Project Documentation | UMRR Automotive Type 132 Data Sheet

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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 (junction box, available as accessory) 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.

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 automotive Radar sensors called UMRR – Universal Medium Range Radar.

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

This data sheet describes the UMRR-11 type-132 4D/UHD High Definition antenna model.

Type 132 antenna aims at long range and wide horizontal angular coverage. It features wide beam mode with medium-range and long-range mode with narrower field of view.
3.1 Sensor Photograph

**Figure 1:** Traffic Sensor Type 132 - Front.

**Figure 2:** Traffic sensor Type 132 - Rear.
3.2 Function Description

The sensor is a small, lightweight, very robust low cost 77-GHz Radar for automotive applications. It is intended for multiple applications and can be used almost worldwide in this frequency band.

It works in adverse conditions, almost unaffected by weather, and independent of sunlight, in a wide temperature interval. The radar withstands high shock and vibration levels, is maintenance free and made for a long lifetime.

Using a patented transmit signal waveform, each individual sensor measures range, radial speed, azimuth and elevation angle, reflectivity and other parameters of multiple stationary and moving reflectors (targets) simultaneously. Having multi target capability, the sensor will report many reflectors at a time being within the field of view (target list = point cloud) using a 4D/UHD detection principle:

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

Additional (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 are tracked simultaneously; the individual reflectors are separated in the detection algorithms by having a different radial speed value and/or different range value and/or by different az. angles, as well as by the tracking algorithms and data base. The result of the tracking is an object list with the following parameters:

- x position  
- y position  
- absolute velocity  
- heading angle  
- other...

Finally based on all detected targets and tracked objects in the field of view a function/application algorithm can optionally be implemented, like adaptive cruise control or collision warning signal.

Hence the sensor optionally reports such a list of all tracked objects, including stationary objects, inside its field of view in every measurement cycle of typ. 50ms length.

In addition to that, status and diagnose data from the sensor are reported.
3.3 Multi-Mode Operation, Adaptive Beams, Multi-Band Operation

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

3.3.1 Multi-Mode Operation

Note that UMRR-11 type-132 also allows to switch between medium- and long-range mode. This changes waveform and detection performance.

3.3.2 Adaptive Beams

In addition to that, and independently, narrow beam (ACC) and wide beam (AEB) operation can be selected.

Narrow beam (ACC) mode can be selected for long range and wide beam (AEB) mode can be selected for medium range.

Figure 3: 4D/UHD graphical illustration for medium-range mode with wide beam and long-range mode with narrow beam.

3.3.3 Multiple Frequency Bands

Long-Range Mode: 4 frequency bands are available. These frequency bands are non-overlapping so that mutual interference can be reliably avoided.

Medium-Range Mode: 2 frequency bands are available. These frequency bands are non-overlapping so that mutual interference can be reliably avoided.
3.4 Object Separation Performance

UMRR-11xxxx features the latest technology automotive radar sensors: 4D/UHD. For each reflector, there is a true 4D measurement of range, Doppler, azimuth and elevation angle.

UMRR-11xxxx can 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.

The sensor provides excellent target separation (UHD). Individual reflectors are separated in the detection algorithms by:

a) having a different radial speed value OR
b) having a different range value OR
c) having a different azimuth angular position.
3.5 Field of View

The sensor is equipped with narrow and broad antenna beams. Antenna with narrow beam mode can be used for the applications like ACC/FCW, where antenna with broad beam mode can be used for AEB and RCW applications.

Both antenna modes have their maximum range at bore sight. A typical configuration is shown below.

The figures below show typical sensor configuration with antenna field of view and for rear and forward collision warnings.

![Figure 4: Front sensor configuration with narrow and broad antenna field of view. Colors indicate field of view for truck, passenger car, motorbike, pedestrian.](image-url)
Figure 5: Front sensor configuration with combination of narrow and broad antenna field of view.

