Table of contents

Analog encoders

.Analog encoders

.General information

The term "analog encoders" describes position encoders with the following features:

- They display actual position values by two corresponding, analog voltage signals.
- They do not feature a data memory.

.Types of design

Analog position encoders are available in rotary and linear types of construction:

- For rotary position encoders, the number of lines or cycles per revolution is specified.
- For linear encoders, the length of a division period is specified.

.Reference marks

Analog position encoders typically can only be evaluated in relative form. Absolute position measurement is only possible over one division period, the position measuring range, however, always covers many division periods. Therefore, absolute evaluation over the position measuring range is impossible. As an aid for establishing the position data reference to the axis mechanics, analog position encoders for the most part come with reference signals (reference marks).

For the resolver, a virtual reference mark is generated per pole pair on the firmware side. This reference mark can be used like an encoder-side reference mark. With an advantageous resolver selection (number of pole pairs the same as for the motor), multiple reference marks are generated per motor revolution.

For rotary encoders, the reference marks have a fixed mechanical relation to the encoder shaft.

.Encoders with resolver signals

.Application-related information for project planning

.Special case resolver encoder

As motor encoders, resolvers can be advantageously used as "absolute commutation initialization encoders" for rotary synchronous motors, if their resolution (number of pole pairs) is the same as the number of pole pairs of the motor.

See "Commutation setting", ↘ “Application-related information for project planning”

.Encoder connection

Resolver encoders can be connected via the multi-encoder input of the ctrlX DRIVE controllers (interface option EC).

.Hardware-side information

- Supported resolver ratios, stator/exciter winding:
  - 0.5 +/-10%
  - 0.286 +/-10% (EDS1-L0xxx-... devices only)
- Technical data of the power supply and signal inputs:
  See "Multi-encoder interface EC" in the Project Planning Manual of the ctrlX DRIVE controllers

.Commissioning

This is no "Plug & Play" encoder type and thus cannot be automatically configured by the "encoder scan" function!

If necessary, reduce the initialization period by deactivating the "encoder scan" function in "S-0-0602.x.1, Phys. encoder type" see also .

Configuration of encoders connected to the control section is supported by dialogs of the ctrlX DRIVE Engineering commissioning tool:

1. Go to the encoder dialog in the ctrlX DRIVE Engineering Explorer and start it with a double click,
2. Select the encoder interface for the encoder 1/motor encoder function,
3. Open the encoder selection table,
4. Select the encoder connected to the selected encoder interface

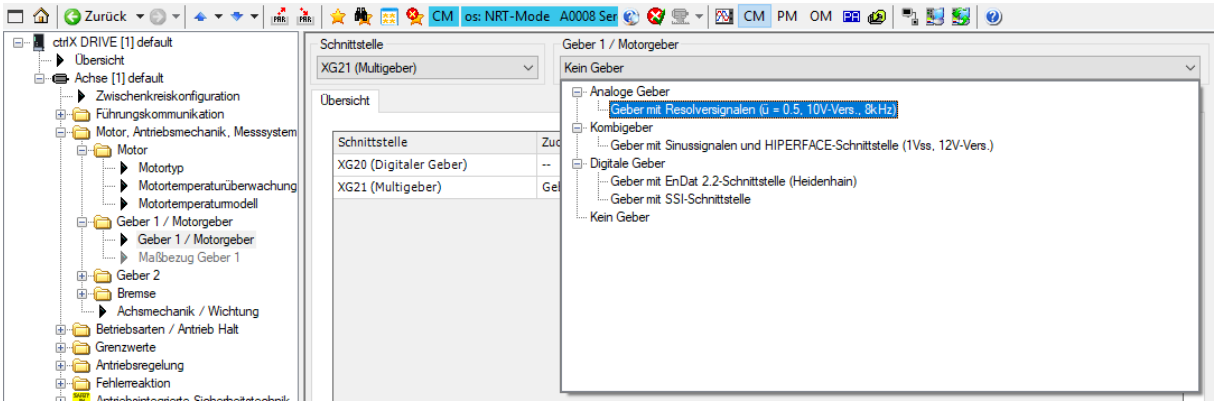


Fig. 177: Selecting the encoder interface and the analog encoder in the ctrlX DRIVE Engineering dialog, "resolver encoder" example

Analog encoders do not have an encoder data memory. The configuration of the encoder is supported by the encoder basic dialog:

- Select the type of construction of the encoder
- Enter the resolution (number of pole pairs of the resolver encoder)
- Adjust evaluation of position data to the motor: If necessary, activate inversion, to achieve actual position value increase with positive torque direction of the motor.

