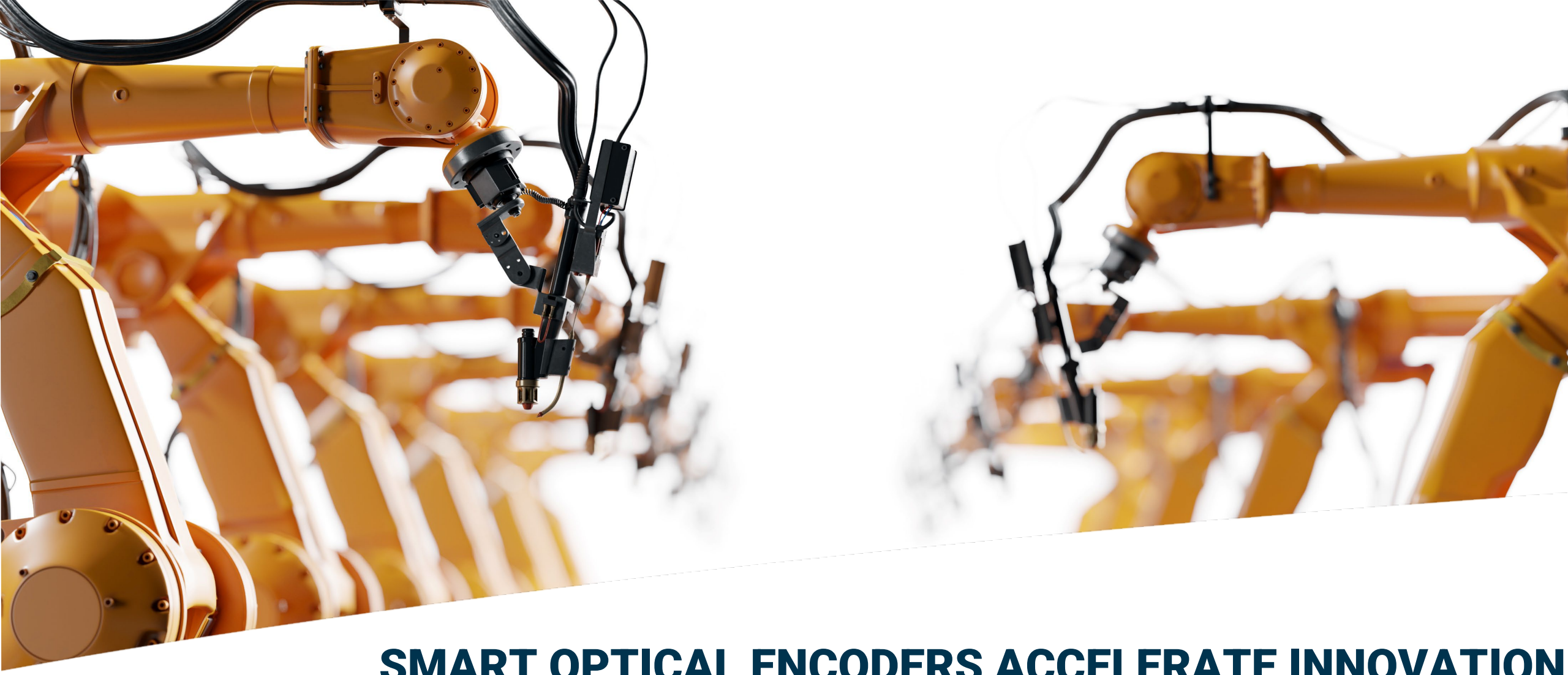
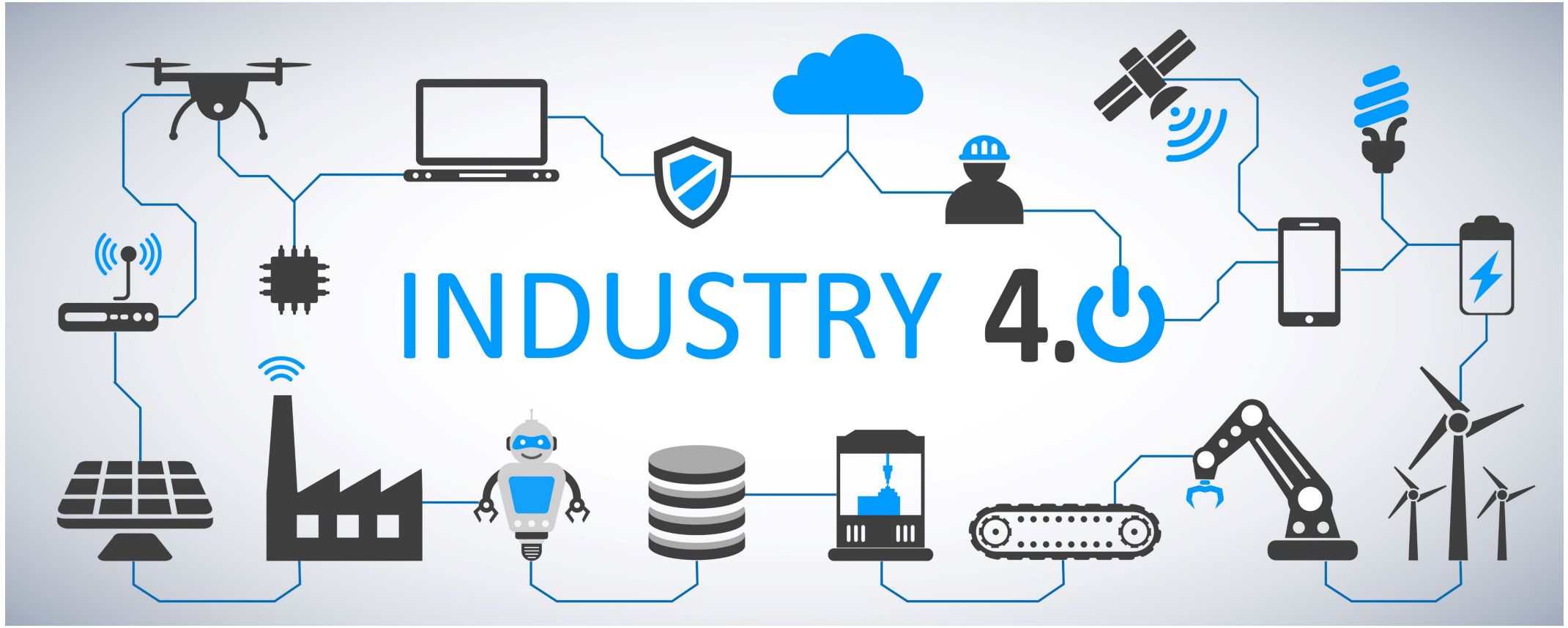


SMART OPTICAL ENCODERS ACCELERATE INNOVATION IN AUTOMATION AND ROBOTICS FOR INDUSTRY 4.0

TT Electronics

Sergey Komarov, Business Development Engineer



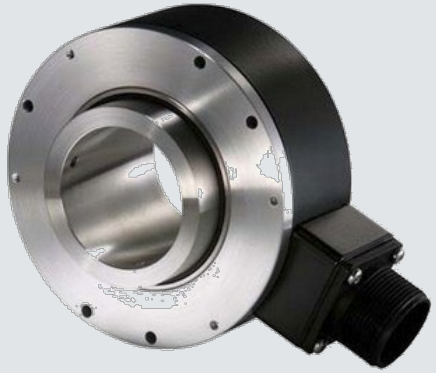
Industry 4.0 relies on smart sensors which enable manufacturing processes and predictive maintenance with minimal downtime, maximum efficiency and sustainable throughput.

