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SMART MICROWAVE SENSORS GMBH

Project Documentation | UMRR-11 Type 132 User Manual

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1 Contents

2 Abbreviations

ACC	Adaptive cruise control
ADC	Analog-to-digital converter
AEB	Advanced emergency braking
CAN	Controller area network
DSP	Digital signal processing; digital signal processor
FMCW	Frequency modulated continuous wave
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 132 radar sensor with type 132 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 and the angle value of each reflector inside the antenna beam are measured and the results are reported via the communication links cycle by cycle.

4.2 Transmit Signal

The UMRR transmit frequency is located in the 76 GHz to 77 GHz band, the used bandwidth is smaller than 1 GHz. The maximum transmit power is smaller than 55dBm.

The UMRR-11 sensor type 132 provides 2 modes, AEB- and ACC-mode. Antenna type 132 is used, consisting of three transmit and four receive antennas, both are linear polarized. The 2 way 3 dB cut-off angle by AEB-mode in azimuth is ± 25 deg. and in elevation is ± 4.1 deg. The 2 way 3 dB cut-off angle by ACC-mode in azimuth is ± 7 deg. and in elevation is ± 4.1 deg.

The device uses different FMCW transmit signal waveforms for distance and speed measurement.

4.3 General Performance Data

After power up or reset, the sensor readings are within specified performance within <10 seconds. In Table 4-1 the general performance data of UMRR-11 Type 132 are given.

Table 4-1: General performance data

Environmental		
Ambient Temperature	-40 ... +74	degree C
Shock	100	g_{rms}
Vibration	14	g_{rms}
IP	67	
Pressure / Transport altitude	0…10.000	m
Mechanical		
Weight	≤ 200	g
Dimensions	See 5.2	
Housing Identification	03	
Antenna Identification	84	
DSP Board Identification	11	
General		
Power Supply	8 ... 32 [I] 5	V DC W
Frequency Band	76.0…77.0	GHz
Bandwidth	< 1000	MHz
Max. Transmit Power (EIRP)	55.0	dBm
Interfaces	CAN V2.0b (passive) RS-485 Ethernet 100Mbit	
Connector	Hirose LF10 series	CAN, Power, RS485, Eth.

[I] measured at connector

5 Hardware

5.1 UMRR-11 sensor

An example picture of a UMRR-11 Type 132 sensor (housing type 030B00) is shown below.

Figure 5-2: Front view of UMRR-11 Type 132 with housing type 030B00

Figure 5-1: Rear view of UMRR-11 Type 132 with housing type 030B00

5.2 Sensor Dimensions

All values are given in mm.