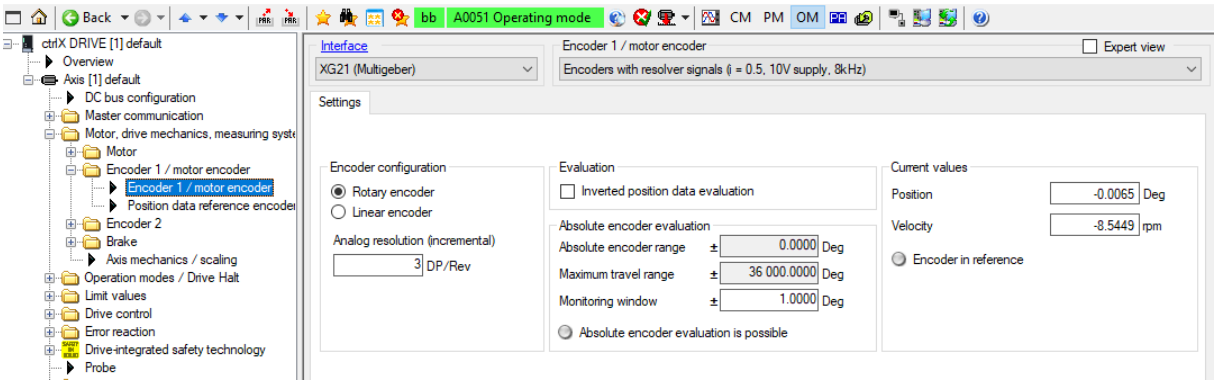


Fig. 178: ctrlX DRIVE Engineering dialog for configuring analog encoders using the example of "resolver encoder"

For detailed diagnostic messages, also Extended input data and input status can be displayed in ctrlX DRIVE Engineering:

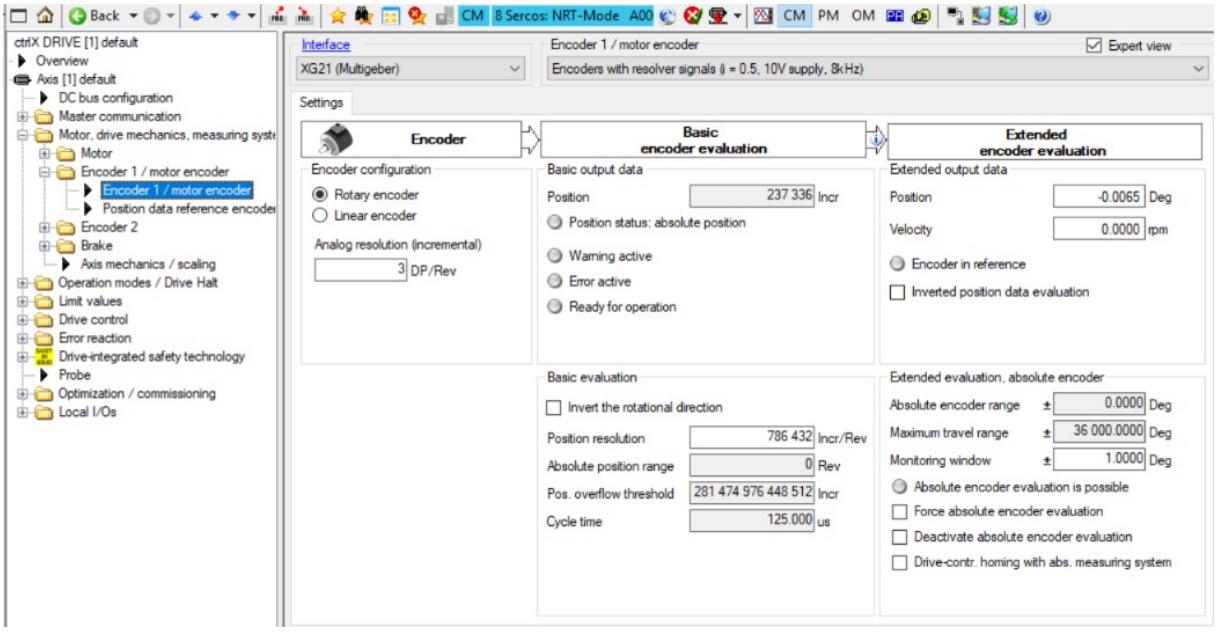


Fig. 179: Expert view of the settings dialog of ctrlX DRIVE Engineering for diagnostic purposes and for further configurations

.Track signals diagnostics

The analog voltage signals read in at the encoder interface can only be displayed in the drive-internal oscilloscope via firmware-internal patch addresses. Please contact our service and support!

