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# Monitoring the position measuring systems

## .Monitoring the position measuring systems

### .General information

For position-controlled drives, the position encoders used for drive control are decisive. The high-quality FOC motor control also uses a position encoder.

Monitoring functions are possible, particularly in conjunction with the mechanical configuration of the axis, the arrangement and use of the position encoders.

See also .

### .Relevance for the user

The operability of the position encoders used is constantly monitored on the drive side. In addition, mechanical monitoring options are derived from the actual position value measurement at the axis. These options ensure the intended functionality.

### .Use case

Identifying malfunctions by encoder-related monitoring functions:

- Signal monitoring for sine encoders, see also
- Signal monitoring for digital encoders, see also ↘ “Digital encoders ”
- Actual value monitoring in case of combined encoders with EnDat2.1 and with HIPERFACE® interface (E2074, E2075), see also ↘ “Combined encoders ”
- Where applicable, manufacturer-side status codes of the errors and warnings occurred at the position encoder are listed in the encoder-side data memory and in the drive-side diagnostic trace

### .Use case

Using axis-related monitoring functions for physical position scaling (e.g., in mm or angular degrees), not for incremental scaling, see also:

- ↘ “Monitoring the axis position when switching on (F2074, F2075)”
- ↘ “Monitoring the position data reference (F2174, F2175)”
- ↘ “Monitoring for encoder replacement (F2174, F2175)”
- ↘ “Monitoring mechanical transfer elements for position difference (F2036)”
- ↘ “Monitoring mechanical transfer elements for slip (F2036)”
- "Monitoring of lag error by means of model calculation"

### .Application-related information for project planning

For the position encoders that can be used, please refer to the chapter "System overview", see ↘ “Encoder and

mechanics”.

Depending on the position encoders intended for the application, the ctrlX DRIVE controller needs to have the interfaces required for connecting the encoders.

## .Commissioning

See also Notes on commissioning in section ↘ “Basics on position measuring systems, evaluation, resolution ”

# .Setting the axis position monitoring (with absolute encoder only)

If monitoring the axis position is desired when the drive is switched on, the value for the monitoring window has to be entered:

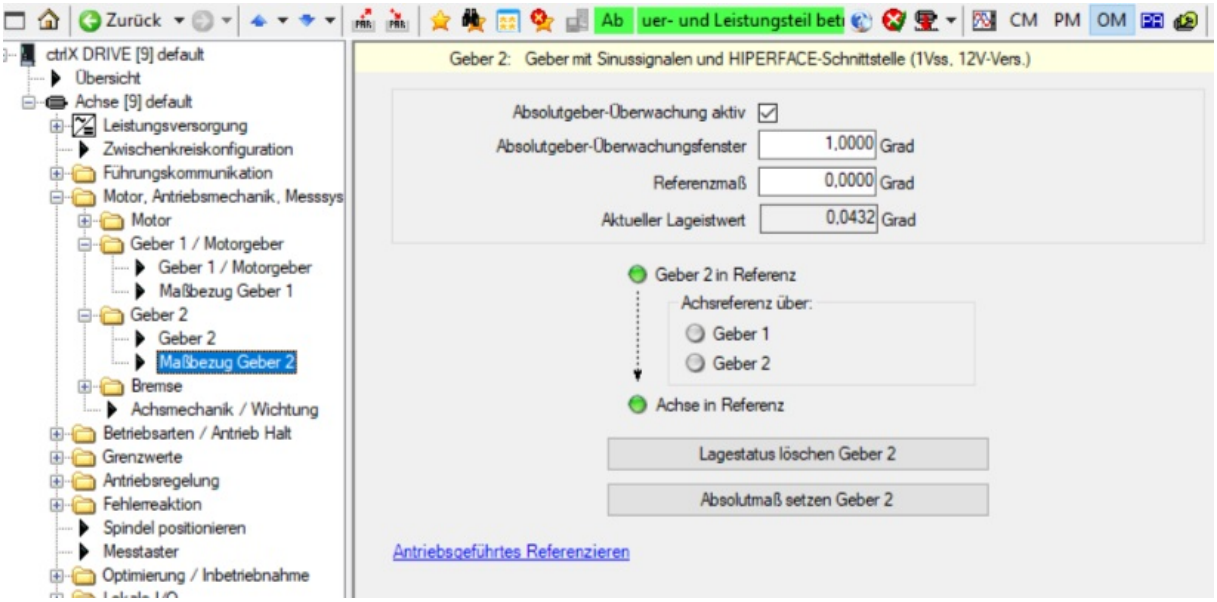


Fig. 174: ctrlX DRIVE Engineering dialog for absolute encoder monitoring of encoder 1/motor encoder

