calibration amplitude" would appear at the top (h).
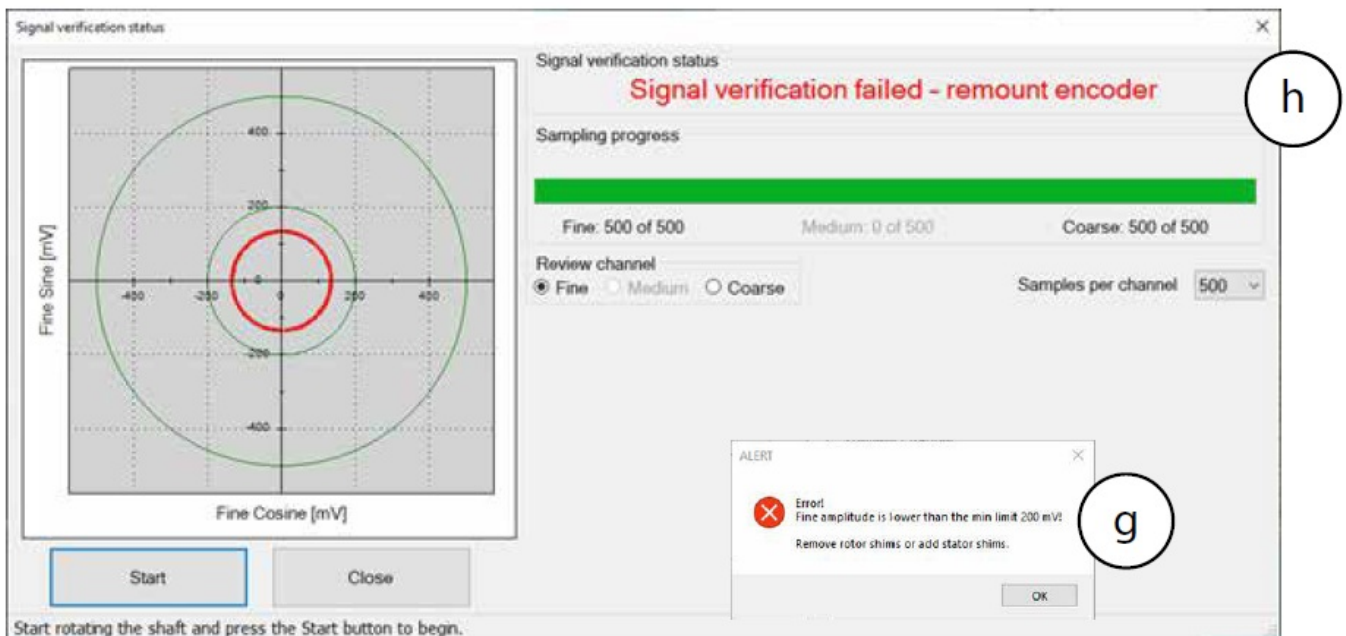
- Stop the process and re-mount the encoder, making sure that the mechanical installation tolerances are not exceeded, removing or adding shims as required.
- Repeat the Signal Verification process after the remount.

Once the signal verification process is successfully completed, proceed to the encoder calibration phase, Section 13

Calibration

The VLX encoders include several options for performing calibration:

- 'Push-Button' Calibration
- Auto-calibration
- Manual Calibration

'Push-Button' calibration
This simple calibration procedure is possible once the encoder is mounted and connected to the application, without using the Encoder Explorer software or connecting to a PC.
In this calibration procedure, the zero point cannot be changed ans is set at the factory default zero point.
It is not possible to use the Push-Button calibration if the encoder rotation sector is less than 360 degrees.

'Push-Button' calibration process
Connect a 5V power supply to the encoder and the calibration process can be started.

- Upon power connection the LED should continuously blink green.
  This means the encoder is ready for calibration
- Press the Push-Button (a) for 5 seconds.
- Continuously rotate the rotor for about 10-20 seconds.
  The LED will blink alternately red & green (b).
- When the LED is showing constant green the calibration process has ended successfully.
- If the LED blinks red this means that the calibration process failed. In case of failure – refer to the troubleshoot

