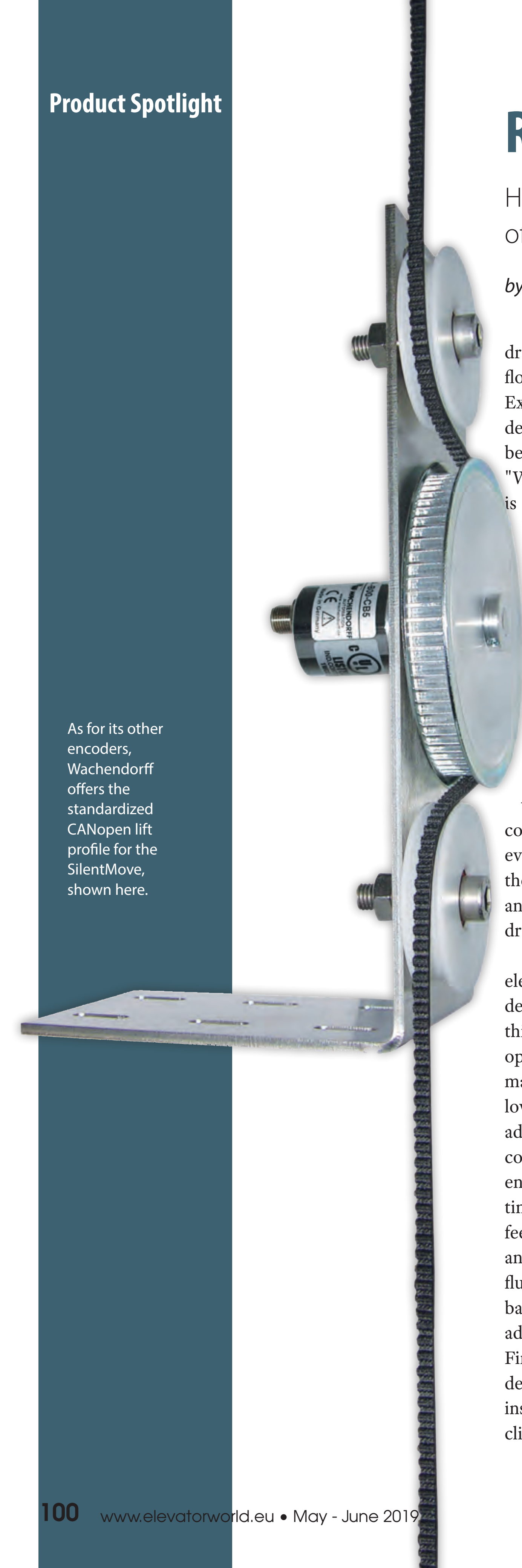
Rotary Encoder System

How to correctly measure position and speed of low-rise residential elevators

by Robert Wachendorff



As for its other encoders, Wachendorff offers the standardized CANopen lift profile for the SilentMove, shown here.

Ever since Elisha Graves Otis dramatized his safety device on the floor of the Crystal Palace Exposition in NYC in 1854, lift designers and manufacturers have been trying to answer the question, "Where is my lift car, and how fast is it going right now?"

Over the years, a fundamental principle that detected only the critical positions with absolute reliability in the shaft head, shaft floor and door zones, was established. Optical sensors or magnetic switches with a fixed installation in the elevator shaft and with associated tape with holes or magnets that confirm the pre- and shutoff points of the control units have been installed in every elevator. At the same time, the speed of the car is measured and controlled using encoders and drives.

It is possible to imagine that all elevator manufacturers have developed countless variations of this basic principle with the aims of optimizing safety, assembly and maintenance requirements at the lowest possible cost. However, the additional requirements of ride comfort, positional accuracy and energy savings were added over time. Ideally, passengers will not feel the car's starting and braking and would like it to stop completely flush with the floor. A uniform and balanced control system also allows additional energy to be saved. Finally, elevator manufacturers' desire for faster and more flexible installation and the requirement of clients to, in principle, reduce installation time also became increasingly important.

As international standardization also continues to develop, it is no longer enough to detect the car only in the critical positions. Rather, it has become necessary to know the precise speed and position of the previous "zero-visibility phase" and be able to precisely regulate it. Over time, these new requirements have resulted in various technical solutions for measuring position and speed in the shaft to improve elevator performance with respect to positioning and leveling.

Apart from many variants in the design, functions and characteristics that result from the very different approaches around the world, some basic solutions have been established on the market:

- Optical scanning using sensors installed on the car, in combination with a reading tape mounted in the shaft
- As above, but as a magnetic system
- Optical scanning with a perforated metal tape (also referred to as a tape selector)
- A rotary encoder with a deflection mechanism and a timing belt mounted in the shaft

SilentMove™ is an example of the latter system. While it is only of limited use for high-rise buildings, it is designed for applications in a wide range of medium-sized buildings. This includes residential elevators or home lifts, hydraulic

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lifts, limited-use/limited-application (LU/LA) systems, cargo lifts or car lifts.

