Project Documentation | UMRR Traffic Management Sensor Data Sheet

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Traffic Management Sensor
3D/UHD

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1 Content

2 User Safety Warning Information

Read the instructions carefully before you start to work.

Installation

Please observe the following advices when installing and connecting the sensors:

- Only use provided or approved equipment for installation. Use stainless screws with metric thread M3x8. Screw length must be adapted if the customer uses own brackets.
- Only skilled and instructed persons shall install and connect the devices. Proper experience in working with mains voltage, electrical and electronic devices is required.
- Don't connect the devices directly to mains voltage, instead use the voltage given in the manual.
- Don't wire any connections while power is applied to the device.
- Ground the devices carefully to prevent electrical shock.
- All connectors are pin-coded and fit in only one position. Also note the arrows indicating the top side of the sensor.
- Only use fully functional equipment (ladders, aerial work platform, ...) when working above ground. Staff shall be capable of working at heights.
- Use caution when installing the devices on or around active roadways. Pay attention to moving traffic.
- Mount the devices carefully to prevent them from shifting or dropping.
- The devices must be mounted to a stiff and solid support. Vibration, oscillation or any kind of movement will reduce the sensor performance.
- Make sure that your installation methods are in accordance with local safety policy and procedures and company practices.

Technical service

Only use provided or approved equipment for operation.
Persons other than authorized and approved electrical technicians shall NOT attempt to connect this unit to a power supply, Traffic Management Interface Board and/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 unit.

- No user-maintainable parts are contained within 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:
1. This device may not cause harmful interference, and
2. 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. These limits are designed 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.
- Nevertheless, 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.

Operation

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

Using a JBOX or SRO does not influence sensor performance.

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 by doing so. Please note that this position is not intended for permanent use.

It is recommended that only one connection interface is used at a time.

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

The sensors may become hot during operation, so proper hand protection is recommended for maintenance work.

3 Sensor Data Sheet

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

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-0C Type 42 **3D/UHD** Ultra High Definition antenna model (all model specific values are highlighted).

Type 42 Antenna aims at long range with very wide horizontal angular coverage.

3.1 Sensor Photograph

Figure 1: Traffic Sensor Type 42 - front.

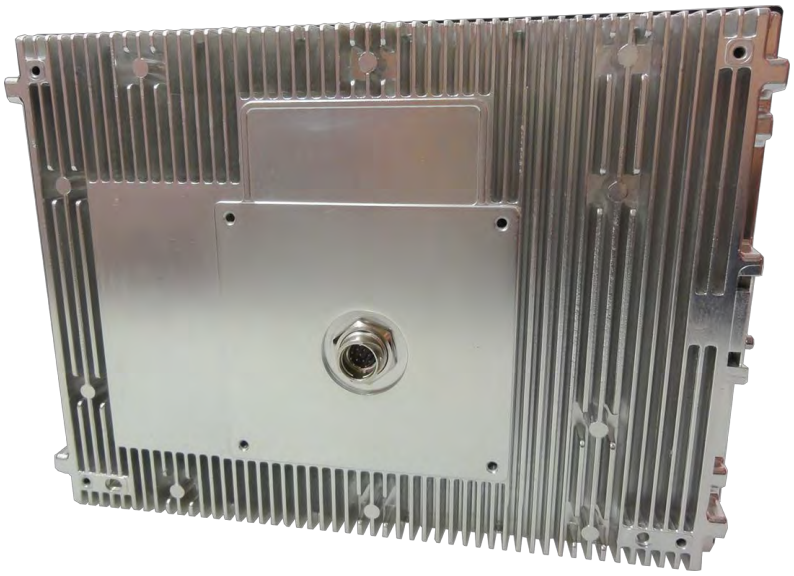


Figure 2: Traffic sensor Type 42 - rear.

3.2 Function Description

The sensor is a robust low cost **3D/UHD** 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 42 Antenna aims at long range with very wide horizontal angular coverage.

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

3D/UHD:

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

a) Direct Doppler measurement
b) Direct Range measurement
c) Direct 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 to 128. Targets are sorted by range and if more than 128 are detected, 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. 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...

Hence the sensor reports such a list of all tracked objects inside its field of view in every measurement cycle of typ. 79ms / 53ms length (depending on configuration).

The field of view typically covers up to eight lanes.

The sensor is capable of detecting stationary objects.

Object Separation Performance

Measuring object co-ordinates of multiple objects simultaneously in **3D**, i.e. range speed and 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 (UHD).

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...6m (depending on selected bandwidth) **OR**
   having a different range value by 7...20ft (depending on selected bandwidth) **OR**
c) by having a different angular position (typ. 6 degree).

