



Encoder systems for modern and automated container cranes

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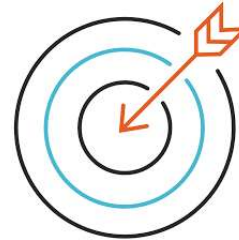
Our company: base for more than 100 motivated people

Year of foundation:	1934
Employees:	105
Sales:	15 Million EUR
Direct Export:	65 %
Subsidiary:	USA
International Representatives:	over 50 world-wide
Quality Management System:	DIN EN ISO 9001:2015



Requirements today:

- Accuracy
- Handling speed
- Safety
- Reliability

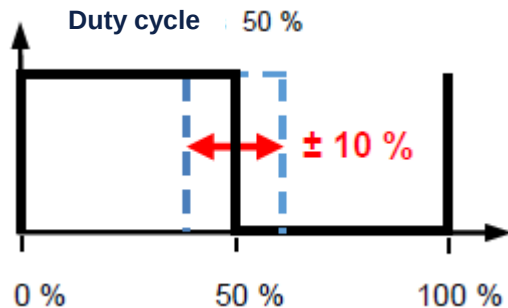


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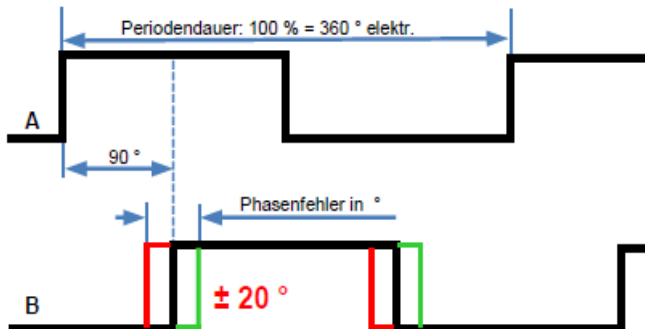


Accuracy:

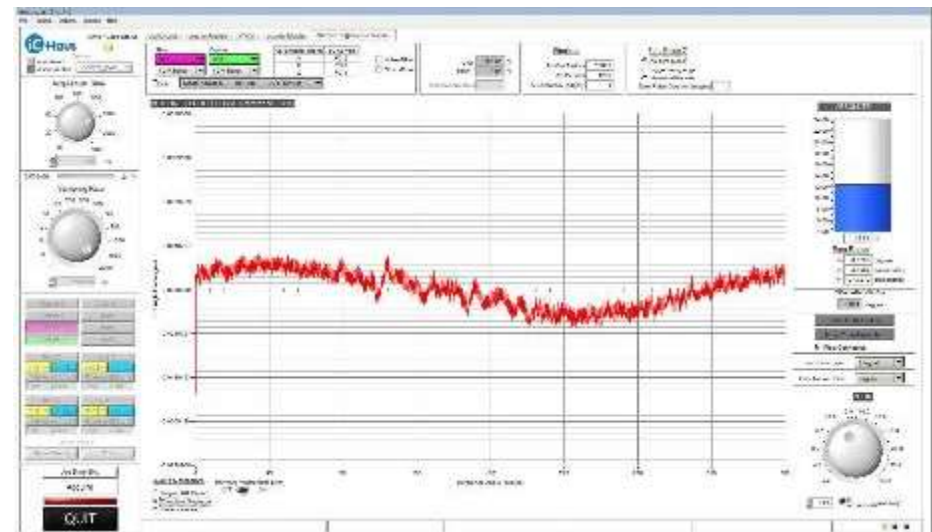
Problem → Unprecise encoder signal (example incremental encoder)



Phase shift : 0° / 90°



„Rotational frequency modulation“





Accuracy:

Problem → Mechanical play
(+ inaccurate signal quality)



