

# TIMKEN

## Advancements in Magnetic Encoders



Mark LaCroix  
Peter Morgan  
A John Santos  
Dr. Lei Wang

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# PRESENTATION OUTLINE

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- Timken Introduction
- Market Demand for High-Resolution Off-Axis Sensors
  - Off- vs. On-Axis Overview
  - Magnetic Sensor Advancements
- Applications
  - Motors
  - Off Road
  - Medical
  - Linear Encoder
- Trends
  - Increased Sophistication
  - Customization
  - Speed to Market
  - Application Diversity
- Conclusions

By Design.

# TIMKEN OVERVIEW

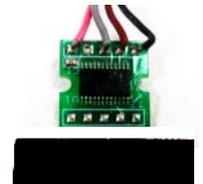
- Industrial components manufacturer serving diversified markets, including:
  - Aerospace
  - Mining
  - Energy/wind
  - Rail
  - Construction
  - Truck
  - Automotive
  - Distribution
- Established in 1899
- Headquartered in Canton, Ohio
- Global footprint with operations in 30 countries



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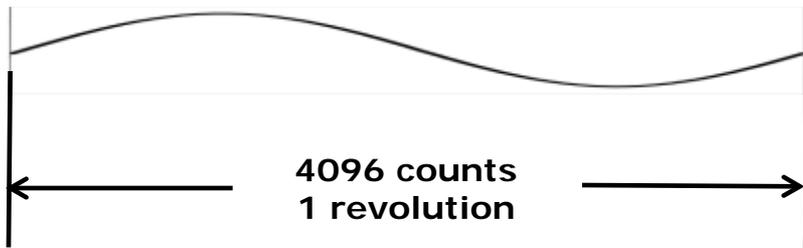
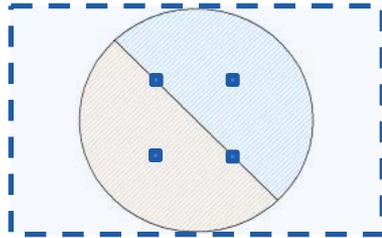
## 15 YEARS IN SENSOR BUSINESS

Supplier of integrated Hall encoder products serving industrial customers and critical vehicle systems



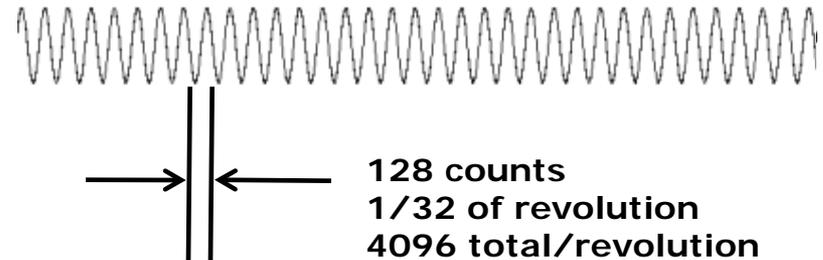
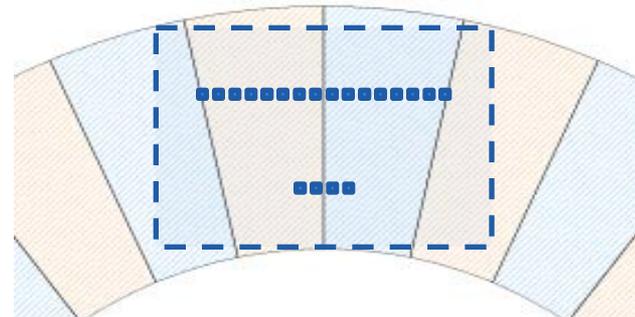
# ON-AXIS VS. OFF-AXIS MAGNETIC ENCODERS

