Digitizing Torque
Revolutionising Industry
Company Presentation

Your experts for magnetostrictive sensors

01

AGENDA

NCTE AT A GLANCE

02 TECHNOLOGY

03 APPLICATIONS

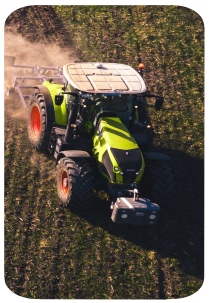
OUR MISSION

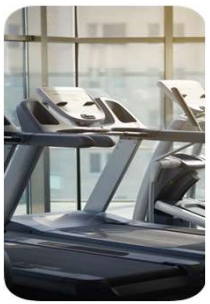
We make machines and products sustainably smarter

We enthusiastically develop, produce and sell sensors that precisely measure torque, force, shear and bending. Whether customized individual solutions or series products "Made in Germany", with our sensor solutions our customers leverage new potentials of their machines and products.

As a pioneer in the field of non-contact torque measurement, we are driven by constant innovation. Our magnetoelastic technology is robust and works under extreme environmental conditions. This allows us to reliably deliver data in real time where no one else can measure.

At our company site in Oberhaching near Munich, the most dedicated employees work every day to make applications smarter with innovative sensor solutions. In this way, we increase sustainability for our customers in future markets such as e-mobility, agricultural technology and Industry 4.0.



NCTE ON A GROWTH PATH

FOUNDATION

SERIES PRODUCTION

INTERNATIONALISATION

2003

2008

2010 — Series production E-Bike sensors

2011 — New segments

2014 — Series production medical technology

Relocation and scaling of production

2018 — Cooperation with Schaeffler

2023 — Listing: Exchange Munich m:access

2024 — Internationalisation

- Founded as an engineering & development company
- Customized developments based on magnetostriction

- Change of strategy towards products suitable for industrial use
- Turnover EUR 2.5 million

- Internationalisation and expansion of the dealer network
- Focus on sustainability and megatrends
- Increase in sales to > EUR 6 million

FACTS AND FIGURES

- Executive Board: Sebastian Müller
- Corporate form: AG (Regulated Market of the Munich Stock Exchange in the m:access segment)
- Number of employees: 36
- Innovations: more than 20 granted patent families
- Segments: E-bike & E-mobility, Motorsport, Medical technology, Agricultural technology & Off-highway, Industry, Robotics and Aviation

02

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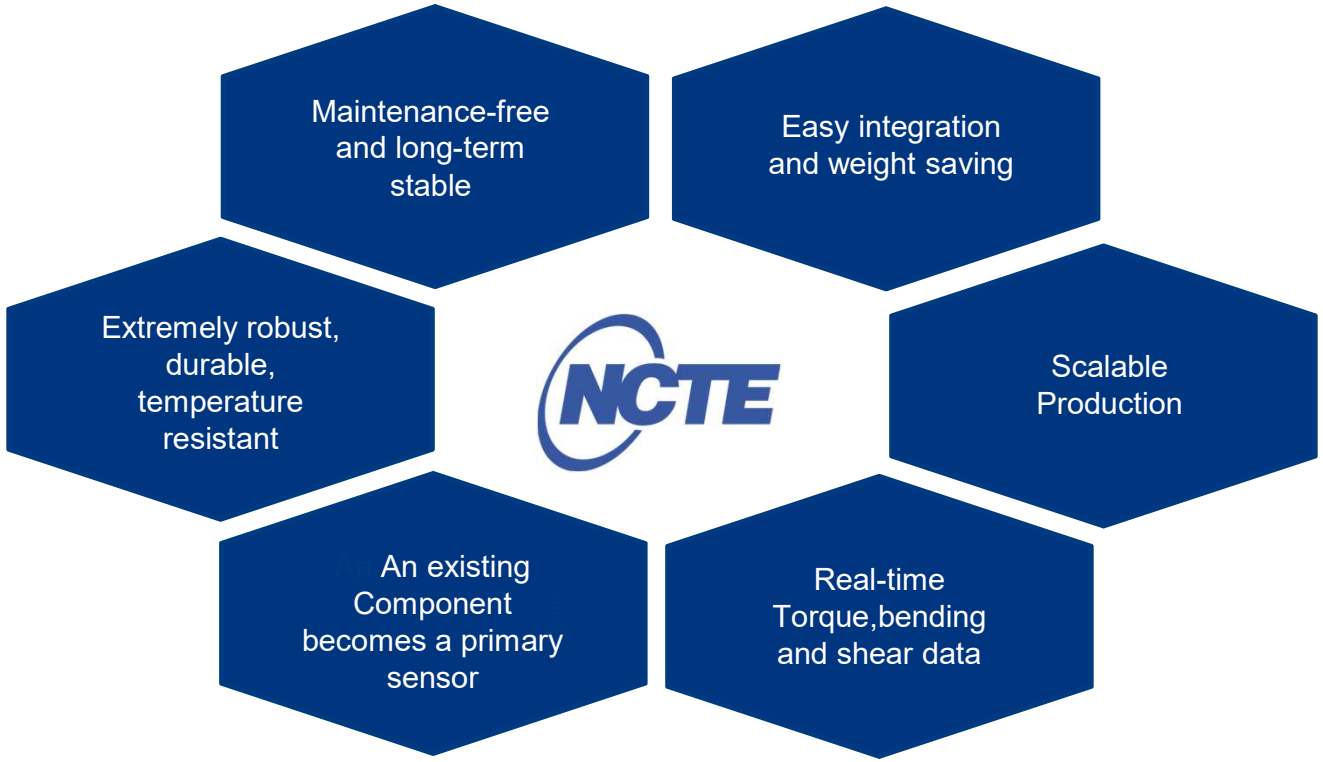
01 NCTE AT A GLANCE

TECHNOLOGY

03 APPLICATIONS

TECHNOLOGY ADVANTAGES

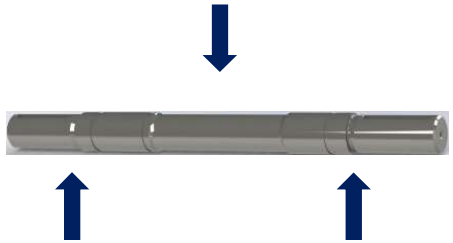


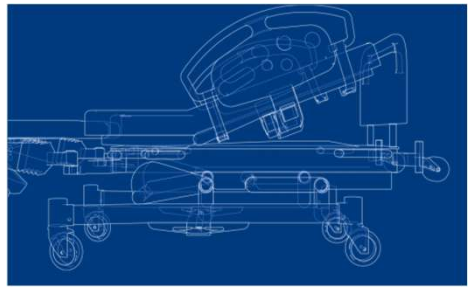
VERSATILE APPLICATION POSSIBILITIES

What sensor technology options does the NCTE offer?

torque and speed

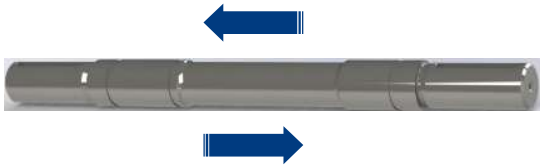
force and bending





absolute position measurement

pressure and tension

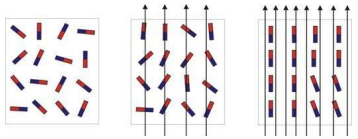


NCTE sensors measure completely contact-free, wear-free and long-term stable.

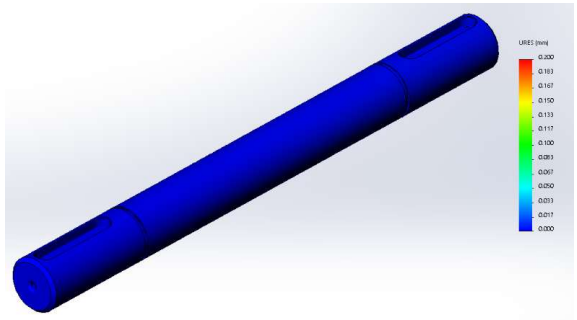
ONE CURRENT PULSE FOR LONG-TERM STABILITY

Magnetostriction

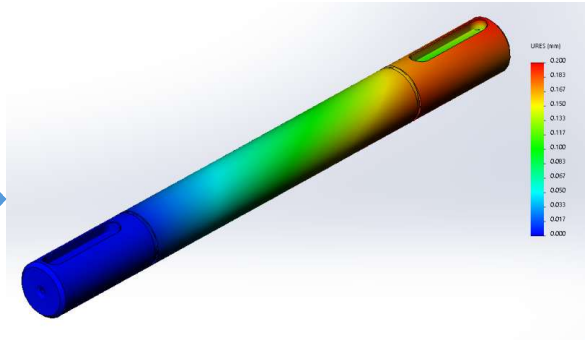
is the deformation of magnetic, in particular ferromagnetic, materials as a result of an applied magnetic field. In the process, the white areas in the metal align themselves.
The body undergoes an elastic change in length at constant volume. (Joule magnetostriction 1847 / Villari effect)

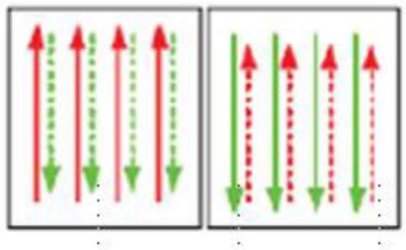


What happens to the magnetic field inside the shaft when force is applied ?

