

Table of contents

Digital encoders

- Encoders with ACURO®link interface
- Encoders with SSI interface
- Encoders with ctrIX SENSEmotor interface
- Encoders with EnDat2.2 interface

Digital encoders

.Digital encoders

.General information

Digital encoders provide absolute position information within the absolute measuring range of the respective encoder. The signal transmission is serial in digital format. An information unit of transmitted information is referred to as telegram. For position control with command value cycle times in the range of milliseconds, the quickness in which the actual position values are made available by serial encoders is perfectly sufficient. It is advantageous to use absolute evaluation for synchronous motor control. However, make sure the actual position values are made available sufficiently quickly.

The serial protocol can also contain information on the encoder status and on error states detected on the encoder side, or other data. In most cases, digital encoders have a data memory containing the relevant data of its own encoder required for operation and diagnostics. In addition, a memory range for user-side data (OEM memory range) can be used with some encoder types.

.Encoders with ACURO®link interface

.Application-related information for project planning

. Encoder types

Rexroth housing motors of the MS2N and MS2E types are optionally equipped with ACURO®link motor encoder:

- Encoder performance Advanced 20 bit/rev., code letter "C", "H"
- Encoder performance High 24 bit/rev., code letter "D"
- For the "encoder type" it is possible to select single-1 rev. ("S") or multi-turn-4096 rev. ("M")



Only rotary encoders are supported!

A data memory range for user data (OEM memory range) with 7.5 kbytes is available on the encoder side.

.Encoder connection

Due to the high data transmission frequency of 10 MHz that is sensitive to interference, it is recommended to use the ready-made electrical connections by Rexroth and to observe the corresponding mounting recommendations.

Position encoders with ACURO ® link interface can be connected via the standard encoder input of the ctrIX DRIVE controllers.





With the MS2N option "encoder performance C and D" (ACURO®link encoder), singlecable connection of the motor is possible. Refer to the Project Planning Manual "IndraDyn S Synchronous Servo Motors MS2N", DOK-MOTOR*-MS2N******-PR, mat. no. R911347583.

.Commissioning

.Encoder configuration

MS2N motors are optionally available with a motor encoder with ACURO®link interface. In the beginning of commissioning, "load basic parameters" should have been carried out.

The ACURO®link encoder is automatically detected when the drive controller is switched on, and also after "load basic parameters" has been carried out. The data of the motor and of the encoder from the encoder data memory are already available in the controller in CM.



This is a "Plug & Play" encoder type which is configured automatically via the "encoder scan" function!

If it is required to reduce the initialization period, deactivate the "encoder scan" function in "S-0-0602.x.1, Phys. encoder type". See also .

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Id ctrlX DRIVE [1] default	Interface XG20 (Digitaler Geber) ~ Settings	Encoder 1 / motor encoder Encoders with ACURO®Ink interface (10MHz, 12V supply)	Expert view
Motor Motor Fincoder 1 / motor encoder Fincoder 1 / motor encoder Fincoder 1 / motor encoder Fincoder 2 Fincoder 2 Fincoder 2 Fincoder 3 Brake Avis mechanics / scaling Operation modes / Drive Halt Fincoder 2 Divise control Fincoder 3 Error reaction	Encoder configuration Rotary encoder Linear encoder	Evaluation Inverted position data evaluation Absolute encoder evaluation Absolute encoder range ± 0.0000 Deg Maximum travel range ± 36 000.0000 Deg Monitoring window ± 1.0000 Deg Monitoring window ± 1.0000 Deg Monitoring window ± 1.0000 Deg	Current values Position 0.0000 Deg Velocity 0.0000 rpm Encoder in reference

Fig. 182: ctrlX DRIVE Engineering encoder basic dialog for ACURO®link encoder (encoder option of MS2N motor)

.Encoder diagnostics

Diagnostics of the drive are chronologically listed in the "diagnostic trace" of the controller. The listing in the diagnostic trace can be comfortably displayed in ctrIX DRIVE Engineering. If encoder errors or warnings have occurred, these are registered in the respective bits of "S-0-0600.x.1, Encoder status" and listed in the diagnostic trace.

The encoder status is also displayed in the "Expert view" of the encoder dialog:



ctrlX DRIVE [9] default	Interface	Encoder 1 / motor encoder	Expert view
Overview	XG20 (Digital encoder) ~	Encoders with ACURO®link interface (10MHz, 12V supply))
Constant of the sum of the second secon	Settings		
	Encoder	Basic encoder evaluation	Extended encoder evaluation
	Encoder configuration Rotary encoder Linear encoder Digital resolution (absolute) 1 048 576 - 	Basic output data Position Position Position status: absolute position Warning active Fror active Ready for operation	Extended output data Position
Contraction Solution Solution Probe Coptimization / commissioning Cocal I/Os		Basic evaluation Invert the rotational direction Position resolution Absolute position range 4096 Pos. overflow threshold 4 294 967 296 Incr Cycle time 0.000 us	Extended evaluation, absolute encoder Absolute encoder range ± 214.748.3647 Deg Maximum travel range ± 36.000.0000 Deg Monitoring window ± 1.0000 Deg Absolute encoder evaluation is possible Force absolute encoder evaluation Deactivate absolute encoder evaluation Drive-contr. homing with abs. measuring system

Fig. 183: Expert view of the settings dialog of ctrIX DRIVE Engineering for diagnostic purposes and for further configurations

.Additional information and details

The ACURO®link interface is a digital interface for Hengstler encoders for bidirectional, serial and secure communication between sensors, actuators and controls. The actual position values cyclically transmitted in so-called "telegrams" have an ACURO®link-specific transmission protocol:

.Protocol specification

- Telegram length: 4 bytes transmission, 20 bytes reception
- Diagnostic bits: 1 error, 1 warning bit
- Checksums: 8 bits (CRC), 16 bits (CRC) for position (standard and safety telegram), 32 bits (CRC) for total telegram (safety telegram only)
- Position bits: 24 bits with single-turn, 12 bits with multi-turn
- Transmission: 115 kBaud (initialization, acyclic operation), 10 MBaud (cyclic operation), transmission type: Semiduplex

.Features of ACURO®link encoders

Encoders with ACURO®link interface are an encoder option for MS2N motors. They have an encoder data memory containing the manufacturer-side motor and encoder data ("electronic type plate"), including:

- Single-turn resolution: "S-0-0602.x.22, Phys. encoder resolution (digital)"
- Multi-turn range: "S-0-0601.10.23, Absolute position range" (no battery required!)
- Mechanical maximum velocity
- Encoder serial number: "S-0-0611.x.136, Serial number of encoder" unit-specific

Other features:



- Virtual reference marks at every single-turn overflow
- The encoder memory makes available an OEM memory range for user data.
- The encoder provides a standard telegram and two safety telegrams.
- Transmission of the motor temperature if a temperature sensor is connected to the encoder.

.Monitoring and diagnostics

- Telegram monitoring by means of several CRC (Cyclic Redundancy Check) of the data transmitted by the encoder. From this, warnings and error states can be derived.
- The bits for "error" and "warning" are set in "S-0-0600.x.1, Encoder status" if warning or error states occur.

.Application as motor encoder

There is a time offset between the recording of actual position values and their availability for drive control due to the serial transmission of the position data. Due to the transmission rate of 10 MHz for the cyclic position and status data, the time offset between the recording of actual position values and their availability for motor control is sufficiently small in the case of serial transmission by the ACURO®link format.

