Project Documentation | UMRR Automotive Sensor Data Sheet

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1 Sensor Data Sheet

Smartmicro offers a family of automotive Radar sensors called UMRR – Universal Medium Range Radar.

A number of different antennas are available - so the permanent fixed field of view and max. range can be selected by the customer.

This data sheet describes the type 40 antenna model (all model specific values are highlighted).

Type 40 Antenna aims at very long range with wide horizontal angular coverage.

1.1 Sensor Photograph

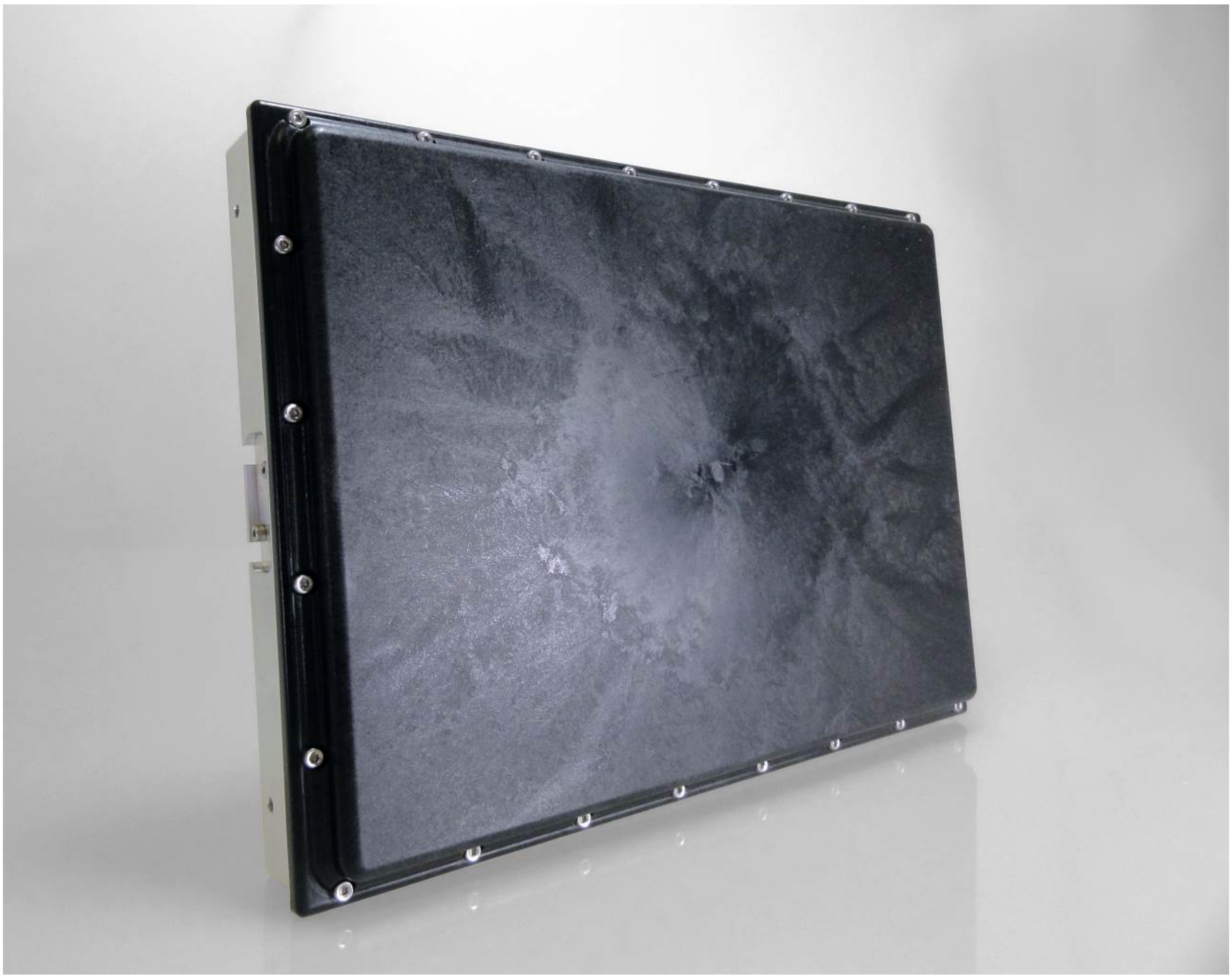

Figure 1: Automotive Sensor Type 40 - front.

