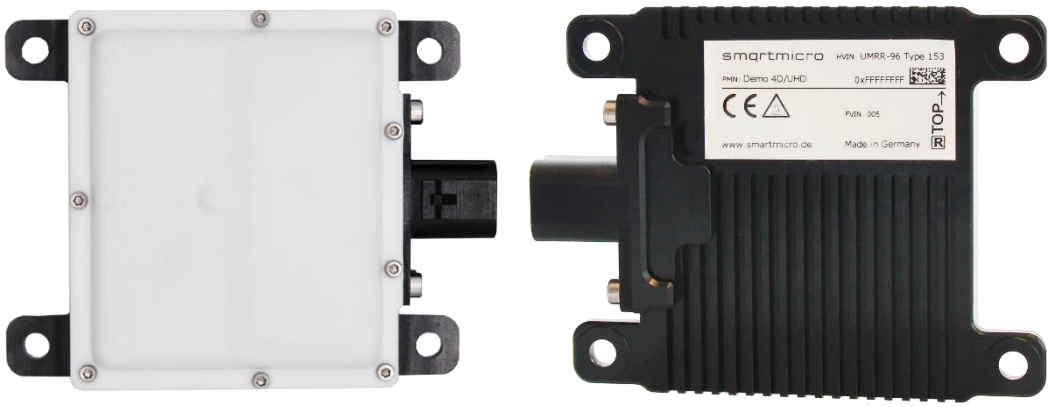
PRODUCT INFORMATION

AUTOMOTIVE SENSOR

UMRR-96 TYPE 153



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CONTENT

1 USER SAFETY WARNING

Please read the entire document carefully before using the sensor.

INSTALLATION

Please pay attention to the details below before installing and connecting the sensor:

- Only use provided or approved equipment for the installation.
- Only skilled and instructed persons shall install and connect the sensor. Proper experience in working with mains voltage, electrical and electronic devices is required.
- Do not connect the sensor directly to the mains voltage; instead use the voltage specified for the product.
- Do not wire any connections when power is applied to the device.
- Ground devices carefully to prevent electrical shock.
- All connectors are pin-coded and fit in only one position. Also note the arrow indicating the top side of the sensor.
- Only use fully functional equipment (ladders, aerial work platform, etc.) when working above ground. Staff shall be capable of working at heights.
- Be cautious when installing the sensor on or around active roadways and pay attention to moving traffic.
- Mount the sensor carefully to prevent it from shifting or dropping.
- The sensor must be mounted to a stiff and solid support. Vibration, oscillation or other movement will reduce the sensor performance.
- Make sure that installation methods are in accordance with local safety policies and procedures as well as company practices.

OPERATION

Do not operate the sensor if the device itself or any cables are damaged.

Transmission of radio frequency waves starts after the sensor is powered up and stops when it is disconnected from power.

For testing purposes, the sensor may be laid on its face when it is powered up, given that the surface or connectors will not be damaged this way. Please note that this position is not intended for permanent use.

The sensor may become hot during operation. Proper hand protection is recommended for maintenance work.

Do not dispose electrical and electronic equipment in household trash.

TECHNICAL SERVICE

Only use provided or approved equipment for operation. People other than authorized and approved electrical technicians shall NOT attempt to connect the device to a power supply or other controllers, as there is a risk of electrical shock by unsafe handling of the power source.

Do not attempt to service or repair this device:

- No user-maintainable parts are contained in the device.
- To avoid electrical shock, do not remove or open the cover.
- Unauthorized opening will void all warranties.
- smartmicro is not liable for any damages or harms caused by unauthorized attempts to open or repair the device.

RADIATION

This product has been tested and found to comply with Part 15 Subpart C of the Federal Communications Commission (FCC) or the European RED directive, or other national rules, depending on the country where it may be in use.

Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

This device generates radio frequency energy. There are strict limits on continuous emission power levels to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

- Human exposure to transmitted waves from this device is generally considered as safe. Still, it is considered good practice that humans are not subject to higher radiation levels than necessary.

This device may interfere with other devices using the same frequency band.

2 SENSOR SPECIFICATIONS

UMRR-96 Type 153 is a 79GHz radar sensor for multiple automotive applications that features 4D/UHD technology.