table below:
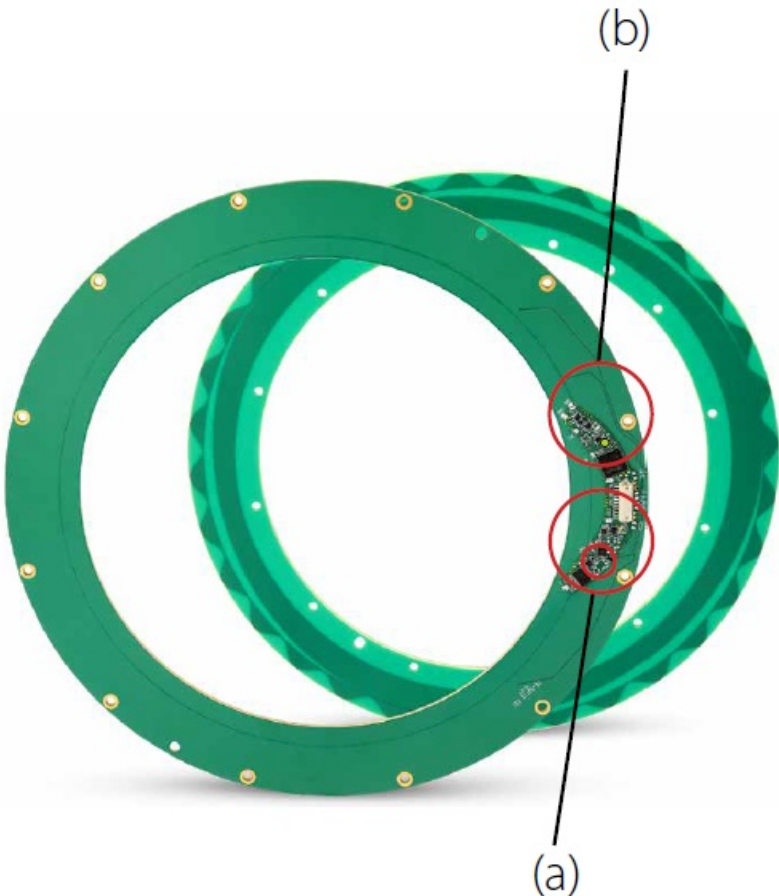
No. of blinks	Calibration step with error	Recommended corrective action
1	Noisy electrical environment	1. Improve grounding 2. Repeat calibration process
2	1. Signal Amplitude out of tolerance 2. Offsets cannot be calibrated	1. Check Amplitudes via Encoder Explorer. (See Section 12) 2. Correct the mechanical installation and remount encoder 3. Repeat calibration process
3	1. Rotation speed too high for calibration process 2. Process timed-out	Repeat calibration process at lower speed

If 'Push Button' calibration repeatedly fails after the applying the corrective actions, revert to the auto or manual calibration processes (sections 13.2 & 13.3).
If calibration still fails – contact Netzer support department.

Auto-calibration
Auto Calibration is supported by encoders with FW 4 version 4.1.3 or higher. For these encoders an additional "Auto-calibration" button is displayed.
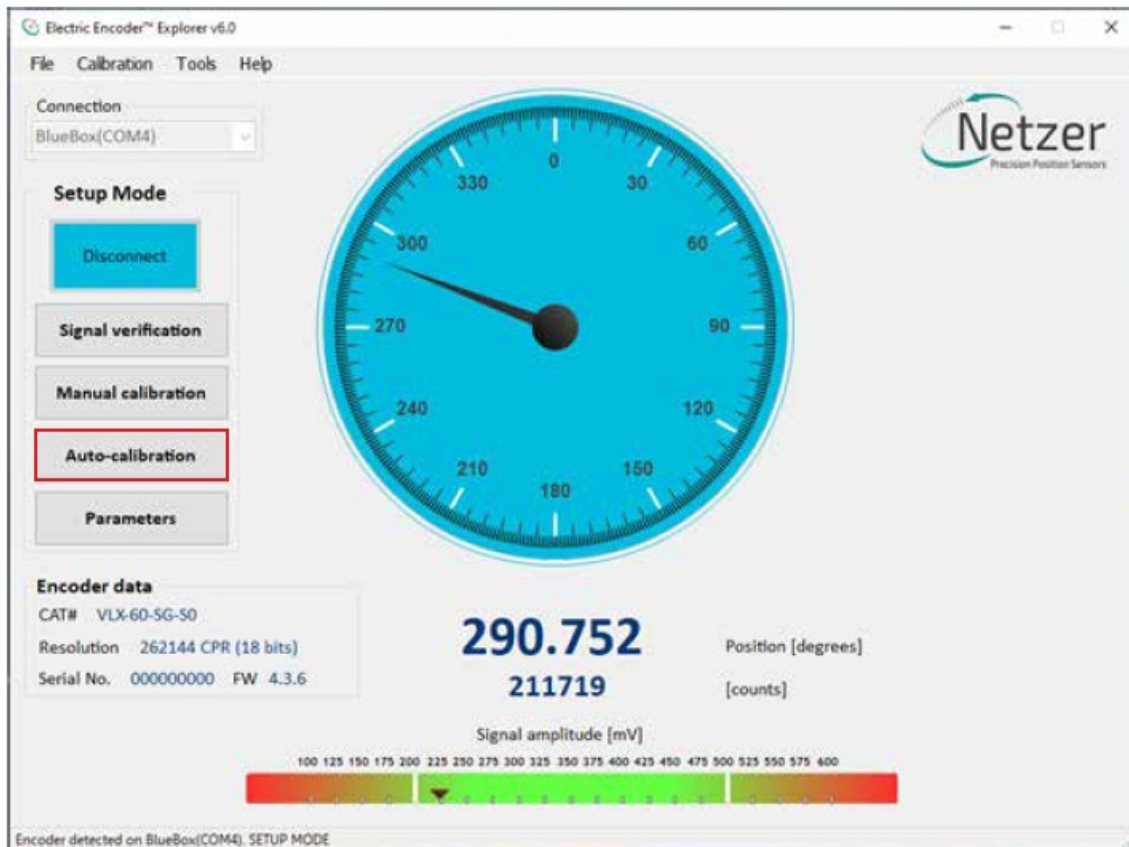
Auto-calibration process

