

Multi Coil Resolver

The Tyco Electronics E-Motor Commutation Sensor Technology

The MCR resolver is measuring the rotor angular position of a synchronous electrical engine, using analysis of magnetical fields. The performance of this smart technology has been recently improved by a Tyco Electronics development.

Automotive industry is progressively moving towards hybrid or electric powertrains, where electrical engines, mainly from synchronous type, are being used. This growing market needs higher performances for these e-machines. One critical point for the engine is to determine accurately the rotor angular position, in order to enable its control and allow phase inversions at the right timing.

The accuracy of this angular position influences the engine efficiency, but also the torque control for optimum driving sensation. Such angle sensors need to be able to work in harsh environments, be accurate, safe and reliable.

The Tyco Electronics MCR strength is to be able to determine the angular position without placing coils on the rotor, this principle is cost effective and reliable. Its basic working principle is a metal part, with a symmetrical shape, which is placed on the rotor, and which acts as the rotating target. The resolver



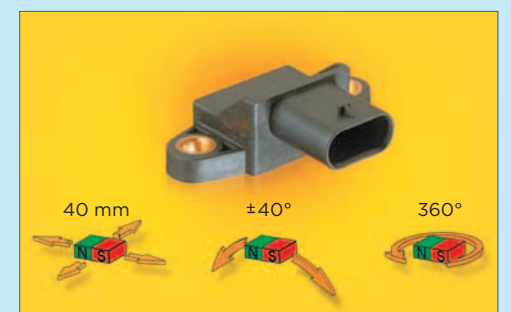
is fixed on the stator (non-moving part), where coils are placed all along the radius. Depending on the angle of the rotor there is a high or low coupling to the Sin- and Cos-windings. The specific combination of windings in series gives a U_{sin} and U_{cos} signal. Out of these two signals the electronics calculates the position angle with the tangent equation.

This principle, which is using Tyco Electronics know-how in terms of winding, magnetics, packaging and assembly, allows us to adapt to the different customer needs. Tyco Electronics resolver design is robust, cost-effective, flexible and can accommodate different sizes and different numbers of electrical engine speeds.

Highlights of this Edition:

Platform Technology (Page 4)

In the automotive industry time to market is a key factor for successful market positioning. The answer of Tyco Electronics for this is a platform product portfolio for non-contact switches, angular- and travel sensors based on Hall or PLCD Technology. These platform sensors are available for our customers within short time and can directly be used within system validation tests. Tyco Electronics supports with this strategy the need of the automotive industry for short time to market, cost effective design / production and low investment.



Transmission Sensor Modules (Page 5)

The increasing amount of sensors within new transmission concepts continuously lead to high integrated sensor modules. The wide product and process portfolio of Tyco Electronics offers an ideal base for the development and production of such robust and reliable sensor modules.



CVI Sensors (Page 7)

The Commercial Vehicle Industry (CVI) is constantly evolving due to current and future emission regulations. Stringent emission regulations increase the need for capable sensor systems in various applications. Many of these applications require reliable and robust non-contact sensor technologies to fulfil the high demand that are typical for trucks, busses, tractors and agricultural machines.



AUTOMOTIVE SENSORS MANUFACTURING & ENGINEERING LOCATIONS



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Product News

Clutch Position Sensor

Application:
Concentric Slave Cylinder (CSC)

Function:
Measuring clutch position

Technology:
PLCD (moving magnet)

Features:
• Oil sealed pigtail interface



Transmission Drive Mode Sensor

Application:
Automatic Transmission

Function:
Measuring drive mode position
(P-R-N-D-L)

Technology:
Hall (moving magnet)

Features:
• New digital output interface (PWM)
• Inside transmission (150°C, oil, vibrations...)



Clutch Position Sensor

Application:
Clutch Master Cylinder

Function:
Measuring clutch position (EPB control)

Technology:
Hall (moving magnet)

Features:
• Up to 34 mm cylinder stroke



Transmission Neutral Position Sensor

Application:
Automated Manual Transmission

Function: Measuring piston position of
Clutch Slave Cylinder

Technology: Active PLCD (moving magnet)

Features:
• Non-contact travel measurement
through cylinder wall
• Small magnet design



Clutch Position Sensor

Application:
Clutch Sensor for CSC Truck

Function:
Measuring position of pneumatic CSC
in truck application

Technology:
PLCD (moving magnet)

Features:
• Travel measurement of 44 mm
• Highly robust design acc. truck specification