For more detailed information, see ↘ “Additional information and details”

Absolute encoder monitoring can be activated as an alternative or simultaneously for encoder 2: The ctrlX DRIVE Engineering dialog corresponds to the one for encoder1/motor encoder

The unit is the same as for the actual position value. The size of the monitoring window depends on application-specific aspects of operational safety. If this monitoring function is not desired, enter the value "0" in:

- Absolute encoder monitoring window, encoder 1 (P-0-0095)

- Absolute encoder monitoring window, encoder 2 (P-0-0096)

## .Setting the position difference monitoring

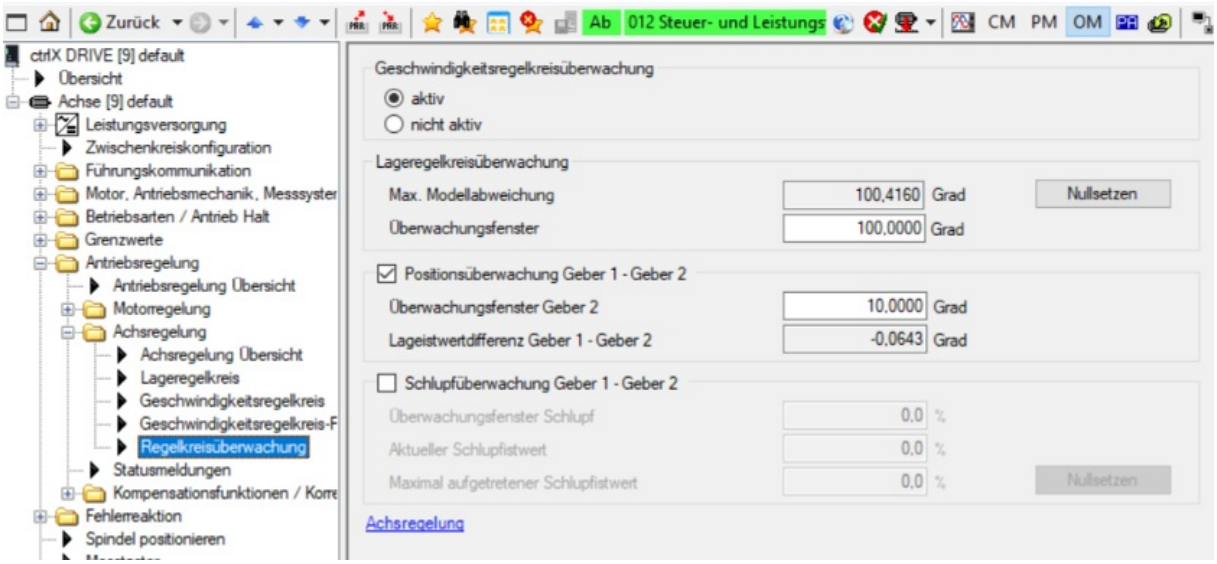

Fig. 175: ctrlX DRIVE Engineering dialog for position difference monitoring of encoder1/motor encoder and encoder 2 with exemplary values

If the actual position value difference of motor encoder (encoder 1) and external encoder (encoder 2) is to be monitored, you first have to determine a useful value for the "monitoring window of encoder position", according to the following procedure:

- Accelerate the axis to maximum velocity with maximum acceleration, then decelerate it with maximum deceleration. If possible, let the maximum stationary machining load operate on the mechanical axis system.
- Read the occurred maximum value of the actual position value difference in the display window of "Actual position value difference encoder1 - encoder2" (P-0-0391).
- Multiply this value with a safety factor (recommendation: 2-fold value) and enter it in the "monitoring window of encoder 2" (S-0-0391, Monitoring window feedback 2). The unit is the same as for the actual position value.

If this monitoring function is not desired, enter the value "0" in the "monitoring window encoder position".

