R600V.RAH5 Retro-Reflective Operating Manual (EN)

Off-Highway retro-reflective Radar Sensor with counter function

Last Update: 07 Feb 2024

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1. General Information

1.1. Scope

This manual is intended for the Baumer “Off-Highway retro-reflective radar sensor with counter function”. The sensors and their software configuration are listed below:

Tab 1 Applicable Products

Art. no.	Product	Type	SW Version
11225384	R600V.RAH5-11225384	Radar retro-reflective sensor	R600VRTF_S,1.0 (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 retro-reflective radar sensor with counter function” has been developed with the off-highway market (agriculture vehicles, construction vehicles, etc.) in mind. It is intended for use cases to detect the presence of objects, or count objects passing through the sensor beam.

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

"Off-Highway retro-reflective radar sensor with counter function" is intended to detect the presence of objects, or count objects passing through the sensor beam.

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 Mult-object 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
11225384	Data sheet (DAB)	DAB Radar Radar retro-reflective sensor
11225384	Mounting instruction (MAL)	MAL Radar retro-reflective sensor
11225384	Declaration of conformity (EU)	Baumer_R600V_ML_DoC_81302233
11225384	Declaration of conformity (US)	CTC_FCC_R600V_EN_RoC_81371135

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. Reflector, Blind-range

The sensor shall be mounted directed towards the reflector. The sensor opening angle, angular sensitivity and a blind range of 300mm must be considered. Further details can be found in chapter 2.2. No detection of objects is possible within the blind range of the sensor.

The radar reflectance of the reflector material (metal, non-metal, …), its geometry (size, surface structure, shape) determine the how stable objects can be detected or counted. Coatings on the reflector may affect the reflectance properties. The reflectance depends on the dielectric constant and conductance of the material at the radar wavelength. Sufficient signal must be validated through integration testing.

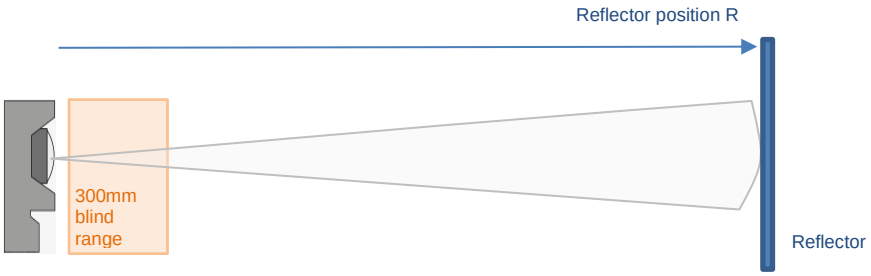


Fig 1 Mechanical Setup (for visualization only)

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.

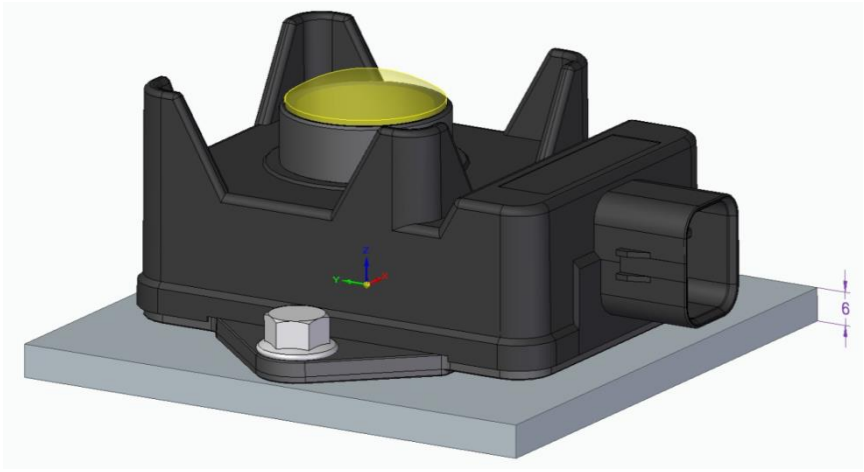


Fig 2 Mounting on a thick soft steel plate (≥6mm).

