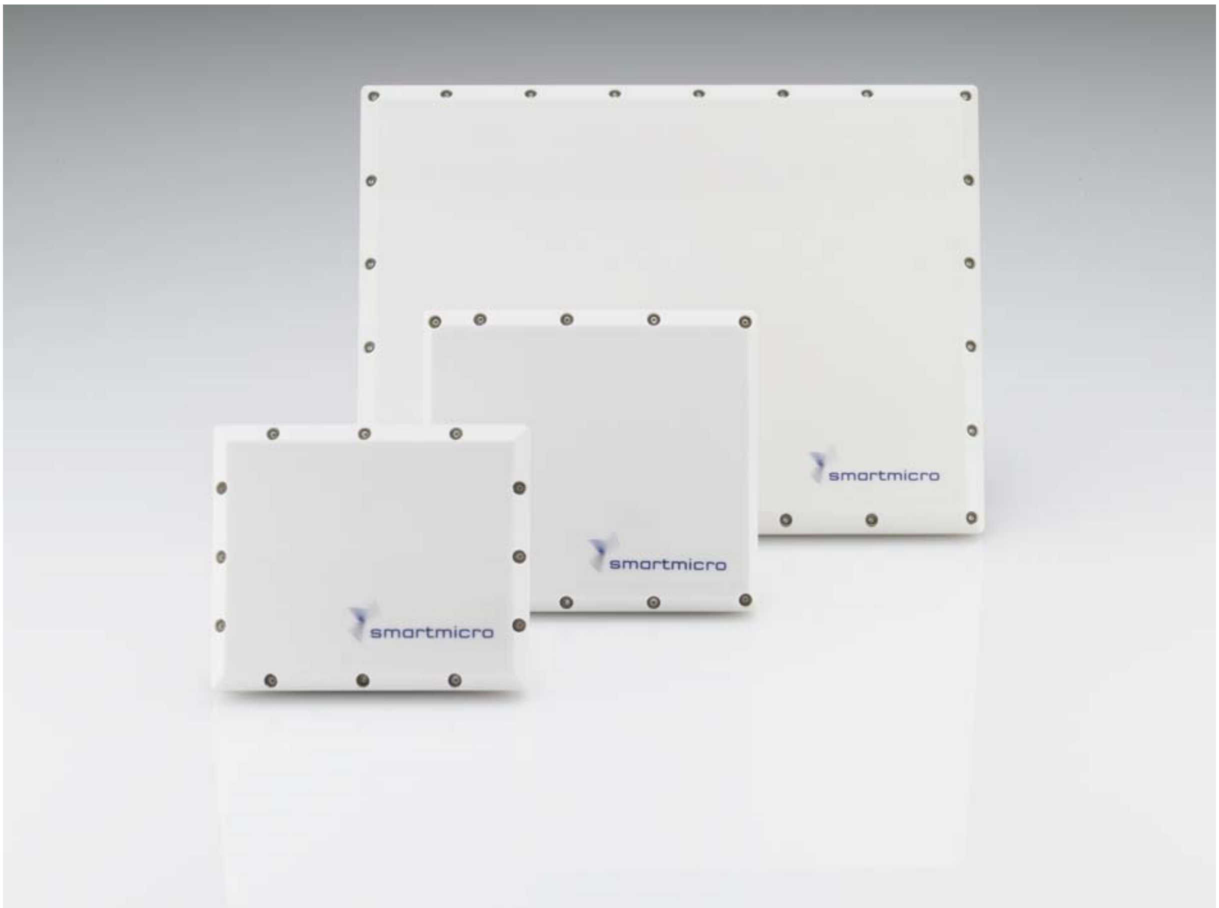
Functional description

UMRR-09

UMRR

Universal Medium Range Radar
Documentation



Contents

1 Intended usage / application

The UMRR-09xx (UMRR) device is used as a field disturbance sensor. The user installs the UMRR on a stationary or moving platform.

As soon as power is applied to the UMRR, transmit and receive start operating. The UMRR sensor permanently monitors the volume within the vicinity of the antenna field pattern (compare section 5).

The sensor itself is not rotated and has no moving parts.

The sensor acts in measurement cycles of 30 .. 150ms. Field disturbance is active throughout every measurement cycle. Results are processed in parallel to watching the scene. Results from the measurement cycles are transmitted on a CAN bus (optional RS485) every measurement cycle.

