FTE automotive

FTE automotive – Innovation drives

DISPLACEMENT AND POSITION SENSORS

Systems Competence for Cars and Commercial Vehicles

Sensor Technology for Intelligent Mobility

INNOVATIVE, HIGH-PERFORMANCE, COST-EFFECTIVE

Increase Your Success – with a Long List of Benefits:

- **A one-stop shop that meets all of your development and engineering needs.**
  All solutions from one source, from housings across signal processing to sizing of magnetic systems.
- **Lean production and logistical processes, thanks to seamless vertical integration.**
  Specialized departments for all steps of production, from prototyping to series manufacture.
- **Cost-effective final assembly and installation.** Process-related requirements taken into account from the start.
- **Forward-looking technology that propels our customers forward.** Hardware and software competence from one source.
- **Highly satisfied customers.** Verifiably top standards of quality and safety: ASIL Levels A to C according to ISO 26262.
- **Proven millions of times over.** Reliable and non-wearing throughout a vehicle's service life.

Drawing on more than 15 years of experience with contactless sensors integrated in the hydraulic cylinders of clutch, brake, and transmission systems, FTE automotive is a major force driving advances in safety, comfort, and driving enjoyment. Our developers and engineers consistently strive to anticipate tomorrow's trends and meet them with new innovations. Around the world, our technologies continue to raise the bar for accuracy, reliability, and space-saving designs that couple technical perfection with maximum cost-effectiveness. It's no accident that the automotive industry consistently relies on our components to help meet major present and future requirements. We're committed to giving our customers a competitive edge with our displacement and position sensors and other products. We meet the challenges posed by rising costs, stricter environmental standards, and the need for ever-greater performance and production efficiency by constantly improving the quality of our products and expanding our system competence.

Products

Committed to innovation. We're constantly optimizing our sensors: their accuracy and lifetime, and also the materials used to make them. Based on the results of constant research, we mainly produce them with ferrite magnets to minimize the need for special materials such as neodymium and samarium. Our state-of-the-art design and production methods also let our customers benefit from highly integrated ASIC electronics.

Processes

Driving efficiency with system logistics. With 11 production plants on four continents, FTE automotive is close to the automotive industry's major centers. This proximity allows our specialists to respond proactively to new logistical developments.

Partnership

Advancing as a team. FTE automotive collaborates closely with vehicle manufacturers to develop and enhance products and processes. By defining goals together, we make sure that our innovations strengthen our customers' competitiveness.

Sensors from FTE automotive

LONG-LIFE AND ACCURATE

The Vehicle of the Future Is Intelligent

Electronic control systems and components are playing a key role in designing tomorrow's vehicles. Faster and smaller microchips, more accurate processing of larger data volumes, and especially advances in artificial intelligence are enabling vehicle producers to make giant strides in improving their models.

A Revolution in Drives, Clutches, and Brakes

Intelligent electronics have been essential for getting groundbreaking innovations ready for mass production. There are good examples of this in the field of drive technology, including dual-clutch transmissions and hybrid drives, which were developed in response to calls by consumers, policymakers, and associations for significantly improved fuel efficiency. But also in conventional clutch systems and automatic transmissions, electronic control components continue to play key roles in synchronizing the driver and vehicle while using energy more efficiently. Brake systems are yet another application in which electronic systems ensure greater speed and precision – and thus also greater safety – than humans could do by themselves. Intelligent technology is a must for achieving greater driving comfort and safety on the road, in addition to the very important aspects of enhancing energy efficiency and environmental friendliness.

Sensors: the Crucial Link in the Chain

In order to do their jobs, control systems and components require a steady stream of reliable data from highly functional and accurate displacement and position sensors. Absolutely accurate, reliable measurement technology is essential for letting intelligent control systems respond in the most appropriate way in a given driving situation, also to prevent harm to vehicle occupants. Sensors are the critical first link in the high-tech chain of an electronic control system. Which is why a vehicle's market success depends in such large measure on meeting very high standards of quality, lifetime, and servicing ease.

Technological Challenges

Incorrect measurements by a sensor, data transmission gaps, or a system failure would instantly prevent an electronic control system from functioning properly. It's therefore crucial to reliably prevent scenarios of this kind throughout the service life of a car or commercial vehicle, ensuring that it still runs well and safely even after many years of use and thus also preventing harm to drivers and passengers. Achieving this longevity poses special challenges, because sensors are exposed to extreme stresses in the form of heat, vibrations, jolts, or pressure. In addition, the total number of components is increasing as intelligent vehicles continue to evolve. Manufacturers therefore depend on compact, volume-reducing designs that also permit cost-effective, fast, easy assembly.