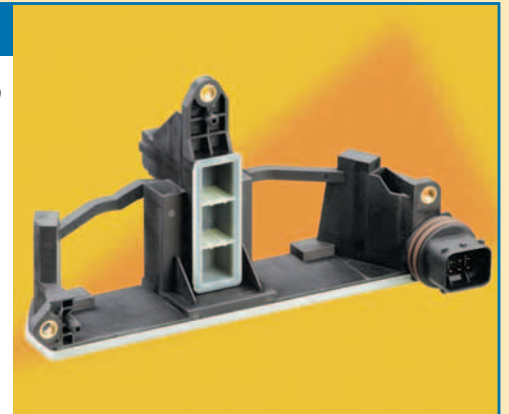
Integrated Sensor Module

Application: Dual Clutch Transmission (DCT)

Function: Measuring 4 x shift fork position,
2 x gear wheel speeds and temperature

Technology:
PLCD and Hall (moving magnets)

Features:
• All sensor functionalities integrated in one
housing with main connector interface
• Inside transmission, robust against high
temperature, oil and vibration



Clutch Position Sensor

Application:
Automated Manual Transmission (AMT)

Function: Measuring piston position
of Clutch Slave Cylinder

Technology:
Active PLCD (moving magnet)

Features:
• Non-contact travel measurement
through cylinder wall
• Small magnet design



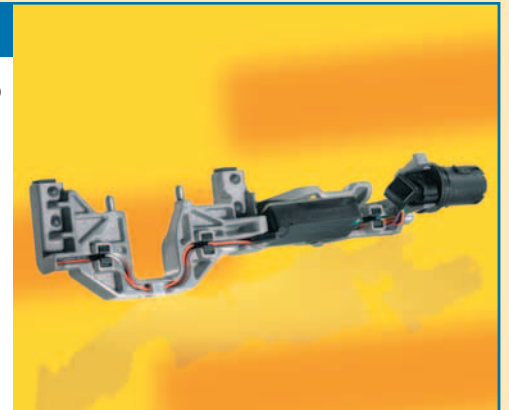
Integrated Sensor Module

Application: Dual Clutch Transmission (DCT)

Function: Measuring different gear wheel
speeds, drive mode and parking lock

Technology: PLCD & Hall (moving magnets)

Features:
• Full redundant drive mode sensor
• New connector system with sealing
between ATF & MTF environmental
• Inside transmission, high temperature
and vibration resistance



Dual Clutch Position Sensor

Application:
Dual Clutch Transmission (DCT)

Function:
Measuring piston position of clutch
actuator

Technology:
Active PLCD (moving magnet)

Features:
• Two sensors in one housing
• Small and robust design



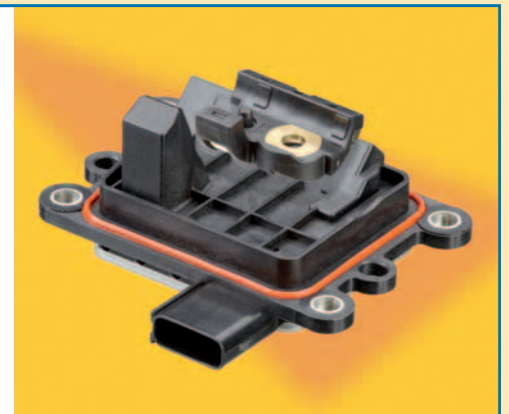
Gear Shift Sensor

Application:
Gear Shift Position Sensor for Manual
Transmission

Function: Dynamic measuring shift lever
movement for MT sport

Technology: PLCD (moving magnet)

Features:
• Dual sensor module for travel and angle
• 25 mm travel, 35° angle measurement



Tailgate Sensor

Application:
Tailgate

Function:
Measuring tailgate position

Technology:
Hall (magnet integrated in sensor)

Features:
• Diagnostic interface
• Small geometry



Gear and Shift Sensor

Application:
Automated Manual Transmission (AMT)

Function:
Measuring gear and shift position

Technology:
Active PLCD (moving magnet)

Features:
• Non-contact rotary and travel
measurement integrated in one housing
• Robust design



Product News

Exhaust Gas Recirculation (EGR) Position Sensor

Application:
EGR Sensor for Truck Industry

Function:
Measuring position of pneumatic EGR

Technology:
PLCD (moving magnet), Hall

- Features:**
- Travel measurement of 36 mm
 - Fulfil durability requirements in truck applications



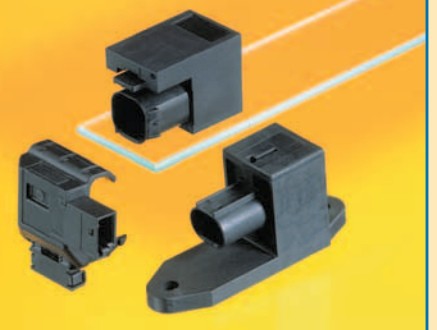
Seat Position Sensor

Application:
Dual Staged Airbag

Function:
Measuring seat track position

Technology:
Hall (magnet integrated sensor)

