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2 Sensor Data Sheet

Smartmicro offers a family of traffic 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 29 antenna model (all model specific values are highlighted).

Type 29 Antenna aims at long range with wide horizontal angular coverage.

2.1 Sensor Photograph

![Traffic Sensor Type 29 - front.](image)

Figure 1: Traffic Sensor Type 29 - front.
Also available:
- Other versions of the housing for OEM integration.
- Other physical interface options.

For more details please contact us.
2.2 Function Description

The sensor is a very robust low cost 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 29 Antenna aims at long range with 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:

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 report many reflectors at a time being within the field of view.

Additionally filter algorithms are implemented 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 (difference > 0.25m/s) and also by the tracking algorithms and data base.

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. 50ms length. Stationary reflectors are not reported. Stopped objects are reported, as they remain valid in the tracking data base until they start moving again, for example at a stop bar. The field of view typically covers up to four lanes.
2.3 Applications

2.3.1 Intersection Management
At intersections, the sensor is typically used:
   a) for stop bar detection only, or
   b) for combined stop bar and advance detection.

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 29 sensor for intersection applications is shown in the left picture of Figure 3 and its parameters are given in Table 1.
Table 1: Standard Configuration for Stop Bar Detection Type 29

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Direction</td>
<td>Typ. Approaching</td>
</tr>
<tr>
<td>Mounting Height</td>
<td>Typ. 6m (1...10m)(^I)</td>
</tr>
<tr>
<td>Sensor Azimuth angle</td>
<td>Typ. -8° (-15 ...+15 deg.)(^II)</td>
</tr>
<tr>
<td>Sensor Elevation angle</td>
<td>Typ. -6° (-9...0 deg.)(^III, IV)</td>
</tr>
<tr>
<td>Stop Bar Distance</td>
<td>Typ. 35m (20m ... 50m)(^IV)</td>
</tr>
<tr>
<td>Advance Detection Distance</td>
<td>Typ. 135m (50m ... 160m)(^IV)</td>
</tr>
</tbody>
</table>

\(^I\) 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 seven sensors can usually be mounted at or around an intersection using separate configurable frequency channels, avoiding mutual interference.

Summary of intersection features and functions:
- **Stop bar detection**
- **Advance detection** (exploiting the long detection range)
- **Loop replacement** (non-intrusive detection)
- **Queue length** measurement
- **Custom trigger conditions** (e.g. location, vehicle speed and class condition)
- **ETA** measurement
- **Speed** measurement
2.3.2 Arterial Management

On highways and country roads, the sensor is typically used to count and classify traffic. Usually three classes 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)

![Figure 4: Standard Configuration Type 29](image-url)
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 29 sensor for counting applications is shown in Figure 4 and its parameters are given in the table below.

Table 2: Standard Configuration for Counting and Statistics Type 29

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Direction</td>
<td>Typ. Approaching &amp; Receding</td>
</tr>
<tr>
<td>Mounting Height</td>
<td>Typ. 6m (4...10m)</td>
</tr>
<tr>
<td>Sensor Azimuth angle</td>
<td>Typ. -8º (-15 ...+15 deg.)</td>
</tr>
<tr>
<td>Sensor Elevation angle</td>
<td>Typ. -6º (-9...0 deg.)</td>
</tr>
<tr>
<td>Counting Line Distance (Approaching)</td>
<td>Typ. 35m (20m ... 50m)</td>
</tr>
<tr>
<td>Counting Line Distance (Receding)</td>
<td>Typ. 90m (50m ... 160m)</td>
</tr>
<tr>
<td>Setback</td>
<td>Typ. 1m (0... 10m)</td>
</tr>
<tr>
<td>Counting Accuracy</td>
<td>Typ. &gt; 95%</td>
</tr>
<tr>
<td>Classes</td>
<td>Usually 3 classes are used of the following: Bicycle, Motorbike, Passenger Car, Truck</td>
</tr>
</tbody>
</table>

*1 May affect max. detection range. Occlusion needs to be considered.
*2 Smaller absolute angles allow longer detection range along a road.
*3 Application specific. Gantry mount: steeper el. angle possible, with limitations of maximum range. Negative elevation angle means sensor pointing towards road.
*4 Typical value for counting applications; may be different for other applications.
*5 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.