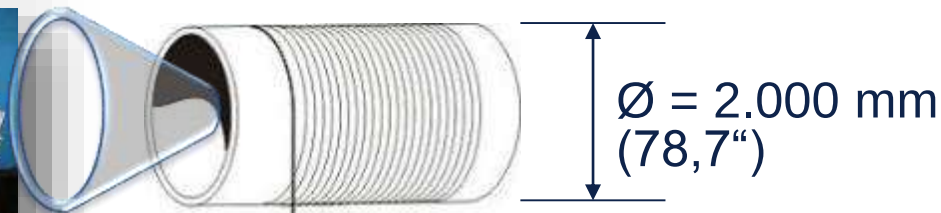
Encoder systems for modern and automated container cranes



Accuracy:

Example hoist

Total inaccuracy e.g. 5 % caused by several mechanical interfaces (play) and hysteresis



with $U = 3,14 \times d$
and inaccuracy = 5 %



Inaccuracy = 314 mm (12,3")

Encoder systems for modern and automated container cranes



Accuracy:

Solution

- More precise encoder solution, choosing the right measuring principle
- Reduction of mechanical interfaces by using universal encoder systems, e.g. U-ONE®



Before



After

Encoder systems for modern and automated container cranes

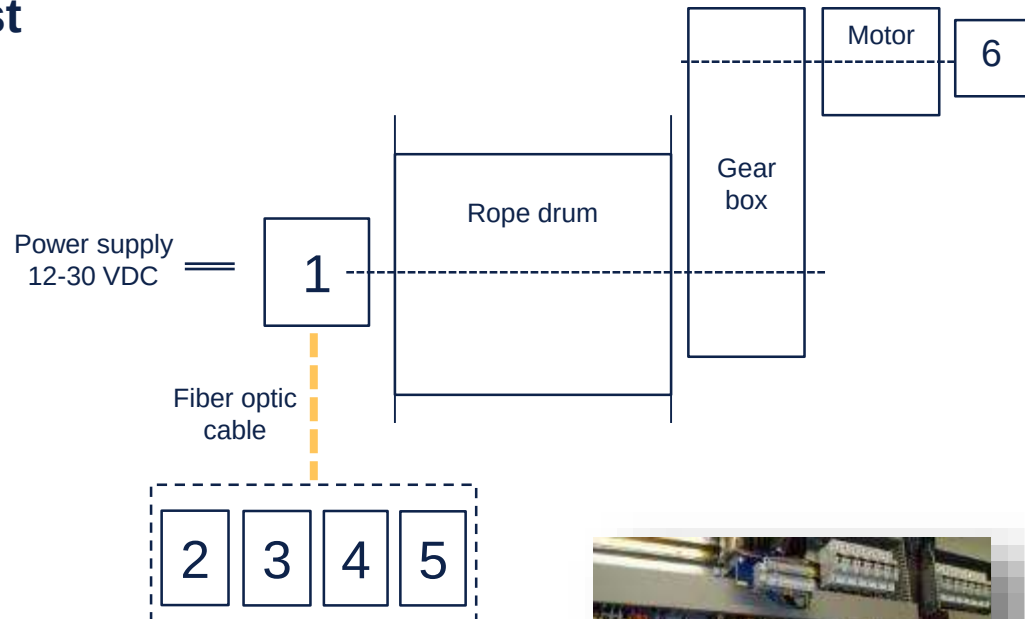


Accuracy:

Solution example: Main Hoist



1. U-ONE detection unit
2. Decoder
3. Overspeed switch
4. Absolute output interface
5. Electronic position switch
6. Incremental encoder with FOC