The Auto-calibration process consists of three stages:

1. Jitter test – evaluates the electric noise for the Fine, Medium, and Coarse encoder channels. During the jitter test, the shaft must be stationary.

   Attention! The Pass/Fail criteria of the Jitter test is according to very strict factory criteria and failing it would abort the Auto Calibration process.

   However, the manual Jitter test as part of the Manual Calibration process in section 13.4, would enable the user to decide whether the jitter is acceptable to its needs.

2. Offset calibration – performs the offset calibration, the shaft must rotate continuously.

3. Absolute Position (AP) calibration – performs Coarse Amplitude Alignment (CAA) and Medium Amplitude Alignment (MAA) are calculated.

During Auto-Calibration process the encoder's Zero-Position remain in the factory default zero position for new encoders. It is possible to set the Zero Point through the top menu bar, by selecting "Calibration" tab, and clicking "Set UZP" as defined in section 13.3.

Performing Auto-calibration

Press the <Auto-calibration> button.
The main auto-calibration window opens.
Select the appropriate measurement range applicable to your application (a).
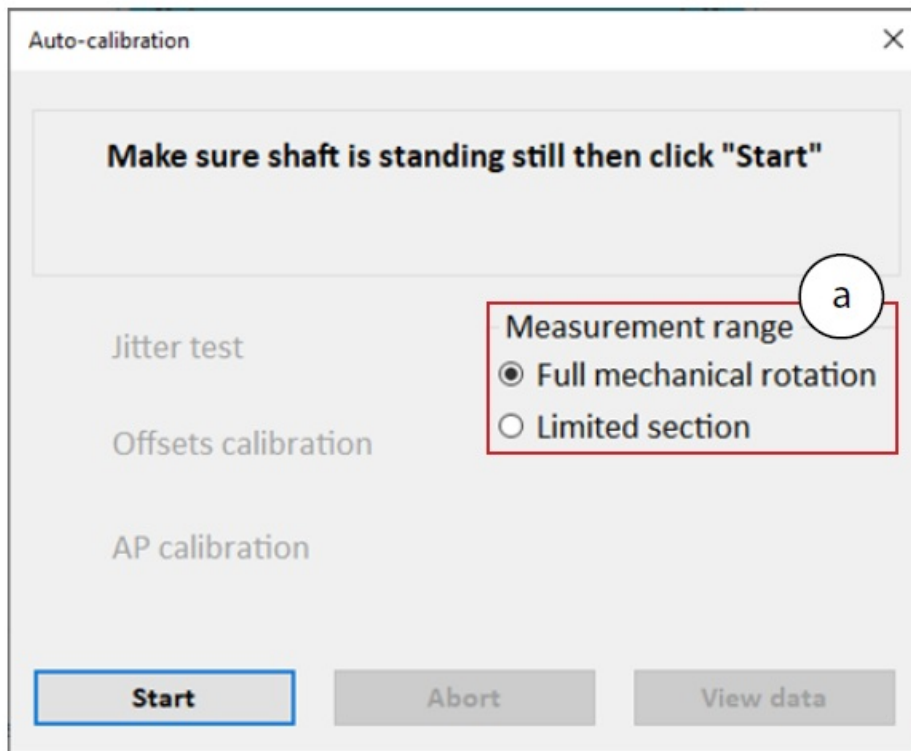
Make sure to keep the shaft still and press the <Start>