.Additional information

.Encoders with resolver signals, details

.

Resolvers are rotary encoders returning two sinusoidal voltage signals with different amplitudes depending on the encoder position. They work according to the transformer principle and generate voltage signals by two windings arranged with an offset of 90° in a stator. A rotor with only one winding generates a sinusoidal, magnetic alternating field inducing voltage with rotor position-dependent amplitude in the stator windings. Due to angular offset of the two stator windings, voltage amplitudes occur in the sine-cosine ratio of the rotor position angle.

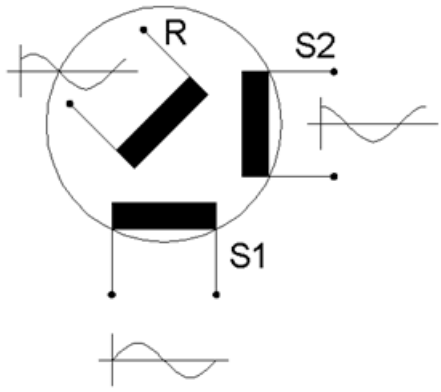
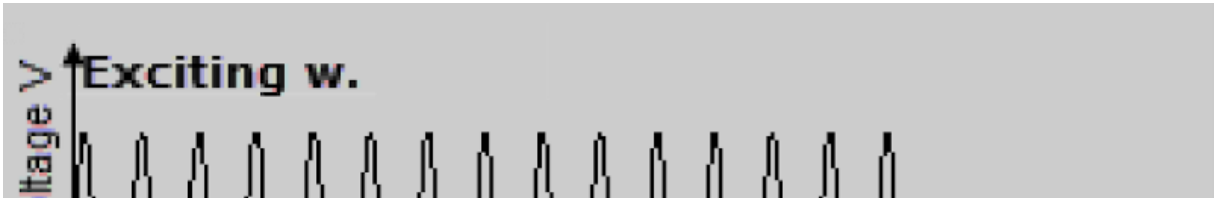


Fig. 180: Schematic diagram of a resolver

S1, S2	Stator windings, electrical offset of 90°
R	Rotor winding

."Electrical" absolute position

Due to the transformer principle, a resolver has to be supplied with sinusoidal voltage, which is generally in kHz range. The excitation of the rotor winding is carried out brushless. The rotor is connected to the shaft the angle position of which is to be determined (e.g., motor shaft). The angle position can be determined absolutely according to a rotor revolution if the windings of the rotor and stator are single pole-paired. However, they can also be multi pole-paired supporting electrical absolute position determination if synchronous motor and resolver motor encoder have the same number of pole pairs.



