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 43 antenna model (all model specific values are highlighted).

Type 43 Antenna aims at long range with very wide horizontal angular coverage.

1.1 Sensor Photograph

![Sensor Photograph](image)

Figure 1: Automotive Sensor Type 43 - front.
Figure 2: Automotive sensor type 43 - 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 43 Antenna aims at long range with very wide horizontal angular coverage, very high sensitivity.

One individual sensor measures range, radial speed, az. and el. angle, reflectivity and other parameters of multiple stationary and moving reflectors (targets) simultaneously. The following 4D detection principle is integrated:

a) Direct Doppler measurement (including Doppler = 0)
b) Direct Range measurement
c) Direct Azimuth Angle measurement
d) Direct Elevation 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). Elevation angle measurement is accomplished in a similar manner.

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. 40-60ms 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 4D, i.e. range, speed and az. and el. angle, or x, y, z 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 43 features a technology called 3DHD. 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 (3DHD). 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) by having a different azimuth angular position.

Nominal separation values (meaning bin to bin distance or beam to beam distance):

speed: 0.13m/s, range: 1m, azimuth angle: 3.8°.

Notes:
This configuration: 150MHz freq. sweep, 60ms 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 43, Range values given for 12.7dBm 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
- z 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](image-url)
## 1.6 General Performance Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensor Performance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Range on Passenger Car</td>
<td>280 (^{1} \text{ (@20dBm) / 180} \text{ (@12.7dBm)})</td>
<td>m</td>
</tr>
<tr>
<td>Max. Range on Truck</td>
<td>330 (^{1} \text{ (@20dBm) / 290} \text{ (@12.7dBm)})</td>
<td>m</td>
</tr>
<tr>
<td>Instrumented Range</td>
<td>330 (^{1} \text{ m} )</td>
<td>m</td>
</tr>
<tr>
<td>Minimum Range</td>
<td>1.5 (^{1} \text{ m} )</td>
<td>m</td>
</tr>
<tr>
<td>Range accuracy</td>
<td>Typ. (&lt; \pm 2.5% \text{ or } \pm 0.25\text{m (bigger of)})</td>
<td>% , m</td>
</tr>
<tr>
<td>Radial Speed Interval</td>
<td>-68.3 (\text{ ...+68.3 (±88.8 available)})</td>
<td>m/s</td>
</tr>
<tr>
<td>Minimum abs. Radial Speed</td>
<td>0.1 (^{1} \text{ m/s} )</td>
<td>m/s</td>
</tr>
<tr>
<td>Speed accuracy</td>
<td>Typ. (&lt; \pm 0.28 \text{ or } \pm 1% \text{ (bigger of)})</td>
<td>m/s</td>
</tr>
<tr>
<td>Angle Interval (total field of view)</td>
<td>-8 (\text{ ...+8 (El.)}; -50 \text{ ...+50 (Az.)})</td>
<td>degree</td>
</tr>
<tr>
<td>Update time</td>
<td>(\leq 79) (^{1} \text{ ms} )</td>
<td>ms</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>-40 (\text{ ... +74 degree C} )</td>
<td></td>
</tr>
<tr>
<td>Shock</td>
<td>100 (^{1} \text{ gms} )</td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>14 (^{1} \text{ gms} )</td>
<td></td>
</tr>
<tr>
<td>IP</td>
<td>67 (^{1} \text{V} )</td>
<td></td>
</tr>
<tr>
<td>Pressure / Transport altitude</td>
<td>0 (\text{...10.000 m} )</td>
<td></td>
</tr>
<tr>
<td><strong>Mechanical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>1290 (^{1} \text{ g} )</td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td>See 1.9</td>
<td></td>
</tr>
<tr>
<td><strong>Model No.</strong></td>
<td>\textbf{0Cxxxx-2Bxxxx}</td>
<td></td>
</tr>
<tr>
<td>DSP Board – Antenna Identification</td>
<td>\textbf{0Cxxxx-2Bxxxx}</td>
<td></td>
</tr>
<tr>
<td>Housing Identification</td>
<td>\textbf{0707xx}</td>
<td></td>
</tr>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td>13 (\text{ ... 32V} ) (^{1} \text{ W} )</td>
<td>V DC</td>
</tr>
<tr>
<td>Frequency Band</td>
<td>24.0 (\text{...24.25 GHz} )</td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>(&lt; 250 \text{ MHz} )</td>
<td></td>
</tr>
<tr>
<td>Max. Transmit Power (EIRP)</td>
<td>(&lt;20 \text{ (&lt;12.7 for certain regions)} \text{ dBm} )</td>
<td></td>
</tr>
<tr>
<td>Interfaces</td>
<td>CAN V2.0b (passive) (^{1, 7} \text{, RS485 full duplex}^{1, 7} \text{, 10/100 Ethernet}^{1, 7} \text{,}</td>
<td>CAN, Power, RS485, Eth.</td>
</tr>
<tr>
<td>Connector</td>
<td>12 Pin plug Hirose LF10WBRB-12PD (^{1} \text{ CAN, Power, RS485, Eth.} )</td>
<td></td>
</tr>
</tbody>
</table>

\(^{1}\) 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.

\(^{2}\) Measured on object having const. radial speed, at bore sight.

\(^{3}\) Total field of view is angle interval where reflectors can be detected; 3dB field of view is narrower.
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.

![Type sticker example](image)

The individual sensors are referred to as **UMRR-xxxyyzz-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)](image)

<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>

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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