The Noise test would be performed and upon successful completion the "Noise test" label will be marked with a green check mark.
The Offset calibration would automatically start upon completion of the Noise test. This calibration requires that the shaft be rotated continuously.
The AP calibration would automatically start upon completion of the Accuracy Calibration. Continue rotating the shaft in this phase until the AP calibration is completed, and the encoder is reset.
Once the reset is over, the Auto-calibration process is successfully finished.
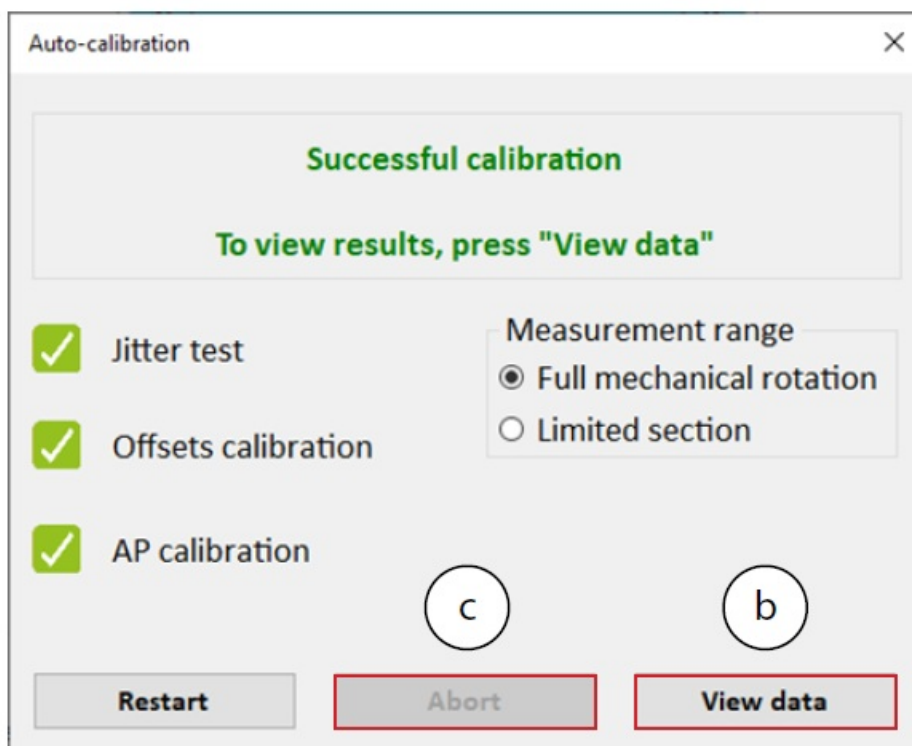
The user can review the calibration results by clicking the <View data> button (b).

It is always possible to abort the Auto Calibration process by clicking the <Abort> button (c).

Auto-calibration failures
If a test fails (for example the Noise test) – the result will be marked with in red X.

If the calibration process failed, corrective recommendations will be displayed, corresponding to the element which had failed the test.

Auto-calibration Troubleshooter   ×

Auto-calibration failed

Recommendation
1. Make sure shaft is standing still
2. Improve grounding
Then restart calibration

Press "Detailed data" button for more information

(d) **Detailed data**
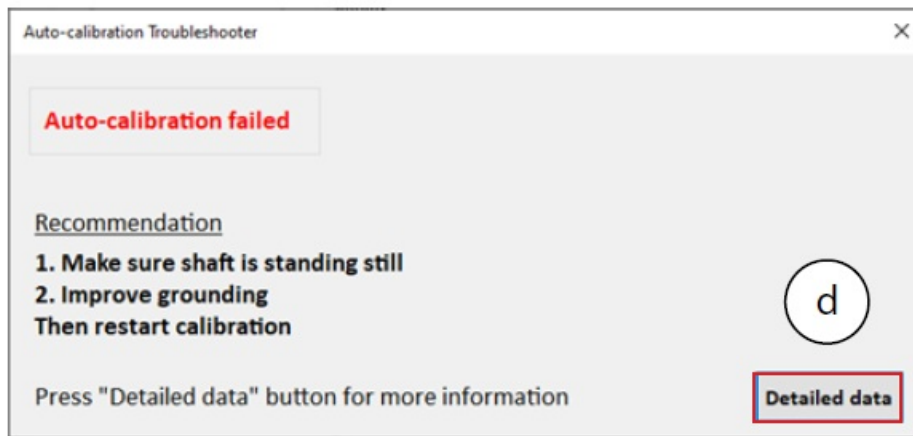
It is possible to review detailed information regarding the failure, by clicking the <Detailed data> button (d).