.Transmission of motor temperature

The ACURO®link protocol can also transmit additional information (motor temperature) besides the position data. For this purpose, the following requirements must have been complied with:

- A temperature sensor has to be connected to the dedicated connection points of the encoder.
- Transmission of the motor temperature has to be activated in "P-0-0512, Temperature sensor" by entering the matching characteristic number (automatic entry for MS2N motors).
- The motor temperature is transmitted in intervals of 64 ms.

.Parameterization

ACURO®link encoders track the encoder-specific data in the encoder data memory. If used as MS2N motor encoder, the encoder data memory also tracks the motor parameter values. Data and parameter values are automatically loaded to the respective parameters of the drive if...

- the characteristic number for this encoder was entered in "S-0-0602.x.1, Phys. encoder type",
- the encoder was automatically recognized by the controller by scanning the encoder interfaces after "load basic parameters" and the encoder data memory is read thereupon.

This parameterization/configuration is supported by dialogs in ctrIX DRIVE Engineering, see also > "Commissioning".

.Data memory range for user data

ACURO®link encoders are equipped with an encoder data memory and also provide a data memory range for user data (OEM memory range) with 7.5 kbytes besides providing their own encoder-specific data. The data are stored in non-volatile form. That is to say, the stored data are maintained in the case of voltage failure. For MS2N motors, the motor parameter values are stored in the OEM memory range and provided with write protection. Otherwise, the user data memory range is available for additional data.

.Encoders with SSI interface

.Application-related information for project planning



The actual position values cyclically and serially transmitted in so-called "telegrams" have an SSI-specific transmission protocol:

.Protocol specification SSI interface:

ctrlX DRIVE controllers support the following SSI transmission protocol specification:

- Length of the SSI telegram: max. 64 bits
- Coding of position information: Binary or Gray
- Number of position bits: max. 48
- Number of status bits (error, warning, etc.): max. 7
- Number of padding bits ("zero" bits): max. 15 + max. 7 (padding bits 2)

.SSI telegram types, transmission protocol

SSI encoders do not feature an encoder data memory. The transmission protocol of the respective SSI encoder has to be forwarded manually via "S-0-0602.x.7, Phys. encoder protocol configuration" to the encoder evaluation of the controller.

Two different SSI telegram types are supported for the transmission protocol (can be selected in S-0-0602.x.7):

SSI telegram type 1

	MSB		LSB		
Padding bits	Position bits				Padding bits 2
	Multi-Turn		Sinale-Turn		

SSI telegram type 2

_				MSB			LSB
Padding bits 2	Status bits	Padding bits		Position bits			ion bits
				M	lulti-Turn		Single-Turn

Fig. 184: Supported SSI telegram types of SSI transmission protocols

most significant bit
least significant bit
with rotary encoder only: Number of bits for display of encoder revolutions within which the multi-turn encoder can provide absolute actual position values
with rotary encoder: Number of bits for display of one encoder revolution
with linear encoder: Number of bits for display of the entire absolute position range
Spaces in the transmission protocol ("zero bits")



The length of the SSI telegram (number of bits to be transmitted) requires proportionally adjusted transmission rates (baud rate), see "S-0-0602.x.7, Phys. encoder protocol configuration". However, the usable transmission rate is limited by the length and signal damping properties of the selecetd encoder line.

.Encoder connection

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

Absolute evaluation

Encoders with SSI interface can be evaluated in absolute form if the travel range of an axis is within the actual position range that can be displayed in absolute form, i.e. the absolute encoder range. The absolute encoder range (S-0-0601.x.23) describes one encoder revolution for single-turn encoders and usually 4096 encoder revolutions for multi-turn encoders. For linear encoders, it is encoder type-specific.

.Commissioning



This is no "Plug & Play" encoder type and thus is not 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 .

SSI encoders are typically used as encoder 2 and therefore usually parameterized in the "encoder 2" dialog. First, the used interface has to be assigned and the encoder with SSI interface selected.



Fig. 185: ctrIX DRIVE Engineering dialog for assigning an SSI encoder to interface X8 as encoder 2

In the "Settings tab", the encoder and its properties are configured:

- Mechanical design
- Position resolution for linear encoder, number of position bits and number of multi-turn bits for rotary encoder
- Absolute encoder monitoring window, see > "Monitoring the position measuring systems"





• Inversion of position data if the counting direction of the encoder is against the rotational direction of the axis due to installation, for example.

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	Interface XG21 (M	lultigeber) 🗸	Encoder 2 Encoders with SSI interface	Expert view
DC bus configuration Master communication Gommunication Gommunication	Settings	SSI transmission protocol Usag	e	
Finder 1 / motor encoder Finder 2 Finder 2	Encod	er configuration ktary encoder lear encoder resolution (SSI) 1] nm/Incr	Evaluation Inverted position data evaluation Absolute encoder evaluation Absolute encoder range ± Maximum travel range ± Monitoring window ±	Current values Postion O.0000 Deg Velocity O.0000 rpm Encoder in reference Usage
ia Drive control ia Error reaction ia Drive-integrated safety technology			Absolute encoder evaluation is possible	Position control encoder

Fig. 186: ctrIX DRIVE Engineering "Settings" tab in the dialog for configuring the mechanical features of an SSI encoder

For the rotary encoder, the resolution is automatically calculated according to the configuration of the SSI transmission protocol!

The encoder telegram is configured in the "SSI transmission protocol" tab. Two telegram types are available for selection. The SSI encoder has to be configured manually according to manufacturer specifications since the SSI encoder does not feature any encoder memory:

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	ctrlX DRIVE [1] default	- Interface		_	Encoder	2				
1	Overview Avia [1] default	XG21 (M	ultigeber) 🗸	~	Encoders	with SSI interface				
	DC bus configuration	Settings	SSI transmission protocol	Jsage	•					
	Motor, drive mechanics, measuring sys									
	🖮 📸 Motor		Baud rate			400 KHz	~			
	Encoder 17 motor encoder		Coding			Binary code	~			
	Encoder 2 Position data reference encod		Telegram type			Telegram 1	~			
	⊞ 🛅 Brake					2				
	Axis mechanics / scaling			М	SB			LSB		
	Operation modes / Drive Hait		Padding bits			Position b	oits		Status bits	Padding 2
	Error reaction									
	Drive-integrated safety technology Probe		Number of position bits			25 bi	ts			
	Optimization / commissioning									
	⊞ Local I/Us		Number of status bits (error, wa	aming	g etc.)	2 bi	ts			
			Number of padding bits			1 bi	ts			
			Number of padding bits 2			0 bi	ts			

Fig. 187: ctrlX DRIVE Engineering dialog for configuring the SSI transmission protocol (multi-turn bits are only possible with rotary encoders!)



- The number of position bits of the SSI telegram results as the sum of the multi-turn bits and the number of bits for the encoder resolution/revolution. A maximum of 64 bits is possible, including the status bits made available by the encoder. All bits made available by the encoder have to be configured! The maximum number of position bits is 48.
- The baud rate is the transmission velocity of the SSI encoder telegrams. It can be set in multiple steps. It is basically preferable to select the highest possible baud rate so that the pieces of position and status information are transmitted with the shortest delay. Lower baud rates may be necessary for error-free transmission of the SSI telegrams, depending on the properties and the length of the encoder cable.

