TIMKEN

Advancements in Magnetic Encoders

Mark LaCroix
Peter Morgan
A John Santos
Dr. Lei Wang

January 21, 2015 • Orlando

Originally Presented at the Motor and Drive Systems 2015 Conference

Stronger.

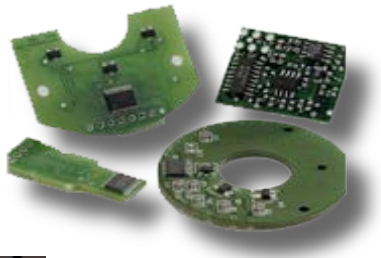
PRESENTATION OUTLINE

TIMKEN

- 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

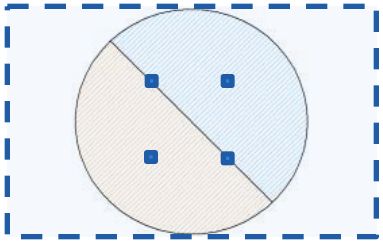
15 YEARS IN SENSOR BUSINESS

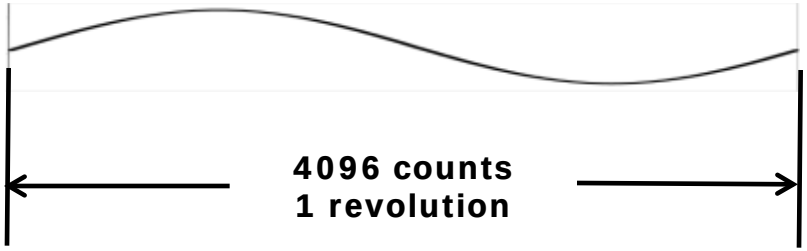
Supplier of integrated Hall encoder products serving industrial customers and critical vehicle systems