This precise level of control, data collection and processing is guaranteed by a new generation of highly integrated, multi-functional smart optical sensors.

ENCODERS 101

Low-cost control electronics are trending up, allowing more industrial segments to automate. This has led to the widespread use of encoders.

Encoders automatically detect shaft rotation or linear displacement. This information is fed back into a computer or control mechanism for controlling velocity or shaft position. The main applications are motor feedback, robots and numerical control machine tools (CNC machines).



ENCODERS

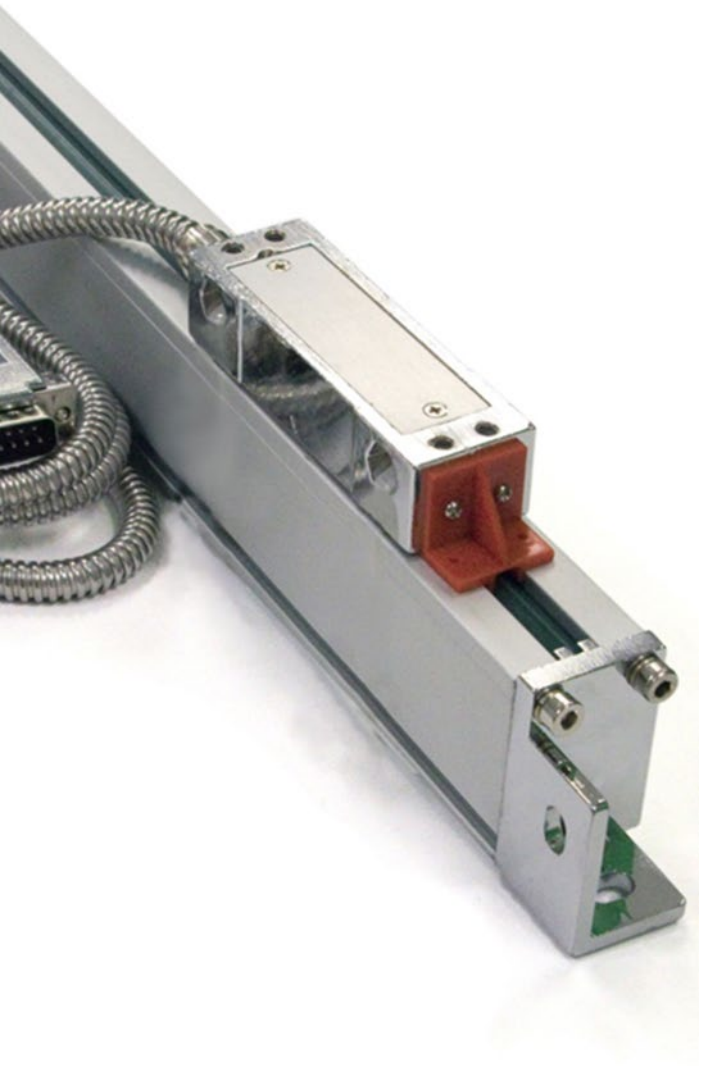
Encoders can generally be categorized into 3 types:

- Optical
- Magnetic
- Mechanical-Contact

There are two basic types:

- Linear
- Rotary

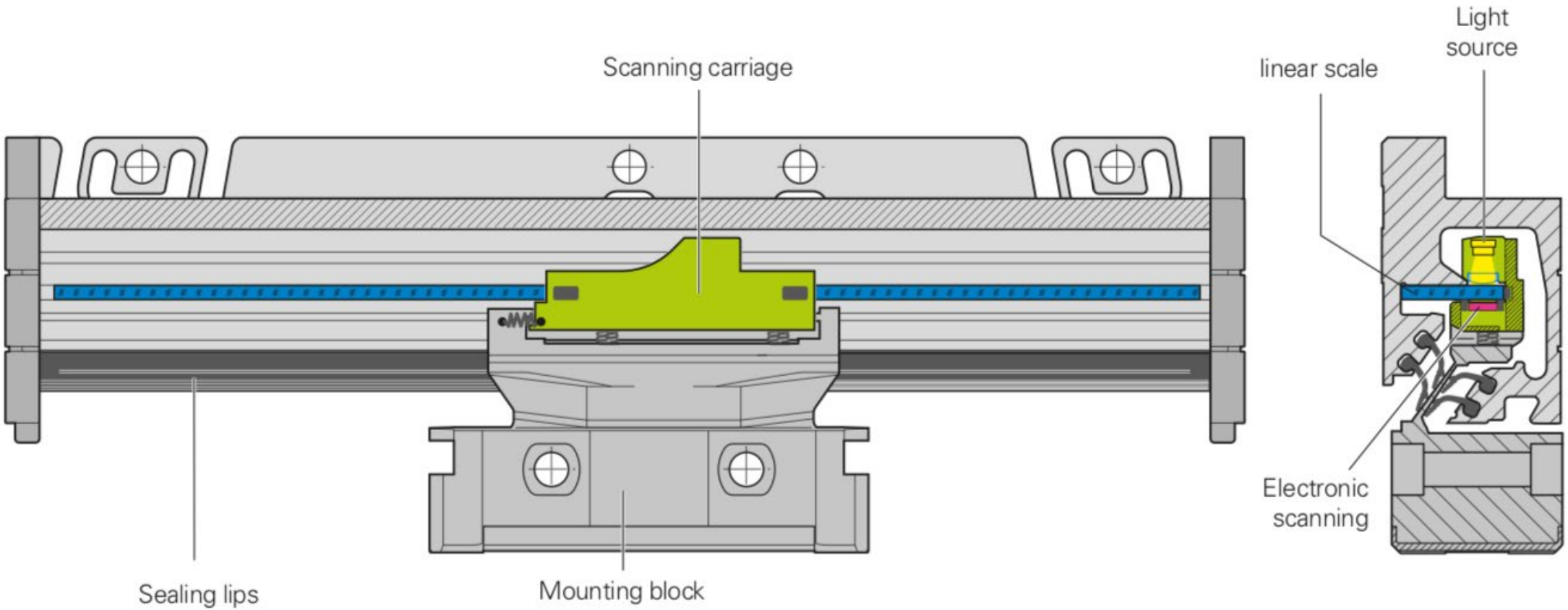
While the principles behind them are similar, their specific applications most often are not.



