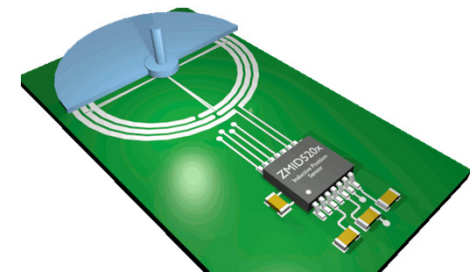


ZMID5201 | ZMID5202 | ZMID5203

Inductive Position Sensors

March 27, 2017



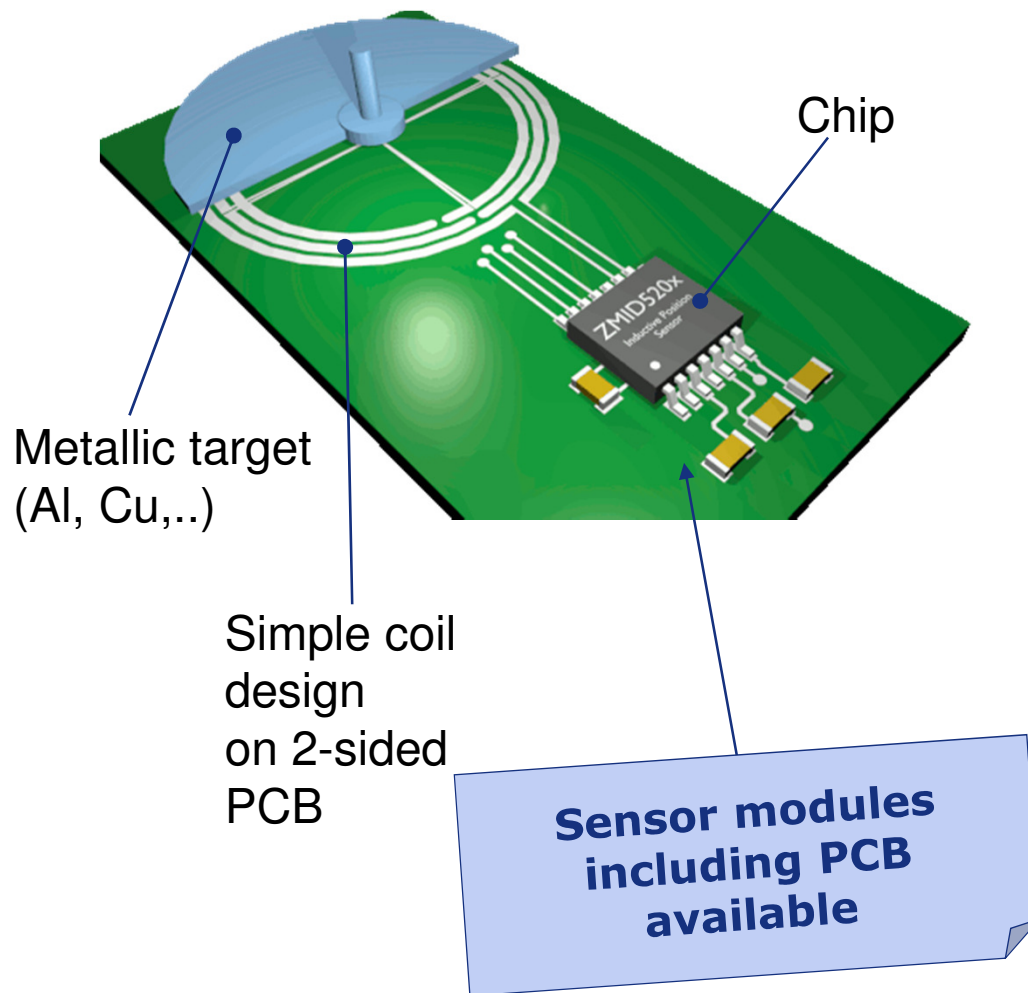
ZMID520x

Inductive Position Sensors



Overview

Inductive Position Sensors



- No magnet needed
- Total stray field immunity - ISO 11452-8 compliant
- Ultra-thin solution - Small form factor
- No external sensor chip needed - the sensor is a PCB coil
- Compliant to auto standards - AECQ-100, ESD, EMC
- Suitable for high temperature
- On and off-axis capability and alignment

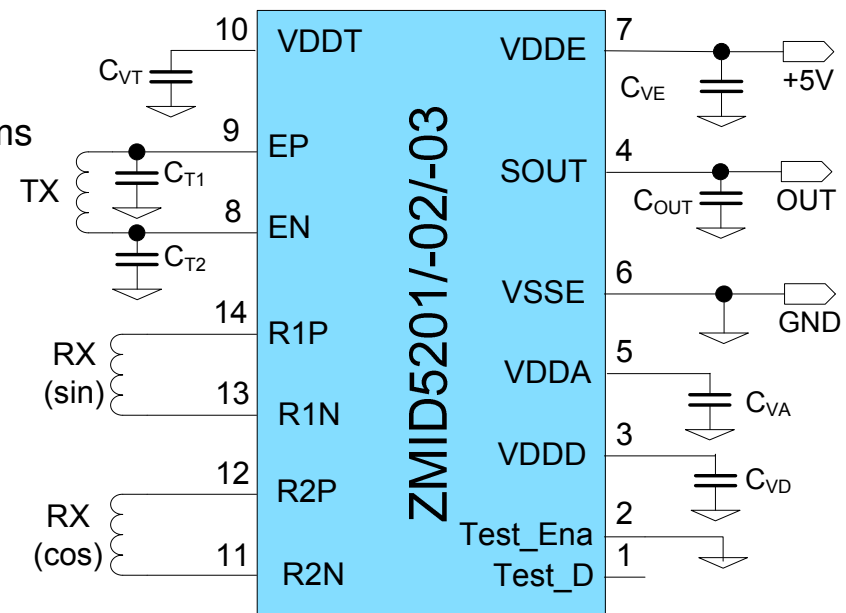
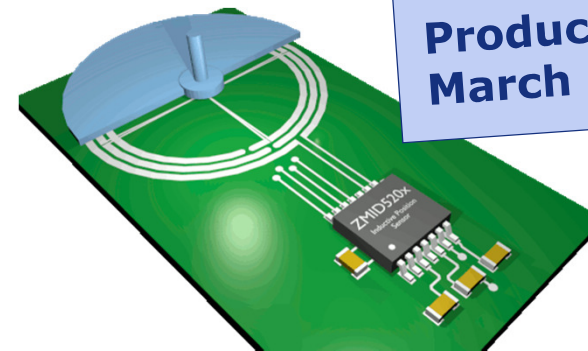
ZMID520X Inductive Position Sensors

Features

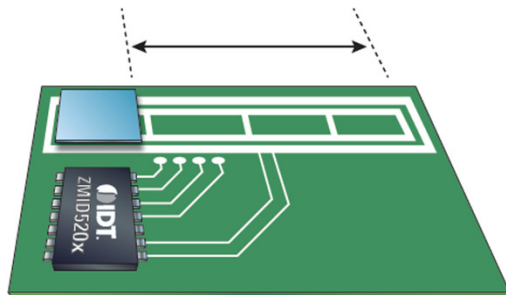
- Fully automotive qualified to AECQ-100
- 5V supply
- Overvoltage, reverse polarity, short-circuit protected
- Analog output, 1024 steps: ZMID5201
- PWM output, 1024 steps: ZMID5202
- SENT output, 4096 steps: ZMID5203
- High precision: $\pm 0.2\%$ accuracy
- Suitable to be implemented in safety related systems compliant to ISO26262 up to ASIL-B