ON-AXIS VS. OFF-AXIS MAGNETIC ENCODERS

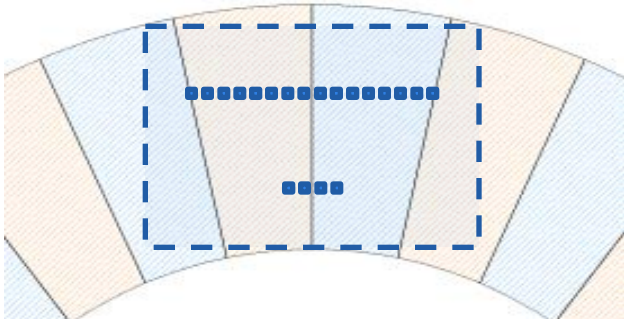
On-axis
1 pole pair

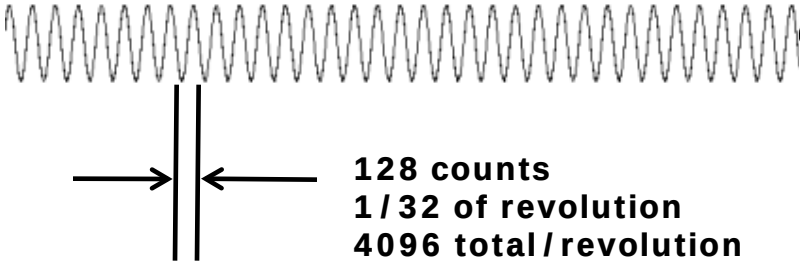




Deep interpolator required to get full resolution from 1 revolution

Off-axis
32 pole pairs





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

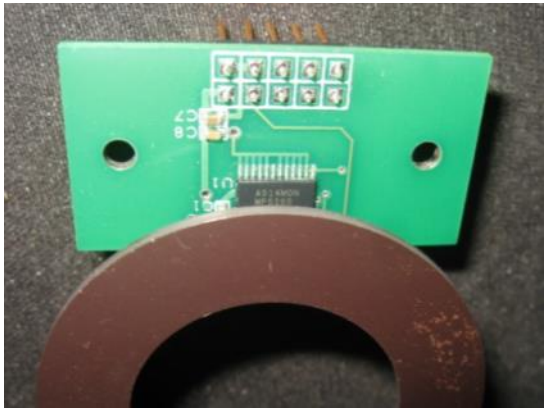
TIMKEN

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

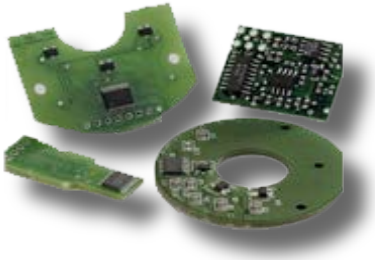


Sensor chip and target

TIMKEN

MAGNETIC ENCODER ADVANCEMENTS

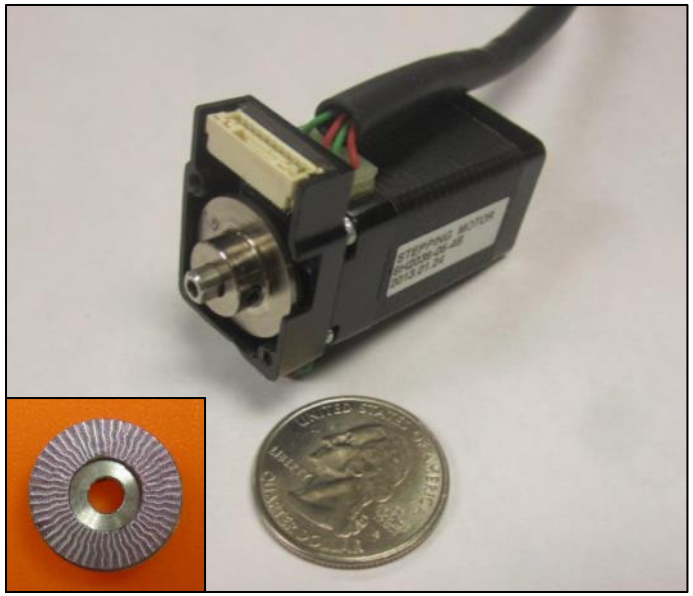
- Resolution up to 16 bits/turn
- Data rates in excess of optical encoders
- Advancements in magnetic target accuracy and size
- End of line/field programmability
- Rejection of external magnetic fields
- Extended operating temperatures -40^0 to 125^{0}C
- Large air gaps without sacrificing accuracy
- Absolute position capability