Colors indicate field of view for truck, passenger car, motorbike, pedestrian.
### 3.6 General Performance Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Frequency [GHz]</strong></td>
<td>Long-Range Mode: 76 (76…77) 4 center frequencies (bands)</td>
</tr>
<tr>
<td></td>
<td>Medium-Range Mode: 76 (76…77) 2 center frequencies (bands)</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>Min/Max [m]</td>
</tr>
<tr>
<td></td>
<td>Min: 1.0</td>
</tr>
<tr>
<td></td>
<td>Max: 175</td>
</tr>
<tr>
<td></td>
<td>Min: 0.5</td>
</tr>
<tr>
<td></td>
<td>Max: 64</td>
</tr>
<tr>
<td><strong>Discrimination [m]</strong></td>
<td>≤1.8</td>
</tr>
<tr>
<td><strong>Accuracy [m]</strong></td>
<td>&lt; 0.5 or 1% (bigger of)</td>
</tr>
<tr>
<td><strong>Velocity</strong></td>
<td>Min/Max [km/h]</td>
</tr>
<tr>
<td></td>
<td>-400 ... +200</td>
</tr>
<tr>
<td></td>
<td>-340 ... +170</td>
</tr>
<tr>
<td><strong>Discrimination [m/s]</strong></td>
<td>&lt; 0.26</td>
</tr>
<tr>
<td><strong>Accuracy [m/s]</strong></td>
<td>≤ 0.1</td>
</tr>
<tr>
<td><strong>Angle</strong></td>
<td>FoV of Azimuth [°]</td>
</tr>
<tr>
<td></td>
<td>-16...+16 (narrow beam)</td>
</tr>
<tr>
<td></td>
<td>-50...+50 (wide beam)</td>
</tr>
<tr>
<td><strong>Discrimination of Azimuth [°]</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>Accuracy of Azimuth [°]</strong></td>
<td>≤ 0.25</td>
</tr>
<tr>
<td></td>
<td>≤ 0.5</td>
</tr>
<tr>
<td></td>
<td>≤ 0.5</td>
</tr>
<tr>
<td><strong>Initialization Time [s]</strong></td>
<td>&lt; 4</td>
</tr>
<tr>
<td><strong>Update Cycle Time [ms]</strong></td>
<td>≤ 55</td>
</tr>
<tr>
<td><strong>Processing Latency [ms]</strong></td>
<td>2-4 Cycles</td>
</tr>
<tr>
<td><strong>Operating Voltage [V]</strong></td>
<td>8 ... 32</td>
</tr>
<tr>
<td><strong>Power Consumption [w]</strong></td>
<td>&lt; 5</td>
</tr>
<tr>
<td><strong>Max. Transmit Power (EIRP) [dBm]</strong></td>
<td>&lt;25</td>
</tr>
<tr>
<td><strong>Operating Temperature [°C]</strong></td>
<td>-40 ... +85</td>
</tr>
<tr>
<td><strong>Humidity [%]</strong></td>
<td>0 ... 95 (non-condensing)</td>
</tr>
<tr>
<td><strong>Sensor Weight [g]</strong></td>
<td>≤ 275</td>
</tr>
<tr>
<td><strong>Dimension (H/W/D) [mm]</strong></td>
<td>95x85x34 plus connector</td>
</tr>
<tr>
<td><strong>Interfaces</strong></td>
<td>1xCAN V2.0b (passive)</td>
</tr>
<tr>
<td></td>
<td>2xCAN FD (optional)</td>
</tr>
<tr>
<td></td>
<td>Ethernet 100Mbit (4-wire Eth.)</td>
</tr>
<tr>
<td><strong>Connector</strong></td>
<td>Hirose LF10 series</td>
</tr>
<tr>
<td><strong>Model No.</strong></td>
<td>UMRR-11xxxx</td>
</tr>
<tr>
<td><strong>Shock [g_{rms}]</strong></td>
<td>100</td>
</tr>
<tr>
<td><strong>Vibration [g_{rms}]</strong></td>
<td>14</td>
</tr>
<tr>
<td><strong>IP</strong></td>
<td>67</td>
</tr>
<tr>
<td><strong>Pressure / Transport altitude [m]</strong></td>
<td>0...10.000</td>
</tr>
</tbody>
</table>

**Table 1: Performance Parameters**

1. 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. Presence detection below is available. Minimum range may be reduced customer specific depending on local frequency regulations.