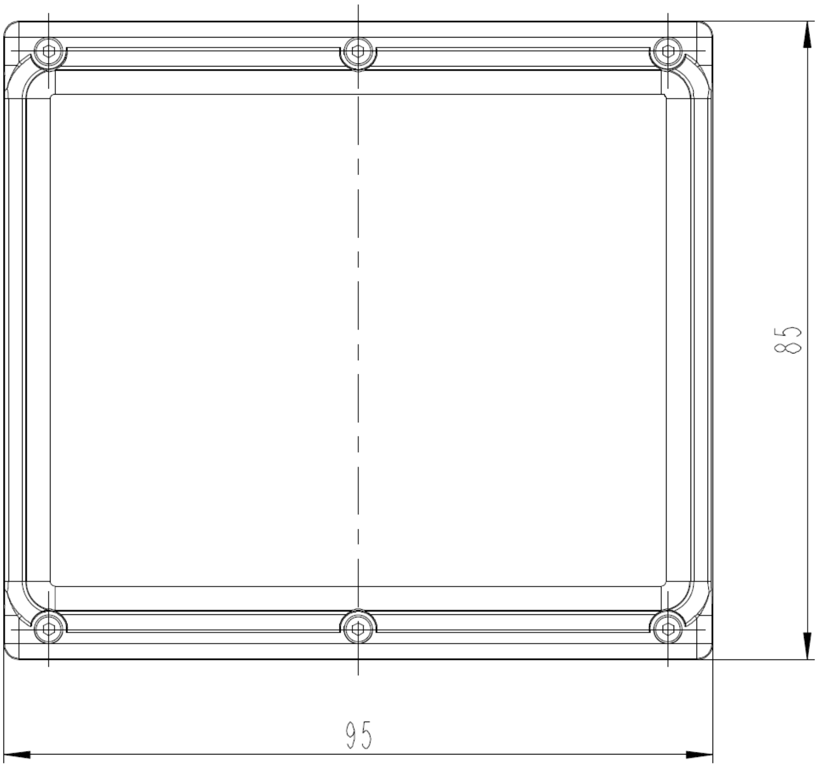

Figure 5-3: Sensor front view

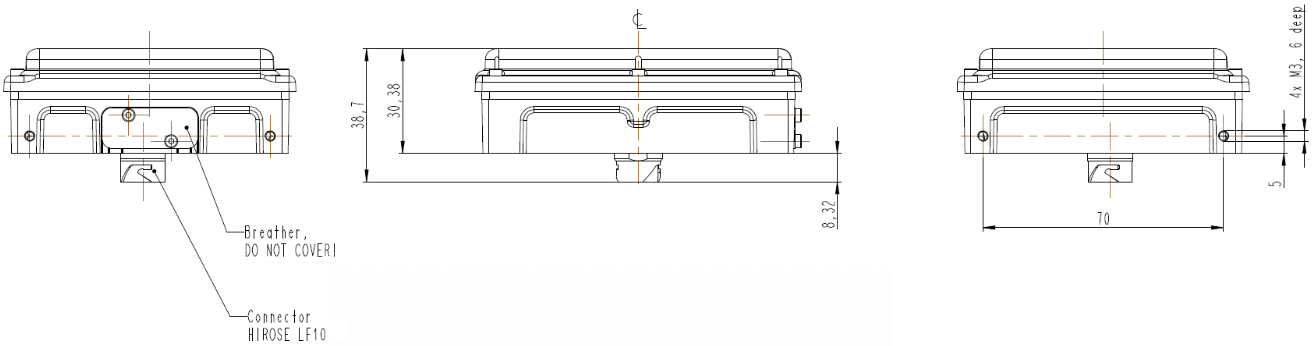

Figure 5-4: Sensor left, top and right side view

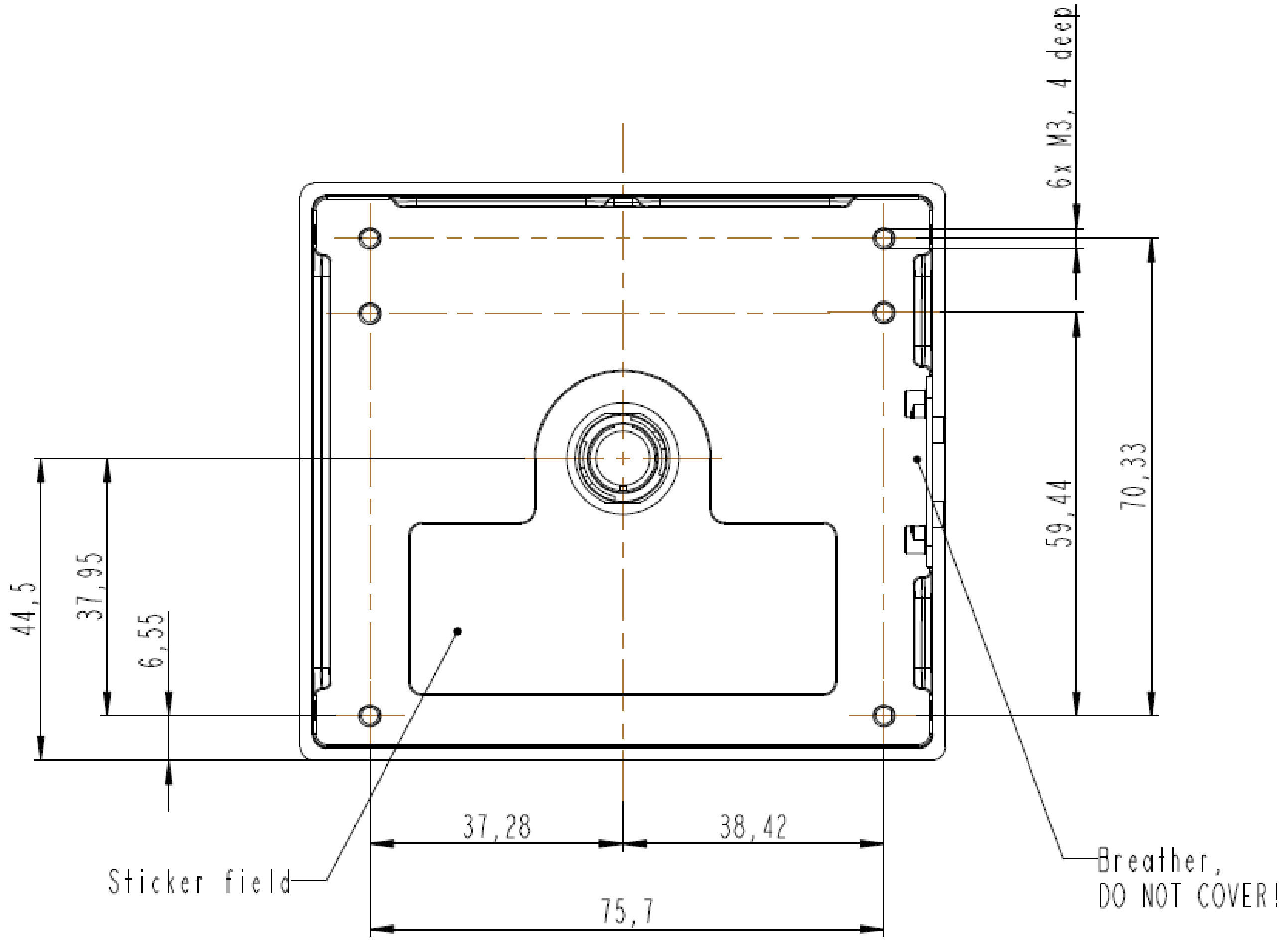

Figure 5-5: Sensor rear side view

6 Cables and connectors

6.1 Sensor connector

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 6-1 and the pin description is given in Table 6-1.

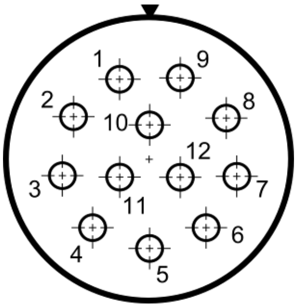

Figure 6-1: Rear view of female counterpart to be connected to sensor

Table 6-1: Connector pin out model of sensor UMRR-11

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.

7 Data interfaces

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 and 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.