TIMKEN

APPLICATIONS

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



Velocity feedback for a mining truck

Compact designs

TIMKEN

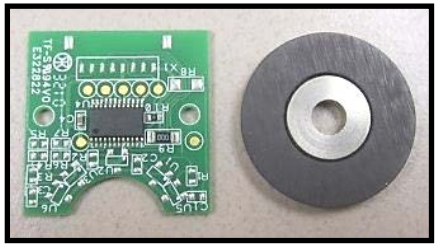
APPLICATIONS

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

Agriculture equipment
GPS steering systems

Sensor / PCB / target

- New applications include axle torsional measurement

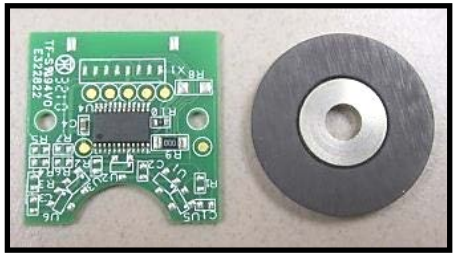


TIMKEN

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

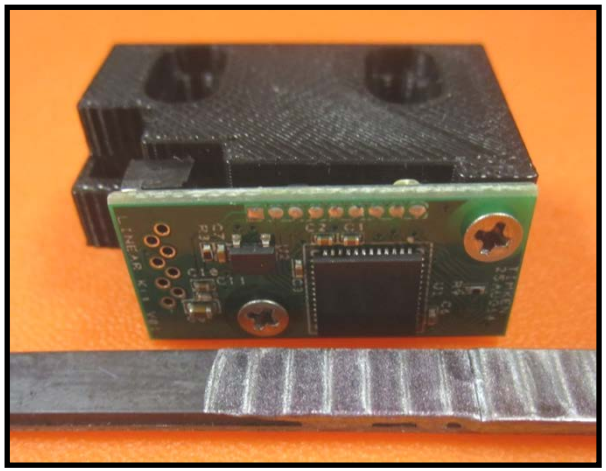


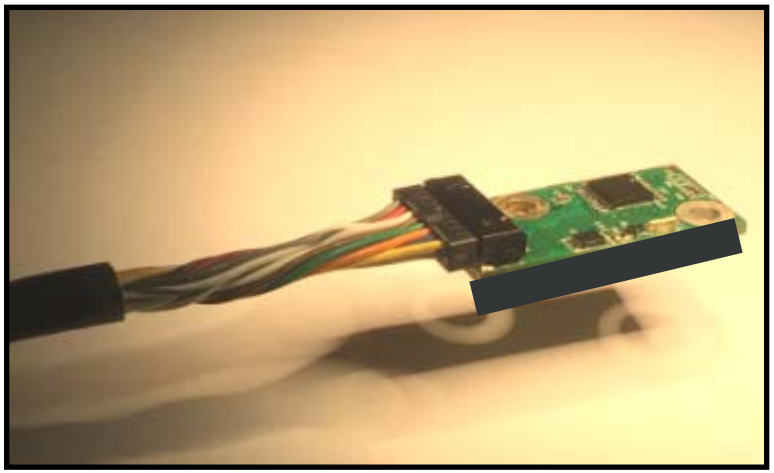
Medical equipment for patient diagnosis

TIMKEN

APPLICATIONS

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



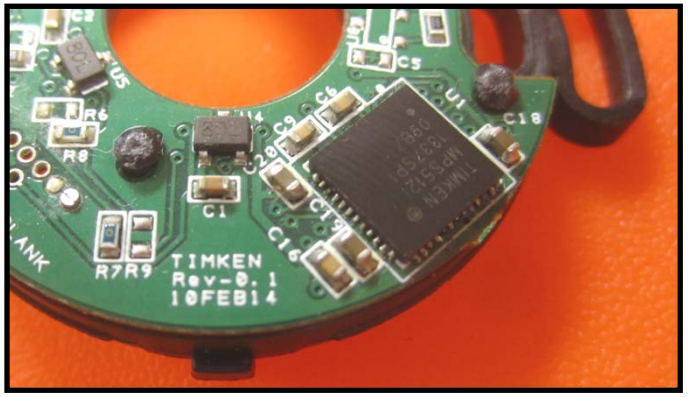


High-resolution linear magnetic sensors for automation, actuation, 3D printing

TIMKEN

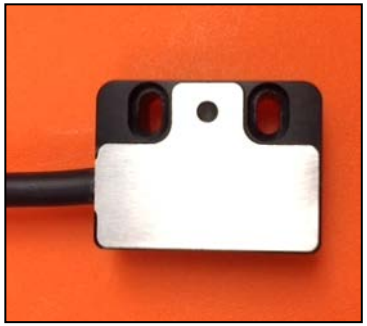
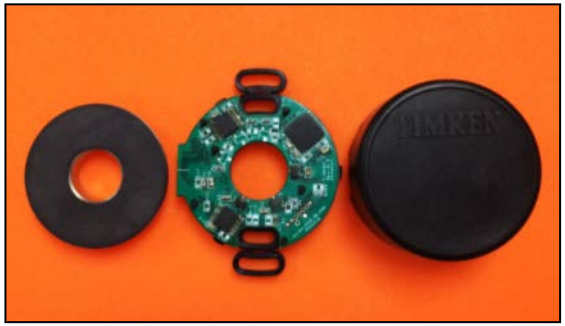
MAGNETIC ENCODER MARKET TRENDS

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



INCREASED SOPHISTICATION

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

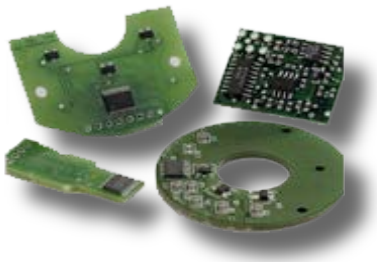




TIMKEN

CUSTOMIZATION

ASIC-based design lends itself to various customizing capabilities:

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



TIMKEN

SPEED TO MARKET

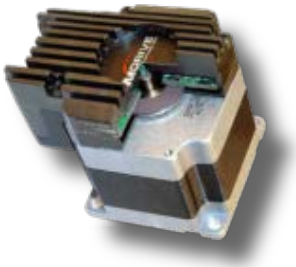
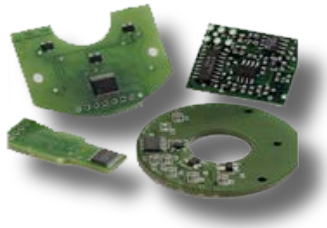
- New systems on chip encoders are programmable for a variety of resolutions and electrical outputs
- Magnetic targets are easily designed and customized for optimal performance and size to meet customer requirements
- Rapid customization of modular kit designs can be used to meet compressed customer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

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

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.


TIMKEN

TIMKEN

Booth 200