R600V.DAH5 Operating Manual (EN)

Off-Highway Distance Radar Sensor

Last Update: 07 Feb 2024

Table of Contents

1. General Information 4
1.1. Scope 4
1.2. Comments, notes, and warnings 4
1.3. Intended Use 4
1.3.1. General 4
1.3.2. Audience 5
1.3.3. Application Policy 5
1.3.4. Compliance Statements 7
1.3.5. Maintenance 8
1.3.6. Mechanical Damage 8
1.3.7. Disposal (environmental protection) 8
2. Integration Guidance 9
2.1. Mechanical Integration 9
2.1.1. Targets, Blind-range 9
2.1.2. Reference Target 10
2.1.3. Mounting 10
2.2. Rules for Installation 11
2.2.1. Free Space and Directional Sensitivity 11
2.2.2. Target area guidelines 13
2.2.3. Multi-path beam propagation 13
2.3. Electrical Integration 15
2.4. Visual Diagnostic 16
2.5. CAN Interface (Physical Layer) 17
3. CAN Protocol 18
3.1. ISO Name 18
3.2. Device address 18
3.2.1. Commanded address (PGN 0xFED8) 18
3.2.2. Address Claim 18
3.2.3. Address resolution sequence (for default settings) 19
3.3. Supported PGNs 20
3.3.1. ECU Identification Info 20

3.3.2. ECU Software Identification 20
3.3.3. DM14 Memory access command message 20
3.3.4. DM15 Memory access reply message 20
3.3.5. DM16 Memory access binary data 20
3.3.6. Target Distance Message (adjustable) 20
3.4. Exemplary Decoding of a CAN message frame 22
3.5. Sensor Configuration 23
3.5.1. Tool ISO name acceptance criteria 23
3.5.2. Adjustable Parameters 23
3.6. Exemplary Sensor Configuration 26
3.6.1. Setting the Transmit Period 26
3.6.2. Setting the Detection Range End 27
3.6.3. Reading the Detection Range End 28
4. Trouble Shooting 30
5. Accessories 30
6. Environmental and Electrical Ratings 31
6.1. Overview of Environmental and Electrical Ratings for R600V 31
6.2. Notes 38
6.2.1. A – Chemical Resistance 38
6.2.2. B – Criteria 38
7. Appendix 39
7.1. Table Overview 39
7.2. Figures Overview 40
7.3. Definitions and Abbreviations 41
8. Terms and conditions of use 42
8.1.1. Copyright 42
8.1.2. No Warranty 42
8.1.3. No Offer 42
8.1.4. Limitation of Liability 42
8.1.5. Governing Law and Jurisdiction 42
9. Document Revision History 43
10. Baumer Worldwide 44

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 1.3.0 (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. The use of this device is on a «no-interference, no-protection" basis. Do not install or operate on board an aircraft or a satellite. Do not aim upwards towards the sky.

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 etre place au meme endroit ou utilise simultanement avec un autre transmetteur ou antenne. L'utilisation de cet appareil est basée sur le principe "pas d'interférence, pas de protection". Ne pas installer ou faire fonctionner l'appareil à bord d'un avion ou d'un satellite. Ne pas diriger l'appareil vers le ciel.

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 recommend 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 18.

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.

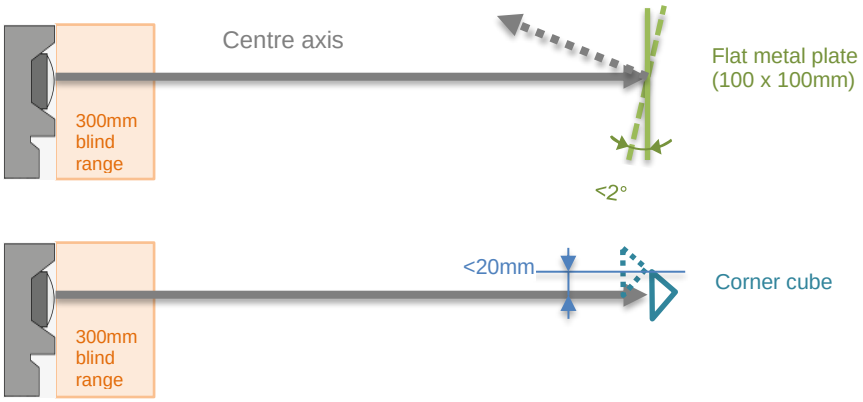


Fig 1 Mechanical Setup (for visualization only)

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 (≥3mm) flange nuts must be used instead.

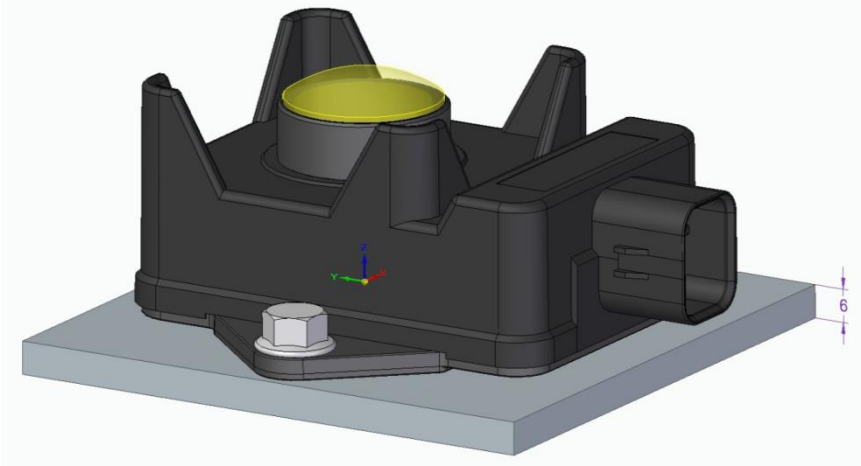


Fig 2 Mounting on a thick soft steel plate (≥6mm).