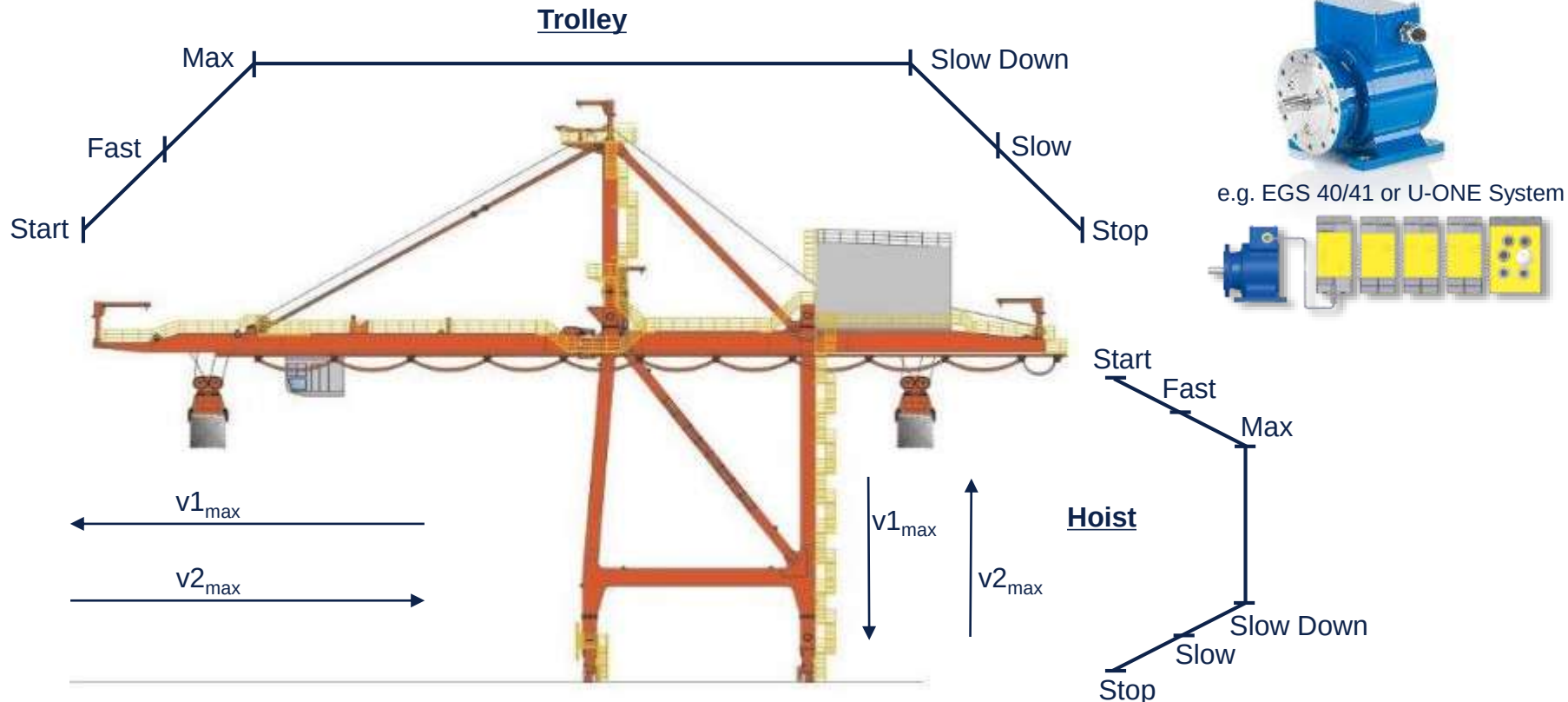
Electronic modules in the switchboard

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Handling speed:

Improving the handling speed by programmable electronic position and speed limit switches

