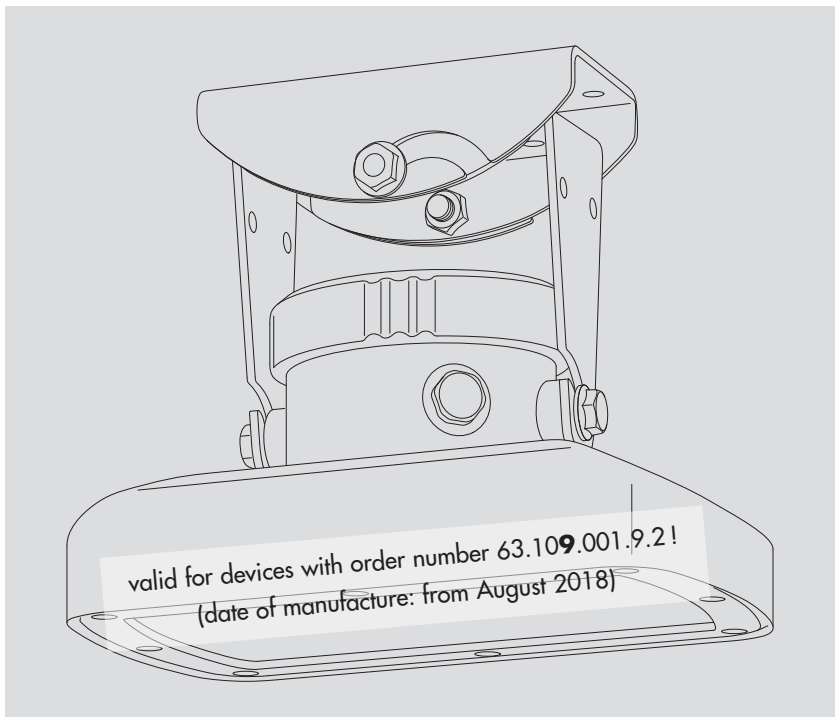


Operating instructions

Radar Level Sensor

OTT RLS



These Operating Instructions, version *04-0124* describe the OTT RLS firmware version *V 3.00.0* used in equipment manufactured as of August 2018. They are only valid for OTT RLS radar sensors with the order number 63.109.001.9.2!

Please note: When you want to swap an existing OTT RLS manufactured before July 2009 for a new unit, the datalogger configuration should be checked and modified as applicable. In such a case, please contact OTT HydroService.

We reserve the right to make technical changes and improvements without notice.

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1 Scope of supply

- ▶ **OTT RLS**
 - 1 Radar sensor OTT RLS, two part swivel mount (consisting of device and wall brackets with 4 M8 Allen bolts) with SDI-12-, RS-485- and 4 ... 20 mA interface
 - 1 Installation kit (4 x wood screws 6 x 40 mm; 4 x plastic plugs S8)
 - 1 Double open-ended wrenches size 10 x 13
 - 1 Operating instructions
 - 1 Factory acceptance test certificate (FAT)

2 Order numbers

▶ OTT RLS	Radar sensor OTT RLS	63.109.001.9.2
▶ Accessories	Connection cable <ul style="list-style-type: none">- twisted-pair design- PVC, black- 2 x 2 x 0,5 mm²AWG 20	97.000.039.9.5
	Connection cable <ul style="list-style-type: none">- twisted-pair design- PVC, black- 2 x 2 x 0,75 mm²AWG 19	97.000.040.9.5
	OTT RLS bridge mounting <ul style="list-style-type: none">- Mounting aid for attaching the OTT RLS to a bridge- For side mounting- Height according to customer requirements- Distance to bridge according to customer requirements- Including angle bracket for attachment from above	63.105.025.3.2
	OTT USB/SDI-12 Adapter <ul style="list-style-type: none">- For temporarily connecting OTT sensors to a PC with SDI-12 or RS-485 interface- Including 1 USB connection cable. USB connector type A to USB type B; 3 m	65.050.002.9.2

3 Basic safety information

3.1 Markings and symbols used in the instruction

- This bullet point indicates an instruction relating to a specific action.
- ▶ This bullet point indicates an item in a list.
 - This bullet point indicates a sub-item in a list.