Type 153 antenna aims at short and medium range and very wide horizontal angular coverage. It features:

- A straight beam with wide field of view
- A squint beam
- Both beams are selectable for short-, medium- and long-range mode

2.1 MEASUREMENT PRINCIPLE

Using a patented transmit waveform, the sensor measures range, radial speed, azimuth and elevation angle, reflectivity and more parameters of multiple stationary and moving reflectors (targets) simultaneously. It is capable of ultra-high definition (4D/UHD), where UHD resolution means that the sensor features resolution (separation) in three parameters: range, Doppler and azimuth angle.

The sensor is almost unaffected by weather, temperature and lighting conditions. It withstands high shock and vibration levels, is maintenance free and made for a long lifetime.

4D/UHD MEASUREMENT

A 4D Doppler based radial motion detection principle is integrated:

a) Direct unambiguous Doppler measurement (speed)
b) Direct range measurement
c) Direct azimuth angle measurement (horizontal angle)
d) Direct elevation angle measurement (vertical angle)

Moving reflectors can be detected as well as stationary objects.

With its multi-target capability, the sensor can *detect* many reflectors within the field of view at a time (target list = point cloud). Additionally, optional filter algorithms are implemented for certain applications for the tracking of all detected reflectors over time. Those tracking algorithms are integrated in the sensor. Multiple objects can be *tracked* simultaneously.

The result of tracking is an object list with the following parameters:

- X-position
- Y-position
- Absolute velocity
- Heading angle
- Length
- Object ID and more

In addition, status and diagnose data from the sensor are reported. The sensor optionally reports such a list of all tracked objects in every measurement cycle of typically ~55ms length. Based on all detected targets and tracked objects within the field of view an application algorithm, such as blind spot warning, lane change assist or collision warning, may be implemented.

ULTRA-HIGH DEFINITION RESOLUTION - OBJECT SEPARATION PERFORMANCE

The sensor divides the field of view into range gates and performs a Doppler (speed) measurement separate for each individual range gate.

Individual reflectors are separated by detection algorithms if having either:

- A different radial speed value or
- A different range value or
- A different azimuth angular position

USER CONFIGURABILITY

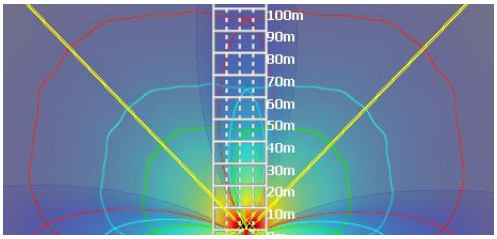
The operational mode, antenna selection and frequency band are user-configurable:

The sensor allows to switch between short-range mode, medium-range mode and long-range mode. The modes differ regarding the waveform and the detection performance.

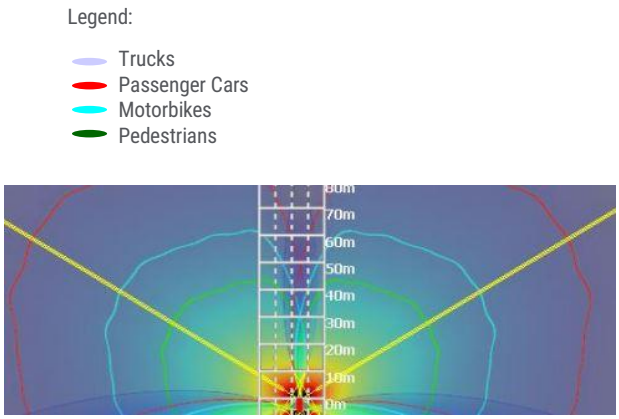
Simultaneously or independently, either straight beam with wide field of view or squint beam operation can be chosen: Both beams can be selected for short-, medium-, or long-range mode. The straight (wide) beam has its maximum range at bore sight, whereas the squint beam has its maximum range off the bore sight, for example, at ~30 degree offset to the mechanical mounting axis.

The straight (wide) beam can be used for applications like Blind Spot Detection (BSD) or Rear Cross Traffic Alert (RCTA), whereas the squint beam can be used for Lane Change Assist (LCA) and Forward Rear Collision Warning (FCW) applications.