- Features:**
- No moving magnet
 - Small geometry



Turbo Charger Position Sensor

Application:
Turbo Charger with Variable Turbine Geometry (VTG)

Function: Measuring linear position of VTG mechanism

Technology: PLCD, Hall (moving magnet)

- Features:**
- Sensor integrated into actuator cover
 - Full contactless measuring principle
 - Programmable at customer EOL



Seat Position Sensor

Application: Seat Track Position Sensor

Function: Provide forward seat position information to the airbag control module

Technology: Hall (integrated magnet)

- Features:**
- Larger air gap capability to accommodate multiple seat track designs
 - Small packaging size
 - Snap-on attachment design without additional fasteners
 - Sealed connector interface



Resolver

Application:
E-Motor for Electrical and Hybrid vehicles

Function:
Measuring rotor position of E-Motor

Technology: MCR (Multi Coil Resolver)

- Features:**
- Sensor and electrical motor interface integrated in actuator cover
 - Non-contact measurement
 - Highly robust design



Seat Weight Sensor

Application: Advanced Airbag

Function: Measuring occupant's weight and classify adult or child

Technology: Strainage type weight sensor

- Features:**
- Meets FMVSS 208 regulations (Occupant Crash Protection)
 - Competitive 2 sensors type
 - High accuracy measurement with temperature compensation
 - CAN interface with ACU



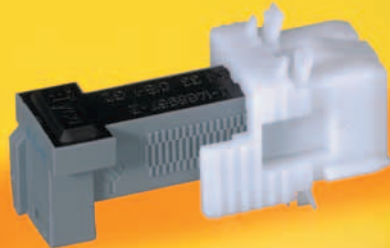
Brake Light Switch

Application: Pedal Box

Function: Measuring brake pedal position

Technology:
Hall switch (magnet integrated in sensor)

- Features:**
- Easy adjustment to brake pedal
 - High switching point accuracy
 - No wear and tear



Steering Wheel Sensor

Application:
Steering Wheel Detection for Attention Assistant

Function:
Measuring steering wheel angle

Technology:
3D-Hall (moving magnet)

- Features:**
- High resolution
 - Small geometry



Redundant Brake Pedal Position Sensor

Application:
Advanced Brake Systems (i.e. recuperation for hybrid cars)

Function:
Measuring pedal position at brake master Cylinder or pedal simulator

Technology: PLCD (moving magnet)

- Features:**
- Full redundant mode
 - 40 mm travel measurement



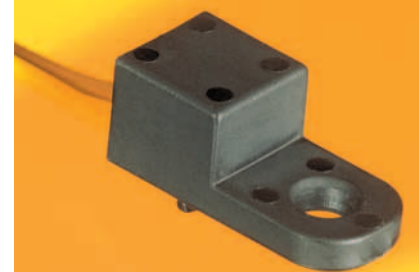
Hall Switch

Application:
Diverse, i.e. convertible roof systems

Function:
End position detection of kinematics

Technology:
Hall (magnet integrated in sensor)

- Features:**
- Programmable interface
 - Small geometry



Wheel Speed Sensor

Application:
Brake Control (i.e. ABS)

Function:
Wheel speed detection

Technology:
Hall

- Features:**
- Highly robust design
 - Optional header or pigtail interface



Engine Compartment Hall Switch

Application:
Brake Disc Cooling

Function:
Measuring end position of air shutter

Technology:
Hall (magnet integrated in sensor)

- Features:**
- Non-moving magnet
 - Highly robust design for engine compartment



SENSORS PLATFORM

Travel

PLCD Travel Sensors

Application:
Transmission, Chassis, Engine, Clutch, Brake, Steering

Function: Measuring travel position

Technology: Active PLCD (moving magnet)

- Features:**
- Meas. range: 5 - 53 mm or angle up to 120°
 - Highly insensitive to vibration
 - Temperature up to 150°C
 - Redundancy possible
 - Analog or PWM interface
 - Supply 5 V (optional 12/24 V)
 - 4-way MQS sealed
 - wide range of magnet design



Hall Sensor T40MC1

Application:
Engine, Transmission, Clutch, Chassis

Function: Measuring travel position

Technology: Hall (moving magnet)

- Features:**
- Non-contact measurement up to 40 mm
 - Highly insensitive to vibration
 - Temperature up to 150°C
 - Analog or PWM interface
 - Small geometry
 - Optional redundancy
 - Supply 5 V (optional 12/24 V)
 - 3-way MCON connector interface



Rotary

PLCD Rotary Sensors

Application:
Transmission, Chassis, Engine, Clutch, Brake, Steering

Function: Measuring angle position

Technology: Active PLCD (moving magnet)

- Features:**
- Meas. range: 5 - 53 mm or angle up to 120°
 - Highly insensitive to vibration
 - Temperature up to 150°C
 - Redundancy possible
 - Analog or PWM interface
 - Supply 5 V (optional 12/24 V)
 - 4-way MQS sealed
 - wide range of magnet design



