Project Documentation | UMRR-11 Type 44 User Manual

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1   Contents

2 Abbreviations

ADC   Analog-to-digital converter

CAN   Controller area network

DAC   Digital-to-analog converter

DSP   Digital signal processing, digital signal processor

MMIC   Monolithic microwave integrated circuit

RS485   Physical communication layer standard EIA RS-485

UMRR   Universal medium-range radar

3 Introduction

This document is a short documentation of the general purpose **u**niversal **m**edium **r**ange **r**adar (UMRR) UMRR-11 Type 44 radar sensor with type 44 antenna.

4 General description

4.1 Sensor description

The main task of the UMRR is the detection of any reflectors in the field of view, to measure the distance, the relative speed and the angle to the shortest reflector (and to other reflectors), to detect motion and to track (filter) the results over time.

For this **general purpose measurement application**, range and relative radial speed as well as the angle value of each reflector inside the antenna beam are measured. The results are reported via the communication links cycle by cycle.

4.2 Transmit signal

The UMRR transmit frequency is located in the 24 GHz ISM band (24000 MHz to 24250 MHz), the used bandwidth is smaller than 200MHz. The maximum transmit power is 12.7 dBm.

The antenna type 44 is used, which consists of one transmit and four receive antennas. All the antennas are linear polarized. The two-way 3dB cut-off angle in azimuth is +-22deg and in elevation is +-5deg.

4.3 General performance data

After the device is powered up or reset, the unit (Tx and Rx) starts operating. Within specified performance the sensor readings are within <3s. In Table 4-1 the general performance data are given.

Table 4-1: General performance data

Environmental		
Ambient Temperature	-40 … +85	degree C
Shock	100	g$_{rms}$
Vibration	14	g$_{rms}$
IP	67	
Pressure / Transport altitude	0…10.000	m
Mechanical		
Weight	340	g
Dimensions	See 5.2	
Housing Identification	05	
Antenna Identification	2C	
DSP Board Identification	11	
General		
Power Supply	8 … 32 [I] <5[II]	V DC W
Frequency Band	24.0…24.25	GHz
Bandwidth	< 200	MHz
Max. Transmit Power (EIRP)	12.7	dBm
Interfaces	CAN V2.0b (passive) RS485 full duplex 10/100 Ethernet	

[I] measured at connector
[II] Power consumption at 20°C.

5 Hardware

5.1 UMRR-11 sensor

An example of the UMRR-11 Type 44 sensor with a housing type 050B00 is shown below.

Figure 5-1: Front view of UMRR-11 sensor with housing type 050B00

Figure 5-2: Rear view of UMRR-11 sensor with housing type 050B00

5.2 Sensor dimensions

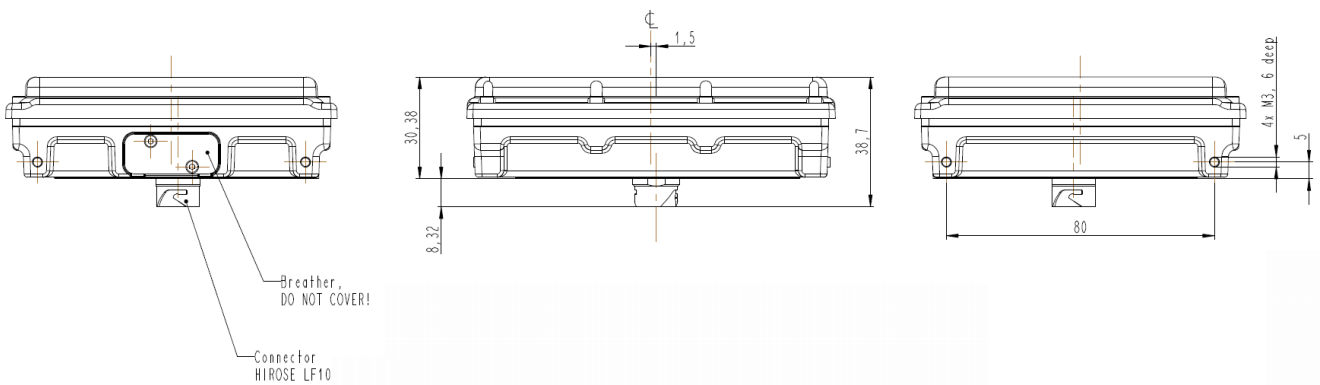All the values in the figures below are given in mm.
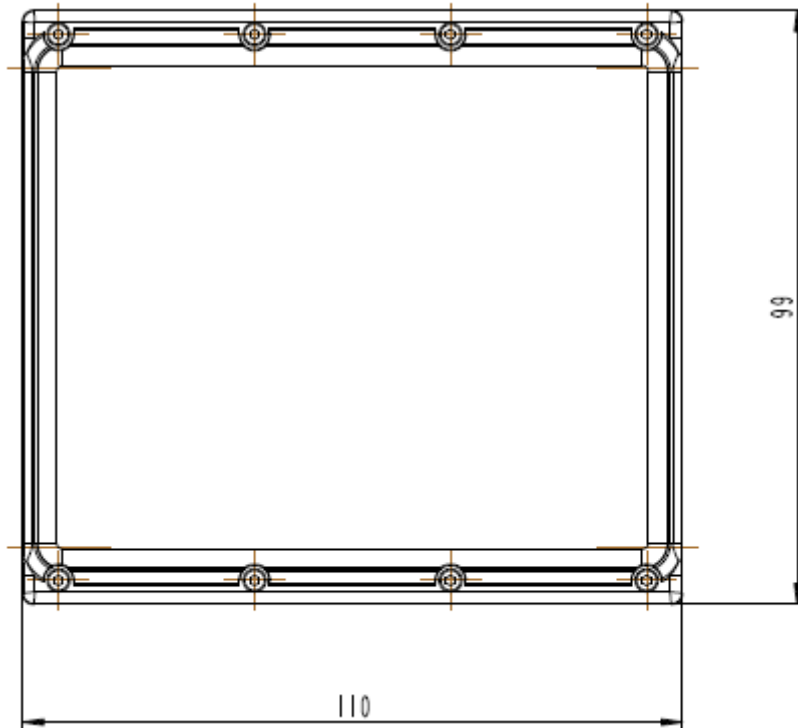
Figure 5-3: Front view of the UMRR-11 sensor

