

R600V.DAH5 Operating Manual (EN)

Off-Highway Distance Radar Sensor

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1. General Information

1.1. Scope

This manual is intended for the Baumer “Off-highway Distance Radar” family. The sensors and their software configuration are listed below:

Tab 1 Applicable Products

| Art. no. | Product | Type | SW Version |
|----------|---------------------|------------------------------|------------------------------|
| 11205779 | R600V.DAH5-11205779 | High accuracy distance radar | R600VSOF_S 1.0.0 (or higher) |



Read this operating manual carefully and follow its safety instructions!

1.2. Comments, notes, and warnings



NOTE

Provides helpful operation instructions or other general recommendations.



ATTENTION

Indicates a possibly situation that may lead to damage.



CAUTION

Indicates a possibly hazardous situation. If it is not avoided injuries may occur or the device be damaged.

1.3. Intended Use

1.3.1. General

The “Off-highway Distance Radar” has been developed with the off-highway market (agriculture vehicles, construction vehicles, etc.) in mind. It is intended for use cases in which the distance onto a defined target such as a corner cube, a metal plate or flat and unstructured surfaces in general (e.g. asphalt, concrete) shall be determined. For highly structured surfaces (rough terrain, stubble, etc.) Baumer recommends the usage of “Off-Highway Ground & Crop Radar Sensor” family (R600V.DAE0-11209335, R600V.DAE0-11188367). The 122GHz band can be used in many different applications. The original equipment manufacturer or system integrator must observe local restrictions regarding the usage and/or placing in the market of this product.

**NOTE**

For highly structured surfaces (rough terrain, stubble, etc.) Baumer recommends the usage of “ground & crop radar sensor” family (R600V.DAE0-11209335, R600V.DAE0-11188367)

The sensor may be integrated into vehicles with 12VDC and 24VDC vehicle power supplies, and provides a CAN SAE J1939 interface with a set speed of 250kbit/sec (may be changed to 500kbit/sec). The output rate defaults to 50ms, but may be varied between 10ms and 1000ms. High visibility LEDs displays the sensor status, even in bright ambient light.

1.3.2. Audience

This manual is intended for original equipment manufacturers (OEMs), or system integrators; but not the end-users of equipment. It is the responsibility of the OEM / system integrator to provide a user manual where relevant information from this manual is passed on, if it either directly affects the safety or indirectly as discovered during a safety assessment of the consequences of this product's integration. The Baumer “Off-highway Distance Radar” sensors are not intended for safety applications and potentially explosive atmospheres. The OEM or system integrator must ensure the safety of the equipment on which this product is used.

The manual is written based on current information. Baumer reserves the right to update products, documentation and its manuals if better information becomes available.

**CAUTION**

This product must not be used in safety applications and in potentially explosive atmospheres.

1.3.3. Application Policy

Baumer products are applicable to a wide range of applications and / or end-use cases. Baumer cannot know all possible conditions under which products are installed, used, and operated. Every application and / or use-case is unique. The suitability and functionality of a Baumer product and its performance under different applications and / or end-use cases can only be verified by testing, and shall ultimately be the responsibility of the Baumer customer using a Baumer product. When the product configuration (software version, electronics revisions, mechanical revisions, etc.) is changed the customer needs to validate and verify the Baumer product to ensure the proper function in the application and / or end-use case.

**NOTE**

The original equipment manufacturer or system integrator must ensure the suitability of this product in the application and / or use case through extensive testing.

Intellectual property rights may exist for some applications and / or end-use cases that may affect the usage and/or placing on the market of machines manufactured by the OEM using a

Baumer product. Baumer does neither implicitly nor explicitly warrant the usage for specific application and / or end use case.

**NOTE**

The original equipment manufacturer or system integrator must consider third party intellectual property rights. No warranty is given for the application and/or end use case.

The product shall not be used for functional safety applications. Possible malfunctions and failed measurements of the sensor must be intercepted at the system level and shall not lead to unsafe situations in the system. The customer shall perform its own safety assessment to account for sensor behaviour in particular situations (e.g. distance fluctuations in static situations, operator caused distance manipulation by hand or other objects). The product shall not be used in the direct control and modification of the state of function of the vehicle.

**CAUTION**

This product must not be used in safety applications. A sensor malfunction must not lead to an unsafe situation.

**CAUTION**

The product shall not be used in the direct control and modification of the state of function of the vehicle.

Baumer ensures the compliance of its products to the specifications and declaration of conformity made available through its website www.baumer.com.

All conditions of use provided in the data sheet, top level drawing must be observed. The machines or equipment manufactured by the customer utilizing Baumer product must only be put on the market as covered by the declaration of conformity provided.

**CAUTION**

The technical documentation provided must be observed.

Some applicable documents are listed below, but are not limited to:

Tab 2 Applicable Documents

| Art. no. | Document Type | Document |
|----------|------------------------------------|-------------------------------------|
| 11205779 | Data sheet (DAB) | DAB Radar distance measuring sensor |
| 11205779 | Mounting instruction (MAL) | MAL Radar distance measuring sensor |
| 11205779 | Declaration of conformity (EU) | Baumer_R600V_DE-EN-FR_CoC_81302233 |
| 11205779 | Declaration of conformity (US) | CTC_FCC_R600V_EN_RoC_81371135 |
| 11205779 | Declaration of conformity (Canada) | CTC_ISED_R600V_EN_RoC_81371136 |

1.3.4. Compliance Statements

FCC Compliance Statement

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.