Figure 2: Automotive sensor type 40 - rear.

1.2 Function Description

The sensor is a robust 24GHz Radar for automotive applications.

It works in adverse conditions, almost unaffected by weather, and independent of sunlight, in a wide temperature interval.

The customer can select from a number of antenna and housing models which determine the permanent fixed field of view and range. Type 40 Antenna aims at very long range with wide horizontal angular coverage, very high sensitivity.

One individual sensor measures range, radial speed, az. angle, reflectivity and other parameters of multiple stationary and moving reflectors (**targets**) simultaneously. The following **3D detection** principle is integrated:

a) Direct Doppler measurement (including Doppler = 0)
b) Direct Range measurement
c) Direct Azimuth Angle measurement

Having multi target capability, the sensor can **detect** many reflectors at a time (**up to 256**) being within the field of view. Azimuth angular measurement is accomplished using digital beam forming (DBF).

Additionally filter algorithms are implemented for the tracking of all detected reflectors over time, those tracking algorithms are integrated in the sensor. **Multiple objects (max. 256)** are tracked simultaneously.

Hence the sensor reports such a list of all tracked objects inside its field of view in every measurement cycle of typ. 40...79ms length (depending on configuration).

The sensor is also capable of detecting stationary reflectors and objects with relative speed = 0. Stationary reflectors are processed in a stationary target grip (STG) which automatically builds a map of the radar's stationary environment whilst driving or when stopped. In this way, road- , building- or other vehicle's 2D structures or shapes can be mapped.

Note: In practice, especially at long ranges, stationary clutter (unwanted infrastructure reflectors) may not always be distinguishable from automotive reflectors, i.e. stopped vehicles.

1.3 Object Separation Performance

The sensor measures object co-ordinates of multiple objects simultaneously in **3D**, i.e. range speed and azimuth angle, or x, y and speed vector. However, what counts even more is the object separation capability where many vehicles are closely spaced, i.e. in multi-lane scenarios with dense traffic, like traffic jams, stop-and-go traffic and busy intersections