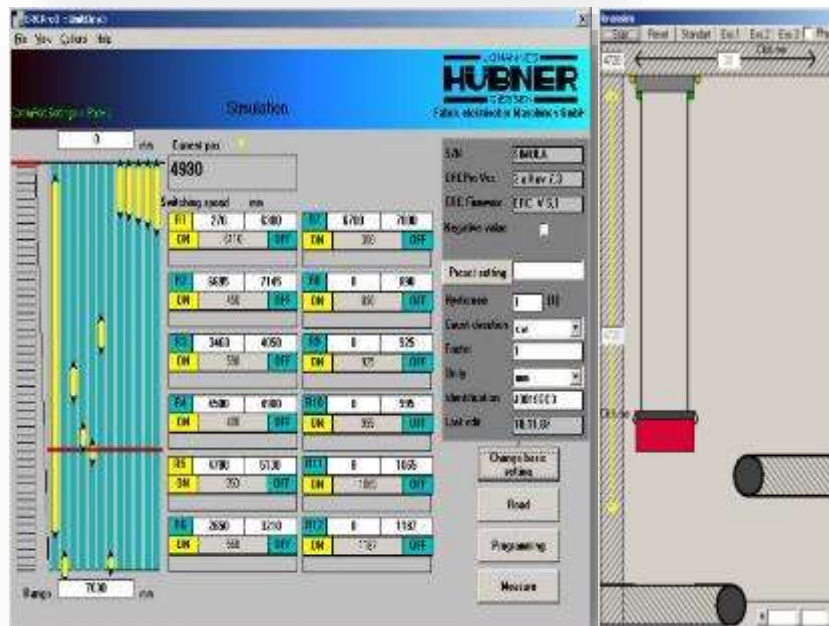


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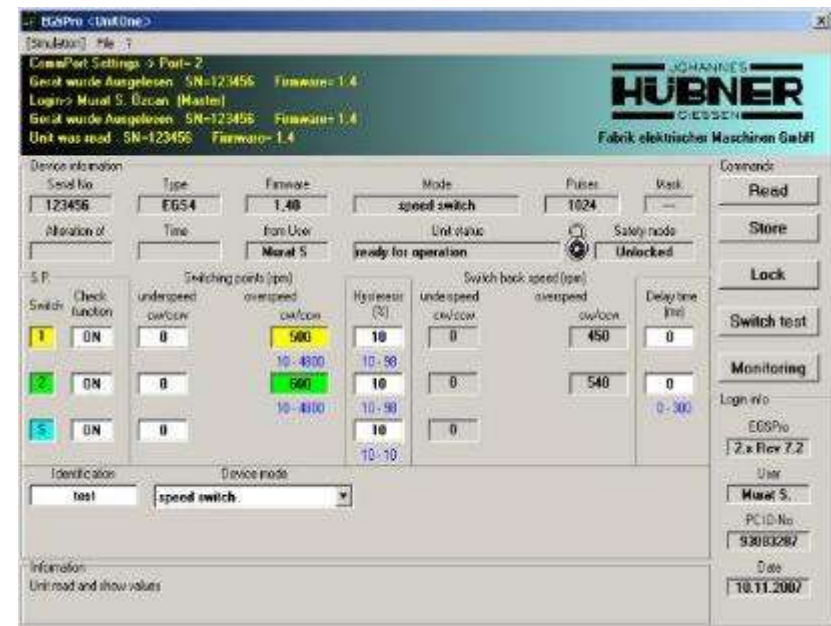


Handling speed:

Improving the handling speed by programmable electronic position and speed limit switches



Settings at electronic position switch (ERC)



Settings at overspeed switch (EGS)

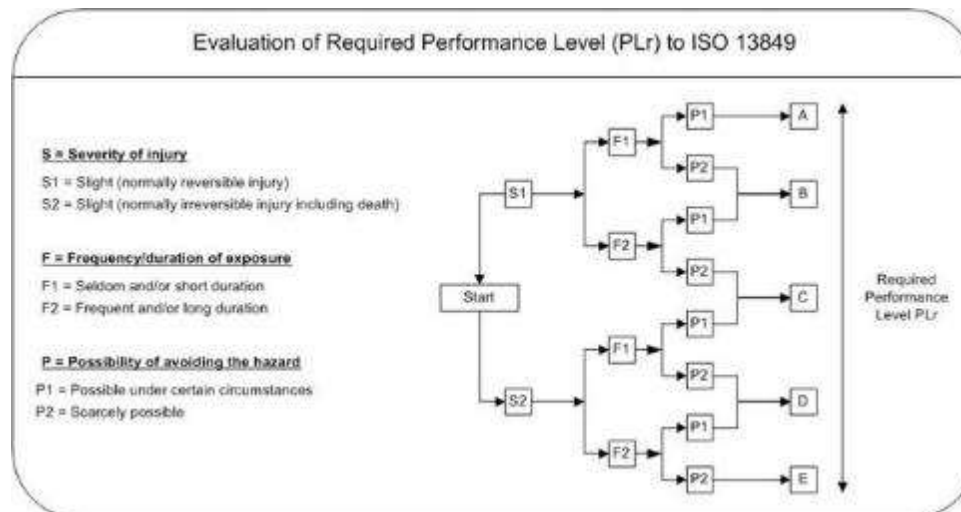
→ Another benefit: Reduction of engineering costs by easy programming and less PLC space