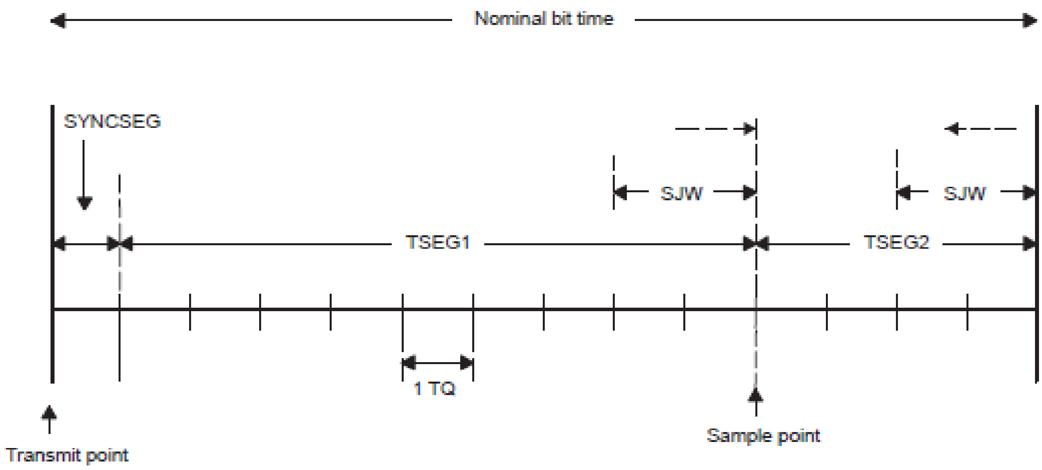

Figure 7-1: CAN bit timing for UMRR sensor

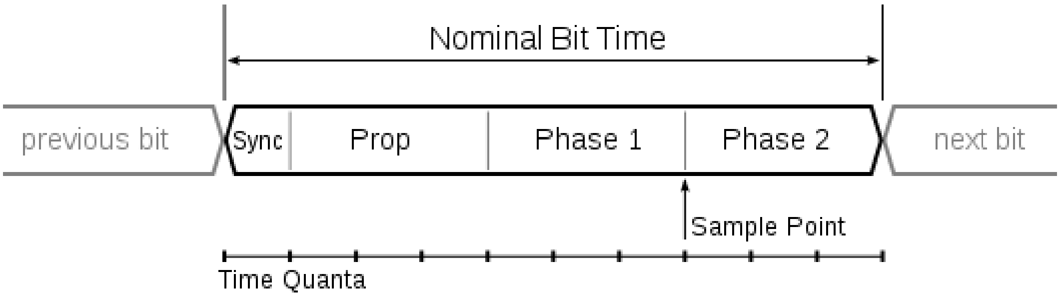

Figure 7-2: CAN bit timing as defined by the CAN protocol

7.3 RS-485 data interface

The RS-485 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 RS-485 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: RS-485 message structure

Byte\Bit	7	6	5	4	3	2	1	0
0	Start sequence (4 x UINT8)							0xCA
1								0xCB
2								0xCC
3								0xCD
x	Data payload (n x UINT8)							
x								
x								
x								
x								
x								
x								
x								
0	XOR Checksum (UINT8)							
1	End sequence (4 x UINT8)							0xEA
2								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 RS-485 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	CAN data payload (length x UINT8)							
4								
5								
6								
7								
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.

7.4 Transceiver schematics

In Figure 7-3 and Figure 7-4 the exact DSP board schematic of the UMRR is given. The CAN pins of the Co-Processor are connected to a CAN transceiver, which is connected to the pins CAN1_P and CAN1_N. Similarly, the RS485 pins of the Co-Processor are connected to a RS485 transceiver, which is connected to the pins RS485_TX_ETHRN_TX4_P, RS485_TX_ETHRN_TX4_N, RS485_TX_CAN2_ETHRN_TX3_P, RS485_TX_CAN2_ETHRN_TX3_N. The Ethernet-Phy is connected to an Ethernet transformer, which is connected to the pins ETHRN-TX1_P, ETHRN-TX1_N, ETHRN-TX2_P, ETHRN-TX2_N.