LINEAR ENCODERS

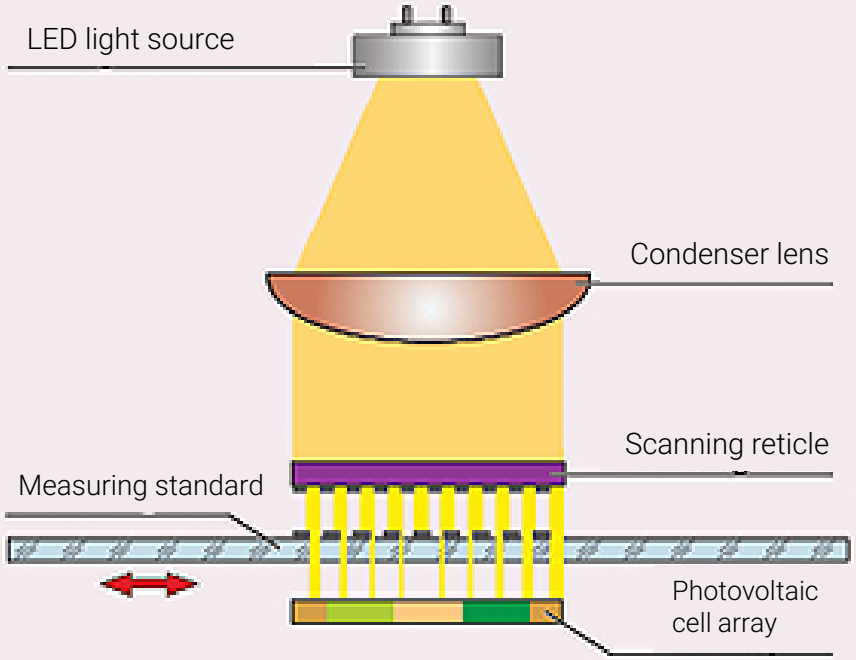
- Operates on photoelectric scanning principle (like rotary encoders)
- Linear scale = straight construction
- Output signals are interpolated (digitized differently in a direct manner)
- Linear feedback systems achieve resolutions in the submicron range (required in semiconductor industry and in ultra-precision machining)

LINEAR ENCODERS

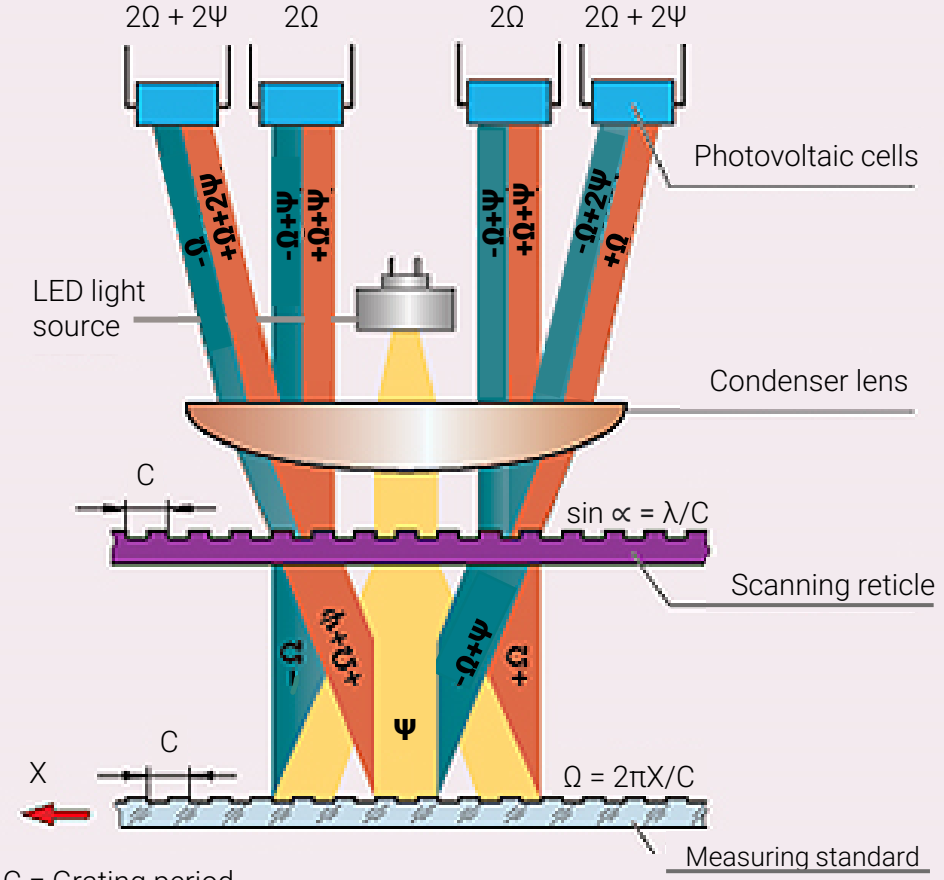


LINEAR ENCODERS

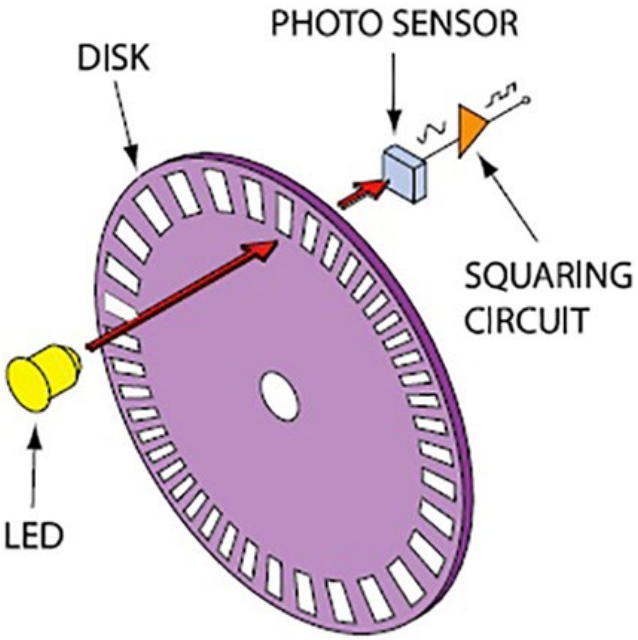
Linear Encoders – scanning imaging

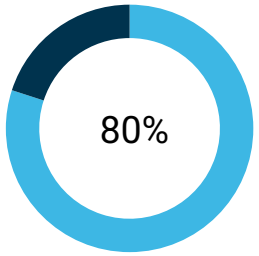


Linear Encoders – interferential scanning



C = Grating period
Ψ = Phase shift of the light wave when passing through the scanning reticle
Ω = Phase shift of the light wave due to motion X of the scale





Of all optical rotary encoders being used today

ROTARY ENCODERS

The code “tracks” on an incremental encoder. It consists of evenly spaced opaque lines that act as “shutters” that alternately open and close to allow light from the light source to the photodetector.