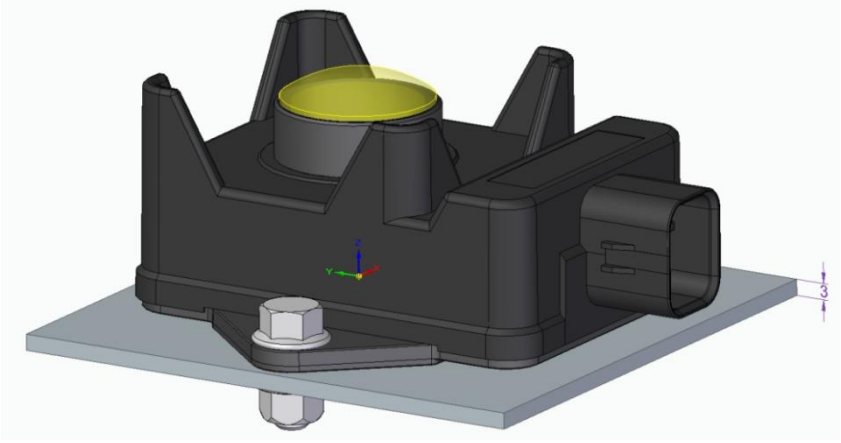


Fig 3 Mounting on a thin soft steel plate (≥3mm)

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.

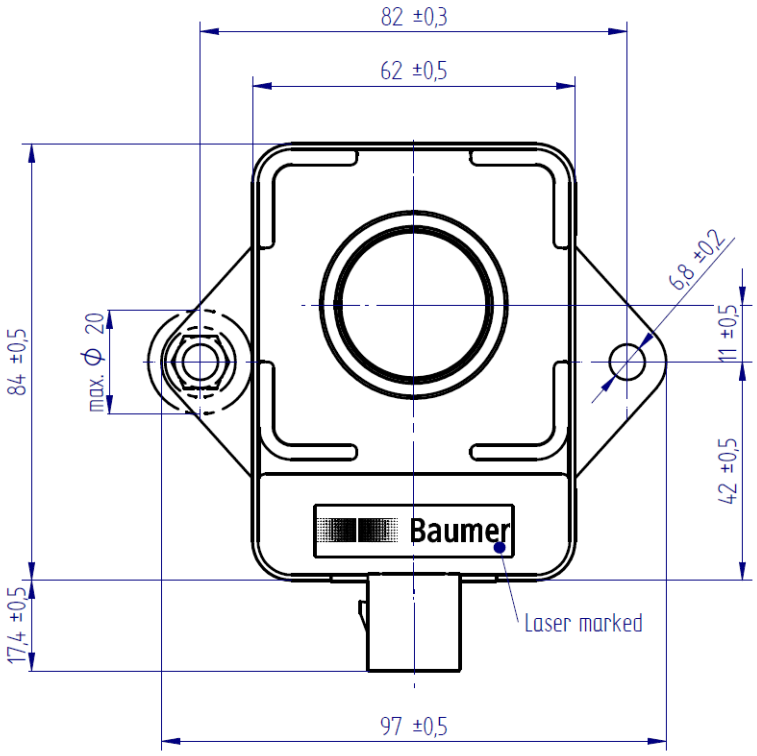


Fig 4 Mounting pattern, tool space.

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.

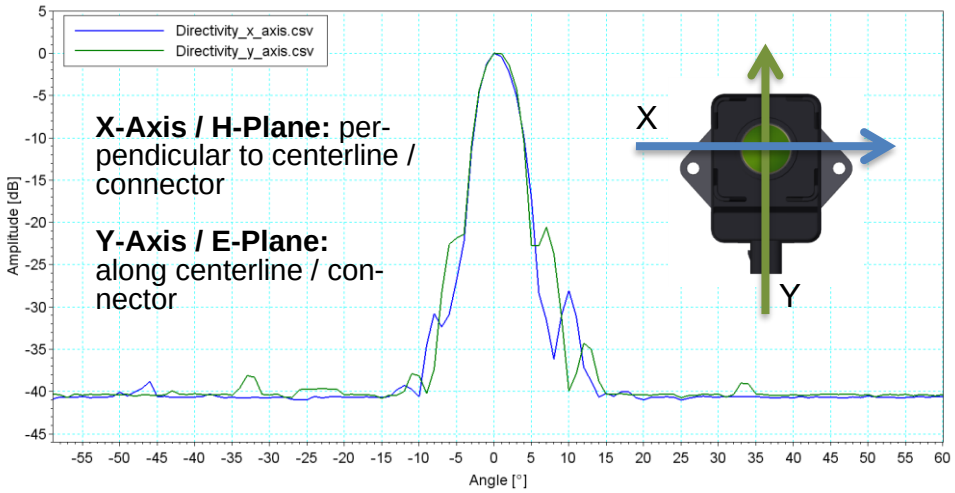


Fig 5 Typical Directional Sensitivity of Sensor

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.

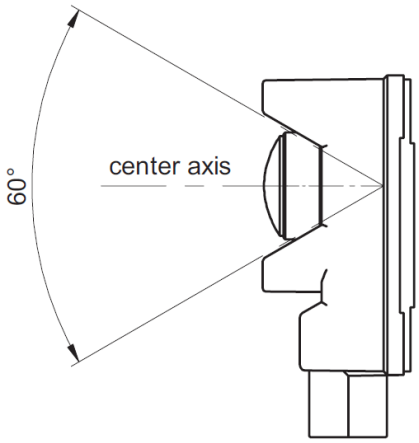


Fig 6 Recommended Free Space for weak targets

For strongly reflecting targets (such as corner cubes and metal plates), the keep out aperture angle is at least +/-3°.

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°) 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.