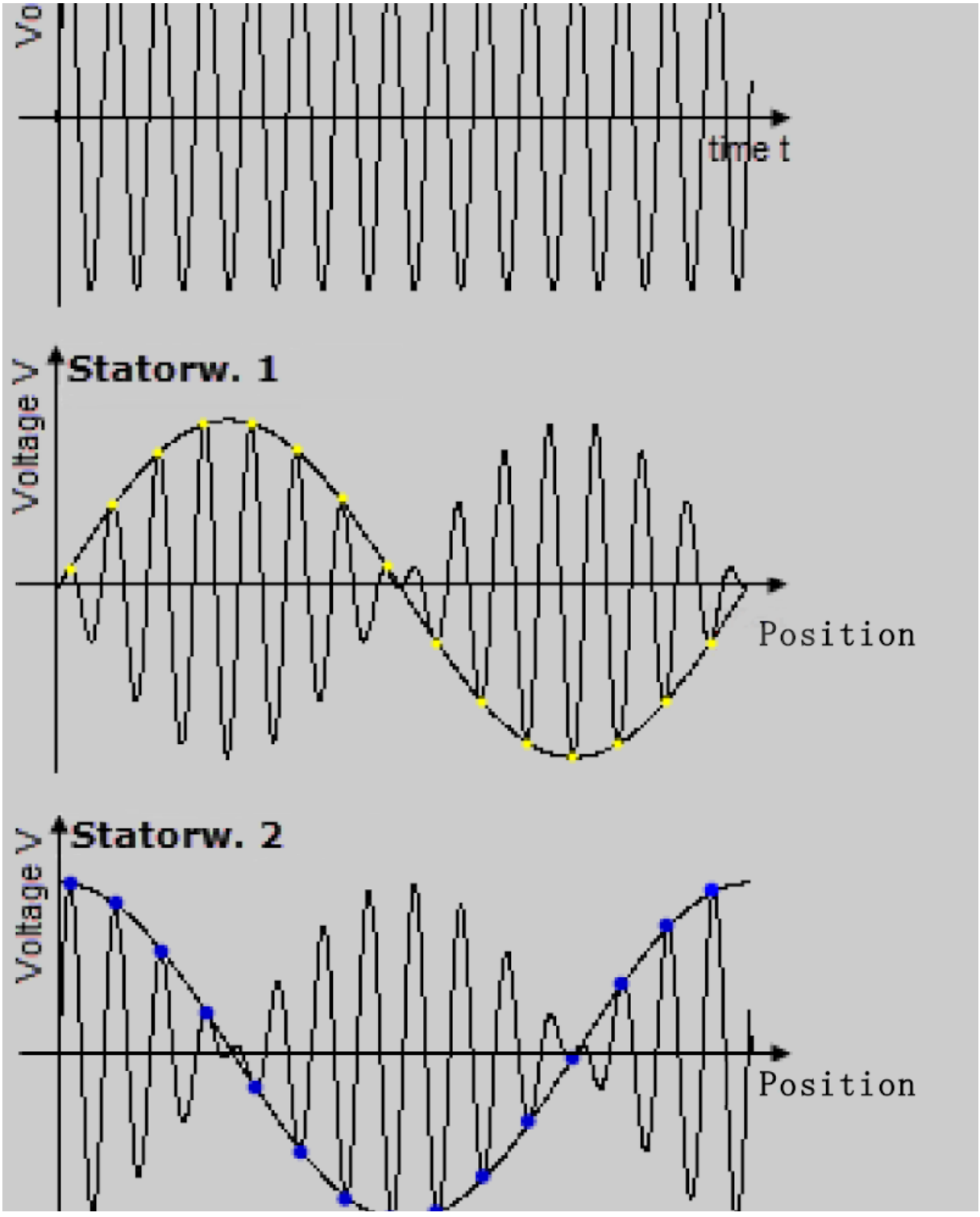

Vo
time t
Statorw. 1
Voltage V
Position
Statorw. 2
Voltage V
Position

Fig. 181: Voltage signals of resolver windings

Exciter winding	Voltage process over time
Stator winding 1	Position-dependent voltage amplitudes
Stator winding 2	Position-dependent voltage amplitudes

.Firmware-side actual position value generation

Position evaluation:

- Maximum resolution of a resolver pole pair: 2^{18}=262144 increments
- Absolute position detection and initialization within a pole pair
- Virtual reference mark per pole pair (at pole pair-related absolute position "zero")
- Track signal sampling at the optimum time
- Eightfold oversampling

The electrical encoder signals are read by the encoder interface in the velocity controller clock and immediately used to determine the actual position values.

.Encoder signal monitoring

- Signal levels of the el. stator windings with an offset of 90° by geometrical addition of both voltage amplitudes to a "pointer" (voltages at the differential inputs of the EC encoder interface):
  - Coupling factor 0.5: 3.0 Vpp < U_pointer < 6.4 Vpp
  - Coupling factor 0.286: 1.72 Vpp < U_pointer < 3.66 Vpp
- Error message at two subsequent signal level errors.

The data of the resolver voltage supply are contained in the Project Planning Manual of the ctrlX DRIVE controllers. The data of the resolver are provided by the manufacturer.

Encoders with resolver signals

.Encoders with resolver signals

.Application-related information for project planning

.Special case resolver encoder

As motor encoders, resolvers can be advantageously used as "absolute commutation initialization encoders" for rotary synchronous motors, if their resolution (number of pole pairs) is the same as the number of pole pairs of the motor.

