Project Documentation | UMRR Traffic Management Sensor Data Sheet

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2 Sensor Data Sheet

Smartmicro offers a family of traffic Radar sensors called UMRR – Universal Medium Range Radar. Within this family, four different Radar generations exist: UMRR-0A, UMRR-0F, UMRR-11 and UMRR-0C.

UMRR-11 is a High Definition multi-lane, multi-object tracking traffic Radar and features **4D/HD** capabilities.

UMRR-11 is the replacement for UMRR-0A and UMRR-0F generations.

For each Radar generation, 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 UMRR-11 Type 44 antenna model (all model specific values are highlighted).

Type 44 Antenna aims at medium range with wide horizontal angular coverage.

Type 44 Antenna replaces Type 30 antenna and exceeds its properties.

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2.1 Sensor Photograph

Figure 1: Traffic Sensor Type 44 - Front.

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Figure 2: Traffic sensor Type 44 - Rear.

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2.2 Function Description

The sensor is a robust low cost **4D/HD** 24GHz Radar for traffic management 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 44 Antenna aims at medium range with wide horizontal angular coverage.

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

4D/HD

4-dimensional Doppler based radial motion detection (> 0.1m/s), including:

a) Direct Doppler measurement
b) Direct Range measurement
c) Direct Azimuth Angle measurement
d) Direct Elevation Angle measurement

Reflectors having a radial speed component of typ. abs. >0.1m/s are detected.

Having multi target capability, the sensor may 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. Targets are sorted by range and short range targets are reported first.

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. 126)** are tracked simultaneously. Depending on the selected communication interface, the number of reported objects may be limited. Objects are sorted by range, 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…

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Hence the sensor reports such a list of all tracked objects inside its field of view in every measurement cycle of typ. 75ms length (depending on configuration).

The field of view typically covers up to six lanes.

The sensor is capable of detecting stationary objects.

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Object Separation Performance

Measuring object co-ordinates of multiple objects simultaneously in 4D, i.e. range speed, azimuth and elevation angle, or x, y and speed vector, is state of the art.

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

The sensor provides excellent target/object separation capabilities (4D/HD).
Individual reflectors are separated in the detection algorithms by:

a) having a different radial speed value (difference > 0.25m/s) **OR**
b) having a different range value by 2.5m or 5m (depending on selected bandwidth)
having a different range value by 8ft or 16ft (depending on selected bandwidth)

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Tracking algorithms and data base further support the separation of objects.

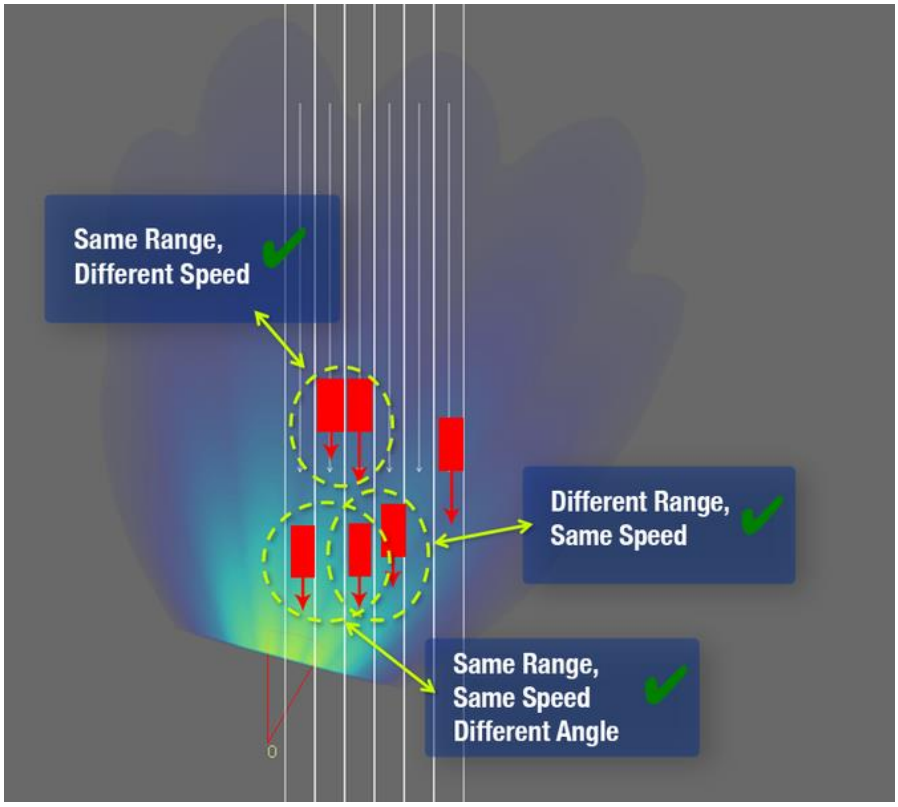

Figure 3: Object Separation Capability.

UMRR-11 features 4D/HD technology. For each reflector, there is a true measurement of the **4 dimensions** range, Doppler, horizontal and vertical angle.