NOTICE: Changes or modifications made to this equipment not expressly approved by Baumer may void the FCC authorization to operate this equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Radiofrequency radiation exposure Information:

This equipment complies with FCC exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Canada Compliance Statement

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 harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

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

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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

Ce transmetteur ne doit pas être placé au même endroit ou utilisé simultanément avec un autre transmetteur ou antenne.

1.3.5. Maintenance

This product does not require any maintenance. If function is impaired dirt should be removed from the lens.

1.3.6. Mechanical Damage

If the product shows mechanical damage to an exterior part, it should be replaced to avoid undetected malfunction. The product must be replaced by skilled and authorized personnel.

1.3.7. Disposal (environmental protection)

Do not dispose of electrical and electronic equipment in household waste. The product contains valuable raw materials for recycling, which is why an old product must be returned to an authorised collection point for correct disposal / recycling. For further information refer to www.baumer.com.

2. Integration Guidance



CAUTION

Installation, mounting and adjustment of this product must only be executed by skilled and authorized personnel.

2.1. Mechanical Integration

2.1.1. Targets, Blind-range

The sensor shall be mounted with its centre axis approximately perpendicular to the target. The distance output is relative to the tip of the lens. A blind range of 300mm must be considered. No measurement is possible within the blind range of the sensor. For applications where accuracy is to be optimised, a flat metal surface (e.g. a 100 x 100mm metal plate) is recommended. If the target surface is not mounted perpendicular to the sensor centre axis the received signal gets weaker. From experience a good value of angular tolerance for a flat target is less than 2° . Corner cubes are not sensitive to angular tolerances and may be the more robust choice for situations in which accuracy need not be optimized. To ensure proper detection over the full sensing range it is recommended aligning the longitudinal axes of sensor and reflector as shown below. Aligning the axes is especially important to improve the signal at short distances (below 0.5m) when using a corner cube. For a selection of available corner cubes, please refer to Tab 15.

The target material thickness (both flat metal plate and corner cube) must be more than 0.5mm and preferably metal. Coatings on the target may affect the reflectance properties. Non-metal targets may work as well, but sufficient reflectance at radar wavelengths is essential. The reflectance depends on the dielectric constant of the material at the radar wavelength. Sufficient signal must be validated through integration testing.

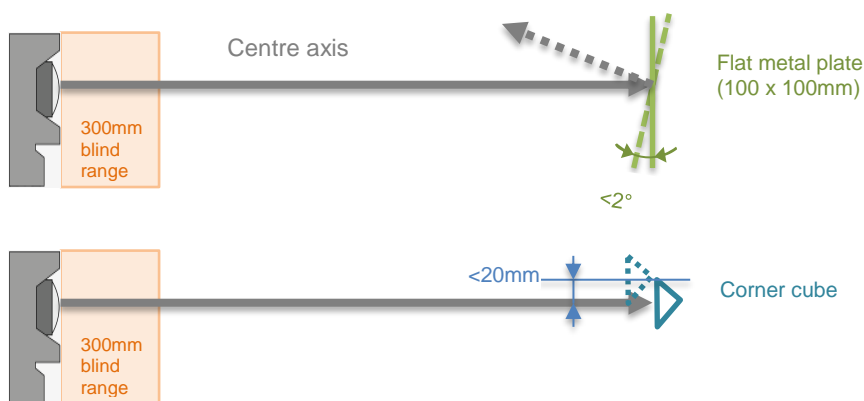


Fig 1 Mechanical Setup (for visualization only)

2.1.2. Reference Target

All data sheet specifications are based on a flat high-reflectance target (a metal plate with dimensions of 100mm by 100mm). The zero point for the measurement is on the tip of the lens.

2.1.3. Mounting

A mounting plate with a flatness of better than 0.2mm per 100mm shall be used. Baumer recommends soft steel as material to match specified mounting torque. For direct mounting (thread in plate) Baumer recommends a thickness of the steel plate of at least 6mm. For mounting on a thinner soft steel plates ($\geq 3\text{mm}$) flange nuts must be used instead.

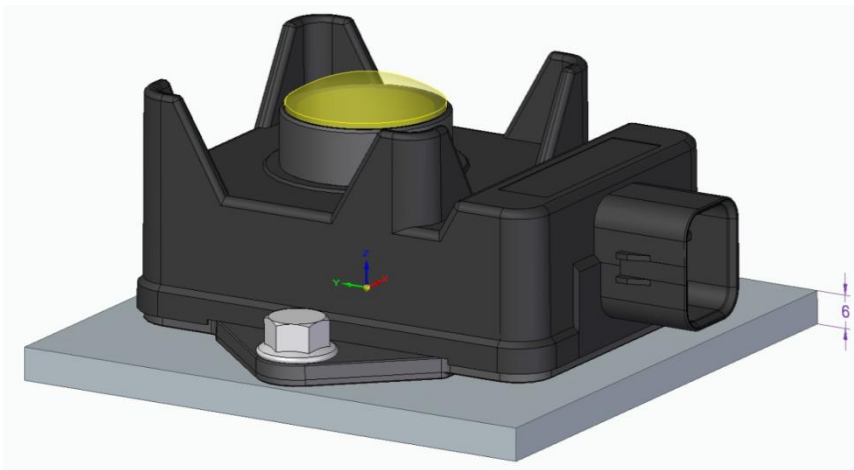


Fig 2 Mounting on a thick soft steel plate ($\geq 6\text{mm}$).