FTE automotive's Answers

Sensors from FTE automotive are installed directly on or inside hydraulic cylinders. This approach permits contactless capture of measurement data and prevents wear. It also makes sensors extremely temperature-resistant. Thanks to reliable, precise designs and extremely fast response times, even highly dynamic processes can be tightly controlled with it. FTE automotive uses coilless sensors in clutch systems, transmissions, and brakes. FTE sensors are designed to be as compact as possible, which makes them ideal when space is limited.

Product Benefits

- Extremely good lifetime and accuracy
- Maximum cost-effectiveness
- Exceedingly compact
- Improved carbon footprints

Clutch Applications

DISPLACEMENT SENSORS ON CLUTCH MASTER CYLINDERS

Intelligent control electronics react much faster and more precisely to changing requirements while driving than a human operator could. Because of this, in recent years the automotive industry has perfected and begun mass-producing a rapidly growing number of innovations for clutch control. Owing to the direct link between engine power transmission and fuel consumption, intelligent technologies – including sensors from FTE – are also greatly contributing to protecting the environment.

The Challenge

To make power transmission more efficient and precise, an increasing number of tasks are being shifted from the driver to electronic control systems. At the same time, new intelligent units are being developed to autonomously perform complex functions such as automatically stopping and then restarting the engine when a vehicle halts at a traffic light. This wave of innovations has greatly increased safety and comfort while slashing emissions. It has also caused an explosion in the number of electronic components used. As a result, sensors have to fit into less and less space while still ensuring maximum reliability and accuracy.

The Solution

To minimize space requirements, FTE automotive's sensors are directly integrated in the clutch master cylinder. The sensors don't contain any coils, so they are extremely compact. Sensors from FTE automotive contactlessly capture the travel and position of the clutch mechanism. The sensor's proximity to the clutch yields considerably more accurate measurements.

Product Applications

Automatic Start/Stop

When the vehicle stops, for example at a traffic light, sensors tell the control system that no drive power is needed. It then automatically switches the engine off.

Start-Lock Function

The clutch pedal must be fully depressed or the engine won't start smoothly. Sensors tell the control system whether this is the case.

Cruise Control

Sensors on the clutch master cylinder make sure that cruise control is switched off the moment the clutch pedal is depressed.

Electronic Parking Brake

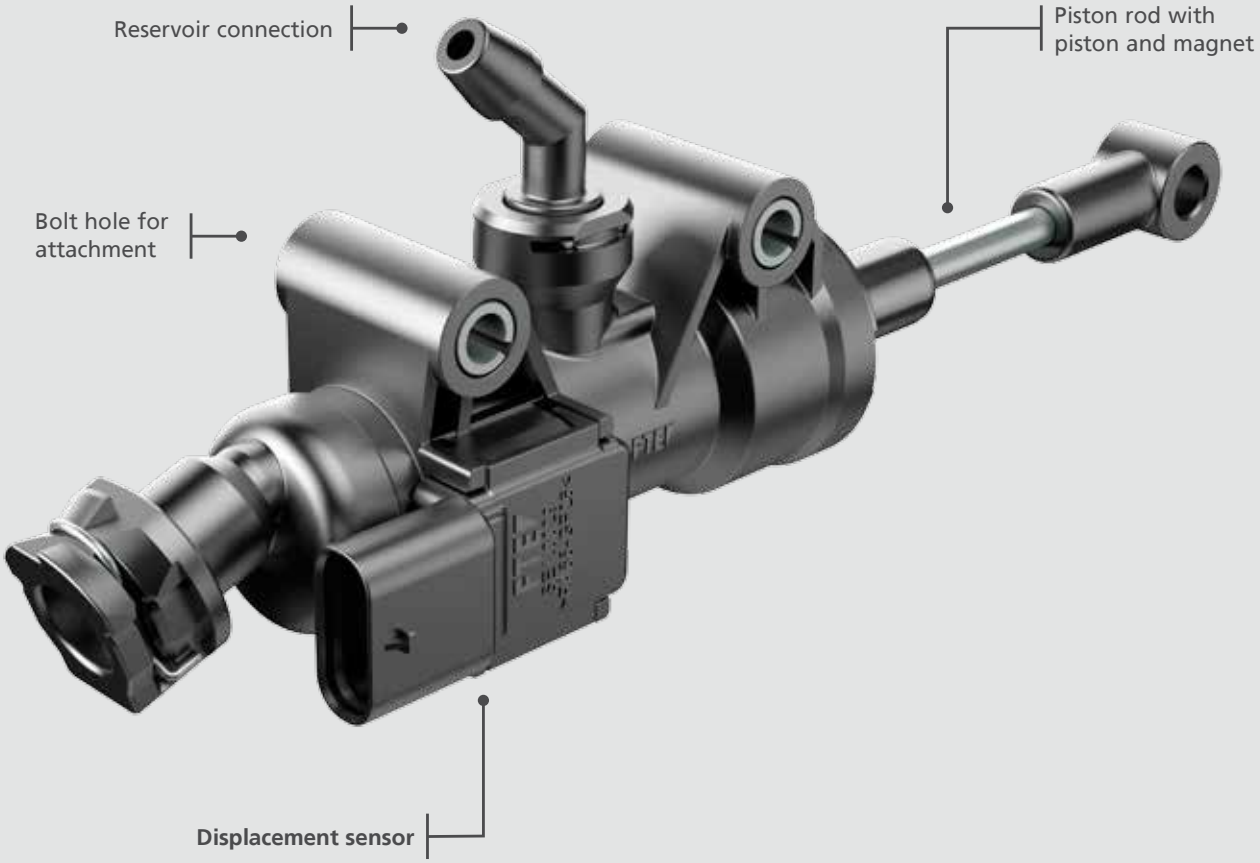
When a vehicle halts on a slope, the electronic parking brake makes it easier to begin moving forward again by releasing in steps. Highly accurate sensor measurements are needed to synchronize the brake and clutch system.

