



Technical Information

Safety-Related Position Measuring Systems

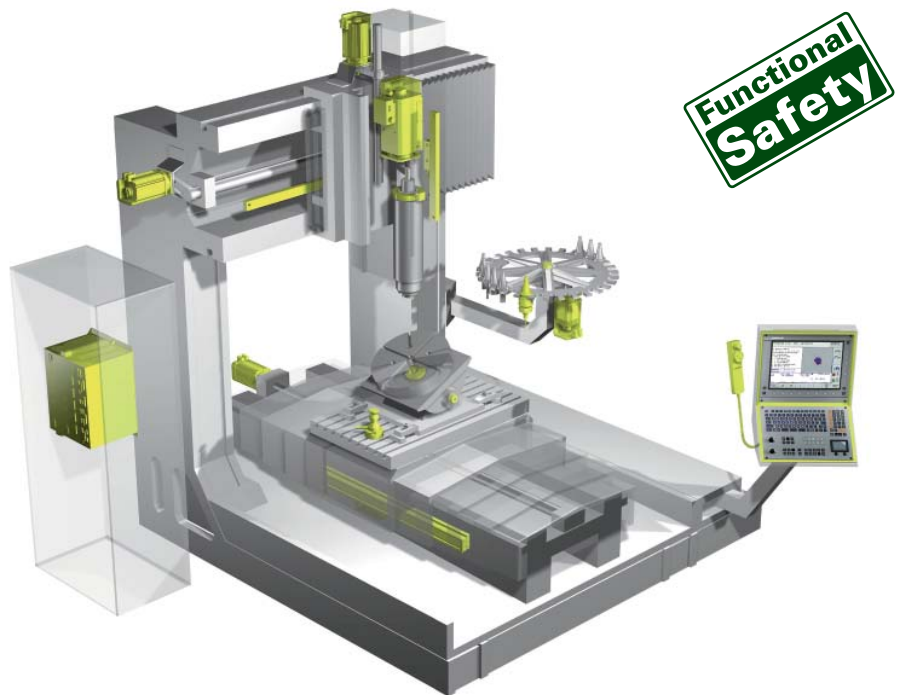
with purely serial EnDat 2.2 interface for safety-oriented applications with control category SIL-2 (according to EN 61508) or performance level "d" (according to EN ISO 13849)

HEIDENHAIN offers safety-related position measuring systems that are based on purely serial data transfer via EnDat 2.2 and can be used in safety-oriented applications. A safety-related position measuring system can be used as a single-encoder system in conjunction with a safe control in applications with control category SIL-2 (according to EN 61508) or performance level "d" (according to EN ISO 13849). Reliable transmission of the position is based on two independently generated absolute position values and on error bits. These are then provided to the safe control.

The first encoders available are rotary encoders with various mounting possibilities. Absolute linear encoders and angle encoders round out HEIDENHAIN's product program for Functional Safety.

Safety is becoming increasingly important in machine and plant construction. Proof of this can be seen in new legislation and in the heightened safety regulations of national and international standards. These high requirements mainly serve to protect human beings, but material assets and the environment are also receiving more consideration.

The goal of functional safety is to minimize or even eliminate risks that can occur during normal or impaired operation of machines or facilities. This is achieved primarily with redundant systems. For example, axes that are moved in safety-oriented applications require redundant position information in order to perform the corresponding safety functions. Various system configurations can be realized in order to capture independent position values. One possibility is using two encoders per axis, but due to cost considerations, a solution with only one position encoder is aspired to in most cases. Until now, analog encoders with sine and cosine signals were used for this.



HEIDENHAIN now offers a purely serial, single-encoder solution for safety-related position measuring systems in safety-oriented applications in accordance with EN 61508. This means that safety

applications can now take advantage of all the benefits of serial data transfer, such as optimization of costs, diagnostic possibilities, automatic commissioning and rapid formation of the position value.

