# Project Documentation | TRUGRD Stream User Manual

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# 1 Contents


1 Contents ..... 2
2 Abbreviations ..... 3
3 Introduction ..... 4
4 General description ..... 5
4.1 Sensor description ..... 5
4.2 Transmit Signal ..... 5
4.3 General Performance Data ..... 5
4.4 Software and Firmware Version ..... 6
5 Hardware ..... 7
5.1 TRUGRD Stream Sensor View ..... 7
5.2 Sensor Dimensions ..... 8
6 Cables and Connectors ..... 9
6.1 Sensor connector ..... 9
6.2 CAN data interface ..... 9
6.3 CAN-Settings ..... 10
6.4 RS485 data interface ..... 11
7 Designated Use ..... 12
8 Compliance ..... 13
8.1 Declaration of Conformity for USA ..... 13
8.1.1 FCC-Label ..... 13
8.2 Declaration of Conformity for Canada ..... 14
8.2.1 Declaration of Conformity in English ..... 14
8.2.2 Déclaration de conformité en francais ..... 14
8.2.3 Industry Canada (IC) Label ..... 14

# 2 Abbreviations

| | |
|---|---|
| ADC | Analog-to-Digital Converter |
| AFE | Analog Front-End |
| CAN | Controller Area Network |
| DSP | Digital Signal Processing; Digital Signal Processor |
| EEPROM | Electrically Erasable Programmable Read-only Memory |
| FMCW | Frequency Modulated Continuous Wave |
| GPIO | General Purpose Input Output |
| MMIC | Monolithic Microwave Integrated Circuit |
| RAM | Random Access Memory |
| RS485 | Physical communication layer standard EIA RS-485 |
| SPI | Serial Peripheral Interface |
| SOC | System on Chip |
| UMRR | Universal Medium-Range Radar |

# 3 Introduction

This document is a short documentation of the general purpose universal medium range radar (UMRR) TRUGRD Stream sensor with type 48 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 in the 24 GHz ISM band (24000 MHz to 24250 MHz) and the used bandwidth is smaller than 250MHz.

Antenna type 48 consists of 2 TX antennas with same antenna characteristics but different center position on the board and 8 uniform RX antennas. The TX antenna have a 3dB antenna beam width of +-34° in azimuth and +-6,5° in elevation. The 8 RX antennas have a 3dB antenna beam width of +-25° in azimuth and +-7° in elevation. Highest TX antenna sidelobe: @+74°, highest RX sidelobe at +-50°.

Note: max. Gain for TX antenna at azimuth angle +-22°, elevation angle 0°. The RX antennas have max. gain at boresight.
Gain RX: 11.1 dBi.

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 <30 seconds. In Table 4-1 the general performance data is given.

Table 4-1: General performance data

| | | |
|---|---|---|
| Environmental | | |
| Ambient Temperature | -34 ... +74 | degree C |
| Shock | 100 | $g_{rms}$ |
| Vibration | 14 | $g_{rms}$ |
| IP | 67[I] | |
| Pressure / Transport altitude | 0...10.000 | m |
| Mechanical | | |
| Weight | 1580 | g |
| Dimensions | See 5.2 | |
| Housing Identification | 07 | |
| Antenna Identification | 30 | |
| DSP Board Identification | 12 | |
| General | | |
| Power Supply | 7 ... 32[II]<br>12[III] | V DC<br>W |
| Frequency Band | 24.0...24.25 | GHz |
| Bandwidth | < 250 | MHz |
| Max. Average Transmit Power (EIRP) | < 12.7 | dBm |
| Interfaces | CAN V2.0b<br>RS485 full duplex<br>10/100 Ethernet | |
| Connector | 12 Pin plug Hirose LF10WBRB-12PD | CAN, Power, RS485, Eth. |

[I] IP 67 only when connector or cap attached.
[II] measured at connector, min. voltage slew rate 500V/s or max. voltage rise time 15ms; supply source impedance 0.5Ohms.
[III] Typical value 9W @20°C, may slightly increase over temperature.

## 4.4 Software and Firmware Version

The software in the TRUGRD Stream has the version 6.

# 5 Hardware

## 5.1 TRUGRD Stream Sensor View

An example picture of a TRUGRD Stream sensor is shown in the figures below.

Figure 5-1: Housing of TRUGRD Stream front

Figure 5-2: Housing of TRUGRD Stream rear

## 5.2 Sensor Dimensions

All values given in mm.