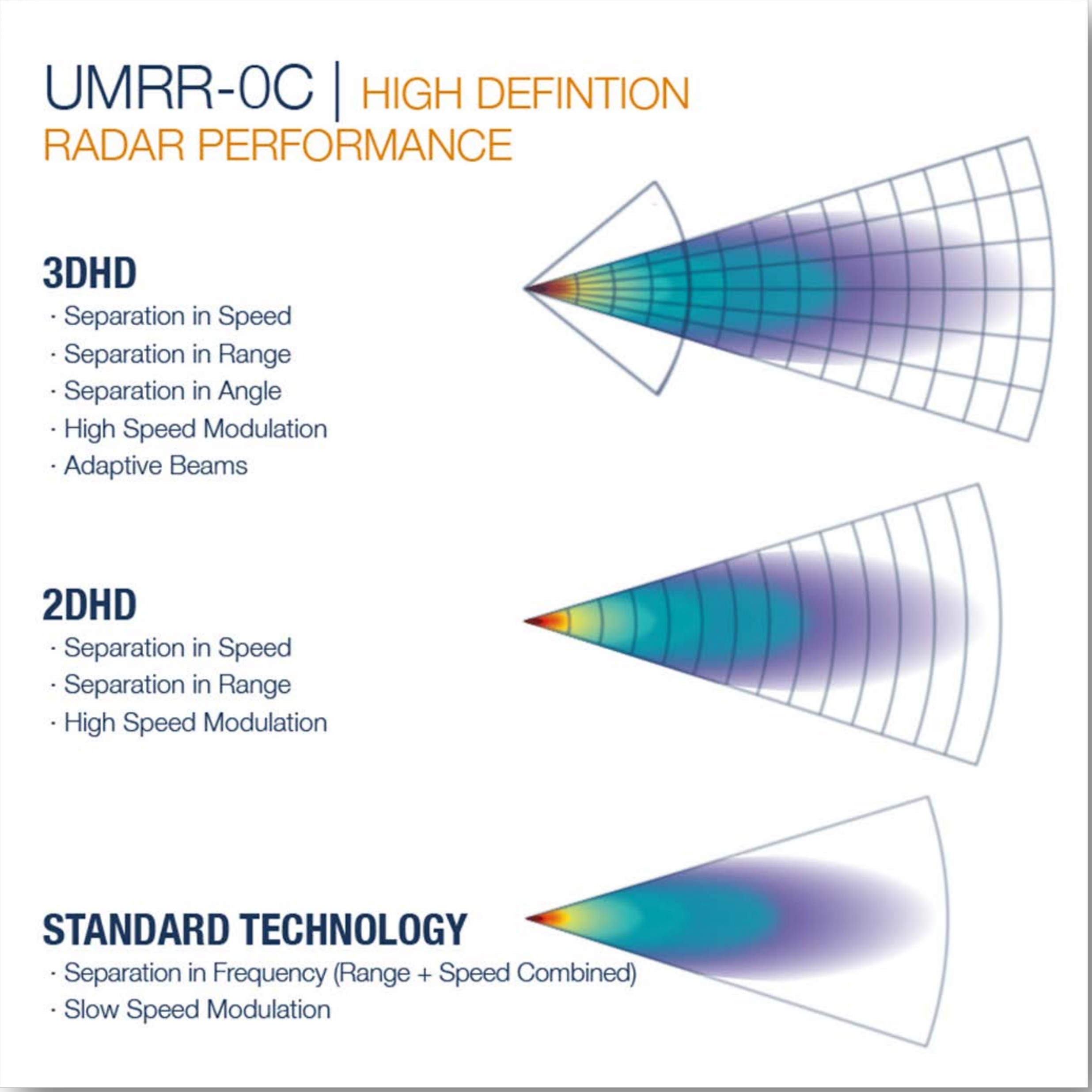

Figure 3: Object Separation Capability.

UMRR-0C type 40 features a technology called 2**DHD**. For each reflector, UMRR-0C can accomplish range gate specific and az. angular gate (beam) specific detection of moving and stationary vehicles. In each of these gates a separate Doppler detection is accomplished. Figure 3 explains the principle.

The sensor provides excellent target/object separation capabilities (2DHD).
Individual reflectors are separated in the detection algorithms by:
a) having a different radial speed value **OR**
b) having a different range value

Nominal separation values (meaning bin to bin distance or beam to beam distance):
speed: 0.13m/s, range: 1m.

Notes:
This configuration: 150MHz freq. sweep, 79ms cycle time. Real separation values are typically factor 1.0-2.0 x nominal values, if no super resolution algorithms are applied. Tracking algorithms, STG, super resolution and other algorithms further support the practical separation of objects.