The output signals are evaluated by an electronic counter. The measured value is determined by counting increments.

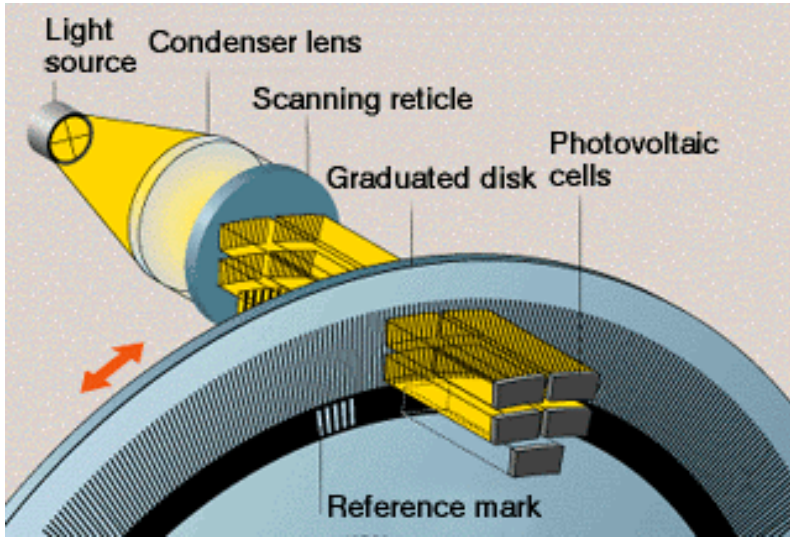
ROTARY ENCODERS

Types:

- Incremental for measuring angles
- Incremental for measuring linear positions (used in conjunction with measuring ball screws or rack/pinion)
- Absolute for one rotation (single-turn rotary encoders for measurement of angles)
- Absolute for several rotations (multi-turn rotary encoders)

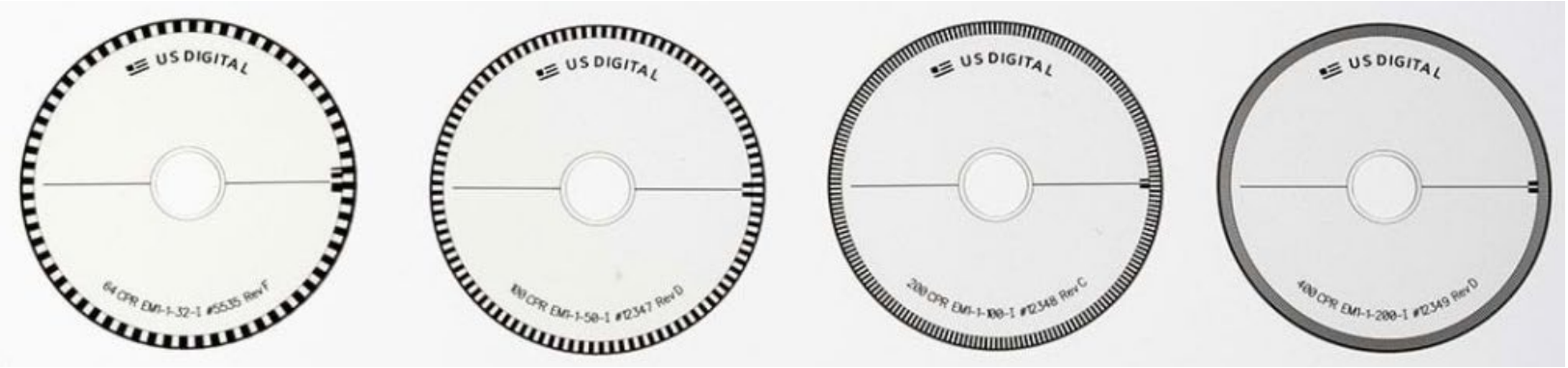
ROTARY ENCODER UNIT

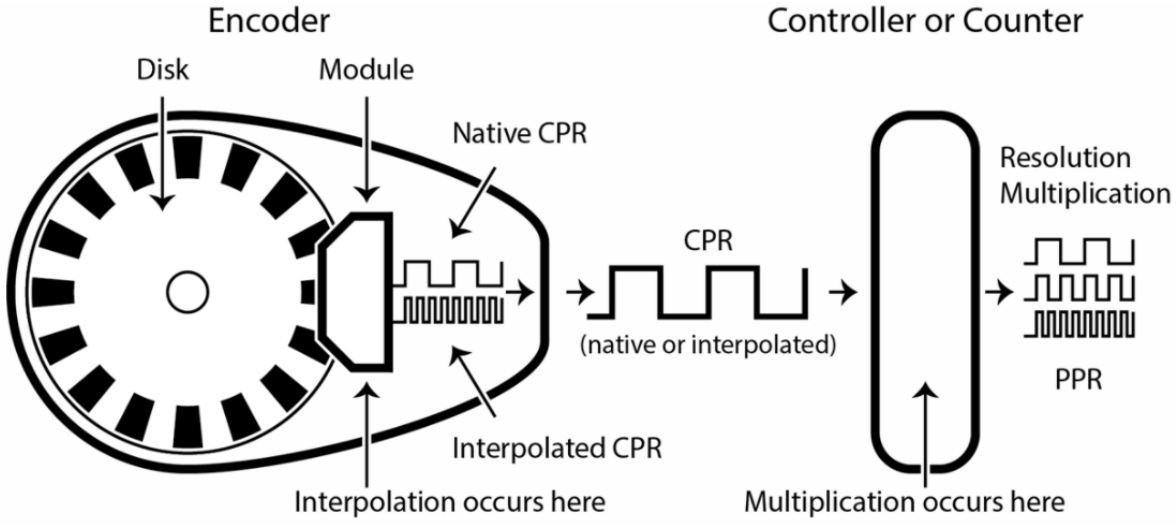
- Light source
- Condenser lens for collimating the beam
- Scanning reticle
- Encoder disk
- Silicon photosensors
- Amplification circuitry to “square-up” the photodetector outputs
- Analog and digital signal processing (e.g. interpolation)



3 FORMS OF ENCODER RESOLUTION

Native resolution is determined by the number of lines on the disk.