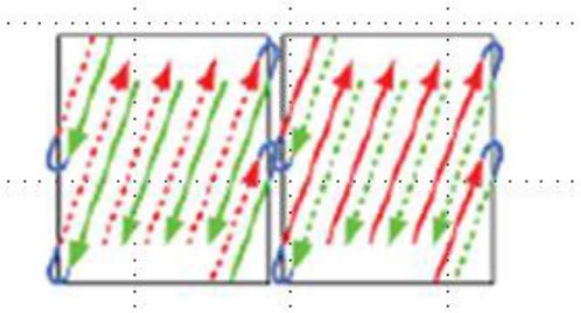


The lattice structure changes during an application of force, which becomes visible through a CAD simulation





In the same way, the magnetic field also changes due to force

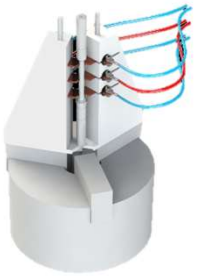


The change in the magnetic field is measurable and gives the measurement signal of the NCTE sensors.

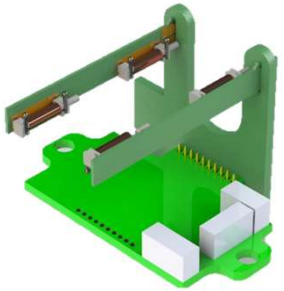
TECHNOLOGY – 5 STEPS TO THE SENSOR

Step 1: Ultrasonic cleaning and degausing of shaft

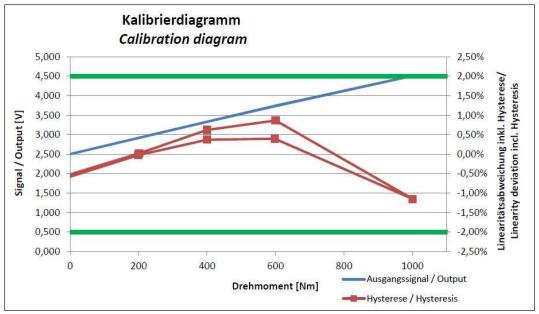
Step 2: Generating the magnetic field into the shaft



Step 3: Assembling electronics including coil integration



Step 4: Calibration of the sensor



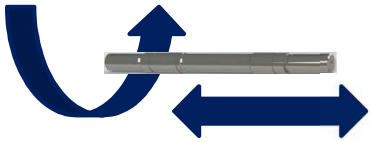
Step 5: Final housing

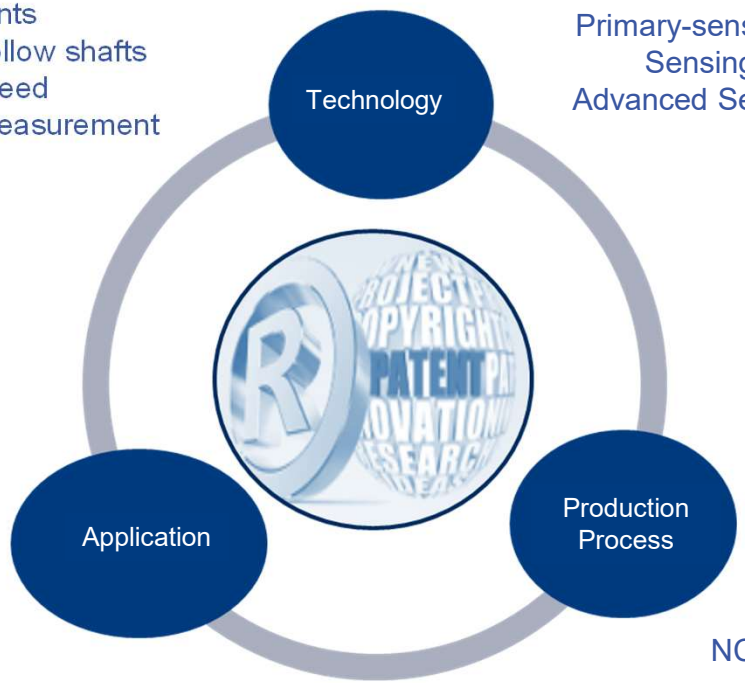
POWERFUL INNOVATION AND TECHNOLOGY SECURITY

Competitive edge through innovation

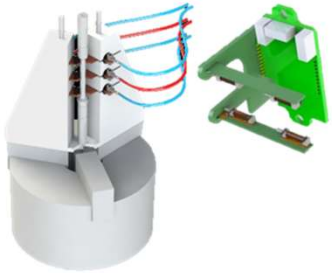
NCTE secures its competitive edge with over 20 granted patent families in the field of technology, manufacturing processes and application patents

Shaft variants
Measurement in hollow shafts
Torque / Speed
Absolute position measurement





Primary-sensor generation
Sensing System
Advanced Sensing System



Wireless E-bike
Aviation
Robotic
Path measurement

NCTE machines for generating the primary-sensors

How to use inverse magnetostriction ?

- Certain steel types are useful for measuring inverse magnetostriction because of following material characteristic:

- Ferromagnetic → magnetization can be realized

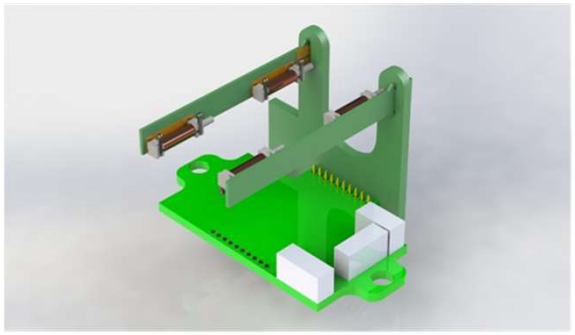
- Hard surface with high HRC level → *robust grid structure is necessary for long-term operation*

Material examples that can be used:
DIN 1.2767, 1.5752, 1.4021, 300M

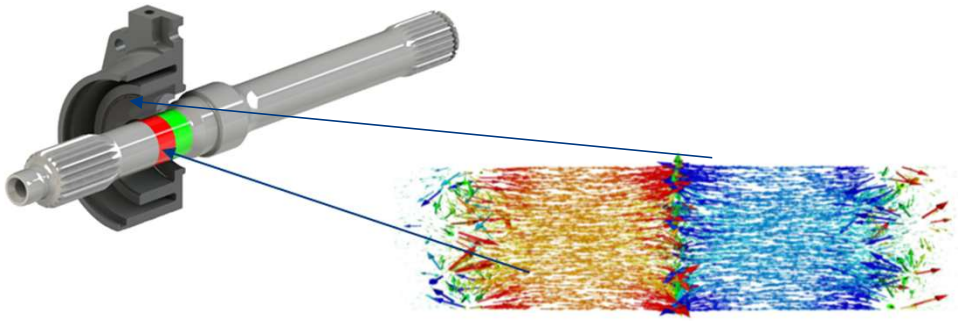
- NCTE is measuring inverse magnetostriction → *change in the magnetic field of an object due to the application of force*

TECHNOLOGY

Characteristic of electronics and magnetic field

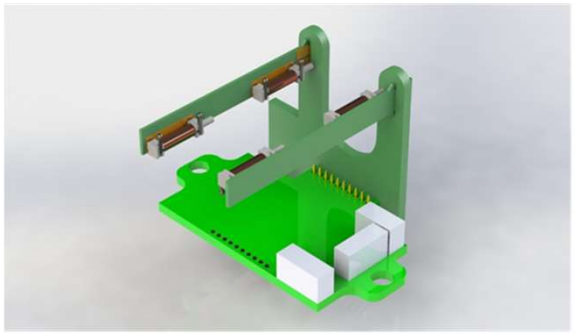


Dedicated Electronics with coils measering the movements of the magnetic field and can send an output signal (analoge or digital) with the detected force

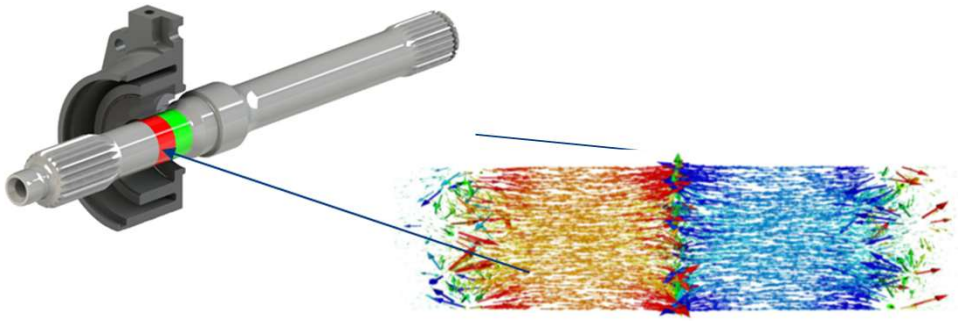


There are always 2, 4 or 6 coil couples to measure 2 independent magnetic fields to avoid mismatch by external influences (e.g. earth magnetic field)

Characteristic of electronics and magnetic field



- Up to 10kHz frequency measuring
- Contactless (no touch of the shaft)
- Analogue output (Volt or Current)
- Digital Output (CAN, I²C)
- Flexible design that follows the application
- Can be protected against dust and liquid like oil
- Fast transmission of signal output in msec



- Field strenght is low (mT)
- Stable against vibration
- Longterm operation is feasible
- Independent from the shaft design
- Need smooth surface and dedicated shaft material
- Shearstress between 50 und 150 MPa is necessary

IT‘S ALL IN ONE PLACE

Convincing technology

- Sensors easily scalable and efficiently producible
- Long-term stability of the magnetic fields proven even under toughest requirements