See "Commutation setting", ↘ “Application-related information for project planning”

.Encoder connection

Resolver encoders can be connected via the multi-encoder input of the ctrlX DRIVE controllers (interface option EC).

.Hardware-side information

- Supported resolver ratios, stator/exciter winding:
  - 0.5 +/-10%
  - 0.286 +/-10% (EDS1-L0xxx-... devices only)
- Technical data of the power supply and signal inputs:
  See "Multi-encoder interface EC" in the Project Planning Manual of the ctrlX DRIVE controllers

.Commissioning

This is no "Plug & Play" encoder type and thus cannot be automatically configured by the "encoder scan" function!

If necessary, reduce the initialization period by deactivating the "encoder scan" function in "S-0-0602.x.1, Phys. encoder type" see also .

Configuration of encoders connected to the control section is supported by dialogs of the ctrlX DRIVE Engineering commissioning tool:

1. Go to the encoder dialog in the ctrlX DRIVE Engineering Explorer and start it with a double click,
2. Select the encoder interface for the encoder 1/motor encoder function,
3. Open the encoder selection table,
4. Select the encoder connected to the selected encoder interface

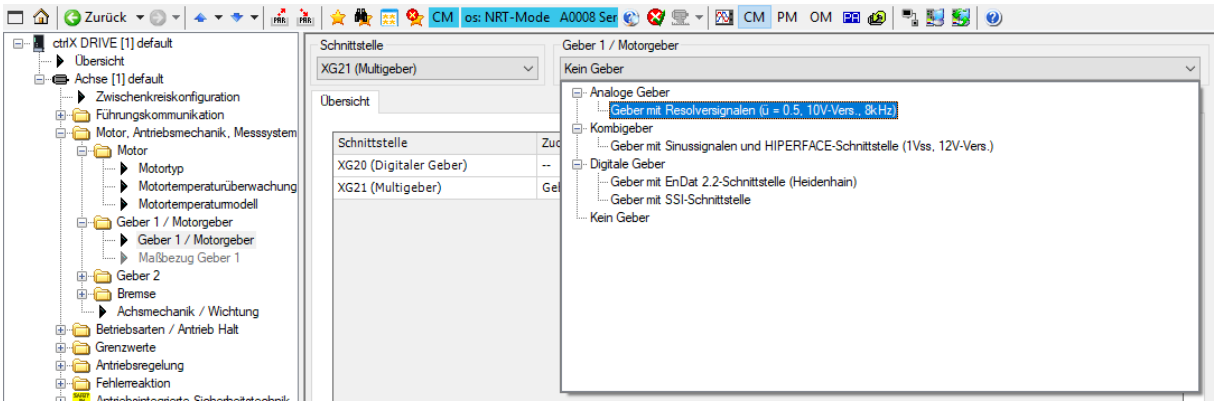


Fig. 177: Selecting the encoder interface and the analog encoder in the ctrlX DRIVE Engineering dialog, "resolver encoder" example

Analog encoders do not have an encoder data memory. The configuration of the encoder is supported by the encoder basic dialog:

- Select the type of construction of the encoder
- Enter the resolution (number of pole pairs of the resolver encoder)
- Adjust evaluation of position data to the motor: If necessary, activate inversion, to achieve actual position value increase with positive torque direction of the motor.