Safety-Related Position Measuring Systems

Basic principle

HEIDENHAIN encoders for safety-related applications are tested for compliance with EN 61 508 and EN ISO 13 849-1 (which replaced EN 954-1). These standards describe the assessment of safety-oriented systems, for example based on the failure probabilities of integrated components and subsystems.

This modular approach helps manufacturers of safety-related systems to implement their complete systems, because they can begin with subsystems that have already been qualified. Safety-related position encoders with pure serial data transmission via EnDat 2.2 accommodate this technique. In a safe drive, the **safety-related position measuring system** is such a subsystem. The safety-related position measuring system consists of:

- Encoder with EnDat 2.2 transmission component
- Data transmission line with EnDat 2.2 communication and HEIDENHAIN cable
- EnDat 2.2 receiver component with monitoring function (EnDat master)

In practice, the **complete “safe servo drive” system** consists of:

- Safety-related position measuring system
- Safety-oriented control (including EnDat master with monitoring functions)
- Power stage with motor power cable and drive
- Physical connection between encoder and drive (e.g. shaft connection/coupling)

Integration of the position measuring system

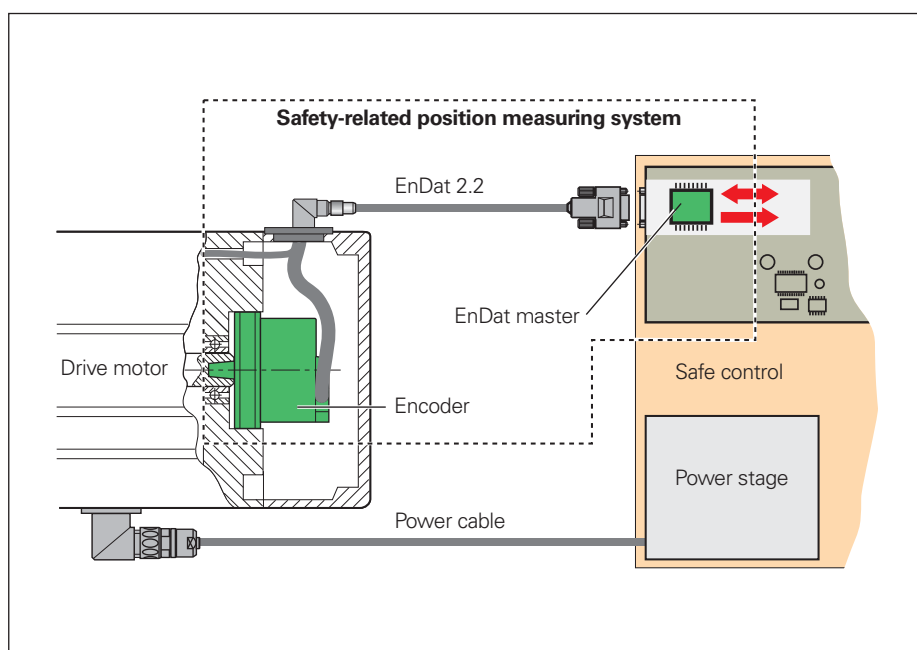
The position measuring system is integrated by a mechanical and an electrical interface into the complete system. The physical coupling of the encoder to the drive is determined by the encoder's geometry. Table 16 of the standard for electrical drives, EN 61 800-5-2, defines the loss or loosening of the mechanical connection between the encoder and drive as a fault that requires consideration. Since it cannot be guaranteed that the control will detect such errors, in many cases the possibility of the mechanical connection becoming loose or lost must be ruled out. There are possibilities for attaching encoders from HEIDENHAIN that rule out such errors.

Including the EnDat master with its monitoring functions in the safe control ensures its electrical integration. The necessary measures have already been defined. The control manufacturer must only implement them. With regard to a safe complete system, the remaining components of the complete system must also be designed for safe technology.

Function

The safety strategy of the position measuring system is based on two mutually independent position values and additional error bits produced in the encoder and transmitted over the EnDat 2.2 protocol to the EnDat master. The EnDat master assumes various monitoring functions with which errors in the encoder and during transmission can be revealed. The two position values are then compared. The EnDat master then makes the data available to the safe control. The control monitors the correct operation of the safety-related position measuring system with periodic tests.