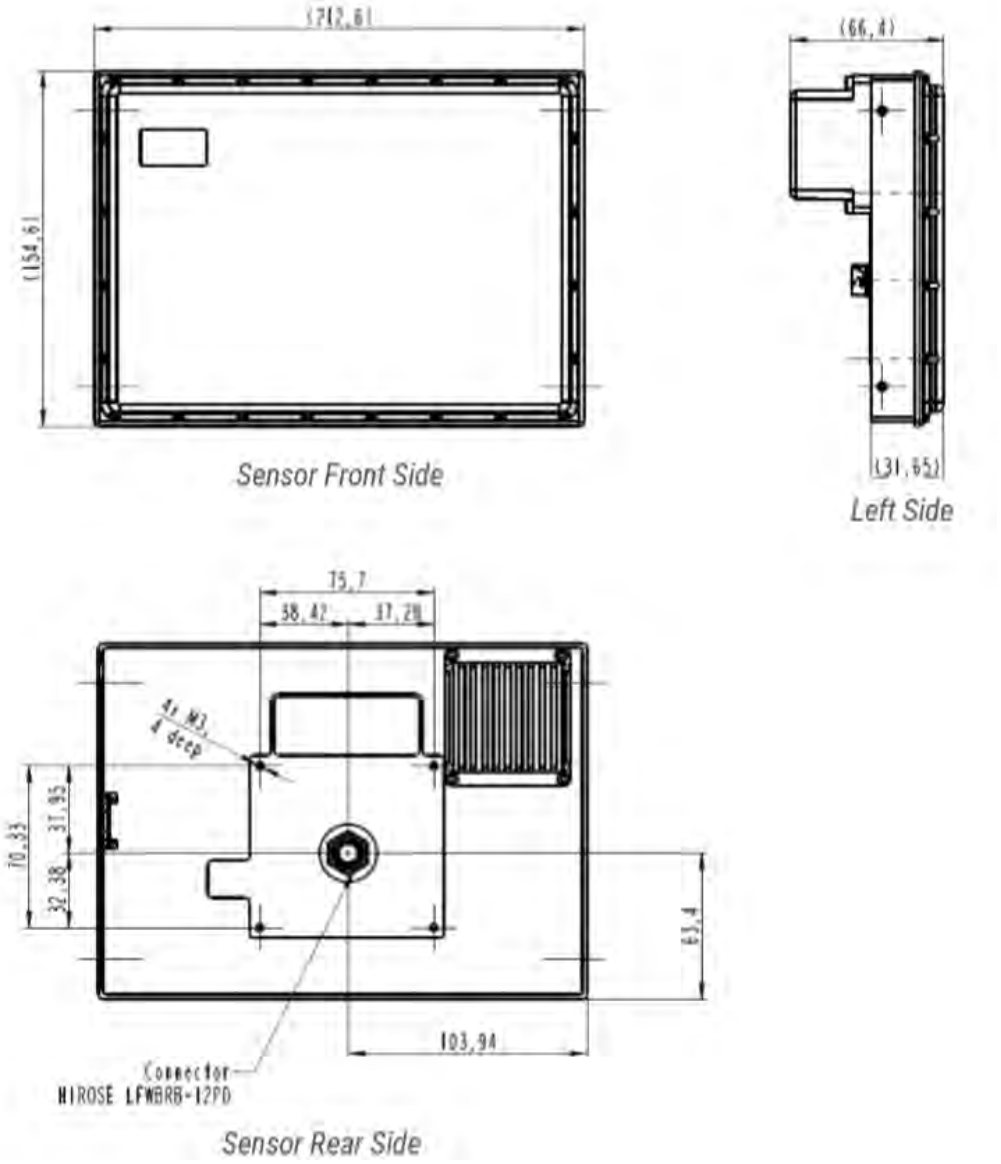


Figure 5-3: Dimensions of TRUGRD Stream Sensor

# 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, is used to connect to the sensor. The pin numbering of the socket is shown in Figure 6-1 the pin description is given in Table 6-1.