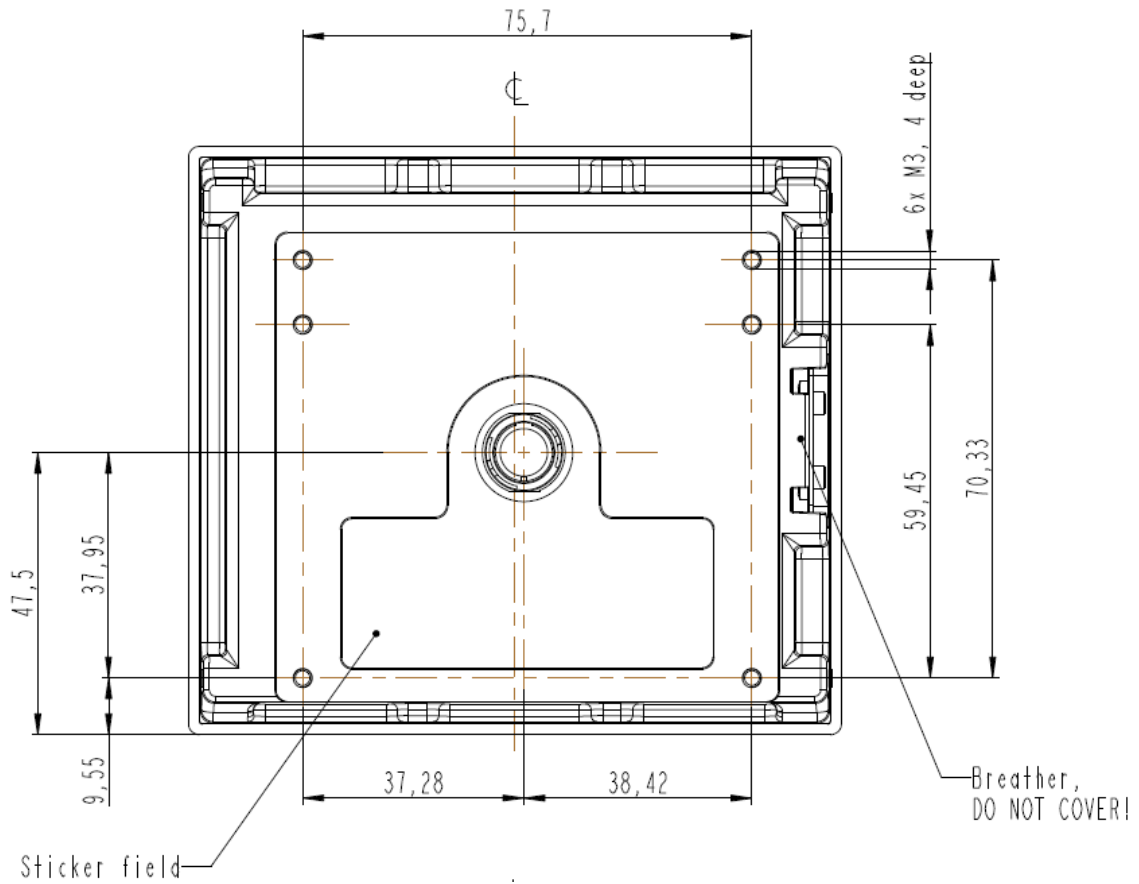**Figure 5-4: Right, top and left view of the UMRR-11 sensor**