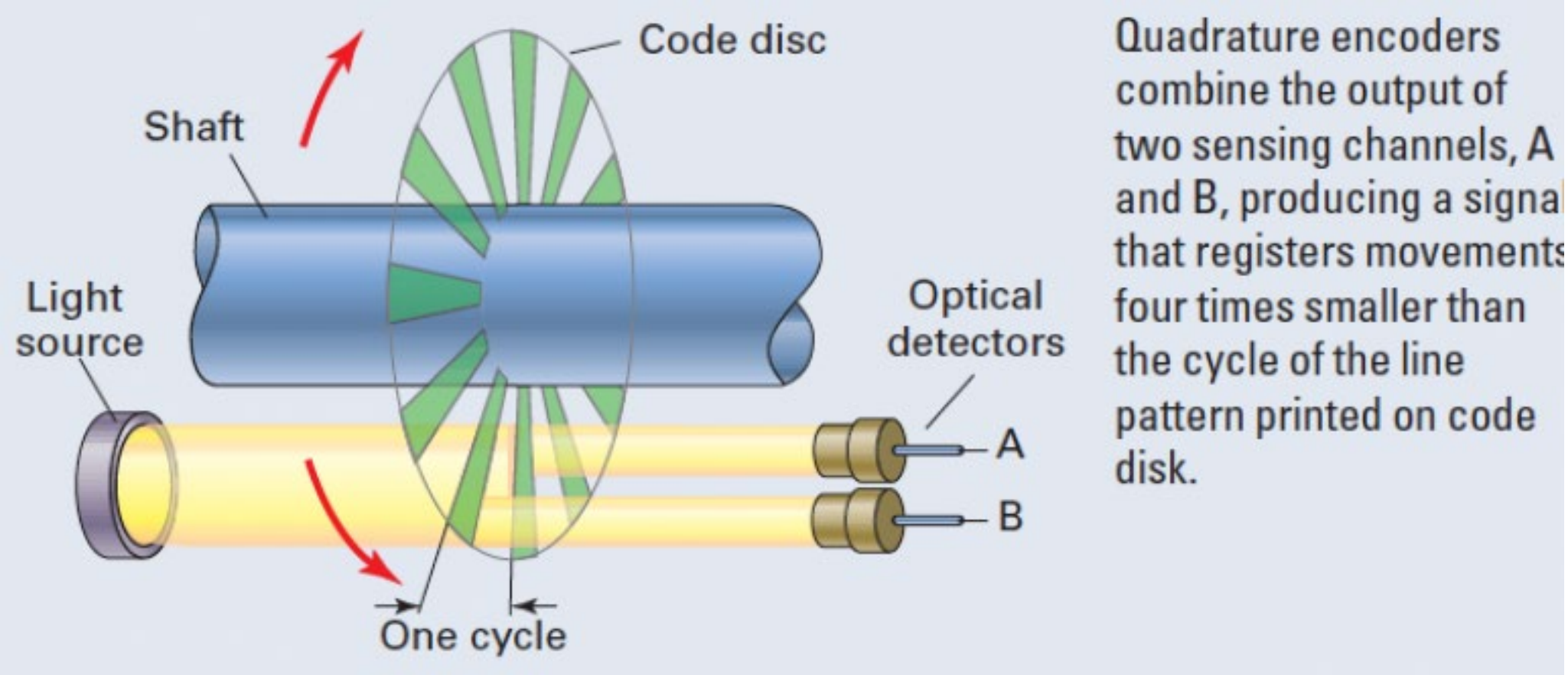




Interpolated measurements produce higher resolution, without the need for more lines.