Benefits

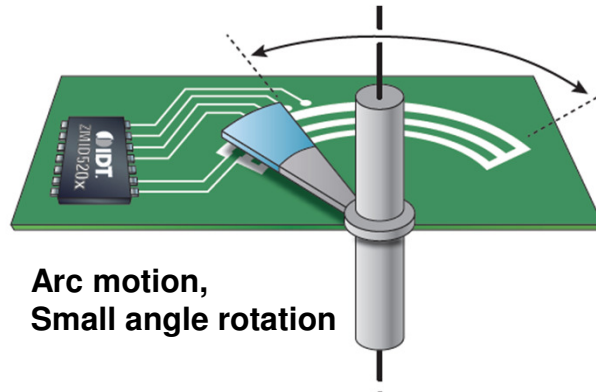
- Ultra thin
 - Small form factor
- No magnet needed, Low BOM
 - Moving target = copper or aluminum foil
- Ratiometric measurement
 - Tolerant against misalignment of target



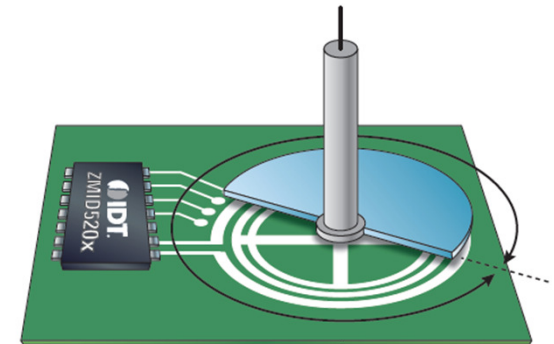
Typical Inductive Position Sensing Applications: Linear, Arc Motion, Rotation



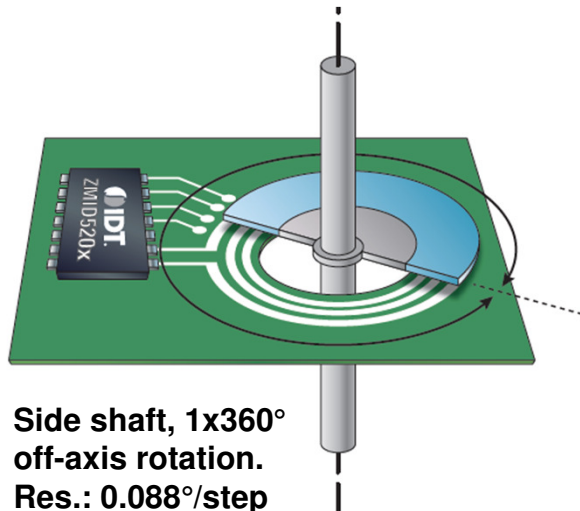
Linear motion



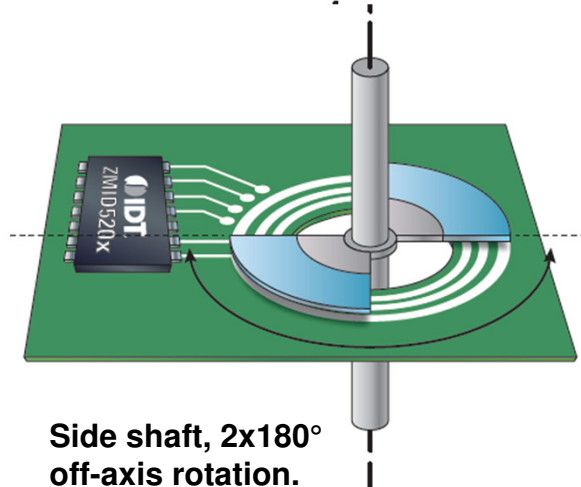
Arc motion,
Small angle rotation



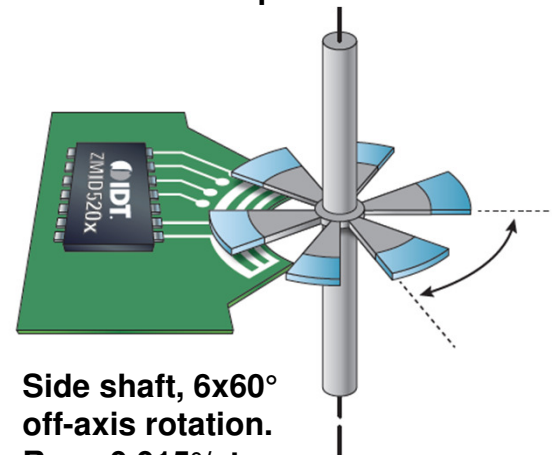
End of shaft, 1x360°
on-axis rotation.
Res.: 0.088°/step



Side shaft, 1x360°
off-axis rotation.
Res.: 0.088°/step

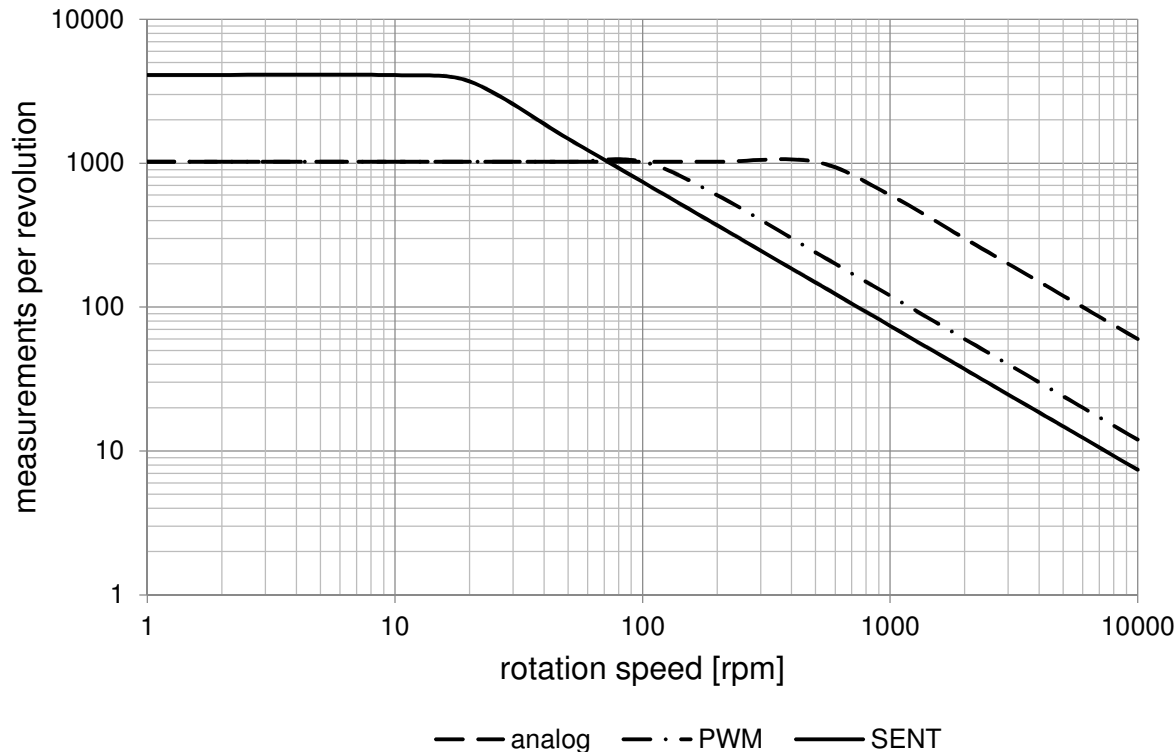


Side shaft, 2x180°
off-axis rotation.
Res.: 0.044°/step



Side shaft, 6x60°
off-axis rotation.
Res.: 0.015°/step
arc coil shape for limited space