1.4 Antenna Characteristics

1.4.1 Beam Pattern

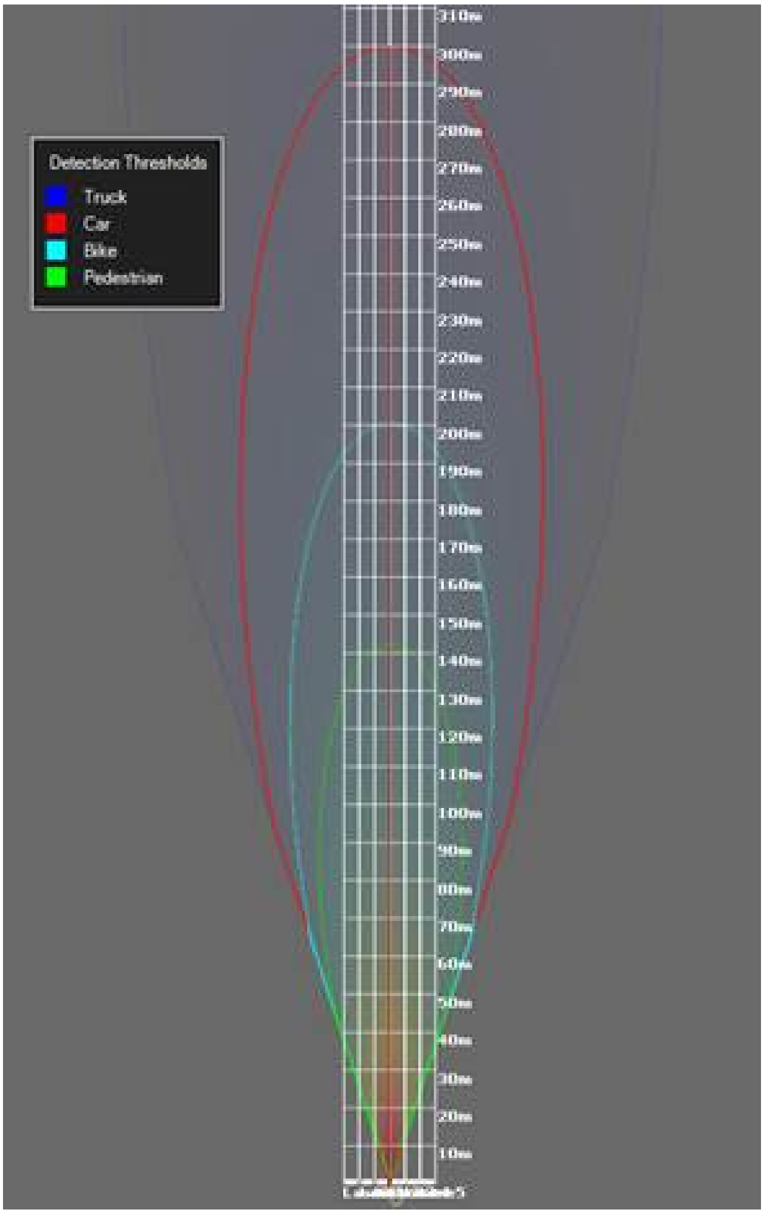

Figure 4: Beam Pattern Type 40 Range values given for 20dBm EIRP

1.5 Data Interfaces

1.5.1 Target List

Having multi target capability, the sensor will **detect** many reflectors at a time (**up to 256**) being within the field of view. Depending on the selected communication interface, the number of reported targets may be limited to 128. Targets are sorted by range and if more than 128 are detected, short range targets are reported first. Target list interface is unfiltered, uncorrelated, model-free and reported every cycle.