Engine Management

Fuel consumption and emissions are reduced further by appropriately adjusting the air-fuel mixture when the clutch is released. The sooner a sensor notices that the drive train has been disengaged, the faster this can be done. FTE automotive therefore also integrates these sensors into the clutch.

Clutch master cylinder

Clutch master cylinder



Displacement Sensor Technical Data

Measuring range:	up to 37 mm
Sensor technology:	Hall effect
Non-linearity:	1 %
Resolution:	12 bit
System accuracy:	±2 % sensors and mechanical parts
Repetitive accuracy:	< 50 µm
Operating temperature range:	–40 °C to +125 °C; briefly up to 150 °C
Protection ratings:	sealed tight against dust and use of high-pressure cleaners in compliance with IP6K7K and IP6K9K
Current drain:	typ. 10 mA per output
Supply voltages:	5 V from controller 12 V from on-board power supply

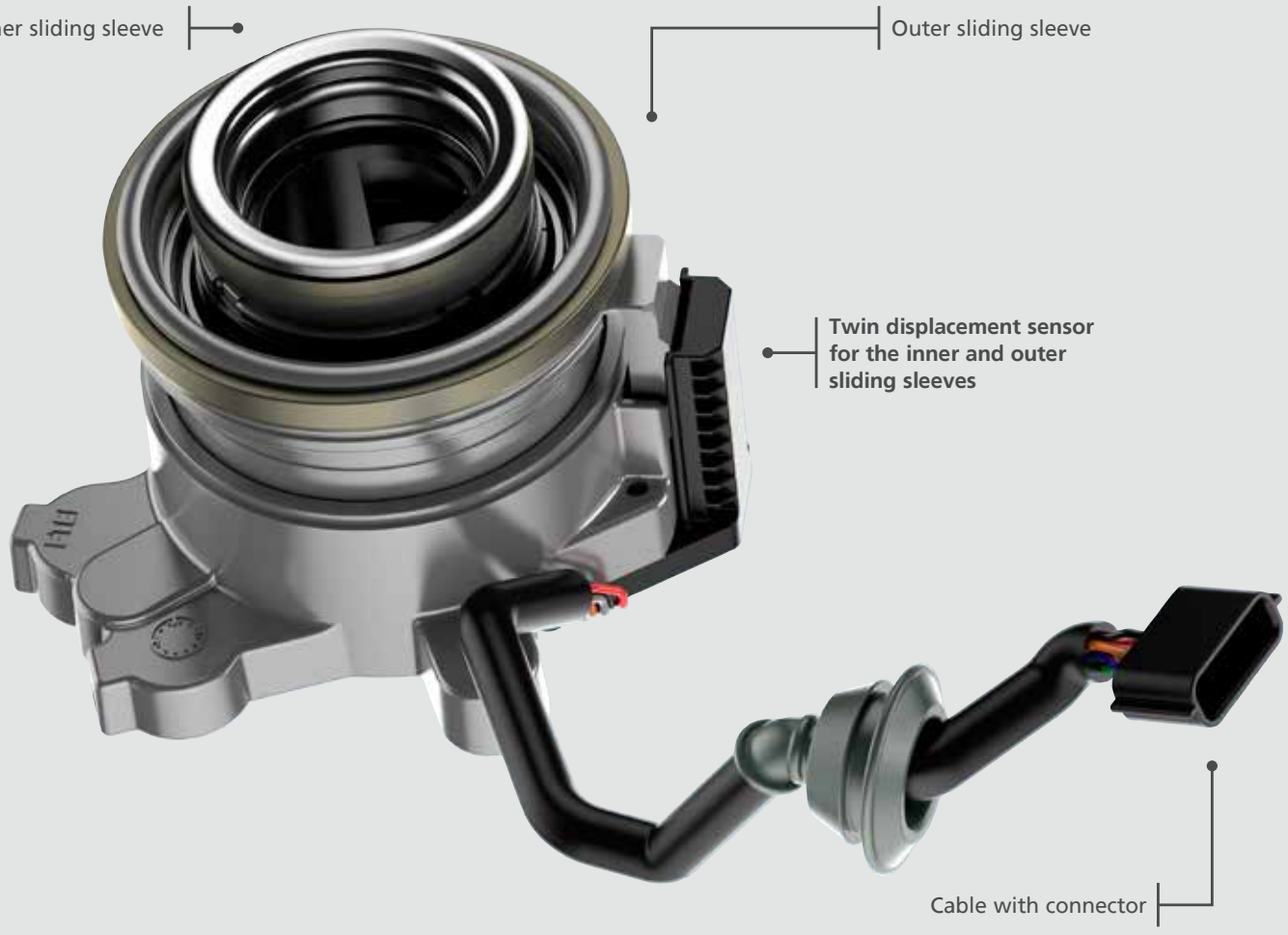
Signal outputs:	
Analog voltage:	0.5 to 4.5 V ratiometric
Single PWM:	e.g. 10 % to 90 % DC (Duty Cycle)
Dual PWM:	e.g. 20 % to 80 % DC and 10 % to 40 % DC
Digital protocol:	SENT protocol
Switching points:	high/low levels as high-side/low-side switches

DISPLACEMENT SENSORS ON CLUTCH SLAVE CYLINDERS, CONCENTRIC SLAVE CYLINDERS, AND DUAL CONCENTRIC SLAVE CYLINDERS

Dual-clutch transmissions, which were first manufactured on a large scale about a decade ago under the name of direct-shift gearboxes, have solved the issues around interrupting the power in manual transmissions. This invention drove a quantum leap forward in the efficiency of drive transmissions.

Dual-clutch transmissions use two separate clutches, each of which opens when the other closes. They have to be very precisely synchronized, and the electronic controller relies on very accurate measurement data to ensure this.

Dual concentric slave cylinder



The Challenge

In order for the transmission's controller to precisely synchronize the two clutches, it's essential to constantly and accurately determine the actual positions of both. And the sensors used must reliably perform this task throughout a vehicle's service life, despite being subjected to extreme temperature fluctuations and mechanical stresses. To prevent a dual-clutch transmission from increasing the vehicle's weight and volume, they must also be designed for compactness and seamlessly integrated into the clutch mechanisms.

The Solution

For dual-clutch transmissions, FTE automotive uses two 3D hall-effect sensors that detect the displacement of the concentric slave cylinders with the required extremely high accuracy. The magnet and sensor housing are both incorporated into the contours of each dual concentric slave cylinder. The sensors therefore take up a minimum of space. Each one is connected to the controller via a flexible, high-temperature-resistant cable terminating in a connector. This robust, reliable connection method offered by FTE automotive permits fast, straightforward assembly and eliminates the need for any additional signal processing electronics outside the transmission.