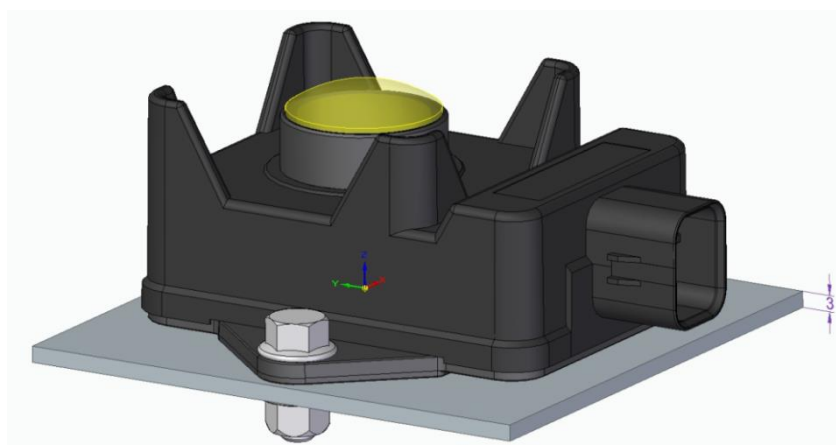


Fig 3 Mounting on a thin soft steel plate ($\geq 3\text{mm}$)

It is recommended to use M6 screws per MBM 10105. The mounting torque for 10.9 (property class) screws must be within 12Nm...15Nm, and for 8.8 (property class) screws it must be within 10Nm...12Nm. For the mounting pattern and available tool space for tightening the

mounting screws please refer to the Figure below. Enough space must be allowed for the wiring harness to avoid excessive bending of the wires or wire assembly. The wires must also be appropriately secured and be suitable for the application.

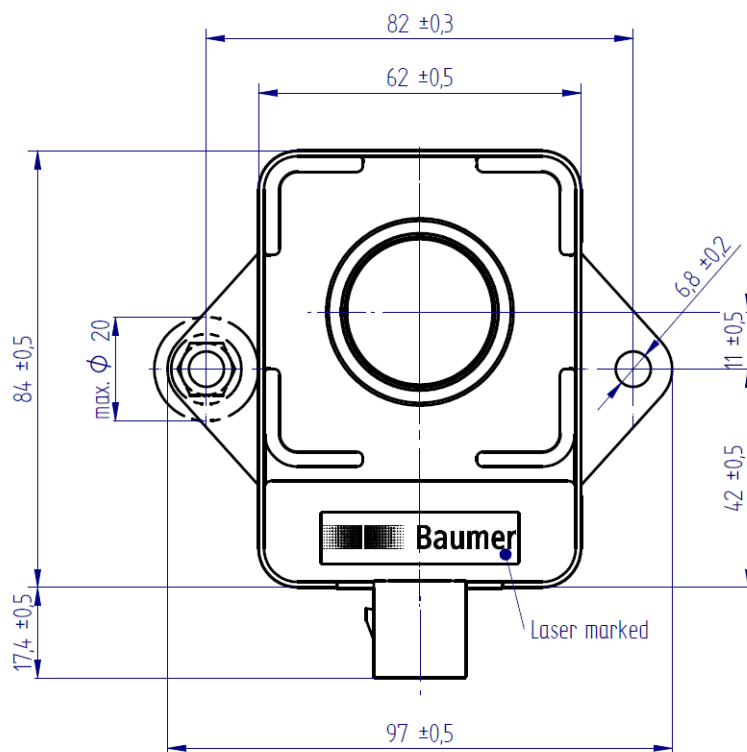


Fig 4 Mounting pattern, tool space.



ATTENTION

Observe mounting torque and tool space to avoid damage to sensor.

2.2. Rules for Installation

2.2.1. Free Space and Directional Sensitivity

The Baumer off-highway radar distance sensor is a very sensitive device to deliver superior measurement accuracy and speed. The opening angle of the main beam is 6° (for 3dB signal reduction, or approx. 9° for 20dB signal reduction). A typical directional sensitivity is shown below.

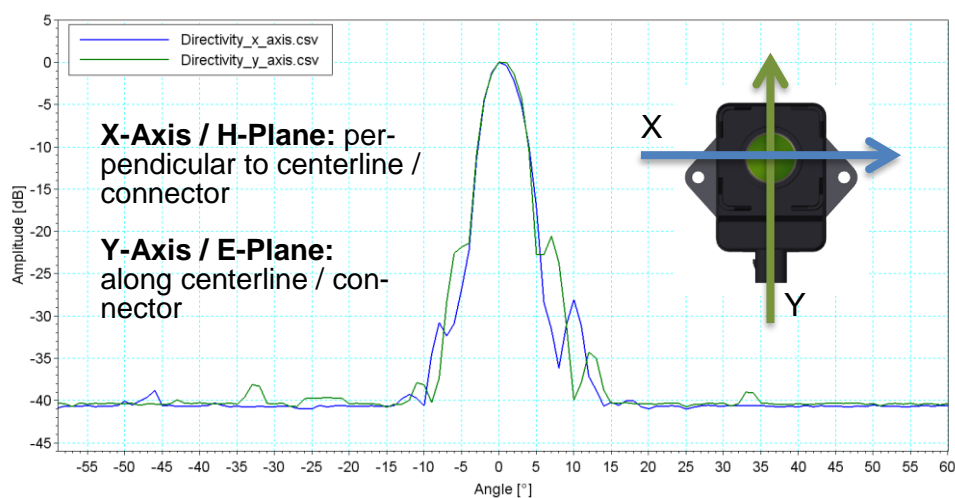


Fig 5 Typical Directional Sensitivity of Sensor

Baumer recommends limiting intrusion of objects, into a rotational cone of approx. 60...70° from the lens for very weakly reflecting targets. Integration testing must be done to ensure that the integration with available free space does not have impact on the measurement.