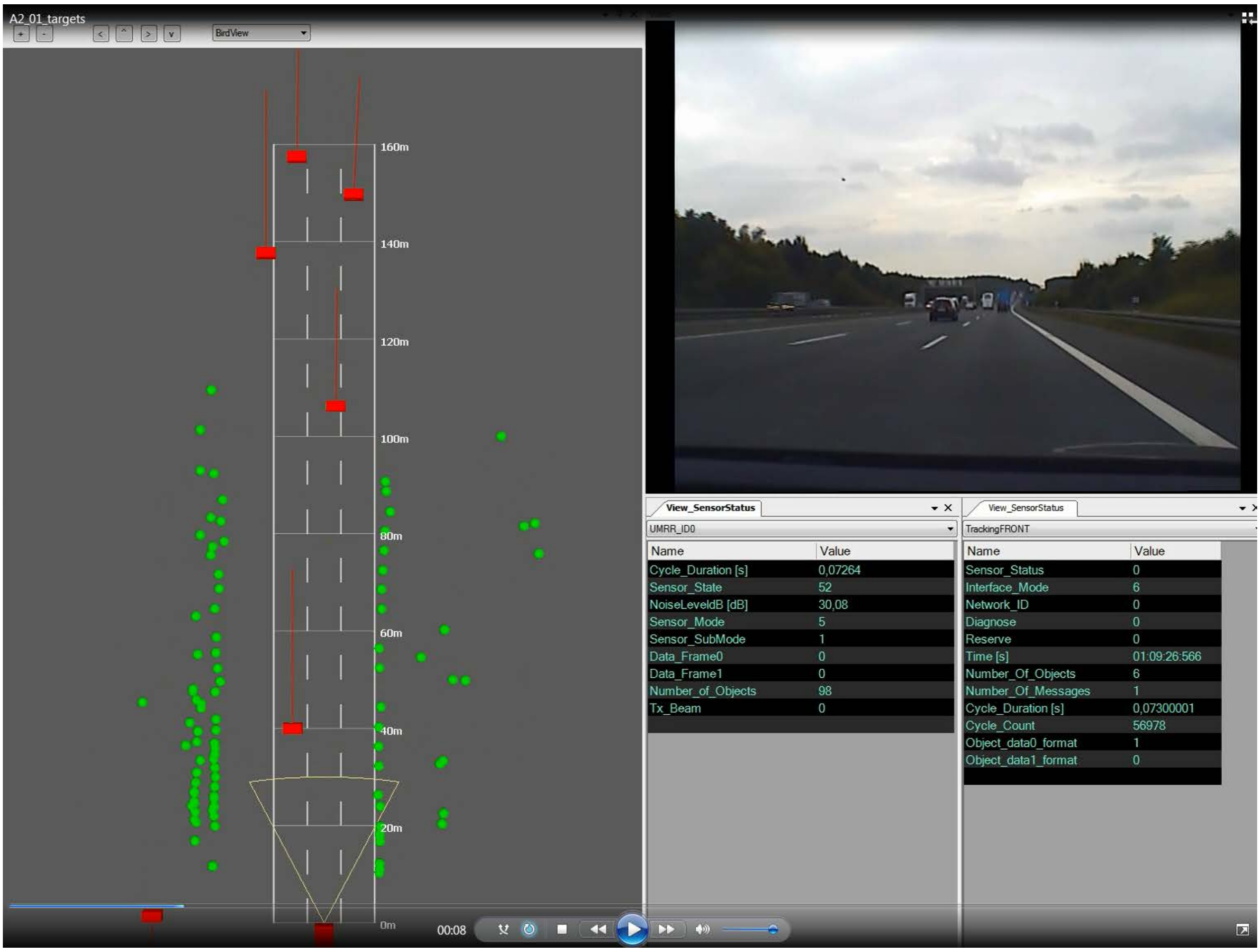

Figure 5: Target (green) and Object (red) Visualization

1.5.2 Object List

Filter algorithms are implemented for the tracking of all detected reflectors over time, those tracking algorithms are integrated in the sensor. **Multiple objects (max. 256)** are tracked simultaneously. Depending on the selected communication interface, the number of reported objects may be limited to 126. Objects are sorted by range and if more than 126 are tracked, short range objects are reported first.

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, other…

1.5.3 Stationary Target Grid (STG)

Stationary reflectors are processed in a **stationary target grid** (STG) which automatically builds a map of the radar's stationary environment whilst driving or when stopped. In this way, road- , building- or other vehicle's 2D structures or shapes can be mapped. This interface is available in real-time via Ethernet interface only.