Production and Technology at one place

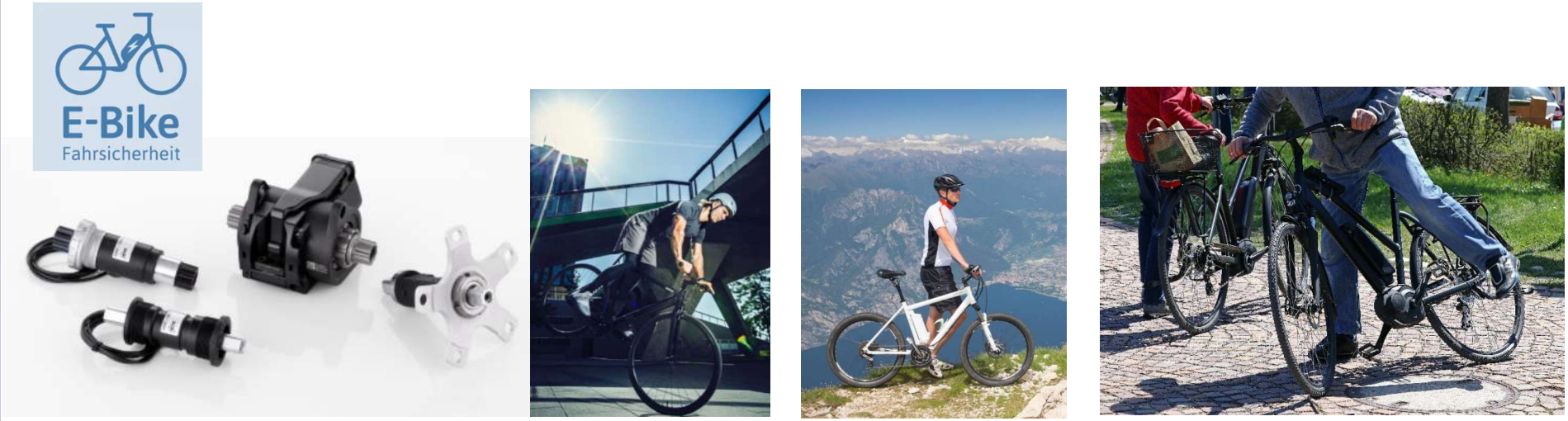
- Company expansion, processes and structure, investments in manufacturing
- More than 1 million sensors in the market, with our e-bike sensors alone
- Current production capacity 365.000 sensor / year in one shift (700k/2 shift)
- Concepts for increasing capacity ready worked out and quickly implemented

WE MAKE E-BIKES MORE SAFE

We make E-Bikes more safe and increase the riding comfort !

NCTE torque sensors ensure safe and relaxed riding of electric bicycles.
Our torque sensor measures with high precision whether and how strongly the rider is pedaling.

With this signal, the electric motor is precisely controlled and supports the rider with exactly the desired power or interrupts it immediately and without delay if necessary. This improves the driving experience and increases safety.



SUSTAINABILITY IN AGRICULTURE

We contribute to a healthier food and protect the environment!

NCTE sensors make agricultural machinery more intelligent. Both the fertilizer quantity and the fertilizer discharge widths are precisely measured and controlled at all times.

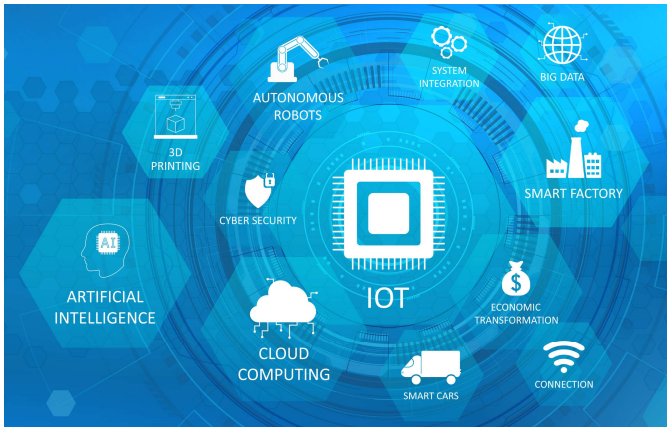
This avoids over- and under-fertilisation and makes optimal use of field margins without polluting adjacent lakes, rivers or groundwater.

Due to the non-contact measurement and complete encapsulation, the NCTE sensors cannot be disrupted by anything and are also designed for the harshest environmental conditions.

SERIAL PRODUCTS IN THE INDUSTRY

We make machines intelligent (IoT)

At the beginning of the Internet of Things there is always a sensor, because only with a sensor things can detect states and perform actions. Together with the connection to the internet, objects become "intelligent". Our sensors detect the torque of machines and this "contactless", reliably and in real time.



03

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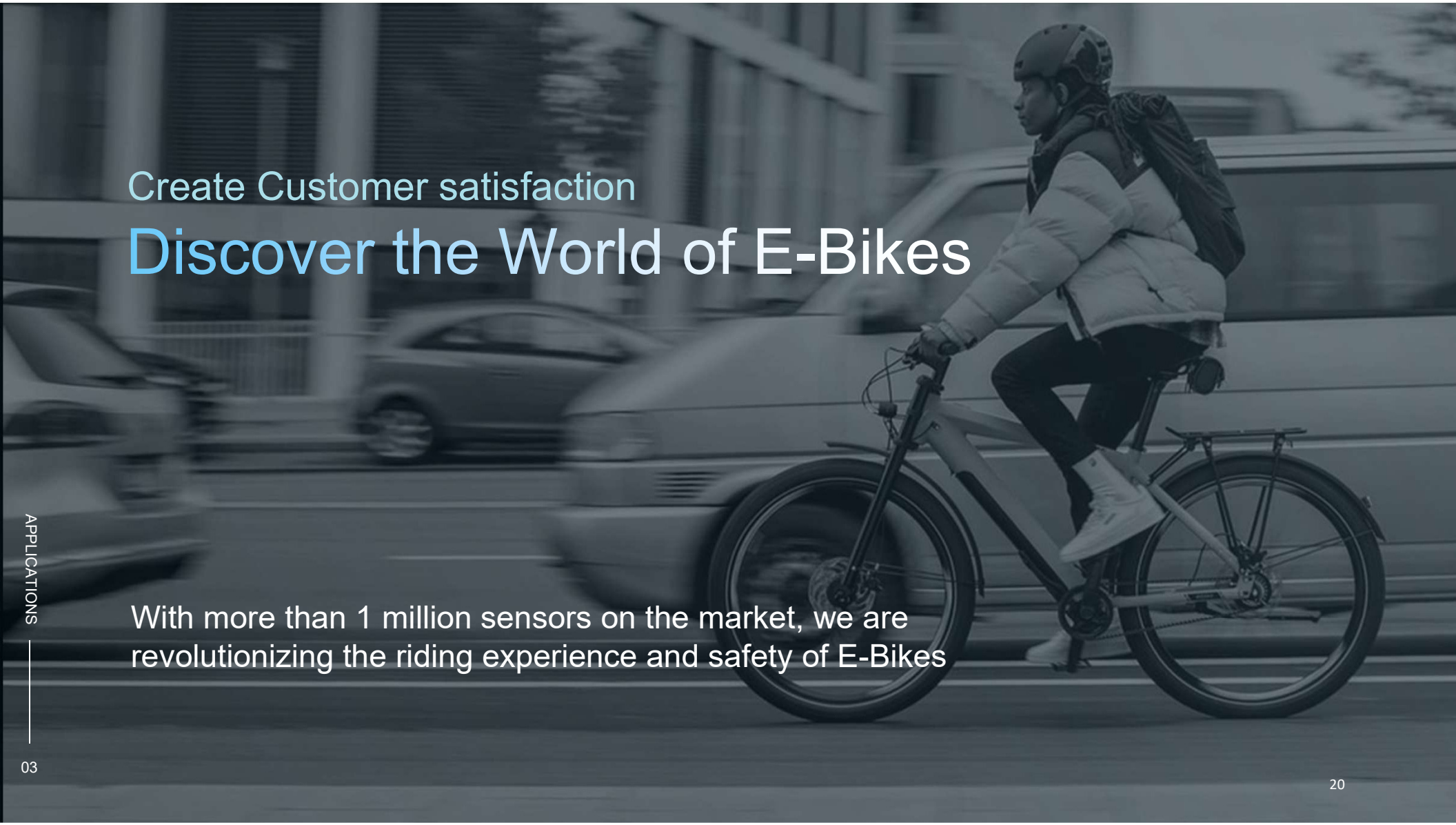
02 TECHNOLOGY

APPLICATIONS



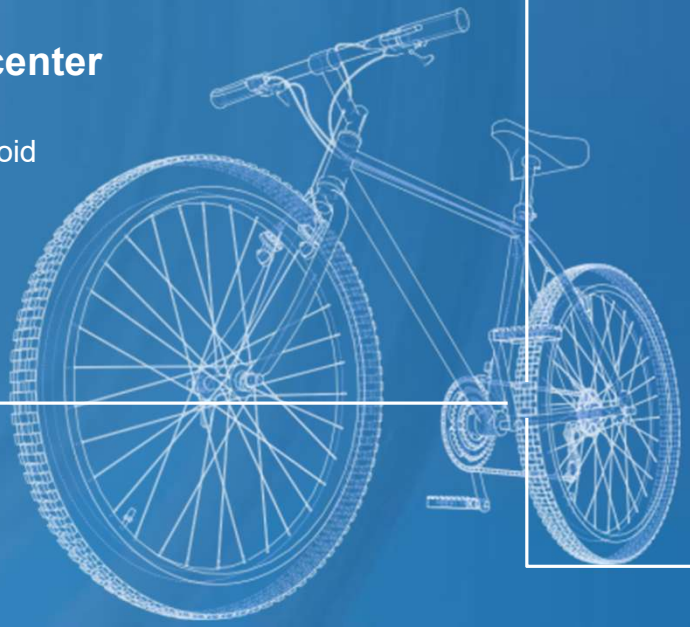
Create Customer satisfaction

Discover the World of E-Bikes

With more than 1 million sensors on the market, we are revolutionizing the riding experience and safety of E-Bikes