Hall Sensor R360MC1

Application:
Transmission, Engine, Chassis, Clutch, Steering

Function: Measuring angle position

Technology: Hall (moving magnet)

- Features:**
- Non-contact measurement up to 360°
 - Highly insensitive to vibration
 - Temperature up to 150°C
 - Analog or PWM interface
 - Small geometry
 - Redundancy possible
 - Supply 5 V (optional 12/24 V)
 - 3-way MCON connector interface



Switches

Hall Switch SW01M

Application: Powertrain, Chassis, Brake

Function: Digital position detection

Technology:
Hall Switch (magnet integrated in sensor)

- Features:**
- Triggered by ferromagnetic part (= no moving magnet)
 - Current interface
 - Sealed connector interface
 - Diagnostics ability due to two-wire interface
 - IP6K9
 - Temperature range -40°C up to 150°C



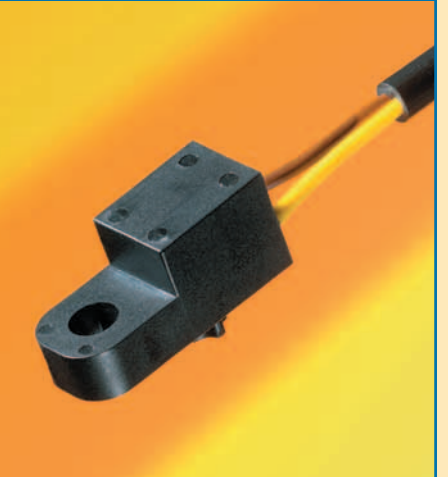
Hall Switch SW01P

Application: Body, Chassis

Function:
Digital position detection

Technology:
Hall Switch (magnet integrated in sensor)

- Features:**
- Triggered by ferromagnetic part (= no moving magnet)
 - Current interface
 - Sealed connector interface
 - Diagnostics ability due to two-wire interface
 - Temperature range -40°C up to 125°C



Speed

Speed Sensor SP1M

Application: Transmission

Function: Measuring gear speed

Technology:
Hall (with integrated magnet)

- Features:**
- Triggered by ferromagnetic gear wheel
 - Current interface with direction detection
 - Sealed connector interface
 - Diagnostics ability due to two-wire interface
 - IP6K9
 - Temperature range -40°C up to 150°C



Tyco Electronics provides standardized sensor solutions in addition to customer specific solutions.

Our Sensors Platform designs offer:

- Samples within weeks
- Proven
- Flexibility at design-in
- Usage for low volume serial production

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Creating an Advantage in Powertrain Applications

“GREEN” is the current slogan in all kind of automotive applications. Especially new legal requirements for fuel and CO₂ reduction require appropriate optimizations and new concepts in the powertrain. In order to control this complex system a feedback of several applications is an essential part and a challenge for the whole industry.

Powertrain applications require sensors to be reliable and durable for data transmission and in safety applications. To reach these targets it is important to understand our customer requirements for unified design results. The developments of sensor modules provide a highly flexible system and meet performance requirements in a cost-effective package.

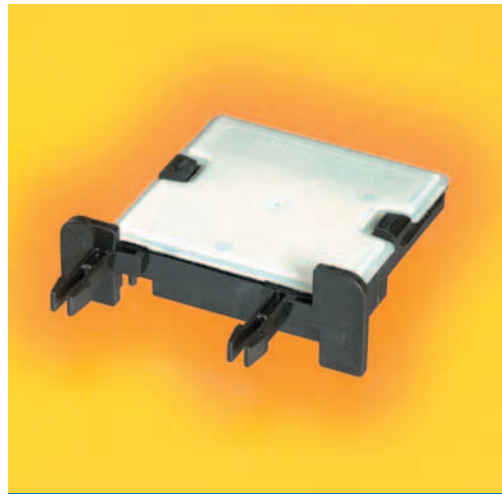
The integration of different functions, product and process technologies require a large development background. Using this know-how is a main advantage for the customer regarding quality, performance and costs.

Tyco Electronics offers application-specific sensor solutions for specific customer requirements. The right definition and selection for the sensor technology depends on the technical requirements for the powertrain. See beside for Tyco Electronics sensor solutions for engine and transmission applications.

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Transmission Rotary Sensor (up to 360°)



Clutch Position Sensor for Dual Clutch Transmission



Turbo Charger Position Sensor



Exhaust Gas Recirculation Position Sensor for Truck application



Clutch Position Sensor for Truck Concentric Slave Cylinder



Gear and Shift Sensor for Automated Manual Transmission

The increasing amount of sensors within new transmission concepts continuously lead to high integrated sensor modules. In special Dual Clutch Transmissions (DCT) require new modular concepts in order to package the various sensor functions.