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

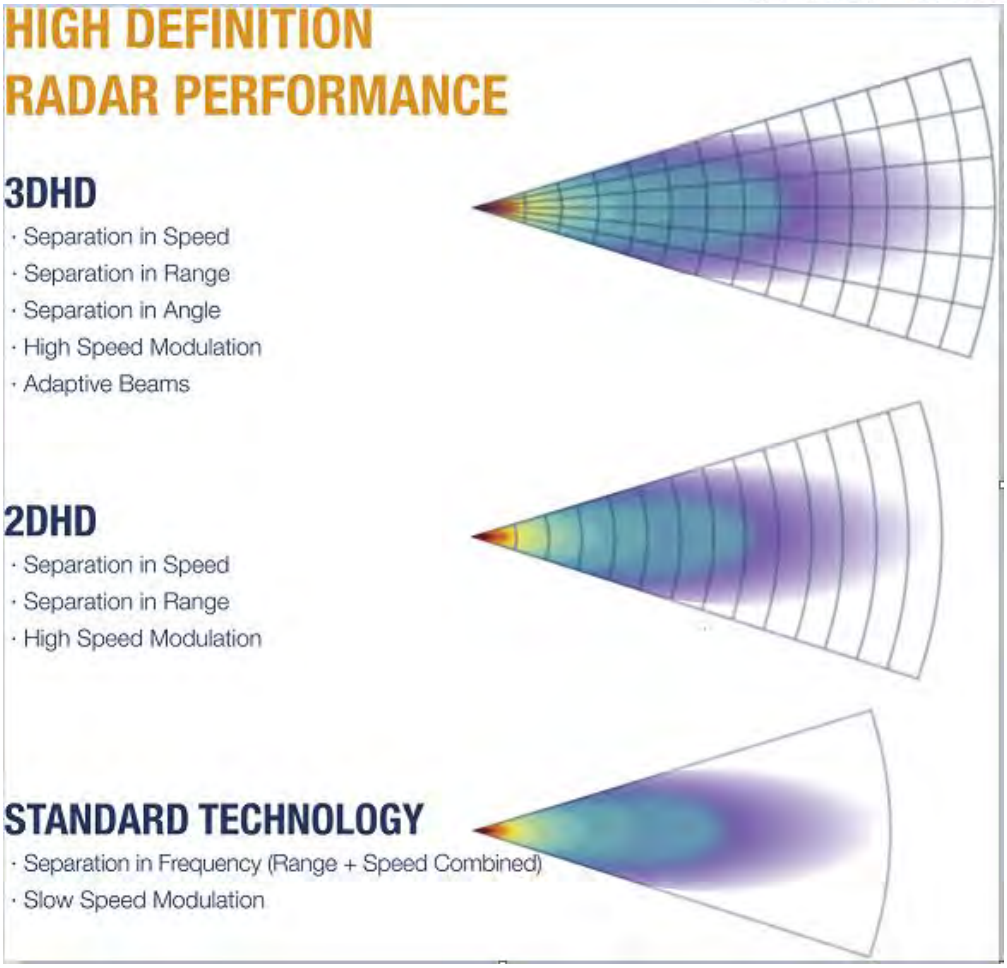


Figure 3: Object Separation Capability.

UMRR-0C features a technology which was never available before for traffic Radar sensors: **3D/UHD**. For each reflector, there is a true measurement of range, Doppler and angle.

UMRR-0C can now accomplish range gate specific and even angular gate specific detection of moving and even stationary vehicles. In each of these gates a separate Doppler detection is possible, including stationary detectors. Figure 3 explains the principle.

