Chassis Systems Control

LRR3: 3rd generation Long-Range Radar Sensor

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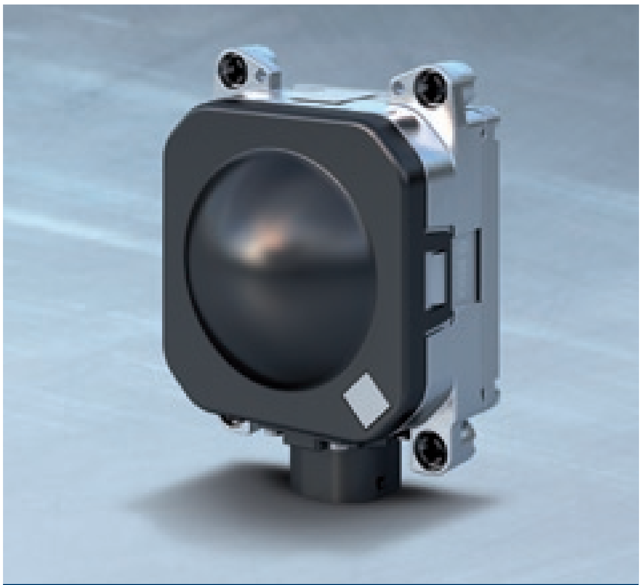

Customer benefits

- Best-in-class price performance ratio by using cost-effective SiGe technology
- Excellent measurement accuracy and object separation capability (velocity, angle, distance)
- Sensor performance unaffected by harsh weather conditions (snow and ice) due to optional lens and radome heating
- Adjustable detection range via modification of the focusing element (lens aperture)
- Scalable system performance with multiple sensor configurations including sensor data fusion
- Robust sensor design allows application even in heavy commercial vehicles
- CAN and FlexRay interfaces allow for easy integration into the vehicle

Operating principle

The main task of the radar sensor is to detect objects and measure their velocity and position relative to the movement of the host radar-equipped vehicle. To do this, the sensor has four antenna elements that simultaneously transmit radar waves in the frequency range between 76 and 77 GHz. These waves are reflected by objects in front of the vehicle. By comparing the amplitudes and phases of the signal echo received by the antenna elements, conclusions about the objects' position can be drawn. The relative speed of objects is measured using Doppler effect (shift in frequency between the reflected and transmitted signals) and distance to the object can be determined by the time lag.

Mechanical sensor design

The robust sensor design without any mechanically moving parts and its high mechanical vibration resistance allows the application in commercial vehicles, particularly in heavy trucks. An optional lens and radome heating is implemented to allow full sensor performance even under bad weather conditions (snow and ice). Important parameters and interfaces such as field of view (opening angle), the configuration of the car connector and the position of the mirror for the optical sensor alignment can be customized.

Standardized manufacturing processes and the usage of fully automotive qualified electronic devices (according to AEC Q100) guarantee the best quality and reliability. The cost-effective design encourages application in all segments. It also makes advanced driver assistance systems with multiple sensor configurations (complementary or redundant) economically viable.

Technical features	
Frequency range	76...77 GHz
Distance	0.5...250 m
Accuracy	±0.1 m
Relative speed	-75 ...+60 m/s
Accuracy	±0.12 m/s
Vision range	
Horizontal opening angle	30° (-6 dB)
Vertical opening angle	5° (-6 dB)
Modulation	FMCW
Max. number of detected objects	32
Operating temperature	-40°C...+85°C (periphery)
Vehicle connector	MQS 8 Pins
Cycle time (incl. auto diagnosis)	typically 80 ms
Dimensions (H x W x D)	77 mm x 74 mm x 58 mm
Weight	285 g
Power consumption	typically 4 W
ISO certification	ISO 15622 Class IV sensor

Sensor architecture

The LRR3 sensor is a monostatic Frequency Modulated Continuous Wave (FMCW) radar with four fixed beams. An important aspect of the sensor architecture is the high level of integration for the RF-functionality as well as for the sensor control unit and the signal processing. This results in a highly reliable and compact sensor. We use cost-effective, fully silicon based technology for the RF-components. Innovative signal processing algorithms allow excellent measurement performance and the handling of complex traffic situations such as a "lane free detection" by angular separation of objects. Our dedicated safety concept guarantees the compatibility of the sensor with safety relevant applications.

The sensor consists of two PCBs:

- The RF-module contains the RF-circuitry (SiGe-MMICs) and the Radar-ASIC with integrated modulation control and the signal pre-processing (pre-amplification, A/D conversion, filtering).
- The sensor control unit contains the microcontroller, the System-ASIC and optionally a FlexRay transceiver. The integrated sequencer takes over control tasks of the radar sensor. This enables the handling of new signal processing algorithms by the microcontroller as certain time consuming task schemes are outsourced and taken over by the Radar-ASIC. The microcontroller has been developed especially for driver assistance systems. The System-ASIC forms an essential part of the safety concept. It provides the power supply and contains the CAN interfaces.

Sensor performance

The LRR3 sensor exhibits a combined patch lens antenna which is well suited for large frequency ramps allowing a high resolution in distance. Its advanced antenna design enables a detection range of 0.5 up to 250 m with a field of view of 30°. The field of view can be customized to an opening angle up to 45° by modifying the aperture of the lens. LRR3 provides excellent measurement accuracy of angle, velocity and distance as well as object separation.

Applications

The LRR3 is the centerpiece of the automatic distance and speed control system ACC (Adaptive Cruise Control) and Predictive Emergency Braking Systems. ACC and the Predictive Emergency Braking Systems network the radar sensor with the ESP® system.

ACC uses information from the long-range radar sensor to control the vehicle's speed by automatically braking and accelerating so that it maintains at a predefined minimum distance from the preceding vehicle.

Our Predictive Emergency Braking Systems continuously monitor the situation in front of the vehicle and trigger appropriate collision avoidance/mitigation measures in critical situations. They support the driver with an intelligent predictive warning concept and also provide effective emergency braking assistance in critical situations. If a collision is unavoidable, the system automatically triggers emergency braking in order to reduce the risk of injury.

Via intelligent networking of our radar sensor with components and systems installed in the vehicle or by integrating information of other sensors such as a camera or additional radar sensors we enable new applications or enhancements of existing functions. Through the use of multiple sensors and components we further increase the safety of vehicle occupants and other road users without increasing cost. Bosch collects this networking of components and systems under the name CAPS – Combined Active Passive Safety.

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