The "use" of encoder 2 can be configured in the "Expert view"; "position control encoder" is set by default.

Additional information and details

.Firmware-side actual position value generation

Position display of Basic encoder evaluation of SSI encoders is max. 48 position bits.

- Position display with rotary encoders: Single-turn resolution and multi-turn range as required by the respective encoder according to data sheet or type plate.
- Position display with linear encoders: The resolution in nm/increment is encoder type-specific. The possible measuring length is limited by the number of encoder position bits (max. 48).

.Monitoring functions

Telegram failure monitoring:

- Monitoring of the telegram transmission time to be expected for exceeding (hardware-side)
- In the case of two subsequent failures of the telegram, the error bit is set in "S-0-0600.x.1, Encoder status".
- In the case of one telegram failure, the position value is extrapolated.

Status bits in the SSI telegram:

• Encoder-side error states can be displayed via these bits.

• Status bits set on the encoder side (value "1") cause the error bit in "S-0-0600.x.1, Encoder status" to be activated.

- Warning bits in the SSI telegram:
- Encoder-side warning bits have to be configured as padding bits to avoid encoder errors.

Wire break monitoring:

• Hardware-side monitoring for connected SSI encoder. If no encoder is detected, the error bit is set in "S-0-0600.x.1, Encoder status".



There is no defined method for monitoring the data transmission of encoders with SSI interface. Generally, when a position encoder with SSI interface is used, all monitoring fuctions of the position and velocity control loops should be activated and configured accordingly. See \searrow "Monitoring the position measuring systems".

.Application

There is a time offset between the recording of actual position values and their availability for drive control due to the serial transmission of the position data.

For position control, this is uncritical if the actual position values can be transmitted within the position control cycle time. For this purpose, the transmission rate of the telegrams has to be sufficient. The position is evaluated in the same clock as the velocity control. SSI encoders should not be used for motor control!

The transmission rate for SSI telegrams can be set between 100 kHz and 2 MHz depending on the encoder itself and the length and damping of the encoder cable. The possible transmission rate is reduced with increasing length of the encoder cable.

.Parameterization

SSI encoders are commonly not equipped with encoder data memory. For this reason, encoder-specific data have to be entered manually. Parameterization is supported by dialogs in ctrIX DRIVE Engineering if the characteristic number for the encoder was entered in "S-0-0602.x.1, Phys. Encoder type". See also > "Commissioning".

.Encoders with ctrIX SENSE^{motor} interface

.Application-related information for project planning

The ctrlX SENSE^{motor} interface is a digital interface for encoders developed by Bosch Rexroth according to RS485 standard. It establishes a bidirectional, serial communication between sensors, actuators and controls. The encoder is exclusively used as a motor encoder and has an encoder memory that provides the encoder and motor data.

.Encoder connection

Due to the high data transmission frequency of 10 MHz that is sensitive to interference, it is recommended to use the ready-made electrical connections by Rexroth and to observe the corresponding mounting recommendations.

The connection is made to the standard encoder input of the controller or the controller axis. Position encoders with ctrIX SENSEmotor interface can be connected via the standard encoder input of the ctrIX DRIVE controllers.

.Motor encoder

Rexroth housing motors of type MS2S are equipped with a ctrIX SENSE^{motor} encoder:

- Encoder performance BASIC 19 bits/rev.: Code letter "I"
 - Encoder design multi-turn 65,536 rev. absolute: Code letter "M"



Only rotary encoders are supported!

A data memory range for user data (OEM memory range) of 4 kbytes is available on the encoder side.

.Commissioning

.Encoder configuration

MS2S motors are equipped with a motor encoder with ctrlX SENSE^{motor} interface. At the beginning of commissioning, "Load basic parameters" should have been carried out.

The ctrIX SENSE^{motor} encoder is automatically detected when the drive controller is switched on. When switching from CM to PM, the data of the motor and of the encoder are automatically loaded from the encoder memory to the controller.



This is a "Plug & Play" encoder type which is configured automatically via the "Encoder scanning" function!

If a reduction of the initialization period is required, the "Encoder scanning" function can be deactivated in "S-0-0602.x.1, Phys. encoder type". See also

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Fig. 188: Selecting the encoder interface and the digital encoder in the ctrIX DRIVE Engineering dialog, example "ctrIX SENSE^{motor} encoder".

In the "Settings" tab, the encoder and its properties are shown:

- Mechanical design
- Number of position bits and number of multi-turn bits

There are setting options for



- Absolute encoder monitoring window, see \searrow "Monitoring the position measuring systems"
- Inversion of position data, for example, if the counting direction of the motor encoder is against the rotational direction of the axis due to the mounting.

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ctrlX DRIVE [1] default Overview Axis [1] default DC bus configuration	Interface XG20 (Digitaler Geber) ✓ Settings ✓	Encoder 1 / motor encoder Encoders with ctrlX SENSE interface	Expert view
Motor, drive mechanics, measuring syste Motor, drive mechanics, measuring syste Comparison of the system Comparison of the system Motor and the system Comparison of the system Motor and the system Comparison of the system Comparison of the system Comparison of the system Comparison of the system Motor and the system	Encoder configuration Rotary encoder Linear encoder	Evaluation Inverted position data evaluation Absolute encoder evaluation Absolute encoder range ± 214 748.3647 Deg Maximum travel range ± 36 000.0000 Deg Monitoring window ± 1.0000 Deg Obsolute encoder evaluation is possible	Current values Position 32 365.9379 Deg Velocity 0.3719 pm Carrow Content of the second se

Fig. 189: ctrIX DRIVE Engineering dialog for configuring the encoder of a ctrIX SENSE^{motor} encoder

Additional information and details.

.Features of ctrIX SENSE^{motor} encoders

ctrIX SENSE^{motor} encoders are equipped with data memory containing all motor-specific and encoder type-specific data ("electronic type plate") including:

- Motor data and motor control parameters
- Encoder resolution and absolute encoder range
- Serial number of the encoder

Other features:

• Memory range for user data (OEM memory range) with a data volume of 4096 bytes

.Transmission of motor temperature

In addition to position and diagnostic data, the ctrlX SENSE^{motor} protocol also transmits the motor temperature.

.Data memory range for user data

ctrlX SENSE^{motor} encoders are equipped with an encoder data memory and also provide a data memory range for user data (OEM memory range). The data are stored in non-volatile form. That is to say, the stored data are maintained in case of a power failure. (Write protection for the user data memory range is not available.)

.Monitoring and diagnostics

Errors of the correct function of the encoder are displayed via the "Error" bit in "S-0-0600.x.1, Encoder status":

- Error states occurring in the encoder
- Double data telegram failure of the encoder, this causes the cyclic encoder evaluation to be interrupted. In addition, the detailed diagnostics of the ctrIX DRIVE Engineering configuration tool show more detailed error causes.

The drive recognizes replacement of the connected encoder type by checking the serial number after activation. If the



serial number has changed, position data reference is deleted and the axis is no longer homed.