Figure 5-5: Rear view of the UMRR-11 sensor

6 Cables and connectors

6.1 Sensor 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) has to be used to connect to the sensor. The pin numbering of the socket is shown in Figure 6-1 and the pin description is given in Table 6-1.
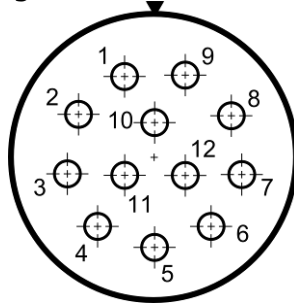
Figure 6-1: Female counterpart of sensor connector (rear view)

Table 6-1: Sensor connector pin out of UMRR-11

Pin	Function	Wire Color
1	Ethernet TX H	gray / red
2	Ethernet TX L	red / blue
3	RS485 RX L	pink
4	RS485 RX H	gray
5	RS485 TX L	brown
6	RS485 TX H	white
7	GND	blue
8	Vcc	red
9	Ethernet RX L	black
10	Ethernet RX H	purple
11	CAN H	green
12	CAN L	yellow

Please note that in the standard configuration the sensor has no 120Ohms 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 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.

7 Data interface

7.1 CAN data interface

This specification gives a detailed description of the CAN data communication used in the UMRR based systems on the sensor CAN. The UMRR is compliant with CAN 2.0B standard.

CAN is a very robust full duplex bidirectional interface.

7.2 CAN-settings

|		
Baud Rate:	500kBit/s or lower	
Prescalar:	1	
T_{seg1}:	8	
T_{seg2}:	7	
T_{sjw}:	2	(SJW: synchronization jump width)

Above values for CAN bit timing are illustrated in Figure 7-1 used in the UMRR radar sensor (note: the CAN module is integrated in the DSP). For comparison purposes, in Figure 7-2 the CAN bit timing as defined by the CAN protocol is shown.

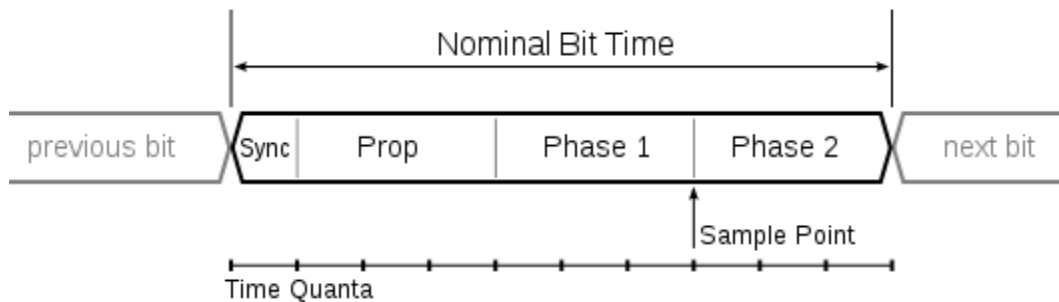The CAN bit timing parts as defined by the CAN protocol (Figure 7-2) can be described as follows:

- **Sync**: This part of bit time is used to synchronize the various nodes on the bus. An edge is expected to lie within this segment. For the UMRR sensor, this segment is always 1 TIME QUANTUM (TQ).
- **Prop**: This part of the bit time is used to compensate for the physical delay times within the network. It is twice the sum of the signal's propagation time on the bus line, the input comparator delay, and the output driver delay. For the UMRR sensor, this segment is programmable from 1 to 8 TIME QUANTA (TQ).
- **Phase 1**: This phase is used to compensate for positive edge phase error. For the UMRR sensor, this segment is programmable from 1 to 8 TIME QUANTA (TQ) and can be lengthened by resynchronization.
- **Phase 2**: This phase is used to compensate for negative edge phase error. For the UMRR sensor, this segment is programmable from 2 to 8 TIME QUANTA (TQ) and can be shortened by resynchronization.
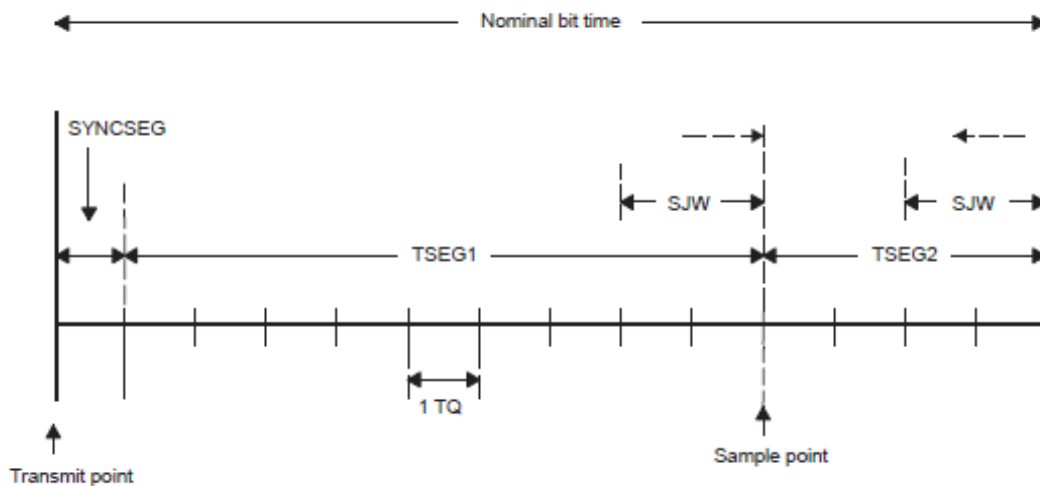
Figure 7-1: CAN bit timing for UMRR sensor

Figure 7-2: CAN bit timing as defined by the CAN protocol

7.3 RS485 data interface

The RS485 interface from the UMRR sensor has a predefined speed of 115200 baud/s. Typical other data rates are between 921.6kBit/s and 56.7kBit/s.

The RS485 message payload is identical to the CAN format. The data messages will be sent in several packets of one byte.

Every cycle begins with a start sequence and ends with a calculated checksum and an end sequence. The length of the data payload depends on the number of targets and tracked objects.
Every cycle has one start sequence one end sequence and one checksum.

Table 7-1: RS485 message structure

Byte\Bit	7	6	5	4	3	2	1	0
0								0xCA
1				Start sequence (4 x UINT8)				0xCB
2								0xCC
3								0xCD
x								
x								
x								
x				Data payload (n x UINT8)				
x								
x								
x								
x								
0				XOR Checksum (UINT8)				
1								0xEA
2				End sequence (4 x UINT8)				0xEB
3								0xEC
4								0xED

Every data message consists of its own message ID, the number of used data bytes and the data bytes itself.

The checksum is calculated on all data except the start sequence and the end sequence. The Checksum is a simple XOR Assignment of all n data bytes.
Byte0 **XOR** Byte1 **XOR** Byte2 ... **XOR** Byte (n-1)

Table 7-2: Structure of a RS485 data payload block

Byte\Bit	7	6	5	4	3	2	1	0
0				CAN message ID (UINT16)				High
1								Low
2				CAN message length (UINT8)				
3								
4								
5								
6								
7				CAN data payload (length x UINT8)				
8								
9								
10								

The sensor receives only one message per cycle. It is important to wait for the end sequence to send an additional command.

8 Designated Use

The UMRR general purpose medium range radar is suitable for any application where the distance to and relative radial speed of large objects has to be measured.

Typical applications are:

Robotics: measure shortest distance to obstacle.
Security: detect motions and measure distance to moving object.
Traffic management: detect moving objects, count those, measure speed and measure distance to moving object.
Cranes: measure distance to ground.
Aircraft: measure distance to ground.

The detection range depends on object size. Very large reflectors can be detected at a range of more than 500 m.

9 Compliance

9.1 Declaration of Conformity for USA

This device complies with Part 15 of the FCC Rules. 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.

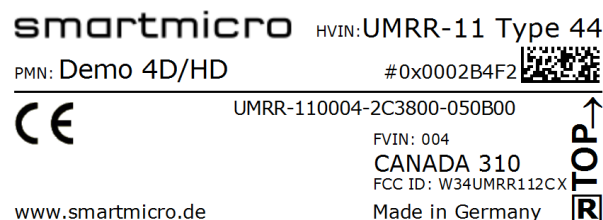Usually this is followed by the following FCC caution:
Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Note:
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may case harmful interferences to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different
  from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help.

9.1.1 FCC Label

Figure 9-1: Sample of FCC Label