Radar based Information System
MCR1
Integration Manual

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Valeo Schalter und Sensoren GmbH
Laiernstraße 12
74321 Bietigheim-Bissingen
GERMANY

Document Purpose

This document provides the specifications to operate and integrate MCR-1 sensors in a car.

Acronyms

bps	Bits per Second
CAN-FD	Controller Area Network
ECU	Electronic Control Unit
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FoV	Field of View
MC	Major Cycle
OEM	Original Equipment Manufacturer
RF	Radio frequency
Valeo	Valeo Schalter und Sensoren GmbH

Definitions

Radar sensor: MCR1 sensor

Host vehicle: The vehicle fitted with the ADAS system.

Object vehicle: The vehicle the ADAS system is searching to.

Field of view: The area located in front of the sensor that the radar is able to monitor

Part I Document Scope

1. Multi Beam Radar Principle

The automotive radar is a radar sensor module used to monitor the alert zone of a vehicle, i.e. by sensing the front & back sides of the vehicle and by reporting to the ECU if an object in that area is present. A message is transmitted on the CAN-FD bus within the vehicle to indicate detection of any object within the field of view.

1.1. System Operation

The radar sensor modules are to be mounted on each corner of a vehicle near the back (or front), behind the left and right hand side of the bumper with their radar beams radiating towards the side of the vehicle. The other variant is a sensor to the front-center of a vehicle. Each radar sensor is operating in a narrow band frequency around 76.0~77.0GHz. Under normal driving conditions, the sensors receive multiple beams of radar data oriented in a fan shaped pattern in order to cover the alert zone as shown in figure 1.

Each sensor is able to continuously search its own field of view (FoV) to determine whether any object is present within the MCR-1 FoV. Messages with detected objects are transmitted over the CAN-FD bus.

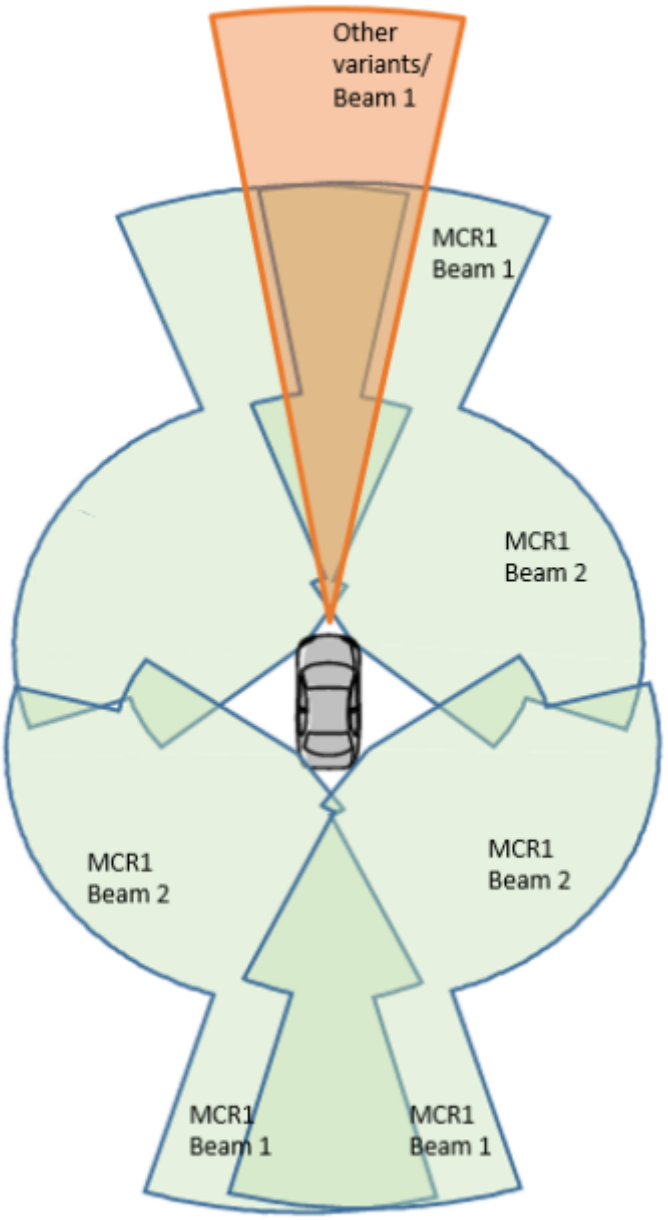

Figure 1: Illustration of the MCR1 covering area.