The architecture of the EnDat 2.2 protocol makes it possible to process all safety-oriented information and control mechanisms during unconstrained controller operation. This is possible because the safety-relevant information is saved in the additional information. According to EN 61 508, the architecture of the position measuring system is regarded as a single-channel tested system.



Complete safe drive system

Field of application

Safety-related position measuring systems from HEIDENHAIN are designed so that they can be used as single-encoder systems in applications with control category SIL-2 (according to EN 61 508). This corresponds to performance level "d" of EN ISO 13849 (category 3 of EN 954-1). Also, the functions of the safety-related position measuring system can be used for the following safety functions in the complete system (also see EN 61 800-5-2):

| | |
|------------|-----------------------------|
| SS1 | Safe Stop 1 |
| SS2 | Safe Stop 2 |
| SOS | Safe Operating Stop |
| SLA | Safely Limited Acceleration |
| SAR | Safe Acceleration Range |
| SLS | Safely Limited Speed |
| SSR | Safe Speed Range |
| SLP | Safely Limited Position |
| SLI | Safely Limited Increment |
| SDI | Safe Direction |
| SSM | Safe Speed Monitor |

Safety functions according to EN 61 800-5-2.

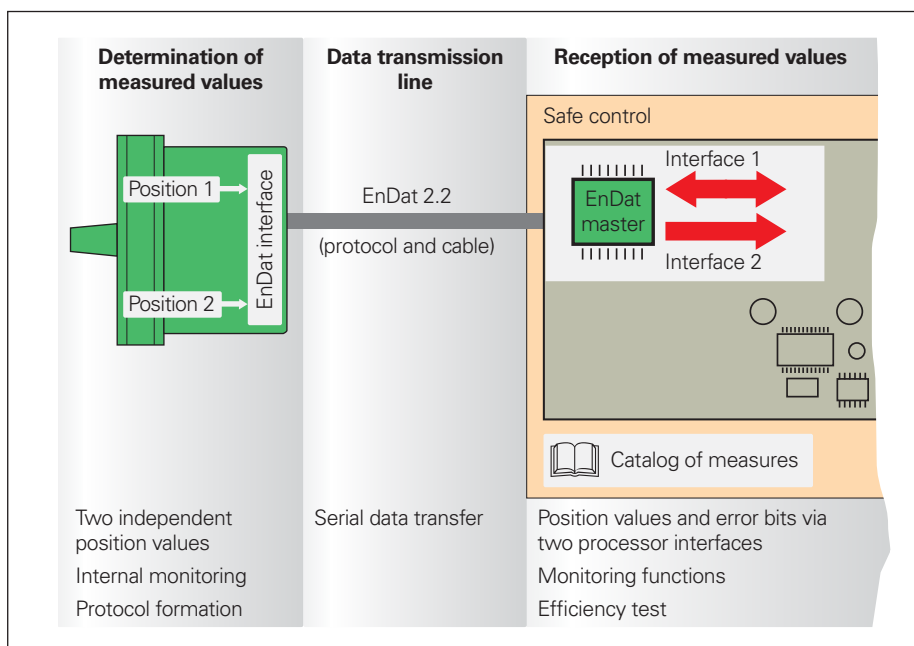
Requirements to be fulfilled by the safety-oriented control

Examples of important tasks of the safe control for setting up a safe axis using a safety-related position measuring system are detailed below.

- The position values and error bits are to be evaluated by the safe control during operation. Depending on the safety function required, this includes the comparison of the two position values

(Position 1 and Position 2), as well as monitoring of the servo lag and standstill monitoring, for example.

