Bosch Engineering

Long-Range-Radar LRR3: Radar sensor for railway applications

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Invented for life

Customer benefits

- Excellent measurement accuracy and object separation capability (velocity, angle, distance)
- Sensor performance unaffected by harsh weather conditions (snow and ice) due to integrated lens heating
- Scalable system including adjustable sensor configuration and sensor data fusion
- Robust sensor design allows reliable operation in railway applications
- CAN-interface allow for easy integration into railroad vehicles

Operating principle

The radar sensor detects objects and measures their relative velocity and position. For that purpose, 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. By comparing the amplitudes and phases of the signal echo received by the antenna elements, precise conclusions on the objects' position can be drawn. The relative speed and distance of objects is measured using Doppler Effect (shift in frequency between the reflected and transmitted signals) and time lag.

Mechanical sensor design

The robust sensor design without any mechanically moving parts and its high mechanical vibration resistance allows the reliable operation in all railway applications. The integrated lens heating is implemented to allow full sensor performance even under bad weather conditions (snow and ice).

Standardised manufacturing processes and the usage of fully qualified electronic devices deliver best quality and reliability. It also provides economically viable enhanced systems with multiple sensor configurations (complementary or redundant).

Technical features	
Frequency range	76...77 GHz
Distance Accuracy	0,5...250 m ± 0,1 m/s
Relative speed Accuracy	−75...+60 m/s ± 0,12 m/s
Modulation	FMCW
Max. number of detected objects	32
Operating temperature	−40 °C...+85 °C (periphery)
Connector	MQS 8 Pins
Cycle time (incl. auto diagnosis)	typ. 80 ms
Dimensions (H x W x D)	77 mm x 74 mm x 58 mm
Weight	285 g
Interface	CAN acc. ISO 11898
Supply voltage	14 Volt
Power consumption	typ. 4 W
Protection category	IP 6K9K (conditioned assembly, min. IP 6K7)
Standards	EN 50155, EN 50121

Sensor architecture

The LRR3 sensor is a monostatic Frequency Modulated Continuous Wave (FMCW) radar with four fixed beams. The high level of integration for the RF-functionality as well as for the sensor control unit and the signal processing has an important impact on the reliability of the sensor. We use fully silicon based technology for the RF-components. Innovative signal processing algorithms allow excellent measurement performance and the handling of complex situations such as a ‘lane free detection’ even with a great number of objects close to rail gauge. Our integrated safety concept enables the compatibility of the sensor with safety relevant applications.

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 modern antenna design enables a detection range of 0.5 up to 250 m with a field of view of 30°. The object separation as well as the measurement accuracy of angle, velocity and distance is excellent.

Applications

The LRR3 radar sensor can be applied to a series of functions which can also be accomplished parallell. By the identification of objects in the driveway the radar sensor is able to measure the distance and the relative speed of these objects. The subsequent object classification in relevant and non-relevant barriers enables the recognition of critical situations.

The LRR3 enables the realization of an intelligent, predictive and adaptable warning system for innovative safety functions. Thereby measures to avoid accidents or reduce the risk of injury are triggered in critical situations. In addition a precise determination of speed over ground and the integration of the LRR3 into assistance systems for the optimization of the efficiency are possible.

Via intelligent networking of the radar sensor with components and systems 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 and productivity without increasing cost.

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Printed in Germany
292000P0YL-C/CCA-201209-En