Typical sensors for integration are:

- Drive mode travel or rotary sensors
- Gear fork travel sensors
- Clutch travel sensors
- Gear wheel speed sensors
- Clutch pressure sensors
- Temperature sensors

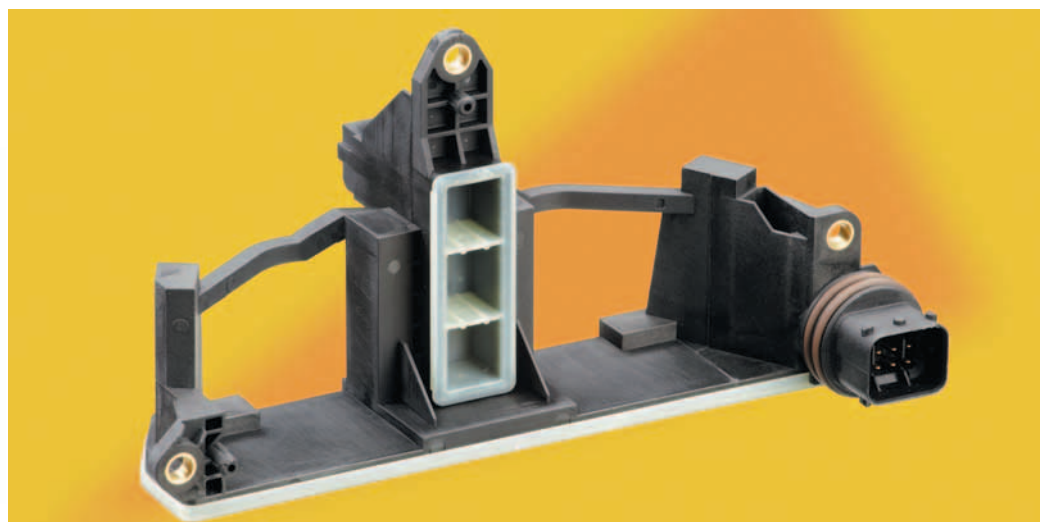
By integrating the single sensor units into their function-oriented position and adjusting the interconnection technology accordingly, the final 3-D configuration of the complete module is determined. The wide product and process portfolio of Tyco Electronics offers for this an ideal

base for the development and production of such robust and reliable sensor modules. Tyco Electronics extensive design and process capabilities include:

- Functional safe according ASIL requirements
- Power distribution and electrical interface for hydraulic or electrical actuators
- Single conductor wiring for optimized interconnections
- Oil and water tight sealed pass through connectors
- Robust interface technologies like i.e. press fit, soldering or welding

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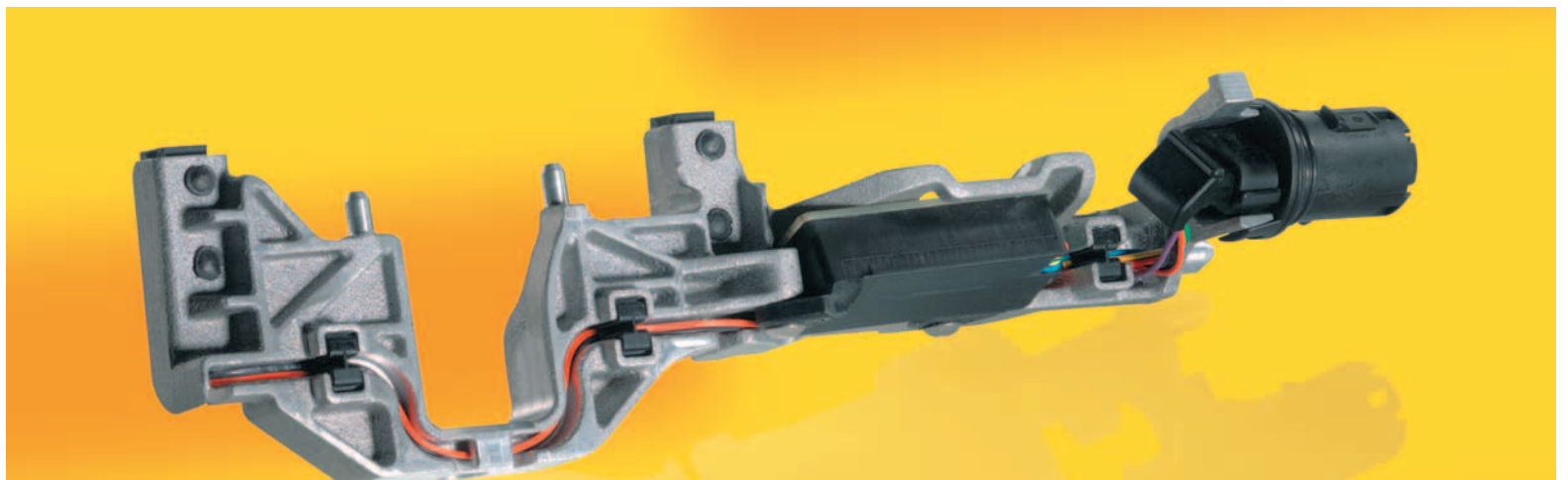
Transmission Sensor Modules