For more detailed information, see ↘ “Additional information and details”

## .Setting the slip monitoring function (for hybrid position control)

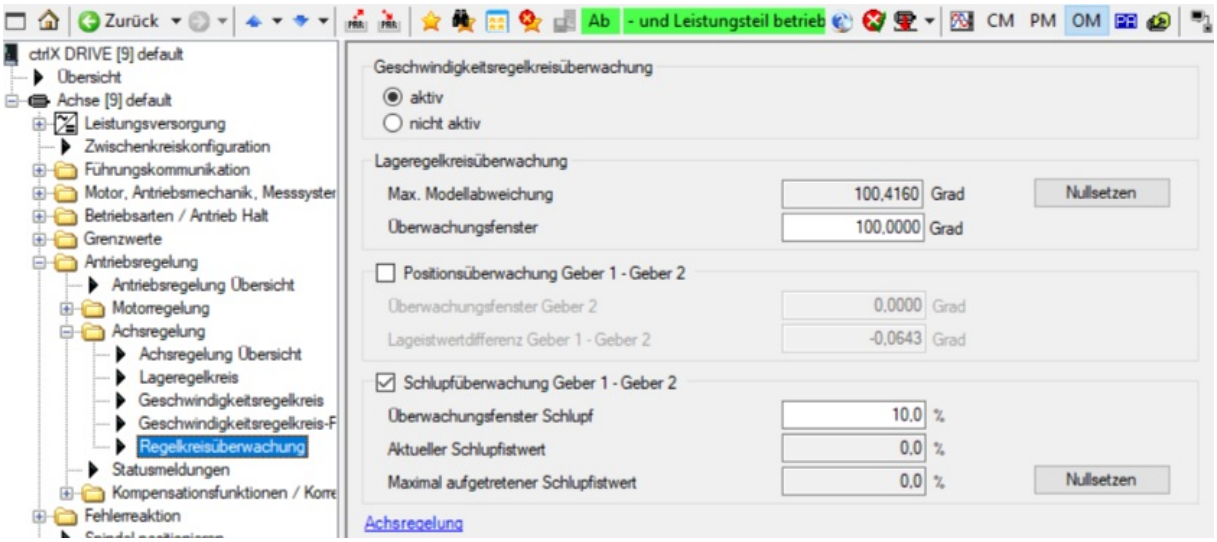

Fig. 176: ctrlX DRIVE Engineering dialog for slip monitoring of encoder 1/motor encoder and encoder 2 with exemplary values for "hybrid position control"

If the slip occurred between the motor encoder and the external encoder in "hybrid position control" or "measuring wheel mode" is to be monitored, first a useful value for the "monitoring window of slip" has to be defined based on the following procedure:

- Accelerate the axis to maximum velocity with maximum acceleration, then decelerate it with maximum deceleration. If possible, let the maximum stationary machining load operate on the mechanical axis system.
- Read the maximum value of the slip in the display window of "Maximum occurred actual slip value" (P-0-0243).
- Multiply this value with a safety factor (recommendation: 2-fold value) and enter it in the "monitoring window of slip" (P-0-0244).

If this monitoring function is not desired, enter the value "0" in the "Monitoring window of slip".

## .Diagnostics

If the actual position value difference between the motor encoder and external encoder (P-0-0391) exceeds the value of the monitoring window for encoder 2 (S-0-0391) or if the occurred slip is higher than the value of "Monitoring window of slip in %" (P-0-0244), then the drive generates the error message

- F2036 Excessive position feedback difference

For more detailed information, see ↘ “Additional information and details”

## .Additional information and details

## .General information

The two-step Basic and Extended encoder evaluation provides monitoring functions in both evaluation steps. The encoder type-specific monitoring functions of Basic encoder evaluation are described in the sections on the respective

encoder types. The Basic evaluation displays the status information on the respective encoder in "S-0-0600.x.1, Encoder status", for forwarding to Extended evaluation. Additionally, one bit each is transmitted for "Warning", "Error" and "Ready for operation".

See also ↘ “Evaluating position measurement”, ↘ “Additional information and details” et seq. and ↘ “Physical encoder resolution”, et seq.

If **Basic evaluation** is not ready for operation, a command error occurs on initialization when the drive is switched from CM to PM.

**Extended evaluation** is also initialized by switching from CM to PM.

Requirements for the drive to switch to the parameter mode PM:

- Mechanics and scaling have to be configured accordingly. The mechanical configuration must be supported by the drive.
- All internally required factors and data must have been transmitted without errors from parameterization.
- The velocity of the encoder must not exceed a threshold value on switching to the operating mode.