3.3 Application Characteristics

3.3.1 Intersection Management

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

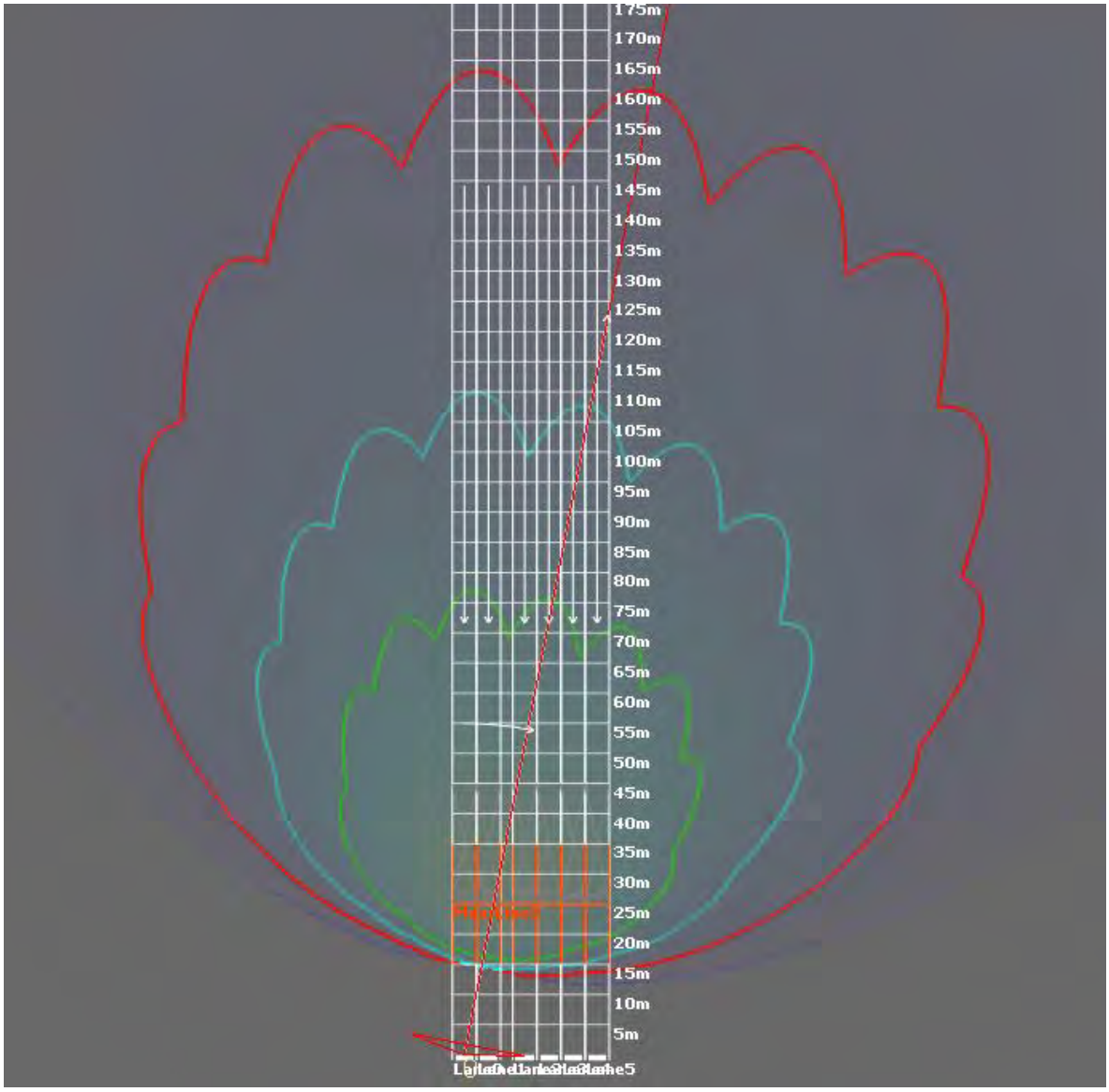


Figure 4: Stop Bar Detection only and Stop Bar + Advance Detection Type 42 (12.7dBm EIRP)

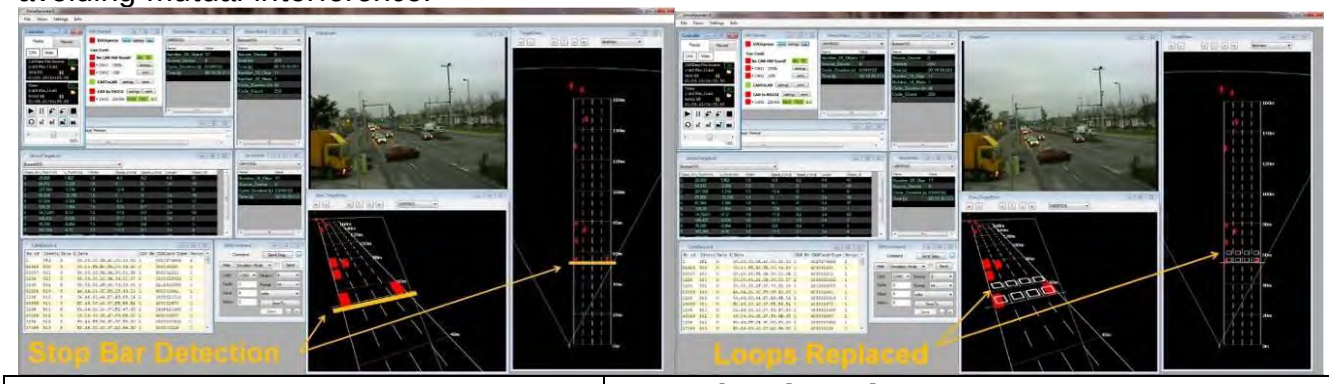
The sensor is usually mounted at the corner of an intersection on a vertical pole. Other mounting positions (gantry, mast arm, luminaire) may be possible. The **standard configuration** for type 42 sensor for intersection applications is shown in the picture of Figure 4 and its parameters are given in Table 1.

Table 1: Standard Configuration for Combined Stop Bar and Advance Detection Type 42

Parameter	Value
Traffic Direction	Typ. Approaching
Mounting Height	Typ. 6m (1…10m)[I] Typ. 20ft (3…33ft)[I]
Sensor Azimuth angle	Typ. -10° (-25 …+25 deg.)[II]
Sensor Elevation angle	Typ. -2° (-6…0 deg.)[II, III]
Stop Bar Distance	Typ. 25m (20 … 90m)[IV] Typ. 82ft (66 … 295ft)[IV]
Advance Detection Distance	Typ. 90m (50 … 150m)[IV] Typ. 295ft (164 … 492ft)[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. Multiple sensors may however be used at an intersection. While usually four approaches need to be covered, up to four sensors can usually be mounted at or around an intersection using separate configurable channels, avoiding mutual interference.