UMRR-11 can now accomplish range gate specific detection of moving and even stationary vehicles. In each of these gates (HD) a separate Doppler detection is possible, including stationary detectors. Figure 3 explains the principle.

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2.3 Application Characteristics

2.3.1 Intersection Management

At intersections, the sensor is typically used for stop bar detection.

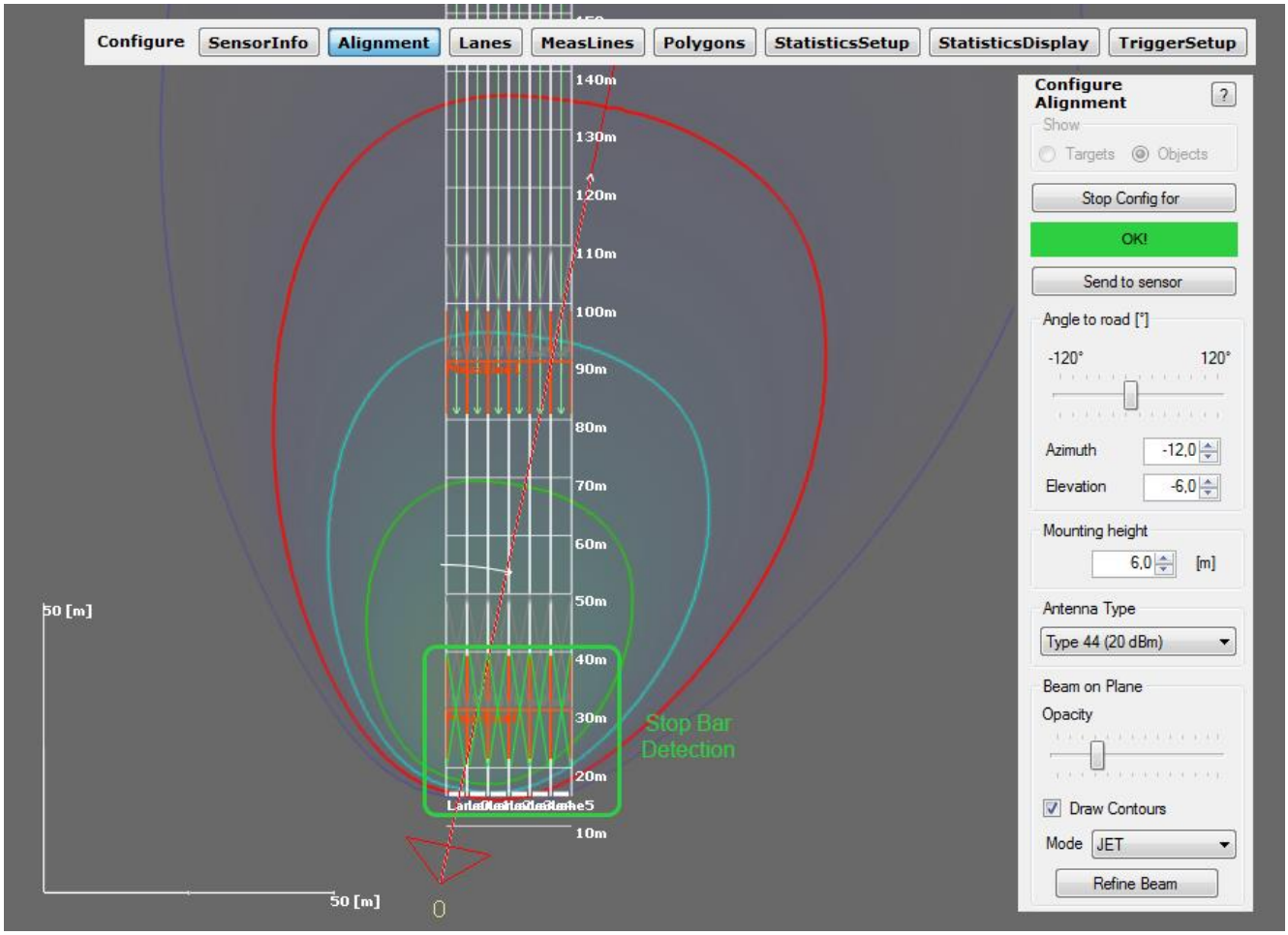

Figure 4: Stop Bar Detection Type 44

The sensor is usually mounted at the corner of an intersection on a vertical pole. Other mounting positions (gantry, mast arm, luminaire) may be possible. The **standard configuration** for Type 44 sensor for intersection applications is shown in Figure 4 and its parameters are given in Table 1.

