SIX THINGS TO CONSIDER WHEN BUILDING ADVANCED DRIVER ASSISTANCE SYSTEMS

By EETech

INTRODUCTION

Advanced driver assistance systems (ADAS) are a ubiquitous feature of modern vehicles, including a host of electronic technologies for enhancing the safety and drivability of automobiles. ADAS functions include adaptive cruise control (ACC), forward collision warning (FCW), traffic sign detection (TSD), lane departure warning (LDW), automatic braking systems, and battery management. Two decades into their existence, these safety-critical features have been instrumental in reducing the likelihood of near misses, injuries, and deaths due to road accidents.

ADAS includes Hall-effect and xMR (magnetic) sensors that enable real-time, accurate measurement of variables such as rotational speed, position, and distance. For example, camera-based sensor ICs capture information from the surroundings, such as proximity to vehicles and obstacles, which then relay the information to functional systems, such as the engine, transmission, and wheels/braking that initiate safety measures to protect the vehicle, other road users, and pedestrians.

ESSENTIAL CONSIDERATIONS FOR BUILDING ADAS

Emerging trends in the automotive industry place greater demand on automakers to enhance automobiles' safety and drivability. Discussed below are six essential considerations that engineers should look at when designing vehicles with cutting-edge ADAS.

ASIL Compliance

Automotive Safety Integrity Level (ASIL) is a risk classification system based on ISO 26262 and provides guidelines to guarantee the functional safety of road vehicles. According to ISO 26262, functional safety is the "absence of unreasonable risk due to hazards caused by malfunctioning behavior of electrical and electronic systems." The ASIL system consists of four levels: A, B, C, and D (with A being the lowest automotive hazard and D as the highest). ASIL values are assigned after performing a requisite risk analysis of potential hazards by evaluating parameters, such as exposure, severity, and controllability. For example, rear lights fall under the ASIL A level while rearview cameras, brake lights, radar cruise control, and vision ADAS are ASIL B. Similarly, engine management and active suspension fall under ASIL C. In contrast, safety-critical features, such as electric power steering, airbags, and anti-lock braking systems (ABS), fall under ASIL D since they offer the highest hazard levels.

GMR vs. Hall Technology

Hall-effect sensors work by measuring changes in voltage levels when a semiconductor device is placed within a magnetic field, thus, converting magnetically encoded information into electrical signals. In automobiles, Hall-effect sensors measure distance, position, and speed. For example, a Hall sensor, monolithically integrated with BiCMOS processing circuitry, can measure the timing and direction of an engine's rotation. The Hall effect, because it measures the strength of magnetic fields around conductors with a constant current, can inversely measure current in automotive applications such as battery management.

GMR offers some advantages over Hall-effect technology. GMR sensors are based on giant magnetoresistance (GMR) and also integrate magnetoresistive sensor elements and BiCMOS circuits monolithically. Compared to Hall-effect ICs, GMR-based sensor ICs achieve highly accurate rotational speed measurements with lower edge jitter at farther air gaps (e.g., transmission and wheel speed sensing and engine control). They can match Hall sensor performance with much smaller magnetic signals and outperform the jitter at similar air gaps. These advantages, combined with the compact package footprints, make them suitable for component-dense configurations. Allegro MicroSystems' A19250 and A19350 wheel speed sensor ICs and ATS19480 and ATS19580 transmission sensor ICs are built with patented GMR technology and have robust performance with sensing orientations that are compatible as drop-in solutions to the Hall-effect predecessors.

Using the Latest 3D Sensor ICs

To avoid obsolescence in a fast-paced automotive industry, engineers must ensure that they are using hardware and software that can be updated in the future. Fully-integrated Hall-effect sensors are ideal for use in linear position and absolute rotary sensing. The latest solutions offer on-chip diagnostics to help improve driver, passenger, and pedestrian safety in driver-assisted and autonomous vehicles.