Safety:

Automated operation requires higher safety standards

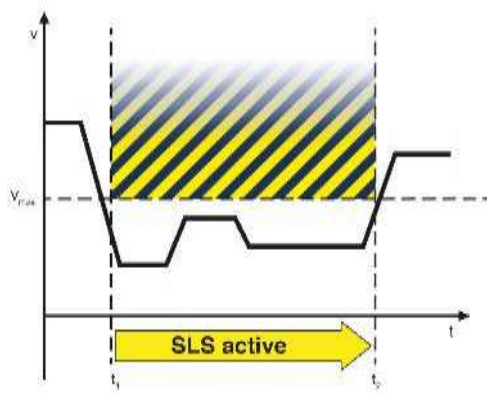
- SIL or PL-rating according to EN 61508 (SIL) and EN ISO 13849 (PL)
- SIL / PL is an evaluation or calculation of the failure potential and its consequences





Safety:

Important safety functions for crane applications



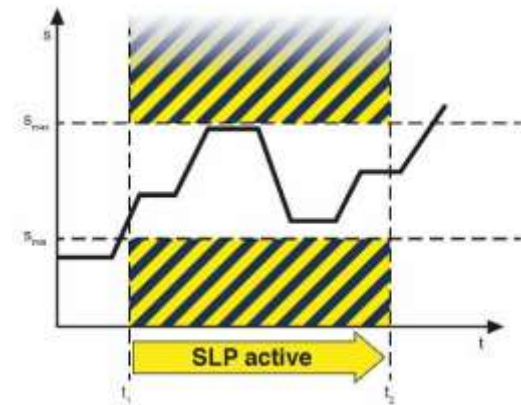
SLS – Safely-Limited Speed

The SLS function prevents the motor exceeding defined speed limits. Monitored functions that exceed the limit value are detected and the drive is shut down safely.



SDI – Safe Direction

The SDI function prevents the motor shaft moving in an unintended direction. Any movement in the wrong direction is detected and the drive is shut down safely.



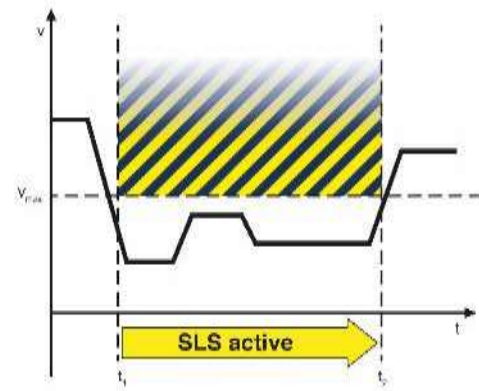
SLP – Safely-Limited Position

The SLP function prevents the motor exceeding defined position limit(s). Monitored functions that exceed the limit value are detected and the drive is shut down safely.



Safety:

SLS - Safely-Limited Speed



Application examples

- Overspeed monitoring hoist or boom hoist (max. speed depending on load)
- Commissioning („Teach-in mode“)
- Maintenance during operation mode



Safety:

SDI – Safe Direction



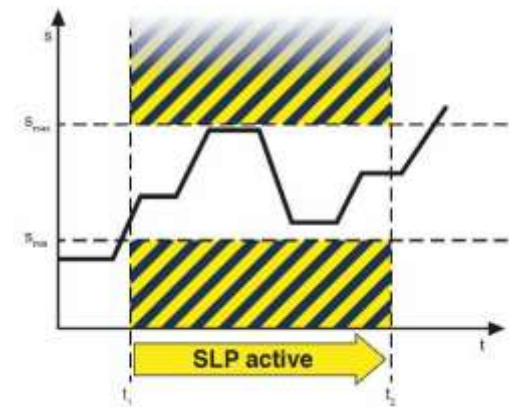
Application examples

- Overload situations such as weight limit exceeded or blocking the twist locks (Snag load situation)
- Retracting of limit switch positions