The subject objects are typically road vehicles and pedestrians. Usually, subject objects are expected within 200m .. 3m to the sensor.

A typical moved platform installation is behind the front bumper of a car. Elevation orientation is almost parallel to the road surface.

A typical stationary application is mounted in above 2.5m height on a pole. Elevation orientation is almost parallel to the road surface - elevation is less than 10 degrees.

All installations have in common that the user is free to select the azimuth orientation angle.

2 Detection Performance Data

2.1 FMCW Narrowband Mode

Parameter	Value
Basics:	
Frequency Band	24.000 GHz to 24.250 GHz Bandwidth < 100 MHz
Transmit Peak Power (Individual Sensor)	<= 20dBm
Antenna:	
Antenna Type	Type 29
Angle Interval (field of View)	Type 29: +-20 degree
Detection Performance:	
Range Interval	Minimum Range: 0.5m Maximum Range: Type 29: 180m/240m (The figures are reflectivity and software limited, first number is a typical value for a car as reflector, second number max. output range)
Range Accuracy	Typical: < 0.25m General: 0.5m + 1%
Speed Interval	Opening: -68.5m/s to –0.1m/s Closing: +0.1m/s to +65.8m/s Defined as absolute world co-ordinates, transformed at run-time to relative speed intervals by using the platform ego-speed. Example: ego-speed = 0: -70m/s (opening) m/s to +70 m/s (closing) Example: ego-speed = 50m/s: -20m/s (opening) m/s to +120 m/s (closing)
Speed Accuracy	Typical: < 0.25 km/h General: ±0.28 at –28m/s .. +28m/s 1% else

Separation of two objects	To be separately detectable, two objects of identical reflectivity must be different in speed >= 0.25ms^{-1}
Tracking Performance:	
Number of simultaneously tracked objects	Up to 32 (can be adjusted by software)
Supply:	
Power Supply	8...32V Single Sensor Power consumption: < 3,5W
Interface:	
CAN Bus	Interface V2.0B(passive) Data rate typically set to 500kbit/s (other data rates possible)
Synchronous Serial IF	Not accessible for customers.
Timing:	
Cycle Time	Typ. <=160ms Depending on Operational Mode, Parameter Settings, CAN communication requirements.
Environmental Conditions:	
Temperature Range	-40°C .. +95°C

3 Radar System Components

3.1 Individual sensors

The main task of the sensor component is the **detection of any obstacles** in the field of view. Range, relative radial speed and angle of each object are measured. Its interface to the central processor is the object list reported cycle by cycle.

Figure 1: Photograph of the UMRR Sensor

Each sensor comprises a CAN port for communication and an SPI port for data logging.

3.1.1 Sensor Hardware Identification

The individual sensors are referred to as

UMRR-P-xxdd-yy-zz

-P	Platform Sensor
-xxdd	(DSP Generation xx, Derivative dd)
-yy	(Microwave Module Generation yy)
-zz	(Antenna Type zz)

Example:

UMRR-P-0708-14-32

where UMRR means the Universal Medium Range Radar platform developed by s.m.s GmbH.

3.1.2 Sensor Software Identification

The sensor software is given as follows:

Example:

Umrrflsh_ID0_RF1208_DSP0436_Rel005_2004-02-18_P_ACCSG_OUV

Umrrflsh	Software for Flash or RAM Download
ID0	Sensor ID in the network
RF1108	RF Module Serial Number
DSP0366	DSP Module Serial Number
Rel005	Software Release
P	Platform Software
ACCSG	Parameter Settings for ACC Stop&Go Application
OUV	Software for Upside Down Mounted Sensor

3.1.3 FCC Label and Label position

The FCC label is placed on one side of the UMRR sensor.

Figure 2 FCC Label

3.2 Block Diagram

The block diagram of the UMRR sensor is shown below.