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Table 1: Standard Configuration for Stop Bar Detection Type 44

Parameter	Value
Traffic Direction	Typ. Approaching
Mounting Height	Typ. 6m (1...10m)[I] Typ. 20ft (3...33ft)[I]
Sensor Azimuth angle	Typ. -12° (-15 ...+15 deg.)[II]
Sensor Elevation angle	Typ. -6° (-9...0 deg.)[II, III]
Stop Bar Distance	Typ. 30m (20m … 50m)[IV] Typ. 985ft (66 … 164ft)[IV]

[I] May affect max. detection range. The best performance is typically achieved for mounting heights between 2-8m. Occlusion needs to be considered.
[II] Smaller absolute angles allow longer detection range along a road.
[III] Application specific. Gantry mount: steeper e. angle possible, with limitations of maximum range. Negative elevation angle means sensor pointing towards road.
[IV] Typical value for stop bar applications; may be different for other applications.

The sensor is typically used standalone. Up to four sensors can usually be mounted at or around an intersection using separate configurable frequency channels, avoiding mutual interference.

UMRR-11 Stop Bar+ 4D/HD	• **Stop bar detection** • **Loop replacement** (non-intrusive detection) • **Custom trigger** conditions (e.g. location, vehicle speed, classification) • **Speed** measurement • **Range** is limited to 80m (262ft)

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2.3.2 Arterial Management

On highways and country roads, the sensor is typically used to count and classify traffic. Usually are selected and reported in configurable counting /statistics intervals.

The sensor delivers the following data:

- Volume
- Occupancy
- Average Speed
- Vehicle Presence

The data can be retrieved in Push Mode

a) in low data volume as aggregated statistics output
b) as per vehicle record (PVR)

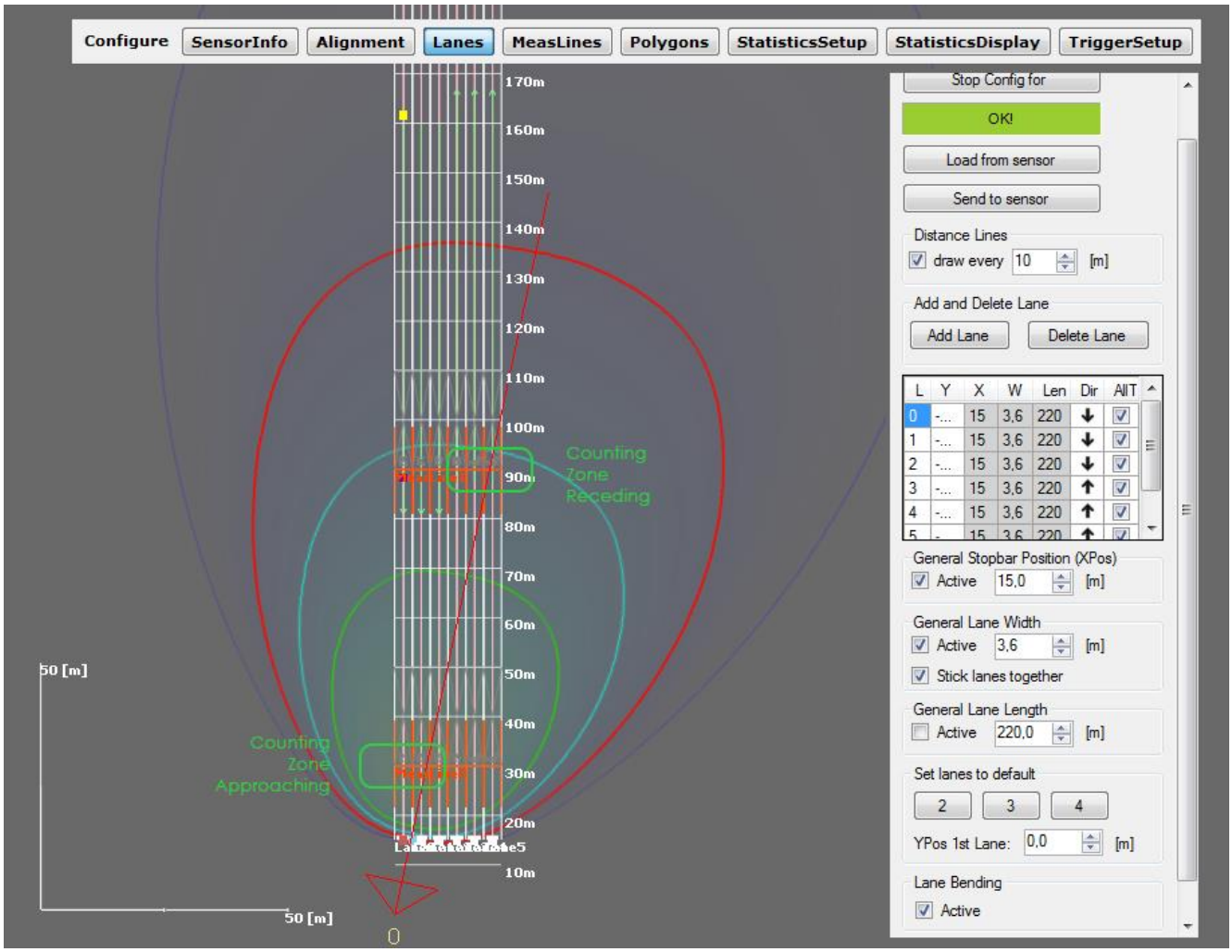

Figure 5: Standard Configuration Type 44

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Because of the forward looking principle, the sensor provides the significant higher speed accuracy / general speed based information, compared to other traffic counting equipment.