Failure Detailed Data   ×

Issue description

Noise test failed
Fine jitter is too big
Detected Fine jitter is 900 counts
Allowed jitter is 20 counts

Additional data for Netzer customer support

First Electrical Angle 17223
Positive counts 860
Negative counts 40
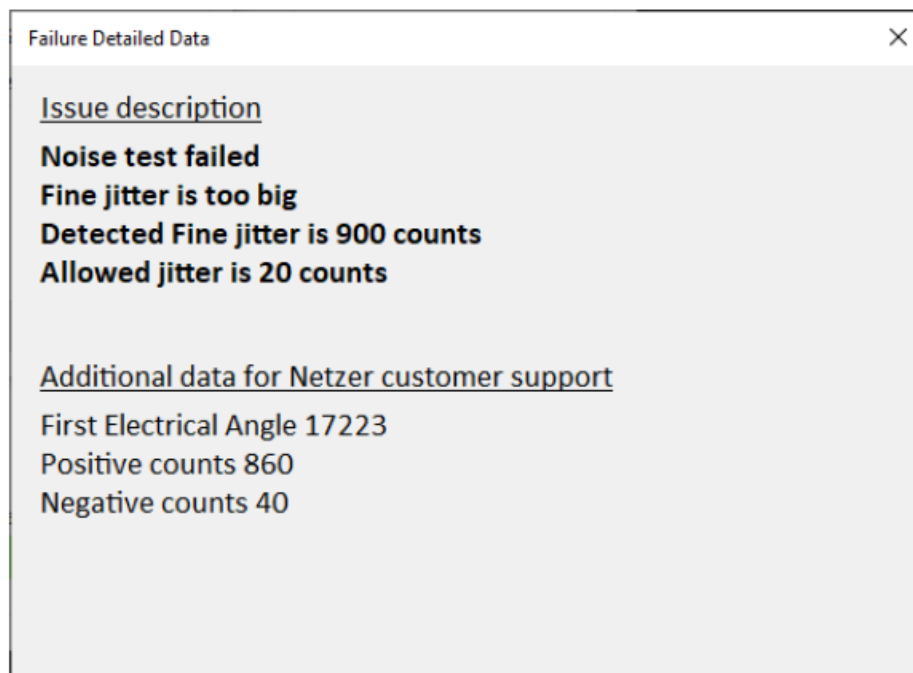
Setting the zero-position of the encoder
Select one of the options for setting the zero point and click <Apply and close>.
It is possible to set either current position or rotate the shaft to any other position to be set as the zero point.

Set User Zero Position   ×

Set current position as   0.0000   Degrees

0   Counts

☐ Advanced

Apply and close
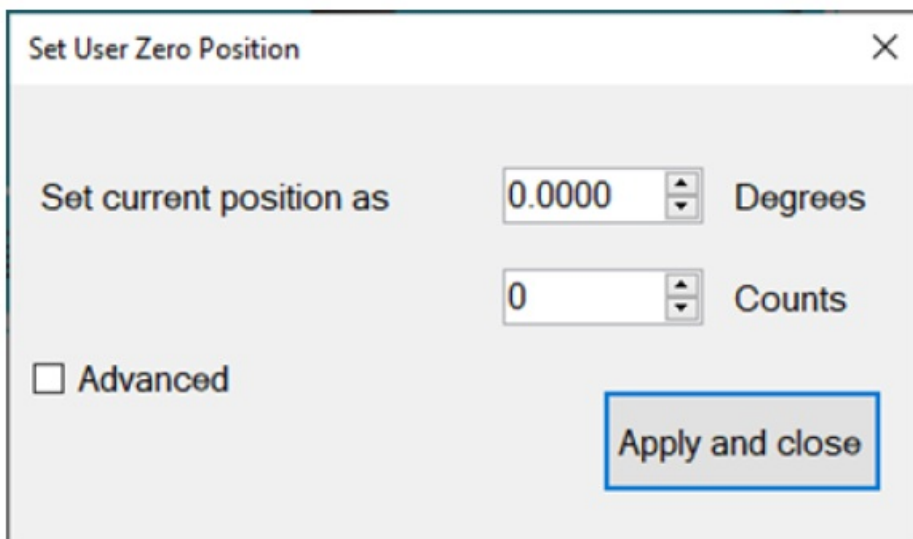
It is also possible to set the Zero Point through the top menu bar, by selecting "Calibration" tab, and clicking "Set