E-BIKE

Measuring directly in the center motor
Optimization of the mid-engine to avoid jerky driving behavior



Measuring for front and rear drive
For increased safety, optimal driving feeling and battery life

Torque and angle measurement at the rear-wheel drive
Monitoring and optimization of the e-bike drive

E-BIKE MID-MOTORS

NCTE MID SENSE Concept

- Based on validated standard components
- Flexible design according to modular concept
- Adaptable to individual customer needs
- EMC validation according EN1519:2017 passed
- Vibration tests according DIN79009 chapter 5.2.3
- MTBF results available

PATENT PROTECTED

Anlage A

Schaeffler Technologies AG & Co. KG
Industriestraße 1-3
91074 Herzogenaurach

NCTE AG
Raiffeisenallee 3
82041 Oberhaching

Bestätigung	**Confirmation**
*Hiermit bestätigt der **Lizenzgeber**, Schaeffler Technologies AG & Co. KG Industriestraße 1-3 91074 Herzogenaurach,*	*The **Licensor**, Schaeffler Technologies AG & Co. KG Industriestraße 1-3 91074 Herzogenaurach hereby confirms to have granted*
*dem **Lizenznehmer** NCTE AG Raiffeisenallee 3 82041 Oberhaching*	*to the **Licensee** NCTE AG Raiffeisenallee 3 82041 Oberhaching*
Lizenznutzungsrechte für folgende Patente eingeräumt zu haben:	*licence rights for the following patents:*
• *Europäisches Patent EP 2365927 B1 („Konzept magnetoelastische Drehmomentmessung mittels Messhülse") sowie sämtliche hieraus abgeleiteten nationale Schutzrechte US8707824 B2 und CN102143883 B*	• *European patent EP 2365927 B1 ("Concept of magnetoelastic torque measurement by means of a measuring sleeve") as well as all national property rights derived therefrom US8707824 B2 and CN102143883 B*
• *Europäisches Patent EP 2156156 B1 und abgeleitete nationale Schutzrechte: Deutsches Patent 10 2007 046 749, das Chinesisches Patent 101715548 und Europäisches Patent 08 748 790.6.*	• *European patent EP 2156156 B1 and derived national property rights: German Patent 10 2007 046 749, Chinese Patent 101715548 and European Patent 08 748 790.6.*
Der Lizenzgeber sichert zu, aus keinem der obengenannten Vertragsschutzrechte gegen Kunden des Lizenznehmers Rechte geltend zu	*The Licensor warrants that it will not assert any rights under any of the abovementioned contractual property rights against the Licensee's customers if and to the extent that they continue*

CONFIDENTIAL

For mid motor requests NCTE is authorized to grant patent usage rights directly to end customers.

NCTE has a license agreement for the following patents:
“Concept of magnetoelastic torque measurement by means of a measuring sleeve”

- EP2365927 B1 in Europe
- US8707824 B2 in the US
- N102143883 B for China

machen, sofern und soweit diese die vom Lizenznehmer erworbenen Vertragsprodukte bestimmungsgemäß weiterverwenden.

to use the contractual products acquired from the Licensee as intended.

Für / for
Schaeffler Technologies AG & Co. KG

19.11.2021
Datum / Date

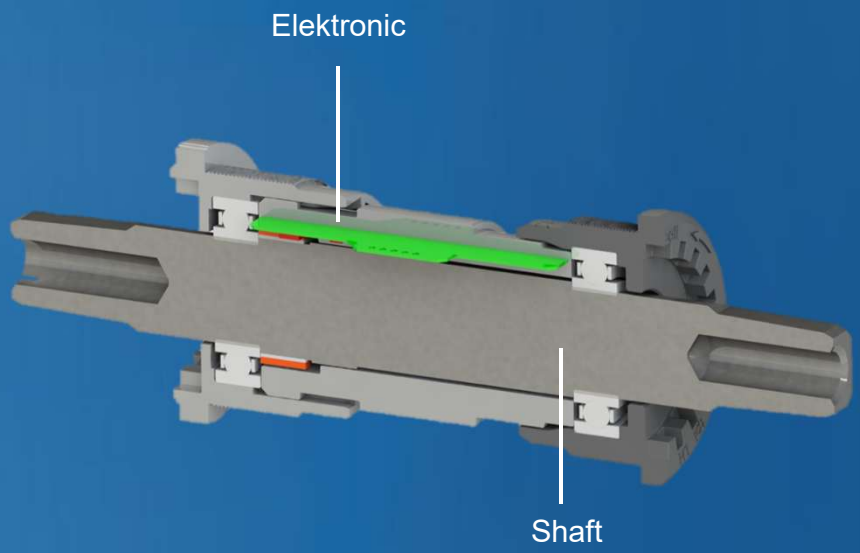
ppa.
[Name] Marcus Geentuth
[Name] Rudolf Walker

Schaeffler Technologies
AG & Co. KG
Georg-Schäfer-Straße 30
97421 Schweinfurt

E-BIKE

Measuring directly in the center motor

Optimization of the mid-engine to avoid jerky driving behavior



Sensor Data	
Installation:	Plug & Play BSA68
Output signals:	Torque, Speed and Direction
Passed Test:	EN 15194; 96 hours salt spray test, CE compliant

OVERVIEW: STANDARD PORTFOLIO E-BIKE

APPLICATION	SENSOR TYPE	TYPE	OUTPUT SIGNAL
Mid-Motor	Modular concept or complete customized	Integration according customer requirements	Analogue/Digital CAN-Bus I2C UART
Rear-Motor	Speed	Square ISIS*	Digital or Analogue*
	Speed Torque	Square ISIS*	Speed: Digital or Analogue* Torque: Analogue
Front-Motor	Speed	Square ISIS*	Digital or Analogue*
	Speed Torque	Square ISIS*	Speed: Digital or Analogue* Torque: Analogue
Front/rear/hub motor	Customized	Integration according customer requirements	Analogue/Digital CAN-Bus I2C UART