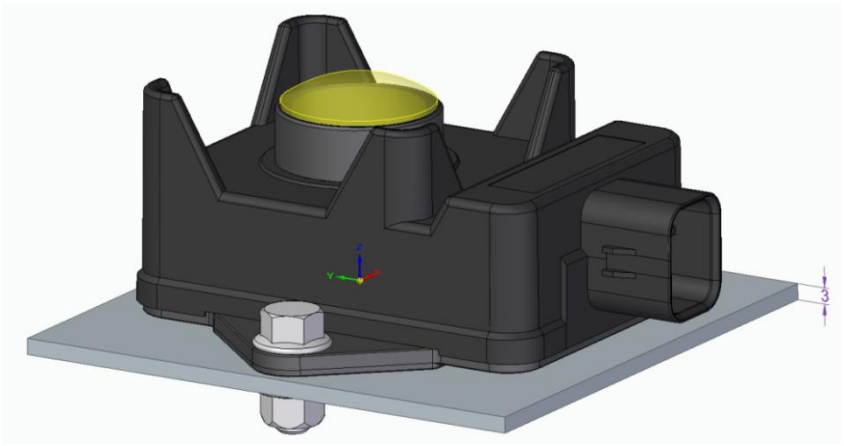


Fig 3 Mounting on a thin soft steel plate (≥3mm)

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.

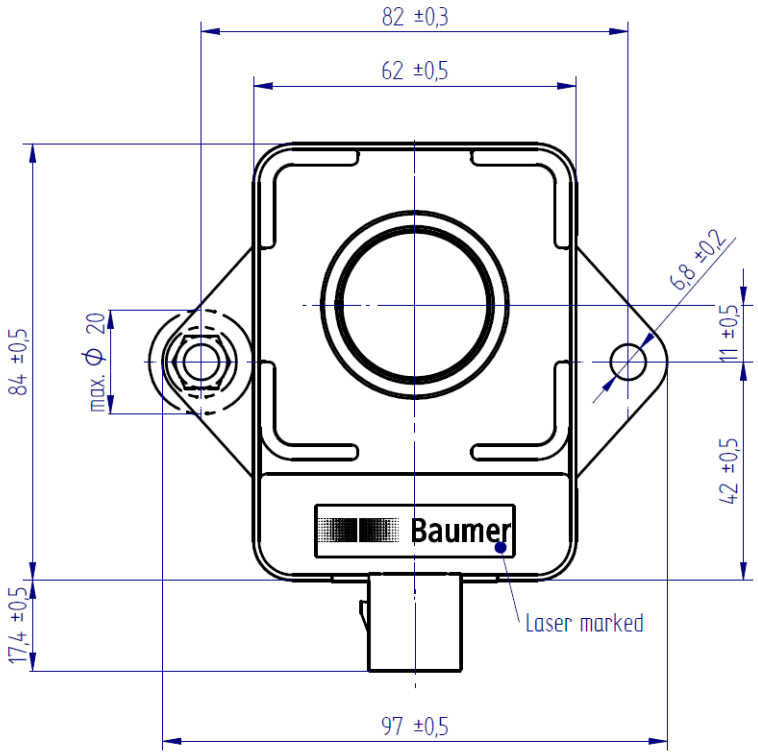


Fig 4 Mounting pattern, tool space.

ATTENTION

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

2.2. Rules for Installation

2.2.1. Directional Sensitivity

The Baumer Off-Highway retro-reflective radar sensor with counter function 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.