UZP".
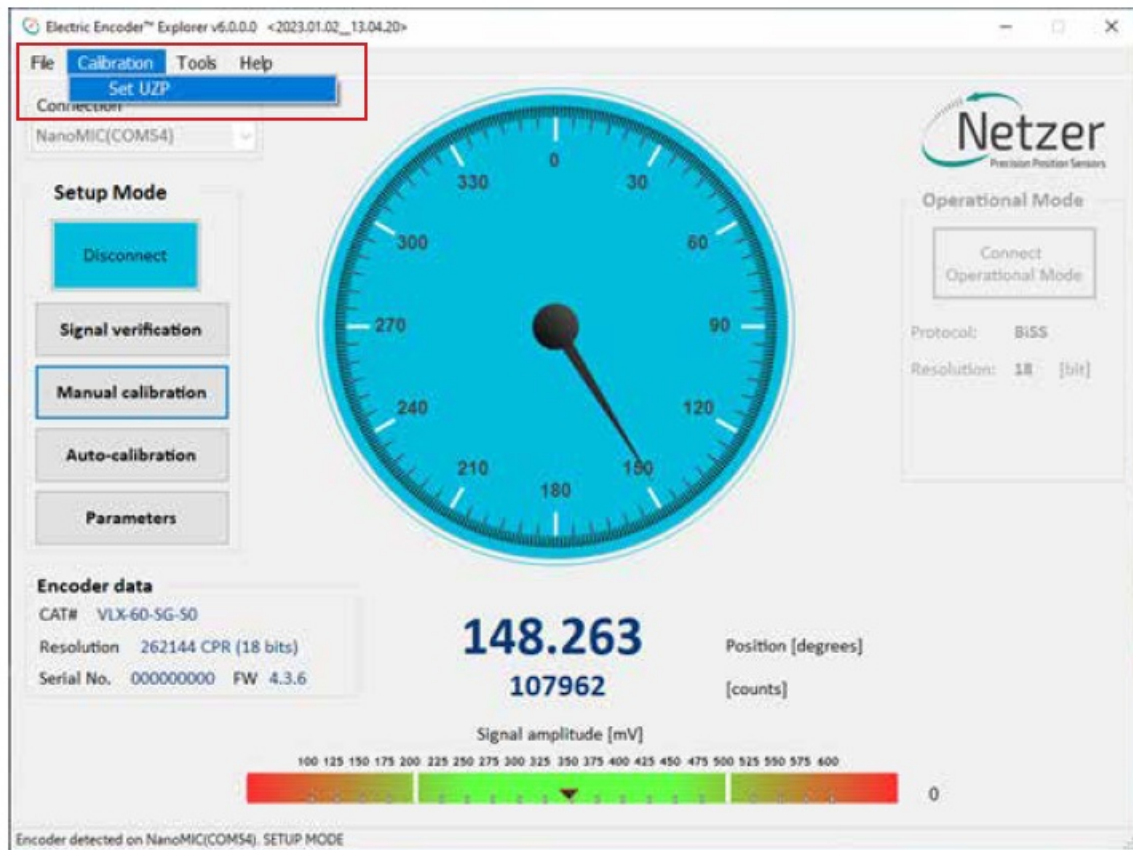
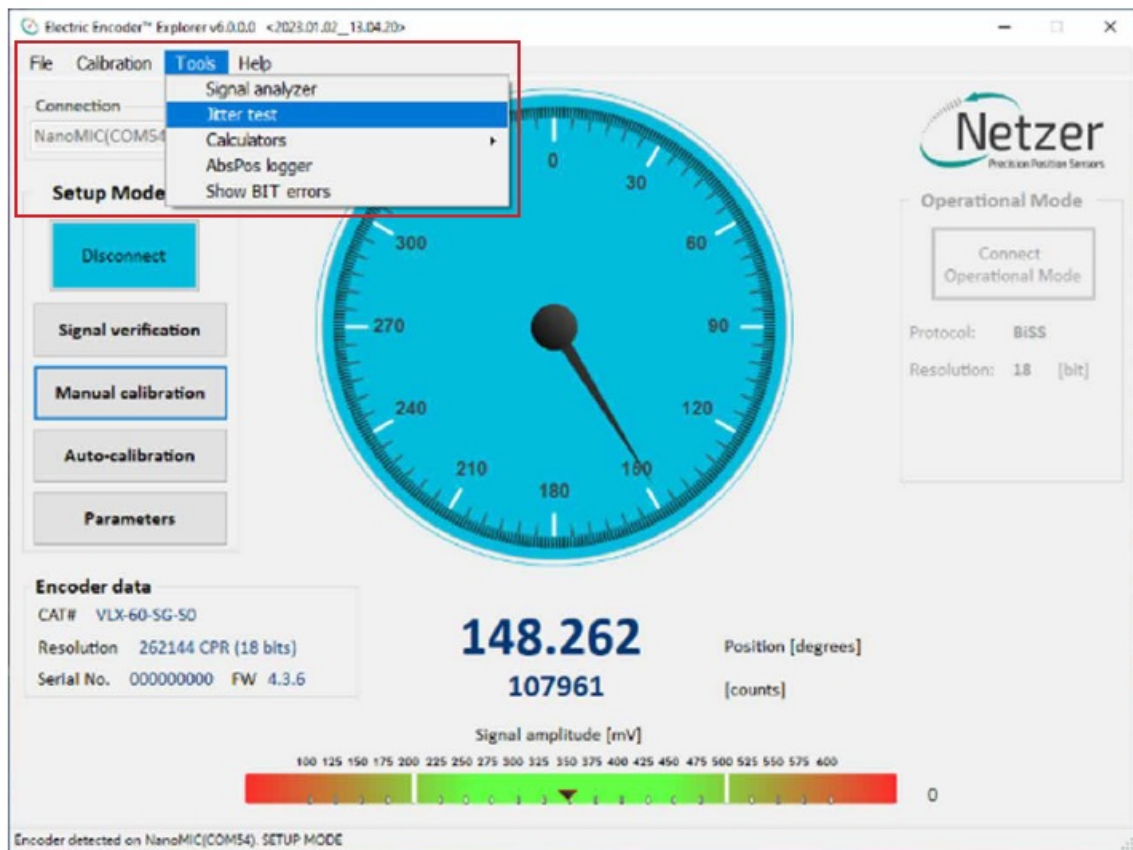**Jitter test**

