Application Brief

Position Sensors for Braking System Development

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Modern automotive braking systems have evolved significantly beyond traditional hydraulic designs. In earlier systems, braking was primarily controlled by the driver through the brake pedal, with hydraulic fluid transmitting force to the brake calipers.

In contrast, contemporary vehicles integrate multiple control inputs into a unified braking architecture. These inputs include the brake pedal, Anti-lock Braking System (ABS), Adaptive Cruise Control (ACC), Electronic Stability Control (ESC), and Electronic Parking Brake (EPB). All these systems interact with a centralized braking control module, enabling coordinated and optimized braking performance under various driving conditions.

Furthermore, emerging brake-by-wire technologies are replacing conventional hydraulic actuation with fully electronic control systems. These systems eliminate the need for brake fluid and instead use electronic signals and actuators to apply brake force. This shift enhances system responsiveness, enables advanced driver assistance features, and supports higher levels of vehicle automation.

Introduction

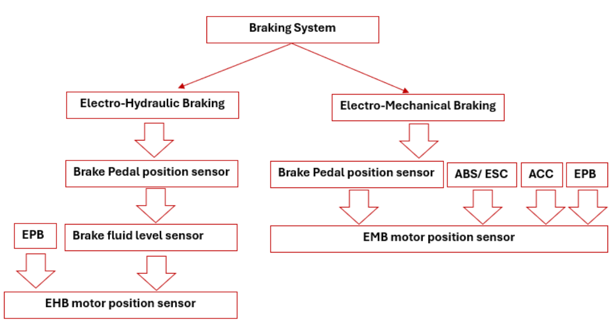

Figure 1. Braking System

Pedal Wake Up

Modern automotive braking architectures employ an intelligent power management strategy where the primary braking subsystem — being a high-current, high-power domain — remains in a deep power-down state during vehicle standby. To prevent parasitic battery, drain on the main power rail, the wake-up trigger mechanism is isolated on an independent, low-capacity battery bank, operating under a dedicated low-voltage, ultra-low-power domain. For functional safety (FuSa) compliance (per ISO26262), this wake-up path must operate as an independent, fault-tolerant channel, decoupled from the primary system to ensure reliable brake pedal detection even under main system failure conditions. TMAG5131-Q1 is precisely engineered for this class of application Automotive low-power (10 Hz, 1 µA) low-voltage (down to 1.65 V) Hall-effect switch

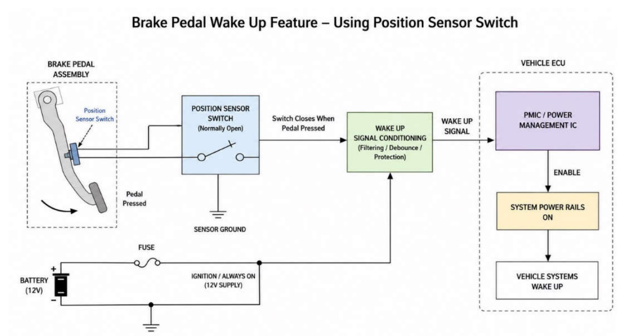

Figure 2. Pedal Wake up

Brake Pedal Positioning

Brake pedal position sensing using inductive technology is widely adopted in modern vehicles due to its inherent immunity to stray magnetic fields and its magnet-free design. In this approach, an inductive coil is integrated into a fixed module, while a metallic target is attached to the moving brake pedal mechanism. When the brake pedal is pressed, the target moves relative to the stationary inductive coil, causing a change in inductance. This variation is precisely measured by devices such as the LDC5071-Q1 and LDC5072-Q1, which convert the inductive changes into accurate position data. The system then provides reliable and high-resolution brake pedal position feedback to the vehicle's control unit.