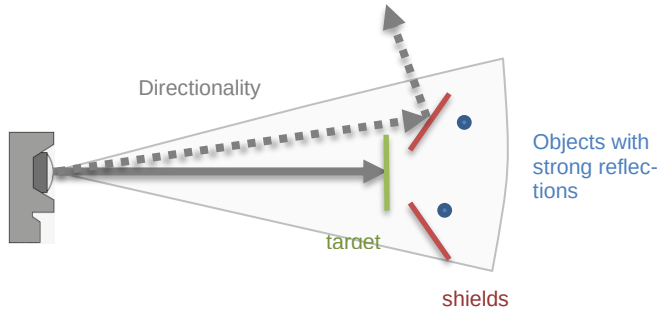


Fig 7 Usage of shields to cover strongly reflecting objects

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.

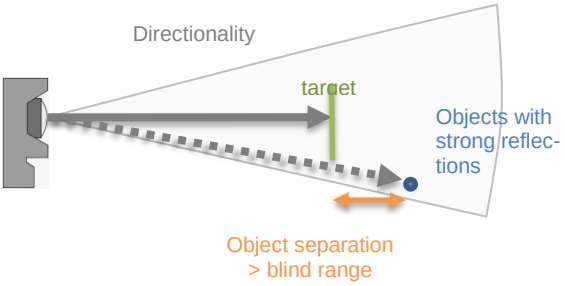


Fig 8 Separate strongly reflecting objects from target

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.

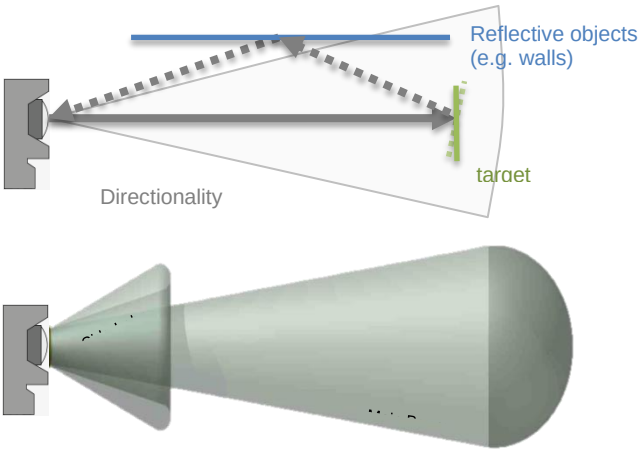


Fig 9 Multi-path beam propagation

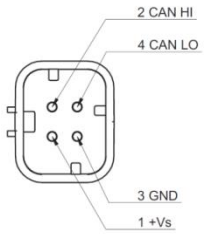
2.3. Electrical Integration

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.

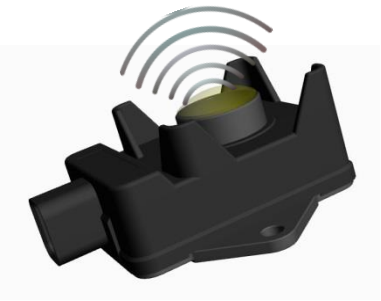
NOTE
For test installations a cable with the order code 11213075 (ZCABL-ALL.AMP0300) may be used.

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:

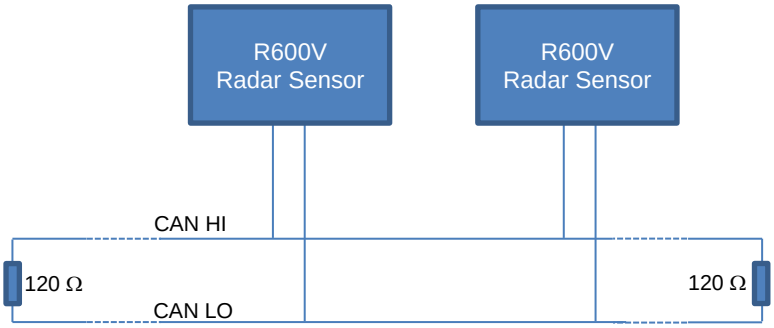


Fig 10 CAN connection setup diagram

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)

More information can be found in the table “Address Management Messages” further down. The “commanded address” must be within the limits of the parameters 0x07E398 (lowest address to claim) and 0x07E399 (highest address to claim) as shown in table “adjustable parameters” below. Default address must be in the range of lowest address to claim and highest address to claim and can be set with parameter 0x07E39F.

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 0000 0110 0100 1000 1001 0111 0001 0000 0000 0000 0000 1110 1110 0111 1111]$_2$				
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)
[00]$_2$	0x 64	0x 00 71 89	0x 00	0x7F 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 = lowest sensitivity 1 = normal sensitivity 2 = high sensitivity (6)	0 … 2	0	1	1
0x07E3A7	Output filter mode (only with mode 3 in 0x07E3AB) 0 = tracking filter: moving average 1 = tracking filter: exponential averaging	0 … 1	0	1	0
0x07E3A8	Output filter history length (only for mode 0 as set in SPN 0x07E3A7, together with mode 3 in 0x07E3AB)	1 … 32	0	1	2

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 main 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
0x07E398	Lowest device address to claim in address resolution sequence	128..209	0	1	128

Address	Parameter	range	offset	scaling	Default value
0x07E399	Highest device address to claim in address resolution sequence	128..209	0	1	209
0x07E39F	Default address (this address will be claimed first, even it is outside the lowest/highest device address)(9)	128…209	0	1	128
0x07E39A	CAN Bus speed. 0 = 250k 1 = 500k 2 = reserved (do not use)	0..1	0	1	0
0x07E3A3	CAN Bus speed inheriting, need to be sent after CAN Bus speed 0x07E39A was changed.(8) 0 = 500k 1 = 250k → switch to 250k independently what 0x07E39A was set. Do a power cycle to activate selected CAN Bus speed	0,1	0	1	1
0x07EF40	Reset device to default values Write data in this sequence to reset 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

(8) Will not reset to default after a power cycle nor at Reset SPN 0x07EF40

(9) A change will be activated after a power cycle, can be reset with SPN 0x07EF40 and a power cycle

3.6. Exemplary Sensor Configuration

For the communication a 1.25sec time-out must be observed. If the Service Tool does not respond within 1.25sec the connection will be dropped.