Datasheet and more product info: www.ncte.de/e-bikes/

* At Customer Request

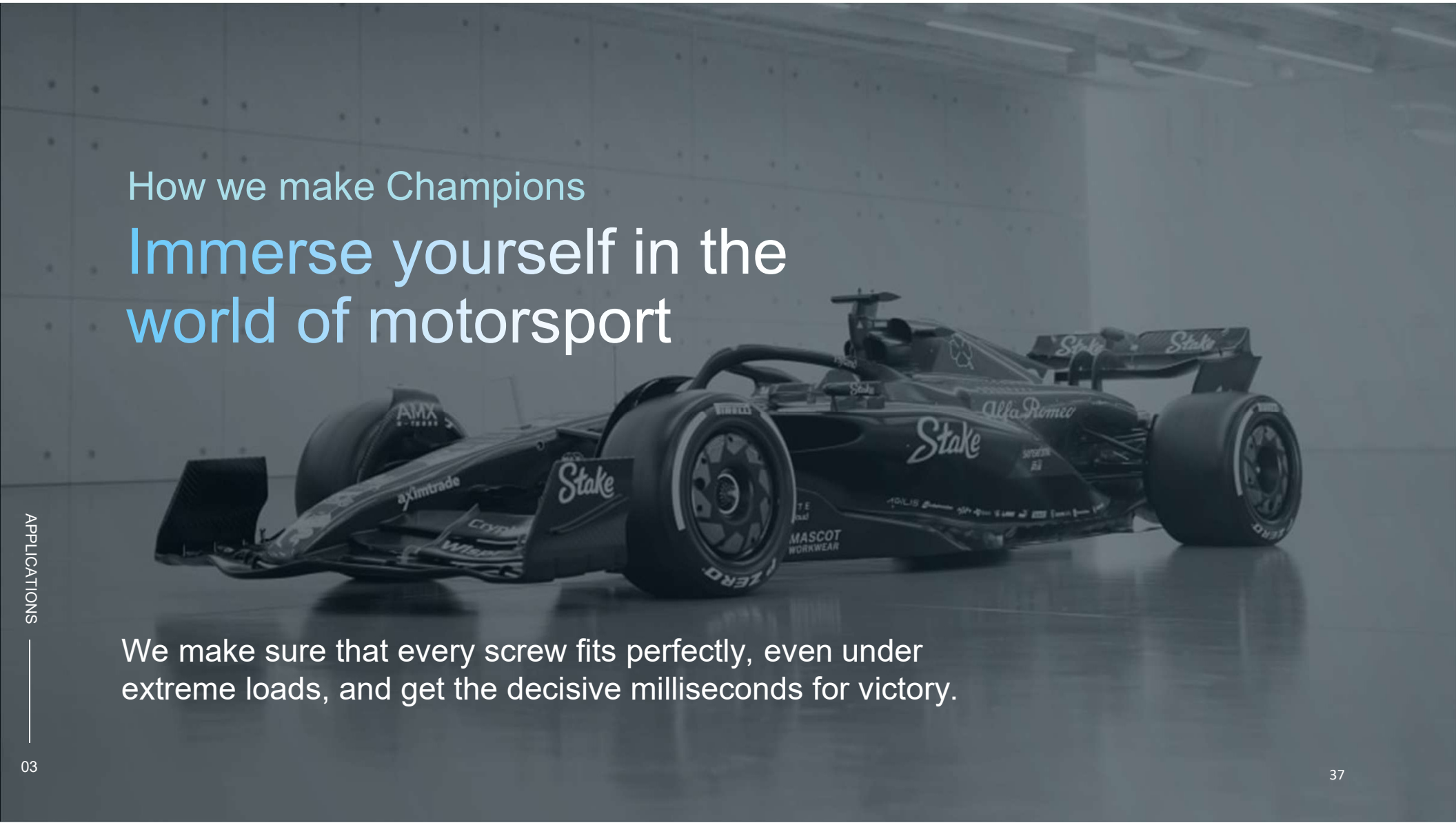
E-BIKE

The advantages of our torque sensors for e-bikes and pedelecs at a glance

- Compact and space-saving
- Easy to integrate
- Low weight
- Available as standard solution and customized sensors
- More cost-effective than comparable solutions
- Non-contact measurement: wear- and maintenance-free
- Can be used in all e-bike drives and drive types
- extremely robust (even under strong vibrations, underwater or in an oil bath, -40°C to +125°C)

How we make Champions

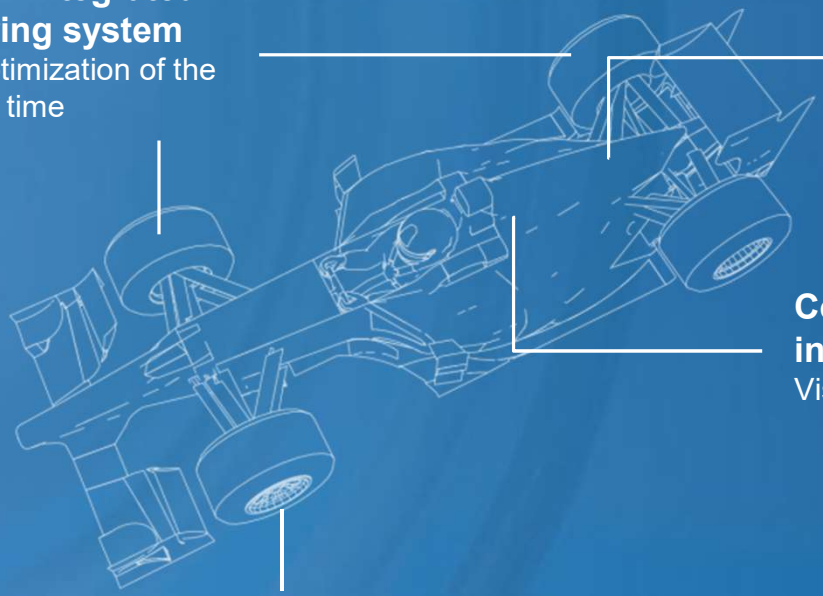
Immerse yourself in the world of motorsport



We make sure that every screw fits perfectly, even under extreme loads, and get the decisive milliseconds for victory.

MOTORSPORT
RACING CAR

Drive shaft with integrated torque measuring system
Monitoring and optimization of the drive setup in real time



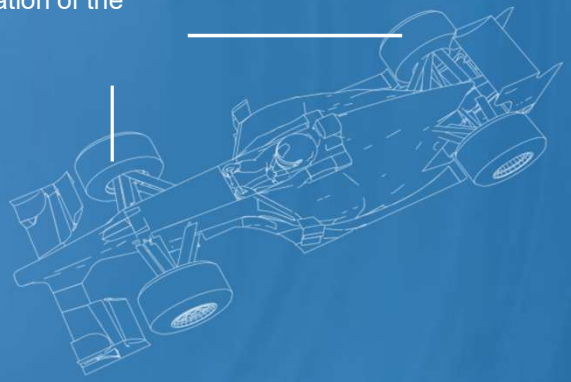
Gear output measurement in a hollow shaft

Coupling Actuator with integrated torque sensor unit
Visualization of the ideal gear-shift-time

Torque measurement system for impact wrench in range racing technology and box stop
Ensuring the tightening torque of the wheels up to completely networked pitstop equipment

MOTORSPORT
RACING CAR

Drive shaft with integrated torque measuring system
Monitoring and optimization of the drive setup in real time

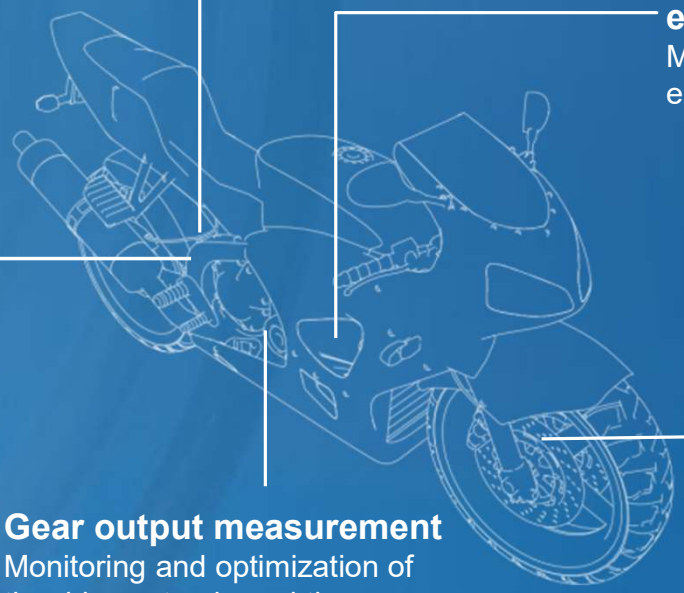


Sensor	
Measuring range:	Up to 2.000 Nm
Accuracy:	≤ ± 0,5 %
Robust:	Against vibration and heat

MOTORSPORT
RACING MOTORCYCLE

Integrated torque measuring system at the drive
Monitoring and optimization of the drive

Length-/ Position measurement in chassis
Monitoring and optimization of the chassis

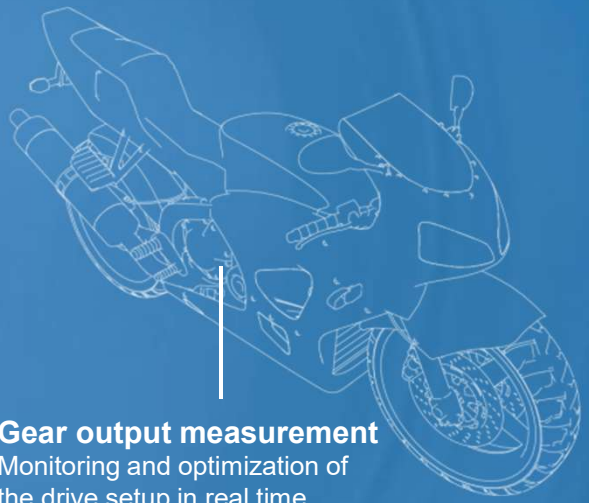


Force measurement on the engine
Monitoring and optimization of the engine control system

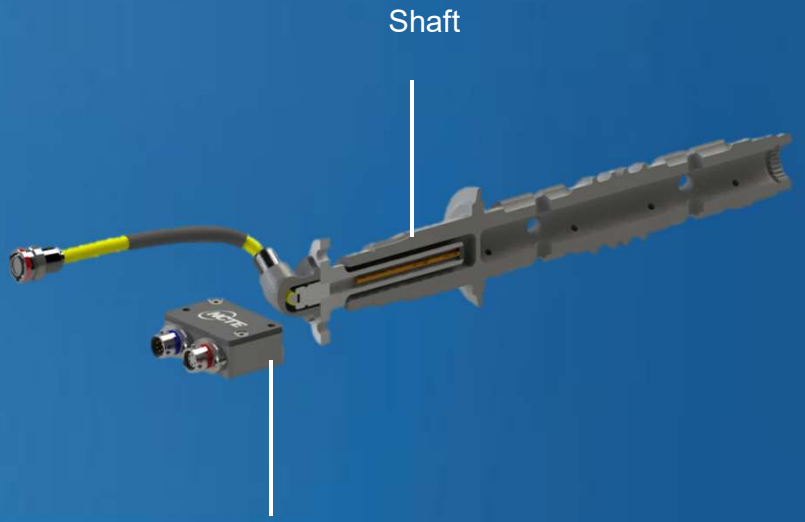
Length measurement at the suspension fork
Monitoring and optimization of the chassis

Gear output measurement
Monitoring and optimization of the drive setup in real time

MOTORSPORT
RACING MOTORCYCLE



Gear output measurement
Monitoring and optimization of
the drive setup in real time