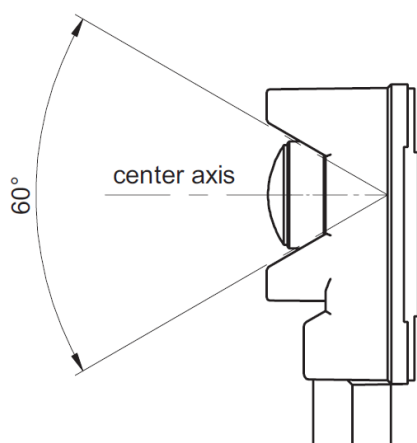


Fig 6 Recommended Free Space for weak targets

For strongly reflecting targets (such as corner cubes and metal plates), the keep out aperture angle is at least $\pm 3^\circ$.

2.2.2. Target area guidelines

Generally it is desirable that the target is the object with the strongest reflection back to the radar sensor. If strongly reflecting objects in the background cannot be avoided the insertion of shields is recommended. As a rule of thumb a shield angle larger than approx. the total opening angle (e.g. $>10^\circ$) is recommended. Multi-path reflections may need to be considered. The following figure shows the setup schematically. Target selection preference (first, last, strongest target) can be set via CAN commands. For details refer to chapter 3.5.2.

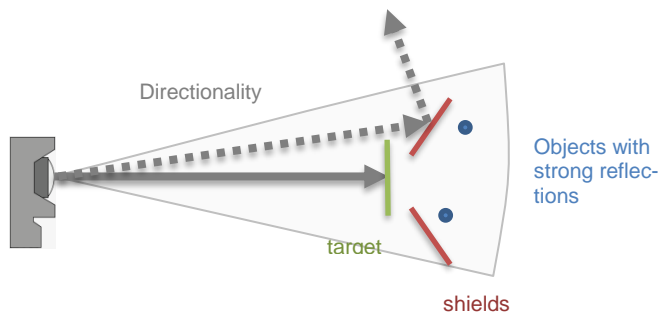


Fig 7 Usage of shields to cover strongly reflecting objects

If strongly reflecting objects in the background of the target cannot be covered by shields the target should be kept at a minimum distance of at least the specified blind range.

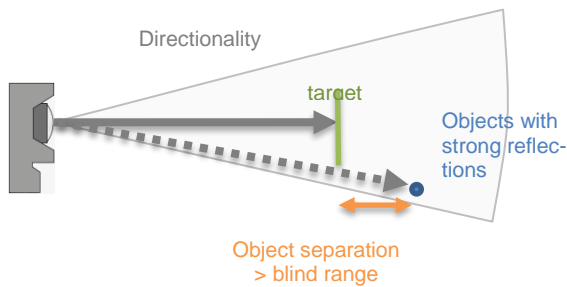


Fig 8 Separate strongly reflecting objects from target

2.2.3. Multi-path beam propagation

Multi-path beam propagation may impact the accuracy of the measurement and should be avoided. Multi-path propagation may occur due a combination of target alignment, existence of a reflective object and side lobes of the sensor. Integration testing is important to understand the impact of the build space on the result.

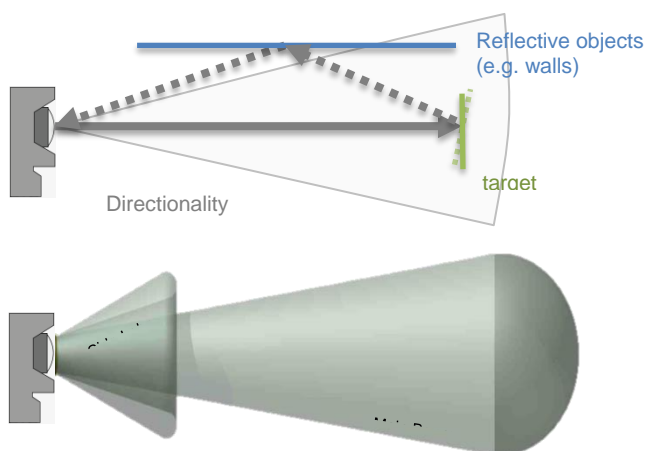


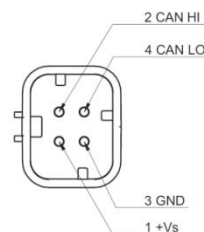
Fig 9 Multi-path beam propagation

2.3. Electrical Integration

The sensor can be used on direct vehicle power for 12VDC nominal voltage systems and 24VDC nominal voltage systems in the range +VS = 9VDC ... 32VDC). A centralized load dump suppression (35V at 12VDC, and 58V at 24VDC respectively) is required. The product shall not be used in the direct control and modification of the state of function of the machine. Please refer to the data sheet for information regarding operation during the engine start phase, and further technical details. Prior to electrical connection of the product the system must be down and not live. Do not exceed permissible bending radius of the cable. The device shall be appropriately protected by an external R/C or fuse. In an industrial environment the device shall be protected by an external R/C or listed fuse, rated max. 100W/Vp or max. 5A below 20VDC, and a UL class 2 power supply be used.