• **Remarks: ...**

- ▶ Information on easier and more efficient work
- ▶ Further information
- ▶ Definition

! **Please note: ...**

Information that prevents potential damage or malfunction on the OTT RLS.

3.2 Explanation of safety information used

The safety information used in these operating instructions is classified according to the nature and severity of a particular hazard. The hazard level defined is indicated by the signal word "WARNING" and a pictogram (orange triangle) in these operating instructions.

WARNING



Warning of a hazardous situation with a medium level of risk

The safety information specifies the nature and source of the hazard.

If you fail to carry out the specified actions, the hazardous situation can result in **death** or **serious injuries**.

- ▶ Action to prevent the hazardous situation!
 - ▶ Action to prevent the hazardous situation!
-

3.3 Note the following for safe and trouble-free operation

- ! ▶ Read these operating instructions before using the OTT RLS for the first time! Make yourself completely familiar with the installation and operation of the OTT RLS! Retain these operating instructions for later reference.
- ▶ The OTT RLS is used for contactless level measurement of surface waters. Only use the OTT RLS in the manner described in these operating instructions! For further information → see Chapter 4, *Introduction*.
- ▶ Note all the detailed safety and warning information given within the individual work steps.
- ▶ Never use the OTT RLS in areas where there is a danger of explosion. For further information → see Chapter 5, *Installing the OTT RLS*.
- ▶ Note that the electric installation of the OTT RLS may only be done by a professional. For further information → see Chapter 5, *Installing the OTT RLS*.
- ▶ Protect the power supply connection with a fuse (0.250 ampere, blowing speed: fast). For further information → see Chapter 5, *Installing the OTT RLS*.
- ▶ It is essential to comply with the electrical, mechanical and climatic specifications given in the Technical Data section. For further information → see Chapter 11, *Technical data*.
- ▶ Do not make any changes or retrofits to the OTT RLS. If changes or retrofits are made, all guarantee claims are voided. Furthermore, the radio approval required for its operation is void!
- ▶ Have a faulty OTT RLS inspected and repaired by our repair center. Never make any repairs yourself under any circumstances. For further information → see Chapter 8, *Repair*.
- ! ▶ Dispose of the OTT RLS properly after taking out of service. Never put the OTT RLS into the normal household waste. For further information → see Chapter 10, *Note about the disposal of old units*.

3.4 Radio frequency approvals

Federal Communications Commission (FCC) Approval

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.

The power listed is EIRP measured in 50 MHz bandwidth. This device must be installed and maintained to ensure a vertically downward orientation of the transmit antenna's main beam. This device may only operate at fixed locations and may not operate while being moved, or while inside a moving container. Hand-held applications are prohibited.

- ! Warning – Unauthorized modification or changes to this wireless communication equipment will void the right to use it. Changes or modifications to this unit not expressly approved by the party responsible for compliance will void the user's authority to operate the equipment. Any change to the equipment will void the FCC grant.

Industry Canada Approval

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s).

- ▶ Operation is subject to the following two conditions:
 - (1) this device may not cause interference, and
 - (2) this device must accept any interference, including interference that may cause undesired operation of the device.
- ▶ The installation of the device shall be done by trained installers, in strict compliance with the manufacturer's instructions.
- ▶ The use of this device is on a "no-interference, no-protection" basis. That is, the user shall accept operations of high-powered radar in the same frequency band which may interfere with or damage this device. However, devices found to interfere with primary licensing operations will be required to be removed at the user's expense.

! Warning – Unauthorized modification or changes to this wireless communication equipment will void the right to use it. Changes or modifications to this unit not expressly approved by the party responsible for compliance will void the user's authority to operate the equipment. Any change to the equipment will void the Industry Canada certification.