On-axis  
1 pole pair



Deep interpolator required to get full resolution from 1 revolution

Off-axis  
32 pole pairs

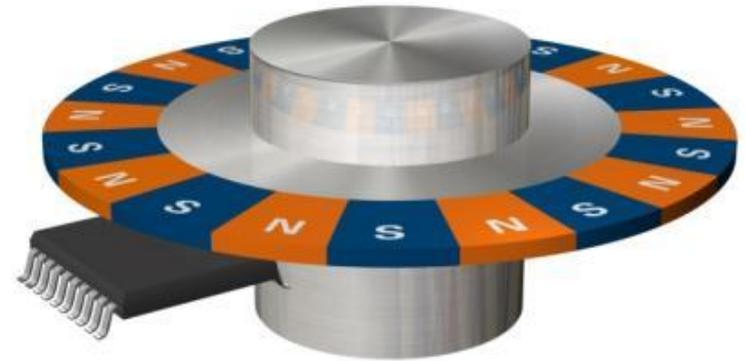


Shallow interpolator used to get 1/32 of the resolution from 1 pole pair

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# OFF-AXIS ENCODERS

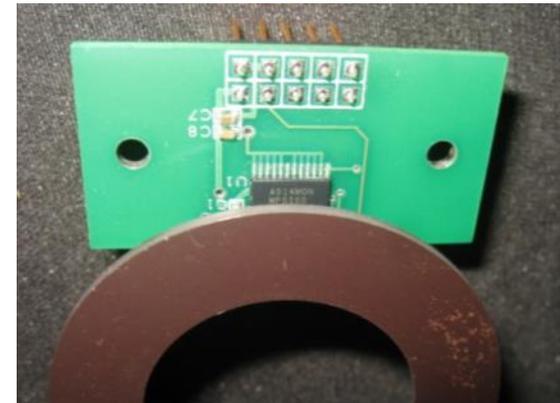
- Multi-pole magnet: Typically 17 to 300 mm diameter axial or radial
- Sensor IC typically has an 8- to 16-Hall element array
- Produces a sine and cosine signal for each pole pair; signals are converted to an A, B, Z quadrature or serial position signal



**Multi-pole magnet**



**Signal conversion**



**Sensor chip and target**

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# MAGNETIC ENCODER ADVANCEMENTS

- Resolution up to 16 bits/turn
- Data rates in excess of optical encoders
- Advancements in magnetic target accuracy and size
- End of line/field programmability
- Rejection of external magnetic fields
- Extended operating temperatures  $-40^{\circ}$  to  $125^{\circ}\text{C}$
- Large air gaps without sacrificing accuracy
- Absolute position capability

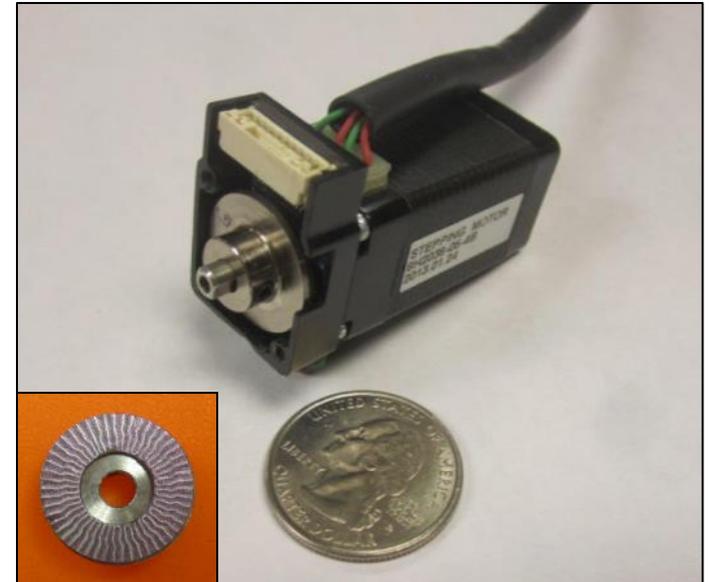


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# APPLICATIONS

Off-axis high-resolution magnetic sensors are used on motors and specialty applications