Tab 3 Connector Pin-Out

| Connection type | | Ampseal 16 4P (776536-1) |
|------------------|--------|---|
| Mating connector | | Ampseal 16 4P (776524-1) |
| Pin | Code | Description |
| 1 | +Vs | Positive Supply voltage (12VDC / 24VDC nominal) |
| 2 | CAN HI | CAN High |
| 3 | GND | Ground (supply voltage) |
| 4 | CAN LO | CAN Low |



This product may be used on vehicle power fulfilling these requirements:

Tab 4 Vehicle Power Electrical Transients

| Test pulse (ISO 7637-2, ISO 16750-2) | 1 | 2a | 2b | 3a | 3b | 4 | 5b |
|--|----|-----|----|-----|-----|-----|----|
| Severity level | IV | III | IV | III | III | III | -- |
| Functional status (12 VDC vehicle power) | C | A | C | A | A | C | A |
| Functional status (24 VDC vehicle power) | C | A | C | A | A | C | A |

For test installations a cable with the order code 11213075 (ZCABL-ALL.AMP0300) may be used.



ATTENTION!

The product shall not be used in the direct control and modification of the state of function of the machine.



ATTENTION!

The product shall not be operated during engine start phase.



ATTENTION

The product shall not be used on machines without centralized load dump suppression.

**ATTENTION**

The product shall be appropriately protected by an extern fuse or R/C.

**NOTE**

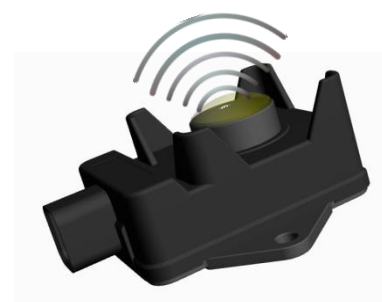
For test installations a cable with the order code 11213075 (ZCABL-ALL.AMP0300) may be used.

2.4. Visual Diagnostic

High luminosity LEDs provide quick feedback on the operational status of the sensor. The LEDs are positioned behind the radar lens and may be observed even in bright ambient light. The following table indicates sensor status and LED blink codes.

Tab 5 Status Mapping (Visual Diagnostic)

| Status | Code |
|--|---|
| Sensor fully operational (object detected) | 100ms Green LED ON 400ms LED OFF |
| Sensor fully operational, (no object detected) | As above 100ms Yellow LED ON in "LED OFF" interval |
| Hardware fault | 50ms Red LED ON 50ms LED OFF |
| CAN bus Off (malfunction) | 50ms Magenta LED ON 150ms LED OFF |
| Address claim failed | 50ms Magenta LED ON 50ms LED OFF |
| Waiting for Master ECU address claim | 500ms Magenta LED ON 500ms LED OFF |
| Other | Blue LED |



2.5. CAN Interface (Physical Layer)

The CAN physical layer is according to SAE J1939-15 (reduced physical layer). Some base parameters are shown in the table below.

Tab 6 CAN Interface

| Parameter | Value |
|-----------------|-------------------------------|
| Bus Speed | 250 kbit / sec (1) |
| Bus Termination | External termination |
| Bus Voltage | 5V |
| Wiring | Unshielded twisted pair (UTP) |
| Cable impedance | 120 Ohm (+/- 10%) |

(1) may be parameterized to 500 kbit/sec. (see below)

The bus termination resistor is not included in the device. The bus setup is shown in the figure below:

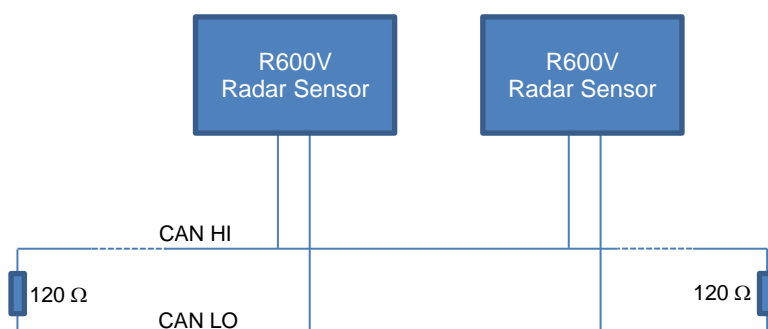


Fig 10 CAN connection setup diagram

For further information please refer to the CAN Protocol chapter.

3. CAN Protocol

The physical layer of the 2-wire interface is specified according to SAE J1939-15. The wires are protected against short-circuit.

The implementation of the protocol stack follows the SAE J1939 standards and is visualized in the OSI network model as follows:

Tab 7 SAE J1939 in the OSI reference model

| OSI Layer | Implementation | Network Management |
|----------------------|---|--------------------|
| Application Layer | SAE J1939-71 (Vehicle) SAE J1939-73 (Diagnostic) | SAE J1939-81 |
| Presentation | N/A | |
| Session | N/A | |
| Transportation Layer | SAE J1939-21 (Data Link Layer) | |
| Network Layer | SAE J1939-31 | |
| Data Link Layer | SAE J1939-21 | |
| Physical Layer | SAE J1939-14 SAE J1939-15 | |

Not all functions listed in the referenced standards have been implemented. The following chapters explain the extent and implemented functions.

DBC files can be downloaded from the respective product page on www.baumer.com.

3.1. ISO Name

| | |
|---------------------|--------------------|
| Manufacturer code | 343 (Baumer Group) |
| ECU instance | 0 |
| Function instance | 2 |
| Function | 255 (nonspecific) |
| System | 127 (nonspecific) |
| System instance | 0 |
| Industry group | 2 |
| Arbitration Capable | 1 |

3.2. Device address

3.2.1. Commanded address (PGN 0xFED8)

Supported

3.2.2. Address Claim

The device is arbitrary address capable.