UMRR-0C Type 42 Stop Bar+	• **Stop bar detection** • **Loop replacement** (non-intrusive detection) • **Custom trigger** conditions (e.g. location, vehicle speed, classification) • **Speed** measurement • **Range** is limited to 80m • **Range** is limited to 262ft
UMRR-0C Type 42 Stop + Advance	• **Stop bar detection** • **Advance detection** • **Loop replacement** (non-intrusive detection) • **Queue length** measurement • **Custom trigger** conditions (e.g. location, vehicle speed, classification) • **ETA** measurement • **Speed** measurement

3.3.2 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
- 85 percentile speed
- Headway
- Gap
- Wrong Way Detection Trigger

The data can be retrieved in Push or Record Mode

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

The data can be recorded in internal FLASH memory (option) and can be retrieved later. The capacity allows storage for >1 month of traffic data logging, depending on the recorder configuration:

- Example 1: 4 lanes highway monitored, Statistic Report only – 43.000h capacity
  3 classes, 5minute Statistics Report Interval

- Example 2: 4 lanes highway monitored, Statistic Report + PVR – 810h capacity
  5 classes, 5minute Statistics Report Interval, 17% of the time fully occupied

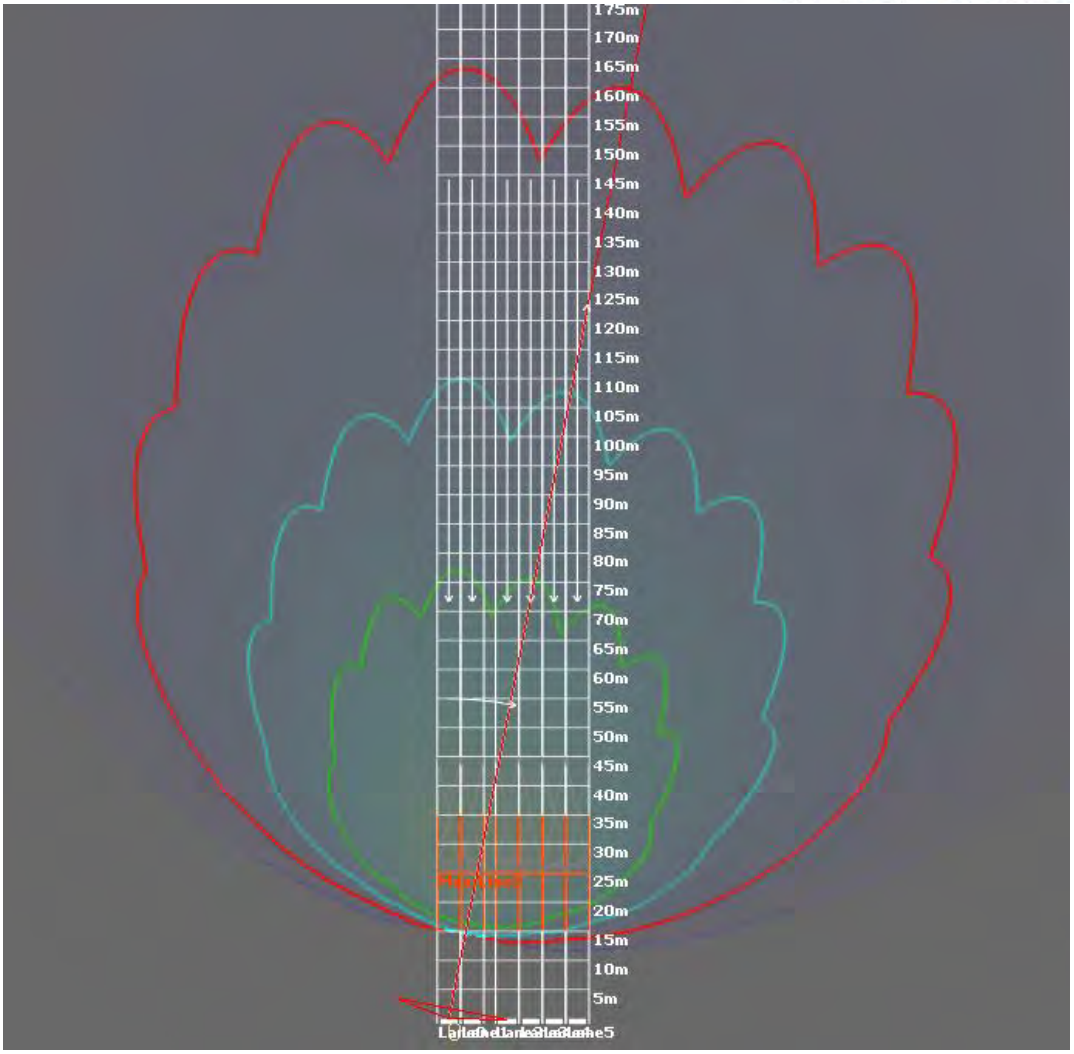


Figure 5: Standard Configuration Type 42 (12.7dBm EIRP)