Safety:

SLP: Safely-Limited Position



Application examples

- Range limitation of the boom hoist (collision avoidance)
- Limitation of traversing range

Encoder systems for modern and automated container cranes

Safety: Solution concept, e.g. Safely Limited Speed

Sensor

Logic (PLC)

Actuator

Old solution



Incremental encoder



Mechanical overspeed switch



„Lilly“ Controller



Conventional PLC



Drive system with external motor and line contactor

New solution concepts:



+



Two independent speed encoder



and / or



Safety PLC

External safety switch gear



Drive system with integrated safety



or

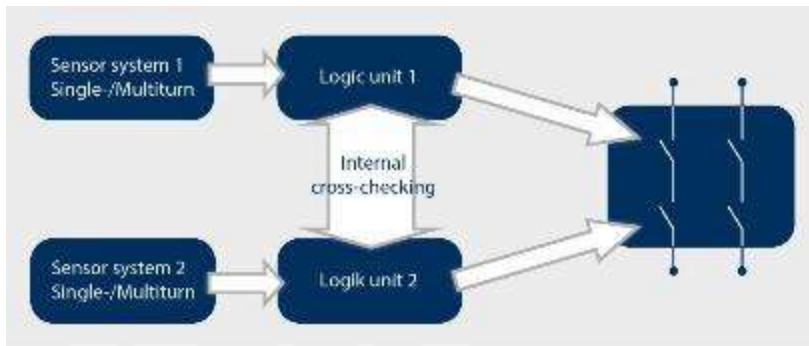


Certified over speed switch EGS 41 /
certified universal encoder system U-ONE



Safety: Main strategies for safety encoder design

Dual channel architecture



Dual channel architecture with internal cross-checking



Integrated diagnostics



- voltage range (min/max)
- temperature range (min/max)
- speed range (max)
- position range (min/max)
- relais lifetime (B10d-value)
- operating hours counter
- use duration monitoring
-