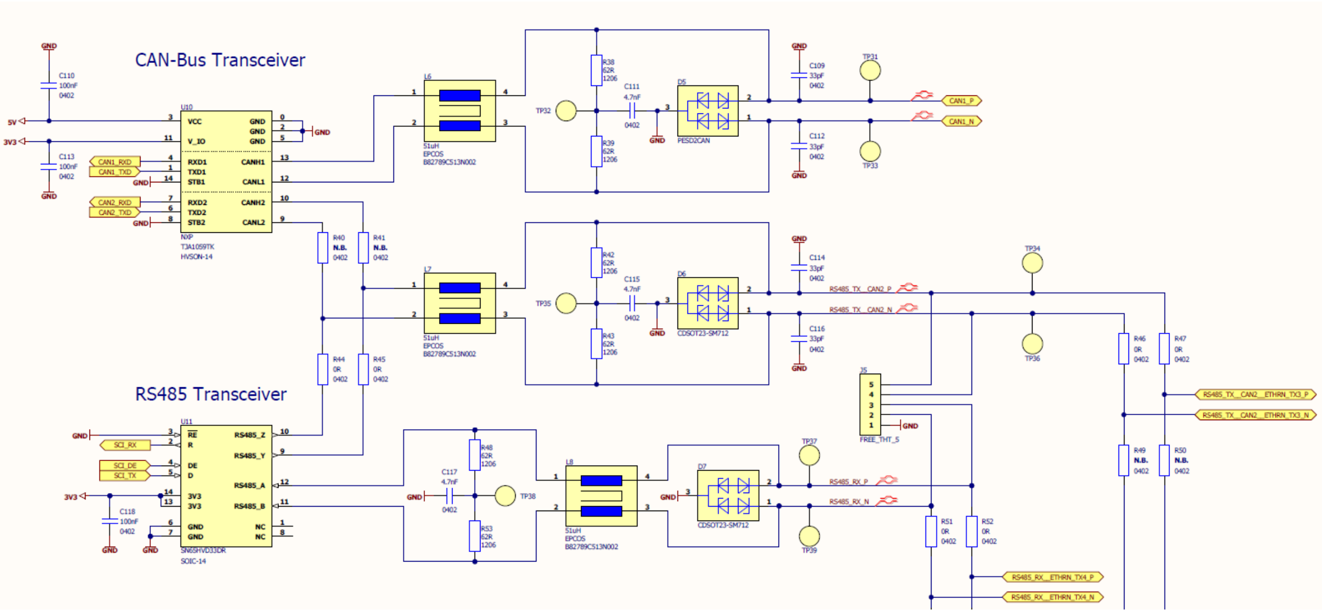

Figure 7-3: UMRR-11 DSP board schematics of CAN and RS485 transceivers

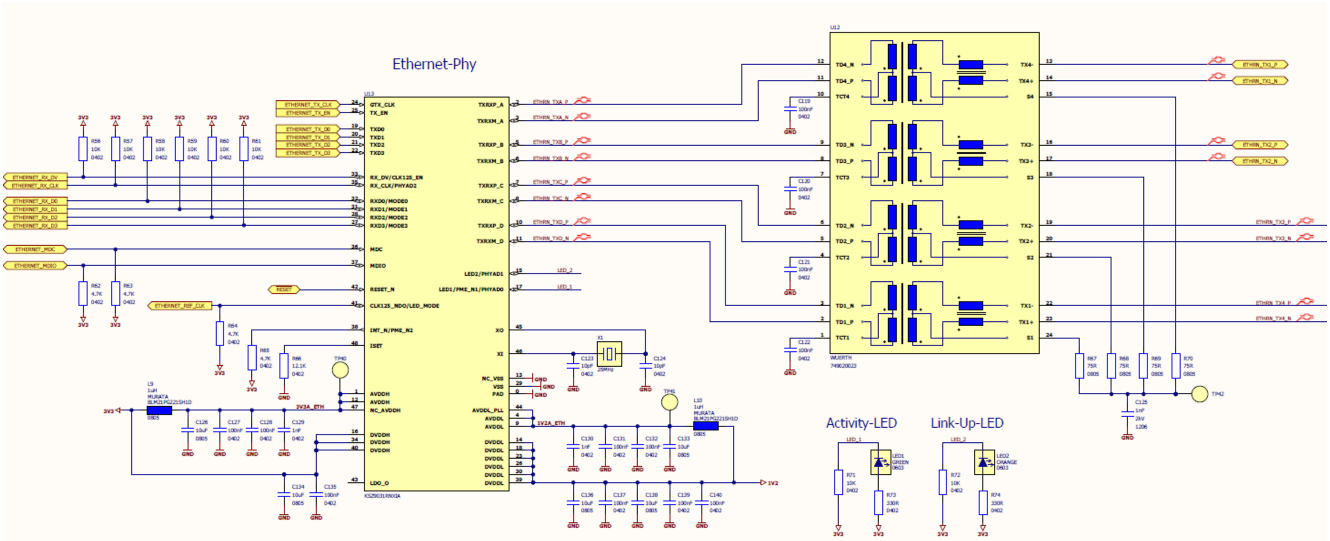

Figure 7-4: UMRR-11 DSP board schematics of Ethernet-Phy

8 Applications

It can be used for long and medium range collision warning (CW), adaptive cruise control (ACC) applications in autonomous driving systems.