## .Encoder diagnostics

If an error state occurs **after switching on** the drive in Basic or Extended evaluation, the drive denies switching to parameter mode PM and generates **transition command error C11xx**.

- The related diagnostics are listed in the drive-side "diagnostic trace".
- If a problem is detected after the Basic or Extended evaluation has been initialized, an error or a warning is generated according to the Extended evaluation (encoder 1 or encoder 2) and the problem.

## .Monitoring the encoder signals

Correct position information is the prerequisite for reliable drive behavior and motion according to contour. In order to guarantee best possible position evaluation the encoder signals are therefore monitored for validity and compliance with the allowed tolerances.

Monitoring the encoder signals allows detecting faulty states, such as:

- Encoder is dirty
- Noise injection in the case of inappropriate wire routing or wire design
- Exceeding the max. allowed encoder velocity (limit frequency of the encoder signals)
- Wire break or short circuit on wire

## .Monitoring the encoder position after the initialization ( (F8022, F2042, E....)

In the velocity controller clock, the Basic encoder evaluation generates the original encoder position (ENCB position) and the encoder status from the encoder position data. The encoder status (errors, warnings, etc.) of the respective encoder is made available in "S-0-0600.x.1 Encoder status" for forwarding to the Extended evaluation (S-0-0610.x.1, Encoder status (input). The Extended evaluation evaluates the status in the same clock. If the error bit or warning bit has been set, a function-specific (encoder 1 / encoder 2) error or warning reaction is triggered.

## .Monitoring the axis position when switching on (F2074, F2075)

In addition it is possible to monitor drives with an encoder that can be evaluated in absolute form for compliance with the position when switching on compared to the last time the drive was switched off. This allows detecting, for example, whether a vertical axis moved down after the machine was switched off or whether an axis was moved away from the position it had when the machine stopped.

When the drive is switched off, the current encoder data of absolute encoders are stored depending on their functional application (Extended evaluation):

- P-0-0177, Encoder 1, absolute encoder buffer
- P-0-0178, Encoder 2, absolute encoder buffer

When switching on, a check is run for absolute encoders evaluated by the drive to determine in how far the current actual position value differs from the actual position value at the time of the last switch-off. The maximum allowed deviation is set in the following parameters:

- P-0-0095, Absolute encoder monitoring window, encoder 1
- P-0-0096, Absolute encoder monitoring window, encoder 2

If the deviation exceeds the determined value, the respective error message F2074, F2075 is output indicating that the actual position value is outside the absolute encoder window.

This monitoring function can be deactivated by the value "zero" in the respective absolute encoder monitoring window!

## .Monitoring the position data reference (F2174, F2175)

For position control of an axis drive, the position data reference between position encoder and mechanics has to be established during commissioning. For position encoders that can be evaluated in absolute form, the position data reference is always retained. However, it can be lost if:

- The parameter values of the mechanical drive system have been changed
- The scalings of the physical data have been changed
- The modulo range is changed
- The maximum travel range of an axis is changed
- Where applicable, measuring wheel mode is activated
- The encoder type is replaced (servicing)

During the transition from configuration mode (CM) to parameter mode (PM), the drive recognizes that the former position data reference of the encoder enabling absolute evaluation does no longer exist. It sets the parameter "S-0-0403, Status of actual position values" of the encoder or encoders to "relative" and signals the loss of position data reference by the following error messages:

Reference loss is also displayed if an encoder that can be evaluated in absolute form has not yet had position data reference.

## .Monitoring for encoder replacement (F2174, F2175)

In most of the cases, encoders that can be evaluated in absolute form feature an encoder data memory. The original encoder position is adjusted to the absolute position of the axis by an offset value. It is stored in the encoder memory. By replacement with a type-identical encoder in case of malfunction, a different potential offset value in the encoder memory may become effective and lead to an incorrect actual position value at the axis.

The **data memory of an encoder** usually includes its own **configuration data** and additional **administration data**. Additionally, **user-side data for adjusting the encoder**, e.g. to the motor or the axis, can be strored in the encoder data memory. The administration data usually include the **serial number of the encoder type** or a **unique identifier**. If a change

of the encoder type is detected,"S-0-0403, Status of actual position values" is set to relative, i.e. non-homed.

The drive signals the loss of reference by the error messages F2174 and F2175.

Prior to operation of the drive in the machine or system, position data reference to the axis has to be established again.