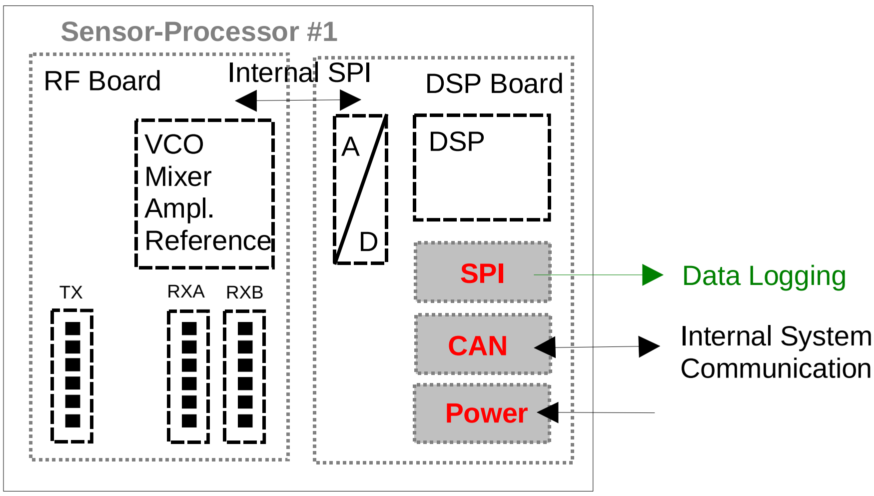


Figure 3 Block Diagram of the Individual Sensor

The UMRR consists of a DSP (digital signal processing) board controlling the RF circuit. All interactions with the user are through the DSP board interfaces, mainly CAN (Controller Area Network) interface.

The DSP board controls the VCO through an internal SPI (Serial Peripheral Interface). The VCO signal is split into transmit and receive path. The transmit path feeds the TX antenna. The receive path feeds mixers for the receive antennas.
The mixer outputs are fed into an A/D converter attached to the digital signal processor. All Signal processing tasks there performed in this device.

Frequency band allocation is permanently controlled through a reference oscillator onboard the RF circuit. The reference is controlled through internal SPI.

The UMRR unit hosts power supervisors and a watchdog. CAN bus has in built jabber inhibit.

4 Sensor System Architectures

4.1 Stationary Applications

The UMRR sensor family can be used for many stationary applications. Among those are:

- Surveillance systems
- Moving objects detection
- Traffic monitoring
- Traffic enforcement
- Rail applications

etc.

In a stationary application, usually the sensor output is a list of detected **targets** (reflectors) on the sensor CAN bus (referred to as *internal CAN*) with the parameters

- Range
- Angle (Position)
- Radial Speed
- Reflectivity level
- Type of Target (Reliability Figure).

In addition to that, status and diagnose data form the sensor are reported.

Usually the tracking (filtering and smoothing of all detected reflectors over time) is done in an additional unit (central ECU BUMPER-08xx or a PC or the like). If required, those tracking algorithms can also be integrated in the sensor.

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

- x position
- y position
- x component of the velocity
- y component of the velocity
- type of reflector
- size of reflector.

When multiple sensors are applied, the data fusion algorithms are typically run on the fusion PC or the fusion central ECU BUMPER08xx.

In any case, a visualization both of the **targets** and the **objects** is possible using the DriveRecorder2 software in any PC equipped with a CAN card.

5 Antenna

5.1 Type 29

This setup is commonly used for long range applications like ACC or similar rear-looking functions.

Parameter	Value
Type	29
Operational Mode(s)	FMSK
Maximum Range (Truck)	240m
Maximum Range (Car)	160m
Max. Range (Pedestrian)	60m
Azimuth 3dB Limits	+-6 degree
Elevation 3dB Limits	+-4 degree
Max. Az. Field of View	+-20 degree
Antenna Type	Patch Antenna
Housing Type	5.6(.x) / 5.7