The sensor is usually mounted at the roadside on a vertical pole. No setback is required. Other mounting positions (gantry, mast arm, luminaire) may be possible. The **standard configuration** for Type 44 sensor for counting applications is shown in Figure 5 and its parameters are given in the table below.

Table 2: Standard Configuration for Counting and Statistics Type 44

Parameter	Value
Traffic Direction	Typ. Approaching & Receding
Mounting Height	Typ. 6m (4...10m)[I] Typ. 20ft (13...33ft)[I]
Sensor Azimuth angle	Typ. -12° (-15 ...+15 deg.)[II]
Sensor Elevation angle	Typ. -6° (-9...0 deg.)[II, III]
Counting Line Distance (Approaching)	Typ. 30m (20m … 50m)[IV] Typ. 98ft (66 … 164ft)[IV]
Counting Line Distance (Receding)	Typ. 90m (50m … 105m)[IV] Typ. 295ft (164… 344ft)[IV]
Setback	Typ. 1m (0… 10m) Typ. 3ft (0 … 33ft)
Counting Accuracy	Typ. > 95%[V]
Classification Accuracy	Typ. > 80%[V]
Classes	Usually 3 classes are used of the following: Bicycle, Motorbike, Passenger Car, Truck

[I] May affect max. detection range. Occlusion needs to be considered.
[II] Smaller absolute angles allow longer detection range along a road.
[III] Application specific. Gantry mount: steeper el. angle possible, with limitations of maximum range. Negative elevation angle means sensor pointing towards road.
[IV] Typical value for counting applications; may be different for other applications.
[V] Typical value when properly installed at suitable location. The counting and classification accuracy typically depends on the following main (and other) factors: mounting height, traffic density

The sensor is typically used standalone. Multiple sensors may however be used in close vicinity using separate configurable frequency channels, avoiding mutual interference.

UMRR-11 Forward+ 4D/HD	• **Counting and Classification** • **Wrong Way Detection** (vehicle moving opposite to the defined direction of traffic) • **Incident Detection** supported • **Speed** measurement

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2.3.3 Traffic Enforcement

The high speed and range accuracy of the UMRR sensor makes it very suitable for lane specific speed and red light enforcement applications. According to the specification of the enforcement application, the sensor can be used either in approaching or in receding traffic mode.