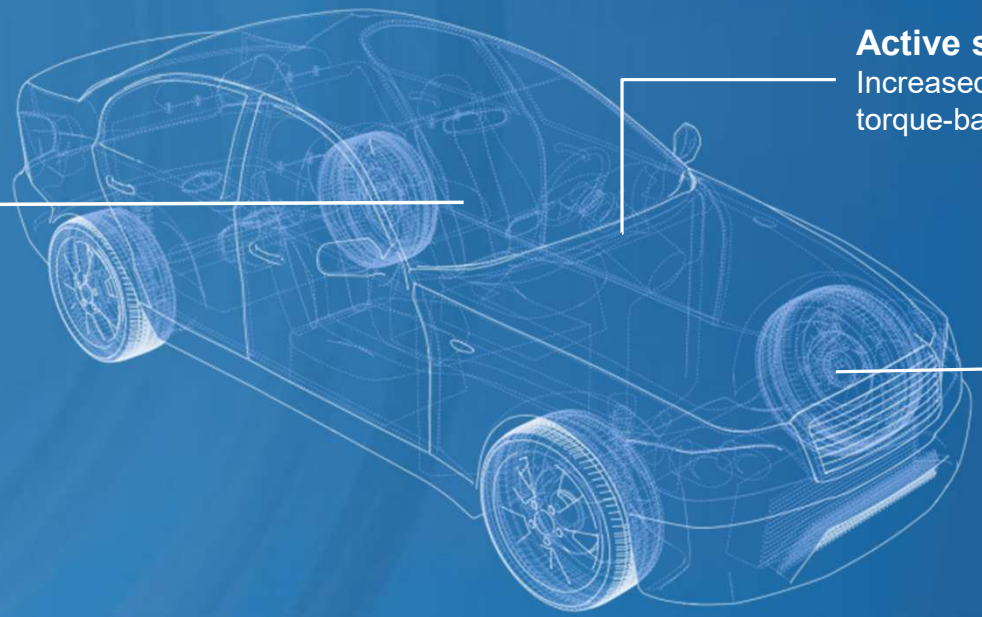


Sensor Data	
Data acquisition:	Up to 5 kHz
Temperature:	- 40 ° C … + 120 ° C
No additional space needed:	Fits in an hollow shaft

The advantages of our sensors for motorsports at a glance

- Improve the setting of the car to make it faster
- Extremely space - saving - your original design will not be compromised
- Non-contact measurement; wear- and maintenance-free
- Precise measurement even under strong vibrations
- Very small and compact designs are possible (30 mm x 8 mm)
- Compatible with all common monitoring systems (CAN bus, USB, analogue)
- Perfect interaction with typical motorsport steel grades
- No extra weight on the primary sensor
- Temperature insensitive between -40 °C and 120 °C
- Integrated temperature and speed sensor

AUTOMOTIVE

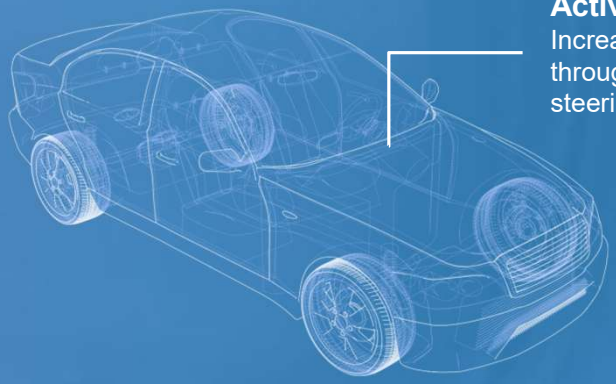


Active steering
Increased driving comfort through torque-based steering support

Torque measuring system on drive shaft
Monitoring and optimization of the drive setup in real time

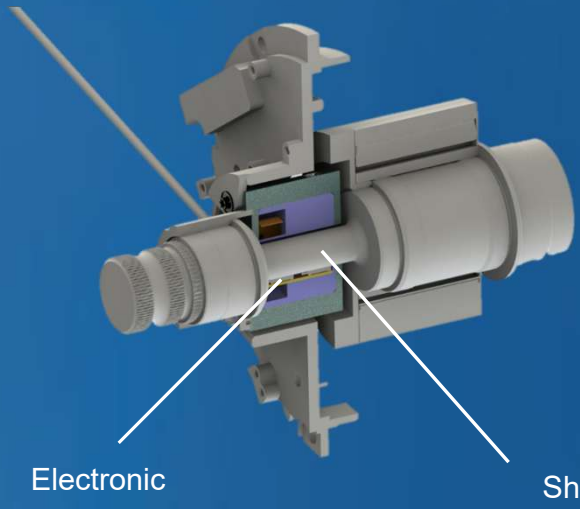
Position detection of the seats and headrests
Monitoring of the setting position

AUTOMOTIVE



Active steering
Increased driving comfort through torque-based steering support

Sensor Data	
Measuring range:	±25 Nm
Accuracy:	≤ ± 0,5 %
Output signal:	CAN



AUTOMOTIVE

The advantages of our sensors for motorsports at a glance

- Very easy to integrate in vehicles
- Only little space required – no changes to your original design necessary
- No additional weight on the primary sensor
- Our technology works reliably even if strong vibrations occur
- Very precise measurement results even over long periods of time
- On demand/depending on requirements: With integrated temperature and speed sensor
- Our sensors work even at extreme temperatures (-40 °C to 120 °C)
- Supplied with IP67 protection if required

Environmental protection and savings in the companies

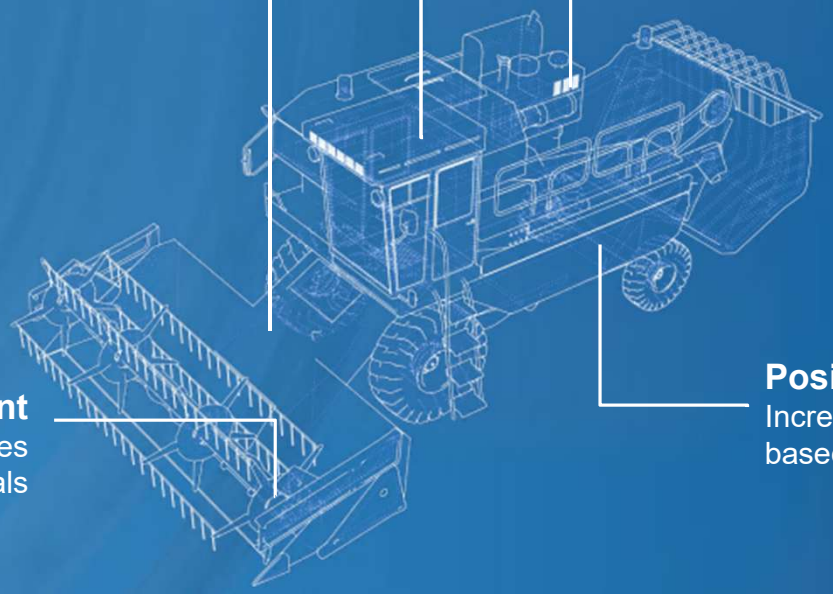
A look at agriculture

In line with the UN Sustainable Development Goal for clean water, we reduce the over-fertilisation and pollution of water bodies by offering sensors for agricultural machinery that are designed for the harshest environmental conditions.

AGRICULTURE

Torque measurement ensures optimal material flow
Guarantee of optimum material flow

Monitoring belt lift
Monitoring and optimization of the real-time



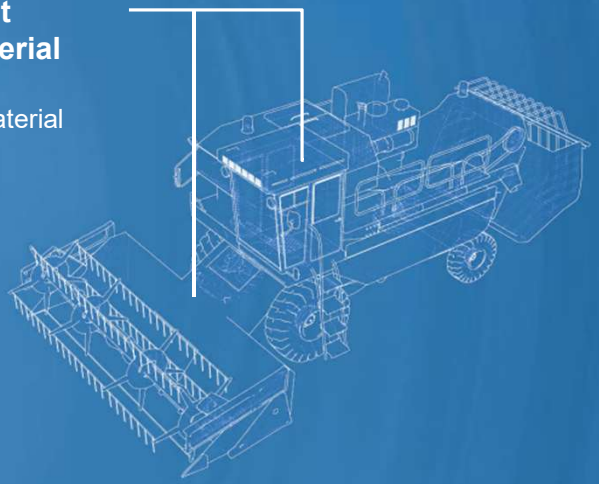
Torque and angle measurement
Protects against damage and guarantees optimum maintenance intervals

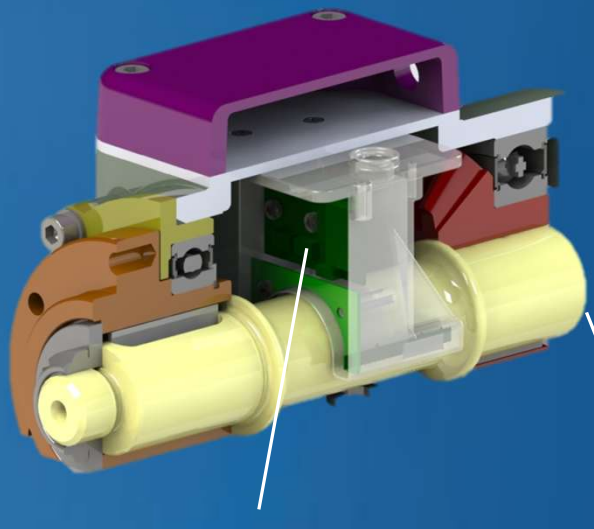
Position measurement steering
Increased driving comfort due to torque-based steering assistance