The jitter test is used evaluate the level of electric noise.

Common jitter should be up +/- 3 counts; higher jitter may indicate system noise and would require better grounding or shielding of the electric noise source.

- Select "Calibration" tab, and click "Jitter Test"

- Select the Jitter test mode (a).
- Set the Timing and Sampling parameters (b).
- Click <Start> button (c) and check if the results (d) are within acceptable tolerances for the intended application.

Another indication of excessive jitter/noise when the blue dots in signal amplitude circle are not evenly distributed on a thin circle as appears below.
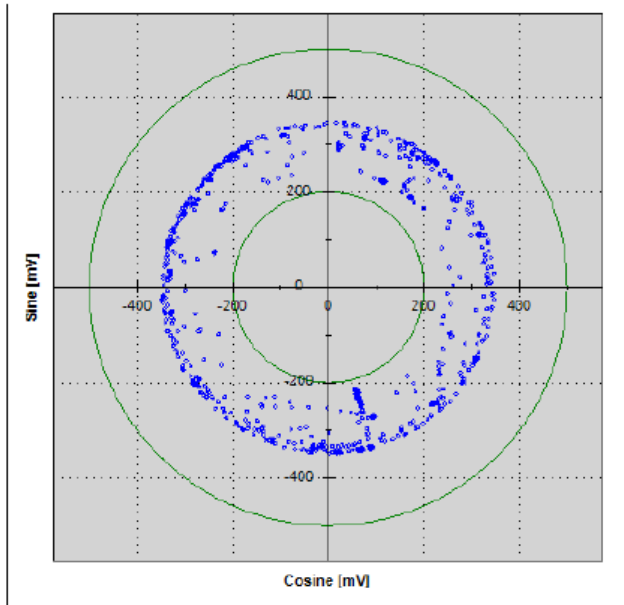
Excessive jitter/noise
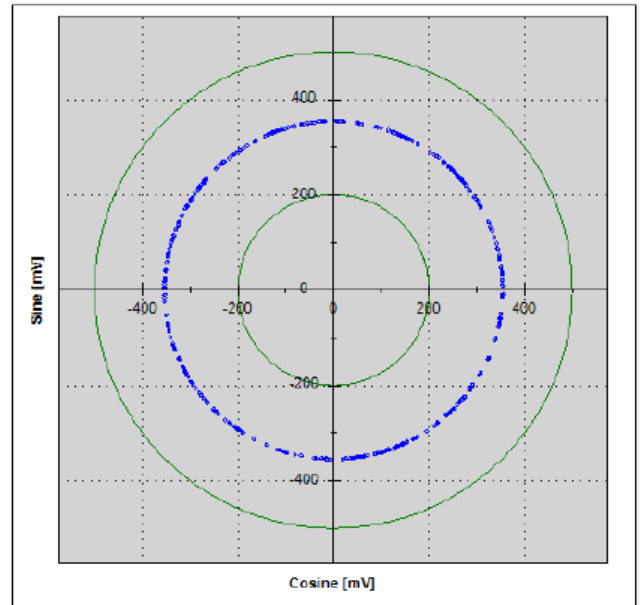