Resolution versus Rotation Speed



- The ZMID520x family is primarily designed for low speed or static operation.
- Maximum speed is limited by the update rate of the various output interfaces
 - Analog :~10.000
 - PWM: ~2.000
 - SENT ~1.000(readings per second)
- There is no upper speed limit, but the resolution (measurements per revolution) will be reduced with increasing speed.

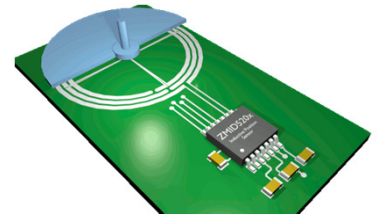
ZMID520x

Inductive Position Sensors



Markets and Applications for Position Sensors

Selected Automotive Applications



Powertrain

- Air intake manifold
- Throttle valve
- Turbocharger wastegate
- Turbocharger bypass valve
- Exhaust gas recirculation
- Transfer case gear position
- Transmission gear position
- Gear shift lever position
- Double clutch actuator
- Transmission actuator
- Engine cooling fan
- Hybrid E- Generator
- Fluid level sensors
- Crankshaft
- Camshaft

Safety

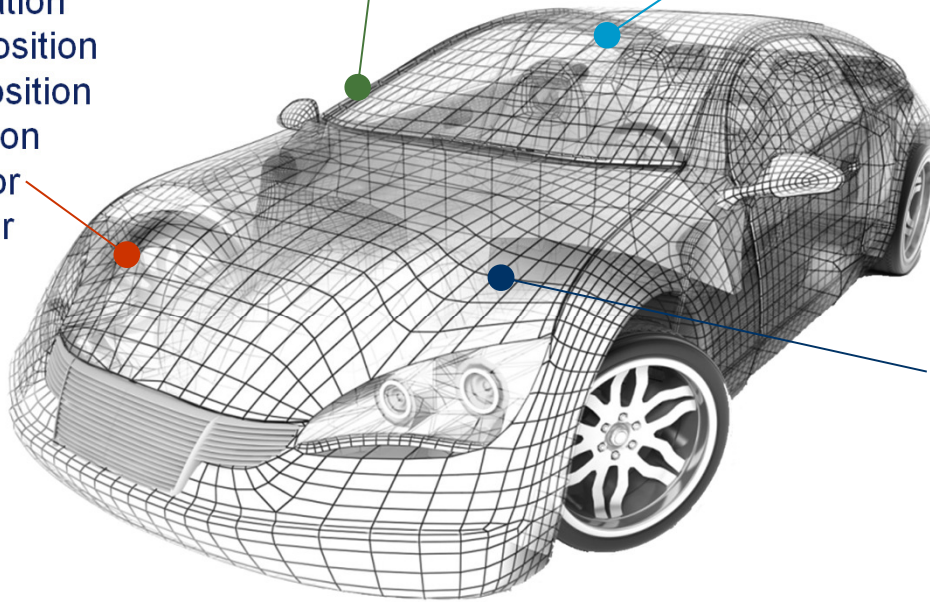
- Auto Brake actuator
- Steering Angle & Torque

Body

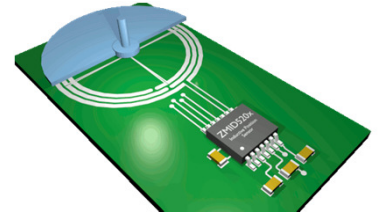
- HVAC pump motor
- Airflow actuators position
- Wiper position & motor
- Mirror position
- Seat position
- Accelerator pedal
- Clutch pedal, e-clutch
- Brake pedal

Chassis

- Steering motor
- Steering column position
- Suspension height
- Headlamp leveling
- Power seat position
- Electric park brake
- Fuel level sensor
- Convertible roof position

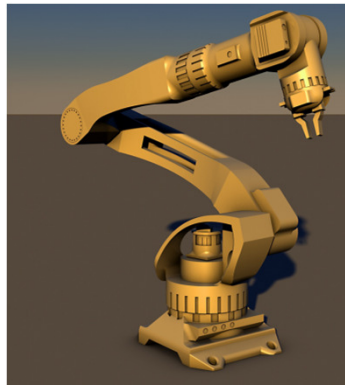


Selected Industrial Applications



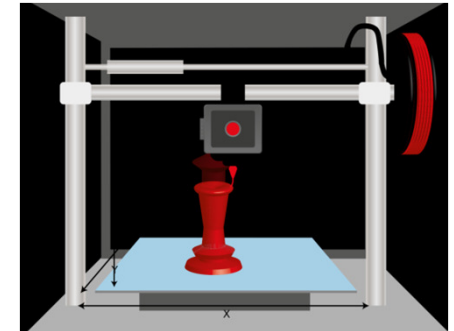
• Robotics

- Warehouse robots
- Industrial robots
- Surgical robots
- UAV/Drones
- Humanoid robots
- ...



• Office Automation

- 3D printers
- 3D scanner
- Security cameras
- ...



• Industrial Automation

- Encoder module
- Electrical motors

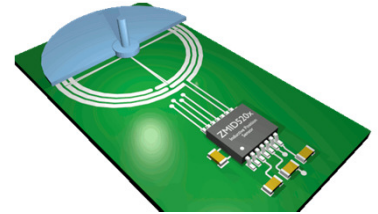


• Building Automation

- Flaps in air condition
- Window shutter
- Marquees
- Doors
- Valves
- Actuators



Selected Robotic Applications



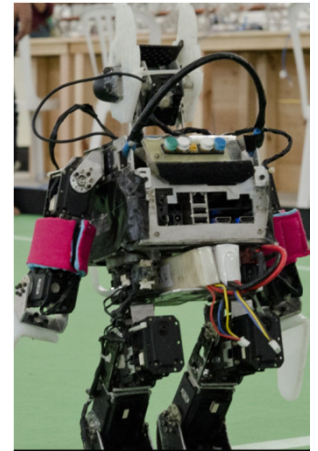
- Consumer Robot

- Wheel motor - gearbox motors using position sensors for wheel control
- Head movement - position sensors for position control
- Joint motor control and position feedback



- Consumer Robot

- Position Sensors replace low performance potentiometers in servos for improved robot performance



- Service Robots

- Industrial servo modules profit from Position Sensors

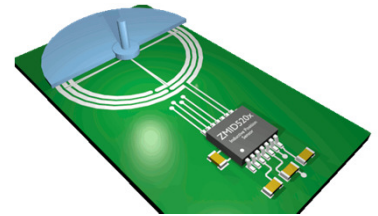


- Drones

- Position sensors enabling improved payload capacity and performance, e.g. camera stability



Selected Home Appliance and Consumer Applications



- White goods:
 - Washing machine
 - Dryer
 - Dishwasher

– ...