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 42 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 42

Parameter	Value
Traffic Direction	Typ. Approaching & Receding
Mounting Height	Typ. 6m (1…10m)[I] Typ. 20ft (3…33ft)[I]
Sensor Azimuth angle	Typ. -10° (-25 …+25 deg.)[II]
Sensor Elevation angle	Typ. -2° (-6…0 deg.)[II, III]
Counting Line Distance (Approaching)	Typ. 30m (20 … 90m)[IV] Typ. 98ft (66 … 295ft)[IV]
Counting Line Distance (Receding)	Typ. 120m (70 … 130m)[IV] Typ. 394ft (230 … 427ft)[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.

Sensor Variants and Features

UMRR-0C Type 42 Forward+	• **Counting and Classification** • **Wrong Way Detection** (vehicle moving opposite to the defined direction of traffic) • **Incident Detection** supported • **Speed** measurement

3.3.3 Traffic Enforcement

The high speed 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.

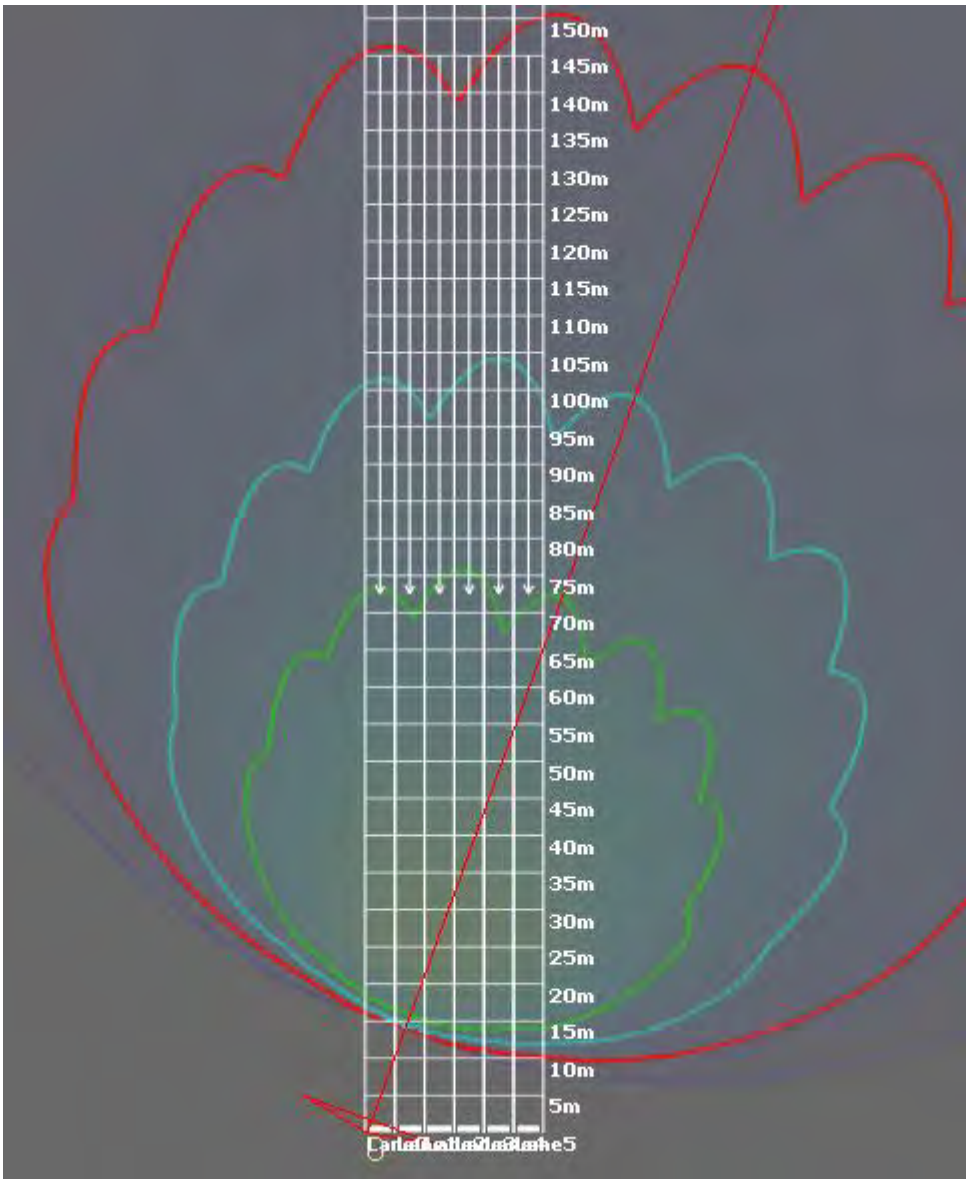


Figure 6: 4 Lane Speed / Red Light Enforcement in Approaching Mode Type 42 (12.7dBm EIRP)