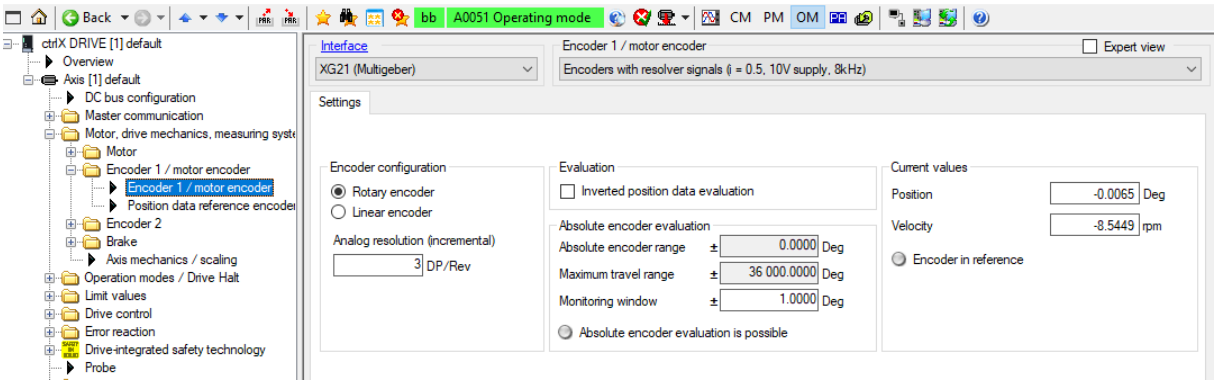


Fig. 178: ctrlX DRIVE Engineering dialog for configuring analog encoders using the example of "resolver encoder"

For detailed diagnostic messages, also Extended input data and input status can be displayed in ctrlX DRIVE Engineering:

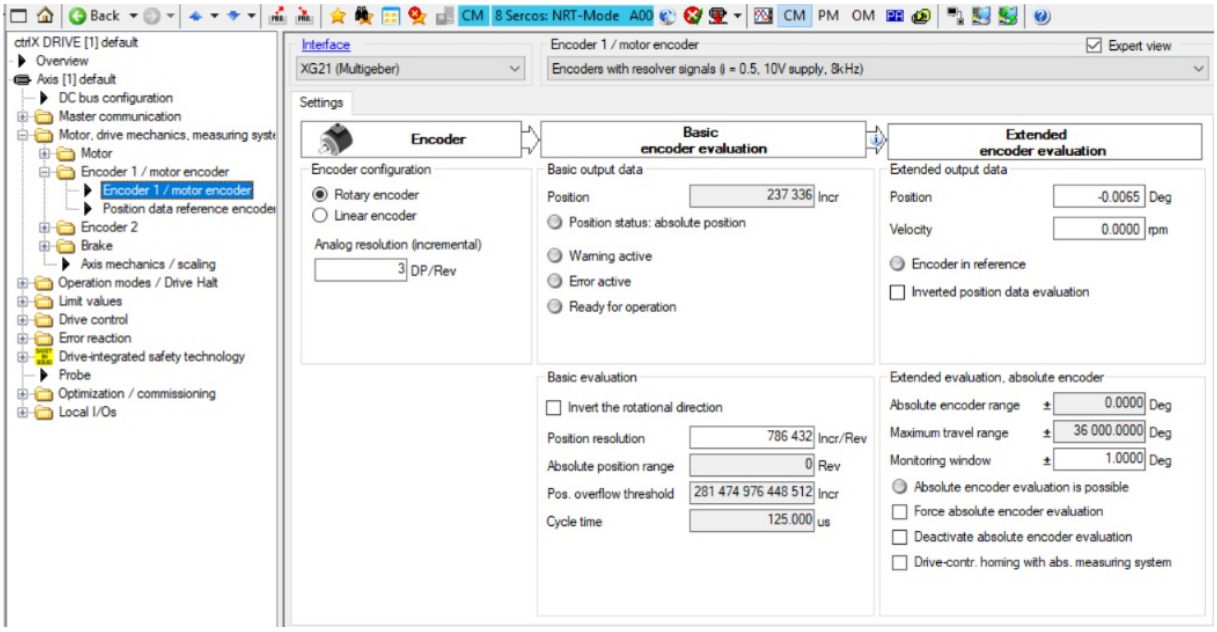


Fig. 179: Expert view of the settings dialog of ctrlX DRIVE Engineering for diagnostic purposes and for further configurations

.Track signals diagnostics

The analog voltage signals read in at the encoder interface can only be displayed in the drive-internal oscilloscope via firmware-internal patch addresses. Please contact our service and support!

.Additional information

.Encoders with resolver signals, details

.

Resolvers are rotary encoders returning two sinusoidal voltage signals with different amplitudes depending on the encoder position. They work according to the transformer principle and generate voltage signals by two windings arranged with an offset of 90° in a stator. A rotor with only one winding generates a sinusoidal, magnetic alternating field inducing voltage with rotor position-dependent amplitude in the stator windings. Due to angular offset of the two stator windings, voltage amplitudes occur in the sine-cosine ratio of the rotor position angle.