- Arcade gaming
- Toy-robots
- Gaming pedals
- ...



- Volume control
- Hi-fi audio
- Car-radio
- Temperature control
- ...



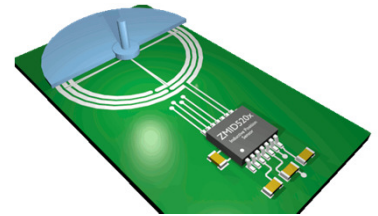
ZMID 520x

Inductive Position Sensors



Solving the Problems

Solving the Problems – Stray Fields

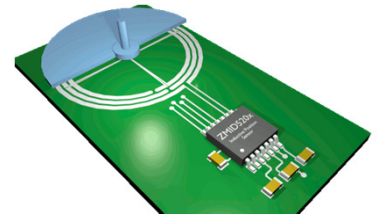


Position sensor with integrated stray field immunity achieves high accuracy performance even near high current carrying cables

**Total stray field immunity -
ISO 11452-8 compliant!**

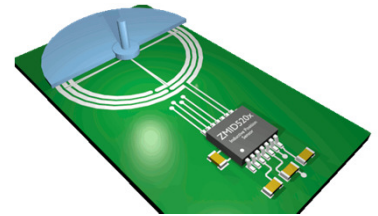
- The issue of stray fields is of particular concern with electric wires carrying high currents and generating unwanted magnetic stray fields such as e-motors, active suspension, etc..
- This has become a major issue among AMR, GMR, TMR and Hall suppliers
- IDT's inductive technology is insensitive to magnetic stray fields

Sensors and Stray Fields



- Sensors
 - Use of sensors has dramatically increased
 - Number and strengths of electric fields have increased
 - Exposure to environmental factors such as magnetic stray fields, vibration and misalignment cause issues with system safety and reliability
- What is a stray field?
 - Magnetic fields are generated by magnets, motors, transformers or any current-carrying conductors
 - Stray Fields are parasitic magnetic fields as observed by a sensor
- Why stray fields in automotive
 - Increased electrification of automobiles
 - Electric cars - high current carrying wires run between the front and back of the vehicle, generating magnetic fields
- Issues caused by stray fields
 - High levels of electro-magnetic interference (EMI) are a strong concern in industrial and automotive applications

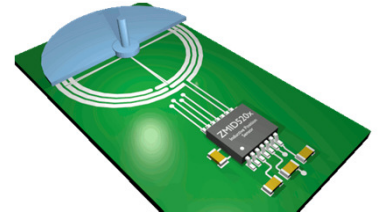
Inductive – Solving the Stray Field Problem



- Adherence to Standards

- Naturally, these unique inductive position sensors meet the latest standards for immunity to magnetic fields and functional safety
 - ISO11452-8 - immunity to magnetic fields
- Inductive = Stray field immunity. This enables a small form factor and it allows for a cost effective solution as external components and expensive external shielding are not needed - in short:
 - Simple
 - Inexpensive; no shielding required
 - Small form factor
 - Safer usage
 - Unlimited protection from stray fields

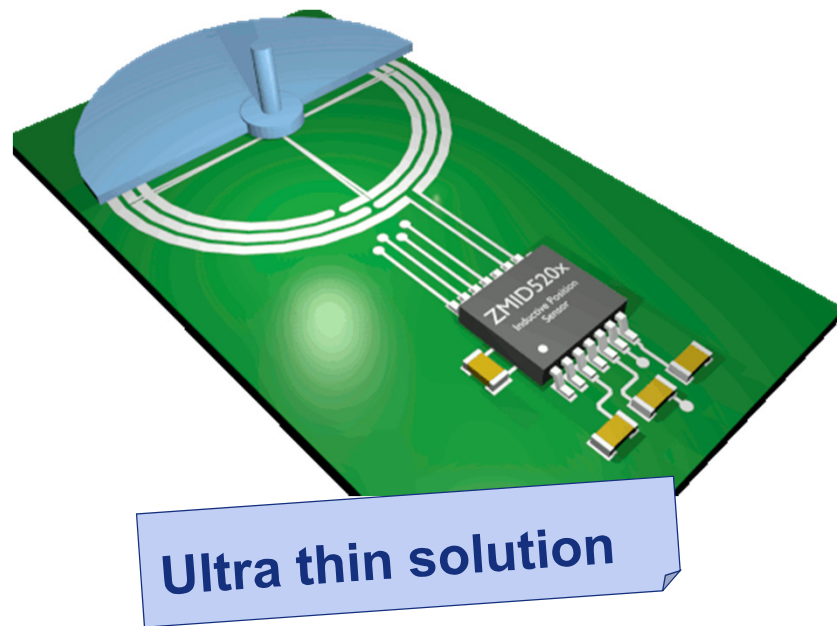
Solving the Problems – Harsh Environments



- IDT's inductive technology is non-contacting, no wear & tear
- Coils and Target are simple metallic structures and can withstand extreme temperatures or other harsh environments such as dust, humidity, corrosive liquids or gases

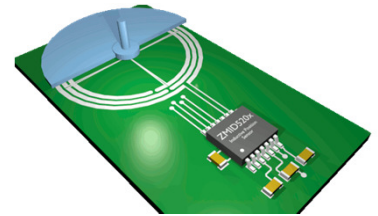
No temperature limitation

Solving the Challenges – Installation Space



- IDT's inductive sensor coils can be designed in any size, down to few millimeters in diameter
- Moving target can be as thin as household aluminum foil
- Very thin sensors: only ~2-3mm height for sensor + target