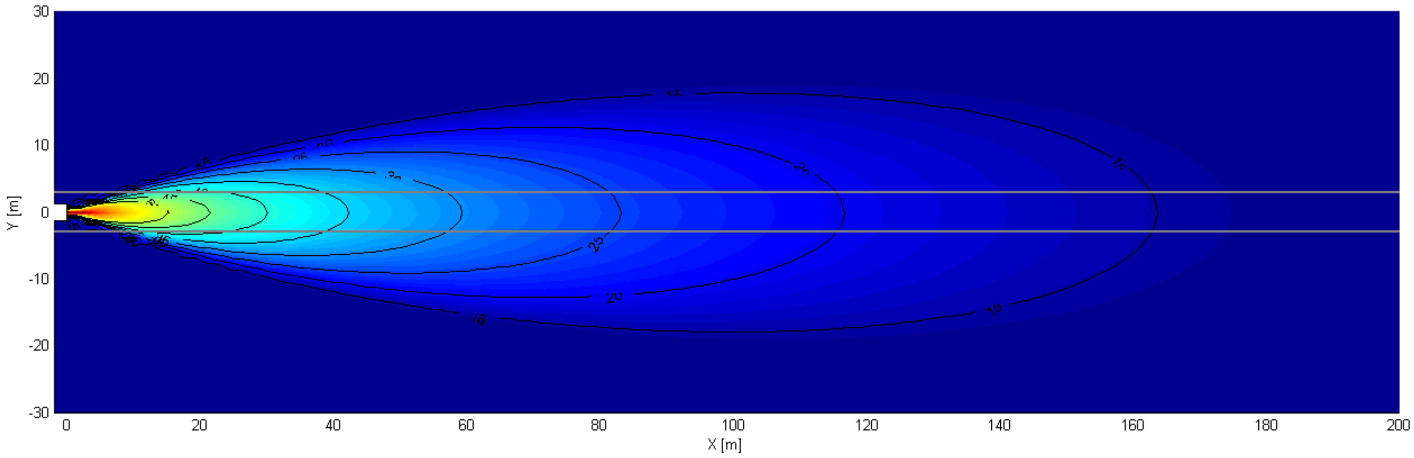


Figure 4: Type 29 antenna single sensor setup.

6 Cables and Connectors

The set of cables and connectors comes prepared with the sensor system to avoid damage due to pinout mismatches.

6.1 Sensor Connector

Mounted on the back side of the radar there is a 8 pin male circular connector (waterproof IP67 series 702, manufacturer Binder GmbH, Germany). You must connect a female counterpart (see drawing):

Figure 5: Sensor Connector (UMRR Housing 5.6.1)

Figure 6: Sensor Connector (UMRR Housing 5.7)

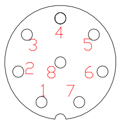


Figure 7: Female counterpart of sensor connector (rear view)

Sensor Version UMRR9.xx:

Pin	UMRR-yyxx	Color (New Cables)
1		
2	GND	Blue = GND
3		
4	CAN_L	Yellow = CAN_L
5	CAN_H	Green = CAN_H
6		
7	+8V...+32V	Red = +8V...+32V
8		