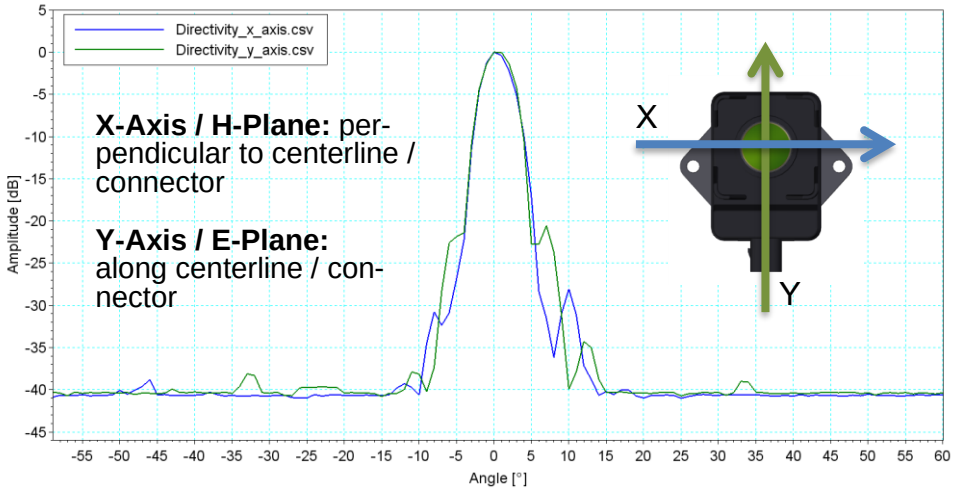


Fig 5 Typical Directional Sensitivity of Sensor

Static objects within the measurement range are effectively suppressed. Nevertheless Baumer recommends limiting intrusion of unwanted objects, into a rotational cone of approx. 60…70°. Integration testing must be done to ensure that the integration with available free space does not have impact on the measurement.

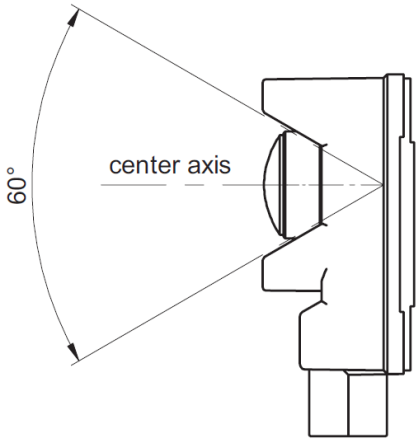


Fig 6 Recommended Free Space for weak targets

2.2.2. Reflector Positioning and Static Objects

Generally it is desirable that the reflector is positioned perpendicular to the sensor. As a rule of thumb a reflector angle needs to be < 2°. The actually achievable reflector angle depends on reflector and object properties. In the default configuration static objects (disturbing echos) are suppressed in most cases. The filter constant for suppressing static objects is 5 seconds. The suppression of static objects can be de-activated with a DM14 request at address 0x07E3B4 (for details please refer to Tab 14). Transient objects are the objects that are of interested and are counted and / or their presence detected.

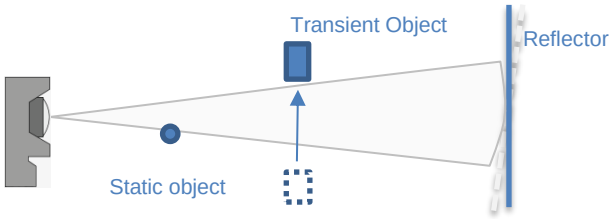


Fig 7 Reflector positioning

Transient objects should always be kept at a minimum distance of at least the specified blind range to the reflector.

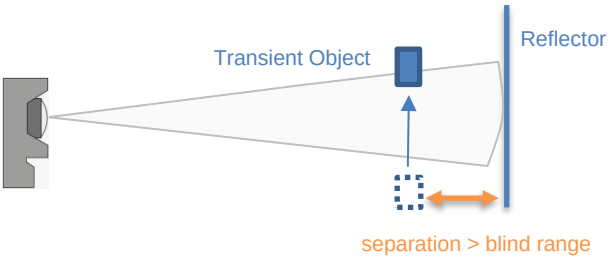


Fig 8 Separation of transient object from reflector

The reflector position can be set via CAN with a DM14 request at address 0x07E3B0 (for details please refer to Tab 14).