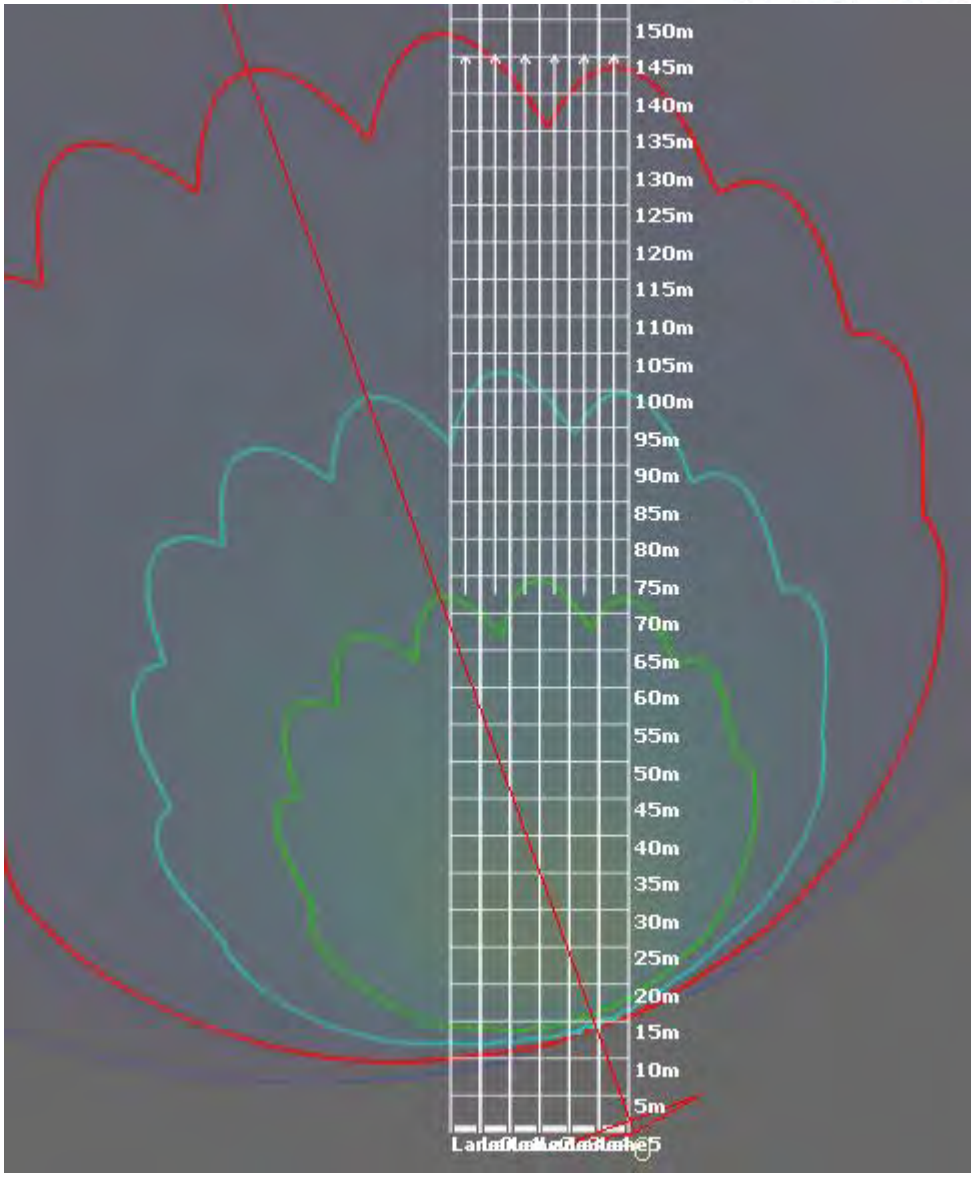


Figure 7: 4 Lane Speed / Red Light Enforcement in Receding Mode Type 42 (12.7dBm EIRP)