- The control is to perform efficiency tests (test interval < 8 h) in the encoder and in the EnDat master. As part of this, the error bits are subjected to forced dynamic (i.e. intentionally triggered) sampling, and their reactions are evaluated.
- If an error should occur, the control must assume a safe condition. The reaction that the control triggers when an error is revealed depends on the application, and is therefore part of the strategy of the drive or control manufacturer.
- An acceptance test must be performed when the machine is first put into operation, or when changes are made which influence the safety functions of the machine.
- The encoder and the EnDat master must be subjected to a switch-on test when they are switched on.
- The EnDat master makes the data available to the safe control. As an example, the figure shows the version with two processor interfaces. Position 1, Position 2 and the error bits must reliably be transmitted to the control over these two interfaces. The control has the tasks of reliably operating the interfaces and of temporarily monitoring the data transmission.
- The EnDat master and the encoder must each be supplied with protective low voltage according to EN 60204-1 from the subsequent electronics. Overcurrent protection must be provided for the encoder according to EN 60204.



Safety-related position measuring system

HEIDENHAIN Encoders with EnDat 2.2 for Safety-Oriented Applications



HEIDENHAIN offers encoders with purely serial data transfer for safety-oriented applications. The two measured values are already formed independently of each other in the encoder, and are transmitted to the safe control via the universal EnDat interface purely digitally.



EQN 1337



EQN 1035



ROC 1023



RCN 5510



LC 115

| Rotary encoders | | Positions per rev. | Distinguishable revolutions | Protection |
|-----------------|------------|--------------------|-----------------------------|------------|
| ECN 1325 | Singleturn | 25 bits | – | IP 40 |
| EQN 1337 | Multiturn | 25 bits | 4096 | IP 40 |
| ECN 1123 | Singleturn | 23 bits | – | IP 40 |
| EQN 1135 | Multiturn | 23 bits | 4096 | IP 40 |
| ECN 1023 | Singleturn | 23 bits | – | IP 64 |
| EQN 1035 | Multiturn | 23 bits | 4096 | IP 64 |
| ROC 1023 | Singleturn | 23 bits | – | IP 64 |
| ROQ 1035 | Multiturn | 23 bits | 4096 | IP 64 |

| Angle encoders ¹⁾ | | Positions per rev. | Accuracy | Hollow shaft |
|------------------------------|------------|--------------------|----------|---------------------|
| RCN 2310 | Singleturn | 26 bits | ± 5" | ∅ 20 mm |
| RCN 2510 | Singleturn | 28 bits | ± 2.5" | ∅ 20 mm |
| RCN 5310 | Singleturn | 26 bits | ± 5" | ∅ 35 mm |
| RCN 5510 | Singleturn | 28 bits | ± 2.5" | ∅ 35 mm |
| RCN 8310 | Singleturn | 29 bits | ± 2" | ∅ 60 mm ∅ 100 mm |
| RCN 8510 | Singleturn | 29 bits | ± 1" | ∅ 60 mm ∅ 100 mm |

| Linear encoders | Measuring lengths | Resolution | Accuracy |
|----------------------|-----------------------------|------------|----------|
| LC 115 ¹⁾ | Up to 3040 mm | 0.005 µm | ± 3 µm |
| | Up to 4240 mm | 0.01 µm | ± 5 µm |
| LC 415 ¹⁾ | Up to 2040 mm ³⁾ | 0.005 µm | ± 3 µm |
| LC 800 ²⁾ | Up to 28040 mm | 0.005 µm | ± 5 µm |

¹⁾ Scheduled availability: second half of 2010

²⁾ Scheduled availability: end of 2010

³⁾ Over ML 1240 only with mounting spar or tensioning elements

HEIDENHAIN

DR. JOHANNES HEIDENHAIN GmbH

Dr.-Johannes-Heidenhain-Straße 5

83301 Traunreut, Germany

+49 8669 31-0

+49 8669 5061

E-mail: info@heidenhain.de

www.heidenhain.de

For catalogs, brochures and product information sheets, visit

www.heidenhain.de/docu

Related documents:

- Product Information and Mounting Instructions of safety-related position measuring systems
- "Specification of the E/E/PES Safety Requirements for the EnDat Master and Measures for Safe Control"
ID: 533095-xx
- EnDat Interface Description
ID: 297403-xx