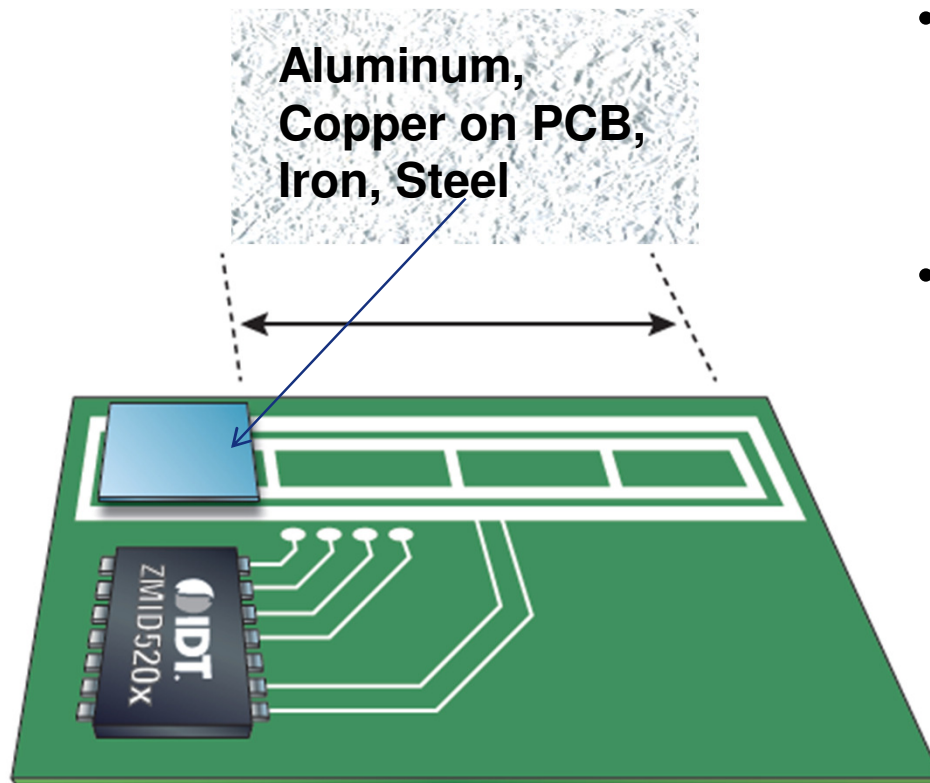
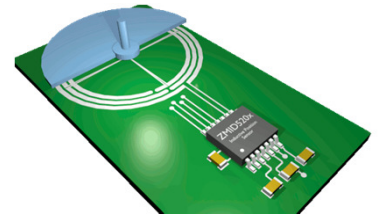
Solving the Problems – Mechanical Tolerances



**No tight assembly
tolerances required!**

- IDT's inductive sensors are very tolerant to mechanical misalignment in any direction (horizontal and vertical)
- This is due to ratiometric measurement principle
- The larger the coil, the larger is the misalignment tolerance
- This large tolerance is specific to IDT's sensing technology; competitive inductive sensor products are much less tolerant to misalignment

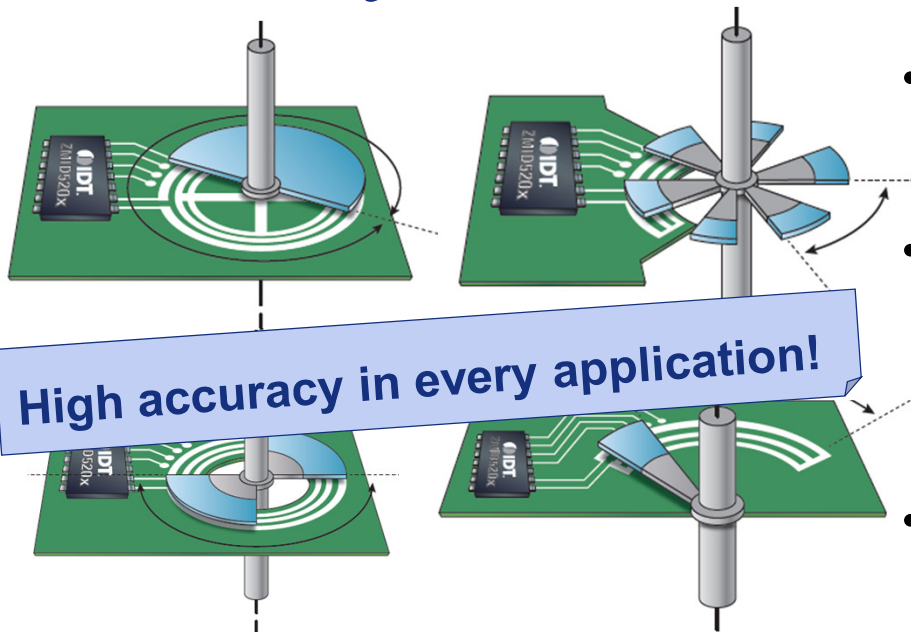
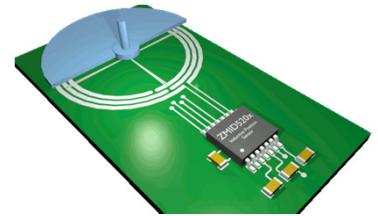
Solving the Problems – Sensing Target



- Sensing target is a simple piece of copper, aluminum or other metallic material. Very low cost and low sensor height
- Competition: Hall, AMR: Low quality magnets result in low quality measurement; Non-perfect magnets lead to large errors

No magnet required!

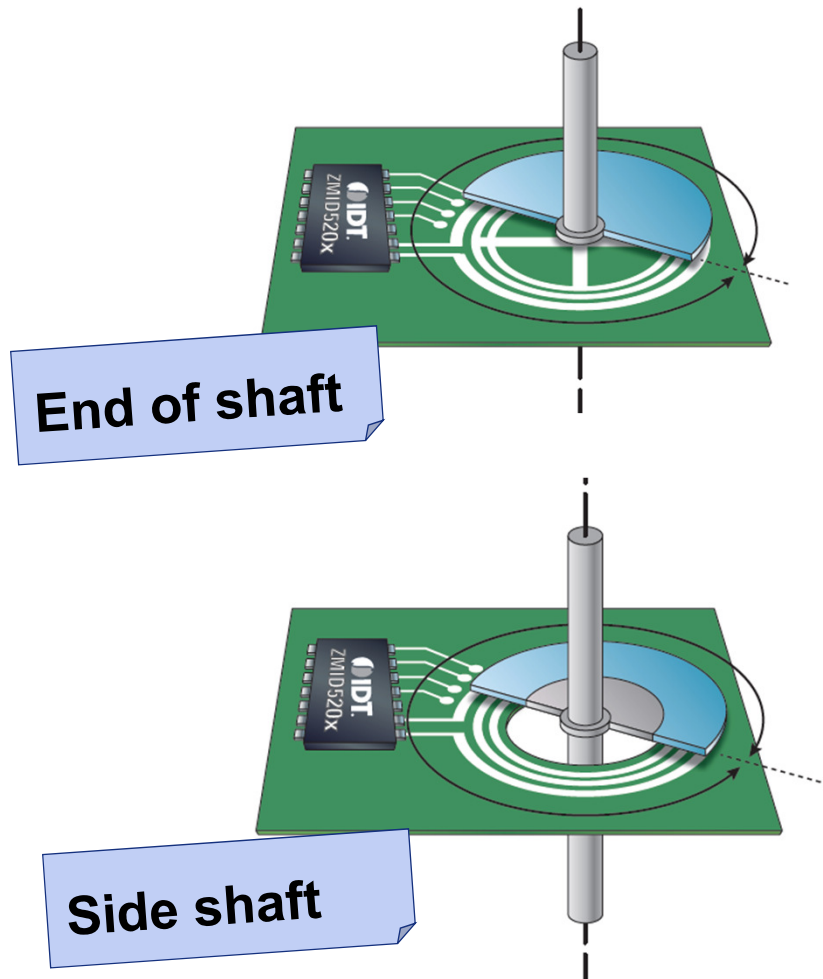
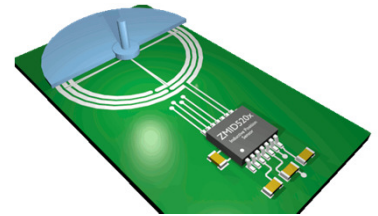
Solving the Problems – Accuracy