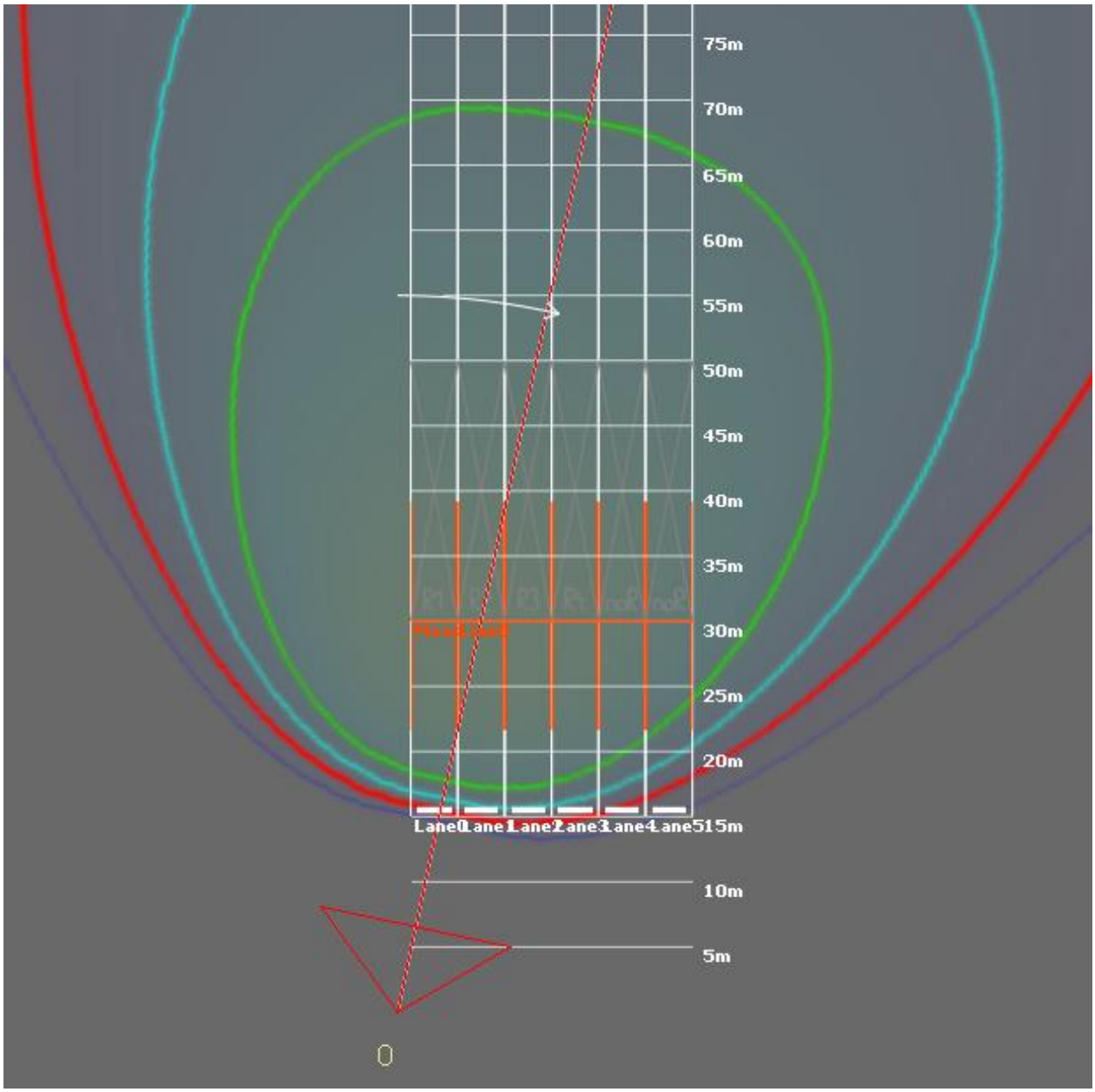

Figure 6: 4 Lane Speed / Red Light Enforcement in Approaching Mode Type 44

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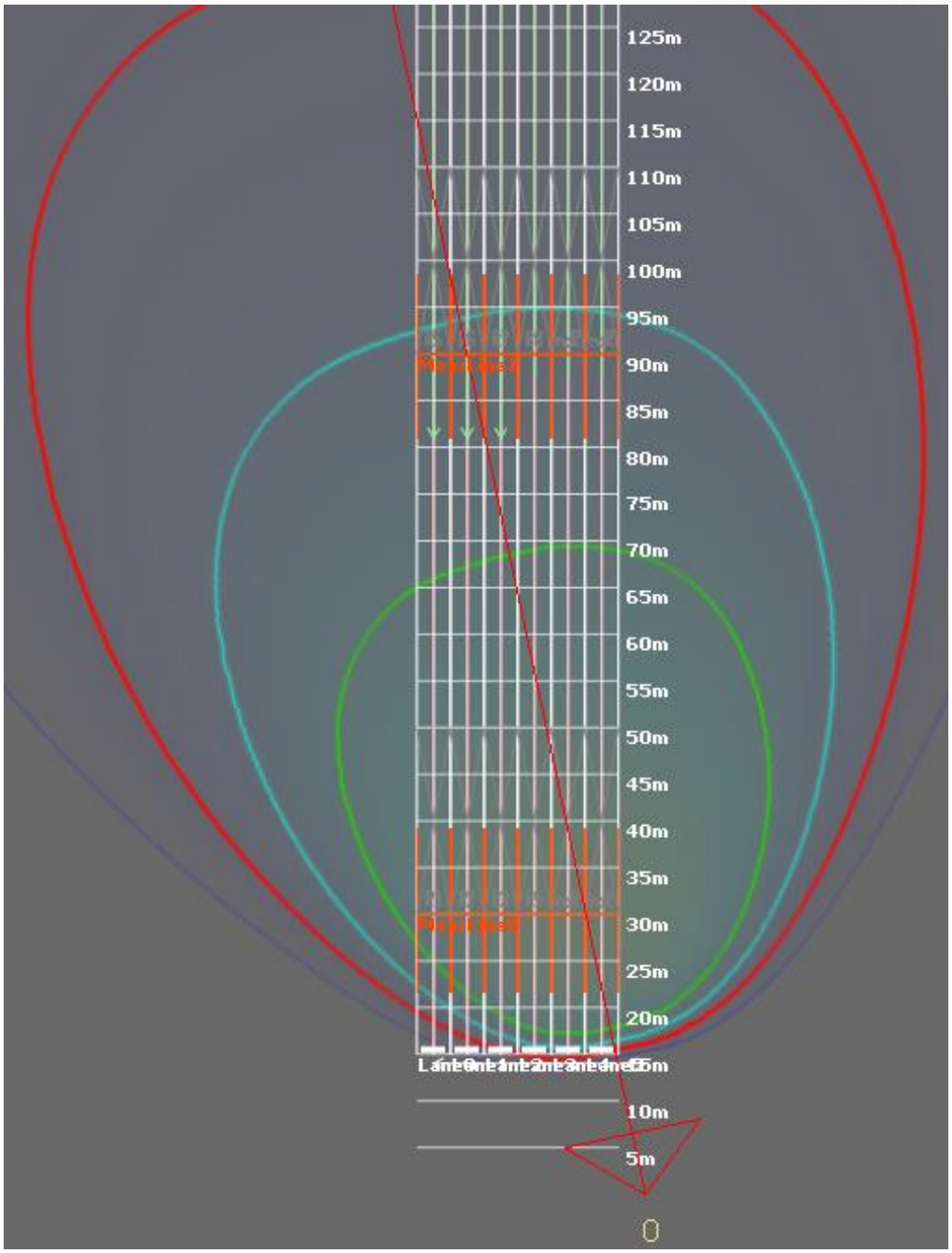