There are three user-configurable frequency bands. These frequency bands are non-overlapping in long- and medium-range mode, so that the mutual interference can be reliably avoided. In short-range mode, the bands will partly overlap.



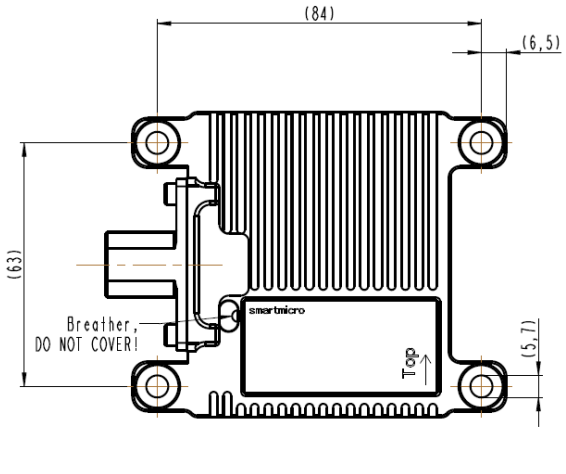
Corner sensor configuration with straight (wide) beam antenna



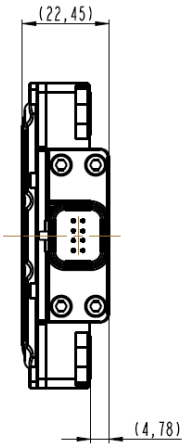
Two corner sensor configurations with squint beam antenna, exemplarily at 30° offset

2.2 SENSOR DIMENSIONS

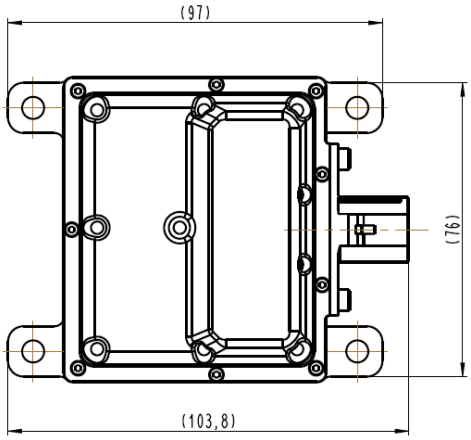
All values are given in mm.



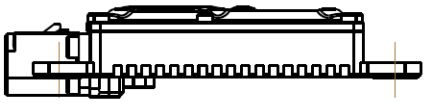
Sensor Rear Side



Left Side



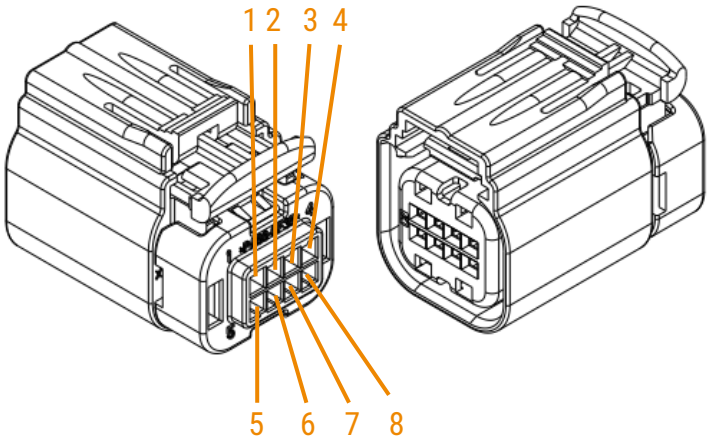
Sensor Front Side



Top Side

2.3 SENSOR CONNECTOR

The sensor connector is an 8-pin male (plug) connector used for automotive interconnections (waterproof IP67, TE 1411001-1, TE manufacturer). A female counterpart (socket) must be used to connect with the sensor.