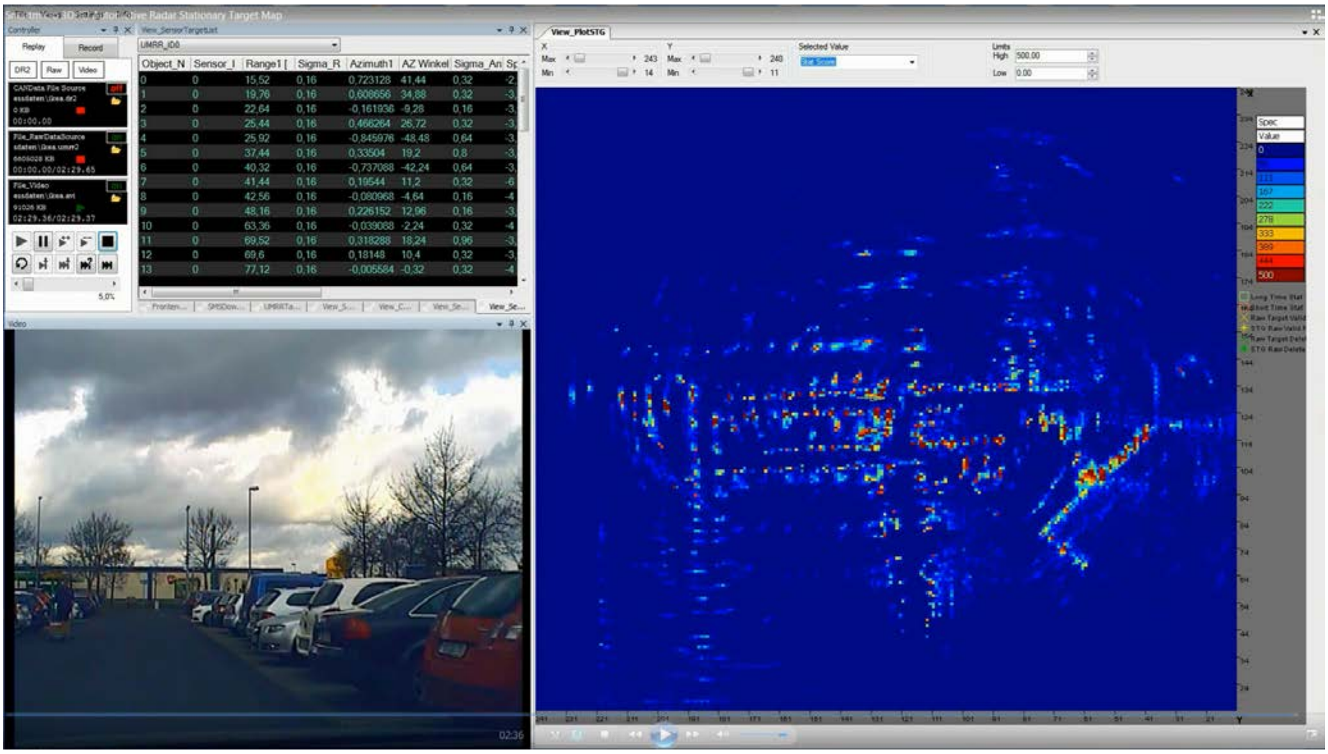

Figure 6: Stationary Target Grid Visualization

1.6 General Performance Data

Parameter	Value	Unit
Sensor Performance		
Max. Range on Passenger Car	350[I] (@20dBm) / 230[I] (@12.7dBm)	m
Max. Range on Truck	450[I] (@20dBm) / 350[I] (@12.7dBm)	m
Instrumented Range	450	m
Minimum Range	1.5	m
Range accuracy	Typ. < ±2.5% or < ±0.25m (bigger of)	%, m
Radial Speed Interval	-68.3 ...+68.3 (±88.8 available)	m/s
Minimum abs. Radial Speed	0.1	m/s
Speed accuracy	Typ.< ±0.28 or ±1% (bigger of) [II]	m/s
Angle Interval (total field of view)	-6 ...+6 (El.); -18 ...+18 (Az.)[III]	degree
Update time	≤ 79	ms
Environmental		
Ambient Temperature	-40 ... +74	degree C
Shock	100	g_{rms}
Vibration	14	g_{rms}
IP	67[IV]	
Pressure / Transport altitude	0...10.000	m
Mechanical		
Weight	1290	g
Dimensions	See 1.9	
Model No.	**0Cxxxx-28xxxx**	
DSP Board – Antenna Identification	0Cxxxx-28xxxx	
Housing Identification	0707xx	
General		
Power Supply	13 ... 32[V] 12[VI]	V DC W
Frequency Band	24.0...24.25	GHz
Bandwidth	< 250	MHz
Max. Transmit Power (EIRP)	<20 (<12.7 for certain regions)	dBm
Interfaces	CAN V2.0b (passive)[VII, VIII] RS485 full duplex [VII, VIII] 10/100 Ethernet [VII,]	
Connector	12 Pin plug Hirose LF10WBRB-12PD	CAN, Power, RS485, Eth.

[I] Typical values; may vary to higher or lower values depending on clutter environment. All values given for bore sight. Please note that the Radar system – like any other sensor system – although being well optimized and providing excellent performance, will not achieve a 100% detection probability and will not achieve a false alarm rate equal to zero.
[II] Measured on object having const. radial speed, at bore sight.
[III] Total field of view is angle interval where reflectors can be detected; 3dB field of view is narrower.

[IV] IP 67 only when connector or cap attached.
[V] measured at connector; min. voltage slew rate 500V/s or max. voltage rise time 15ms; supply source impedance 0.5Ohms.
[VI] Power consumption at 20°C. Power consumption varies with temperatures: 10W … 17.5W at +74°C
[VII] It is recommended to use an external surge protection for power, CAN, RS485, Ethernet and other interface ports.
[VIII] RS485 and CAN have limited bandwidth and may not be able to provide all data interfaces to full extent.

1.6.1 Start-up time

After power up or reset, the sensor readings are within specified performance within < 1 second(s).

1.6.2 On-board diagnostics (BIT)

The UMRR sensor cyclically reports a status message providing the following information (Continuous BIT)

- Sensor run time
- Sensor cycle time
- Sensor mode
- Other status bits

Initiated BIT is available. Sensor will send BIT results when it receives a command to do so.

1.6.3 Sensor Network

The sensor is typically used standalone.

1.6.4 Real Time Clock and Storage

The sensor has a real time clock on board.

1.6.5 Attitude Sensor, Gyro, Digital Compass.

The sensor has a 3-axes attitude Sensor, 3-axes gyro and digital compass on board.