Summary of intersection features and functions:

- **Counting and Classification**
- **Wrong Way Detection** (vehicle moving opposite to the defined direction of traffic)
- **Incident Detection** supported
- **Speed** measurement
2.3.3 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.

![Image of UMRR Sensor Configuration](image)

**Figure 5: 4 Lane Speed / Red Light Enforcement in Approaching Mode Type 29**
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 29 sensor for speed enforcement applications is shown in Figure 5 and Figure 6. The parameters are given in Table 3.
Table 3: Standard Configuration for Traffic Enforcement Type 29

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Approaching Mode</th>
<th>Receding Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Direction</td>
<td>Approaching</td>
<td>Receding</td>
</tr>
<tr>
<td>Mounting Height</td>
<td>Typ. 4m/6m (1...10m)$^I$</td>
<td>Typ. 4m (1...10m)$^I$</td>
</tr>
<tr>
<td>Sensor Azimuth angle</td>
<td>Typ. -10°/-8° (-15 ...+15 deg.$^II$)</td>
<td>Typ. 15° (-15 ...+15 deg.$^II$)</td>
</tr>
<tr>
<td>Sensor Elevation angle</td>
<td>Typ. -2°/-6° (-9...0 deg.$^II$, $^III$)</td>
<td>Typ. -6° (-9...0 deg.$^II$, $^III$)</td>
</tr>
<tr>
<td>Measurement Line Distance</td>
<td>Typ. 35m (20m ... 50m)$^IV$</td>
<td>Typ. 25m (20m ... 50m)$^IV$</td>
</tr>
<tr>
<td>Speed accuracy</td>
<td>Typ. $&lt; \pm 0.28$ m/s or $\pm 1%$ (bigger of) $^V$</td>
<td></td>
</tr>
<tr>
<td>Track initialization time</td>
<td>6...10 cycles typical</td>
<td></td>
</tr>
<tr>
<td>Traffic Direction</td>
<td>Approaching, receding</td>
<td></td>
</tr>
</tbody>
</table>

$^I$ 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.

Summary of traffic enforcement features and functions:
- Speed and Red Light Enforcement at the same time
- Short distance measurement for both directions possible
## 2.4 General Performance Data

### 2.4.1 General 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 Pedestrian</td>
<td>50</td>
<td>m</td>
</tr>
<tr>
<td>Max. Range on Passenger Car</td>
<td>160</td>
<td>m</td>
</tr>
<tr>
<td>Minimum Range</td>
<td>1.5</td>
<td>m</td>
</tr>
<tr>
<td>Range accuracy</td>
<td>Typ. &lt; ±2.5% or &lt; ±0.25m (bigger of)</td>
<td>%, m</td>
</tr>
<tr>
<td>Radial Speed Interval</td>
<td>-68.3 ...+68.3 (±88.8 available)</td>
<td>m/s</td>
</tr>
<tr>
<td>Minimum abs. Radial Speed</td>
<td>0.1</td>
<td>m/s</td>
</tr>
<tr>
<td>Speed accuracy</td>
<td>Typ. &lt; ±0.28 or ±1% (bigger of)</td>
<td>m/s</td>
</tr>
<tr>
<td>Angle Interval (total field of view)</td>
<td>-6 ...+6 (El.); -18 ...+18 (Az.)</td>
<td>degree</td>
</tr>
<tr>
<td>Update time</td>
<td>≤ 50</td>
<td>ms</td>
</tr>
<tr>
<td>Track Initialization time</td>
<td>Typ. 6 ... 10</td>
<td>cycles</td>
</tr>
<tr>
<td>Simultaneously tracked objects</td>
<td>Typ. up to 64</td>
<td></td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>-40 ... +85</td>
<td>degree C</td>
</tr>
<tr>
<td>Shock</td>
<td>100</td>
<td>g rms</td>
</tr>
<tr>
<td>Vibration</td>
<td>14</td>
<td>g rms</td>
</tr>
<tr>
<td>IP</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Pressure / Transport altitude</td>
<td>0...10.000</td>
<td>m</td>
</tr>
<tr>
<td><strong>Mechanical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>330</td>
<td>g</td>
</tr>
<tr>
<td>Dimensions</td>
<td>See 2.6</td>
<td></td>
</tr>
<tr>
<td><strong>Model No.</strong></td>
<td>0Axxxx-1Dxxxx</td>
<td></td>
</tr>
<tr>
<td>DSP Board – Antenna Identification</td>
<td>0Axxxx-1Dxxxx</td>
<td></td>
</tr>
<tr>
<td>Housing Identification</td>
<td>050602</td>
<td></td>
</tr>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td>7 ... 32 VI 3.7 V DC W</td>
<td></td>
</tr>
<tr>
<td>Frequency Band</td>
<td>24.0...24.25 GHz</td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>&lt; 100</td>
<td>MHz</td>
</tr>
<tr>
<td>Max. Transmit Power (EIRP)</td>
<td>20</td>
<td>dBm</td>
</tr>
<tr>
<td>Interfaces</td>
<td>CAN V2.0b (passive) VII RS485 half-duplex</td>
<td></td>
</tr>
<tr>
<td>Connector</td>
<td>8 Pin plug Binder Series 712 CAN, Power, RS485</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.