2. Total field of view is angle interval where reflectors can be detected; 3dB field of view is narrower. Accuracy specified at bore sight.

3. Measured for point reflector at bore sight with >23dB S/N. Falls off toward larger absolute angles.

4. Measured at connector.
3.6.1 Start-up time
After power up or reset, the sensor readings are within specified performance within <4s.

3.6.2 Self-Diagnose
The UMRR sensor cyclically reports a status message providing the following information

- Sensor run time
- Sensor cycle time
- Sensor mode
- Diagnose information

The sensor features certain self-diagnose to allow limited fail-safe capabilities (optional):
- Detection of sensor blindness
- Detection of rain
- Misalignment in roll- or pitch angle
- Detection and suppression of interference

Note that there is no completely fail-safe operation available.
3.6.3 Ethernet Connection

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

Features:

1. Ethernet standards IPv4, ARP, IGMP, IP multicast and UDP
2. Supports DHCP
3. Smartmicro proprietary communication protocol “smartmicro transport protocol” with:
   - IP/UDP Multicast based discovery protocol
   - Client ID based setup
   - Sensor data transmission
3.6.4 Compliance

The sensor model complies with the following EU directives:
- RED 2014/53/EU
- RoHS 2011/65/EU
- EC 1907/2006 REACH

Applied Standards:
- Spectrum Usage:
  - EN 301 091-1 V2.1.1
  - EN 301 091-2 V2.1.1
- EMC:
  - EN 301 489-1 V2.2.0
  - EN 301 489-51 V2.1.0
- Health and Safety:
  - EN 62311: 2008

With regard to spectrum usage, this sensor model was tested and certified by independent test labs:
- EU RED directive (formally approved by test lab or notified body),
- FCC part 95M (formally approved by test lab or notified body),
- ISED RSS-251 (formally approved by test lab or notified body)

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 device allows operation compliant to the listed standards. However, not all standards are certified through test labs and not for all countries formal frequency approval/registration is accomplished.

In certain countries or regions, a customer-specific local frequency approval is reasonable. Smartmicro supports customers for this process.
3.7 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.

![Type sticker example](image)

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.

The (R) symbol designates that a CAN termination resistor is assembled in the sensor.
### 3.8 Sensor Dimensions

All values are given in mm.

![Figure 7: Sensor Front side.](image)

![Figure 8: Sensor Top, Left and Right Side.](image)
Figure 9: Sensor Rear Side.
### 3.9 Connector Pin-Out

The 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 2.

![Diagram of connector](image)

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

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

**Table 2:** Sensor connector pin out model UMRR-11xxxx

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). This resistor is required at either end of a CAN / RS485 bus.

For the RS485 data interface there is a 120 Ohms resistor on board of the sensor. For the RS485 interface is unused – sensor can optionally be assembled for 2nd CAN(FD) bus.

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.

---

1 RS485 interface is unused – sensor can optionally be assembled for 2nd CAN(FD) bus.

Proprietary

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4 Multi Sensor Systems

4.1 Configurations

The sensor may be used standalone or multiple sensors can be connected in a network. Such networks are possible using CAN/CAN(FD) or Ethernet interface. Sensors in the network – after configuration – can work plug and play, free of mutual interference.

Networks can generally be built using CAN, CANFD or Ethernet interface.

Customer specific configurations are possible.

For one vehicle, up to four sensors can be connected to one sensor fusion ECU and can be operated interference-free.