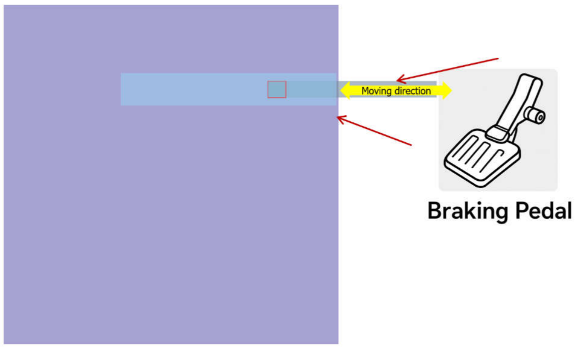

Figure 3. Brake Pedal System

Brake Field Level Sensor

There are several ways to design a brake fluid level sensor, but the primary function is to detect when the fluid level drops too low and send a warning signal to the driver via the instrument cluster.

One key advantage of magnetic sensing in brake fluid level detection is its ability to enable remote sensing of the float position, eliminating the need to expose the PCB to the harsh, caustic environment of brake fluid. However, it is important to note that the magnet itself must be properly encapsulated to prevent deterioration and potential contamination of the brake fluid.

A widely adopted implementation is the float-based approach, in which a magnet is mounted on a float that rises and falls with the fluid level. A Hall-effect sensor, positioned in proximity, detects the magnet's presence as the float descends with a dropping fluid level. TI's TMAG5131-Q1 is particularly well-suited for this application, thanks to its low-power operating mode, making it an efficient and reliable choice. Beyond this device, TI also offers a broad portfolio of Hall-effect switch designs to accommodate a variety of design needs and specifications. (Hall-effect latches & switches | TI.com)

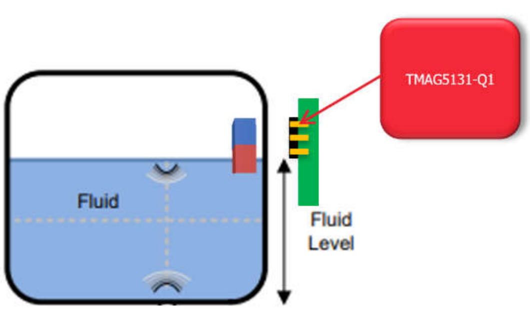

Figure 4. Brake Fluid Level Hall Sensor

Another approach is a high-precision method that uses an ultrasonic sensor. In this design, a transducer emits a series of pulses toward the fluid surface and then detects the reflected signals. The time it takes for the pulses to travel to the liquid surface and return—known as the time-of-flight (TOF)—is used to accurately determine the fluid level TDC1011-Q1 is specially designed for this application. (Liquid Level Sensing with Hall Sensors/Ultrasonic Sensing Basics for Liquid Level Sensing, Flow Sensing, and Fluid Identification Applications (Rev. A))

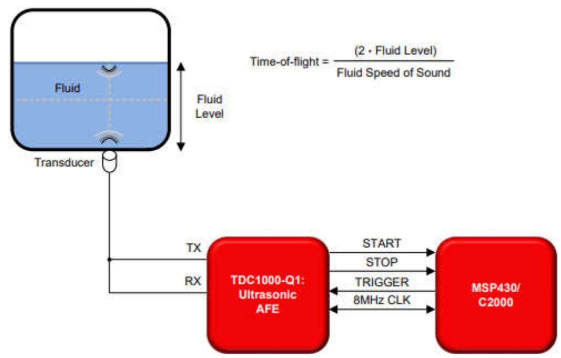

Figure 5. Brake Fluid Level Ultrasonic Sensor

EHB/EHB Motor Positioning

In electrohydraulic braking, once the brake pedal input is processed, an electric motor drives a hydraulic pump or actuates a pressure valve to generate the required braking force, which is then applied through the hydraulic system. In contrast, electromechanical braking eliminates hydraulics altogether, with an electric motor directly controlling the actuator to apply braking force at the wheels.

For such applications, we offer advanced sensing designs like the AMR-based high-speed angle sensor TMAG6180-Q1, which is well-suited for precise position and motion detection. Additionally, our inductive design, LDC5072-Q1, provides a magnet-free and stray-field-immune alternative, verifying robust and reliable performance in demanding environments.