Table 1: Sensor Connector Pinout

7 Mechanical Interface

7.1 Single Sensor Housing Version 5.6.1

Sensor Housing: **WxHxD: 110mm x 99mm x 30mm**
Weight: **455g (Al body)**

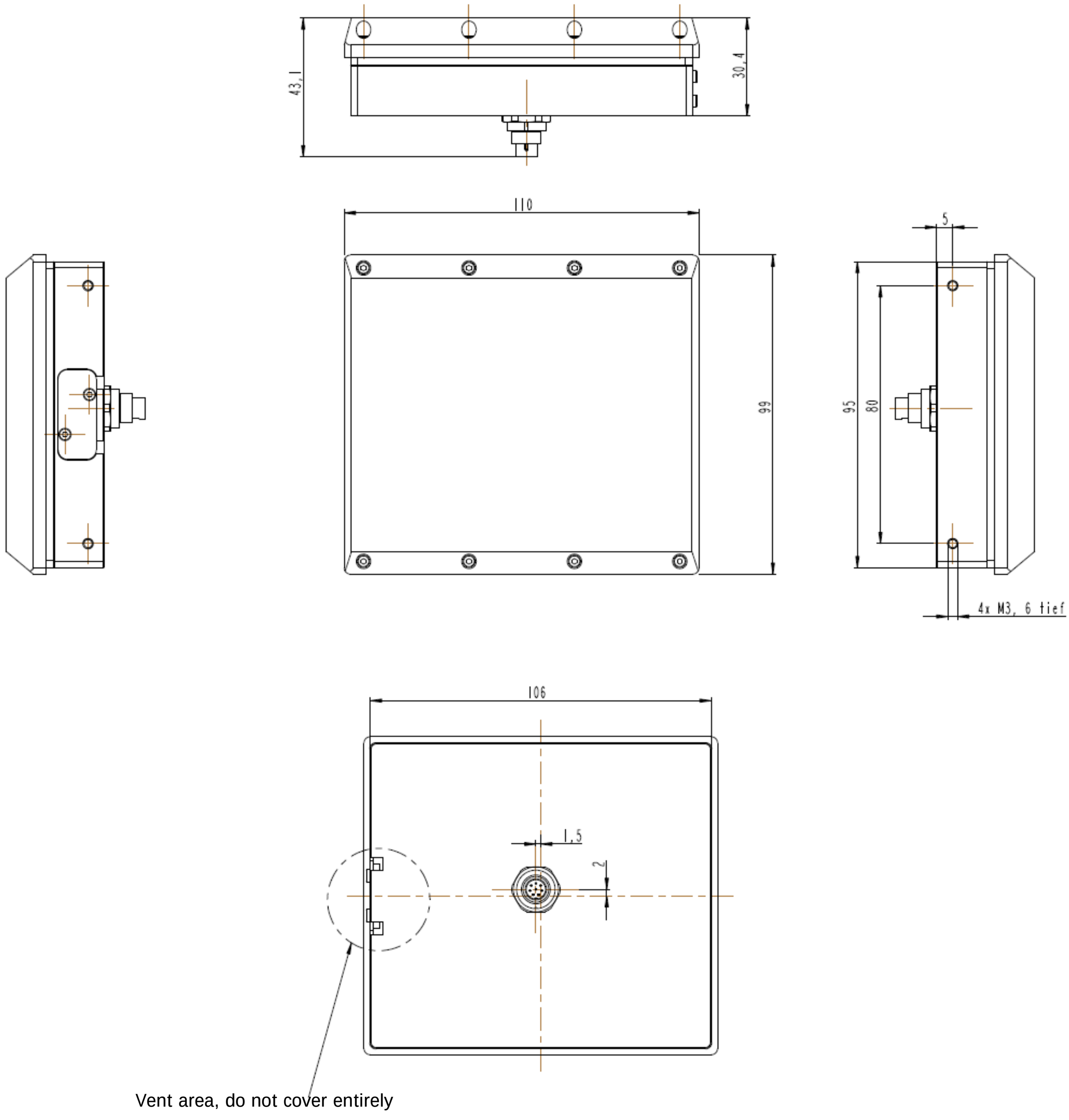


Figure 8: Housing V5.6(.x) aspects

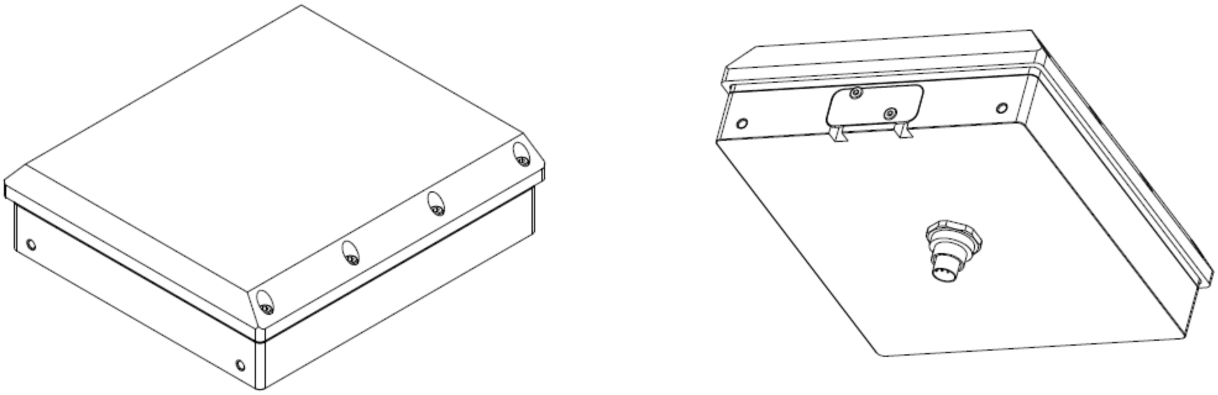


Figure 9: 3D representation of Housing V5.6(.x)