Approbation CNR d'industrie Canada ¹⁾

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique 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.
- ▶ L'installation d'un dispositif doit être effectuée par des installateurs qualifiés, en pleine conformité avec les instructions du fabricant.
- ▶ Ce dispositif ne peut être exploité qu'en régime de non-brouillage et de non-protection, c'est à dire que l'utilisateur doit accepter que des radars de haute puissance de la même bande de fréquences puissent brouiller ce dispositif ou même l'endommager. D'autre part, les capteurs de niveau qui perturbent une exploitation autorisée par licence de fonctionnement principal doivent être enlevés aux frais de leur utilisateur.

! Avertissement – La modification ou les changements non autorisée à cet équipement de communication sans fil annuleront la droite pour l'utiliser. Les changements ou les modifications à cette unité pas expressément approuvé par le parti responsable de la conformité annuleront l'autorité de l'utilisateur pour fonctionner l'équipement. N'importe quel changement à l'équipement annulera la certification d'industrie Canada.

¹⁾ Industry Canada Approval in French language

4 Introduction

The OTT RLS radar sensor is used for contactless measurement of the levels of surface water.

Operation of the OTT RLS is based on pulse radar technology. The transmitting antenna emits short radar pulses on 25.3 GHz. The separate receiver antenna receives the pulses reflected from the water and uses them to determine the distance between sensor and water surface: the time taken by the radar pulses from transmission to reception is proportional to the distance between sensor and water surface. The actual water level of the waterway is then calculated automatically, if required, by the radar sensor. To do this, on initial startup there is the possibility of inputting the relevant measurement mode and a reference value.

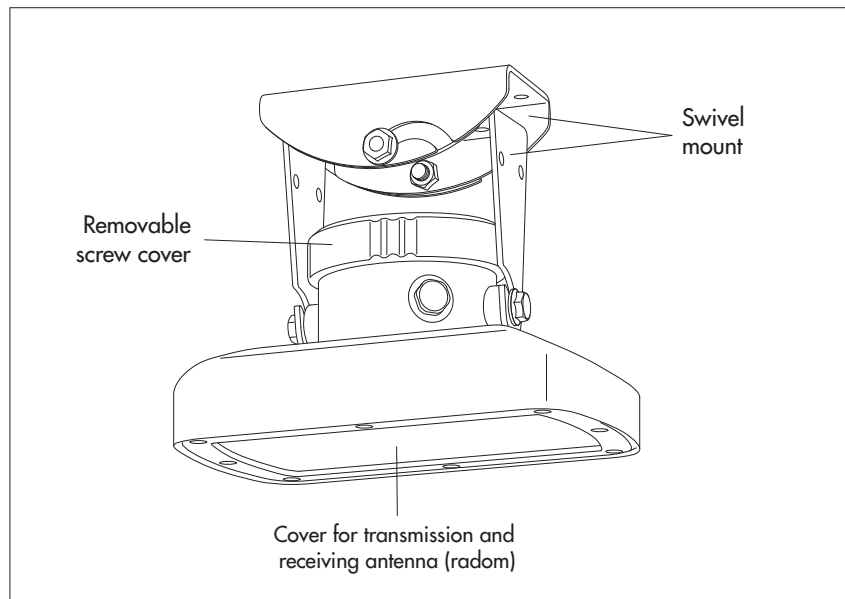
Three standardized electrical interfaces are available for connecting the OTT RLS to a datalogger or peripheral devices: 4 ... 20 mA, SDI-12 and RS-485 (SDI-12 protocol).

The radar sensor can be configured via the SDI-12 transparent mode of a datalogger or via the OTT USB/SDI-12 Adapter (accessory; SDI-12/RS-485 interface). When using the 4 ... 20 mA interface, it is possible to scale the measurement output to a smaller measuring range.

The transmission antenna has a beam width of approx. 12°. The resulting sensor beam can be seen in the depiction in Figures 2 and 3 and the table in Chapter 5.1.

The OTT RLS includes a swivel mount that allows the sensor housing to be mounted parallel (longitudinal and lateral axis) with the water surface, even when the sensor is mounted on a slanted surface. A waterproof terminal area can be found under a removable screw cover for attaching the sensor cable.

Fig. 1: Overview of radar sensor OTT RLS.