Address range: 0x80...0xCF (adjustable)

Default address: 0x80 (lowest address of set address range)

3.2.3. Address resolution sequence (for default settings)

After reset, the device performs the following start-up sequence:

1. After initialization, send "request for address claimed" message (PGN 0xEE00)
 - a. At initialization, clear the address sort table
 - b. Send a request for address claimed. This causes other devices on the bus to claim their addresses
2. Wait 1250 ms. During this time, incoming address claims are evaluated and mark addresses claimed by devices with higher priority ISO names (NAME) than our own as "claimed" in the address sort table.
3. Send "address claimed" message
 - a. Claim the own address, which is derived from the sort table. Address = First free address in the sort table which is equal or higher than the preferred address (0x80) (1)
4. Wait 250 ms and handle address collisions.
When, during this time, another device with higher priority claims our last claimed address, we will mark it as "claimed" and claim the next free address in the table (1)
5. Start transmitting the cyclic target distance message.

Most parameters (times, address, start of transmission, ...) of this sequence are adjustable. For details please refer to chapter 3.5.2.

The CAN SAE J1939 standard generally defines the address claim procedure. Each device on the bus can request an new address claiming from a single device or all nodes. The requesting device has to send a request (PGN 0xEA00) with the desired destination address DA (address of node, global address 0xFF) the data of the message must include the PGN 0xEE00.

Tab 8 Address management messages

| Message | PGN | PF | PS | SA | Length | DATA |
|-----------------------------|--------|-----|-----|--------|-------------|--------------|
| Request for address claimed | 0xEA00 | 234 | DA | SA (2) | 3 bytes | PGN 0xEE00 |
| Address claimed | 0xEE00 | 238 | 255 | SA | 8 bytes | NAME |
| Cannot claim source address | 0xEE00 | 238 | 255 | 254 | 8 bytes | NAME |
| Commanded address | 0xFED8 | 254 | 216 | SA | 9 bytes (3) | NAME, new SA |

(1) This means that, provided no new sensors are mounted, each sensor will end up with the same device address each time. However, if a new sensor is added to the system, addresses might shift up or down according to the new sort order, which is always from lowest to highest serial number.

(2) In case no address has been claimed, yet the address may be set to 254

(3) longer than 8 bytes; transport protocol used instead

3.3. Supported PGNs

3.3.1. *ECU Identification Info*

| | |
|--------------------|---------------------|
| PGN: | 0xFDC5 |
| Direction: | Transmit |
| Transmission rate: | On PGN request only |

3.3.2. *ECU Software Identification*

| | |
|--------------------|---------------------|
| PGN: | 0xFEDA |
| Direction: | Transmit |
| Transmission rate: | On PGN request only |

3.3.3. *DM14 Memory access command message*

| | |
|--------------------|---------|
| PGN: | 0xD900 |
| Direction: | Receive |
| Transmission rate: | Random |

3.3.4. *DM15 Memory access reply message*

| | |
|--------------------|-------------------------------|
| PGN: | 0xD800 |
| Direction: | Transmit |
| Transmission rate: | Reply to DM14 command message |

3.3.5. *DM16 Memory access binary data*

| | |
|--------------------|------------------|
| PGN: | 0xD700 |
| Direction: | Transmit/receive |
| Transmission rate: | When needed |

3.3.6. *Target Distance Message (adjustable)*

| | |
|--|------------------|
| PGN: | 0xC000 |
| Direction: | Transmit |
| Transmission rate: | 50ms |
| Source address: | Sensor address |
| Destination address: | Broadcast (0xff) |
| Initial delay after start-up sequence: | 200ms |

All values are in little endian format. Bit1 of byte 1 = LSB of first byte

Tab 9 Target Distance Message (main message)

| Start bit | Bits | Offset | Scaling | Description |
|-----------|------|--------|---------|--|
| 1 | 2 | 0 | 1 | Sensor status 0 = No error 1 = Reversible error. (e.g. temperature too high) 2 = Irreversible error. Sensor measurement not available |
| 9 | 8 | 0 | 1% | Target confidence*/** Value 0...100% (higher confidence = detection of target better) |
| 17 | 24 | 0 | 0.1mm | Target distance ** |
| 49 | 16 | 32768 | 1mm/sec | Target speed (positive: increasing distance) |

*Target confidence is a function of signal strength. Above certain signal amplitude, confidence will always be 100%

**Target confidence and target distance will be "0" if no target is detected

3.4. Exemplary Decoding of a CAN message frame

Exemplary decoding the "target distance" message (PGN 0xC000)

Based on a line from a CAN log (18100856, 18C0FF80, Rx, 08, 00, 64, 89, 71, 00, 00, EE, 7F)

Tab 10 Decoding a CAN SAE J1939 message frame

| SOF | 11 bit CAN ID | SRR | IDE | 18 bit CAN ID | RTR | 6 bit control field | 0...8 byte data field | 16 bit CRC | 2 bit ACK | 7 bit EOF |
|-----|---|-----|-----|---------------|-----|---------------------|----------------------------------|------------|-----------|-----------|
| | 0x 18 C0 FF 80 [1 1000 1100 0000 1111 1111 1000 0000] ₂ (11+18bit = 29bit) | | | | | | 0x 00 64 89 71 00 00 EE 7F | | | |

Tab 11 Example for decoding the CAN ID (29bit, PDU1 format)

| 3 bit priority PRIO | 1 bit reserved R | 1 bit data page DP | 8 bit PDU format (<240) | 8 bit PDU specific (group extension) | 8 bit source address |
|----------------------------|--------------------------|--------------------------|----------------------------------|--------------------------------------|----------------------------------|
| 0x06 [110] ₂ | 0x00 [0] ₂ | 0x00 [0] ₂ | 0xC0 [1100 0000] ₂ | 0xFF [1111 1111] ₂ | 0x80 [1000 0000] ₂ |
| | | | PDU1 format | Global destination address | |
| | | | PGN (parameter group number) | | |