1.2. MCR-1 Multi Beam Description

MCR1 operates with two beams. The sensor consists of three transmit (Tx) antenna elements. All three Tx antennas are used to form a Beam 1 pattern which is focused to 45 deg of sensor coordination system (to aim to front or rear direction when mounted on 45 deg mounting angle). Only one Tx antenna is used to form a Beam 2 pattern as shown in Figure 2.

The other variant uses only one Beam 1 with all three Tx antenna elements active as shown in Figure 3.

There are 2 model variants. The MCR1 has a waveform with the alternating beams (Beam 1 -> Beam 2 -> Beam 1...), whereas the other variant has only one beam.

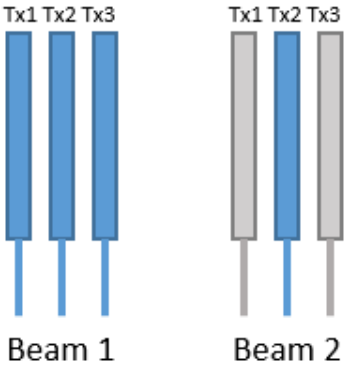

Figure 2: MCR1 Antenna elements usage

Figure 3: Other variant antenna elements usage

The sensor electronically scans through the beams approximately once every major cycle (MC). The distance to an object as well as speed and fine angular position in azimuth of an object is determined using traditional radar techniques. The transmitted signal is linearly swept in frequency as it is being transmitted. The reflected signal is compared to a reference signal, which is the signal currently being transmitted, and the difference in frequency is used to determine the distance to an object. Software processes all the information from the radar to determine if there is an object of interest in the FoV.

1.3. MCR1 System Architecture

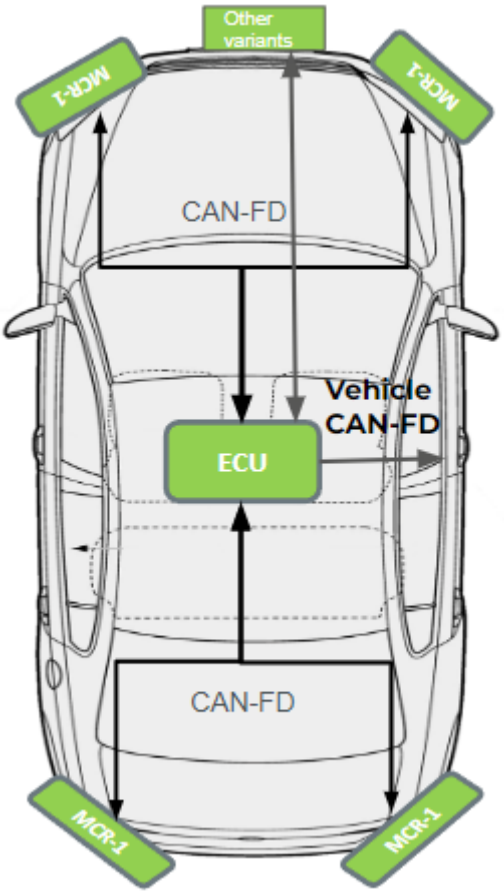

Figure 4: MCR1 system architecture in a vehicle

2. Applicable Documents and Specifications

2.1. Restricted Countries

2.1.1. Frequency Regulation

The frequency regulation status must be reviewed for each project with Valeo, to define the countries where the sales are allowed, and to define markings and information required in the End User Manual

2.2. Other Documents - Only for Reference

ISO/TC204/WG14/N40.24
Lane Change Decision Aid Systems (Standard working draft).