If the RS-485 interface is used, the length of cable between radar sensor and datalogger can amount up to 1000 meters · 3,300 ft. Using the SDI-12 interface, the maximum length of cable is 100 m · 330 ft.

Provided that the unit has been mounted correctly according to the operating instructions, the complete radar sensor is flood proof with IP 67 rating (diving bell principle).

Fig. 2: Application example 1:
Mounting the OTT RLS on a bridge.
The projection of the sensor beam onto the water surface is virtually round.

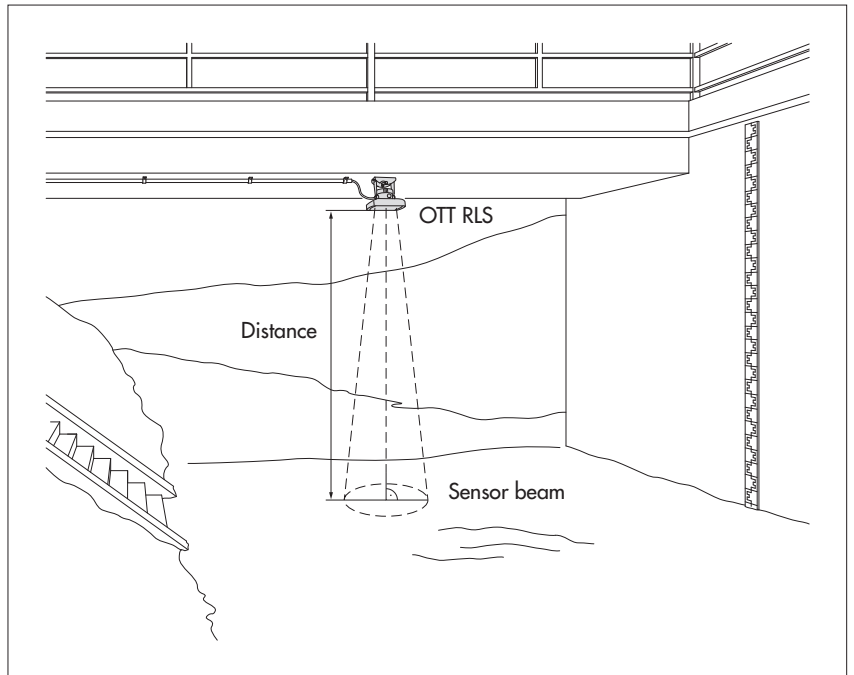
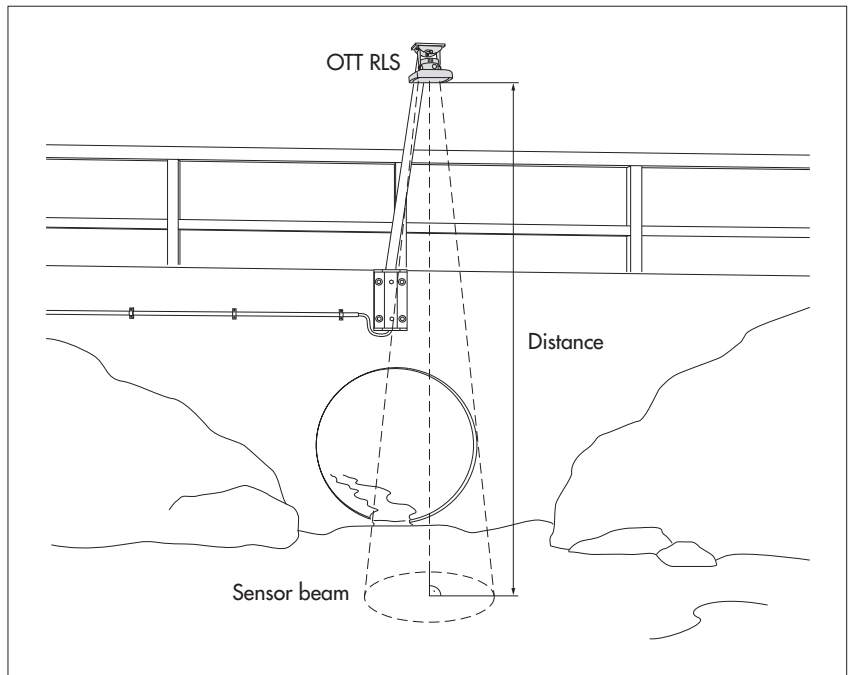


Fig. 3: Application example 2:
Mounting the OTT RLS on an
auxiliary construction, e.g. metal
stand with mounting plate.