Velocity feedback for a mining truck



Compact designs

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# APPLICATIONS

- Off-axis high-resolution magnetic sensors are used off highway

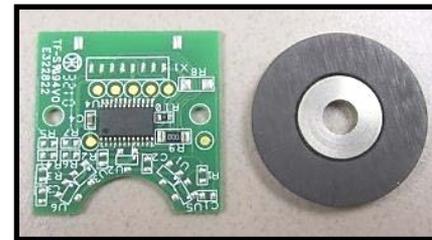


Agriculture equipment  
GPS steering systems



Sensor/PCB/target

- New applications include axle torsional measurement

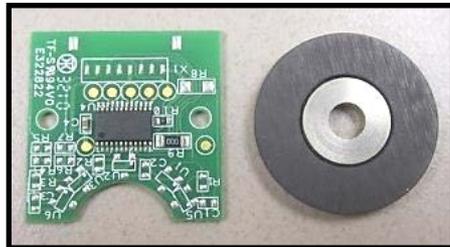


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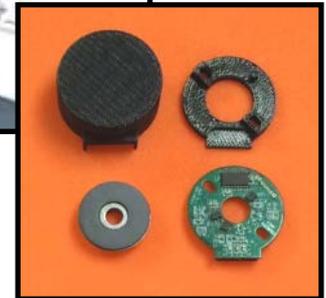
# APPLICATIONS

Off-axis high-resolution magnetic sensors are used on medical and laboratory equipment

**Medical test and laboratory equipment for precise and consistent positioning in moist or harsh environments**



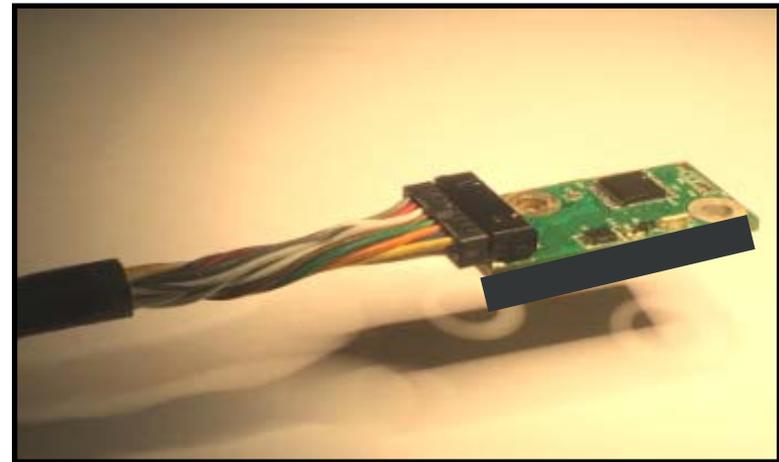
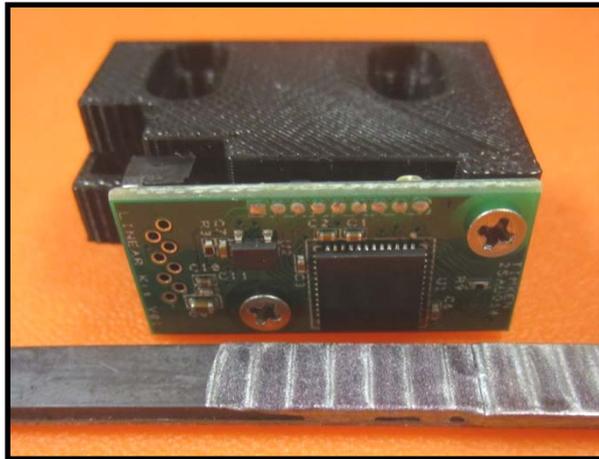
**Medical equipment for patient diagnosis**



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# APPLICATIONS

- High resolution and contaminant resistance make magnetic encoders a good choice for linear actuators
- 3D print head position feedback

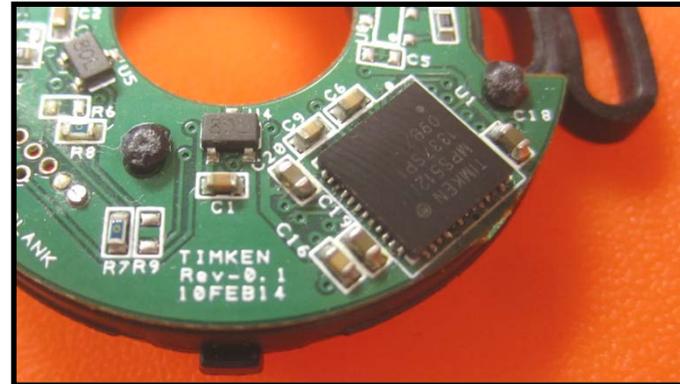


**High-resolution linear magnetic sensors for automation, actuation, 3D printing**

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# MAGNETIC ENCODER MARKET TRENDS