One or multiple sensors are specifically integrated into vehicle models of automotive OEMs. Usually there is a certain OEM-specific engineering effort required for the adaptation to specific vehicle models and the test and qualification procedures to be applied. Customer specific connectors, CAN(FD)/Ethernet interfaces, tracking algorithms, warning algorithms or other custom software packages can be included.

Some examples of application in automotive fields are shown as follows:
- Adaptive cruise control (ACC)
- Advanced emergency braking (AEB)
- Forward collision warning (FCW)
- Rear collision warning (RCW)

This sensor can optionally be compliant to ASIL Level B in customer specific projects (requirements and safety concept to be agreed between OEM and smartmicro). It can also be offered with AUTOSAR compliant software in customer specific projects (specification to be agreed between OEM and smartmicro).

9 Declaration of Conformity

9.1 Declaration of Conformity for USA

This device has been tested and found to comply with the requirements set forth in 47 CFR Part 95, Subpart M for both fundamental emissions and unwanted emissions. These limits are designed to provide reasonable protection against any harmful interference when the device is operated in a commercial environment.

Modifying the device without smartmicro's authorization may result in the device being no longer compliant with FCC requirements. In that event, your right to use the device may be limited by FCC regulations, and you may be required to correct any interference to radio or television communications at your own expense.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the device.

This device complies with the requirements set forth in 47 CFR Section 95.3385 addressing RF exposure from radio frequency devices. To maintain compliance, the minimum separation distance from the antenna to general bystander is 20 cm.

9.1.1 FCC Label

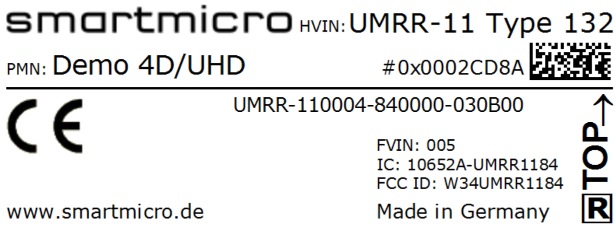

Figure 9-1: Sample of FCC Label

9.2 Declaration of Conformity for Canada

9.2.1 Declaration of Conformity in English

This device complies with Industry Canada license-exempt RSS standard(s).
Operation is subject to the following two conditions:
(1) this device may not cause interference, and
(2) this device must accept any interference, including interference that may cause undesired operation of the device.

IC Radiation Exposure Statement:

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with the minimum distance 20cm between the radiator & your body.

9.2.2 Déclaration de conformité en francais

Le present appareil est conforme aux CNR d'Industrie Canada applicables aus appareils radio exempts de licence. Léxploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisaeur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

DÉCLARATION D'EXPOSITION AUX RADIATIONS

Cet equipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cetéquipement doit être installé et utilisé avec un minimum de 20cm de distance entre la source de rayonnement et votre corps.

9.2.3 Industry Canada (IC) Label

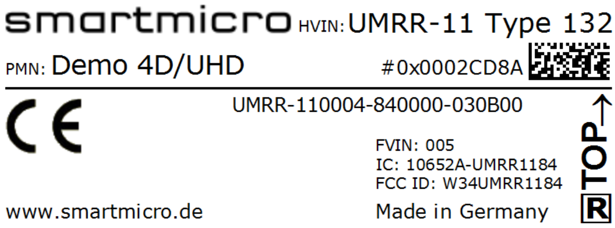

Figure 9-2: Sample of IC Label