.Encoders with EnDat2.2 interface

.Application-related information for project planning

.Supported encoder types

Position encoders with the following manufacturer-side order code are supported as digital position encoders:

• EnDat22 (digital EnDat2.2 interface only, clock frequency <8MHz, no analog 1Vpp signals)



If position encoders with the order code EnDat02 have been designed with an interface clock frequency <2MHz and additionally have 1Vpp sine signals, they can be evaluated as combined encoders with AXS-V-0310 and above (see "Encoders with EnDat2.x interface and 1Vpp signals").

.Encoder connection

Due to the high data transmission frequency of 8 MHz that is sensitive to interference, it is recommended to use die electrical connections of the manufacturer's company and to observe the corresponding recommendations for mounting.

."EC" option required!

Position encoders with EnDat2.2 interface can be connected via the multi-encoder input of the ctrlX DRIVE controllers (EC interface option).

.Absolute evaluation

Encoders with EnDat2.2 interface can be evaluated in absolute form if the travel range of an axis is within the actual position range that can be displayed in absolute form, i.e. the absolute encoder range. The absolute encoder range (S-0-0601.x.23) describes one encoder revolution for single-turn encoders, and for multi-turn encoders in most cases 4096 encoder revolutions. For linear encoders, it is encoder type-specific.

.Battery-buffered multi-turn encoders



WARNING!

. Actual position value offset in case of battery failure of batterybuffered EnDat2.2!

EnDat2.2 encoders with battery-buffered multi-turn memory function are only supported at a later point in time! However, a battery-buffered EnDat2.2 may be connected at ctrlX DRIVE, but:

- The battery status is not checked.
- Battery wear or supply voltage interruption can cause loss of position data reference which may result in actual position value offset.
- In the case of actual position value offset, any previously established position data reference is lost without the position status becoming invalid.

If a battery-buffered EnDat2.2 is used nevertheless, it is mandatory to ensure the following aspects on the user side:

- Separation of battery and position encoder must not be possible with drive switched off
- Only replace the battery with the encoder connected and the controller supplied with control voltage (DC24V)
- Battery replacement at an early stage or permanent external monitoring of the correct battery status required



A data memory range for user data is available on the encoder side.

.Commissioning

Encoders with an EnDat2.2 interface have to be connected at the optional slot XG21 (EC). They are automatically detected when the drive controller is switched on. When switching from CM to PM, the data of the motor and of the encoder are automatically loaded from the encoder memory to the controller.



This is a "Plug & Play" encoder type which is configured automatically via the "encoder scan" function!

If it is required to reduce the initialization period, deactivate the "encoder scan" function in "S-0-0602.x.1, Phys. encoder type". See also .





Fig. 190: Selecting the encoder interface and the digital encoder in the ctrIX DRIVE Engineering dialog, "EnDat2.2 encoder" example

In the encoder basic dialog, the properties of the EnDat2.2 encoder are displayed.

Depending on the maximum travel range of the axis and the absolute encoder range, the option of evaluation as absolute encoder is displayed.



Fig. 191: ctrIX DRIVE Engineering dialog for encoder configuration of an EnDat2.2 encoder

In the "Expert view" of the encoder dialog, diagnostics and details on Basic and Extended encoder evaluation are displayed and further configuration options are provided:



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ctrlX DRIVE [1] default	Interface	Encoder 1 / motor encoder	Expert view
- • Overview	XG21 (Multigeber)	Encoders with EnDat 2.2 interface (Heidenhain)	~
Axis [1] default	(and (and geody		
DC bus configuration	Settings		
Master communication		Denie	
Motor, drive mechanics, measuring syste	Encoder	encoder evaluation	encoder evaluation
Encoder 1 / motor encoder	Encoder configuration	Basic output data	Extended output data
Encoder 1 / motor encoder	Determine	95 940 599 345	D
Position data reference encoder	Rotary encoder	Position 55 540 556 245 Incr	Position -13 229.0500 Deg
Encoder 2	Unear encoder	Position status: absolute position	Velocity 0.0572 rpm
Avis mechanics / scaling	Battery required	Warning active	Encoder in reference
Operation modes / Drive Halt	Digital resolution (absolute)	Error active	
H C Limit values	33 554 432 Incr/Rev	Dest for section	Battery connected / sufficient capacity
Drive control		Ready for operation	Inverted position data evaluation
Error reaction			
Drive-integrated safety technology			
Probe		Basic evaluation	Extended evaluation, absolute encoder
⊕ ← Optimization / commissioning ⊕ ← Local I/Os		Invert the rotational direction	Absolute encoder range ± 214 748.3647 Deg
		Position resolution 33 554 432 Incr/Rev	Maximum travel range ± 36 000.0000 Deg
		Absolute position range 4096 Rev	Monitoring window ± 1.0000 Deg
		Pos. overflow threshold 137 438 953 472 Incr	Absolute encoder evaluation is possible
		Cycle time 125.000 us	Force absolute encoder evaluation
			Deactivate absolute encoder evaluation
			Drive-contr. homing with abs. measuring system

Fig. 192: Expert view of the settings dialog of ctrIX DRIVE Engineering for diagnostic purposes and for further configurations

.Additional information and details

The actual position values cyclically and serially transmitted in so-called "telegrams" have an EnDat2.2-specific transmission protocol:

.Protocol specification EnDat2.2 interface:

- Length of the transmission protocol: variable depending on the selected EnDat2.2 type.
- Coding of position information: Binary code
- Error bits: 2
- Check bits for position: 5
- Check bits for "Additional info 1": 5
- Check bits for "Additional info 2": 5
- Data transmission frequency (baud rate): 160 kHz at initialization, 8 MHz at cyclic data transmission

.Features of EnDat2.2 encoders

EnDat2.2 encoders are equipped with a data memory containing all manufacturer-side type-specific data ("electronic type plate") including:

- Absolute encoder resolution (digital) S-0-0602.x.22: encoder type-specific
- Absolute encoder range S-0-0601.x.23: encoder type-specific
- Serial number of the encoder (S-0-0601.x.136)
- Type designation of the EnDat2.2 encoder (S-0-0602.x.139)

Other features:



- Virtual reference marks at every single-turn overflow
- Memory range for user data (OEM range) with encoder type-specific data volume
- Transmission of additional information (e.g. motor temperature), depending on the encoder type

.Firmware-side actual position value generation

Position display of Basic encoder evaluation of EnDat2.2 encoders:

- Position display with rotary encoders: In total, 48 position bits (single- and multi-turn bits) can be evaluated.
- Position display with linear encoders: The resolution in nm/increment is encoder type-specific. The possible
 measuring length is limited by the number of position bits (max. 48!) for position display.

.Monitoring and diagnostics

Errors of the correct function of the encoder are displayed via the "Error" bit in "S-0-0600.x.1, Encoder status":

- Error states occurring in the encoder
- Double data telegram failure of the encoder, this causes the cyclic encoder evaluation to be interrupted.

In addition, the detailed diagnostics of the ctrIX DRIVE Engineering configuration tool show more detailed error causes:

- Error bit 1 or error bit 2 of the encoder or both have signaled an error
- The CRC check of the position data and/or of the additional data has signaled a transmission error
- Failed data telegrams



The encoder error bits (1 and 2) signal disturbances of sampling lighting, track signal amplitude, position generation, power supply and current consumption.

• The drive recognizes replacement of the connected encoder type by checking the serial number after activation. If the serial number has changed, position data reference is deleted and the axis is no longer homed.