- **Remark:** The OTT RLS described in these operating instructions (order number 63.109.001.9.2) has been developed, tested and approved based on European, Canadian and US Codes and Standards. Different device versions for different geographical locations – as available with the predecessor device – lapse without substitution.

5 Installing the OTT RLS

WARNING



Danger of explosion due to spark formation and electrostatic discharge

The use of the OTT RLS in explosive atmospheres can lead to the danger of ignition of this atmosphere. An explosion resulting from this involves the risk of very severe material and personal damage.

- ▶ **Never** operate the OTT RLS in explosive areas (e.g. in sewers). The OTT RLS is not equipped with EX-protection (EXplosion protection).



Please note:

- ▶ The electrical installation of the OTT RLS may only be undertaken by qualified persons (e.g. a specially trained electrician)!
- ▶ Never operate several radar sensors (OTT RLS, third-party products) at one measuring site at the same time! Simultaneous operation leads to inaccurate measurements or measurement errors. If necessary, synchronise the sample intervals of the radar sensors to each other (factory setting OTT RLS measuring time: approx. 20 seconds).

5.1 Criteria for selecting a suitable mounting location

- ▶ Possible mounting locations are, for example, bridges and auxiliary constructions directly above the waterway section to be measured.
- ▶ The minimum distance between lower edge of the sensor and water surface must be 0.4 m · 1.3 ft (dead area in which no useable measurement is possible).
- ▶ Select a mounting point high enough so that measurement is possible even with high water levels.
- ▶ The mounting point must be steady. Vibrations and movement of the mounting point must be avoided. Bridges are affected by movements of several centimeters as a result of load changes and temperature movements. If pillars are available, the sensor can be mounted to a stable positioned pillar with a suitable spacer.
- ▶ The water surface must be as smooth as possible in the area of the sensor beam. Avoid turbulent areas, areas where foam is created, surge areas and waterway sections where obstructions or bridge piers cause changes in the water level. The measurement result cannot be used if there is ice or snow on the water surface!
- ▶ Choose a mounting location that does not become dry at low water levels.
- ▶ Stations subject to very rapid changes in water level are not suitable. With factory setting the OTT RLS averages its measurement result over a measuring time of approx. 20 seconds. For special applications the default measuring time can be reduced (see advanced SDI-command `aoxm<value>!`; chapter 6.2).
- ▶ The area within the sensor beam (see Figures 2 and 3) must be completely free of obstructions. Table for approximating the size of the sensor beam:

Distance OTT RLS – water surface		Diameter sensor beam	
5 m	16.5 ft	1.06 m	3.5 ft
10 m	33.0 ft	2.12 m	7.0 ft
15 m	49.0 ft	3.19 m	10.5 ft
20 m	66.0 ft	4.25 m	14.0 ft
25 m	82.0 ft	5.31 m	17.5 ft
30 m	98.0 ft	6.38 m	21.0 ft
35 m	115.0 ft	7.44 m	24.5 ft

The diameters given are minimum sizes. Where possible, select an area free of obstruction that is clearly larger.

- ▶ Avoid large metal surfaces near the sensor beam (reflections from these surfaces can distort the measurement result).
- ▶ The climate specifications in the technical data must be kept to at the mounting location.
- ▶ Stilling wells are unsuitable as a mounting location.
- ▶ The OTT RLS cannot be used to measure wave height.

5.2 Notes on power supply

The OTT RLS requires a power supply of 5.4 ... 28 V direct current of type 12/24 V_{DC} (e.g. a battery or mains connection with galvanically isolated low safety voltage).