7.2 Single Sensor Housing Version 5.7

Sensor Housing: **WxHxD: 110mm x 99mm x 30mm**
Weight: **421g (Al body)**

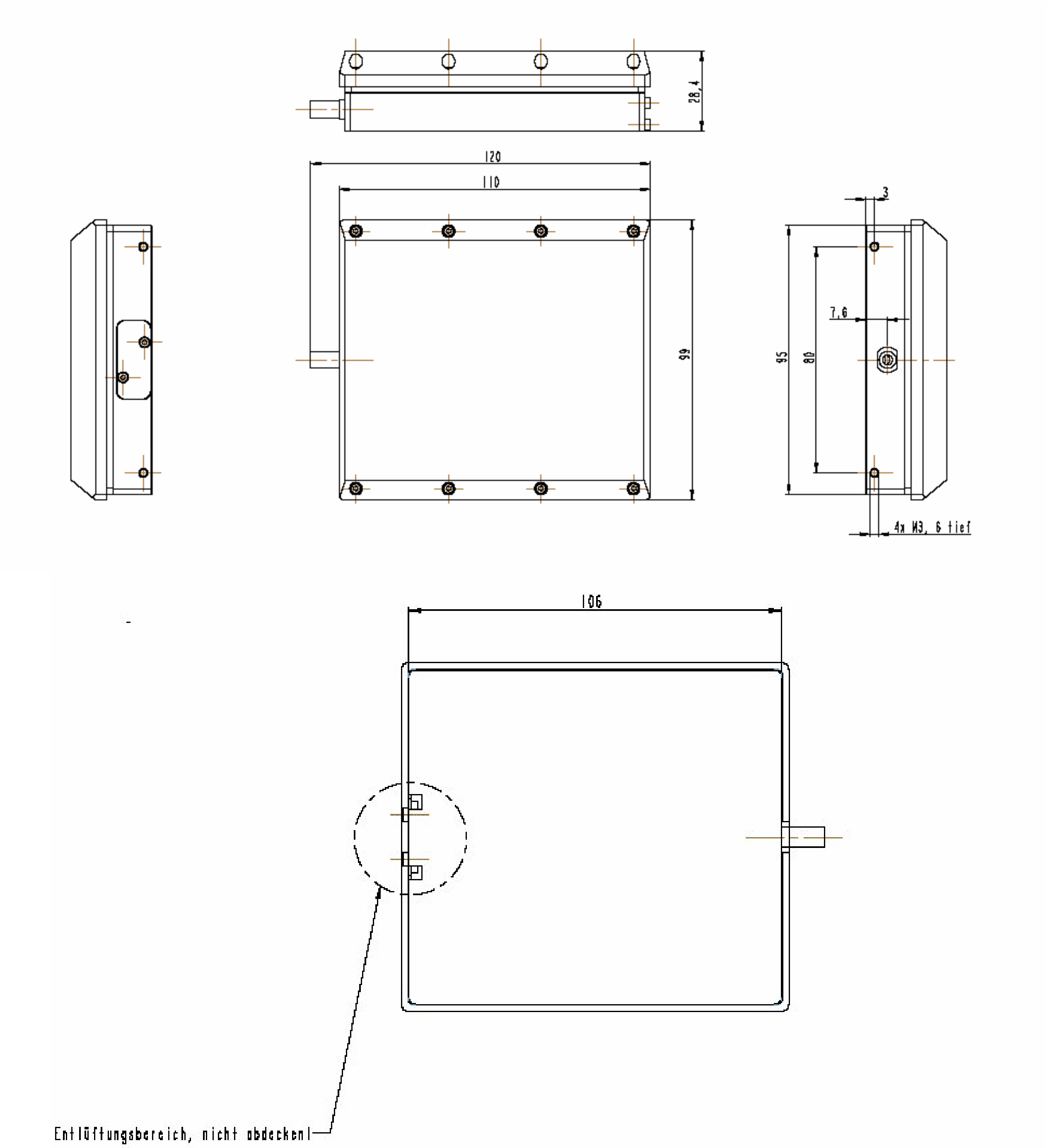


Figure 10: Housing V5.7 aspects

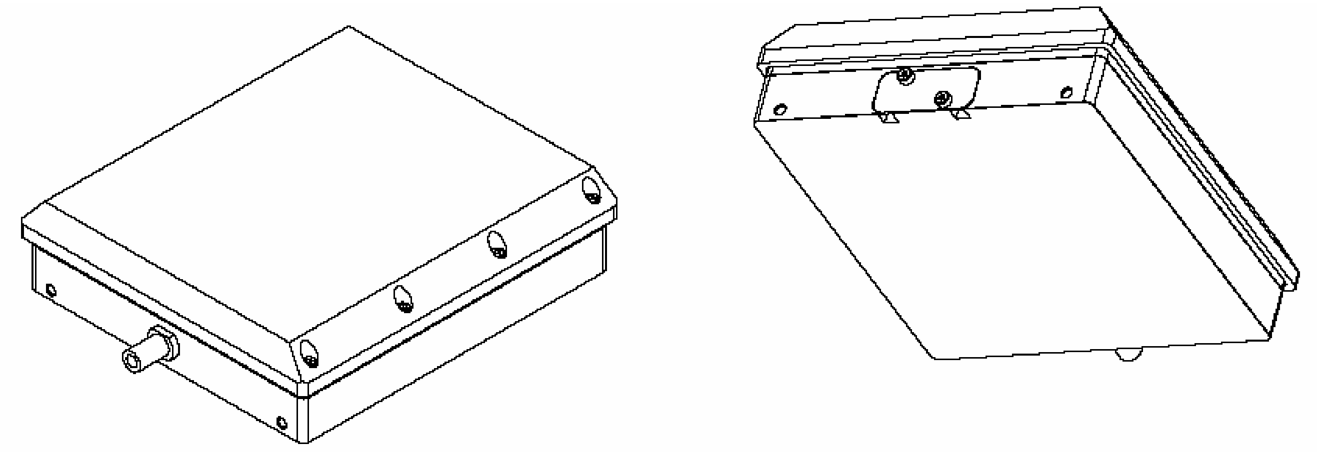


Figure 11: 3D representation of Housing V5.7

7.3 Coverage of the sensor

The sensors have a weather proof plastic radome, which is optimized along with the antenna. It is not necessary to protect the sensors by any additional means.

Hence, for an optimum detection performance, do not mount the radar behind bumper material or similar covers. The effective range will then be reduced depending on the transmission attenuation of the material.

If, however it is required to hide the sensors for design or other reasons, the may be mounted behind other non-conductive materials.

8 Co-ordinate System

Figure illustrates the co-ordinate system of a **radar system** .
- the data are reported in Cartesian co-ordinates.