.Application as motor encoder

There is a time offset between the recording of actual position values and their availability for drive control due to the serial transmission of the position data. The time offset between the recording of actual position values and their availability for motor control due to the serial transmission of data via the EnDat2.2 format at a transmission rate of 8 MHz for cyclic position and status data is sufficiently small.

.Transmission of motor temperature

The EnDat2.2 protocol can also transmit additional information (motor temperature) besides the position data. For this purpose, the following requirements must have been complied with:

- The EnDat2.2 encoder has to support temperature transmission.
- A PT1000 or a KTY84-130 temperature sensor can be connected to the dedicated connection points of the encoder.
- The transmission of the motor temperature must be activated in "P-0-0512, Temperature sensor"

.Data memory range for user data

EnDat2.2 encoders are equipped with encoder data memory and also provide a data memory range for user data (OEM memory range) besides provision of their own encoder-specific data. The data are stored in non-volatile form. That is to say, the stored data are maintained in case of a power failure. Write protection for the user data memory range is not available.



.Parameterization

EnDat2.2 encoders are equipped with an encoder data memory that tracks the encoder-specific data. They are automatically loaded to the respective parameters of the drive if, in "S-0-0602.x.1, Phys. encoder type", the characteristic number for the encoder was entered or the EnDat2.2 encoder was recognized by automatic scanning of the connected encoders. The remaining parameterization is supported by dialogs in ctrlX DRIVE Engineering, see also \sim "Commissioning"

Encoders with ACURO®link interface

.Encoders with ACURO®link interface

.Application-related information for project planning

. Encoder types

Rexroth housing motors of the MS2N and MS2E types are optionally equipped with ACURO^{®link} motor encoder:

- Encoder performance Advanced 20 bit/rev., code letter "C", "H"
- Encoder performance High 24 bit/rev., code letter "D"
- For the "encoder type" it is possible to select single-1 rev. ("S") or multi-turn-4096 rev. ("M")

Only rotary encoders are supported!

A data memory range for user data (OEM memory range) with 7.5 kbytes is available on the encoder side.

.Encoder connection

Due to the high data transmission frequency of 10 MHz that is sensitive to interference, it is recommended to use the ready-made electrical connections by Rexroth and to observe the corresponding mounting recommendations.



With the MS2N option "encoder performance C and D" (ACURO®link encoder), singlecable connection of the motor is possible. Refer to the Project Planning Manual "IndraDyn S Synchronous Servo Motors MS2N", DOK-MOTOR*-MS2N******-PR, mat. no. R911347583.

.Commissioning

.Encoder configuration

MS2N motors are optionally available with a motor encoder with ACURO®link interface. In the beginning of commissioning, "load basic parameters" should have been carried out.

The ACURO®link encoder is automatically detected when the drive controller is switched on, and also after "load basic



parameters" has been carried out. The data of the motor and of the encoder from the encoder data memory are already available in the controller in CM.



This is a "Plug & Play" encoder type which is configured automatically via the "encoder scan" function!

If it is required to reduce the initialization period, deactivate the "encoder scan" function in "S-0-0602.x.1, Phys. encoder type". See also .



Fig. 182: ctrIX DRIVE Engineering encoder basic dialog for ACURO®link encoder (encoder option of MS2N motor)

.Encoder diagnostics

Diagnostics of the drive are chronologically listed in the "diagnostic trace" of the controller. The listing in the diagnostic trace can be comfortably displayed in ctrIX DRIVE Engineering. If encoder errors or warnings have occurred, these are registered in the respective bits of "S-0-0600.x.1, Encoder status" and listed in the diagnostic trace.

The encoder status is also displayed in the "Expert view" of the encoder dialog:



ctrlX DRIVE [9] default	Interface	Encoder 1 / motor encoder	Expert view
Overview Avis [9] default	XG20 (Digital encoder) \lor	Encoders with ACURO®link interface (10MHz, 12V supply) ~
Power supply DC hus configuration	Settings		
Master communication Motor, drive mechanics, measuring system	Encoder	Basic encoder evaluation	Extended encoder evaluation
Motor, drive mechanics, measuring system Motor Encoder 1 / motor encoder Postion data reference encoder Postion data reference encoder Axis mechanics / scaling Axis mechanics / scaling Axis mechanics / scaling Deration modes / Drive Hat Coperation modes / Drive Hat	Encoder configuration Rotary encoder Linear encoder Digital resolution (absolute) 1 048 576 	Basic output data Position O Incr Position status: absolute position Warning active Error active Ready for operation	Extended output data PositionO 0206 Deg Velocity0 0000 ppm Encoder in reference Inverted position data evaluation
		Basic evaluation Invert the rotational direction Position resolution Absolute position range 4096 - Pos. overflow threshold 4 294 967 296 Incr Cycle time 0.000 us	Extended evaluation, absolute encoder Absolute encoder range ± 214 748.3647 Deg Maximum travel range ± 36 000.0000 Deg Monitoring window ± 1.0000 Deg Absolute encoder evaluation is possible Force absolute encoder evaluation Deactivate absolute encoder evaluation Deactivate absolute encoder evaluation Drive-contr. homing with abs. measuring system

Fig. 183: Expert view of the settings dialog of ctrIX DRIVE Engineering for diagnostic purposes and for further configurations

.Additional information and details

The ACURO®link interface is a digital interface for Hengstler encoders for bidirectional, serial and secure communication between sensors, actuators and controls. The actual position values cyclically transmitted in so-called "telegrams" have an ACURO®link-specific transmission protocol:

.Protocol specification

- Telegram length: 4 bytes transmission, 20 bytes reception
- Diagnostic bits: 1 error, 1 warning bit
- Checksums: 8 bits (CRC), 16 bits (CRC) for position (standard and safety telegram), 32 bits (CRC) for total telegram (safety telegram only)
- Position bits: 24 bits with single-turn, 12 bits with multi-turn
- Transmission: 115 kBaud (initialization, acyclic operation), 10 MBaud (cyclic operation), transmission type: Semiduplex

.Features of ACURO®link encoders

Encoders with ACURO®link interface are an encoder option for MS2N motors. They have an encoder data memory containing the manufacturer-side motor and encoder data ("electronic type plate"), including:

- Single-turn resolution: "S-0-0602.x.22, Phys. encoder resolution (digital)"
- Multi-turn range: "S-0-0601.10.23, Absolute position range" (no battery required!)
- Mechanical maximum velocity
- Encoder serial number: "S-0-0611.x.136, Serial number of encoder" unit-specific

Other features:



- Virtual reference marks at every single-turn overflow
- The encoder memory makes available an OEM memory range for user data.
- The encoder provides a standard telegram and two safety telegrams.
- Transmission of the motor temperature if a temperature sensor is connected to the encoder.

.Monitoring and diagnostics

- Telegram monitoring by means of several CRC (Cyclic Redundancy Check) of the data transmitted by the encoder. From this, warnings and error states can be derived.
- The bits for "error" and "warning" are set in "S-0-0600.x.1, Encoder status" if warning or error states occur.

.Application as motor encoder

There is a time offset between the recording of actual position values and their availability for drive control due to the serial transmission of the position data. Due to the transmission rate of 10 MHz for the cyclic position and status data, the time offset between the recording of actual position values and their availability for motor control is sufficiently small in the case of serial transmission by the ACURO®link format.