3.6.1. Setting the Transmit Period

The following sequence message sequence shows how to set the Transmit Period (0x07E38A) to 100ms. The columns “Tool (address = 0xF9)” shows CAN-ID and data sent by the tool and the columns “Sensor (address = 0x80)” the response by the sensor.

Tab 14 Communication Sequence “Transmit Period”

Tool (address = 0xF9)		Sensor (address = 0x80)		Comment
CAN-ID	Data	CAN-ID	Data	
0x18EAFFFE	0x00 EE 00			Request for address claim from the Service Tool
		0x18EEFF80	0x6C3DE01201870CA0	Address claim reply from the sensor
0x18EEFFF9	0xE803000000810000			Address claim reply from the Service Tool
…	…	…	…	Other data transmission, no time limitations
0x18EEFFF9				Function = 129 Industry Group = 0
…	…	…	…	…
0x18D980F9	0x01158AE307000100			DM14 Request <Length = 0x01, Pointer type = 0x1, Command = 0x2 (write), SPN=0x0007E38A, User Level=0x0001>
		0x18D8F980	0x0101FFFFFFFFB5F3	DM15 Response <Length = 0x01, Status = 0 (proceed), Seed=0xF3B5>
0x18D980F9	0x01158AE30700B5F3			DM14 Request < Length = 0x01, Pointer type 0x1, Command=0x2 (write), Key = 0xF3B5, SPN = 0x0007E38A>
		0x18D8F980	0x0101FFFFFFFFFFFF	DM15 Response < Length = 0x01, Status=0 (proceed), seed=0xFFFF> (no further login required)
0x18D780F9	0x0164FFFFFFFFFFFF			DM16 transmission <Length = 0x1, Data = 0x64 (100ms)>
		0x18D8F980	0x0109FFFFFFFF0000	DM15 Resonse: <Length = 0x01, Status=4 (operation com-pleted), Seed=0x0000>
0x18D980F9	0x00198AE30700FFFF			DM14 Request: <Length = 0x00, Pointer type = 0x01, Command = 4 (operation completed),

Tool (address = 0xF9)		Sensor (address = 0x80)		Comment
CAN-ID	Data	CAN-ID	Data	
				SPN=0x0007E38A Key = 0xFFFF>

3.6.2. Setting the Detection Range End

The following sequence message sequence shows how to set the Detection Range End (0x07E388) to 6000mm. The columns “Tool (address = 0xF9)” shows CAN-ID and data sent by the tool and the columns “Sensor (address = 0x80)” the response by the sensor.

Tab 15 Communication Sequence “Setting the Detection Range End”

Tool (address = 0xF9)		Sensor (address = 0x80)		Comment
CAN-ID	Data	CAN-ID	CAN-ID	Data
0x18EAFFFE	0x00 EE 00			Request for address claim from the Service Tool
		0x18EEFF80	0x6C3DE01201870CA0	Address claim reply from the sensor
0x18EEFFF9	0xE803000000810000			Address claim reply from the Service Tool
…	…	…	…	Other data transmission, no time limitations
…	…	…	…	…
0x18D980F9	0x011588E307000100			Service Tool Request to write data over DM14: <Length=0x01, Pointer type = 1, Command = 2 (write), SPN=0x0007E388, Key / User Level=0x0001>
		0x18D8F980	0x0101FFFFFFFF61EF	DM15 Reply from the sensor: <Length=0x01, Status=0 (Proceed), Seed=0xEF61>
0x18D980F9	0x011588E3070061EF			DM14 Request Service Tool: <Length=0x01, Pointer type = 1, Command = 2 (write), Key = 0xEF61, SPN=0x0007E388> Key must match seed from sensor
		0x18D8F980	0x0101FFFFFFFFFFFF	DM15 Reply from the sensor: <Length=0x01, Status=0 (proceed), Seed=0xFFFF> No further login is required (seed=0xFFFF)
0x18D780F9	0x027017FFFFFFFFFF			Service Tool writes data over DM16: <Length / number of valid bytes in message=0x02, Data = 0x1770 (6000mm) > Length must be smaller or equal to the length from DM15 reply

Tool (address = 0xF9)		Sensor (address = 0x80)		Comment
CAN-ID	Data	CAN-ID	CAN-ID	Data
		0x18D8F980	0x0009FFFFFFFF0000	DM15 reply from the sensor: <Length=0x00, Status=4 (operation completed)>
0x18D880F9	0x011988E30700FFFF			DM14 request Service Tool: <Length=0x01, Pointertype = 1, Command = 4 (operation completed), Key / User Level=0FFFF, SPN=0x0007E388>

3.6.3. Reading the Detection Range End

The following sequence message sequence shows how to read the Detection Range End (0x07E388). The columns “Tool (address = 0xF9)” shows CAN-ID and data sent by the tool and the columns “Sensor (address = 0x80)” the response by the sensor.