- Accuracy = Actual position vs. measured position: down to 0.2% full scale (FS)
- Imperfections on coil design (e.g. offsets, non-linearities) can be corrected on-chip by offset-correction and 9-point linearization in a non-volatile memory
- Resolution = number or size of steps within the angle range

Angle Range	Resolution ZMID5201, -5202	Resolution ZMID5203	Accuracy @ 0.2% Full Scale
20° (e.g. Pedal)	0,02°	0,005°	0,04 °
90° (e.g. Throttle)	0,09°	0,022°	0,18 °
180° (e.g. Robot)	0,18°	0,044°	0,36 °
270° (e.g. Potentiometer)	0,26°	0,066°	0,54 °
360° (e.g. rotary knob)	0,35°	0,088°	0,72 °

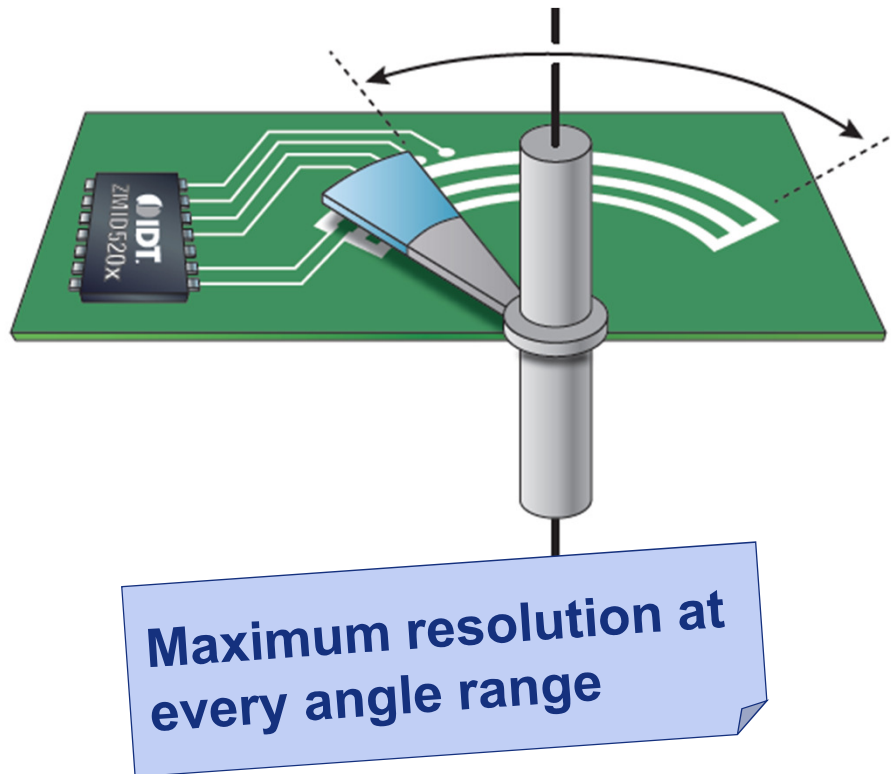
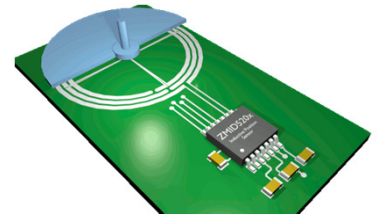
Solving the Problems – Off-axis



- On-axis + Off-axis capability
- On-axis (end of shaft) for applications requiring small diameters
- Off-axis (side shaft) for applications requiring small form factor, short length and hollow shafts
- No expensive ring magnets needed for off-axis

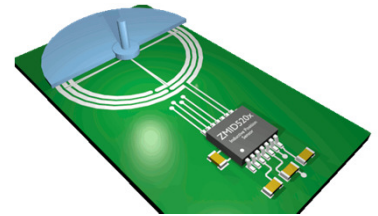
**Same IC for
on-axis + off-axis!**

Solving the Problems – Narrow Angles

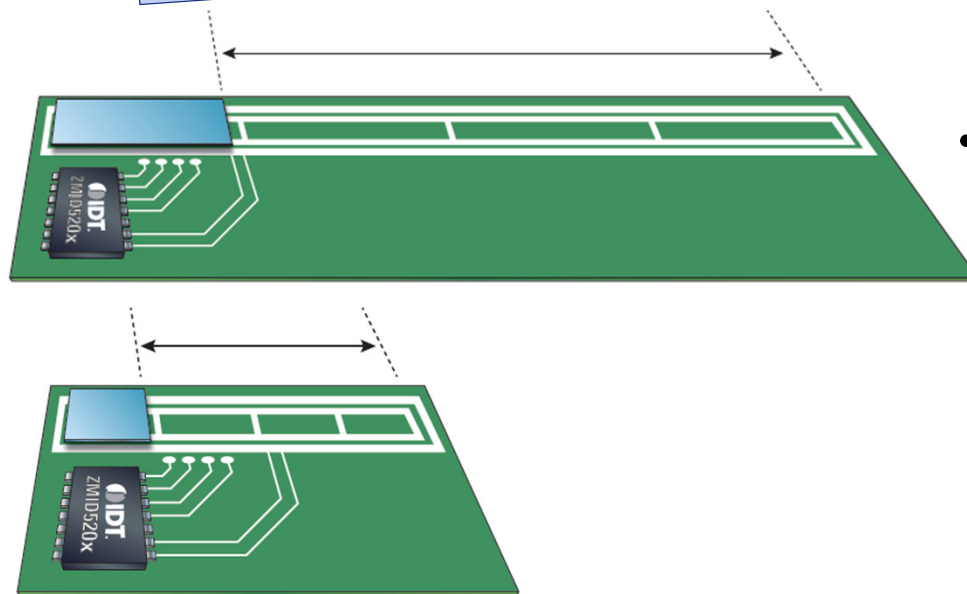


- Full resolution for every angle range, even for small angles (e.g. 4096 steps over 20°)
- Accuracy improves with smaller angle ranges due to scalable angle range : ~10°...360°
- xMR and Hall are facing decreased resolution at small angles due to fixed angle range:
 - AMR: 180°
 - GMR, TMR, Hall : 360°