Displacement Sensor Technical Data

Measuring ranges:	typ. 26 mm concentric slave cylinders typ. 26 mm dual concentric slave cylinders up to 95 mm slave clutch cylinders
Sensor technology:	Hall effect
Non-linearity:	1 %
Resolution:	12 bit
System accuracy:	±1.5 % (sensors and mechanical parts)
Repetitive accuracy:	< 50 µm
Operating temperature range:	–40 °C to +160 °C; briefly up to 180 °C
Protection ratings:	sealed tight against dust and use of high-pressure cleaners in compliance with IP 6K7K and IP 6K9K
Current drain:	typ. 10 mA per output
Supply voltages:	5 V from controller 12 V from on-board power supply

Signal outputs:

Analog voltage:	0.5 to 4.5 V ratiometric
Single PWM:	e.g. 10 % to 90 % DC (Duty Cycle)
Dual PWM:	e.g. 20 % to 80 % DC and 10 % to 40 % DC
Digital protocol:	SENT protocol

Manual and Automatic Gear Shifting Applications

DISPLACEMENT AND GEAR SPEED SENSORS IN TRANSMISSIONS

In terms of mechanical function and materials, classic transmission technology has matured so far that hardly any room is left for groundbreaking innovations anymore. But advances in electronics are opening up many new opportunities to meet consumers' growing demands for comfortable and smooth gear shifting. Intelligent control units will keep assuming more of the tasks originally performed by the driver and setting new standards of accuracy and performance in manual, semiautomatic, and fully automatic transmissions.

The Challenge

The persistent trend from manual to semiautomatic and fully automatic transmissions is creating a need for significantly better ways to capture measurement data. Electronic controllers depend on accurate data to do their jobs properly. And sensors must supply this data by doing more – and doing it with ever-greater accuracy and reliability. Particularly in automatic transmissions, they are also challenged by being installed in places that are subjected to advanced but more aggressive motor oils. Finally, it's necessary to design slimmer sensors as control electronics take up more of the available space.

The Solution

Innovations in sensor technology for manual, semiautomatic, and fully automatic transmissions are a focus of FTE automotive's development work. Based on the results of ongoing, forward-looking research, our specialists can offer solutions that are always a step ahead of the steadily increasing requirements. Being directly integrated, sensors from FTE automotive are particularly wear-resistant. They also take up only minimal space. In addition, vehicle manufacturers can take advantage of the option of documenting the first-class quality and reliability of these sensors according to ASIL Levels A to C of ISO 26262.

Wheel Speed Sensor

Technical Data

Measuring range:	up to 10,000 rpm
Sensor technology:	Hall effect
Accuracy:	±2 %
Operating temperature range:	–40 °C to +140 °C; briefly up to 150 °C
Protection ratings:	sealed tight against dust and use of high-pressure cleaners in compliance with IP6K7K and IP6K9K
Signal output:	current interface with information on direction of rotation
Current drain:	< 17 mA
Supply voltages:	5 V from controller 12 V from on-board power supply