View on solder cup side of socket showing the pin numbering (rear view of female counterpart to be connected to sensor)

Sensor connector pin out model giving pin descriptions:

Pin No.	Function
1	GND
2	BR ETH_P
3	CAN2_H
4	CAN2_L
5	V+
6	BR ETH_N
7	CAN1_H
8	CAN1_L

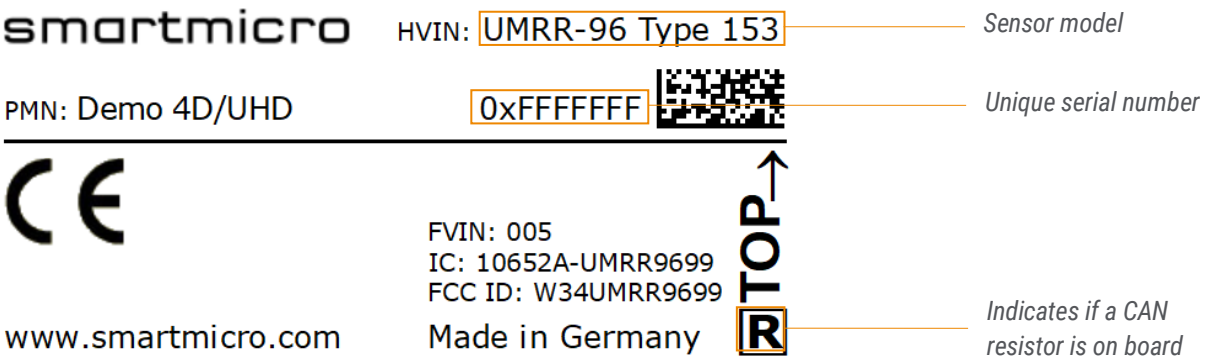
Please note that in the standard configuration the sensor does have a 120 Ohms resistor on board (CAN bus termination between CAN L and CAN H) for both CAN buses. A termination (resistor) is required at both ends of a CAN bus and is not integrated into the cable manufactured by smartmicro.

Please note that if more than two sensors carrying a CAN resistor by default are operated in one CAN network, network issues may occur. For such networks, a sensor version without CAN resistor(s) can be provided. In typical cases, CAN2 is used for the synchronization of multiple sensors, for which the resistor within sensor must be removed. CAN1, on the other hand, provides a point-to-point connection, for which the resistor within sensor is required. Please contact smartmicro for a special product version in which the with removed CAN resistor(s).

2.4 SENSOR AND HARDWARE IDENTIFICATION

The sensor housing is tagged with a type sticker containing the product description and the serial number. It also indicates which side of the sensor is the top side.

Sticker example:



Additionally, the DSP board and the RF board have their own unique serial numbers.

3 GENERAL PERFORMANCE DATA

Parameter		Long-Range Mode	Medium-Range Mode	Short-Range Mode
Operating Frequency		77…81GHz | 3 center frequencies (bands)	77…81GHz | 3 center frequencies (bands)	77…81GHz | 3 center frequencies (bands)
Range	Min./Max.[1]	0.8m/120m | 2.6ft/394ft	0.4m/55m | 1.3ft/180ft	0.15m/19.3m | 0.5ft/63ft
	Separation	< 1.2m | < 3.9ft	< 0.6m | < 2.0ft	< 0.3m | < 1.0ft
	Accuracy	< 0.5m | < 1.64ft or 1% (bigger of)	< 0.3m | < 1.0ft or 1% (bigger of)	< 0.15m | < 0.5ft or 1% (bigger of)
Speed	Min./Max.	-340…+140km/h | -211…+87mph	-340…+140km/h | -211…+87mph	-400…+140km/h | -249…+87mph
	Separation	< 0.3m/s	< 0.3m/s	< 0.3m/s
	Accuracy	< 0.15m/s	< 0.15m/s	< 0.15m/s
Angle	Field of View: Azimuth[2]	-50…+50° (squint beam)	-65…+65° (straight beam)	-65…+65° (straight beam)
	Field of View: Elevation[2]	-7.5…+7.5°		
	Separation: Azimuth	~30° (optional)		
	Accuracy: Azimuth[3]	≤ 1° (at <50° from bore sight)		
	Accuracy: Elevation[3]	≤ 2° (at <10° from bore sight)		
Mechanical Details				
Weight		≤ 153g | ≤ 5.4oz		
Dimensions (H/W/D)		97 x 76 x 17.7mm | 3.8 x 2.99 x 0.7in (plus connector)		
Further Information				
Initialization Time		< 4s		
Update Cycle Time[4]		≤ 55ms		
Processing Latency		2-4 cycles		
Operating Voltage[5]		8…24V		
Power Consumption[6]		3.75…5W		
Bandwidth		< 2000MHz		
Max. Transmit Power (EIRP)		≤ 31dBm		
Operating & Storage Temperature		-40…+85°C | -40…+185°F		
Interfaces[7]		Ethernet 100Mbit (2-wire); 2xCAN V2.0b (passive)		
Connector		TE 1411001-1 series		
Shock / Vibration		$100g_{rms}$ / $14g_{rms}$		
Relative Humidity		0…95% (non-condensing)		
IP		67		
Pressure or Transport Altitude		0…10000m | 0…32800ft		