AGRICULTURE

Torque measurement ensures optimal material flow

Guarantee of optimum material flow





Sensor Daten	
Measurement range:	+/- 150Nm
IP Protection:	IP67
Accuracy:	0,5%

AGRICULTURE

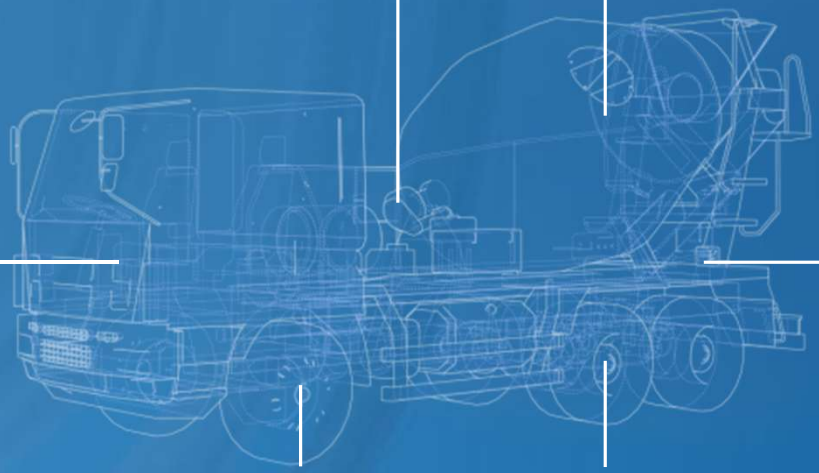
The advantages of our sensors for agriculture at a glance

- Our sensors require fewer space - and are therefore easy to integrate
- Non-contact and wear-free measuring system
- Long life and high operational safety
- Direct measurement on the shaft, no telemetry or slip ring required
- Resistant to strong vibrations and insensitive to dust, oil, water and harvest juice
- Further increased efficiency for your vehicles
- Continuous monitoring and thus improved protection against failures and overloads

OFF-HIGHWAY

Monitoring of power consumption body
Monitoring and optimization of the real-time

Torque and angle measurment for quality determination mixed material
Quality determination of the mix for just-in-time further processing



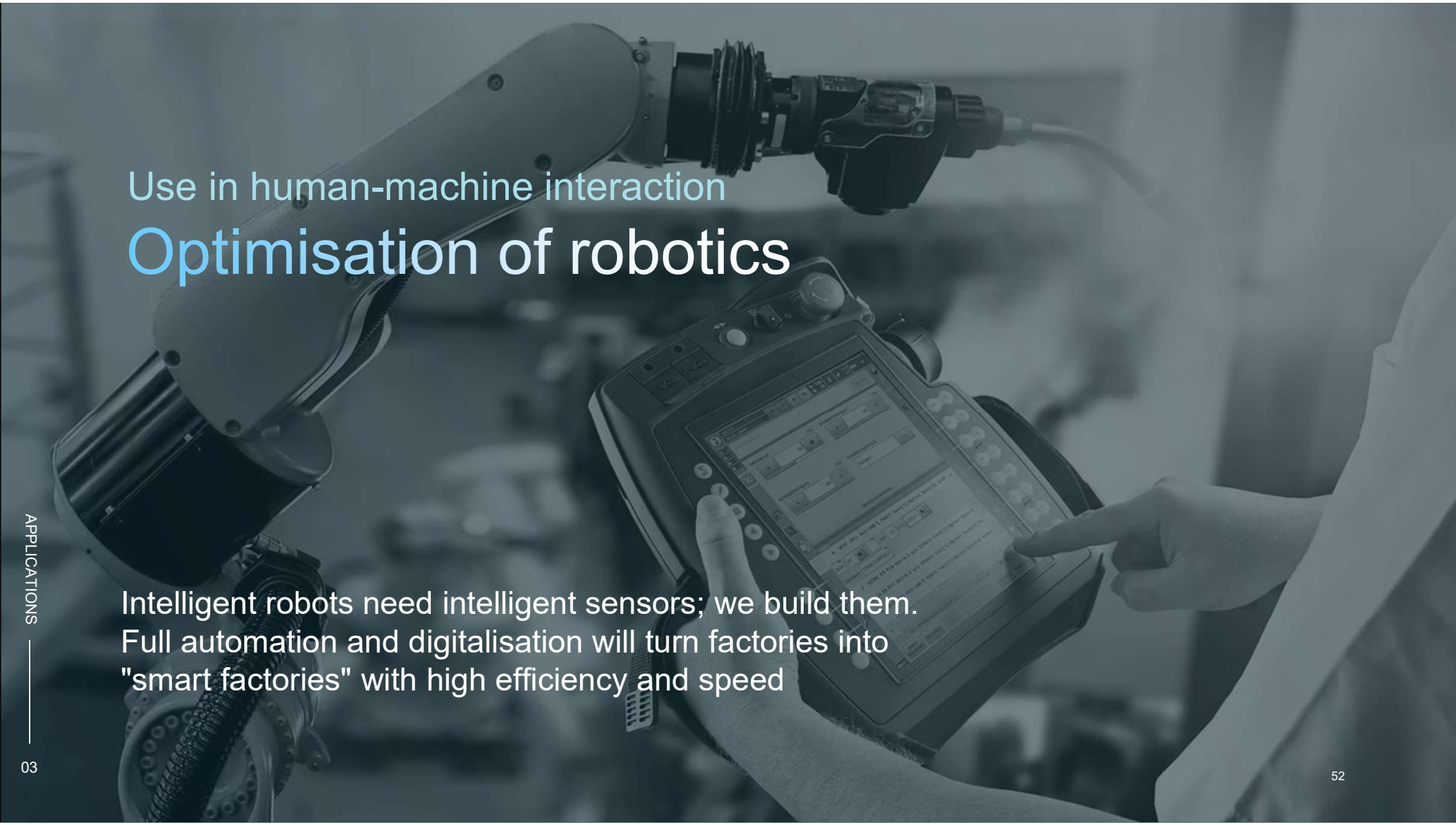
Torque and position measurement
Increased driving comfort through torque-based steering support

Length/Position measurement force support
To support the forces

Force and angle measurement on the powertrain or drice shaft
Monitoring and optimization of the drive setup in real time

The advantages of our sensors for off-highway machines at a glance

- Very easy to integrate also as retrofit
- Non-contact and wear-free measurement
- Very robust and insensitive to dirt, oil, water and extreme temperatures
- Works independently from speed
- Higher efficiency and better overload protection/li>
- Fewer machine failures



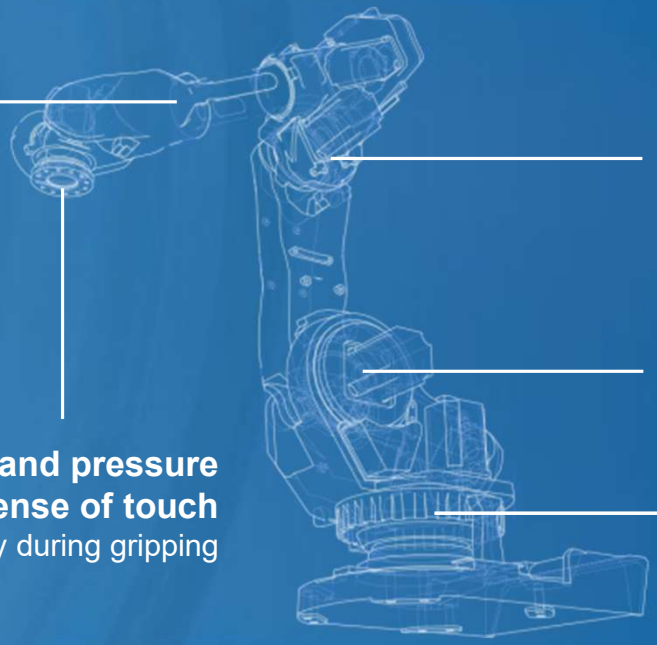
Use in human-machine interaction

Optimisation of robotics

Intelligent robots need intelligent sensors; we build them.
Full automation and digitalisation will turn factories into
"smart factories" with high efficiency and speed

ROBOTIC

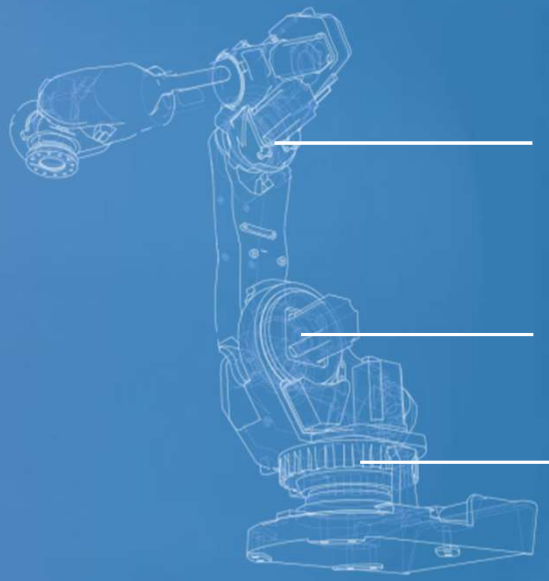
Length measurement for position determination on extendable components
Support in "teaching" the robot



Torque and Angle measurement for the human-machine interaction
Safety mechanism for braking or stopping on contact of human with robot arm