Allegro MicroSystems' 3DMAG sensor ICs integrate vertical and planar Hall-effect elements to detect two out of three magnetic field components (X, Y, and Z). Using configurable signal processing, linearization, and angle calculation, they can accurately resolve absolute rotary (full 360° and short-stroke <360°) or linear positions of moving magnetic targets. These fully integrated sensors deliver measurement accuracy and performance required to meet the stringent requirements of safety-critical automotive applications. Designed to meet ISO 26262 and AEC qualifications, Allegro's sensor ICs remain at the forefront of innovation. Its applications include powertrain actuators, electronic throttles, pedal position, and brake cylinder position.

Braking with Calipers vs. Electric Braking

Conventional front-wheel and four-wheel disc brakes in modern cars and trucks use hydraulic pressure via calipers to apply brake pads to a rotor. However, as vehicles become more efficient, mechanical functions are becoming electrified to reduce weight and emissions. Electric braking, also known as brake-by-wire, helps resolve several limitations with traditional brake systems in modern vehicles. Challenges with hydraulic-only braking include squealing noises due to friction, brake pad wear and tear, and brake fluid leakage. Wheel misalignment can also contribute to disc brake failures which compromise the safety and drivability of automobiles.

On the other hand, electric brakes minimize mechanical actions that are prone to failure. When the brake pedal is pressed, a sensor detects its position and relays electronic signals to a control unit that sends a command to electromagnetic actuators, activating calipers to slow or stop the movement, depending on the pressure applied. Allegro MicroSystems provides Hall-effect and xMR sensor ICs for accurate position measurement in electric braking applications. These products are compliant with automotive industry standards such as ASIL and ISO 26262 and EMC requirements.

STEERING APPLICATIONS

In 2012, the National Highway Traffic Safety Administration (NHTSA) mandated automakers to integrate electronic stability control

(ESC) in all new vehicles to enhance the safety of vehicles, consequently lowering the risk of road accidents. ESC modules are typically part of a vehicle's ABS module and incorporate sensors for measuring parameters such as the yaw rate, lateral acceleration, wheel speed, and steering wheel angle, and steering torque. Hall-effect and xMR sensor ICs can be used as steering angle sensors to detect the direction and speed of the steering wheel, and then relay the information to an ESC module that uses an algorithm to determine if the steering is accurate or the vehicle is steering in the wrong direction. Similarly, magnetic sensors can be used as steering torque sensors to measure the amount of force a driver is applying to the steering wheel, and in the event of a loss of steering control, the ESC sends a signal to electronic throttling systems within the vehicle to reduce the engine torque until control is regained.

DC/DC Regulators and LED Drivers for Heads-Up Displays

ADAS subsystems use voltage regulators to provide power to microcontrollers, sensors, and transceivers for optimum energy efficiency while meeting ASIL / ISO 26262 standards. Allegro offers a broad range of wide-input, Grade-0 automotive power management ICs for 12V and 24V systems with input voltages from 2.8 to 50 V.

LED lighting is an integral component of automotive applications due to its numerous benefits, including low-voltage operation, high luminous efficiency, compact footprints, thermal and UV stability, and a longer lifespan. LEDs are ideal for use in heads-up displays (HUDs) including a very wide dimming range (contrast ratio) using PWM dimming. Exterior LED safety lighting can use a wide variety of LED configurations including different numbers of LEDs, strings, and LED colors. Therefore, a wide variety of LED driver topologies may be required, including linear, buck, boost, and buck-boost – all of which are covered by Allegro's LED driver IC portfolio.

ADAS FEATURES TO IMPROVE SAFETY AND DRIVABILITY

Driver-assistance features in modern cars and trucks place increasing demand on automakers to enhance the ease, safety, and drivability of vehicles. In connection, ADAS prevents human errors that can result in near misses, injuries, and road accidents by incorporating electronic components for speed and position sensing and voltage regulation. Engineers designing ADAS must use best-in-class components and ensure compliance with automotive industry standards. True to that, Allegro is a trusted provider of sensors and voltage regulators for automotive applications across the globe.

Revision History

Number	Date	Description	Responsibility
–	August 25, 2021	Initial release	EETech

INNOVATION WITH PURPOSE

ALLEGRO microsystems

955 PERIMETER ROAD • MANCHESTER, NH 03103 • USA
+1-603-626-2300 • FAX: +1-603-641-5336 • ALLEGROMICRO.COM