2.2.3. Reflector Teach

xxx

Fig 9 Reflector Teaching

2.3. Detection Behaviour

2.3.1. General Detection Behaviour

2.3.2. Amplitude Dependence

2.3.3. Switching Behaviour

2.3.4. De-bouncing

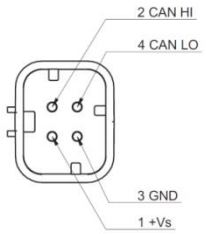
Fig 10 Reflector Teaching

2.4. 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 be used on machines with centralized load dump suppression.

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

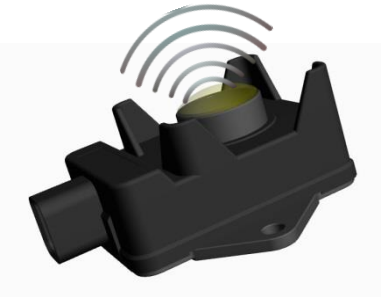
NOTE
For test installations a cable with the order code 11213075 (ZCABL-ALL.AMP0300) may be used.

2.5. 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
Reflector within tolerance A	100ms green LED ON 900ms LED OFF
Reflector within tolerance B	2x 50ms green LED ON 880ms LED OFF
Reflector signal weak	3x 50ms green LED ON 800ms LED OFF
No Reflector detected (e.g.: Object in front of reflector)	As above with additional yellow LED ON (100ms)
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



2.6. 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:

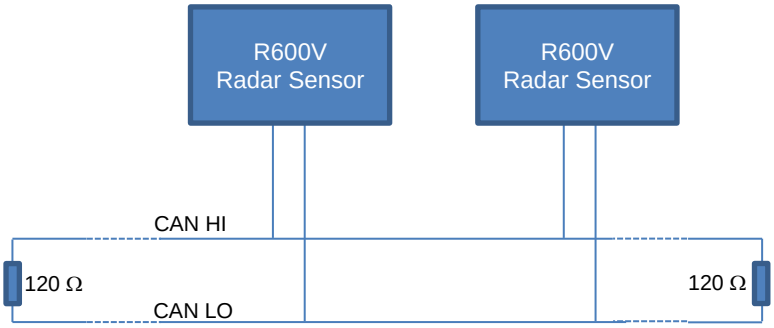


Fig 11 CAN connection setup diagram

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	3
Function	255 (non-specific)
System	127 (non-specific)
System instance	0
Industry group	2 (Agriculture)
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”. 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) (2)
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 (2)
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 0.

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 (3)	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 (4)	NAME, new SA

(2) 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.

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

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

3.3. Supported PGN (Parameter Group Number)

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. Object Detection and Counter Messages (Main Messages)

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. There are two messages identified by a multiplexor shown in the following two tables:

Tab 9 Object Detection and Counter Function

Start bit	Bits	Offset	Scaling	Description
1	2	0	1	Multiplexor = 0
3	2	0	1	Sensor Status 0 = No error 1 = Reversible error. (e.g. temperature too high) 2 = Irreversible error. Sensor measurement not available
5	3	0	1	Sensor status after reflector position (R) teach 0 = No error 1 = Reflector signal was too weak* 2 = Reflector signal outside of valid range (5) 3…7 = N/A
8	1	0	1	Reflector/Object detection status (filtered) 0 = Reflector detected (no object between sensor and reflector) 1 = No Reflector detected (Object between sensor and reflector or no reflector in range)
9	2	0	1	Reflector status (R) (6), (unfiltered) 0 = Reflector in operating range (A) 1 = Reflector in boundary range (B) 2 = Reflector signal is weak but sufficient (weak if quality (6) < 80%) 3 = Reflector outside of range A/B or amplitude not sufficient
11	24	0	1	Counter for object detection events: 0…16,777,215 (ca. 23h)
35	14	0	1 mm	Measured distance (7) of reflector (R), (unfiltered)
49	10	0	0.1 dB	Measured amplitude (7) of reflector (R), (unfiltered)
59	6	0	1	N/A (filled with 0)