Sensor module with integrated Gear Fork (4x) and Speed Sensors (DCT)



Transmission Controller Housing with integrated Drive Mode (P-R-N-D) and Speed Sensor



Sensor Module with integrated Drive Mode (P-R-N-D) and Speed Sensors (DCT)

Redundant Position Sensor for Regenerative Brake Systems

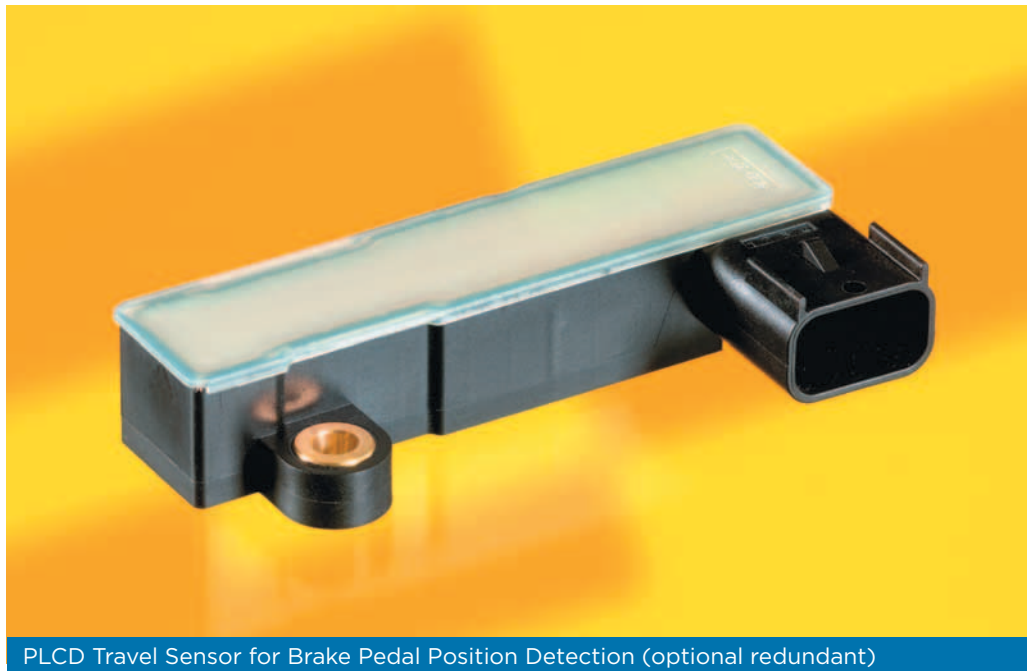
Regenerative Brake for Hybrid Drives

Since the beginning of this century the hybrid principle introduced many different solutions for automotive applications. A hybrid car is equipped with a standard gasoline engine combined with an electric motor. Depending on the architecture the electric motor could be located in a series or in parallel to the combustion engine or the E-motor.

Optimization of Drive Mode

One of the first targets of a hybrid concept is to balance the strengths of both the combustion engine and the electric motor. The electric motor has a high torque and peak power. The combustion engine has an excellent efficiency at high power and high load condition.

Most hybrid cars are using the electric motor as launch device to start the car, low speed operation and average power demand. For higher speed or acceleration the combustion engine will turn on in addition to the electric engine. In combination strong capability to boost the power is available which allows downsizing the combustion engine and enables reduced fuel consumption.



PLCD Travel Sensor for Brake Pedal Position Detection (optional redundant)

Recuperation of Brake Energy

The second target of hybrid concepts is to regenerate or harvest kinetic energy during braking. For this purpose the electric motor is switched in generator mode for recharging the battery. Depending on the current load the generator is decelerating and recharging the battery. When the driver applies

the brake, the demand of deceleration is the controlled parameter to regulate the brake energy recuperation.

Sensor Requirements

In order to achieve this, a high precision signal of the driver's intention is needed whilst braking. Therefore the displace-

ment of the brake pedal or the position of brake master cylinder is monitored. Most solutions are splitting the brake actuation in 10-20% in pure electrical brake and 80-90% in combined electrical and hydraulic brake.

Depending on the architecture of the brake system and for the start lock and brake light switch function a certain safety integrity level is required. Redundant signals and plausibility checks are typically solving the fail safe operation.

Solutions by Tyco Electronics

Tyco Electronics provides standardized solutions and customer specific solutions for regenerative braking based on the Permanent-magnetic Linear Contactless Displacement principle (PLCD) and new Hall technologies.