.Transmission of motor temperature

The ACURO®link protocol can also transmit additional information (motor temperature) besides the position data. For this purpose, the following requirements must have been complied with:

- A temperature sensor has to be connected to the dedicated connection points of the encoder.
- Transmission of the motor temperature has to be activated in "P-0-0512, Temperature sensor" by entering the matching characteristic number (automatic entry for MS2N motors).
- The motor temperature is transmitted in intervals of 64 ms.

.Parameterization

ACURO® link encoders track the encoder-specific data in the encoder data memory. If used as MS2N motor encoder, the encoder data memory also tracks the motor parameter values. Data and parameter values are automatically loaded to the respective parameters of the drive if...

- the characteristic number for this encoder was entered in "S-0-0602.x.1, Phys. encoder type",
- the encoder was automatically recognized by the controller by scanning the encoder interfaces after "load basic parameters" and the encoder data memory is read thereupon.

This parameterization/configuration is supported by dialogs in ctrIX DRIVE Engineering, see also > "Commissioning".

.Data memory range for user data

ACURO®link encoders are equipped with an encoder data memory and also provide a data memory range for user data (OEM memory range) with 7.5 kbytes besides providing their own encoder-specific data. The data are stored in non-volatile form. That is to say, the stored data are maintained in the case of voltage failure. For MS2N motors, the motor parameter values are stored in the OEM memory range and provided with write protection. Otherwise, the user data memory range is available for additional data.

Encoders with SSI interface



.Encoders with SSI interface

.Application-related information for project planning

The actual position values cyclically and serially transmitted in so-called "telegrams" have an SSI-specific transmission protocol:

.Protocol specification SSI interface:

ctrlX DRIVE controllers support the following SSI transmission protocol specification:

- Length of the SSI telegram: max. 64 bits
- Coding of position information: Binary or Gray
- Number of position bits: max. 48
- Number of status bits (error, warning, etc.): max. 7
- Number of padding bits ("zero" bits): max. 15 + max. 7 (padding bits 2)

.SSI telegram types, transmission protocol

SSI encoders do not feature an encoder data memory. The transmission protocol of the respective SSI encoder has to be forwarded manually via "S-0-0602.x.7, Phys. encoder protocol configuration" to the encoder evaluation of the controller.

Two different SSI telegram types are supported for the transmission protocol (can be selected in S-0-0602.x.7):

SSI telegram type 1

	MSB	LSB		
Padding bits	Posit	ion bits	Status bits	Padding bits 2
	Multi-Turn	Single-Turn		

SSI telegram type 2

			MSB	LSB	
Padding bits 2	Status bits	Padding bits	Position bits		
			Multi-Turn	Single-Turn	

Fig. 184: Supported SSI telegram types of SSI transmission protocols

- MSB most significant bit
- LSB least significant bit
- Multiturn which the multi-turn encoder can provide absolute actual position values
- Single- with rotary encoder: Number of bits for display of one encoder revolution turn
- Position with linear encoder: Number of bits for display of the entire absolute position bits range



Padding Spaces in the transmission protocol ("zero bits") bits, padding bits 2

The length of the SSI telegram (number of bits to be transmitted) requires proportionally adjusted transmission rates (baud rate), see "S-0-0602.x.7, Phys. encoder protocol configuration". However, the usable transmission rate is limited by the length and signal damping properties of the selecetd encoder line.

.Encoder connection

Position encoders with SSI interface can be connected via the multi-encoder input of the ctrIX DRIVE controllers (interface option EC).

Absolute evaluation

Encoders with SSI interface can be evaluated in absolute form if the travel range of an axis is within the actual position range that can be displayed in absolute form, i.e. the absolute encoder range. The absolute encoder range (S-0-0601.x.23) describes one encoder revolution for single-turn encoders and usually 4096 encoder revolutions for multi-turn encoders. For linear encoders, it is encoder type-specific.

.Commissioning



This is no "Plug & Play" encoder type and thus is not 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 .

SSI encoders are typically used as encoder 2 and therefore usually parameterized in the "encoder 2" dialog. First, the used interface has to be assigned and the encoder with SSI interface selected.





Fig. 185: ctrIX DRIVE Engineering dialog for assigning an SSI encoder to interface X8 as encoder 2

In the "Settings tab", the encoder and its properties are configured:

- Mechanical design
- Position resolution for linear encoder, number of position bits and number of multi-turn bits for rotary encoder
- Absolute encoder monitoring window, see > "Monitoring the position measuring systems "
- Inversion of position data if the counting direction of the encoder is against the rotational direction of the axis due to installation, for example.



Fig. 186: ctrIX DRIVE Engineering "Settings" tab in the dialog for configuring the mechanical features of an SSI encoder



For the rotary encoder, the resolution is automatically calculated according to the configuration of the SSI transmission protocol!

The encoder telegram is configured in the "SSI transmission protocol" tab. Two telegram types are available for selection. The SSI encoder has to be configured manually according to manufacturer specifications since the SSI encoder does not feature any encoder memory:



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🖃 🖷 📕 ctrlX DRIVE [1] default	Interface Encoder 2	
Overview	XG21 (Multigeber) V Encoders with SSI interface	
DC bus configuration	Settings SSI transmission protocol Usage	
Master communication		
🖶 🖳 Motor	Baud rate 400 KHz \checkmark	
	Coding Binary code V	
Position data reference encod	Telegram type Telegram 1 V	
Axis mechanics / scaling	MSB LSI	3
	Padding bits Position bits	Status bits Padding 2
Error reaction		
Drive-integrated safety technology Probe Optimization / commissioning	Number of position bits 25 bits	
E-Cal I/Os	Number of status bits (error, warning etc.)	
	Number of padding bits 1 bits	
	Number of padding bits 2 0 bits	

Fig. 187: ctrlX DRIVE Engineering dialog for configuring the SSI transmission protocol (multi-turn bits are only possible with rotary encoders!)

- The number of position bits of the SSI telegram results as the sum of the multi-turn bits and the number of bits for the encoder resolution/revolution. A maximum of 64 bits is possible, including the status bits made available by the encoder. All bits made available by the encoder have to be configured! The maximum number of position bits is 48.
- The baud rate is the transmission velocity of the SSI encoder telegrams. It can be set in multiple steps. It is basically preferable to select the highest possible baud rate so that the pieces of position and status information are transmitted with the shortest delay. Lower baud rates may be necessary for error-free transmission of the SSI telegrams, depending on the properties and the length of the encoder cable.

The "use" of encoder 2 can be configured in the "Expert view"; "position control encoder" is set by default.

.Additional information and details

.Firmware-side actual position value generation

Position display of Basic encoder evaluation of SSI encoders is max. 48 position bits.

- Position display with rotary encoders: Single-turn resolution and multi-turn range as required by the respective encoder according to data sheet or type plate.
- Position display with linear encoders: The resolution in nm/increment is encoder type-specific. The possible measuring length is limited by the number of encoder position bits (max. 48).



.Monitoring functions

Telegram failure monitoring:

- Monitoring of the telegram transmission time to be expected for exceeding (hardware-side)
- In the case of two subsequent failures of the telegram, the error bit is set in "S-0-0600.x.1, Encoder status".
- In the case of one telegram failure, the position value is extrapolated.

Status bits in the SSI telegram:

- Encoder-side error states can be displayed via these bits.
- Status bits set on the encoder side (value "1") cause the error bit in "S-0-0600.x.1, Encoder status" to be activated.