Figure 7: 4 Lane Speed / Red Light Enforcement in Receding Mode Type 44

The sensor is usually mounted at the roadside on a vertical pole. Other mounting positions (gantry, mast arm, luminaire) may be possible. The **standard configuration** for Type 44 sensor for speed enforcement applications is shown in Figure 6 and Figure 7. The parameters are given in **Table** 3.

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Table 3: Standard Configuration for Traffic Enforcement Type 44

Parameter	Approaching Mode	Receding Mode
Traffic Direction	Approaching	Receding
Mounting Height	Typ. 4m/6m (1...10m)[I] Typ. 13/20ft (0 ... 33ft)	Typ. 4m (1...10m)[I] Typ. 13ft (0 ... 33ft)
Sensor Azimuth angle	Typ. -12° (-35 ...+35 deg.)[II]	Typ. 12° (-35 ...+35 deg.)[II]
Sensor Elevation angle	Typ. -6° (-9...0 deg.)[II, III]	Typ. -6° (-9...0 deg.)[II, III]
Measurement Line Distance	Typ. 30m (20m ... 50m)[IV] Typ. 98ft (66 ... 164ft)[IV]	Typ. 45m (20m ... 50m)[IV] Typ. 148ft (66 ... 164ft)[IV]
Speed accuracy	Typ.< ±0.28 m/s or ±1% (bigger of) [V]	
Track initialization time	6...10 cycles typical	
Traffic Direction	Approaching, receding	
Simultaneous Object Tracking	Up to 126 objects (single sensor)	

[I] May affect max. detection range. Occlusion needs to be considered.
[II] Smaller absolute angles allow longer detection range along a road.
[III] Application specific. Gantry mount: steeper el. angle possible, with limitations of maximum range. Negative elevation angle means sensor pointing towards road.
[IV] Typical value for counting applications; may be different for other applications.
[V] Measured on object having const. radial speed, at bore sight.

The sensor is typically used standalone. Multiple sensors may however be used in close vicinity using separate configurable frequency channels, avoiding mutual interference.

UMRR-11 Enforcement 4D/HD	**For Speed Enforcement** **Short distance** measurement for both directions possible **Certified speed accuracy**
UMRR-11 Enforcement RL 4D/HD	For **Red Light Enforcement** For combined **Red Light** & **Speed Enforcement** **Short distance** measurement for both directions possible **High speed accuracy**

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2.4 General Performance Data

Parameter	Value	Unit
Sensor Performance		
Max. Range on Passenger Car	120[I] (@20dBm) / 85[I] (@12.7dBm) 393[I] (@20dBm) / 278[I] (@12.7dBm)	m ft
Max. Range on Truck	180[I] (@20dBm) / 120[I] (@12.7dBm) 590[I] (@20dBm) / 393[I] (@12.7dBm)	m ft
Instrumented Range	180 590	m ft
Minimum Range	3 10	m ft
Range accuracy	Typ. < ±2.5% or < ±0.25m (bigger of) Typ. < ±2.5% or < ±0.82ft (bigger of)	%, m %, ft
Radial Speed Interval	-88.8…+88.8 -320…+320	m/s km/h
Minimum abs. Radial Speed	0.1 0.36	m/s km/h
Speed accuracy	Typ.< ±0.28m/s or ±1% (bigger of) [II] Typ.< ±1km/h or ±1% (bigger of) [II]	m/s km/h
Angle Interval (total field of view)	-12 …+12 (El.); -40 …+40 (Az.)[III]	degree
Update time	<75	ms
Environmental		
Ambient Temperature	-40 … +85	degree C
Shock	100	g_{rms}
Vibration	14	g_{rms}
IP	67[IV]	
Pressure / Transport altitude	0…10.000 0…32800	m ft
Mechanical		
Weight	340 10.93	g oz
Dimensions	See 2.6	
Model No.	**11xxxx-2Cxxxx**	
DSP Board – Antenna Identification	11xxxx-2Cxxxx	
Housing Identification	050Bxx	
General		
Power Supply	8 … 32[V] <5[VI]	V DC W
Frequency Band	24.0…24.25	GHz
Bandwidth	< 250	MHz
Max. Transmit Power (EIRP)	<12.7 / <20 depending on country	dBm
Interfaces [VII]	CAN V2.0b (passive)	

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	RS485 full duplex 10/100 Ethernet	
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.
[VI] Power consumption at 20°C.
[VII] It is recommended to use an external surge protection for power, CAN, RS485, Ethernet and other interface ports.

2.4.1 Start-up time

After power up or reset, the sensor readings are within specified performance within <3s.