High demands on accuracy will be satisfied by the PLCD technologies, high demands on reliability are only fulfilled by a redundant system. Tyco Electronics has new standards on these requirements with its second generation of the PLCD technology.

The PLCD sensor has two fully independent output channels serve two complementary signals. The system architecture allows full redundant or redundant electronic designs which are required for high safety levels.

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Tyco Electronics Complies with FMVSS 208 (Occupant Crash Protection)

NHTSA (National Highway Traffic Safety Administration) has FMVSS 208 regulation which originally specified the type of occupant restraints (i.e. seat belts) required. The purpose of the standard is to reduce the number of fatalities and the number and severity of injuries to occupants involved in frontal crashes. In order to meet this regulation, automotive companies (OEM) have equipped airbag and seatbelt system.

However, airbag deployment causes fatal injuries when an infant or child is in the passenger seat. Tyco Electronics weight sensor prevents passenger from crash by classifying occupant is empty,



Seat Track Position Sensor



Seat Track Position Sensor

child or adult. Weight sensor measures weight of passenger and if the measured value does not exceed a predetermined threshold, the airbag will be disabled.

The methods of classification of passenger are measurement of weight, pressure and capacitance type. Tyco Electronics produces the Weight sensor, one of the Occupant Classification System (OCS), which measures the weight of occupants and infers whether it is of sufficient weight to be an adult.

Weight sensor is not only seat cushion design flexible, but good performance. To be measured with weight is the most

trusted way until now and most of automotive companies use this solution. Sometimes, weight sensor classifies an adult as a child. However this situation is happened when adult takes OOP (Out Of Position). In the process of development, our staff (5% female) has to be in all kinds of OOP. After this verification finished, weight sensor qualified.

In addition to the occupant classification requirements, North American vehicle typically utilize a two stage airbag deployment system. This system take inputs from OCS system, the seat track position, and seat belt buckle system. Due to the safety critical nature of these

applications a highly reliable sensor design is required.

Tyco Electronics has developed a flexible integrated magnet Hall effect sensor concept to detect the position of the seat. The Hall-effect sensing element, when used with a current interface, has the same wiring requirements as a mechanical switch but has the additional capability of monitoring the performance of the sensor and allows for basic error detection. The Tyco Electronics unique magnetic design allows for larger air gap ranges than standard biased magnet solutions making it much more suitable for a broad range of seat track designs. These features plus the simplified packaging options provide an advantage to our customers with full system responsibility.

Similarly, this technology is capable of detecting the seat belt buckle latch position. The added reliability of the Hall-effect sensor and Tyco Electronics custom packaging allows seat belt buckle manufacturers to combine the belt reminder function with the airbag control system into a single sensor. Tyco Electronics also offers a variety of connector/cable interface designs to meet industry needs in a cost effective solution.

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Seat Weight Sensor (Occupant Classification System)

Commercial Vehicle Industry - an Important Market for Tyco Electronics Sensors Division

The Commercial Vehicle Industry (CVI) is constantly evolving due to current and future emission regulations. Stringent emission regulations increase the need for capable sensor systems in various applications. Many of these applications require reliable and robust non-contact sensor technologies to fulfil the high demand that are typical for trucks, busses, tractors and agricultural machines.

In the next few years e.g. the EuroVI emission regulation will start to apply in Europe for heavy duty diesel trucks & busses. Currently the EuroVI regulation is forcing the engineers at truck and bus manufacturers to find new technologies to lower the emission. In many applications today there are several sensing systems that use non-contact sensor technologies to avoid wear problems. These sensors also need to be robust in order to provide accurate diagnostics through tough environment experienced in the Commercial Vehicle Industry.

In the near future the off-road market will also be subject to a Stage III and Stage IV emission regulation. These regulations force the manufacturers of off-road vehicles do develop new sensing systems to lower the emission levels.

Tyco Electronics Permanent-magnetic Linear Contactless Displacement (PLCD) sensor is a position sensor for many CVI and off-road applications. The PLCD sensor can be customized to a specific design and is also available in standard platform designs.

Exhaust Gas Recirculation

One possibility to lower the emissions in a diesel engine is to implement Exhaust Gas Recirculation (EGR). In the market there are different EGR technologies available such as pneumatic or electrical based systems. EGR systems using pneumatic technology require a high-precision and temperature sensor system to measure the direct position of the EGR valve.

Tyco Electronics PLCD sensor technology fulfils these requirements and is currently being used in several EGR systems by different truck manufacturers.



EGR Position Sensor for Truck Application

Turbo

In the future, the engine turbo charger with variable turbo geometry will be used more often to minimize emissions, boost engine performance and help downsizing engines. For the turbo charger application Tyco Electronics offers a PLCD and/or Hall based sensor system in which we provide different solutions - the sensor can either be integrated in the housing or it can be mounted separately with a cable pigtail.