III Measured on object having const. radial speed, at bore sight.
IV Total field of view is angle interval where reflectors can be detected; 3dB field of view is narrower.
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.
VII Also available: Ethernet, Relay contacts, see interfaces. It is recommended to use an external surge protection for power, CAN, RS485 and other interface ports.

2.4.2 Start-up time
After power up or reset, the sensor readings are within specified performance within typ. <30 seconds.

2.4.3 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.

2.4.4 Compliance
ETSI EN 300-440, FCC part 15, RSS-310, RSS-210, SRRC, KCC, NCC
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.

![Type Sticker Example](smartmicro.png)

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.
2.6 Sensor Dimensions

All values given in mm.

Figure 8: Sensor Front side.

Figure 9: Sensor Top, Left and Right Side.

Also available:
- Other versions of the housing for OEM integration.
- Other solution for connector and cable stump.
- Other physical interface options.

For more details please contact us.
Figure 10: Sensor Rear Side.
2.7 Connector

The used sensor connector is an 8-pin male (plug) circular connector (water proof IP67, series 712, manufacturer Binder GmbH, Germany). A female counterpart (socket) has to be used to connect to the sensor. The pin numbering of the socket is shown in Figure 11 the pin description is given in Table 4.

![Figure 11: View on solder cup side of socket (rear view of female counterpart to be connected to sensor)](image)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
<th>Wire color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RS485 L</td>
<td>Pink = RS_485_L</td>
</tr>
<tr>
<td>2</td>
<td>Ground</td>
<td>Blue = GND</td>
</tr>
<tr>
<td>3</td>
<td>RS485 H</td>
<td>Grey = RS_485_H</td>
</tr>
<tr>
<td>4</td>
<td>CAN_L</td>
<td>Yellow = CAN_L</td>
</tr>
<tr>
<td>5</td>
<td>CAN_H</td>
<td>Green = CAN_H</td>
</tr>
<tr>
<td>6</td>
<td>not connected</td>
<td>Brown = n.c.</td>
</tr>
<tr>
<td>7</td>
<td>+7V...+32V</td>
<td>Red = Vcc (+7V...+32V)</td>
</tr>
<tr>
<td>8</td>
<td>not connected</td>
<td>White = n.c.</td>
</tr>
</tbody>
</table>

Table 4: Sensor connector pin out Model UMRR-0Axxxx

Please note that in the standard configuration for a CAN data interfaced UMRR the sensor has no 120Ohms resistor on board (CAN bus termination between CAN_L and CAN_H). The resistor is nevertheless required at either end of a CAN 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 120Ohms 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.

Additionally a special junction box to be directly attached to the sensor is available. This IP67 proof sensor + junction box assembly eliminates the need to use the specific sensor connector and provides connectivity for almost any kind of field installation cables using a terminal block (see junction box data sheet). It also provides additional surge and lightning protection.

PROPRIETARY
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