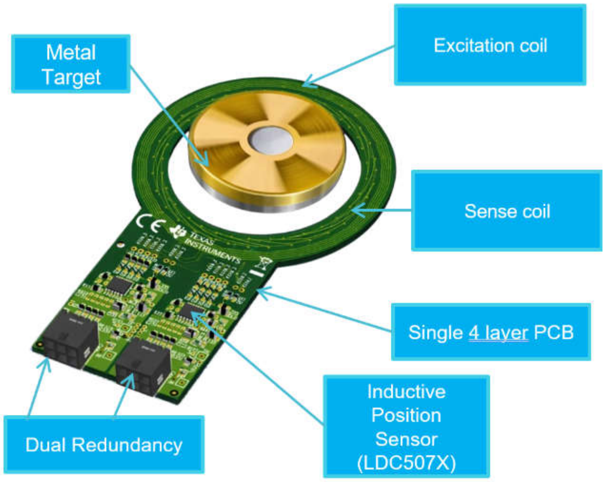

Figure 6. EHB/EMB Inductive Motor Positioning

Electronic Parking Brake

This is a human interface control that bypasses the brake pedal and directly activates the brake actuator to apply pressure at the wheels.

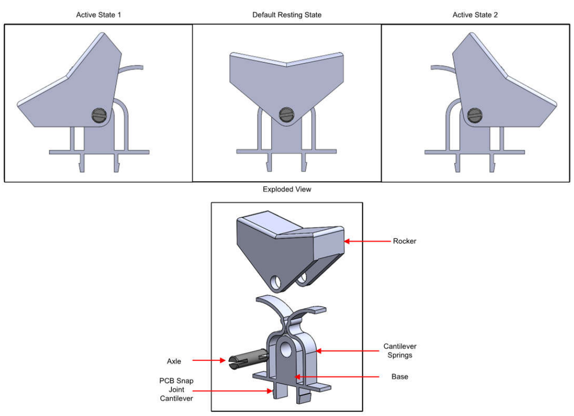

Figure 7. HMI Park Brake

Electronic Parking Brake (EPB) systems can be implemented using various technologies, including capacitive touch buttons (FDC1004-Q1), inductive touch designs (LDC3114-Q1), and Hall-effect–based rocker switches using devices like TMAG5170-Q1 or TMAG5173-Q1.HMI Rocker Switch With Hall-Effect Switches

Table 1. Recommended Devices

Function	Recommended Device
Pedal Wake Up	TMAG5131-Q1:- Automotive low-power (10Hz, 1µA) low-voltage (down to 1.65V) Hall-effect switch
Brake Pedal Positioning	LDC5072-Q1:- Automotive inductive position sensor front end with sine/cosine interface
Brake Fluid Level Sensor	TMAG5131-Q1:- Automotive low-power (10 Hz, 1 µA) low-voltage (down to 1.65V) Hall-effect switch **TDC1011-Q1**Automotive Ultrasonic Sensing Analog Front End (AFE) for Level and ID Sensing **PGA460-Q1**:-Automotive ultrasonic signal processor and transducer driver
EHB/EMB Motor positioning	LDC5072-Q1:- Automotive inductive position sensor front end with sine/cosine interface **TMAG6180-Q1**: Automotive high-precision analog AMR angle sensor with 360° angle range
Electronic Parking Brake	TMAG5131-Q1:- Automotive low-power (10Hz, 1µA) low-voltage (down to 1.65V) Hall-effect switch FDC1004-Q1:- Automotive, 4-channel 16-bit capacitance-to-digital converter with active shield driver for EMC LDC3114-Q1:- Automotive 4-channel inductance-to-digital converter for low-power proximity & touch-button sensing TMAG5173-Q1:- Automotive, high-precision, linear 3D Hall-effect sensor with I²C interface TMAG5170-Q1:- Automotive, high-precision linear 3D Hall-effect sensor with serial peripheral interface

Trademarks

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