Tab 16 Communication Sequence “Reading the Detection Range End”

Tool (address = 0xF9)		Sensor (address = 0x80)		Comment
CAN-ID	Data	CAN-ID	CAN-ID	Data
0x18EAFFFE	0x00 EE 00			Request for address claim from the Service Tool
		0x18EEFF80	0x6C3DE01201870CA0	Address claim reply from the sensor
0x18EEFFF9	0xE803000000810000			Address claim reply from the Service Tool
…	…	…	…	Other transactions, no time-limit
…	…	…	…	…
0x18D980F9	0x011388E307000100			Service Tool Request to read data over DM14: <Length=0x01, Pointer type = 1, Command = 1 (read), SPN=0x0007E388, Key / User Level=0x0001>
		0x18D8F980	0x0101FFFFFFFF61EF	DM15 reply from sensor: <Length=0x01, Status=0 (proceed), Seed=0xEF61>
0x18D980F9	0x011388E3070061EF			Service Tool Request to read data over DM14: <Length=0x01, Pointer type = 1, Command = 1 (read), SPN=0x0007E388, Key =0xEF61 > Key must match seed from sensor
		0x18D8F980	0x0101FFFFFFFFFFFF	DM15 reply from sensor: <Length=0x01, Status=0 (proceed), Seed=0xFFFF> No further login is required (seed=0xFFFF)
		0x18D7F980	0x0470170000FFFF	Sensor transmits data with DM16:

Tool (address = 0xF9)		Sensor (address = 0x80)		Comment
CAN-ID	Data	CAN-ID	CAN-ID	Data
				<Length=0x04 (valid bytes), Data = 0x00001770 (6000mm)>
		0x18D8F980	0x0009FFFFFFFF0000	DM 15 reply from sensor: <Length = 0x00, Status = 4 (operation completed)>
0x18D980F9	0x011988E30700FFFF			DM14 request from Service Tool: <Length=0x01, Pointer type = 1, Command = 4 (operation completed), SPN=0x0007E388, Key =0xFFFF >

4. Trouble Shooting

Tab 17 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 peplace part by qualified personnel
No communication (also magenta blinking)	Check CAN speed (e.g. 250kbit/sec), check 120Ohm termination,
No messages are sent	Check default transmission enable flags (0x0087E38D) 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 18 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	▪ 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	▪ Metal reflector in corner cube design ▪ Material: Steel ▪ Reliable object detection < 20 m

6. Environmental and Electrical Ratings

6.1. Overview of Environmental and Electrical Ratings for R600V

This chapter is for information only and subject to change. The declarations of conformity and data sheet available on the Baumer webpage take precedence over any information given here.

Tab 19 Overview of Environmental and Electrical Ratings for R600V

Ref.	Test Method	Standard	Criteria	Description	Note
			Dust and Particle Impact		
DP1	Inorganic Dust	IEC 60529 - IP6X	Dust ingress	Talcum Powder (<75um) moving in a chamber for 8h	
DP1	Particle Impact	DIN EN ISO 20567-1	Functional / visual check	Gravel acc. EN 11124-2 (white iron granulate, 4…5mm, 500gr) Gravel pressure: 2bar / 2 cycles	
			Fluids & Gases		
FG1	Salt Spray Corrosion	IEC 60068-2-52	Functional / visual check	relH: 95%, pluviometric constant: 1…2cm^3/h, pH: 6.5…7.2, Sodium chloride (NaCl) 50 +5g/l 4 Test Cycles (384h for all cycles) Test Cycle: 2h spray period @40°C, 22h humidity storage period), 3 days storage period in standard atmosphere	
FG2	Cleaning IP X8, IP X9K	IEC 60529: IPx8 ISO 20653: IPx9k	No water ingress, visual check	IPx8: t=24h, depth: 1.5m IPx9k: from all angles and sides	
FG3	Chemical resistance	ISO 16750-5	Functional / visual check	Brush application, application frequency: once per day for 3 days, soak time: 168h	A
FG4	Immersion (Thermal Dunk Test)	IEC 60529	No water ingress	17 parts water, 2 parts industrial liquid detergent or dish liquid 1 part sodium chloride Solution temp: 0°C DUT temp: 70°C 1 cycle @ 4h, Total 5 cycle	

Ref.	Test Method	Standard	Criteria	Description	Note
FG5	Corrosive Atmos-phere	ASTM B827:2014	Functional / visual check	Temperature: 30°C±1°C Relative Humidity: 70%±2% Cl2: 20ppb±5ppb NO2: 200ppb±50ppb H2S: 100ppb±20ppb SO2: 200ppb±5ppb50ppb Duration: 20 days	
			Shock & Vibration		
SV1	Random Vibration	IEC 60068-2-64	Functional / visual check	Frequency : 5Hz…2000Hz Overall Grms: 11.55 Grms Axis: All 3 axes / 8h per axis **And** Axis: All 3 axes / 24h per axis ASID: 10Hz : 1.44 PSD [(m/s^2)^2/Hz] 100Hz : 3.85 PSD [(m/s^2)^2/Hz] 1000Hz : 3.85 PSD [(m/s^2)^2/Hz] 2000Hz : 0.96 PSD [(m/s^2)^2/Hz]	A
SV2	Operating Me-chanical Shock	IEC 60068-2-27	Functional / visual check	Type of Pulse: Half-Sine Pulse Peak pulse amplitude: 50g Pulse duration: 11ms Total shock pulses: 18 per axis (3 axis)	A
SV3	Bench Handling Shock		Functional / visual check	Drop height: 1000mm (±50mm) on concret / 18 drops	
SV4	Transit Shock - Production	EN 60068-2-31	Functional / visual check	Drop height: 1.2m (±50mm) on con-cret / 10 drops / boxed	
			Temperature & Humidity		
TH1	Combined Envi-ronment (12V / 24V System)		Functional / visual check	Voltage: 9VDC, 18VDC, 32VDC Temperature: -40°C…70°C, humid-ity: 0%...70% relH 100 cycles / 12h per cycles	
TH2	Storage Temper-ature		Functional / visual check	-40°C … +85°C (min/max temp. for 24h each)	