If a position encoder provides its own configuration data as well as additional administration data in the data memory, it is referred to as an encoder with "digital or electronic type plate"!

In the case of incremental position scaling, monitoring for F2174, F2074, F2036 does not take place.

## .Monitoring mechanical transfer elements for position difference (F2036)

For axis drives equipped with a motor-side and load-side encoder, the controller provides the possibility of monitoring the difference of the actual position values of both encoders with regard to a maximum value that can be set. The position difference is displayed in "P-0-0391, Actual position value difference encoder1 - encoder2".

The maximum admissible deviation of the actual position values of both encoders can be defined in parameter " S-0-0391, Monitoring window of encoder 2" If this value is exceeded, the error message "F2036 Excessive actual position difference" is generated. This monitoring function is active from parameterization mode PM or operating mode OM (bb, Ab) on, and can be deactivated by the value "0" in S-0-0391.

## .Monitoring mechanical transfer elements for slip (F2036)

For axis drives with encoder on the motor and load side, the controller provides an adjustable monitoring window for any mechanical slip of the axis that may occur. If the monitoring window is exceeded, the drive reacts with the error reaction that was set:

- This is particularly advantageous in measuring wheel mode to detect increased slip due to mechanical problems or wear
- In hybrid position control (with regard to encoder1/motor encoder **and** encoder 2) of slip-free drive mechanics, its elasticity is taken into account in the position control. Temporary slip indicates elastic deformation in acceleration or loading processes. The configurable monitoring window helps to prevent inadmissible deformation of axis mechanics.

The maximum allowed slip is defined in parameter "P-0-0244, Monitoring window of slip". If this value is exceeded, the error message "F2036 Excessive actual position difference" is generated.

The current slip is displayed in "P-0-0242, Current actual slip value", and the maximum value is stored in "P-0-0243, Maximum occurred actual slip value". The value for P-0-0244 can be derived from the maximum value, taking into account a safety margin.

100% slip means:

- With rotary load-side encoder 2: One encoder revolution of encoder 2
- With linear load-side encoder 2: Position offset from the value of the feed constant (S-0-0123)

Slip monitoring becomes active in measuring wheel mode with drive enable (AF), if position control is performed with

regard to encoder 2. In "hybrid position control", it is always active. The value of "P-0-0243, Maximum occurred actual slip value" starts at "0". Slip monitoring can be deactivated by the value "0" in "P-0-0244, Monitoring window of slip".

## .C11xx when switching on a third-party motor with HIPERFACE® encoder

For commutation reasons, some motor manufacturers shift the digital absolute track compared to the incremental analog signals with HIPERFACE® encoders. This can cause an initialization error in ctrlX DRIVE. This initialization error "C11xx Encoder Basic: Error during encoder initialization XG2X.x.y" can be avoided by position initialization without incremental track, which can be activated in the parameter "S-0-0602.x.136, Phys. Encoder evaluation configuration".

By position initialization without incremental track, the accuracy of the determined position is reduced!

## .Parameters involved

- S-0-0391, Monitoring window of encoder 2
- S-0-0600.x.1, Encoder status , x= characteristic number for encoder interface
- S-0-0610.x.1, Encoder status (input), x=1: encoder1/motor encoder, x=2: encoder2
- P-0-0095, Absolute encoder monitoring window, encoder 1
- P-0-0096, Absolute encoder monitoring window, encoder 2
- P-0-0177, Encoder 1, absolute encoder buffer
- P-0-0177.0.1, Encoder 1, absolute encoder buffer (static)
- P-0-0178, Encoder 2, absolute encoder buffer
- P-0-0178.0.1, Encoder 2, absolute encoder buffer (static)
- P-0-0242, Current actual slip value
- P-0-0243, Maximum occurred actual slip value
- P-0-0244, Slip monitoring window
- P-0-0391, Actual position value difference encoder1 - encoder2

## .Diagnostics involved

- E2074 Encoder 1: Encoder signals disturbed
- E2075 Encoder 2: Encoder signals disturbed
- F2036 Excessive position feedback difference
- F8022 Encoder 1: Encoder signals incorrect
- F2042 Encoder 2: Encoder signals incorrect
- F2074 Actual pos. value 1 outside of absolute encoder window
- F2075 Actual pos. value 2 outside of absolute encoder window
- F2174 Loss of encoder 1 reference
- F2175 Loss of encoder 2 reference