

Armed for the Future

Rotary Encoders for Servo Drives are ready for Integrated Safety Technology

Rotary encoders for electrical drives measure the rotary movement of synchronous servo motors. These data, usually absolute, are transferred to the subsequent electronics for use in control and positioning.

The bidirectional interface EnDat 2.1, which HEIDENHAIN introduced to the market about 15 years ago, are distinguished by the following features:

- automatic self-configuration;
- high data transfer rates;
- a write-accessible memory area for the customer;
- the capability of transferring purely serial data even at high shaft speeds or traversing velocities at clock speeds up to 2 MHz;
- realized in sealed linear encoders, angle encoders, and rotary encoders;
- connection to controls well established in the market.

These characteristics enabled the interface to establish itself some time ago for highly dynamic drive tasks in the machine tool and printing industry fields.

With the development of this interface toward the present purely serial EnDat 2.2, the data is no longer accompanied by the analog signals, which ensures a much higher tolerance of the information to noise. Now the subsequent electronics no longer have to interpolate these additional analog signals. At the same time, a cable with six lines and single shield together with M12 connectors reduce the cost. The system costs are reduced by up to 50 %, depending on the cable length.

First, the new rotary encoders of the ExN 1300 standard series with EnDat 2.2 interface are equipped with new highly integrated scanning and evaluation electronics. Unlike the electro-

nic available on the market up to now, they were prepared for safety engineering with purely digital data transmission, i.e. they were designed to fulfill the safety functions laid down in IEC 61508. This change has no effect on the dimensions of the encoders, so that no mechanical design changes are required in the motor connections.

Scanning

The absolute information is encoded in only one track on the new circular scale, such as HEIDENHAIN introduced years ago for sealed linear encoders with their "single-field scanning." In combination with the incremental track, the number of tracks required on the graduated disk was reduced from the previous 13 to only two. The information from both of these tracks is processed together in the new highly integrated electronics to produce a high-resolution absolute position value. These make the absolute value continuously available up to the maximum rotational speed and without restrictions. This provides purely digital data transmission for controls with sampling cycles of as little as approx. 10 µs.

In developing their scanning and evaluation electronics, HEIDENHAIN was able to exploit years of experience in the field of linear encoders for machine tools and the electronics industry. They have profited from field experience in the most disparate applications. In the area of optical scanning, high tolerance to contamination is

crucial for the signal quality. A rotary encoder should normally have no contamination after it has been produced – and this can be expected from highly automated production under clean room conditions. But practice has shown repeatedly that encoders built into servomotors show traces of oil from the bearing, dust from the breaks and gases from the motor windings.

The new, optimized scanning process of the ECN/EQN 1300 rotary encoders has allowed further improvement in reliability under the influence of contamination. They scan the line graduation over a very large number of signal periods to produce the analog signals needed internally. Up to now the analog signals have been generated from the tracks by four separately mounted photovoltaic cells, electronically processed, and provided as 1 VPP, TTL or HTL signals. This will also remain the standard with the incremental rotary encoders. Because of the "spatially" distributed scanning of the tracks by four photocells (see illustrations), each photocell is affected differently by contamination on the graduated disk, depending on the angle of rotation. Another benefit of the new scanning method is an increase in accuracy.

Highly integrated electronics

The scanning and evaluation electronics in the encoder transform the unconditioned signals directly into digital information. The new, optimized scanning and internal compensation improves the quality of the internal signals by a factor of 4 to 5. On an incremental encoder, the inter-

polation error without digital signal compensation would be reduced at least to half that of a comparable encoders available today. This is why reliable 14-bit interpolation is now possible in the chip. Complex and costly interpolation in the subsequent electronics is no longer required and the purely digital transmission is hardly influenced by external disturbances, which is a basic requirement for reliable position measurement.

The breath-taking pace of technological advancement in electronics is reflected in the realization of the new scanning and evaluation electronics. Thanks to the booming cell phone market, mixed signal ASICs have become affordable, smaller and more reliable. But only large quantities can move semiconductor manufacturers to develop tailor-made designs. As a manufacturer of highly sophisticated encoders at high production volumes, HEIDENHAIN is in the position to provide those quantities.

The reduction of individual error components, clearly visible in the illustrations, results in a decided improvement in reliability during manufacture and when in use by the customer. The high quality and reliability has been increased. The signal characteristics have been enhanced and linked with additional benefits, for example in expanded diagnostics capabilities and temperature sensing of the motor winding by the encoder. As another significant benefit, the new scanning and evaluation electronics eliminate the need for voltage monitoring at the unit while increasing the range for the power supply to 3.6 to 14 V.

For future-oriented applications, the question of safety standards is becoming increasingly important. HEIDENHAIN has had years of experience in this area. The challenge to the new encoder generations was the realization of functions for safety-related applications with purely serial data transmission based on the IEC 61508, EN ISO 13849-1 and EN 954-1 standards. The design check of the encoders

for the above standards was successful. In conjunction with a safety-oriented control, the rotary encoders can be used as single-encoder systems for applications with control category SIL2 in accordance with IEC 61508 and performance level "d" of ISO 13849.

This manner of combining scanning and evaluation electronics with integrated safety technology is unique among the solutions now offered on the market. Purely digital signal transmission and the safety-related data transferred with it over inexpensive cables and connectors increase the benefit for the user. Moreover, the improved signal quality and the decrease

of thermal influence over the entire temperature range increase control loop performance and reduce velocity fluctuation. Also, it results in less noise generation and lower heat generation in the drive, which further increases accuracy. The end results are better surfaces on machined parts, sharper printed designs, and improved machining results in general.

Author:

Ludwig Schmid, Michael Stempfle
Produktmarketing
DR. JOHANNES HEIDENHAIN GmbH
Dr.-Johannes-Heidenhain-Str. 5
83301 Traunreut - Germany
Tel.: +49 (0) 8669/31-0
Fax: +49 (0) 8669/3 86 09
www.heidenhain.de