Tab 12 Example for decoding the 8 byte data field

| 0x 00 64 89 71 00 00 EE 7F [0000 00 <u>00</u> 0110 010 <u>0</u> 1000 100 <u>1</u> 0111 000 <u>1</u> 0000 000 <u>0</u> 0000 000 <u>0</u> 1110 111 <u>0</u> 0111 111 <u>1</u>] ₂ | | | | |
|---|------------------------------|-----------------------------|-----------------|--------------------------|
| Sensor-status (bit 1-2) | Target confidence (bit 9-16) | Target distance (bit 17-40) | N/A (bit 41-48) | Target speed (bit 49-64) |
| [<u>00</u>] ₂ | 0x 64 | 0x 00 71 89 | 0x 00 | 0x 7F EE |
| 0 | 100% | 2'906.5 mm | N/A | -18 mm/sec |

Notes: little endian format, bit 1 underlined; colours indicate correspondences

3.5. Sensor Configuration

A number of sensor parameters can be read and written over the CAN bus using the J1939 memory access (MA) protocol.

User level for access = 1

Key for access is equal to the "seed" generated by the device.

All addresses are direct spatial (is pointer)

The access is similar to the SPN space. Each parameter has an individual size.

The tool shall issue a read or write command with a memory length of 1 (one).

In its "proceed" reply, the device returns the actual number of bytes to be used for the transfer.

3.5.1. Tool ISO name acceptance criteria

The sensor accepts MA sessions from any tool that fulfils all of the following criteria:

- ISO name Function field = 129
- ISO name Industry group field = 0

3.5.2. Adjustable Parameters

The following parameters are available for adjustment:

Tab 13 Adjustable Parameters

| Address | Parameter | range | offset | scaling | Default value |
|-----------------------------|---|-----------|--------|---------|---------------|
| LED settings | | | | | |
| 0x07DFAA | Green LED duty cycle (5) | 0..100 | 0 | 1% | 0 |
| 0x07DFAB | Green LED period (5) | 0..255 | 0 | 100ms | 0 |
| 0x07DFAC | Red LED duty cycle (5) | 0..100 | 0 | 1% | 0 |
| 0x07DFAD | Red LED period (5) | 0..255 | 0 | 100ms | 0 |
| 0x07DFAE | Blue LED duty cycle (5) | 0..100 | 0 | 1% | 0 |
| 0x07DFAF | Blue LED period (5) | 0..255 | 0 | 100ms | 0 |
| Measurement Settings | | | | | |
| 0x07E388 | Max. Detection range (4) | 300..8500 | 0 | 1mm | 8500 |
| 0x07E389 | Min. Detection range (4) | 300..8500 | 0 | 1mm | 300 |
| 0x07E3A6 | Sensor Sensitivity | 0 ... 2 | 0 | 1 | 1 |
| | 0 = lowest sensitivity | | | | |
| | 1 = normal sensitivity | | | | |
| | 2 = high sensitivity (6) | | | | |
| 0x07E3A7 | Output filter mode (only with mode 3 in 0x07E3AB) | 0 ... 1 | 0 | 1 | 0 |
| | 0 = tracking filter: moving average | | | | |
| | 1 = tracking filter: exponential averaging | | | | |
| 0x07E3A8 | Output filter history length | 1 ... 32 | 0 | 1 | 2 |
| | (only for mode 0 as set in SPN | | | | |
| | 0x07E3A7, together with mode 3 in | | | | |
| | 0x07E3AB) | | | | |

| Address | Parameter | range | offset | scaling | Default value |
|----------|---|-------------|--------|---------|---------------|
| 0x07E3A9 | Output filter number of cycles to bridge (during signal loss, only with mode 3 in 0x07E3AB) | 0 ... 32 | 0 | 1 | 1 |
| 0x07E3AA | Output filter time constant (only for mode 1 as set in SPN 0x07E3A7, together with mode 3 in 0x07E3AB) | 0...1000000 | 0 | 1us | 50000 |
| 0x07E3AB | Output distance selection 0 = distance is taken from strongest peak in range (unfiltered) 1 = distance is taken from nearest peak in detection range (unfiltered) 2 = distance is taken from farthest peak in detection range (unfiltered) 3 = filtered output (see 0x07E3A7, 0x07E3A8, 0x07E3A9, 0x07E3AA) | 0...3 | 0 | 1 | 1 |

CAN Settings

| | | | | | |
|----------|---|-------------------|---|-----|-------|
| 0x07E38A | Data PGN transmit period | 10..5000 | 0 | 1ms | 50 |
| 0x07E38B | PGN for distance message transmission | 0..131071 | 0 | 1 | 49152 |
| 0x07E397 | PDU transmission start mode. Default enabled main message 0 = start immediately 1 = start after master address claim received (msg transmission starts only when enable flags are set 0x07E38C) 2, 3 = reserved (do not use) | 0..3 | 0 | 1 | 0 |
| 0x07E38C | Msg transmission enable flags (5) 0 = Main message off 1 = Main message on This SPN can be used to switch message on and off dynamically | 0..1 | 0 | 1 | 1 |
| 0x07E38D | Default msg transmission enable flags 0 = Main message off 1 = Main message on Use to prevent the sensor from sending data after start up. | 0..1 | 0 | 1 | 1 |
| 0x07E392 | Min time to wait before sending a request for address claimed message | 0..5000 | 0 | 1ms | 100 |
| 0x07E393 | Range of random time to wait before sending a request for address claimed message | 0..5000 | 0 | 1ms | 100 |
| 0x07E394 | Time to wait after sending a request for address claimed message before own address claim is sent | 0..5000 | 0 | 1ms | 1250 |
| 0x07E39D | Compare mask for "bitwise AND" of ISO name used for Master ECU Detection | 0..0xffffffffffff | 0 | 1 | 0 |