4.2 Data Logging and Visualization Tools

4.2.1 Drive Recorder

Visualization of all data (i.e. target lists, object lists, other) is possible using the Drive Recorder software on any PC, as well as data logging, associated video documentation, play back and analysis functions and more.

4.2.2 ROS

Smartmicro is offering ROS support / ROS drivers for easier customer integration of the radar sensors including ready-to-run real time display in ROS. Customers can read the proprietary radar protocol into ROS, which significantly facilitates the processing and visualization of radar data.

4.2.3 Customer Tools

Instead of the Drive Recorder, or ROS based Visualization, other customer specific visualization, logging, or function/application software products may be applied; the radar system’s data interface is easy to integrate.

Smartmicro can provide interface documentation, dbc files, example code (in C) and/or API for handling data interfaces.
5 Mobile Speed Enforcement Applications

This sensor can be used for mobile speed enforcement applications.

A mobile speed enforcement system typically consists of an enforcement vehicle equipped with a smartmicro mobile enforcement radar sensor, a video camera, a computing device and a speed reference. A possible setup is shown in the figure below.

![Setup for mobile speed enforcement (3G optional)](image)

*Figure 11: Setup for mobile speed enforcement (3G optional)*
5.1 Example Situations for Mobile Speed Enforcement

The Mobile Speed Enforcement functionality is available for stopped vehicle and moving vehicle situations.

No matter if stopped or driving, the sensor tracks all other vehicles going in the same direction as the enforcement vehicle, as well as oncoming traffic (if there is no barrier that occludes the oncoming traffic).

By configuration it is possible to report the absolute speed or the relative speed of the detected vehicles.

5.2 EGO Vehicle Speed Reference

The Mobile Speed Enforcement vehicle needs a speed reference (the speed of the enforcement vehicle, EGO speed) for correct operation of the vehicle tracking algorithms.

5.2.1 Built-In Speed EGO Vehicle Speed Reference

By default, the sensor determines the speed information by itself (measuring the speed of stationary objects) without any external speed reference inputs. As of today, this only works for situations where the vehicle is going relatively straight (e.g. highway situations).

5.2.2 GPS EGO Vehicle Speed Reference

A GPS sensor can optionally be used as an external source for the host car's own speed value. This sensor also provides exact position and date/time information.

The connection is realized using the CAN interface of the sensor.

Supported GPS sensors:
- VBSS 10 by Racelogic, Inc. ([http://www.racelogic.co.uk/](http://www.racelogic.co.uk/))

5.2.3 OBD-II

The radar sensor can optionally connect to the OBD-II interface of the vehicle to read the ego speed information from the vehicle. The connection is realized using the CAN interface of the sensor.

(Remark: only non extended OBD-II CAN protocol is supported.)
5.3 Sensor Mounting Position

There are almost no restrictions on the type of car to be used for mobile enforcement, except it should allow for the sensor to be mounted at a height of 0.4 to 0.8 m over ground for best performance, but it is possible to install the sensor on maximum height of 2 m (like installation in a “bar” on the roof of the vehicle).

The sensor can be mounted
- At the vehicle front or behind the car’s bumper
- on the hood of the vehicle
- on top of the car with up to 2 meters mounting height (e.g. in a “bar”)
- behind the windshield

![Image of sensor mounted in front of air intake](image-url)

Figure 12: Sensor mounted in front of air intake
Figure 13: Sensor mounted behind bumper
Figure 14: Sensor mounted on top of the car roof
6 Important Legal Disclaimer Notice

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www.smartmicro.de
7 Contact

Address:

smart microwave sensors GmbH
In den Waashainen 1
38108 Braunschweig
Germany

Phone / Fax numbers:

Phone: +49-531-39023-0
Fax: +49-531-39023-599

Web / Email address:

Web: www.smartmicro.de
Email: info@smartmicro.de