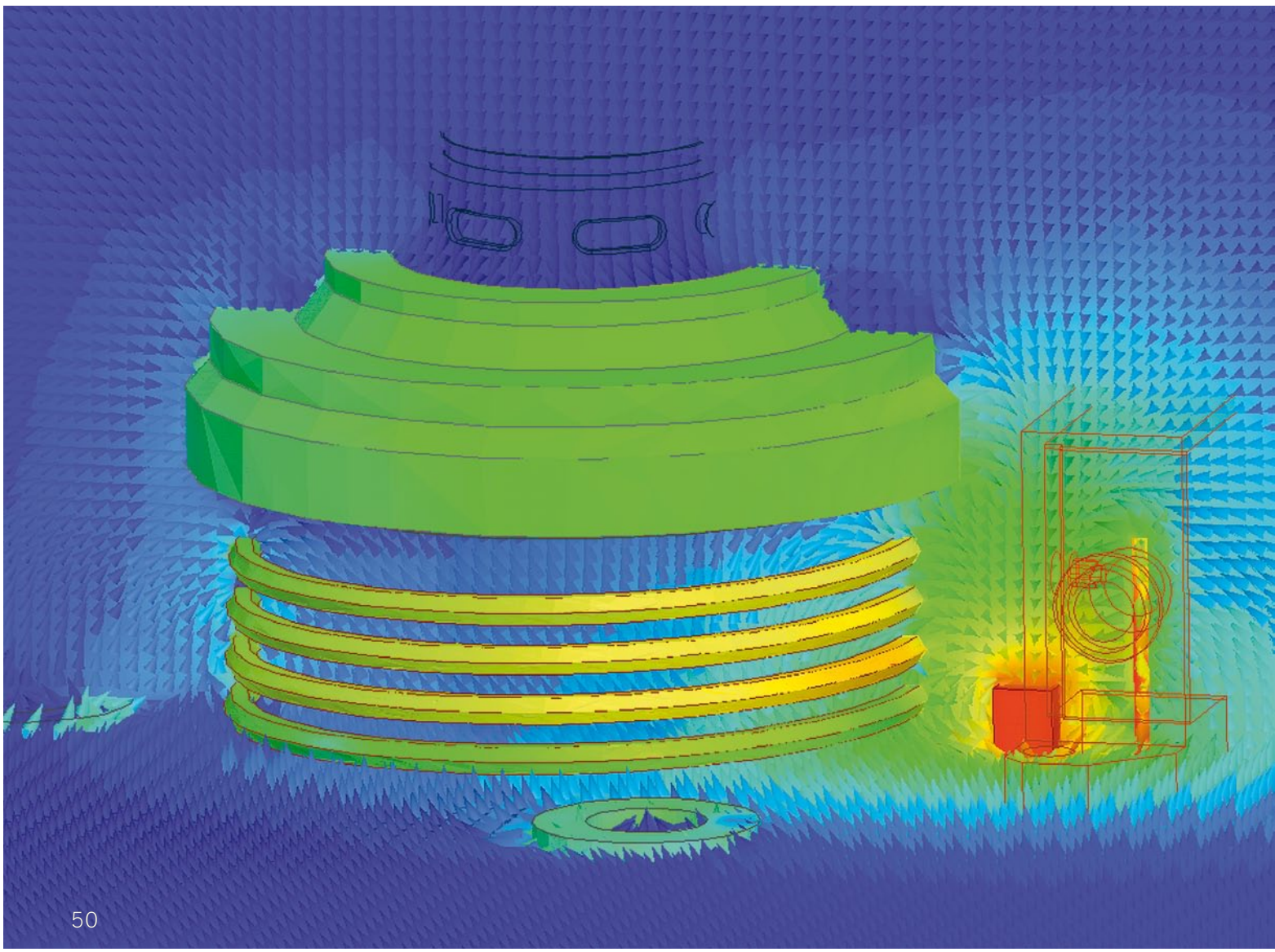
INTEGRATED HALL DISPLACEMENT SENSORS FOR CLUTCHES

For using start-stop systems and hybrid drives one has to know whether the clutch is open or not. Therefore, FTE automotive developed new Hall displacement sensors with linear output signal which need no space due to integration in the hydraulic cylinder and feature a twist protection for the piston and the magnet.



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COSTS AND ACCURACY

Since 1998, FTE automotive supplies customers in the automobile industry with sensor equipped hydraulic cylinders for clutch actuation systems and shift actuators. Until a few years ago, conventional (mostly inductive) sensors or reed switches were used.

Today, due to increased requirements regarding costs, accuracy and installation space, the contactless Hall technology [1] is applied. Depending on the application, this technology is directly integrated into the hydraulic cylinder. Next to the common Hall position sensors (several switching points as output signal), the Hall displacement sensory system (linear output signal), based on in-house sensor technology, could be very successfully established in the area of clutch activation. ❶ shows the technical data of typical Hall displacement sensors as they produced by FTE automotive.

REQUIREMENTS

Apart from the improvements in security, comfort and performance (for the functions cruise control, start lock, electric parking brake and torque adjustment) particular attention of automotive R&D is paid currently to the realization of the start-stop function. Here, the combustion engine is turned off during longer stops, for example at red traffic lights, to save fuel and avoid exhaust emission. One of the necessary pieces of information is provided by a displacement sensor at the clutch master, ❷.