The OTT RLS is immediately ready for operation after connecting the power supply.



Please note:

- ▶ Secure the power supply cable (terminal 1 of the screw terminal strip) with a fuse (0.250 ampere, reaction time: fast)!
- ▶ When using solar panels, we recommend the use of an overvoltage protection device.

5.3 Suitable cable types when using the RS-485 interface

The maximum length of the connecting cable is 1,000 m · 3,300 ft. Recommended cable type: Twisted-pair cable; unshielded (alternatively: shielded). The wires intended for the power supply can be twisted pair, but do not have to be.

Types of OTT cable which can be used (see accessories)

- ▶ up to 500 m · 1,650 ft length of connecting cable: 2 x 2 x 0,5 mm²; approx. AWG 20 (flexible wires)
- ▶ 500 to 1000 m · 1,650 to 3,300 ft length of connecting cable: 2 x 2 x 0,75 mm²; AWG 19 (flexible wires)

5.4 Mounting the OTT RLS



Please note: Ensure no moisture enters the connection area when the screw cover is open! If the connection area gets moist there is increased danger of corrosion of the electric contacts.

Assembling the swivel mount (see also Annex C)

Mounting surface: concrete or masonry

- Make four holes (Ø 8 mm · 5/16" / 43 mm · 1.7 ft deep) using a hammer drill (use wall bracket as a template).
- Insert the four plastic plugs supplied into the holes.
- Attach the wall bracket using the four wood screws supplied.
- Insert housing bracket (without sensor) into wall bracket and lightly tighten the hex bolts A (see fig. 5).

Mounting surface: auxiliary construction, e.g. metal stand with mounting plate

- Drill four holes (Ø 7 mm · 9/32") in the mounting plate (use wall bracket as a template).
- Attach the wall bracket e.g. using four hex bolts (M6) and nuts.
- Insert housing bracket (without sensor) into wall bracket and lightly tighten the hex bolts A (see fig. 5).

Preparing the cable gland

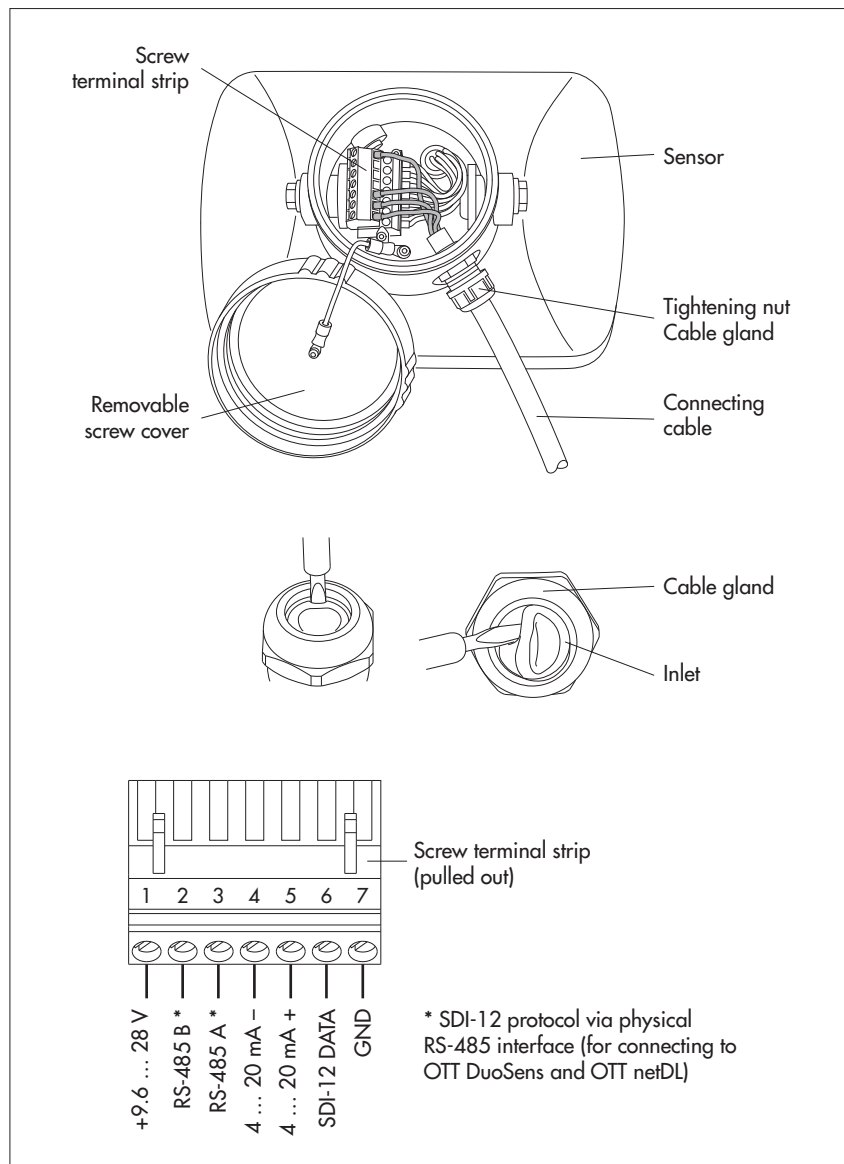
- With a cable diameter of 7.0 ... 11.0 mm, remove inlet: Insert screwdriver vertically into the seam and lever out the inlet. See Figure 4.
- Insert the connecting cable.