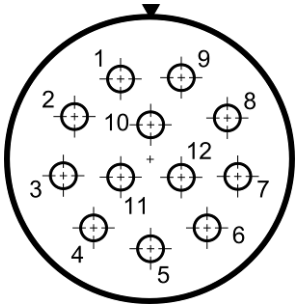


Figure 6-1: View on solder cup side of socket (rear view of female counterpart to be connected to sensor)

Table 6-1: Sensor connector pin out model

| Pin No. | Function | Wire Color (MEDI type #KU110C12J002) |
|---|---|---|
| 1 | SENSOR_ETH_TX1_P | gray / red |
| 2 | SENSOR_ETH_TX1_N | red / blue |
| 3 | SENSOR_RS485_RX_N | pink |
| 4 | SENSOR_RS485_RX_P | gray |
| 5 | SENSOR_RS485_TX_N | brown |
| 6 | SENSOR_RS485_TX_P | white |
| 7 | External GND | blue |
| 8 | V_SUPPLY | red |
| 9 | SENSOR_ETH_TX2_N | black |
| 10 | SENSOR_ETH_TX2_P | purple |
| 11 | CAN_H | green |
| 12 | CAN_L | yellow |

Please note that in the standard configuration the sensor has 120 Ohms resistor on board (CAN bus termination between CAN_L and CAN_H).

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.

## 6.2 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.

## 6.3 CAN-Settings

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

Above values for CAN bit timing are illustrated in Figure 6-2 used in the UMRR radar sensor (note: the CAN module is integrated in the DSP). For comparison purposes, in Figure 6-3 the CAN bit timing as defined by the CAN protocol is shown.

The CAN bit timing parts as defined by the CAN protocol (Figure 6-3) 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.

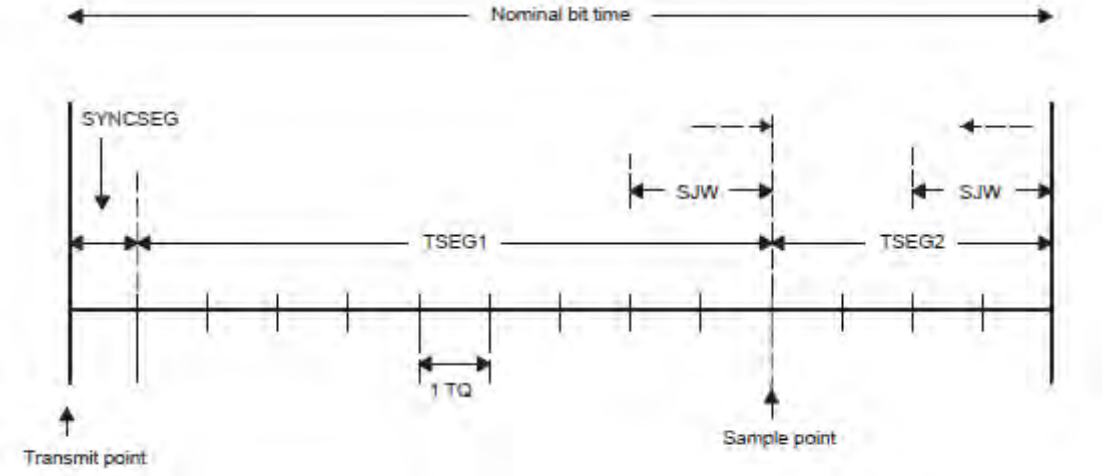


Figure 6-2: CAN bit timing for UMRR sensor

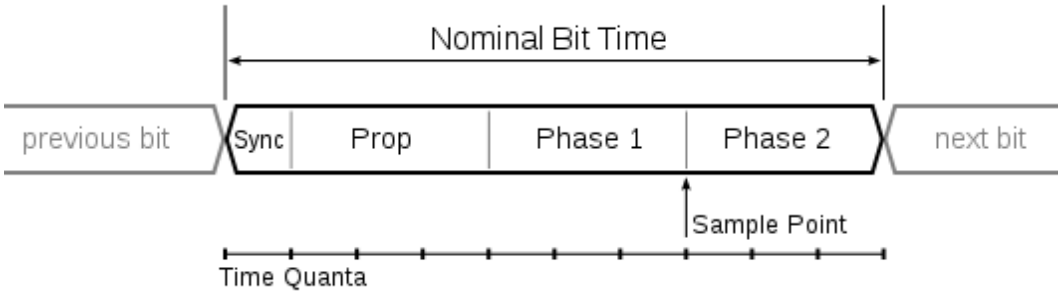


Figure 6-3: CAN bit timing as defined by the CAN protocol

## 6.4 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.

# 7 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.

# 8 Compliance

## 8.1 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.

### 8.1.1 FCC-Label

An example of FCC-label is shown as following:


Figure 8-1: Sample of FCC Label

## 8.2 Declaration of Conformity for Canada

### 8.2.1 Declaration of Conformity in English

This device complies with Industry Canada licence-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.

### 8.2.2 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.

### 8.2.3 Industry Canada (IC) Label

An example of IC-label is shown as following:


Figure 8-2: Sample of IC Label