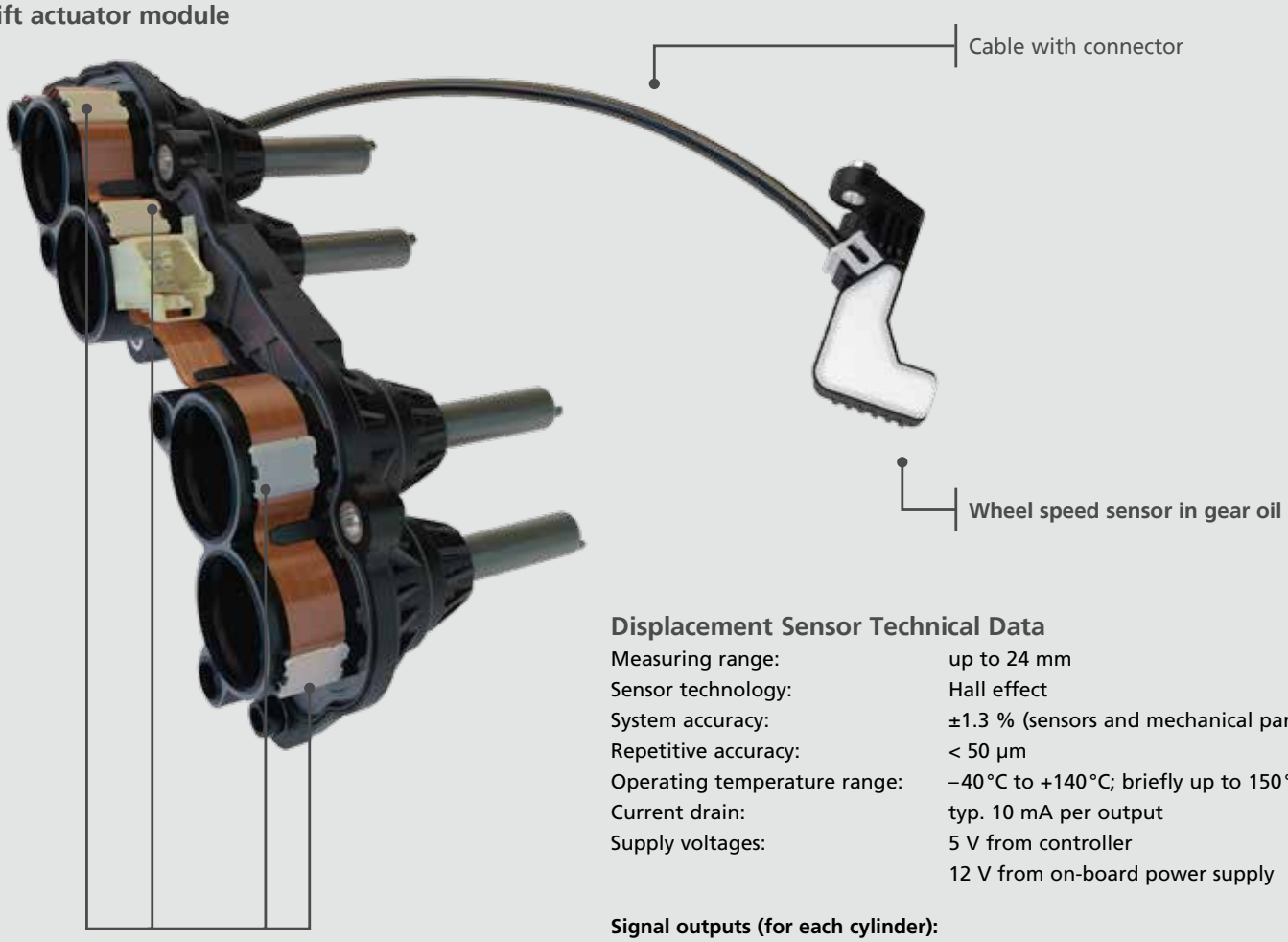
Product Applications

Semiautomatic and Fully Automatic Transmissions

To make sure that gears shift smoothly and at an optimal speed, sensors have to accurately determine both the gear-shifting mechanism's initial position and how fast different parts are rotating inside the gearbox. FTE automotive's customers benefit from our many years of experience and millions of series-produced products.

Automated manual transmission have become the standard for cost-effectively meeting today's greater expectations with regard to driving comfort, fuel efficiency, and low emissions. Since 2006, FTE has been supporting manufacturers with highly efficient, contactless sensors that it develops specifically for these applications. They are the first choice worldwide for identifying the gear shifter's position.

Shift actuator module



Displacement Sensor Technical Data

Measuring range:	up to 24 mm
Sensor technology:	Hall effect
System accuracy:	±1.3 % (sensors and mechanical parts)
Repetitive accuracy:	< 50 µm
Operating temperature range:	–40 °C to +140 °C; briefly up to 150 °C
Current drain:	typ. 10 mA per output
Supply voltages:	5 V from controller
	12 V from on-board power supply

Signal outputs (for each cylinder):

Analog voltage:	0.5 to 4.5 V ratiometric
Single PWM:	e.g. 10 % bis 90 % DC (Duty Cycle)
Digital protocol:	SENT

Brake Applications

DISPLACEMENT AND POSITION SENSORS ON TANDEM MASTER CYLINDERS

Contemporary brake systems are able to perform a complex range of tasks that go well beyond simply slowing or stopping the vehicle when the driver depresses the brake pedal. For example, thanks to intelligent electronics modern cars and commercial vehicles can recognize a dangerous situation and execute an emergency stop faster than a human could. Another application in which highly accurate sensors play an important role is recovering the kinetic energy of braking (regenerative brakes).