Part II Functional Description

3. System Characterization

3.1. Appearance

The sensors will be invisible and must be mounted behind the non-conductive bumper material. This portion of the bumper can be painted. The use of exotic metallic painting shall be used in accordance with Valeo.

Appropriated brackets must be designed and realised in such a way to avoid any trying of disassembling or any undesirable intrusion from outside of the vehicle, unless the bumper and/or cover are removed.

3.2 Vehicle Packaging

The radar sensor bracket and electrical harness must provide the following functions:

- Connect to vehicle electrical system;
- Allow for removal and replacement of sensor;
- Identify sensor as left side or right side as well as front or rear;
- Prevent squeak and rattle;
- Fit to bumper or car body;
- Define module position with regard to bumper, car body and car axis;
- If possible, take up harness connector when radar sensor is not fitted;
- Prevent contamination and mud build-up, protect against “stone throw” from tires.
- The sensors must be installed to provide a separation distance of at least 20cm from all persons.

3.2.1. Radar Sensor Module

The radar sensor module shall provide the following functions:

- Determine sensor location on vehicle based on position pins in connector;
- Determine operating states;
- Perform diagnostics functions;
- Perform communication to the vehicle using CAN-FD;
- Detect and report objects of interest in FoV;
- Transmit / receive 76~77GHz RF through the bumper.

3.3. Environmental Conditions

3.3.1. General Requirements

The radar sensor module assembly shall meet the environmental and durability requirements as defined by the OEM.

3.3.2. Weather Conditions

Radar sensors should be able to operate in rain, snow conditions but will have limitations like all sensors in certain conditions. Limitations depend on the integration specific to each car and have to be tested.

In extreme conditions the sensors are blocked.

3.3.3. EMC & EMI

The radar sensor shall meet the requirements specified by the OEM and the regulations applying.

3.3.4. Painting Influence

The radar sensor shall operate to requirements when mounted behind a non conductive bumper material that has been painted with metallic or non metallic paint. The bumper used material as well as the used paints have to be measured for transmissibility and agreed with Valeo before acceptance.

3.4 Product Design

3.4.1. Sensor Enclosure

The sensor housing shall be sealed.

3.4.2. Connector Requirements

The connector is defined by the OEM and has to be compliant with Valeo tools.

3.5. Mechanical Mounting

3.5.1. General Requirements

Attachment applied force shall not exceed 26N per mounting tab of the radar sensor. Retention force of the attachment system shall exceed 110N normal and shear.

3.5.2. Sensor to Car Body Attachment

Each radar sensor will be directly attached to a bracket by clips and a position hole. The whole assembly part will then be glued to the bumper or a car body using screws.

3.5.3. Sensor Alignment & Test

The radar sensor is typically aligned by an alignment procedure at an OEM assembly plant after integration in a car.

3.6. Electrical Features

Table 1: Output Power

Description	Parameters	Remarks
Mean EIRP	32 dBm	At room temperature
	33 dBm	Over operating temperature range

Table 2: Electrical Requirements

Description	Parameters	Remarks
Ambient Temperature		
Operating temperature range	−40°C to +85°C	
Storage Temperature range	−40°C to +95°C	Module not powered
Power Supply		
Operating voltage range	9V to 16V	
Power supply current	max. 700mA @ 12V	Peak current

Table 3: CAN-FD

Description	Parameters	Remarks
CAN-FD speed	2Mbps	

3.6.1. Power

The radar sensor can either be permanently powered or alternatively powered by the ignition.

3.6.2. Ground

Ground offsets of up to 0.5V should be expected between modules.

3.7. RF Exposure

The radar sensor is a wireless device with a distance of at least 0.2 m from any body part of nearby persons.

3.8. Maintenance and Repairing

Proper orientation of the sensor module must be guaranteed by the dealer after repair. After a crash affecting the vehicle body, the car body should be repaired to guarantee a maximum misalignment of the sensor of ±3°.

The radar system shall not require scheduled maintenance or service during its target life.

4. Materials and Processes

Materials and environmental specifications are defined by OEM.

5. Environmental Validation

Defined by OEM

6. End User Manual

Defined by OEM's target country legislative.