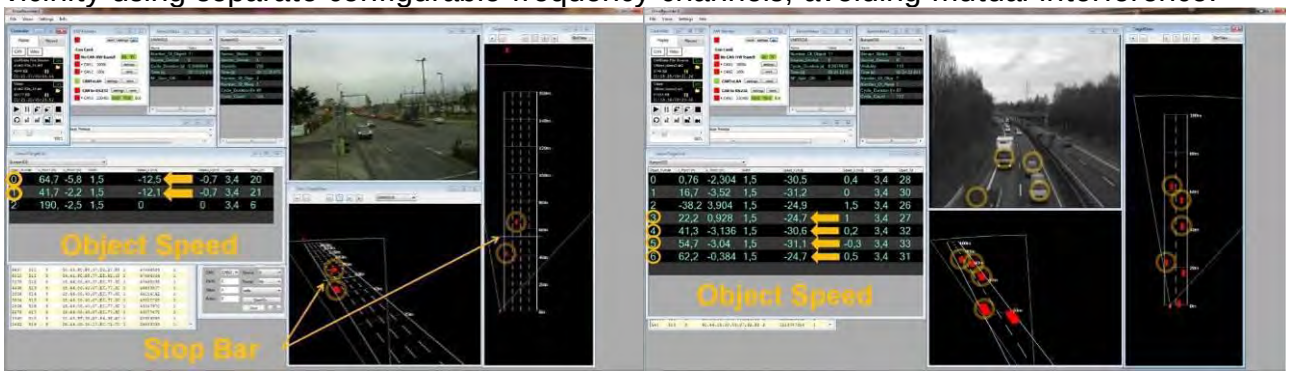
The sensor is usually mounted at the roadside on a vertical pole. Other mounting positions (gantry, mast arm, luminaire) may be possible. The **standard configuration** for Type 42 sensor for speed enforcement applications is shown in Figure 6 and Figure 7. The parameters are given in **Table** 3.

Table 3: Standard Configuration for Traffic Enforcement Type 42

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. 20° (-35 …+35 deg.)[II]	Typ. 20° (-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. 35m (20m … 50m)[IV] Typ. 115ft (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.



Sensor Variants and Features

UMRR-0C Type 42 Enforcement	**For Speed Enforcement** **Short distance** measurement for both directions possible **Certified speed accuracy**
UMRR-0C Type 42 Enforcement RL	For **Red Light Enforcement** For combined **Red Light** & **Speed Enforcement** **Short distance** measurement for both directions possible **High speed accuracy**

3.4 General Performance Data

Parameter	Value	Unit
Sensor Performance		
Max. Range on Passenger Car	250[I] (@20dBm) / 170[I] (@12.7dBm) 820[I] (@20dBm) / 558[I] (@12.7dBm)	m ft
Max. Range on Truck	340[I] (@20dBm) / 280[I] (@12.7dBm) 1115[I] (@20dBm) / 919[I] (@12.7dBm)	m ft
Instrumented Range	340 1115	m ft
Minimum Range	1.5 4.9	m ft
Range accuracy	Typ. < ±2.5% or < ±0.25m (bigger of) Typ. < ±2.5% or < ±0.80ft (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 or ±1% (bigger of) [II] Typ.< ±1km/h or ±1% (bigger of) [II]	m/s km/h
Angle Interval (total field of view)	-8 ...+8 (El.); -50 ...+50 (Az.)[III]	degree
Angle Accuracy (horizontal)	< 1[IV]	degree
Update time	57	ms
Environmental		
Ambient Temperature	-40 ... +74	degree C
Shock	100	g_{rms}
Vibration	14	g_{rms}
IP	67[V]	
Pressure / Transport altitude	0...10.000 0...32800	m ft
Mechanical		
Weight	1290 45.50	g oz
Dimensions	See 3.6	
Model No.	**0Cxxxx-2Axxxx**	
DSP Board – Antenna Identification	0Cxxxx-2Axxxx	
Housing Identification	0707xx	
General		
Power Supply	13 ... 32[VI] typ. 10.5[VII]	V DC W
Frequency Band	24.0...24.25	GHz
Bandwidth	< 250	MHz
Max. Transmit Power (EIRP)	<12.7 (<20 possible)	dBm

Interfaces [VIII]	CAN V2.0b (passive) 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] Typical value; measured at target output level at bore sight, for a point reflector showing >23dB SNR. Error may increase towards larger angles.
[V] IP 67 only when connector or cap attached.
[VI] measured at connector; min. voltage slew rate 500V/s or max. voltage rise time 15ms; supply source impedance 0.5Ohms. Please use an inductance of 100µH in both VCC and GND lines for optimum EM compatibility.
[VII] 9.5W...12.5W depending on Temperature.
[VIII] It is recommended to use an external surge protection for power, CAN, RS485, Ethernet and other interface ports.

3.4.1 Start-up time

After power up or reset, the sensor readings are within specified performance within <30 seconds.

3.4.2 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.

3.4.3 Sensor Network

The sensor is typically used standalone.

3.4.4 Storage

The sensor flash based non volatile memory for long term traffic statistic data on board.

3.4.5 Compliance

EU RED directive,
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.

3.5 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.

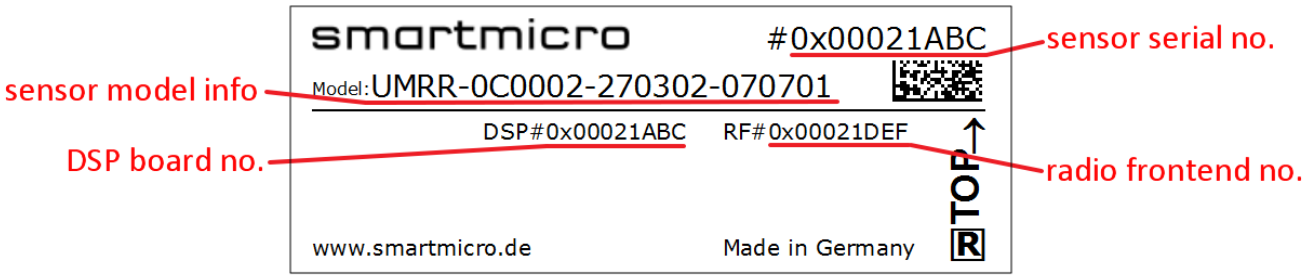


Figure 6: Type sticker example

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.