Ref.	Test Method	Standard	Criteria	Description	Note
TH3	Storage Humidity		Functional / visual check	Temperature = 40°C, humidity = 95%rel duration = 168h	
TH4	Air-to-Air Thermal Shock	IEC 60068-2-14:2009	Functional / visual check	-40°C… 85°C (dwell time 60min, 100 cycles, transition rate between temperatures < 1 minute)	
TH5	Solar Radiation	ISO 4892-2	Functional / visual check	Method A (t=1000h, cycles: 500)	
			Electrical Steady State		
ES1	Maximum Load (12V/24V-System) - Overvoltage Test	ISO 16750-2 ch. 4.3 ISO 15003 ch. 5.14.2	Functional test	Vtest = 32V, Test temperature Tmax = 70°C, duration = 168h, Rload = 120 Ohm (CAN_HI, CAN_LO)	B
ES2	Jump Start Forward Voltage (12V-System) --> Overvoltage Test	ISO 16750-2 ch. 4.3 ISO 15003 ch. 5.14.2	Functional Status A	Vjump = 26.5V, Test temperature Tmax = 70°C, duration = 1h, R load = 120 Ohm (CAN_HI, CAN_LO)	B
ES3	Jump Start Reverse Voltage (12V-System) --> Reverse polarity test	ISO 15003 ch. 5.14.3	Functional Status C	Vjump = -26.5V, Test temperature Tmin =-40°C, duration = 1h, R load = 120 Ohm (CAN_HI, CAN_LO)	B
ES4	Short Circuit (12V-System)	ISO 16750-2 ch. 4.10	Functional Status C	All output lines outputs to 16V / 0V, duration: 1min	B
ES5	ESD Component - Handling	ISO 10605 ch. 9	Functional Status C	2kΩ/ 150pFAC ±15kV CD±8kV	
ES6	ESD Component - Powered	ISO 10605 ch. 8	Functional Status C	330Ω/150pF & 2000Ohm/150pF & 330Ω/330pF & 2000Ohm/330pF AC ±15kV CD±8kV	B
ES7	Reset Behavior during Voltage Drop	ISO 16750-2 ch. 4.6.2	Functional Status C	Vs: Vmin, step size: 5% of VsT1: 10s, T2: 5s	B
			Electrical Transients		

Ref.	Test Method	Standard	Criteria	Description	Note
ET1a	Starting Profile (12V-System)	ISO 16750-2 ch. 4.6.3	Functional Status C	(12V-System), Level III	B
ET1b	Starting Profile (24V-System)	ISO 16750-2 ch. 4.6.3	Functional Status C	(24V-System), Level III	B
ET2	Batteryless Operation (12V-System)	ISO 16750-2 ch. 4.4	Functional Status A	Vsmax = 16V, severity 2 Upp = 4V, Frequency Range: 50 Hz to 25kHz, duration: 120s, number of sweeps: 5, Ri: 50mΩ to 100mΩ	B
ET3a	Load Dump - Clamped (12V-System)	ISO 16750-2 ch. 4.6.4	Functional Status A	Pulse B (clamped to 35V)	B
ET3b	Load Dump - Clamped (24V-System)	ISO 16750-2 ch. 4.6.4	Functional Status A	Pulse B (clamped to 58V)	B
ET4a	Negative Switching Spikes (12V-Sys)	ISO 7637-2 ch. 5.6.3	Functional Status A	Pulse 3a, Level IV, Us=-220V, duration 1h	B
ET4b	Negative Switching Spikes (24V-Sys)	ISO 7637-2 ch. 5.6.3	Functional Status A	Pulse 3a, Level IV, Us=-220V, duration 1h	B
ET5a	Positive Switching Spike (12V-Sys)	ISO 7637-2 ch. 5.6.3	Functional Status A	Pulse 3b, Level IV, Us=150V, duration 1h	B
ET5b	Positive Switching Spike (24V-Sys)	ISO 7637-2 ch. 5.6.3	Functional Status A	Pulse 3b, Level IV, Us=220V, duration 1h	B
ET6a	Parallel Inductive Load Switching (12V-System)	ISO 7637-2 ch. 5.6.1	Functional Status C	Pulse 1, Level IV, Us=-150V, 1k pulses, td=2ms	B
ET6b	Parallel Inductive Load Switching (24V-System)	ISO 7637-2 ch. 5.6.1	Functional Status C	Pulse 1, Level IV, Us=-600V, 1k pulses, td=1ms	B
ET7	Negative Mutual Coupling (12V-Sys)	ISO 7637-3 ch. 4.3.2	Functional Status A,	Pulse a, Us=-60V, t=10min	B
ET8	Positive Mutual Coupling (12V-Sys)	ISO 7637-3 ch. 4.3.2	Functional Status A	Pulse b, Us=40V, t=10min	B

Ref.	Test Method	Standard	Criteria	Description	Note
E9a	DC Motors Acting as a generator (12V-System)	ISO 7637-2 ch. 5.6.2	Functional Status C	Pulse 2b, Us=10V, 10 pulses, Level IV	B
E9b	DC Motors Acting as a generator (24V-System)	ISO 7637-2 ch. 5.6.2	Functional Status C	Pulse 2b, Us=20V, 10 pulses, Level IV	B
E10	Rapid Magnetic Field Collapse (12V/24V-System)		Functional Status A	Vp = 600V, tau = 14.4E-6, fo = 1 MHz, Zout = 50Ohm / Cout = 0.1uF, Repetition / Cycle ≤ 10Hz / 100	B
E11	Wire Harness Inductance (12V/24V-System)		Functional Status A	Vmin = 9V, L = 100uH, C = 10uF, Test duration: 20 minutes	B
E12a	Wiring Harness Inductive Switching (12-System)		Functional Status A,	Pulse 2a, Us=112V,5k pulses, Level IV	B
E12b	Wiring Harness Inductive Switching (24-System)		Functional Status A	Pulse 2a, Us=112V, 5k pulses, Level IV	B
			EMI Immunity		
EI1a	Bulk Current Injection (BCI)	ISO 11452-4	Functional Status A	0.5-400MHz, 100mA (AM) 0.5-400MHz, 60mA (CW)	B
EI1b	Bulk Current Injection (BCI)	ISO 11452-4	Functional Status A	1-400MHz, 300mA (AM) 1-400MHz, 300mA (CW) (Closed loop method)	B
EI2a	Free Field	ISO 11452-2	Functional Status A	200-1000MHz, 100V/m (AM) 200-2700MHz, 30V/m (CW) 800-2700MHz, 30V/m (PW)	B
EI2b	ALSE	ISO 11452-2	Functional Status A	200-1000MHz, 200V/m (AM: 1kHz, 80%) 800-2000MHz, 200V/m (PM: (ton=577us, period 4600us):	B
EI3	Stripline (AM/CW)	ISO 11452-5	Functional Status A	0.5-200MHz, 60V/m (AM, CW)	B