PLCD Travel Sensor for EGR Cylinder

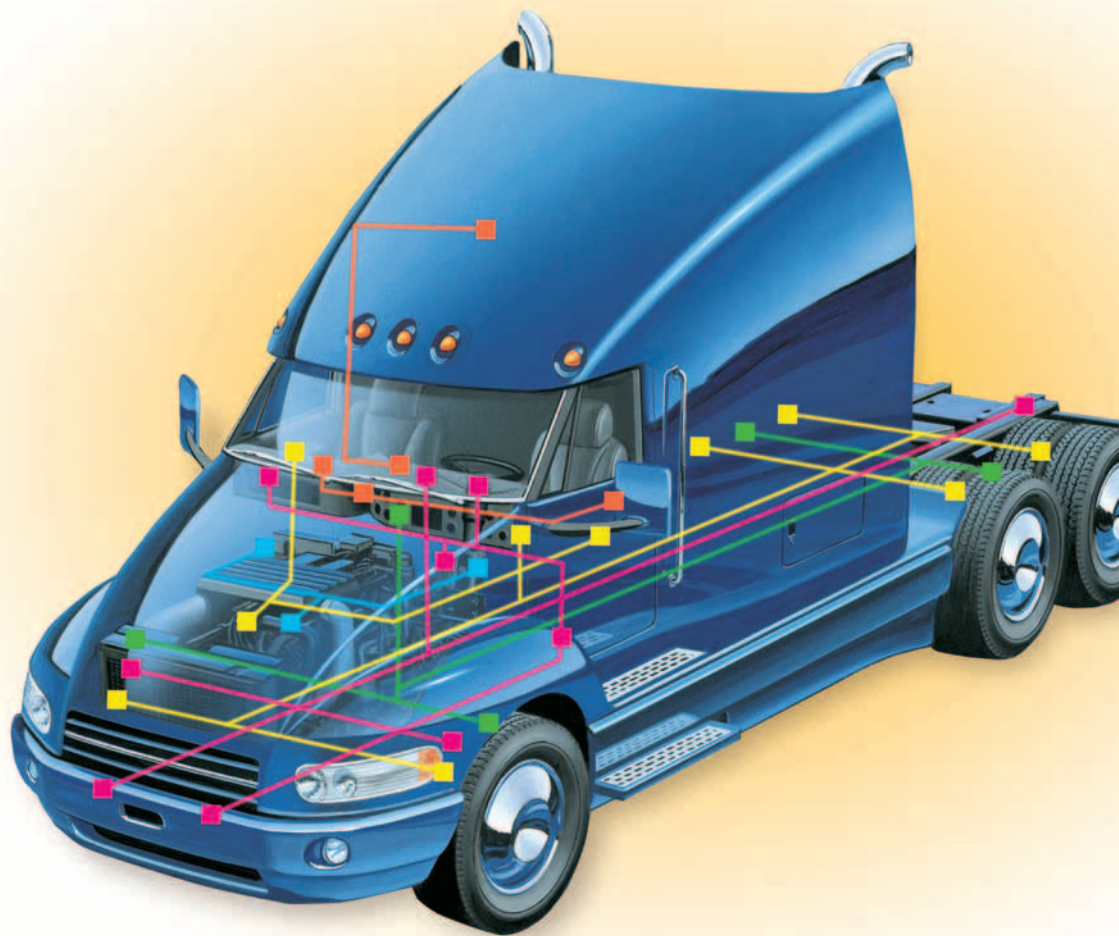
Transmission

In the next coming years we will see new Transmissions in the automotive and truck market such as Automated Manual Transmission (AMT) or Dual Clutch Transmissions (DCT). Transmissions have a strong need for robust and high-precision non-contact sensor technologies for position measurements.

Tyco Electronics PLCD sensors fulfil those requirements and can be used as standalone sensors or integrated in Transmission sensor modules. In addition to the PLCD sensor technology Tyco Electronics makes it possible to combine different sensor technologies such as hall sensors for speed, directional temperature measurement into trans-



PLCD Travel Sensor for Turbo Charger Actuator



Clutch

In new clutch systems Tyco Electronics PLCD sensor technology is used to detect the travel of the clutch plates directly on the pneumatic concentric slave cylinder (CSC). The PLCD sensor can also be used on the clutch slave cylinder, which detects the position of the piston through the cylinder wall.



PLCD Platform Sensors for Automated Transmission Application

mission modules. In addition Tyco Electronics can provide integrated modules using stamping, plating, molding and in-molded leadframes.



PLCD Travel Sensor for Clutch Slave Cylinder



PLCD Travel Sensor for Concentric Slave Cylinder

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