Warning bits in the SSI telegram:

• Encoder-side warning bits have to be configured as padding bits to avoid encoder errors.

Wire break monitoring:

• Hardware-side monitoring for connected SSI encoder. If no encoder is detected, the error bit is set in "S-0-0600.x.1, Encoder status".



There is no defined method for monitoring the data transmission of encoders with SSI interface. Generally, when a position encoder with SSI interface is used, all monitoring fuctions of the position and velocity control loops should be activated and configured accordingly. See \searrow "Monitoring the position measuring systems".

.Application

There is a time offset between the recording of actual position values and their availability for drive control due to the serial transmission of the position data.

For position control, this is uncritical if the actual position values can be transmitted within the position control cycle time. For this purpose, the transmission rate of the telegrams has to be sufficient. The position is evaluated in the same clock as the velocity control. SSI encoders should not be used for motor control!

The transmission rate for SSI telegrams can be set between 100 kHz and 2 MHz depending on the encoder itself and the length and damping of the encoder cable. The possible transmission rate is reduced with increasing length of the encoder cable.

.Parameterization

SSI encoders are commonly not equipped with encoder data memory. For this reason, encoder-specific data have to be entered manually. Parameterization is supported by dialogs in ctrlX DRIVE Engineering if the characteristic number for the encoder was entered in "S-0-0602.x.1, Phys. Encoder type". See also > "Commissioning".

Encoders with ctrlX SENSEmotor interface

.Encoders with ctrIX SENSE^{motor} interface

.Application-related information for project planning

The ctrIX SENSE^{motor} interface is a digital interface for encoders developed by Bosch Rexroth according to RS485



May 1 2025

standard. It establishes a bidirectional, serial communication between sensors, actuators and controls. The encoder is exclusively used as a motor encoder and has an encoder memory that provides the encoder and motor data.

.Encoder connection

Due to the high data transmission frequency of 10 MHz that is sensitive to interference, it is recommended to use the ready-made electrical connections by Rexroth and to observe the corresponding mounting recommendations.

The connection is made to the standard encoder input of the controller or the controller axis. Position encoders with ctrIX SENSEmotor interface can be connected via the standard encoder input of the ctrIX DRIVE controllers.

.Motor encoder

Rexroth housing motors of type MS2S are equipped with a ctrIX SENSE^{motor} encoder:

Encoder performance BASIC - 19 bits/rev.: Code letter "I"

Encoder design multi-turn - 65,536 rev. absolute: Code letter "M"



Only rotary encoders are supported!

A data memory range for user data (OEM memory range) of 4 kbytes is available on the encoder side.

.Commissioning

.Encoder configuration

MS2S motors are equipped with a motor encoder with ctrlX SENSE^{motor} interface. At the beginning of commissioning, "Load basic parameters" should have been carried out.

The ctrIX SENSE^{motor} encoder is automatically detected when the drive controller is switched on. When switching from CM to PM, the data of the motor and of the encoder are automatically loaded from the encoder memory to the controller.



This is a "Plug & Play" encoder type which is configured automatically via the "Encoder scanning" function!

If a reduction of the initialization period is required, the "Encoder scanning" function can be deactivated in "S-0-0602.x.1, Phys. encoder type". See also



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ctrlX DRIVE [1] default	_ Interface	Encoder 1 / motor encoder	Expert view
• Overview	XG20 (Digitaler Geber) V	Encoders with ctrlX SENSE interface	~
Axis [1] default Loss configuration Motor. drive mechanics, measuring syste Motor. drive mechanics, measuring syste Motor - Encoder 1 / motor encoder Pension data reference encoder Postoin data reference encoder Postoin data reference encoder Postoin modes / Drive Hat Dire control Encreaction Dive integrated safety technology Probe Optimization / commissioning	Settings Encoder configuration Rotary encoder Unear encoder	Digital encoders Encoders with ACURO®Ink interface (10MHz, 12V supply) Encoders with ctrlX SENSE interface No encoder	

Fig. 188: Selecting the encoder interface and the digital encoder in the ctrlX DRIVE Engineering dialog, example "ctrlX SENSE^{motor} encoder".

In the "Settings" tab, the encoder and its properties are shown:

- Mechanical design
- Number of position bits and number of multi-turn bits

There are setting options for

- Absolute encoder monitoring window, see \searrow "Monitoring the position measuring systems "
- Inversion of position data, for example, if the counting direction of the motor encoder is against the rotational direction of the axis due to the mounting.



Fig. 189: ctrIX DRIVE Engineering dialog for configuring the encoder of a ctrIX SENSE^{motor} encoder

.Additional information and details

.Features of ctrIX SENSE^{motor} encoders

ctrIX SENSE^{motor} encoders are equipped with data memory containing all motor-specific and encoder type-specific data ("electronic type plate") including:



- Motor data and motor control parameters
- Encoder resolution and absolute encoder range
- Serial number of the encoder

Other features:

• Memory range for user data (OEM memory range) with a data volume of 4096 bytes

.Transmission of motor temperature

In addition to position and diagnostic data, the ctrIX SENSE^{motor} protocol also transmits the motor temperature.

.Data memory range for user data

ctrIX SENSE^{motor} encoders are equipped with an encoder data memory and also provide a data memory range for user data (OEM memory range). The data are stored in non-volatile form. That is to say, the stored data are maintained in case of a power failure. (Write protection for the user data memory range is not available.)

.Monitoring and diagnostics

Errors of the correct function of the encoder are displayed via the "Error" bit in "S-0-0600.x.1, Encoder status":

- Error states occurring in the encoder
- Double data telegram failure of the encoder, this causes the cyclic encoder evaluation to be interrupted. In addition, the detailed diagnostics of the ctrIX DRIVE Engineering configuration tool show more detailed error causes.

The drive recognizes replacement of the connected encoder type by checking the serial number after activation. If the serial number has changed, position data reference is deleted and the axis is no longer homed.

Encoders with EnDat2.2 interface

.Encoders with EnDat2.2 interface

.Application-related information for project planning

.Supported encoder types

Position encoders with the following manufacturer-side order code are supported as digital position encoders:

• EnDat22 (digital EnDat2.2 interface only, clock frequency <8MHz, no analog 1Vpp signals)



If position encoders with the order code EnDat02 have been designed with an interface clock frequency <2MHz and additionally have 1Vpp sine signals, they can be evaluated as combined encoders with AXS-V-0310 and above (see "Encoders with EnDat2.x interface and 1Vpp signals").

.Encoder connection

Due to the high data transmission frequency of 8 MHz that is sensitive to interference, it is recommended to use die



electrical connections of the manufacturer's company and to observe the corresponding recommendations for mounting.

."EC" option required!

Position encoders with EnDat2.2 interface can be connected via the multi-encoder input of the ctrIX DRIVE controllers (EC interface option).

Absolute evaluation

Encoders with EnDat2.2 interface can be evaluated in absolute form if the travel range of an axis is within the actual position range that can be displayed in absolute form, i.e. the absolute encoder range. The absolute encoder range (S-0-0601.x.23) describes one encoder revolution for single-turn encoders, and for multi-turn encoders in most cases 4096 encoder revolutions. For linear encoders, it is encoder type-specific.