The Challenge

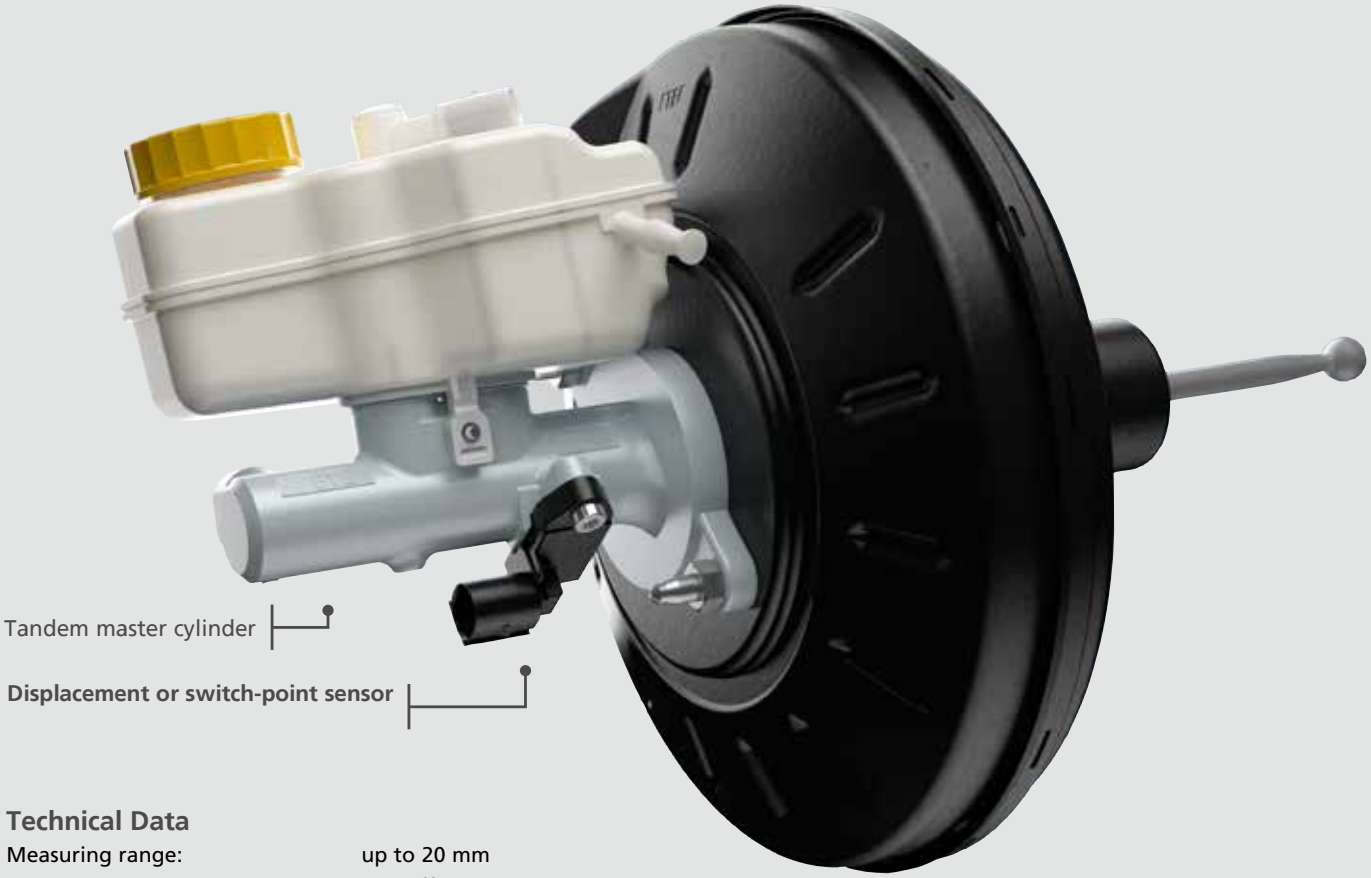
Sensors must provide exactly the right kind of support to controllers that perform a wide range of highly specialized tasks such as emergency brake assistance, turning the brake lights on and off, and recovering braking energy. Because the safety of vehicle occupants depends on fault-free functioning of the sensors, they must be very robust and consistently extremely accurate.

Vehicle manufacturers also have a justified wish for simple, cost-effective assembly. An example of how this can be achieved with conventional brake systems involves getting away from the still-widespread practice of integrating brake light switches in the pedal mechanism. This results in considerable extra work in the assembly line and makes the switches prone to wear. Appropriately designed sensors can avoid this problem.