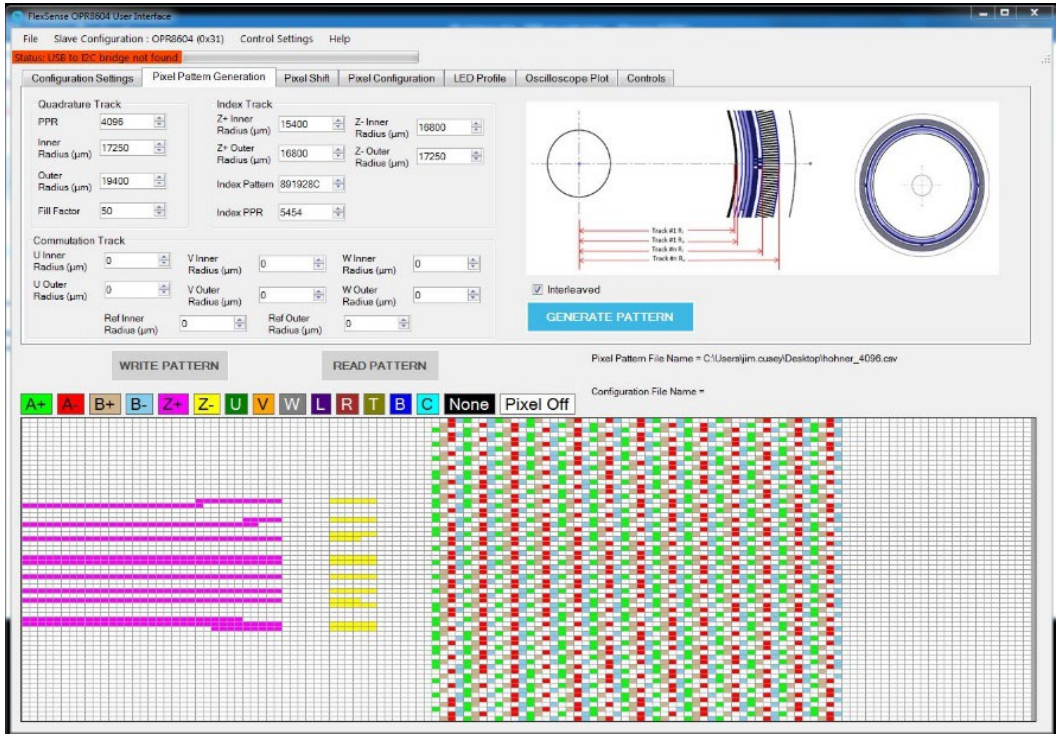
QUADRATURE SIGNALS

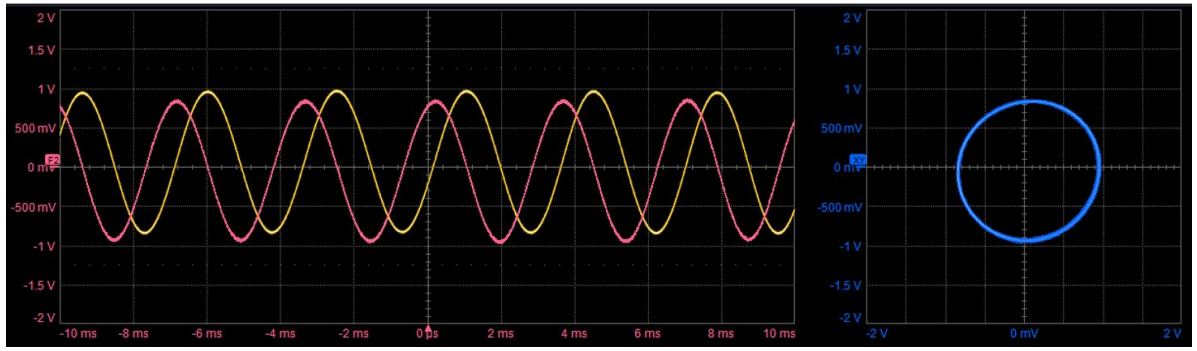
Quadrature signals are produced by using two photo-sensors – one positioned precisely one half a slot width from the other.

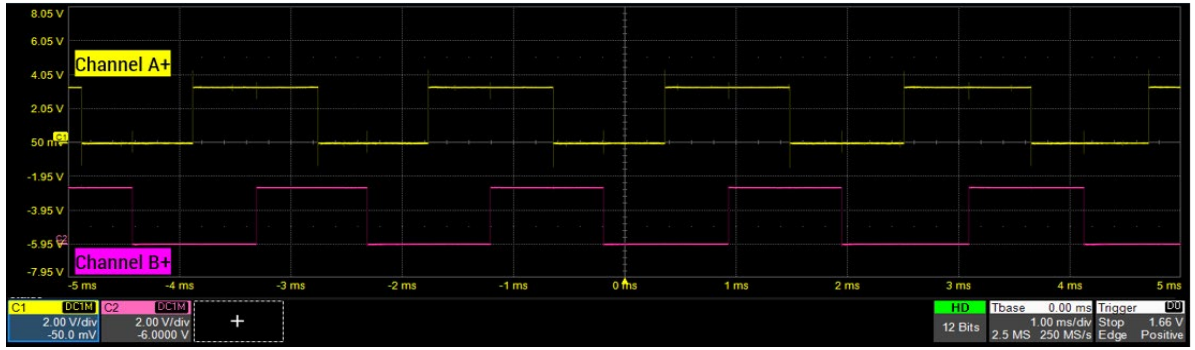


QUADRATURE SIGNALS

These encoders also provide an additional single marker on the disk used to produce a reference pulse. By properly decoding and counting these signals, the direction of motion, speed, and relative position of the encoder can be determined.



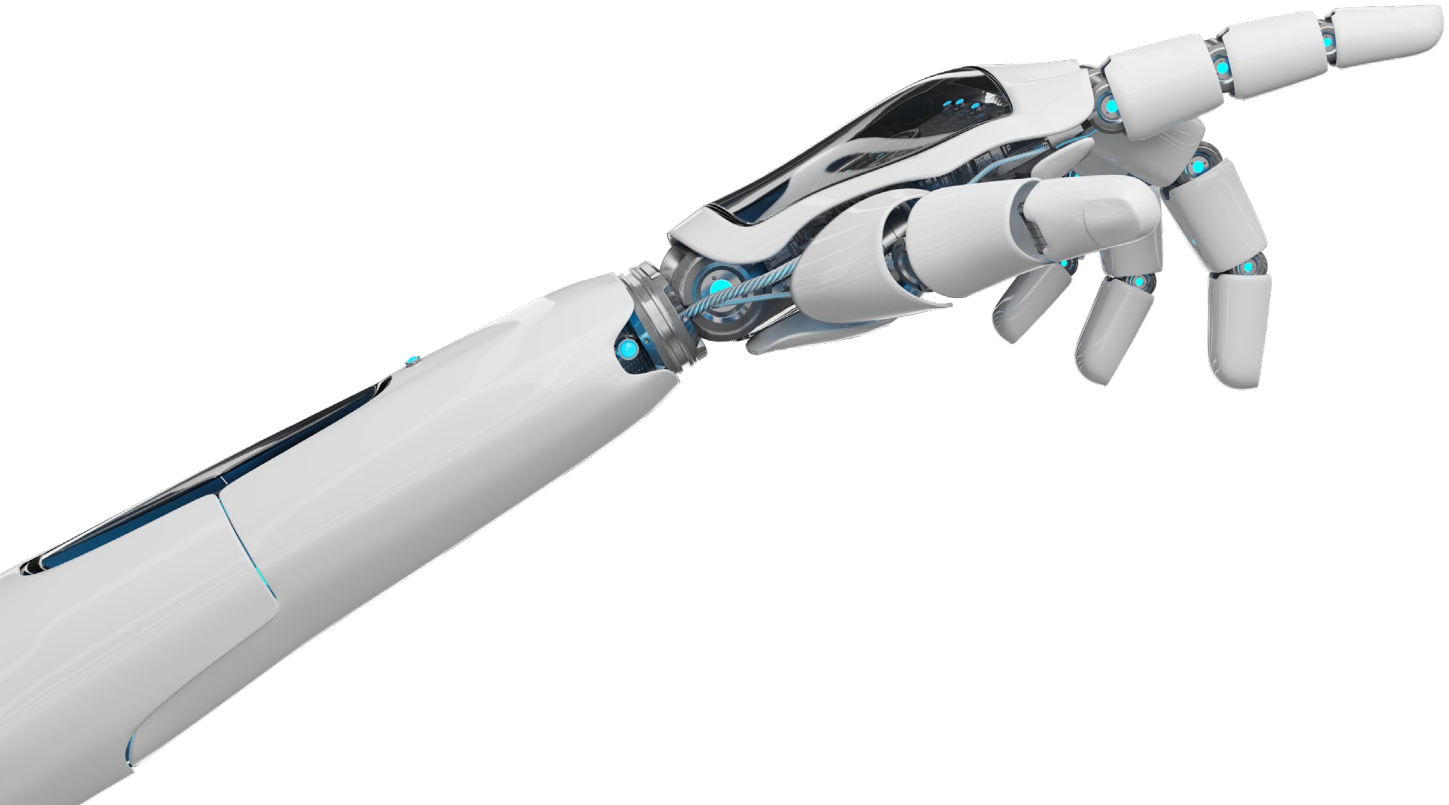




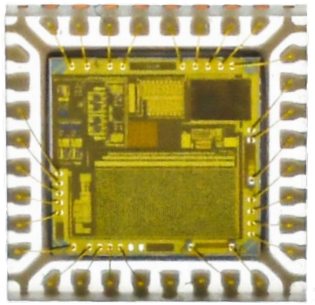
The direction of the rotation can be detected by monitoring the relative phase of both signals. For example, if Channel A leads Channel B, then CCW movement could be indicated. Conversely, if Channel B leads Channel A, CW rotation could be indicated. The shorter the signal period, the smaller the measuring step.