3.6 Sensor Dimensions

All values given in mm.

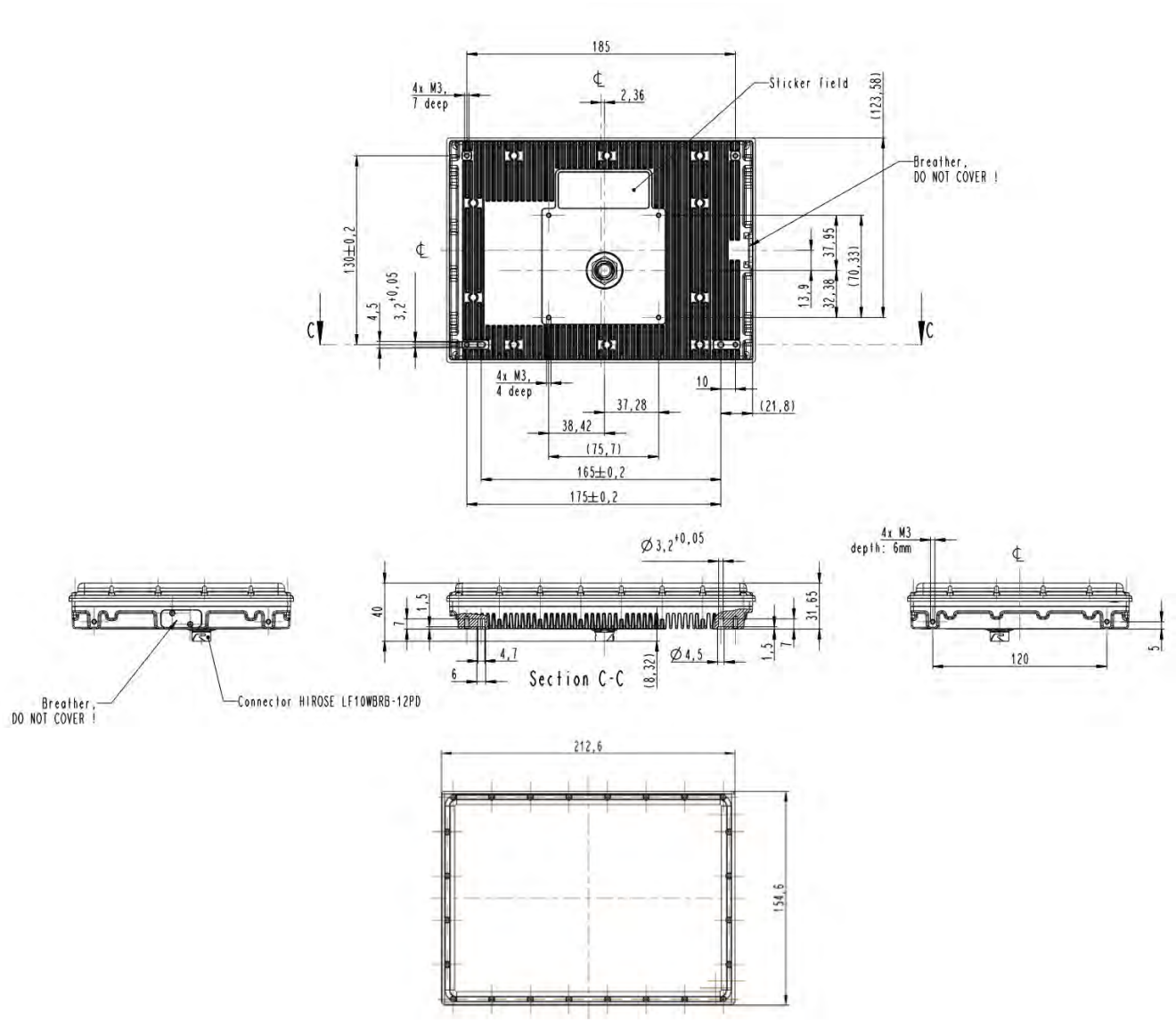


Figure 7: Sensor Dimensions.

3.7 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 8 the pin description is given in Table 3.

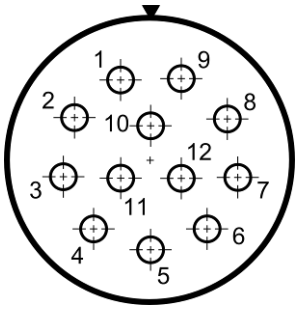


Figure 8: View on solder cup side of socket (rear view of female counterpart to be connected to sensor)

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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