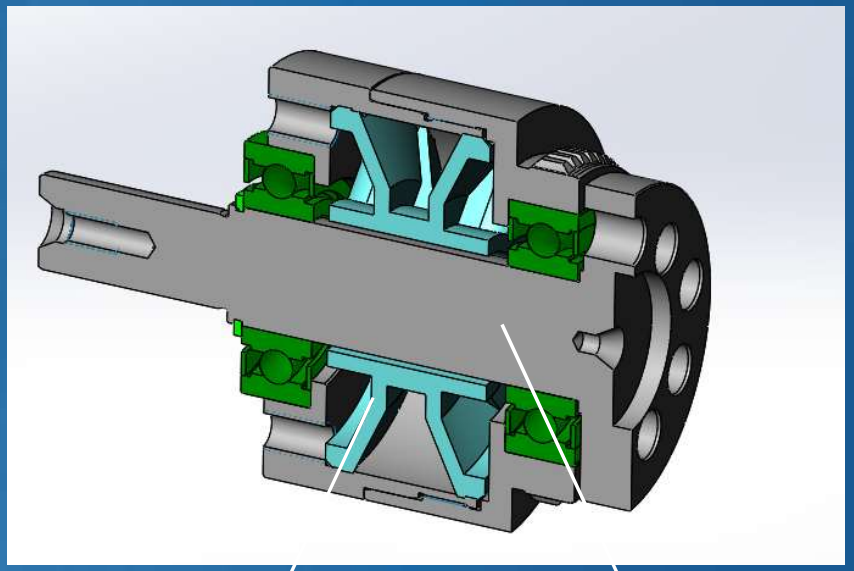
Force measurement and pressure measurement enable a sense of touch
Support of fine sensor technology during gripping

ROBOTIC



Torque and Angle measurement for the human-machine interaction
Safety mechanism for braking or stopping on contact of human with robot arm

Sensor	
Measuring range:	±70 Nm
Protection:	Against grease
Compact Design:	23 mm axial length



The advantages of our sensors for robotic machinery at a glance

- Easy to integrate into robot gears
- Very fast response
- Dynamic measurement of shear, bending and torque in real time
- Short system runtimes
- Higher efficiency of your robots possible
- Non-contact measurement; maintenance-free sensors
- Insensitive to vibrations

TEST BENCHES
STANDARD SENSORS

Wide range of sensor solutions for test benches,
End of Line testing and agriculture testing (series 7000)

Models covering torque range from
2.5 Nm to 15000 Nm (above on request)

ADVANTAGES

- Plug & play
- Great Precision
- Fast Delivery

OVERVIEW
STANDARD SENSORS

Sensor	Name	Nominal torque	Rotational speed	Accuracy
	Serie 2000	2.5 – 500	≤ 5000	≤ ± 1%
	Serie 2300	1 – 100	≤ 10,000	≤ ± 0.5%
	Serie 3000	50 – 2000	≤ 10,000	≤ ± 0.2%
	Serie 4000	50 – 1000	≤ 10,000	≤ ± 0.1%
	Serie 5000	10,000 – 25,000	≤ 5000	≤ ± 0.5%
	Serie 7000	3000 – 5000	≤ 3600	≤ ± 0.75%

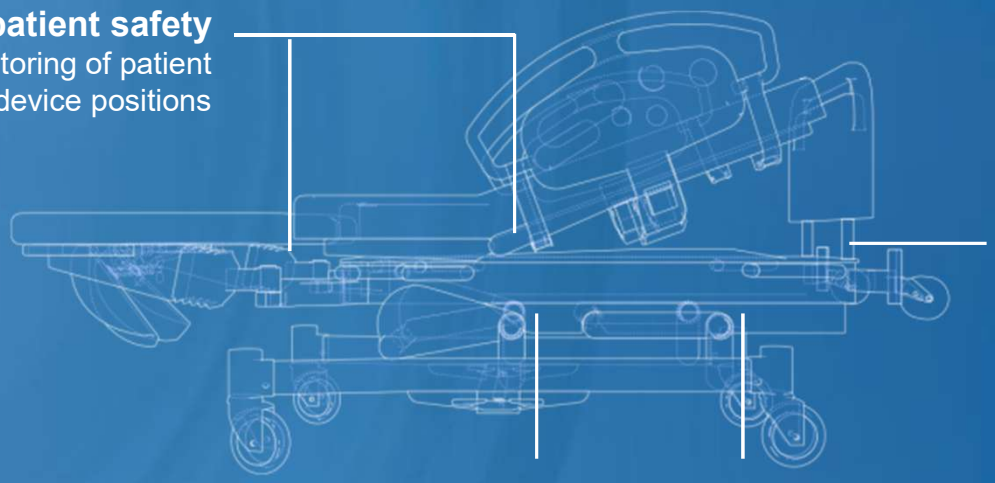
Where safety and routines coexist

Focus on medical technology

We simplify the complexity of medical devices to offer doctors and patients maximum convenience, safety and reliability.

MEDICAL

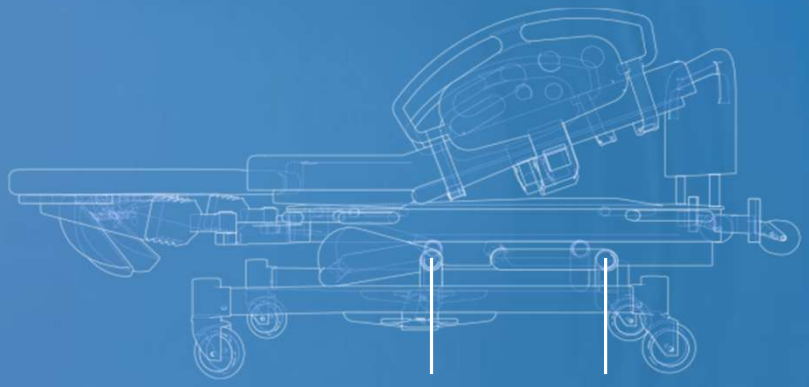
Angle measurement to increase the patient safety
Securing and monitoring of patient and medical device positions



Length and force measurement prevent overload situations
Monitoring the position of medical devices

Angle measurement to increase the patient safety
Securing and monitoring of patient and medical device positions

MEDICAL



Angle measurement to increase the patient safety

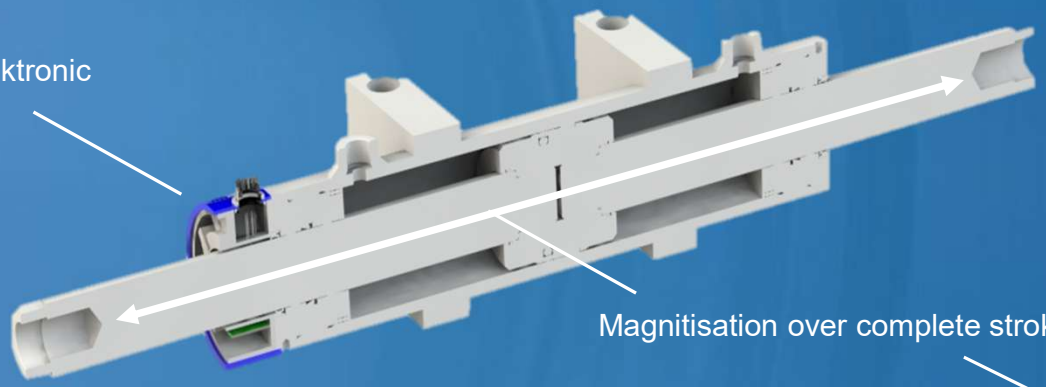
Securing and monitoring of patient and medical device positions

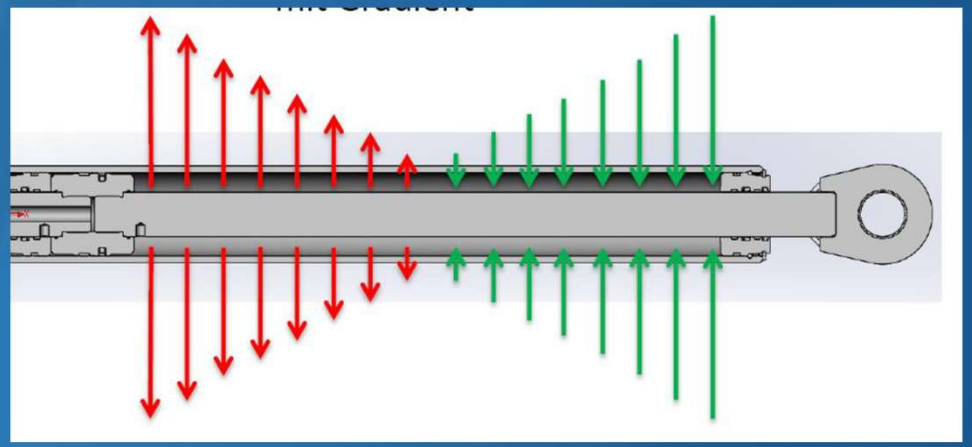
Sensor	
Measuring range:	15.000N
Accuracy:	1%
Protection:	Against germicide

The advantages of our sensors for medical equipment at a glance

- Many years of experience with biomedical technologies and standards
- Easy to integrate into all common cardan systems
- Wide range of applications in medium and large series
- Simple magnetization of existing components
- Very precise and reliable measurements
- Stable even at extreme temperatures and vibrations
- Insensitive to chemicals, disinfection and ageing
- Enclosure according to protection class IP67

ABSOLUTE POSITION MEASURING





Sensor Daten	
Performance Level:	D nach DIN EN ISO 13849-1
Accuracy:	≤ ± 1 % over complete stroke
Protection Class:	IP 67

ABSOLUTE POSITION MEASURING

The advantages of our position measuring for several applications at a glance

- Absolut position measurment
- Design of the cylinder and piston rod can be kept
- Position measuring for synchronous cylinder is feasible
- Non-contact measurement - ideal against vibration
- Sensor can be completely encapsulated to make it resistant against dust and oil (IP67)
- Several diameter and length of piston rods can be equipped

Thank you for your attention!

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