1.6.6 Compliance

ETSI EN 300-440, FCC part 15, RSS-310, RSS-210, SRRC, KCC, NCC
CE
ROHS

Note:
Parts of the UMRR-0C device may be hot. To ensure protection against accidental contact and fire protection, operate this device only with observe safety instructions according EN 60 950-1, corresponding UL Standard or national safety regulation.

1.7 Physical Interfaces

1.7.1 Ethernet

10/100Mbit/s

1.7.2 CAN Bus

Can V2.0b
500kBit/s standard baud rate.

1.7.3 RS485

Full Duplex Operation
115kBit/s standard baud rate.

1.8 Sensor Description and Hardware ID

Every UMRR sensor housing is tagged with a type sticker containing the product description and the serial number. It also contains a mark which side of the sensor is top.

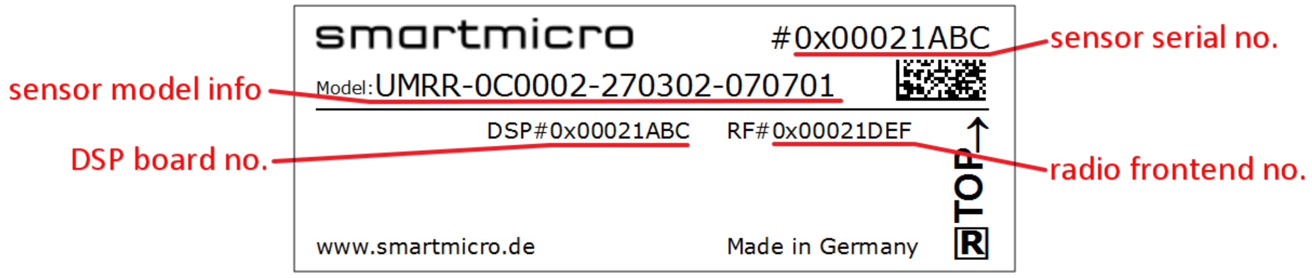

Figure 7: Type sticker example

The individual sensors are referred to as **UMRR-xxyyzz-aabbcc-ddeeff**

-xx (DSP Board Generation xx)
-yy (DSP Board Derivative/Version yy)
-zz (DSP Board Revision zz)

-aa (RF Board (Antenna) aa)
-bb (RF Board Derivative/Version bb)
-cc (RF Board Revision cc)

-dd (Housing type dd)
-ee (Housing Version ee)
-ff (Housing Revision ff)

UMRR means Universal Medium Range Radar platform developed by Smartmicro.

The number in the top right corner is the unique serial number of the sensor. In addition to that the used DSP board and the RF board got their own unique serial numbers.

1.9 Sensor Dimensions

All values given in mm.