How It Works

A toothed pulley mounted on the shaft of a rotary encoder, which in turn is attached to the car, rolls along a timing belt mounted in the shaft. The timing belt is mounted between the shaft head and bottom, using very simple but efficient mounting parts tensioned by a spring. The encoder is easy to incorporate into the elevator by using a mechanism or bracket in both new installations and modernizations.

The information generated about the position, like speed and acceleration of the car, can be transmitted via an interface as absolute or incremental values to a control and regulation system, which, in turn, can use this information to map the elevator's functions. This results in the encoder system's first important advantages:

- ♦ It is much easier to install a timing belt than magnetic or optical reading tape.
- ♦ The large tolerance with respect to the plumb line allows for faster and more flexible assembly.
- ♦ The sensor system is self-contained in a single component. This eliminates the risk of reading errors with separate sensors and tapes in dirty hoistways. This is especially true in harsher environments such as outdoor installations or buildings subject to corrosive salt air.
- ♦ Compared to the installation of optical sensors or magnets, commissioning is quick and easy. The installer can easily move to each floor and accordingly record the door zones and floor positions as soon as the control system has recorded the values of the position in the shaft using a reference run. All values for the run are thus set after a single run. For corrections due to tolerances, the values can simply be rerecorded. Rather than having to move about the shaft, the installer can carry out these tasks seamlessly from the control system or by using a remote control.

However, one disadvantage also shows why the encoder system can only be used to a limited extent at higher speeds and elevations: even if the system reduces noise using vibration dampers, noises are generated at high speeds. Although they may be below the defined requirements, they are, nevertheless, measurable.

Additional special requirements in many of the aforementioned applications (home lifts, hydraulic lifts, LU/LA systems, cargo lifts or car lifts) make SilentMove attractive. First, in some cases, only a few centimeters or steps need to be bridged. Here, a system with magnets or optical sensors cannot provide good positional accuracy, and the other systems are too complex in terms of installation and handling. Only the flexibility of the installation options for the timing belt and the associated freedom of attachment fully solve this application's problems.

With hydraulic elevators, the precise detection of the position and the speed, especially when starting up and braking, can result in significantly greater ride comfort with regard to the uniformity of the acceleration and landing of the car. Above all, the position

Product Spotlight

Specifications

- Noise Produced: 68 dB
- Accuracy: 0.1 mm
- Speed limit: up to 800 ft/min
- Height limit: up to 400 ft
- Belt system: nonslip due to steel reinforcement; Teflon coated
- Encoder: incremental or absolute magnetic via CANopen, SSI or RS485 interface
- Certification: UL listed

of the floor can be approached very precisely. These features allow the customer to reach the floor faster and more accurately, while consuming less energy. With all applications, the highly accurate position makes it easy to adjust the door zone individually, thus minimizing the time between the car's stopping and opening the door.

The rotary encoder is also compact, a design that requires both high bearing loads and technologies to ensure the device does not take up too much space. In Wachendorff Automation GMBH & Co. KG's WDGA series, two key technologies make it possible to accommodate an absolute multiturn encoder in a 36-mm housing: EnDra® and QuattroMag®. The EnDra multiturn technology uses a Wiegand wire consisting of a hard magnetic sheath and a soft magnetic core. The absolute position per revolution (single turn) is measured with a magnet on the rotating shaft and four hall sensors. When the magnet's field moves along the wire due to the shaft turning, the soft magnetic core wants to follow the field, while the hard magnetic shell prevents this from happening. An increasingly large field difference is created in the wire (similar, for example, to drawing a bow). As soon as the external field matches the coercivity of the outer shell, the shell is demagnetized, and the voltage in the core jumps dramatically. This speed-independent pulse is generated twice per revolution and converted via a coil into electrical impulses. These signals create enough power to operate a low-energy fram accumulator and provide information on the number of rotations completed. No additional external energy is needed for this revolution count. When external voltage is available again, an intelligent microcontroller calculates the correct value from the position and number of rotations and sends this value to the control unit. Our QuattroMag single-turn technology is based on four hall sensors, in conjunction with a patented algorithm that calculates the magnetic field generated by a diametrically arranged magnet in such a manner that any interferences from the hall signals cancel each other out. These technologies make the product useful even in highly accurate and dynamic applications that, in the past, only optical systems could handle.

The control and sensor system requirements for residential applications are not comparable with those for the high-rise sector. While a highly accurate position measurement is desired to prevent trip hazards or unevenness, higher safety requirements are only needed to a limited extent, because of the relatively low lift speeds and low elevations.

The elevator installer can save considerable time and material not only regarding the individual costs for the positioning system, but also thanks to the short installation time and, in particular, the interface design. Many microcontrollers used in controls and drives come equipped with interfaces that are already integrated and can be upgraded to a required interface with only a few more components. This provides the control unit designer with a suitable means of communication between encoder and control system at almost no extra cost. In addition, the WDGA encoders offer the versatile and proven CANopen protocol or proprietary adaptations, as well as common interfaces, such as RS485 or SSI.

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