1 Typical values; all values given for bore sight; they may vary depending on the clutter environment. Please note that the radar system can neither achieve a detection probability of 100% nor a false alarm rate equal to zero.
2 The total field of view is an angle interval in which reflectors can be detected; 3dB field of view is narrower.
3 Typical value; measured at target output level at bore sight, for a point reflector showing >23dB SNR. Error may increase towards larger angles. In addition to this angle error, angle may drift over temperature, typically -0.5deg to + 0.5deg over specified operation temperature interval.
4 Typical value; may be longer depending on the number of detected radar targets.
5 Measured at the connector.
6 Depending on supply voltage and temperature; power consumption increases with supply voltage and with temperature.
7 Both CAN interfaces are capable of CAN(FD) by hardware (2 and 5Mbit/s), one of them is also sleep mode capable. It is recommended to use an external surge protection for power, CAN, RS485, Ethernet and other interface ports.

START-UP TIME

After powering up or resetting, sensor readings meet the specified performance in <4s.

3.1 SELF-DIAGNOSIS

The sensor cyclically reports a status message providing its cycle time, run time and diagnosis information. Additionally, the sensor can also provide sensor mode and status information on request.

The diagnosis information provided by the sensor is an optional self-diagnosis feature to allow limited fail-safe capabilities, which helps in detecting for example:

- Sensor blindness
- Misalignment in roll or pitch angle
- Detection and suppression of interference

3.2 SENSOR NETWORK

Sensors are typically used standalone. However, for one vehicle multiple sensors can be connected to one sensor fusion ECU. Such networks are possible by using a CAN/CAN(FD) or Ethernet interface. All sensors in the network can work on a plug-and-play basis after the configuration of separate, maximum three frequency channels, which avoid mutual interference. Since the sensors are typically mounted in the corners of a vehicle, it is also possible to operate more than three sensors free of interference if their fields of view do not overlap. Customer-specific configurations are possible.

DATA LOGGING AND VISUALIZATION TOOLS

The visualization of all data (target lists, object lists, etc.) is possible using the Drive Recorder software on any PC. It also provides for example data logging, associated video documentation, play back and analysis functions.

smartmicro offers Robot Operating System (ROS) support which includes ROS drivers for easier customer integration of the sensors and ready-to-run real-time visualization using ROS display tools. The proprietary radar protocol can be read into ROS, which facilitates the processing and visualization of radar data.