Ref.	Test Method	Standard	Criteria	Description	Note
EI4	AC Power Line Electric Fields	SAE J1113-26	Functional Status A	30kV/m (50/60Hz), 10 minutes per axis	B
			EMI Emissions		
EE1	ESA Radiated Emissions Broadband	CISPR 25		UN/ECE R10 Rev 5 ch. 6.5 f=0.53-30MHz: 24dBµV/m f=30-1000MHz: Limits see: UN/ECE R10 Rev 5 ch. 6.5.2.1	
EE2	ESA Radiated Emissions Narrowband	CISPR 25		UN/ECE R10 Rev 5 ch. 6.6 f=0.53-30MHz: 15dBµV/m f=30-1000MHz: Limits see: UN/ECE R10 Rev 5 ch. 6.6.2.1 f=1159-1590MHz: 10dBµV/m f=2320-2500MHz: 25dBµV/m	
EE3	CP-Method	CISPR 25		Frequency Range: 0.53…2MHz, Class3 BB / QP / NB Limits: Narrowband Peak/Average: 34dBuV Broadband Peak: 63dBuV Broadband Quasi-Peak: 50dBuV	
			Other CE		
CE1	Electromagnetic Emission	EN61000-4-20		30-230MHz, QP, 50 dBµV/m 230-1000MHz, QP, 57 dBµV/m	
CE2	ESD Component - Powered	EN61000-4-2	Criterium A	CD ±4kV / AD ±8kV (Network: 150pf/330 Ohm)	B
CE3	Electromagnetic Immunity EM-Field	EN61000-4-3	Criterium A	80-1000MHz / 80% AM(1kHz) / 10V/m	B
CE4	Electromagnetic Immunity EM-Field	EN61000-4-3	Criterium A	1.4-2.7 GHz / 80% AM(1kHz) / 3V/m	B
CE5	Electromagnetic Immunity	EN61000-4-6	Criterium A	0.15-80MHz / 80% AM(1kHz) / 10V	B

Ref.	Test Method	Standard	Criteria	Description	Note
CE6	Electromagnetic Immunity - Fast Transient	EN61000-4-4	Criterium B	5/50ns / 5kHz / ±2kV	B
CE7	Electromagnetic Immunity - Surge	EN61000-4-5	Criterium B	1.2/50us (Sym: ±0.5kV / Unsym: ±0.5kV)	B
			Radio Standards		
RS1	Radio Standard ECE	EN305550-1 EN305550-2 EN305550 (V2.1.0)		RF output power (nonspecific SRD) 122 GHz to 122.25 GHz: 10 dBm e.i.r.p. 122.25 GHz to 123 GHz: 100mW e.i.r.p./ 20 dBm e.i.r.p. Permitted range of operating frequencies: 122 GHz – 123 GHz Unwanted emissions in the spurious domain - max. spurious level: 47 MHz to 74 MHz, 87.5 MHz to 118 MHz, 174 MHz to 230, MHz 470 MHz to 862 MHz: 54 dBm Other frequencies ≤ 1000 MHz : 36 dBm All frequencies > 1000 MHz: 30 dBm OOB limit: 10 dBm/MHz	
RS2	Occupied bandwidth (6dB bandwidth)	FCC 47 CFR $15.258(d) RSS Gen Issue 5 RSS 210 Issue 10		FCC: 116 GHz … 123GHz RSS 210: 122 GHz … 123 GHz	
RS3	Maximum E.I.R.P	FCC 47 CFR $15.258(b)(1)/(3) RSS Gen Issue 5 RSS 210 Issue 10		FCC: Average power 40 dBm / Peak power 43dBm RSS 210: Average power 20dBm (122...123GHz)	
RS4	Frequency stability (over Temperature: -20…50°C)	FCC 47 CFR $15.258(d) RSS Gen Issue 5 RSS 210 Issue 10		116 ... GHz 123 GHz (regulatory range) 122...123 GHz (R600V sensor)	
RS5	Duty Cycle	RSS Gen Issue 5		38%	

Ref.	Test Method	Standard	Criteria	Description	Note
		RSS 210 Issue 10			

6.2. Notes

6.2.1. A – Chemical Resistance

List of chemicals:

- Diesel Exhaust Fluid (DEF): (AdBlue acc. to DIN 70070-05)
- Diesel Fuel: Acc. to EN590 or ASTM D975
- Engine Oil: SAE 15W-40
- Brake Fluid: e.g.: Würth DOT 4 or Valvoline DOT 3 & 4
- Detergents: e.g.: Daimler AG A 001 986 41 71 10
- Degreaser: e.g.: Sonax Engine Cold Cleaner
- 2% sulfuric acid

6.2.2. B – Criteria

Functional Status A: All functions of the device/system perform as designed during and after the test.

Functional Status C: One or more functions of a device/system do not perform as designed during the test, but return automatically to normal operation after the test.

Criterium A: No noticeable changes of the operating characteristic. Operating as intended.