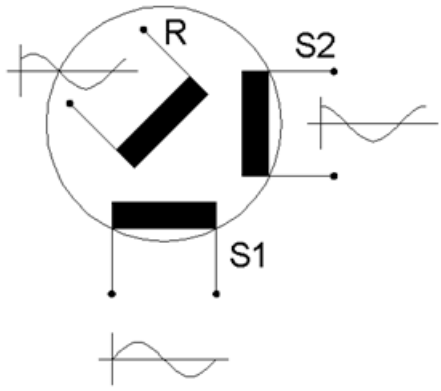


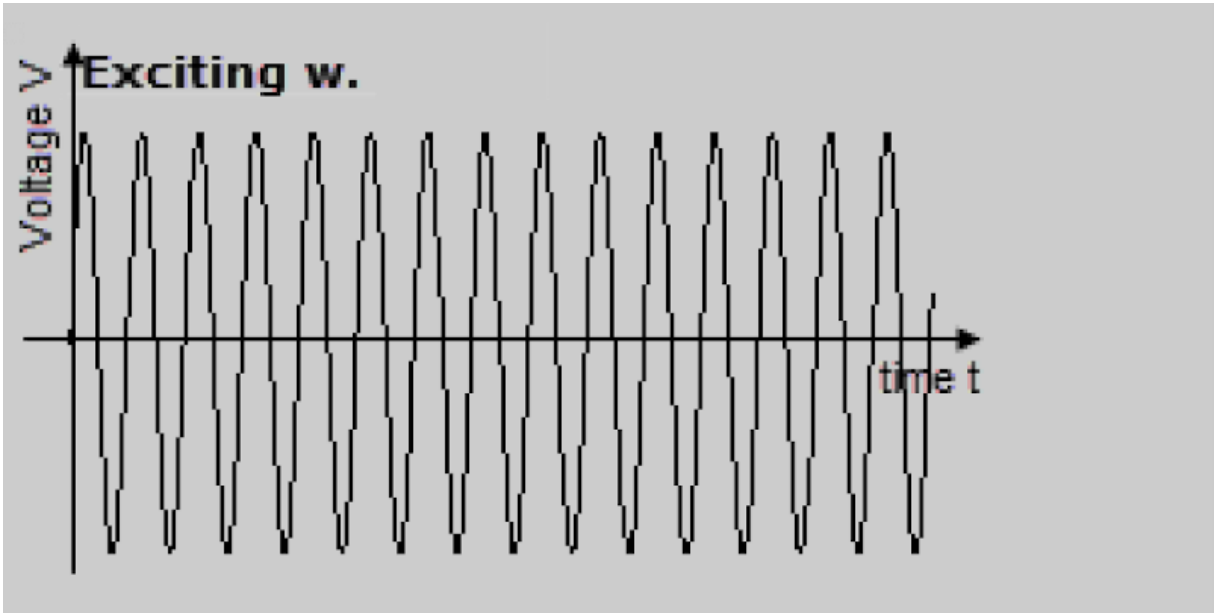
Fig. 180: Schematic diagram of a resolver

S1, S2 Stator windings, electrical offset of 90°

R Rotor winding

."Electrical" absolute position

Due to the transformer principle, a resolver has to be supplied with sinusoidal voltage, which is generally in kHz range. The excitation of the rotor winding is carried out brushless. The rotor is connected to the shaft the angle position of which is to be determined (e.g., motor shaft). The angle position can be determined absolutely according to a rotor revolution if the windings of the rotor and stator are single pole-paired. However, they can also be multi pole-paired supporting electrical absolute position determination if synchronous motor and resolver motor encoder have the same number of pole pairs.