2.4.2 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.

2.4.3 Sensor Network

The sensor is typically used standalone.

2.4.4 Ethernet connection

The sensor supports point-top-point connection or connections via switches inside an intranet. Connections involving the world wide web are not natively supported.

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2.4.5 Compliance

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

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2.5 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.

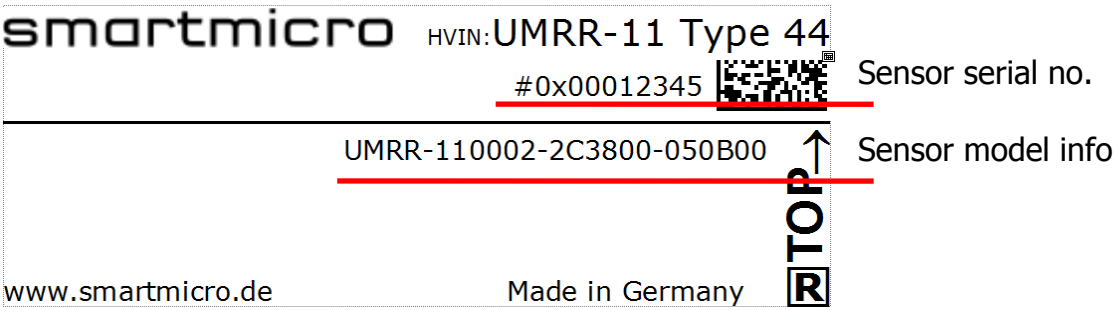

Figure 6: Type sticker example

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.

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2.6 Sensor Dimensions

All values given in mm.

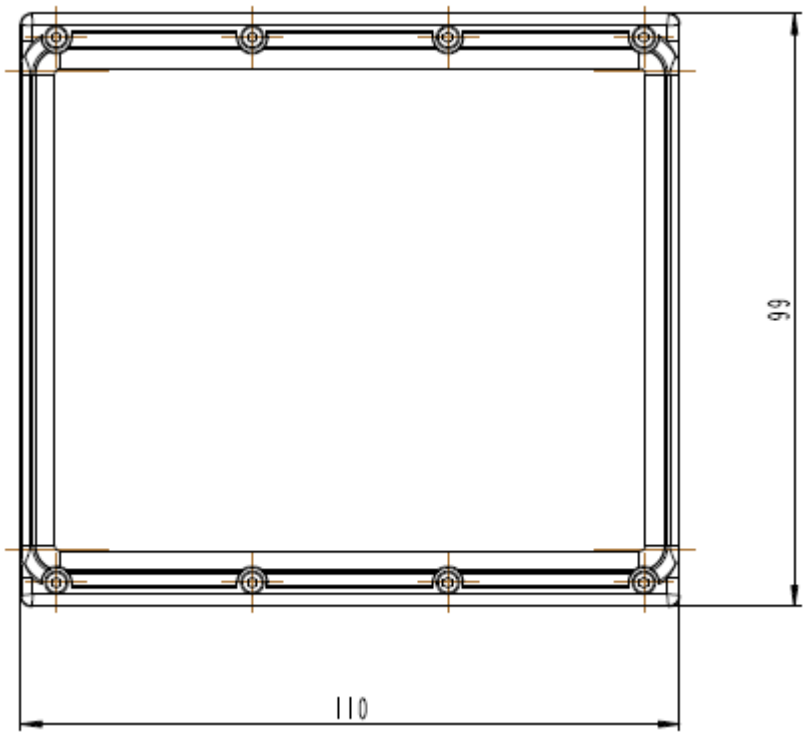

Figure 7: Sensor Front side.

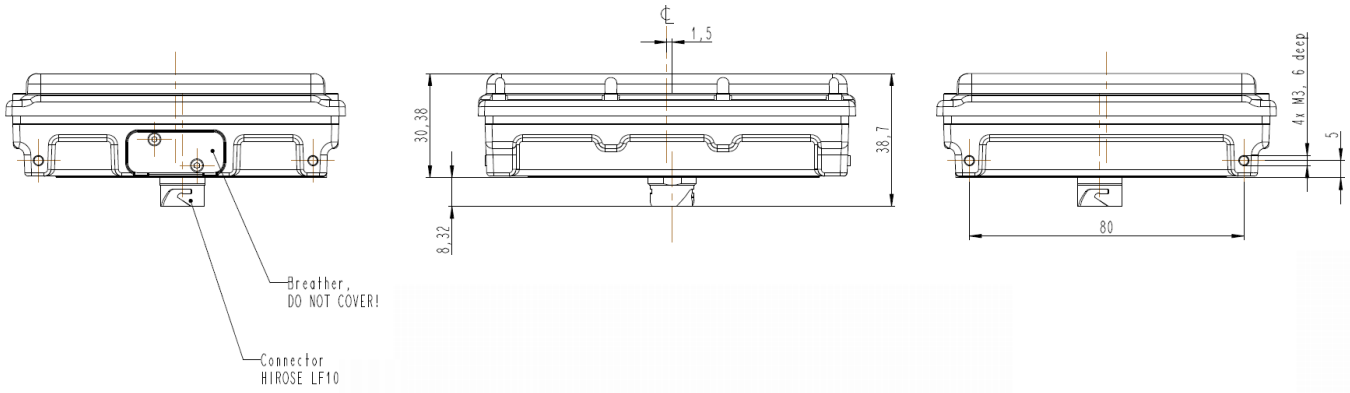

Figure 8: Sensor Top, Left and Right Side.