- Increased sophistication
- Customization
- Speed to market
- Application diversity



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# INCREASED SOPHISTICATION

- Higher resolution
- Higher accuracy
- Faster update and data speed
- End of line or field programmability

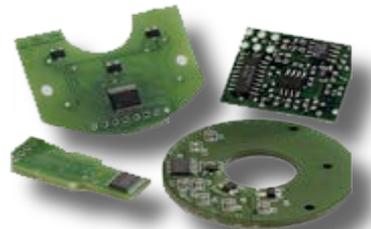


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# CUSTOMIZATION

ASIC-based design lends itself to various customizing capabilities:

- ASIC and custom target
- Kit encoder PCB and custom target
- Modular encoder



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# SPEED TO MARKET

- New systems on chip encoders are programmable for a variety of resolutions and electrical outputs
- Magnetic targets are easily designed and customized for optimal performance and size to meet customer requirements
- Rapid customization of modular kit designs can be used to meet compressed customer timelines.

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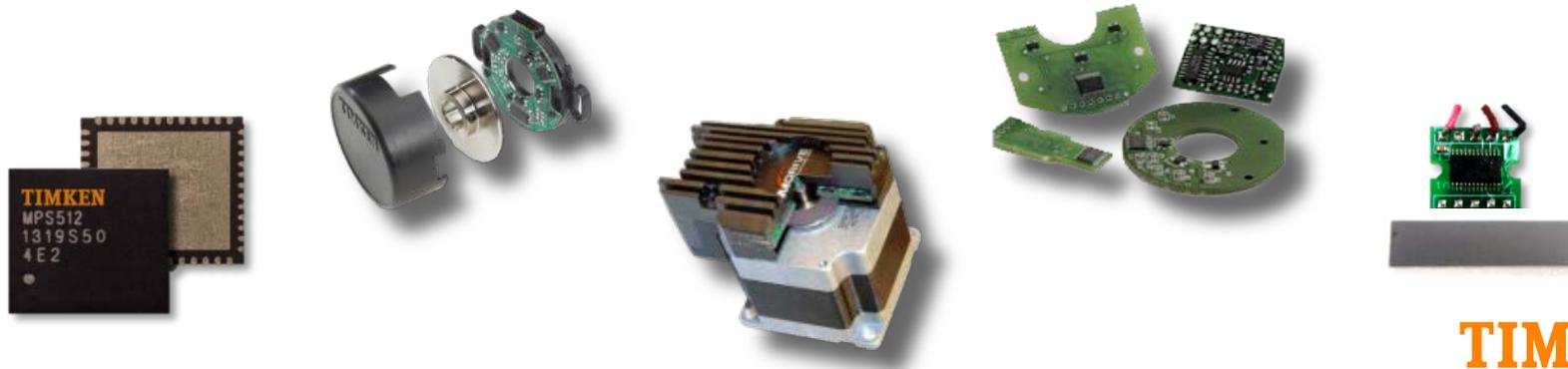
# INCREASED APPLICATION DIVERSITY

- New magnetic encoder designs allow high-resolution sensing from benign to harsh environments using cost-effective technology
- Virtually eliminate the need for bulky and expensive environmental protection for traditional feedback devices

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# CONCLUSIONS

- Because of advances in technology, it is possible to use modern magnetic sensors in applications where traditional magnetic sensors could not be used.
- Market trends show large increases in system feedback requirements, including magnetic encoders.
- Modern off-axis magnetic sensors incorporate innovative circuitry that permits accurate high-resolution sensing in diverse environments.
- Rapid customization allows users to integrate magnetic encoders into products with reduced lead times.



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**Booth 200**