According to customer specification, FTE automotive provides, apart from sensors with one or more displacement signals, sensors with two separate switching signals, for example for use in speed control or start lock applications (as low or high side switch) for further control units within the car. These switching signals are generated through two additional Hall switches on the printed circuit board instead of simply generating them from the core line of one of the existing displacement signals. To ensure the absolute secure start of the vehicle even in critical upper or lower board voltage areas, which is essential from the customer's point of view, a special circuit technology is applied. A parallel two-clamp-voltage supply, which is taken directly from the vehicle's power supply network, rounds up the all-in-one sensor solutions provided by FTE automotive.

FEATURE	VALUE	UNIT
MEASUREMENT RANGE	10 to 95	mm
MEASURING PRINCIPLE	Hall technology	–
APPLICATION TEMPERATURE	-40 to +125	°C
MAXIMUM TEMPERATURE (PEAK 160 °C)	150	°C
TEMPERATURE COMPENSATION	Yes	–
PROTECTION RATING	IP6K9, IP6K7	–
TYPICAL EMC TESTING		
BCI TEST	300	mA
RESISTANCE TO RADIATED FIELDS	200	V/m
RESISTANCE TO IGNITION HIGH VOLTAGE	10	kV
ELECTROSTATIC DISCHARGE (ESD)	25	kV
VOLTAGES		
PERCENTAGE SIGNAL OUTPUT, PWM, DUTY CYCLE	10 to 90	% DC
SIGNAL OUTPUT (RADIOMETRIC)	0.5 to 4.5	V
INTERNAL SUPPLY VOLTAGE (AS SINGLE OR PARALLEL TWO-CLAMP SUPPLY)		
FROM ON-BOARD CONTROL UNIT	5	V
FROM VEHICLE ELECTRICAL SYSTEM	12	V

❶ Technical data of typical Hall displacement sensors

❷ Clutch master cylinder with sensors (typical measurement range 22 to 37 mm)

SIMULATION

Beside the electric functions, construction and simulation of the overall system plays an integral part in the later performance of the sensor. Through 3D magnetic field simulation programs, ❸, complete hydraulic cylinders including all ferro-magnetic and permanent magnetic components can be assessed in motion and can thereby be optimized, should the need arise.

A further advantage is that a complete assessment of the ferromagnetic clearance within the vehicle (firewall) as well as electromagnetic environment (starter cable) occurring therein can be carried out. The sensor technologies which are implemented are optimized relating to this and are therefore well suited for hybrid applications.

BUILD-UP PROCESS

During the last years, it became clear that car manufacturers more and more prefer the direct integration of sensors in the cylinders. Due to the years of experience of FTE automotive in the area of laser welding and plastic moulding techniques not only the integration of the sensors could be realized fast and successfully but also a twist protection for the piston and the magnet.

The core of this technology is the assembly of the sensor's printed circuit board within an intended compartment at the cylinder's body instead of an extern sensor housing as it was done so far. The plug pins are, according to application, integrated either into the laser cap, which then acts as a plug, or they are already overmoulded within the cylinder's body. In this case, the plug is an integral part of the cylinder's body.

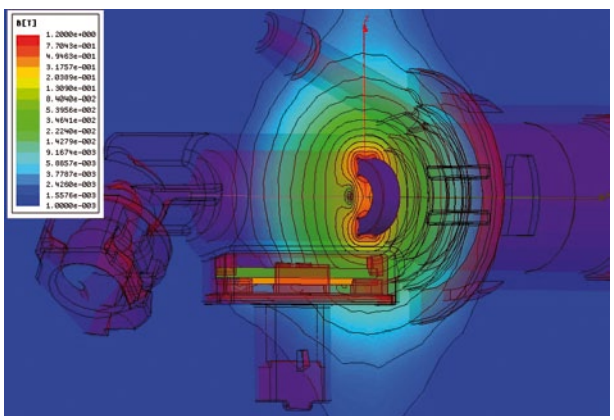
The build-up technology and the twist protection lead to a clearly improved tolerance position of the sensor signal (total error, linearity, slope errors, micro linearity). This mainly shows at the end-off-line test bench, where the teaching (teaching of the characteristics) of the sensors is done on the completely manufactured cylinder at 100 %. Through this it is possible to compensate previous mounting tolerances and the influence of the magnet rotation, thereby reaching an excellent sensor performance.

SUMMARY

Car manufacturers more and more prefer the direct integration of Hall displacement sensors in the hydraulic cylinders of clutches or for start-stop systems. The combination of FTE automotive combines innovative sensor technology with a modern build-up process as an all-in-one solution for the customer. Low-cost sensors as well as high-precision position sensor systems are produced, which will not only find their place on hydraulic cylinders in the future but everywhere where displacement measurement plays a part.

REFERENCE

[1] Wallentowitz, H.; Reif, K. (Hrsg.): Handbuch Kraftfahrzeugelektronik. Abschnitt Hallsensoren, S. 503 ff., 2. Auflage, Vieweg+Teubner-Verlag, Wiesbaden, 2011



❸ Magnetic field simulation of an integrated displacement sensor