.Battery-buffered multi-turn encoders

correct battery status required

WARNING! . Actual position value offset in case of battery failure of batterybuffered EnDat2.2! EnDat2.2 encoders with battery-buffered multi-turn memory function are only supported at a later point in time! However, a battery-buffered EnDat2.2 may be connected at ctrIX DRIVE, but: • The battery status is not checked. Battery wear or supply voltage interruption can cause loss of position data reference which may result in actual position value offset. • In the case of actual position value offset, any previously established position data reference is lost without the position status becoming invalid. If a battery-buffered EnDat2.2 is used nevertheless, it is mandatory to ensure the following aspects on the user side: Separation of battery and position encoder must not be possible with drive switched off Only replace the battery with the encoder connected and the controller supplied

with control voltage (DC24V)Battery replacement at an early stage or permanent external monitoring of the

A data memory range for user data is available on the encoder side.



.Commissioning

Encoders with an EnDat2.2 interface have to be connected at the optional slot XG21 (EC). They are automatically detected when the drive controller is switched on. When switching from CM to PM, the data of the motor and of the encoder are automatically loaded from the encoder memory to the controller.

This is a "Plug & Play" encoder type which is configured automatically via the "encoder scan" function!

If it is required to reduce the initialization period, deactivate the "encoder scan" function in "S-0-0602.x.1, Phys. encoder type". See also .



Fig. 190: Selecting the encoder interface and the digital encoder in the ctrlX DRIVE Engineering dialog, "EnDat2.2 encoder" example

In the encoder basic dialog, the properties of the EnDat2.2 encoder are displayed.

Depending on the maximum travel range of the axis and the absolute encoder range, the option of evaluation as absolute encoder is displayed.



Fig. 191: ctrlX DRIVE Engineering dialog for encoder configuration of an EnDat2.2 encoder



In the "Expert view" of the encoder dialog, diagnostics and details on Basic and Extended encoder evaluation are displayed and further configuration options are provided:

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ctrlX DRIVE [1] default	- Interface	Encoder 1 / motor encoder	Expert view
· • Overview	XG21 (Multigeber)	Encoders with EnDat 2.2 interface (Heidenhain)	~
 Axis [1] default DC bus configuration Master communication Motor, drive mechanics, measuring syste Motor drive mechanics, measuring syste Postion data reference encoder Postion data reference encoder Postion data reference encoder Postion modes / Drive Halt Drive control Error reaction Drive integrated safety technology Probe Postion / commissioning Local I/Os 	Settings Encoder Encoder configuration Rotary encoder	Basic encoder evaluation Basic output data Position 95 940 598 245 Incr	Extended encoder evaluation Extended output data
	Linear encoder Battery required Digital resolution (absolute) 33 554 432 Incr/Rev	Position status: absolute position Warning active Error active Ready for operation	Velocity 0.0572 pm Encoder in reference Battery connected / sufficient capacity Inverted position data evaluation
		Basic evaluation Invert the rotational direction Position resolution 33 554 432 Incr/Rev Absolute position range 4036 Rev Pos. overflow threshold 137 438 953 472 Incr Cycle time 125.000 us	Extended evaluation, absolute encoder Absolute encoder range ± 214 748.3647 Deg Maximum travel range ± 36 000.0000 Deg Monitoring window ± 1.0000 Deg Absolute encoder evaluation is possible Force absolute encoder evaluation Deactivate absolute encoder evaluation Deactivate absolute encoder evaluation Dirive-contr. homing with abs. measuring system

Fig. 192: Expert view of the settings dialog of ctrIX DRIVE Engineering for diagnostic purposes and for further configurations

Additional information and details.

The actual position values cyclically and serially transmitted in so-called "telegrams" have an EnDat2.2-specific transmission protocol:

.Protocol specification EnDat2.2 interface:

- Length of the transmission protocol: variable depending on the selected EnDat2.2 type.
- Coding of position information: Binary code
- Error bits: 2
- Check bits for position: 5
- Check bits for "Additional info 1": 5
- Check bits for "Additional info 2": 5
- Data transmission frequency (baud rate): 160 kHz at initialization, 8 MHz at cyclic data transmission

.Features of EnDat2.2 encoders

EnDat2.2 encoders are equipped with a data memory containing all manufacturer-side type-specific data ("electronic type plate") including:

- Absolute encoder resolution (digital) S-0-0602.x.22: encoder type-specific
- Absolute encoder range S-0-0601.x.23: encoder type-specific



A Bosch Company

- Serial number of the encoder (S-0-0601.x.136)
- Type designation of the EnDat2.2 encoder (S-0-0602.x.139)

Other features:

- Virtual reference marks at every single-turn overflow
- Memory range for user data (OEM range) with encoder type-specific data volume
- Transmission of additional information (e.g. motor temperature), depending on the encoder type

.Firmware-side actual position value generation

Position display of Basic encoder evaluation of EnDat2.2 encoders:

- Position display with rotary encoders: In total, 48 position bits (single- and multi-turn bits) can be evaluated.
- Position display with linear encoders: The resolution in nm/increment is encoder type-specific. The possible measuring length is limited by the number of position bits (max. 48!) for position display.

.Monitoring and diagnostics

Errors of the correct function of the encoder are displayed via the "Error" bit in "S-0-0600.x.1, Encoder status":

- Error states occurring in the encoder
- Double data telegram failure of the encoder, this causes the cyclic encoder evaluation to be interrupted.

In addition, the detailed diagnostics of the ctrIX DRIVE Engineering configuration tool show more detailed error causes:

- Error bit 1 or error bit 2 of the encoder or both have signaled an error
- The CRC check of the position data and/or of the additional data has signaled a transmission error
- Failed data telegrams



The encoder error bits (1 and 2) signal disturbances of sampling lighting, track signal amplitude, position generation, power supply and current consumption.

• The drive recognizes replacement of the connected encoder type by checking the serial number after activation. If the serial number has changed, position data reference is deleted and the axis is no longer homed.

Application as motor encoder

There is a time offset between the recording of actual position values and their availability for drive control due to the serial transmission of the position data. The time offset between the recording of actual position values and their availability for motor control due to the serial transmission of data via the EnDat2.2 format at a transmission rate of 8 MHz for cyclic position and status data is sufficiently small.

.Transmission of motor temperature

The EnDat2.2 protocol can also transmit additional information (motor temperature) besides the position data. For this purpose, the following requirements must have been complied with:

- The EnDat2.2 encoder has to support temperature transmission.
- A PT1000 or a KTY84-130 temperature sensor can be connected to the dedicated connection points of the encoder.
- The transmission of the motor temperature must be activated in "P-0-0512, Temperature sensor"



.Data memory range for user data

EnDat2.2 encoders are equipped with encoder data memory and also provide a data memory range for user data (OEM memory range) besides provision of their own encoder-specific data. The data are stored in non-volatile form. That is to say, the stored data are maintained in case of a power failure. Write protection for the user data memory range is not available.

.Parameterization

EnDat2.2 encoders are equipped with an encoder data memory that tracks the encoder-specific data. They are automatically loaded to the respective parameters of the drive if, in "S-0-0602.x.1, Phys. encoder type", the characteristic number for the encoder was entered or the EnDat2.2 encoder was recognized by automatic scanning of the connected encoders. The remaining parameterization is supported by dialogs in ctrlX DRIVE Engineering, see also \sim "Commissioning"