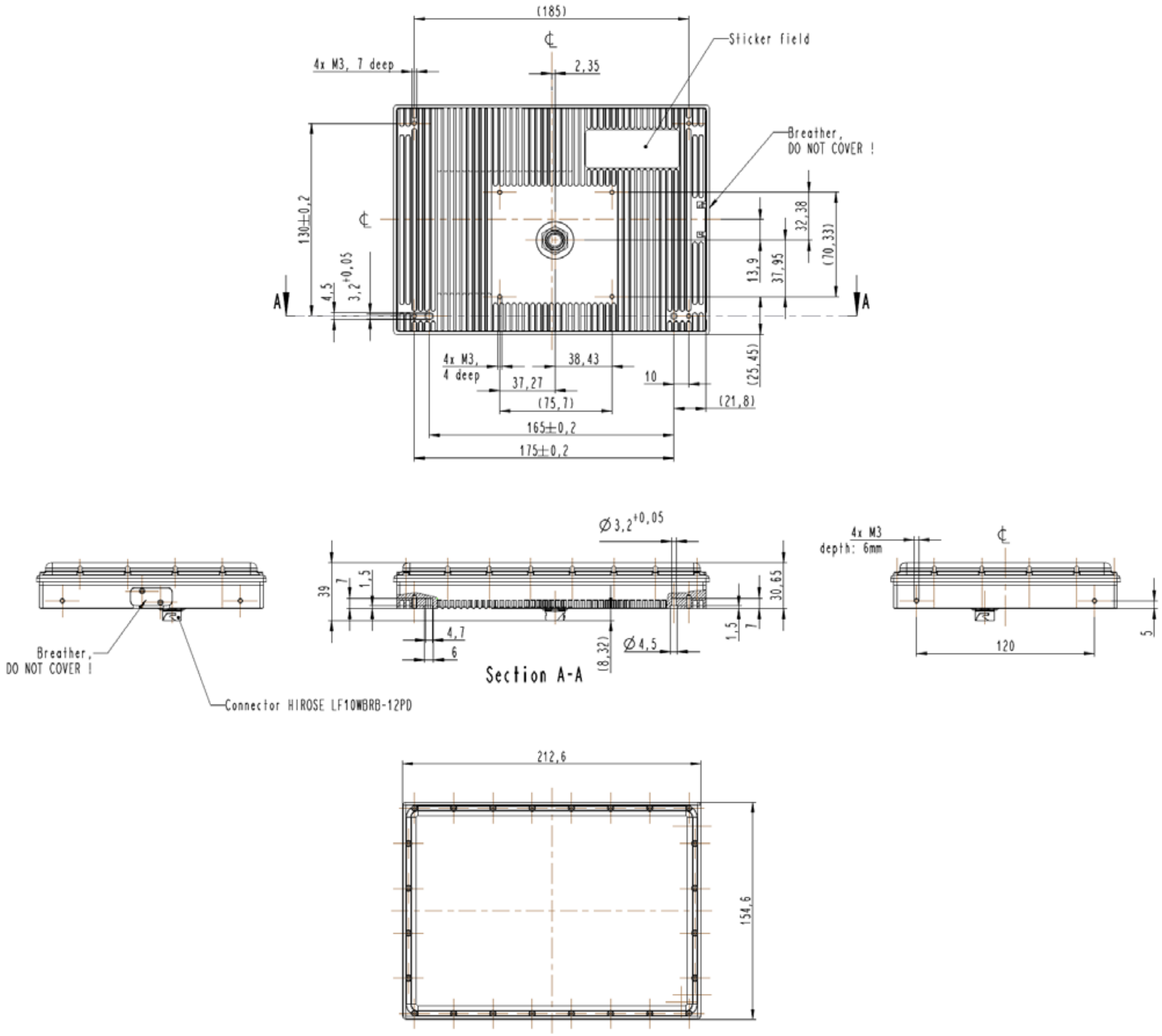

Figure 8: Sensor Dimensions.

1.10 Connector

The used sensor connector is a 12-pin male (plug) circular bayonet type connector (water proof IP67, series LF10WBRB-12PD, manufacturer Hirose, Japan). A female counterpart (socket), e.g. LF10WBP-12S, has to be used to connect to the sensor. The pin numbering of the socket is shown in Figure 9 the pin description is given in Table 1.

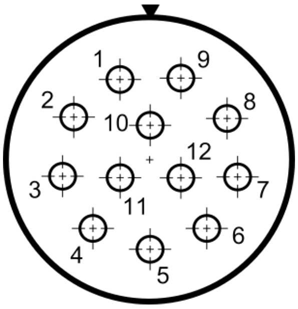

Figure 9: View on solder cup side of socket (rear view of female counterpart to be connected to sensor)

Table 1: Sensor connector pin out model UMRR-0Cxxxx

Pin No.	Function	Wire Color (MEDI type #KU110C12J002)
1	Sensor Ethernet TX H	gray / red
2	Sensor Ethernet TX L	red / blue
3	Sensor RS485 RX L	pink
4	Sensor RS485 RX H	gray
5	Sensor RS485 TX L	brown
6	Sensor RS485 TX H	white
7	Sensor_GND	blue
8	Sensor_Vcc	red
9	Sensor Ethernet RX L	black
10	Sensor Ethernet RX H	purple
11	CAN H	green
12	CAN L	yellow

Please note that in the standard configuration the sensor has no 120 Ohms resistor on board (CAN bus termination between CAN L and CAN H). The resistors are nevertheless required at either end of a CAN / RS485 bus and are in most cases integrated in the cable delivered along with the sensor (if cable is manufactured by Smartmicro).

For the RS485 data interface there is a 120 Ohms resistor on board of the sensor.

A number of cable sets for initial operation and test purposes are offered by Smartmicro, to deliver a fast set-up of a sensor system. Among those preconfigured ready-to-run cables as well as cable stumps (pig tail cables or various lengths) which carry the connector on one side and open wires on the other.

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