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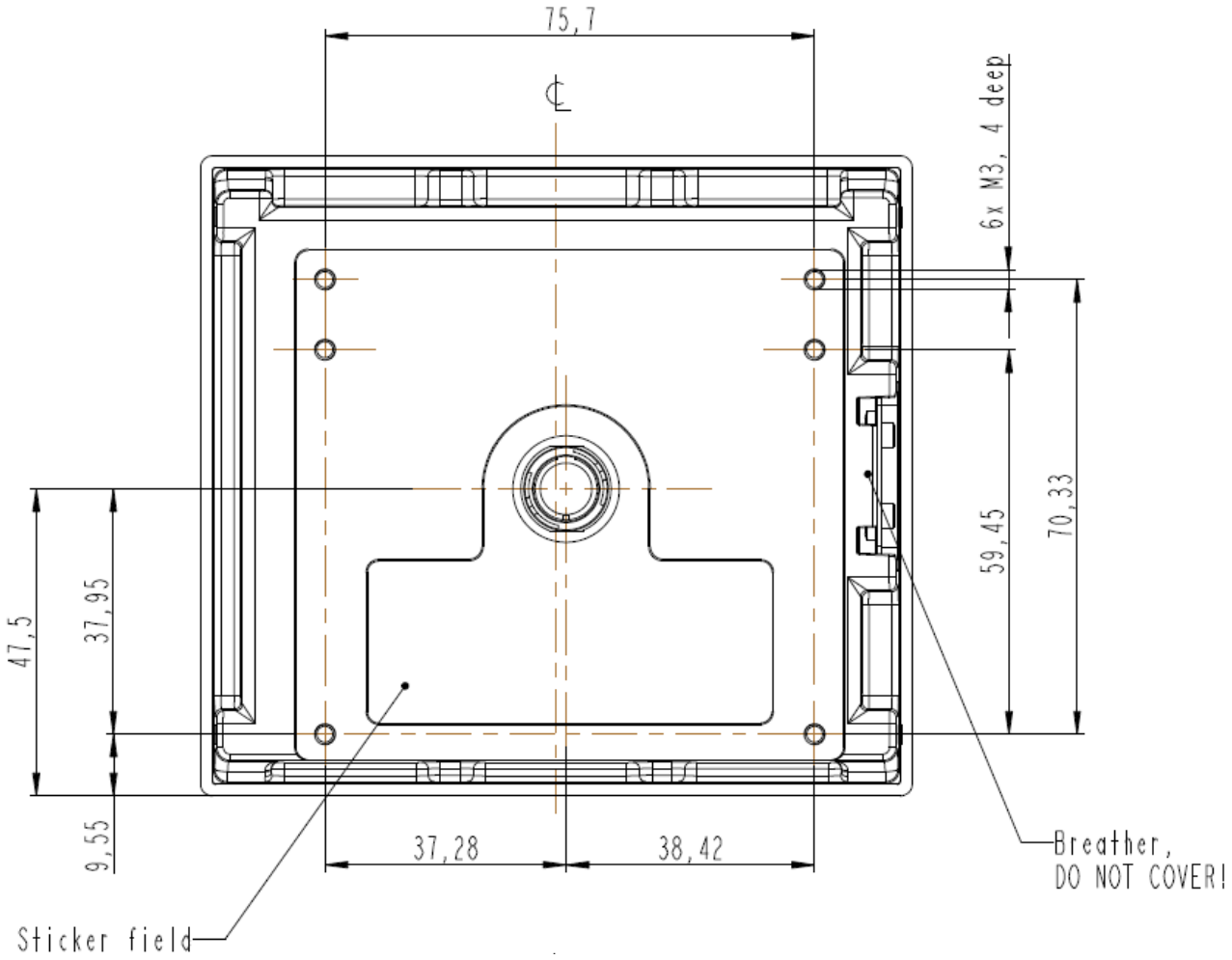

Figure 9: Sensor Rear Side.

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2.7 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 10 the pin description is given in Table 3.

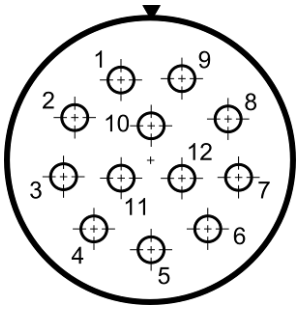

Figure 10: View on solder cup side of socket (rear view of female counterpart to be connected to sensor)

Table 3: 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 is 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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