| Address | Parameter | range | offset | scaling | Default value |
|----------|---|-------------------|--------|---------|---------------|
| 0x07E39E | Compare value for ISO name used for Master ECU Detection (after applying bitwise mask defined in 0x07E39D) | 0..0xffffffffffff | 0 | 1 | 0 |
| 0x07E395 | Delay between detection of master address claim and starting RUN mode | 0..5000 | 0 | 1ms | 250 |
| 0x07E396 | Delay between detection of master address claim and first PDU1 transmission | 0..5000 | 0 | 1ms | 200 |
| 0x07E398 | Lowest device address to claim in address resolution sequence | 128..209 | 0 | 1 | 128 |
| 0x07E399 | Highest device address to claim in address resolution sequence | 128..209 | 0 | 1 | 209 |
| 0x07E39A | CAN Bus speed. 0 = 250k 1 = 500k 2 = reserved (do not use) | 0..1 | 0 | 1 | 0 |
| 0x07EF40 | Reset device to default values Write data in this sequence to re-set all SPNs to default values: 0x00, 0xAA, 0x55, 0x12, 0x34 | N/A | N/A | N/A | N/A |

(4) Detection range can be adjusted to avoid issues with double echo detections.

(5) SPN value is reset to default after a power cycle (volatile)

(6) Accuracy reduced

4. Trouble Shooting

Tab 14 Trouble Shooting Overview

| Failure | Action |
|--|---|
| No function, no LED | Check cables, connections, power supply at pins |
| Function impaired, thick layer of dirt | Clean lens and remove excess water. |
| Mechanical damage to housing and/or lens | Replace part by qualified personnel. |
| Unexplained targets / distance measurement in near range | Check free space (or beyond) for non-stationary objects (such as dangling wires, tubes, water drops on surfaces). |
| Unexplained targets / distance measurement in far range | Check for double reflections, and limit measurement range |
| The LED is blinking red (50ms on / 50ms off) | Hardware fault. Replace part by qualified personnel |
| The LED is blinking magenta | CAN bus error. Check Tab 5 for details. |
| The LED is blinking blue for a long period. | Try a power cycle. If this does not fix the issue replace part by qualified personnel |
| No communication (also magenta blinking) | Check CAN speed (e.g. 250kbit/sec), check 120Ohm termination, |
| | Check default transmission enable flags (0x0087E38D) |
| No messages are sent | Check if master address has been claimed (when required due to PDU transmission start mode setting 0x0087E397) |

5. Accessories

The following accessories are available for this product

Tab 15 Accessories

| Art. no. | Description | Type | Comment |
|----------|--------------------|--|---|
| 11213075 | ZCABL-ALL.AMP0300 | Connector AMPSEAL 16 with PUR-cable | 3m cable with AMPSEAL connector and fly-leads |
| 11181700 | ZREFL-RAD.CCUBE30 | Metal reflector as corner cube, edge length 30 mm | <ul style="list-style-type: none"> ▪ Metal reflector in corner cube design ▪ Material: Steel ▪ Reliable object detection < 6 m |
| 11197315 | ZREFL-RAD.CCUBE100 | Metal reflector as corner cube, edge length 100 mm | <ul style="list-style-type: none"> ▪ Metal reflector in corner cube design ▪ Material: Steel ▪ Reliable object detection < 20 m |

6. Appendix

6.1. Table Overview

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6.3. Definitions and Abbreviations

The following definitions and abbreviations are used throughout this manual

Tab 16 Definitions and Abbreviations

| Key | Definition |
|-----|--|
| CAN | Controller Area Network |
| DAB | Data Sheet |
| DA | Destination address |
| DM | Direct Memory |
| ECU | Electronic Control Unit |
| ISO | International Standardization Organization |
| LED | Light Emitting Device |
| MA | Memory Access |
| OEM | Original Equipment Manufacturer |
| OSI | Open Systems Interconnection |
| PDU | Protocol Data Unit |
| PF | PDU Format |
| PGN | Parameter Group Number |
| PS | PDU Specific |
| SA | Source Address |
| SAE | Society of Automotive Engineers |
| TLD | Top Level Drawing |
| VDC | Volt Direct Current |

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8. Document Revision History

Tab 17 Document revision history

| Vers. | Date | Note | Author | Checked | Released |
|-------|-------------|---|--------|-------------------------|----------|
| 0.5 | 29 Oct 2019 | Technical review | wemi | tip, matts, rma, erv | N/A |
| 1.0 | 15 Nov 2019 | Initial Release | wemi | lph, sfri | N/A |
| 1.1 | 20 Nov 2019 | Fix addresses, and details in "Adjustable parameters" | wemi | linz | N/A |
| 1.2 | 07 Jan 2020 | Tab 9 Target confidence / sensor sensitivity / default values changed | rma | wemi | N/A |
| 1.3 | 17 Jan 2020 | Tab 9 correct output dis- tance selection | wemi | N/A | N/A |
| 1.4 | 05 Mar 2020 | Add a decoded CAN mes- sage as example | wemi | linz | N/A |
| 1.5 | 03 Jul 2020 | Add address management table | wemi | rma | N/A |
| 1.6 | 14 Aug 2020 | Correct ch. 3.4 | wemi | N/A | N/A |
| 1.7 | 07 Jan 2021 | Add compliance statements | wemi | N/A | N/A |

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