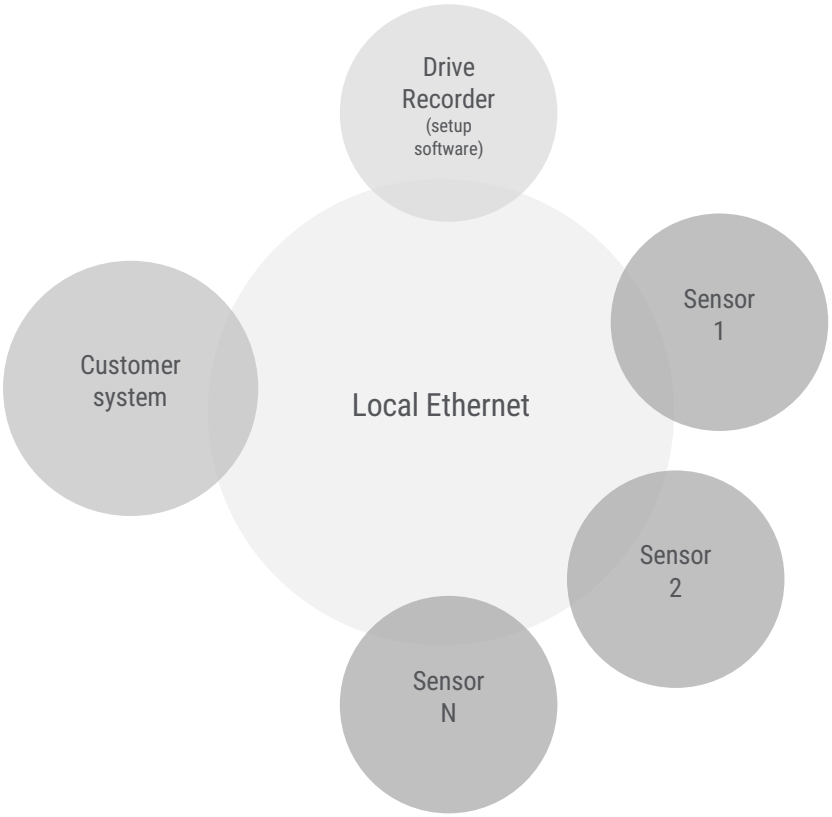
Alternative to the Drive Recorder or ROS-based visualization, other customer specific visualization, logging, or function/application software products may be applied. For the handling and integration of the radar system interface, interface documentation, dbc files, example code (in C) and API can be provided.

3.3 ETHERNET CONNECTION

The sensor supports UDP via Ethernet in a Local Area Network (LAN). Communication over low bandwidth environments or routed networks such as the world wide web are not supported.

Features:

- Ethernet standards IPv4, ARP, IGMP, IP multicast and UDP
- Support of Static IP configuration. DHCP is not supported
- smartmicro's proprietary communication protocol "smartmicro transport protocol" with sensor data transmission, which sends a list of detected targets every radar cycle. Operation parameters can be accessed via Ethernet.



4 APPLICATION-SPECIFIC CHARACTERISTICS

The sensor can be used for different applications by using either point cloud or collision avoidance firmware.

FUNCTIONAL SAFETY

The sensor can optionally be made compliant to ASIL Level B in customer-specific projects. Requirements and safety concepts need to be agreed between an OEM and smartmicro.

AUTOSAR

The sensor is offered with AUTOSAR compliant software in customer-specific projects. Specifications need to be agreed between an OEM and smartmicro.

4.1 POINT CLOUD

Using the point cloud firmware, the sensor can be used for long-, medium-, and short-range applications in autonomous driving systems, for example:

- Autonomous driving
- Blind Spot Detection (BSD)
- Lane Change Assist (LCA)
- Forward Collision Warning (FCW)
- Side Collision Warning (SCW)
- Rear Collision Warning (RCW)
- Rear Cross Traffic Alert (RCTA)
- Front Cross Traffic Alert (FCTA)
- Exit Assistant or Door Open Warning (DOW)
- Parking Assistance
- All kinds of 360-degree applications

One or multiple sensors may be integrated into vehicle models by OEMs. Usually, certain OEM-specific engineering efforts are required for the adaptation to specific vehicle models as well as the application of test and qualification procedures. Customer-specific connectors, CAN(FD) or Ethernet interfaces, tracking algorithms, warning algorithms or other software packages can be included.

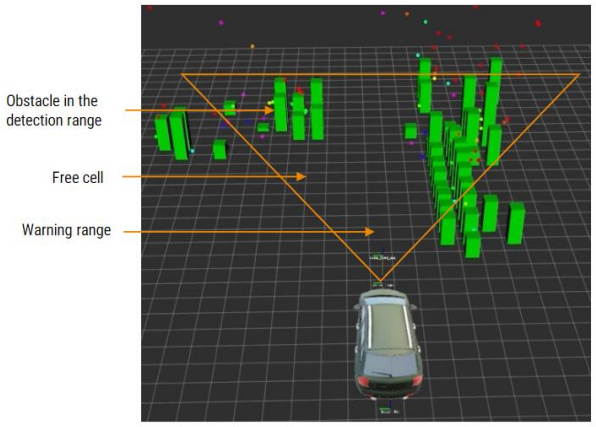
4.2 COLLISION AVOIDANCE

Using the collision avoidance firmware, the sensor comes with a feature called 3D occupancy grid which can be used in a collision warning or collision avoidance system involving slowly driving vehicles - like delivery robots - to provide proximity warning and to avoid collisions with stationary obstacles or slowly moving objects like pedestrians.