Low jitter/noise

Operational Mode

SSi / BiSS

Operational Mode indication of the SSi / BiSS encoder interface is available by using the NanoMIC to connect with the encoder. When in Operational Mode the color of the position dial is orange.
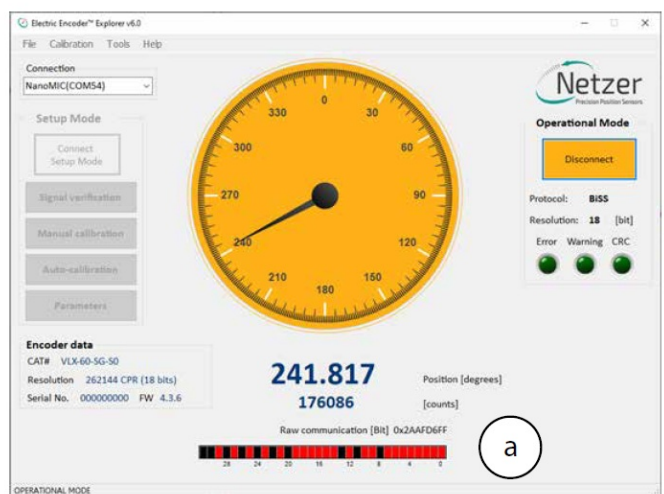
For more information read about NanoMIC on Netzer website
The operational mode is using SSi / BiSS interface with 1MHz clock rate.
The encoder position-dial is colored orange when in Operational Mode. The bar below the dial, is the corresponding binary word output for the current shaft position (a).

SSi Protocol
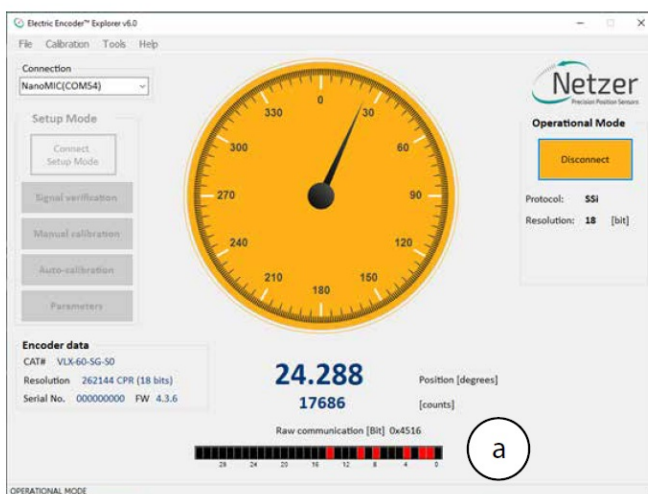
BiSS Protocol

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Documents / Resources

Netzer VLX-247 Hollow Shaft Rotary Encoder Kit Encoder [pdf] User Guide
VLX-247, VLX-247, VLX-247 Hollow Shaft Rotary Encoder Kit Encoder, VLX-247, Hollow Shaft
Rotary Encoder Kit Encoder, Rotary Encoder Kit Encoder, Encoder Kit Encoder, Encoder

References

- ⟳ **Rotary Encoders : Absolute Position Sensors by Netzer**
- **User Manual**