The Solution

FTE automotive always uses contactless technology in its sensors for both conventional and modern, intelligent brake systems. This prevents wear. The sensors are directly integrated in the tandem master cylinder, which speeds up assembly of both types of brake systems. Sensor systems from FTE automotive feature redundant functions that make them extremely failsafe. They set global standards of reliability and accuracy. By helping to recover braking energy, they actively support the automotive industry in achieving its goal of optimally reconciling environmental protection with driving pleasure.

Braking unit

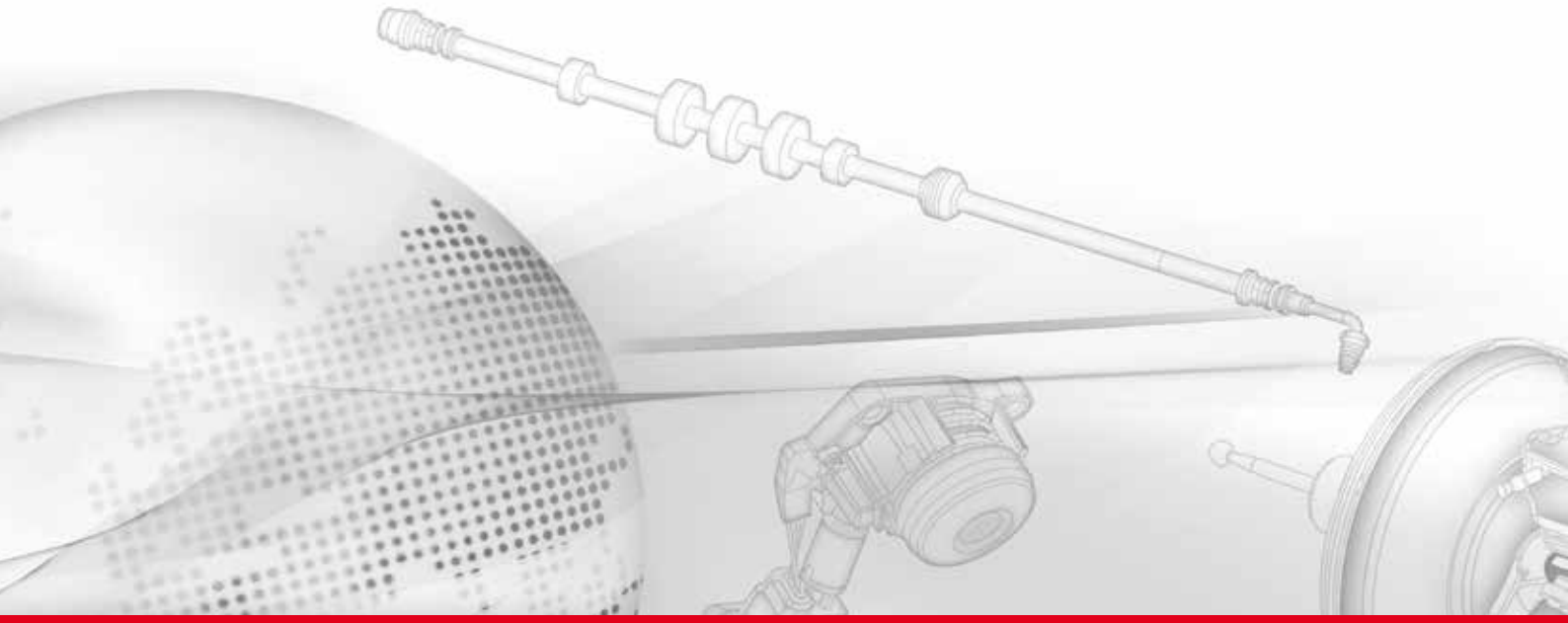


Technical Data

Measuring range:	up to 20 mm
Sensor technology:	Hall effect
Non-linearity:	1 %
Resolution:	12 bit
System accuracy:	±2 %; ±1 mm for switch points (incl. cylinders)
Operating temperature range:	–40 °C to +125 °C; briefly up to 150 °C
Protection ratings:	sealed tight against dust and use of high-pressure cleaners in compliance with IP 6K7K and IP 6K9K
Current drain:	typ. 10 mA per output
Supply voltages:	5 V from controller 12 V from on-board power supply

Signal outputs:

Analog voltage:	0.5 V to 4.5 V ratiometric
Single PWM:	e.g. 10 % to 90 % DC (Duty Cycle)
Dual PWM:	e.g. 20 % to 80 % DC and 10 % to 40 % DC
Digital protocol:	SENT protocol
Switching points:	high/low levels as high-side/low-side switches



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