(5) Status is held until the sensor is successfully teached
(6) Quality is a function of signal strength
(7) Reflector amplitude and reflector distance will be “0” if no reflector is detected

Tab 10 Object 3, 4 Message (Main Message)

Start bit	Bits	Offset	Scaling	Description
1	2	0	1	Multiplexor Value = 1
3	10	0	0.1 dB	First echo amplitude (unfiltered)
13	14	0	1 mm	First echo distance (unfiltered)
27	10	0	0.1 dB	Strongest echo amplitude (unfiltered)
37	14	0	1 mm	Strongest echo distance (unfiltered)
51	14	0	1 mm	Teached Reflector position

3.4. Exemplary Decoding of a CAN message frame

Exemplary decoding the “object” message (PGN 0xC000)

Based on a line from a CAN log (18100856, 18C0FF80, Rx, A0 20 02 AC 78 C3 7D 7F

Tab 11 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 A0 20 02 AC 78 C3 7D 7F			

Tab 12 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 13 Example for decoding the 8 byte data field

0x A0 20 02 AC 78 C3 7D 7F [1010 0000 0010 0000 0000 0010 1010 1100 0111 1000 1100 0011 0111 1101 0111 1111]$_2$									
Multi-plexor (bit 1-2)	Sensor status (bit 3-4)	Object status 2n (bit 5)	Object status 2n+1 (bit 6)	Object 2n distance (bit 7-20)	Object 2n+1 distance (bit 21-34)	Object 2n confidence (bit 35-41)	Object 2n+1 confidence (bit 42-48)	Object 2n speed (bit 49-56)	Object 2n+1 speed (bit 57-64)
[00]$_2$	[00]$_2$	[0]$_2$	[1]$_2$	0x 08 82	0x 0A C0	0x 5E	0x 61	0x 7D	0x 7F
n=0	0	0	1	2’178mm	2’752mm	94 %	97 %	-0.094m/s	-0.031m/s

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 14 Adjustable Parameters

Address	Parameter	range	offset	scaling	Default value
	LED settings				
0x07DFAA	Green LED duty cycle (8)	0..100	0	1%	0
0x07DFAB	Green LED period (8)	0..255	0	100ms	0
0x07DFAC	Red LED duty cycle (8)	0..100	0	1%	0
0x07DFAD	Red LED period (8)	0..255	0	100ms	0
0x07DFAE	Blue LED duty cycle (8)	0..100	0	1%	0
0x07DFAF	Blue LED period (8)	0..255	0	100ms	0
	Measurement Settings				
0x07E3B0	Set reflector position (R)	300 … 8500	0	1mm	8500
0x07E3B1	Teach reflector position (R): 0 = Do not Teach 1 = Teach on first echo 2 = Teach on strongest echo	0 … 2	0	1	0
0x07E388	Max. Detection range (9)	240…10200	0	1mm	240
0x07E389	Min. Detection range (9)	240…10200	0	1mm	10200
0x07E3B4	Suppression of disturbing echos in detection range 0 = No suppression 1 = Suppression	0…1	0	1	1
0x07E3B2	Tolerance A (in ± x % R) (10)	1...20%	0	1%	4%
0x07E3B3	Tolerance B (in ± x % R) (10)	1...20%	0	1%	6%
0x07E3B8	Reset Counter 0 = No Reset of counter 1 = Reset counter value to 0	0 … 1	0	1	0
0x07E3B9	Counter Logic	0 …1	0	0	0