Solving the Challenges – Long Stroke

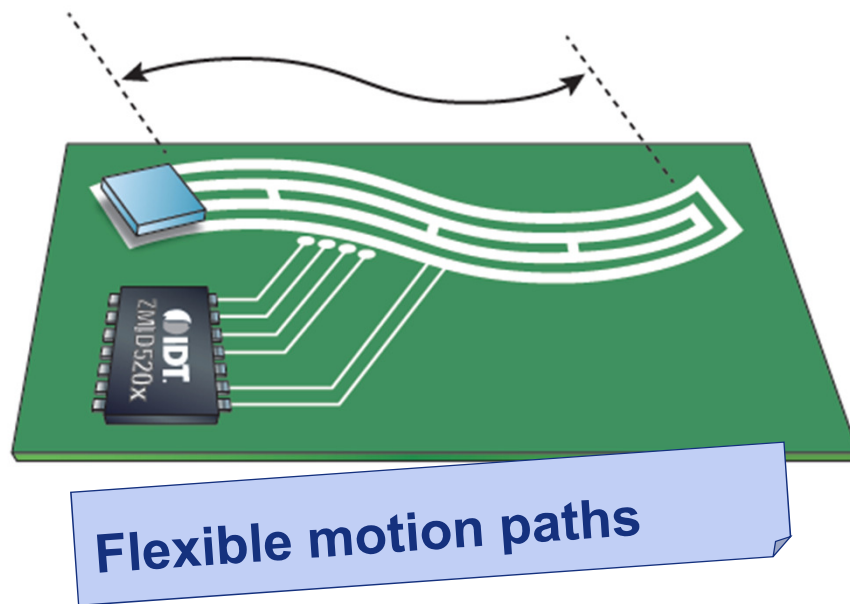
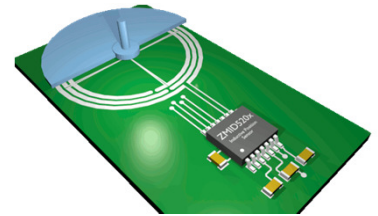


Full resolution for long or short linear strokes



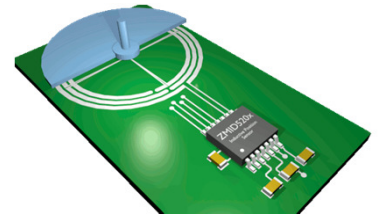
- No limit in sensor coil length for long linear strokes
 - the only limitation = target length should be minimum ~20% of coil length
- Hall and xMR are limited
 - Only with long (expensive) magnets
 - Large non-linearities
 - No stray field immunity

Solving the Problems – Arc Motion/Non-Uniform Sensing



- IDT's inductive sensor provides very flexible sensor coil designs
- Non-uniform sensing paths, such as S- or L- shapes are also possible

Solving the Problems – EMC and Overvoltage

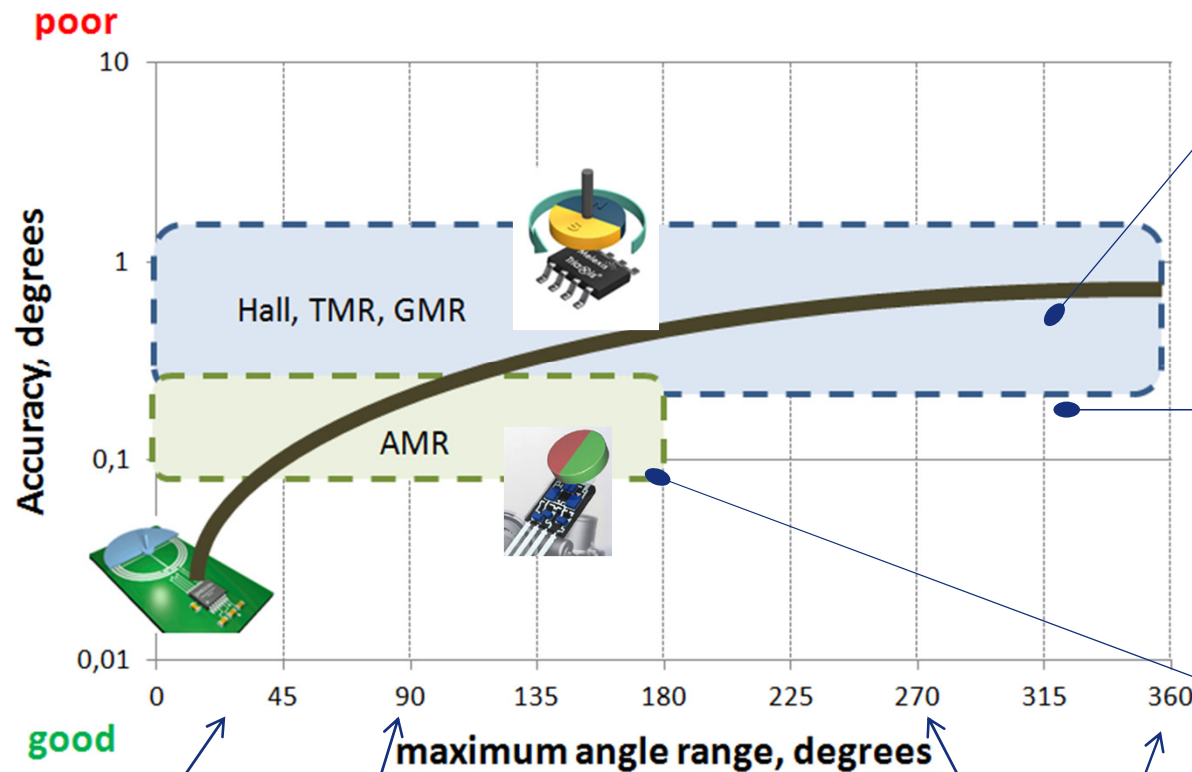


Fully automotive qualified

- IDT's inductive position sensors are fully compliant to automotive standards, including AEC-Q100, ISO11452-x
- They implement
 - Overvoltage protection
 - Reverse polarity protection
 - Short circuit protection up to 18V
- Intensive diagnostics

Non-linearity (INL) – Technology Comparison

Non-Linearity vs. angle range



ZMID520x:

Variable accuracy ,
depends on maximum
angle range
– ~0.2% Full-scale INL
(calibrated)


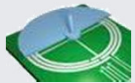
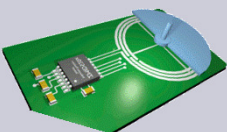
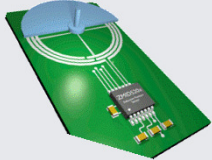
Hall, TMR, GMR:

Fixed accuracy
 $\leq 360^\circ$ angle range
– ~0.5..2.0° INL
(calibrated)

AMR:

Fixed accuracy
 $\leq 180^\circ$ angle range
– ~0.1..0.5° INL
(calibrated)

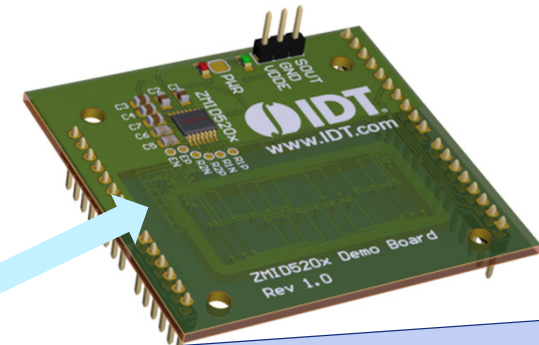
Position Sensor Offering Scenarios

Target market	Channel	Coil design	PCB design	Product
Automotive	IC (high vol)	Customer	Customer	
Automotive	IC (high vol)	IDT (customized)	Customer	
Industrial, Consumer	Module (med vol)	IDT (customized)		
Industrial, Consumer	Module (low vol)	IDT (catalog coil & PCB designs)		