INTRODUCING FLEXSENSE™

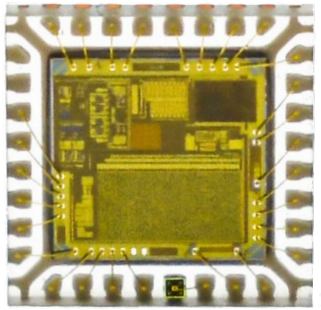
A patented optical sensor array that can be programmed for a wide range of code-wheel diameters and resolutions.



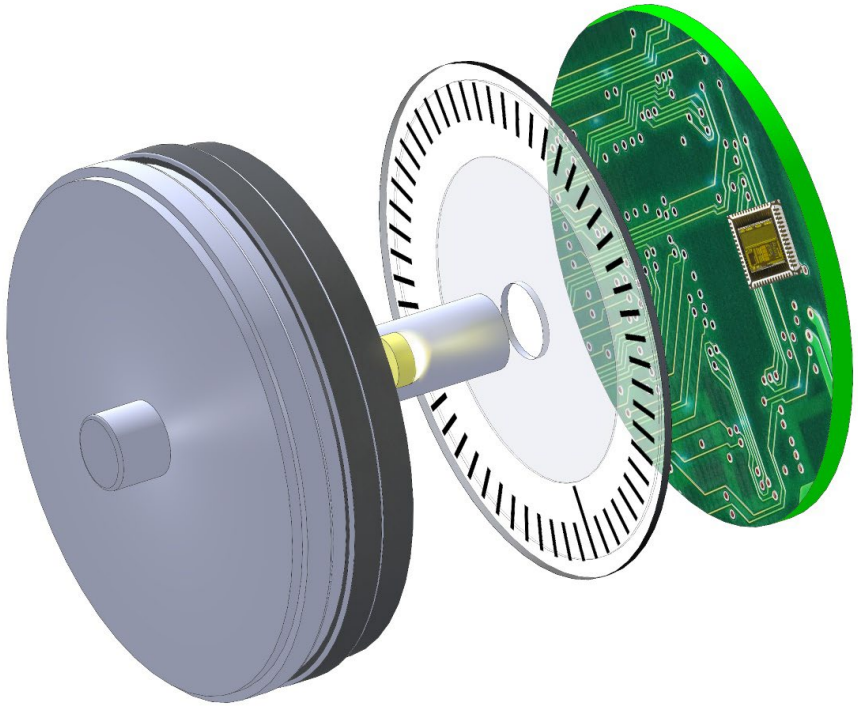
FS210



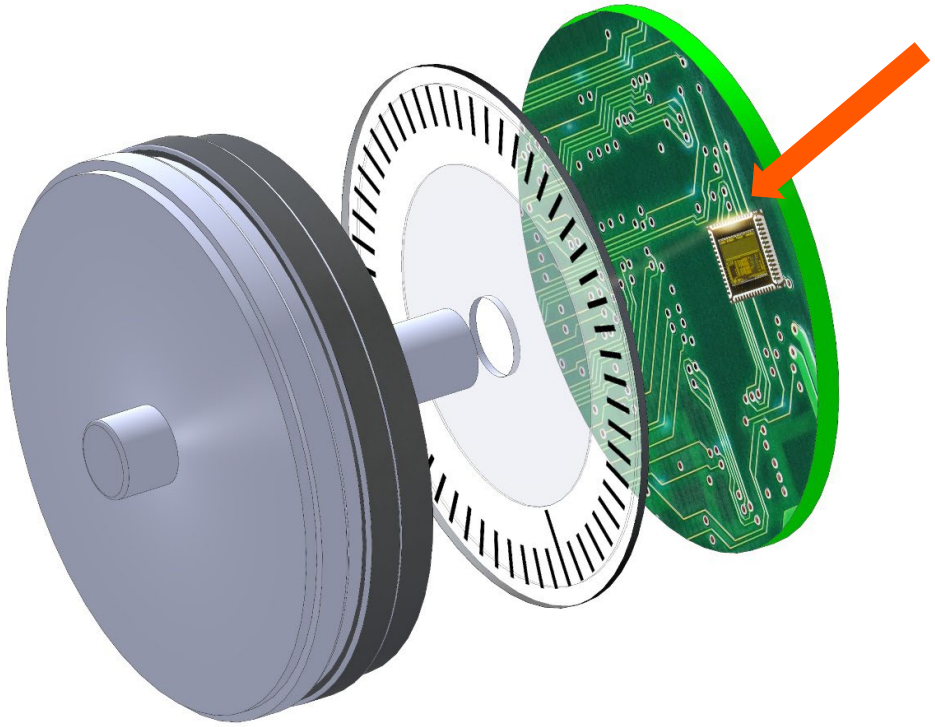
FS310



AVAILABLE IN TRANSMISSIVE AND RELFECTIVE



FS210 TRANSMISSIVE SENSOR



FS310 REFLECTIVE SENSOR

FLEXSENSE CODE WHEEL

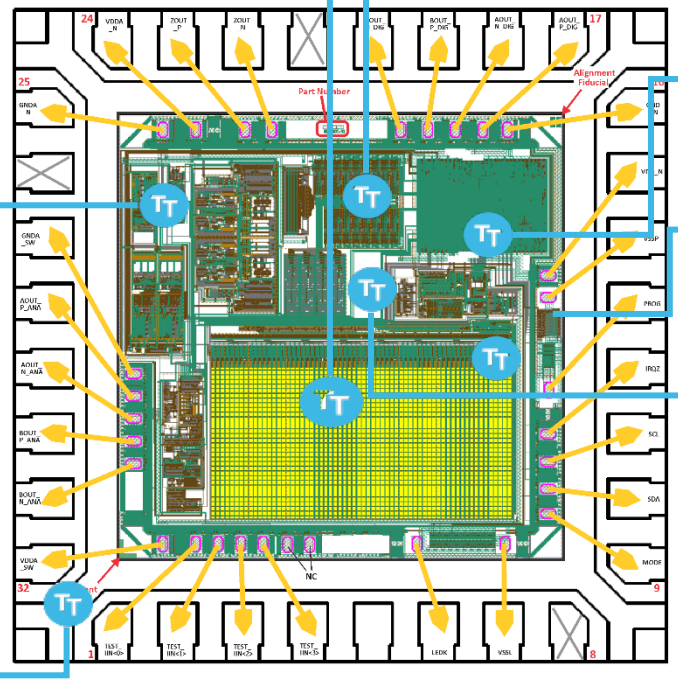
- Incremental optical encoder sensor
- 2 quadrature, 1 index, 3 commutation tracks
- User-programmable photosensor pattern
- 10-40mm code-wheel radii compatibility
- 500-6k PPR resolution compatibility