Criterium B: Temporary degradation or loss of performance which is self-recoverable

7. Appendix

7.1. Table Overview

Tab 1 Applicable Products....4
Tab 2 Applicable Documents....6
Tab 3 Connector Pin-Out....15
Tab 4 Vehicle Power Electrical Transients....15
Tab 5 Status Mapping (Visual Diagnostic)....16
Tab 6 CAN Interface....17
Tab 7 SAE J1939 in the OSI reference model....18
Tab 8 Address management messages....19
Tab 9 Target Distance Message (main message)....21
Tab 10 Decoding a CAN SAE J1939 message frame....22
Tab 11 Example for decoding the CAN ID (29bit, PDU1 format)....22
Tab 12 Example for decoding the 8 byte data field....22
Tab 13 Adjustable Parameters....23
Tab 14 Trouble Shooting Overview....30
Tab 15 Accessories....30
Tab 16 Definitions and Abbreviations....41
Tab 17 Document revision history....43

7.2. Figures Overview

Fig 1 Mechanical Setup (for visualization only) 9

Fig 2 Mounting on a thick soft steel plate (≥6mm). 10

Fig 3 Mounting on a thin soft steel plate (≥3mm).....10

Fig 4 Mounting pattern, tool space. 11

Fig 5 Typical Directional Sensitivity of Sensor.....12

Fig 6 Recommended Free Space for weak targets 12

Fig 7 Usage of shields to cover strongly reflecting objects.....13

Fig 8 Separate strongly reflecting objects from target 13

Fig 9 Multi-path beam propagation.....14

Fig 10 CAN connection setup diagram 17

7.3. Definitions and Abbreviations

The following definitions and abbreviations are used throughout this manual

Tab 20 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

8. Terms and conditions of use

8.1.1. Copyright

The entire content of this manual is protected by copyright law. All rights remain reserved to the Baumer Group. The printout of this manual is permitted provided that neither the copyright statements nor any other legally protected designations are removed or altered. The (complete or partial) reproduction, transmission, modification, linking or utilization of this manual for publishing or commercial goals is prohibited without prior written approval from the Baumer Group.

8.1.2. No Warranty

The Baumer Group uses reasonable efforts in order to ensure the reliability of the information presented in this manual, but makes no warranties or representations whatsoever with respect to the accuracy or reliability of the information provided in this manual. Any information published and any opinion expressed in this manual are provided by the Baumer Group for personal use and for informational purposes only; they may be changed by the Baumer Group at any time without prior notice.

The suitability of the Baumer product must be validated by the customer for every application. Intellectual property rights may exist for some applications and / or end use cases. Baumer does neither implicitly nor explicitly warrant the usage for specific application and / or end use case.

8.1.3. No Offer

The information published in this manual does not constitute a solicitation to submit an offer, nor does it constitute an offer or a recommendation to acquire or sell investment vehicles or to conduct any other transactions. Baumer reserves the right to discontinue the sale of any product. The availability of any particular product cannot be guaranteed. All sales are subject to our standard terms of delivery. For a copy please contact Baumer.

8.1.4. Limitation of Liability

The Baumer Group disclaims, without limitation, all liability for any loss or damage of any kind, including any direct, indirect or consequential damages, which might be incurred through the use of this manual. This is also valid for losses and damages caused by viruses.

8.1.5. Governing Law and Jurisdiction

Subject to the Terms and Conditions set forth herein, any use of this manual and all legal disputes arising in connection therewith shall exclusively be governed by Swiss law. Exclusive place of jurisdiction is Frauenfeld (TG) Switzerland.

9. Document Revision History

Tab 21 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 distance selection	wemi	N/A	N/A
1.4	05 Mar 2020	Add a decoded CAN message 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
1.8	22 Jan 2024	CAN specification correction to adjust Baud-rate (SPN: 0x07E3A3), including chapter 3.6	rma	N/A	N/A

10. Baumer Worldwide

Belgium
Baumer SA/NV
BE-2260 Westerlo
Phone +32 14 57462 0

Brasil
Baumer do Brasil Ltda
13208-120 Jundiaí, São Paulo
Phone +55 11 4523-5120

Canada
Baumer Inc.
CA-Burlington, ON L7M 4B9
Phone +1 (1)905 335-8444

China
Baumer (China) Co., Ltd.
CN-201612 Shanghai
Phone +86 (0)21 6768 7095

Denmark
Baumer A/S
DK-8210 Aarhus V.
Phone +45 (0)8931 7611

France
Baumer SAS
FR-74250 Fillinges
Phone +33 (0)450 392 466

Germany/Austria
Baumer GmbH
DE-61169 Friedberg
Phone +49 (0)6031 60 070

India
Baumer India Private Ltd.
IN-411058 Pune
Phone +91 2066292400

Italy
Baumer Italia S.r.l.
IT-20090 Assago, MI
Phone +39 (0)245 70 60 65

Republic of Korea
Baumer (Korea) Co., Ltd.
KR-411-766 Seoul
Phone +82-2-6351-9909

Poland
Baumer Sp.z.o.o.
PL- 92-333 Łódź
Phone +48 42 676 7330

Singapore
Baumer (Singapore) Pte. Ltd.
SG-339412 Singapore
Phone +65 6396 4131

Spain
Baumer Automación Ibérica S.L
ES-08021 Barcelona
Phone +34 932547864

Sweden
Baumer A/S
SE-56122 Huskvarna
Phone +46 (0)36 13 94 30

Switzerland (Headquarter)
Baumer Electric AG
CH-8501 Frauenfeld
Phone +41 (0)52 728 1122

United Kingdom
Baumer Ltd.
GB-Watchfield, Swindon, SN6 8TZ
Phone +44 (0)1793 783 839

USA
Baumer Ltd.
US-Southington , CT 06489
Phone +1 800 937 9336

www.baumer.com/worldwide