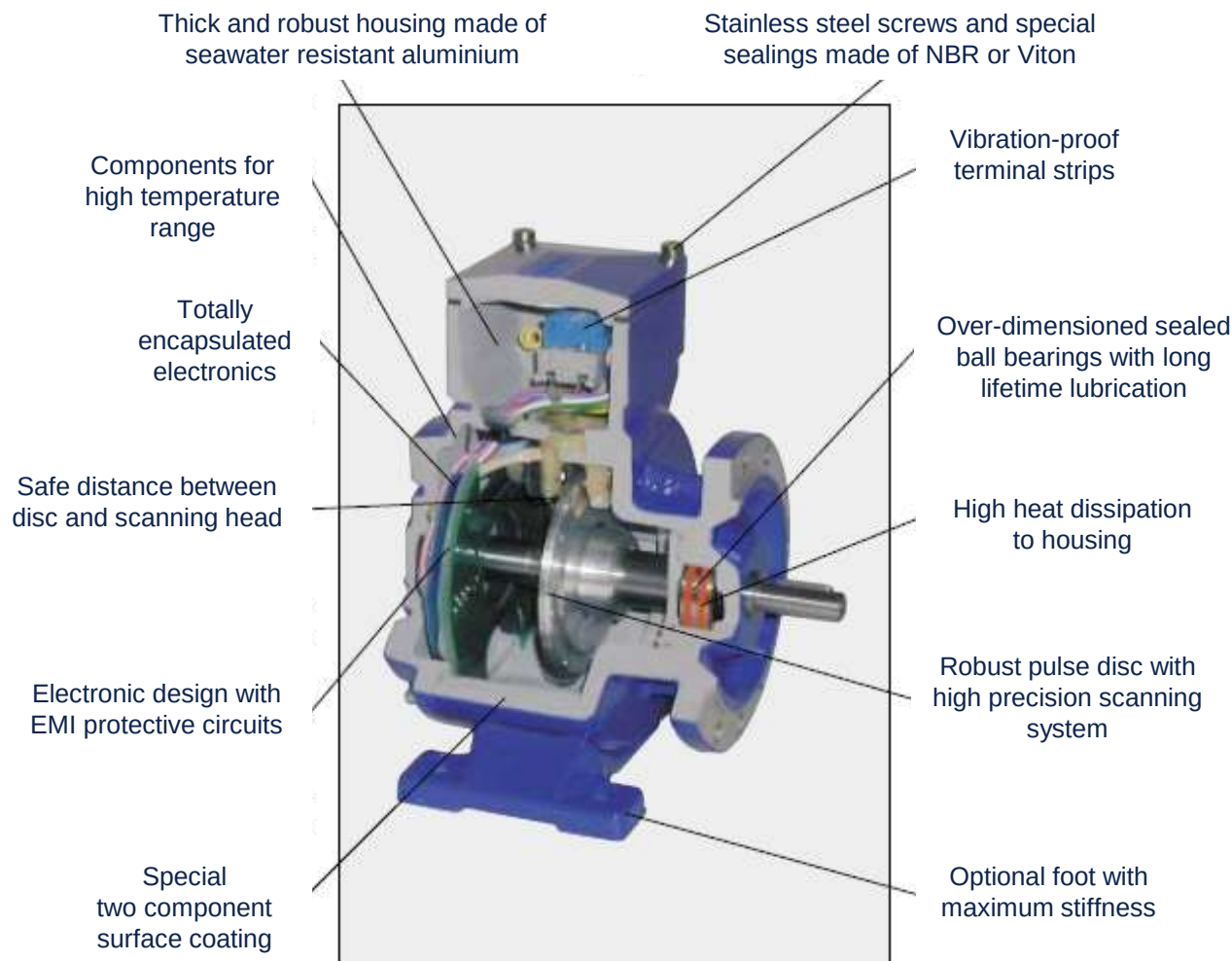


Reliability: Major part of operation costs





Reliability: Attributes of reliable heavy duty encoders





Reliability: Encoder testing



Shock resistance

DIN EN 60068-2-27
IEC 68-2-27

Vibration resistance

DIN EN 60068-2-6
IEC 68-2-6

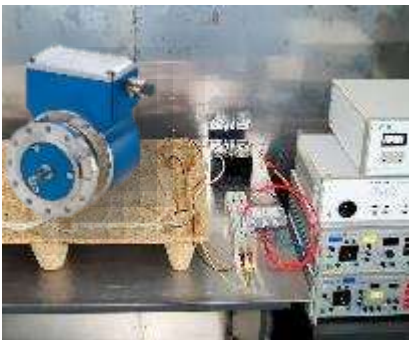


Low temperature

DIN EN 60068-2-1
IEC 68-2-1

High temperature

DIN EN 60068-2-2
IEC 68-2-2



Electromagnetic immunity (EMI)

IEC 61000-6-7



Degree of protection

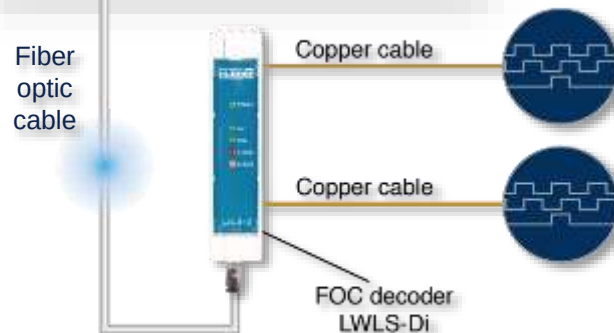
Dust / water
DIN EN 60529 (IP-Code)

Mechanical load

Impact / shock
IEC 62262 (IK-Code)



Reliability: Reduce downtime by fiber optic signal transmission



Main advantages:

- EMI proof (disturbance by: power cable, magnetic fields, starting current)
- Cable breaking monitoring
- Long cable length
- DIN rail mounting
- One fiber optics cable for all signals
- Decoder with 2 output blocks (TTL/HTL)

Thank you very much for your attention!

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