If sensors are used **stand-alone**, without the central ecu, they report the targets in a sensor co-ordinate system which is specified similar to the picture given below.

- The sensor position respresents the origing then
- The sensor pointing direction is equal to the x-axis
- The data are reported in polar co-ordinates.

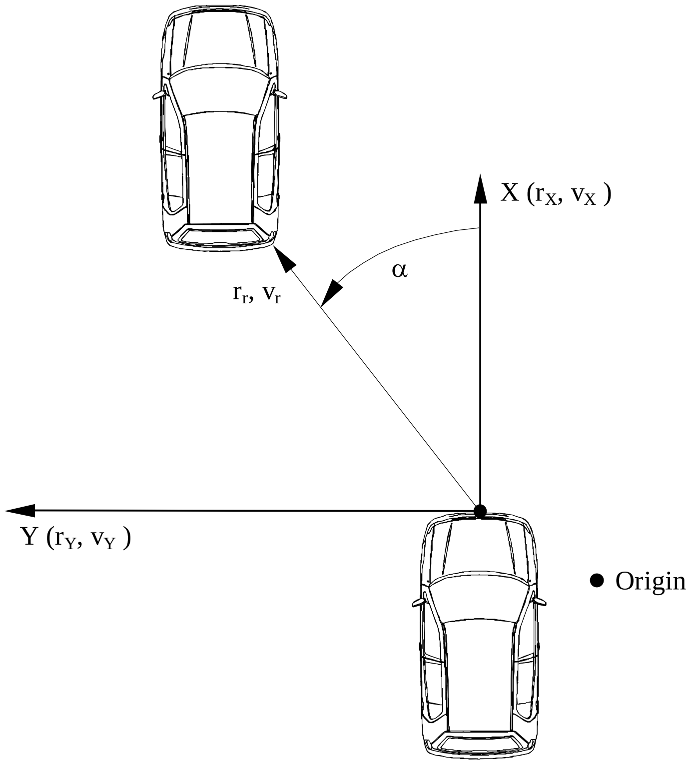


Figure 12: Drawing of co-ordinate system

Variables:

r_X – range in X-direction
r_Y – range in Y-direction
v_X – speed in X-direction
v_Y – speed in Y-direction

r_r – range radial
v_r – speed radial
α – angle

9 Declaration of Conformity for USA

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.
Usually this is followed by the following FCC caution:
Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.
-- Increase the separation between the equipment and receiver.
-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-- Consult the dealer or an experienced radio/TV technician for help.