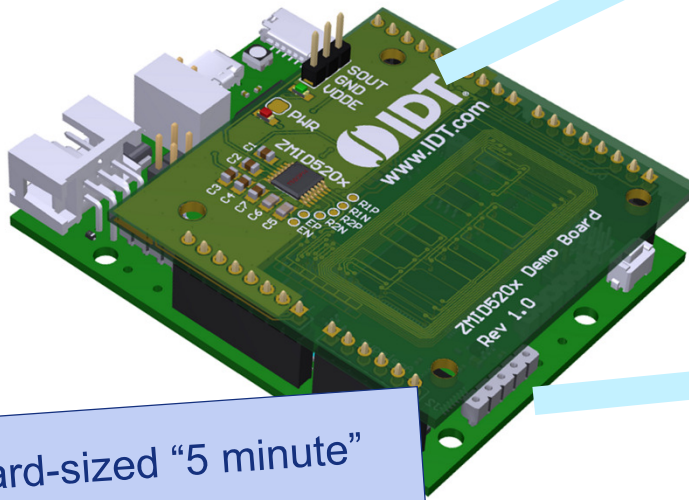
New Evaluation Kit Platform

Eval-kit PRO

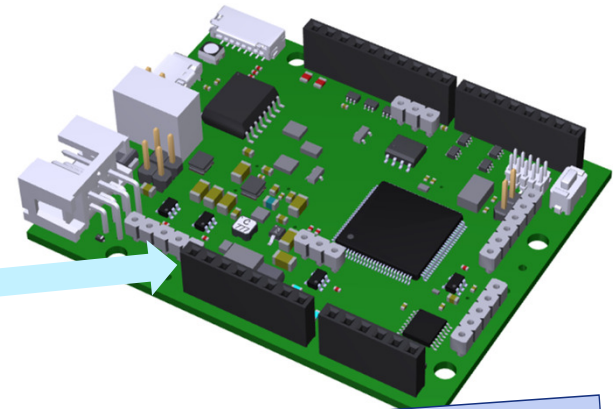
- Full Featured Platform
- USB Isolation
- ADC 16bit
- Arduino™ Compatible
- Standard evaluation kit
- Connection to external, customized sensor



Inductive Sensor Board



Credit card-sized "5 minute" rule proofed



USB Communication Board

ZMID520x vs. Competitors

Contactless position sensors

Feature	IDT ZMID520x	Competitor 1a	Competitor 1b	Competitor 2	Competitor 3
Principle	Inductive, Eddy current	Inductive, Back EMF	Inductance to Digital	Hall with field concentrator	AMR, magneto resistive
Target material	Solid metal	Metal frame, Current loop	Solid metal	Magnet	Magnet
Target horizontal Alignment tolerance	Tolerant, scalable	Less tolerant, scalable	Less tolerant scalable	Critical, depending on magnet size (\$\$)	Critical, depending on magnet size (\$\$)
Target airgap (vertical) tolerance	Tolerant, scalable	Tolerant, scalable	Intolerant, critical	Less tolerant	Tolerant, depending on magnet size (\$\$)
Sensitivity to magnetic stray fields	Very good	Very good	Very good	Poor; shielding required	Poor; shielding required
Accuracy	Good to Very good (scalable)	Good to Very good (scalable)	Medium	Good	Very good
Flexibility, (linear, rotary, arc motion)	Very flexible	Flexible	Very flexible	Limited flexibility	Limited flexibility
Angle range	Up to 360°, scalable	Up to 360°, scalable	Up to 360°, scalable	360° fixed	180° fixed
Availability	Mass market	Only for large automotive customers	Mass market	Mass market	Mass market

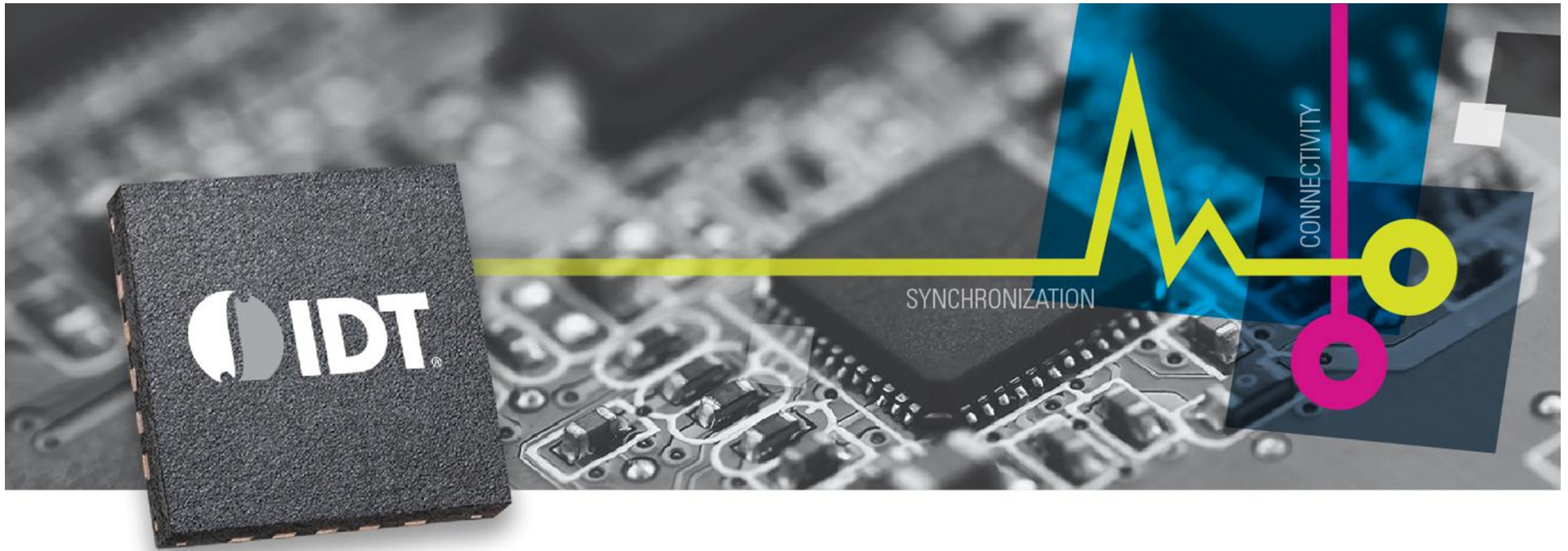
ZMID5201-02-03 Product Summary

- **ZMID5201, ZMID5202, ZMID5203**

- Inductive principle
- Immune to magnetic stray fields
- Suitable for harsh environments (dust, humidity, temperature,..)
- Only three wires: Ground, 5V-Supply, Output
- Three versions: Analog, PWM, SENT output
- Scalable resolution and accuracy
- Suitable for linear, rotational and arc motion
- On-axis and Off-axis rotation up to 360° angle (full turn)
- Overvoltage and reverse polarity protected
- Automotive qualified
- Suitable to be implemented in safety related systems compliant to ISO26262 up to ASIL-B"

- **Availability Dates**

Key Dates	Status
Availability	Samples, eval kits: now PPAP: in preparation



Thank You

Analog Mixed Signal Product
Leadership in Growth Markets

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Heinz Oyrer, heinz.oyrer@idt.com | Jan Leuckfeld, jan.leuckfeld@idt.com



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