Address	Parameter	range	offset	scaling	Default value
	0 = count on interruption of beam 1 = count on release of beam				
0x07E3BA	Switch ON delay (debounce) (0 = Function OFF) (12)	0…5000ms	0	1ms	10ms
0x07E3B6	Switch OFF delay (debounce) (0 = Function OFF) (12)	0…5000ms	0	1ms	10ms
0x07E3B5	Reflector amplitude switching sensitivity Level (13) (50dB = Amplitude switching off)	0.1…50dB	0	0.1dB	3dB
0x07E3B7	Maximum Detection Length (Counting) (11) (0 = Function OFF) (12)	0…5000ms	0	1ms	0
	CAN Settings				
0x07E38A	Data PGN transmit period	10..5000	0	1ms	50
0x07E38B	PGN for 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 (8) 0 = Main messages off 1 = Main messages 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 messages off 1 = Main messages 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
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)(14)	128…209	0	1	128

Address	Parameter	range	offset	scaling	Default value
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. (15) 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 non-volatile parameters to default values: 0x00, 0xAA, 0x55, 0x12, 0x34				

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

(9) Detection range can be limited to avoid issues with disturbing detections outside distances of interest. The maximum detection range is larger than the allowed reflector position (R) to accommodate for tolerances A/B of up to 20%.

(10) B must be greater than A

(11) Automatically increments counter every defined time increment if an object is continuously detected

(12) Will be rounded up to next multiple of 5ms

(13) Determines how much the signal is reduced to be counted / detected

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

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

3.6. Exemplary Sensor Configuration

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 15 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			Service Tool Request to write data over DM14: <Length = 0x01, Pointer type = 0x1, Command = 0x2 (write), SPN=0x0007E38A, User Level=0x0001>
		0x18D8F980	0x0101FFFFFFFFB5F3	DM15 Reply from the sensor: <Length = 0x01, Status = 0 (proceed), Seed=0xF3B5>
0x18D980F9	0x01158AE30700B5F3			DM14 Request Service Tool < Length = 0x01, Pointer type 0x1, Command=0x2 (write), Key = 0xF3B5, SPN = 0x0007E38A>
		0x18D8F980	0x0101FFFFFFFFFFFF	DM15 Reply from the sensor: < Length = 0x01, Status=0 (proceed), seed=0xFFFF> (no further login required)
0x18D780F9	0x0164FFFFFFFFFFFF			Service Tool writes data over DM16: <Length = 0x1, Data = 0x64 (100ms)>
		0x18D8F980	0x0109FFFFFFFF0000	DM15 reply from the sensor: <Length = 0x01, Status=4 (operation completed), Seed=0x0000>
0x18D980F9	0x00198AE30700FFFF			DM14 request Service Tool: <Length = 0x00, Pointer type = 0x1, Command = 0x4 (operation completed),

				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 16 Communication Sequence “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 = 0x1, Command = 0x1 (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 = 0x1, Command = 0x1 (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: <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 = 0x1,

				Command = 0x4 (operation completed), SPN=0x0007E388, Key =0xFFFF >

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 17 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 = 0x1, Command = 0x1 (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 = 0x1, Command = 0x1 (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: <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 = 0x1,
Command = 0x4 (operation completed),
SPN=0x0007E388,
Key =0xFFFF >

4. Trouble Shooting

Tab 18 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,
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 19 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. Appendix

6.1. Table Overview

6.2. Figures Overview

6.3. 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

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8. Document Revision History

Tab 21 Document revision history

Vers.	Date	Note	Author	Checked	Released
1.0	12 Aug 2020	Initial Release	wemi	N/A	N/A
1.1	07 Jan 2021	Add Compliance Statement	wemi	N/A	N/A
1.2	01 Mar 2021	Change CAN settings	wemi	N/A	N/A
1.3	07 Feb 2024	CAN corrections & SPN 0x07E39F included	rma	N/A	N/A

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