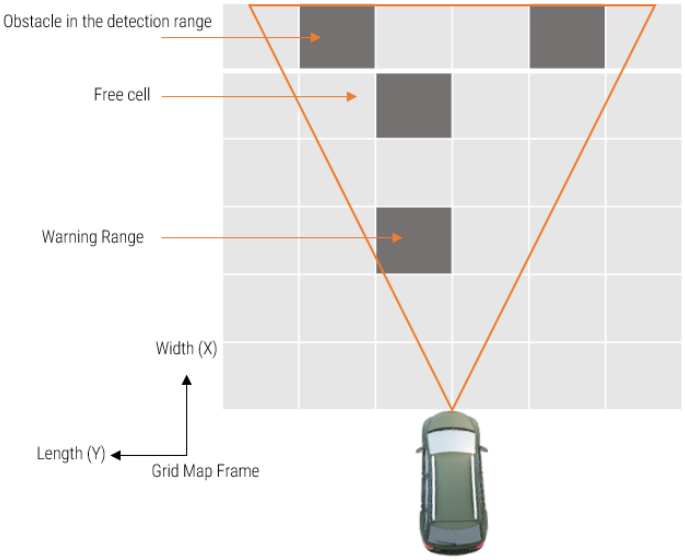
The sensor environment is mapped into 3D grid cells (providing x-, y-, and z-position[8] of the cell), which are monitored and tracked in each sensor update cycle. Vehicles equipped with this sensor can detect obstacles in front of them and it is even possible for the vehicles to decide if an obstacle can be over or under passed.

The sensor does not require any external data input from the vehicle and can be mounted at any position. All algorithms and functions are integrated within the radar sensor, which means that no additional hardware is required.

Collision avoidance can also be combined with the point cloud output.



Grid Map example in 3D



Grid Map example in 2D

[8] The z-position of the occupied cell is not an exact height measurement of the cell but rather a weighed mean height approximation.

Standard configuration:

Parameter	Short-Range Mode (Typical Values)
Range Min./Max.	0.15m/10m | 0.5ft/33ft
Cell Size or Resolution	0.5m | 1.6ft
Grid Map Width	0…10m | 0…33ft
Grid Map Length	-10...+10m | -33…+33ft
Grid Map Size: (Width/Resolution) x (Length/Resolution)	20 x 40 cells
Mounting Height Min./Max.	0m/2m | 0ft/6.5ft
Further Information	
Vehicle Driving Speed	Up to 10km/h | 6.2mph
Obstacle Speed	Up to10km/h | 6.2mph

5 COMPLIANCES

The sensor model complies with the following EU directives:

- RED 2014/53/EU
- RoHS 2011/65/EU
- EC 1907/2006 REACH

Applied standards under RED 2014/53/EU:

- Spectrum Usage:
  - EN 302 264 V2.1.1
- EMC:
  - EN 301 489-1 V2.2.0
  - EN 301 489-51 V2.1.0
- Health and Safety:
  - EN 62311: 2008
  - EN 62368-1: 2014 + AC: 2015

Regarding spectrum usage, this sensor model was tested and certified by independent test labs (formally approved by a test lab or notified body):

- EU RED 2014/53/EU
- FCC part 95M
- ISED RSS-251

This sensor model is also generally compliant with the following regional regulations (but may not be formally tested/approved):

- SRRC
- KCC
- MIIT
- NCC

Note: This statement of compliance means that the sensor allows operation compliant to the listed standards. However, not all standards are certified through test labs. Formal frequency approval or registration is not accomplished for all countries. In certain countries or regions, a customer-specific local frequency approval is reasonable. smartmicro supports customers throughout this process.

6 LEGAL DISCLAIMER NOTICE

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