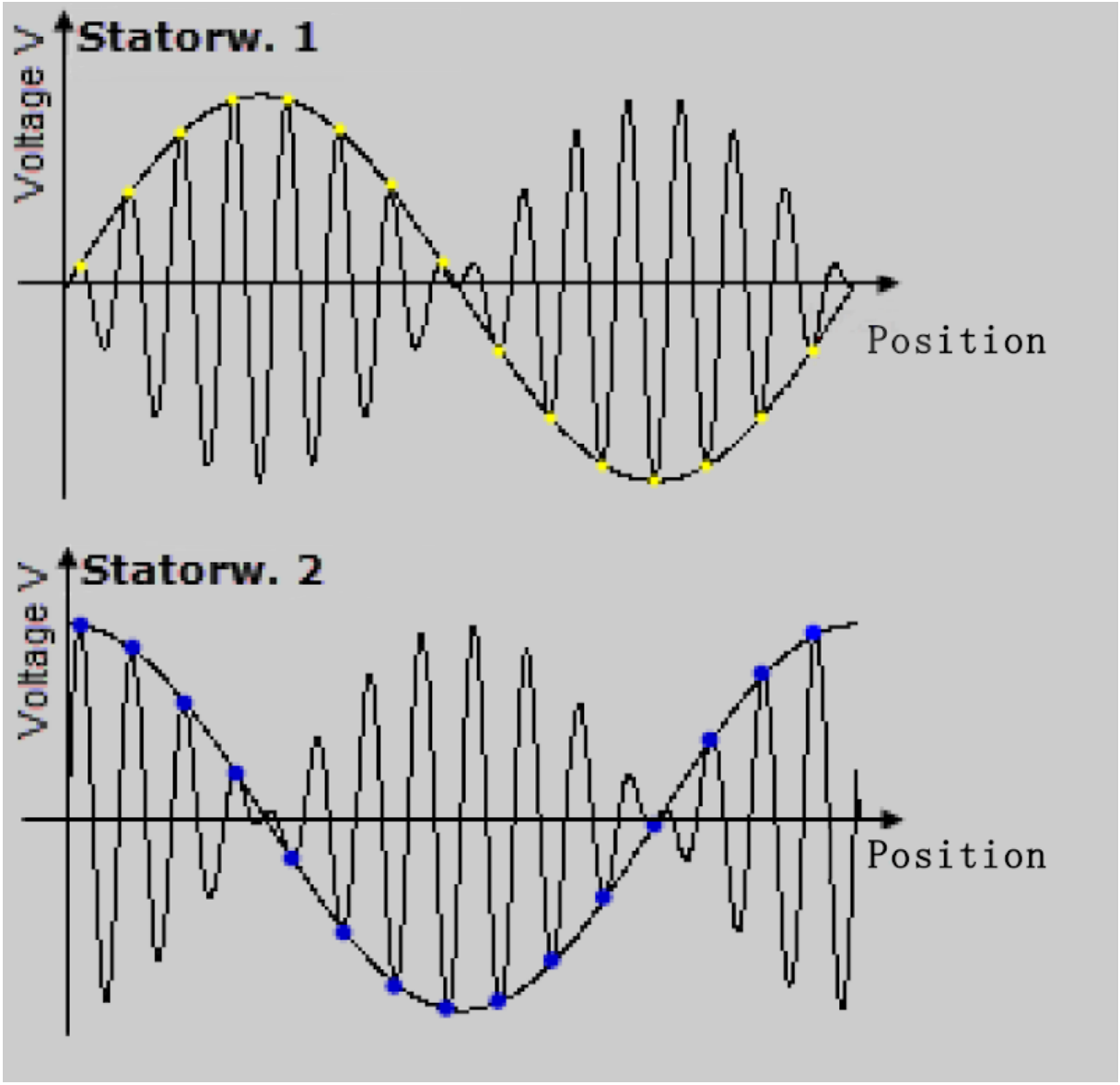


Fig. 181: Voltage signals of resolver windings

Exciter winding	Voltage process over time
Stator winding 1	Position-dependent voltage amplitudes

Stator winding 2	Position-dependent voltage amplitudes

.Firmware-side actual position value generation

Position evaluation:

- Maximum resolution of a resolver pole pair: 2^{18}=262144 increments
- Absolute position detection and initialization within a pole pair
- Virtual reference mark per pole pair (at pole pair-related absolute position "zero")
- Track signal sampling at the optimum time
- Eightfold oversampling

The electrical encoder signals are read by the encoder interface in the velocity controller clock and immediately used to determine the actual position values.

.Encoder signal monitoring

- Signal levels of the el. stator windings with an offset of 90° by geometrical addition of both voltage amplitudes to a "pointer" (voltages at the differential inputs of the EC encoder interface):
  - Coupling factor 0.5: 3.0 Vpp < U_pointer < 6.4 Vpp
  - Coupling factor 0.286: 1.72 Vpp < U_pointer < 3.66 Vpp
- Error message at two subsequent signal level errors.

The data of the resolver voltage supply are contained in the Project Planning Manual of the ctrlX DRIVE controllers. The data of the resolver are provided by the manufacturer.