FLEXSENSE FEATURES

Innovative user-programmable sensor pattern with included software GUI

Complete system-on-chip, includes integrated LED driver, up to 8x interpolation, divide down up to 2048 and I2C communication

Compact, low profile 32-pin 5mm x 5mm x 0.65mm Opto QFN package



On-chip amplification and adjustment to detect multiple wavelengths including 460nm, 640nm and 850nm

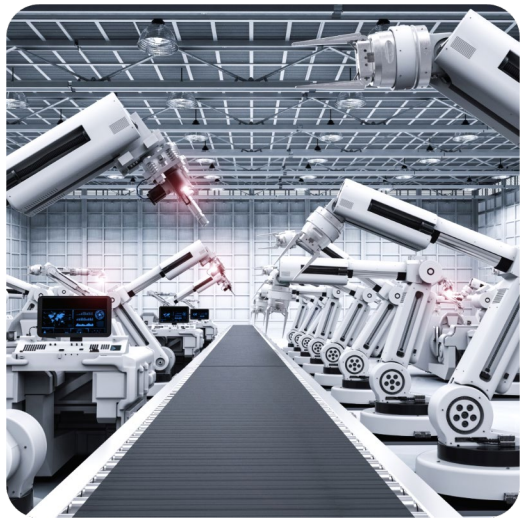
High quality analog sine / cosine signals with less than 1% THD

High-speed, high-resolution signal at native 400kHz frequency

Predictive maintenance signals and interrupt alerts:

- Temperature output proportional to absolute chip temperature with interrupt signal
- LED-drive control loop with alert and interrupt signal
- Wobble detect sin^2 + cos^2 = 1

TARGET END APPLICATIONS



Factory Automation

- Motor control
- Robotics

Medical

- Medical imaging

Oil and Gas

- Drill motors
- Top drives
- Rotary tables
- Mud pumps

Alternative Energy

- Wind power plants
- Wind turbines

WHY FLEXSENSE?

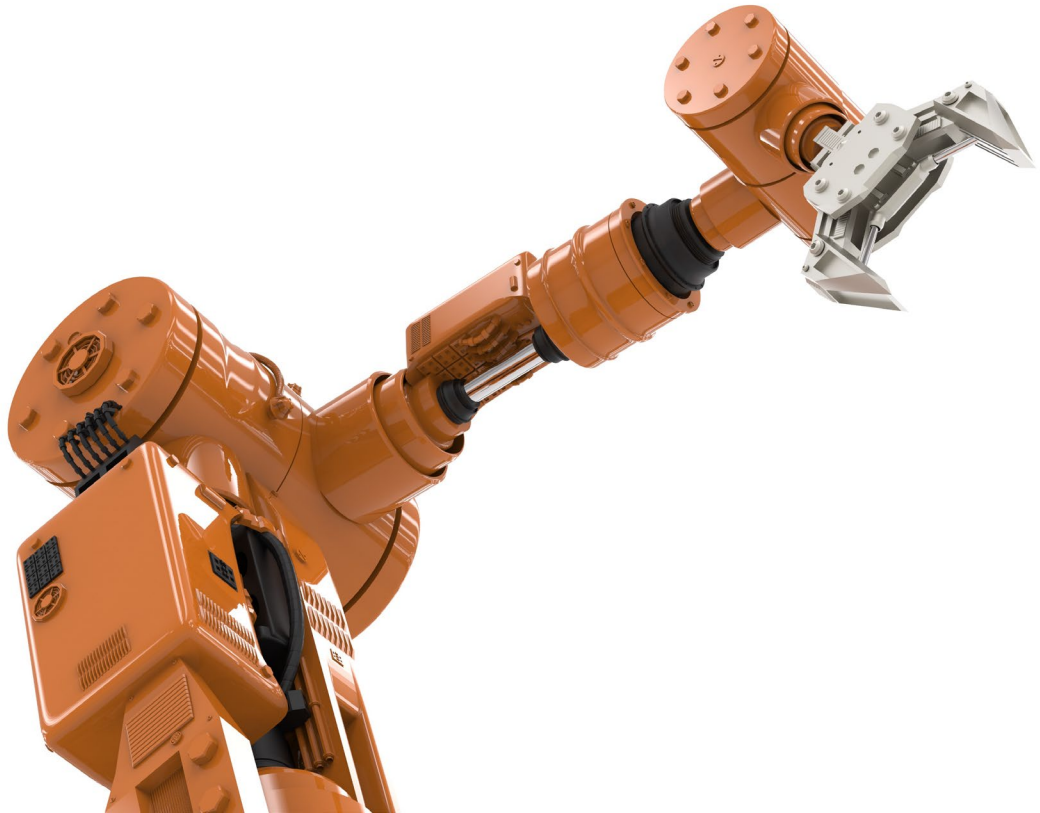
Accelerate time-to-market with programmable sensor pattern and auto alignment

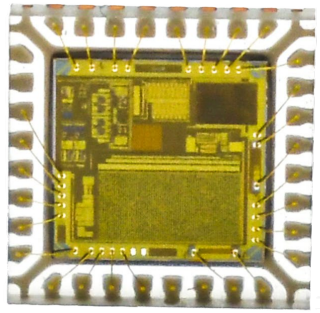
Reduce system cost and design complexity with next generation reflective encoder

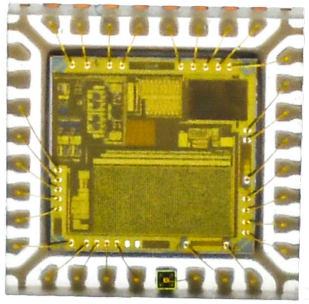
Predictive maintenance alerts to **minimize downtime disruption**

FLEXSENSE AND INDUSTRY 4.0

By utilizing smart encoder options such as FlexSense sensors paired with data analytics and sophisticated AI strategy, industrial operations can gain access to the intelligence needed to transform and sustain business value.







Interested in learning more about how FlexSense™ can optimize your encoder applications?

COME SEE US AT BOOTH #722

Or visit us at www.ttelectronics.com/flexsense

THANK YOU!

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www.ttelectronics.com