Mounting the radar sensor

- Remove screw cover.
- Insert connecting cable from OTT RLS to datalogger through cable gland.
- Remove insulation from connecting cable.
- With flexible wires: put end caps on the wires.
- Connect the connecting cable to the terminal block. Take note of Chapters 5.5 and 5.6 and Appendices A and B. If required, the terminal strip can be pulled out for connecting.
- Retighten connecting cable as necessary.
- Tighten the tightening nut of the cable gland (torque for tightening nut: 6 Nm).
- Screw on the screw cover and tighten firmly by hand.
- Insert sensor into housing bracket and lightly tighten the hex bolts B (see fig. 5).
- Align the housing parallel (longitudinal and lateral axis) with the water surface using a bubble level.
- Tighten the hex bolts B (housing shell) carefully (see fig. 5).
- Tighten the hex bolts A (wall/housing brackets) carefully (see fig. 5).
- Check alignment of the OTT RLS once more.

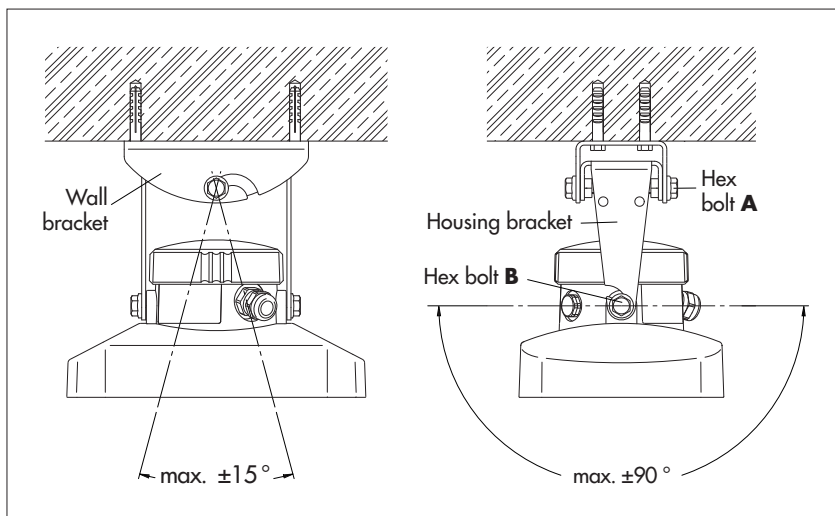
Fig. 4: OTT RLS – connection area.

Clamping range of the cable gland:
with inlet → 4.0 to 7.0 mm
without inlet → 7.0 to 11.0 mm



! **Please note:** The alignment of the sensor parallel to the water surface must be carried out as accurately as possible! Deviation from the parallel alignment leads to a linearity error!

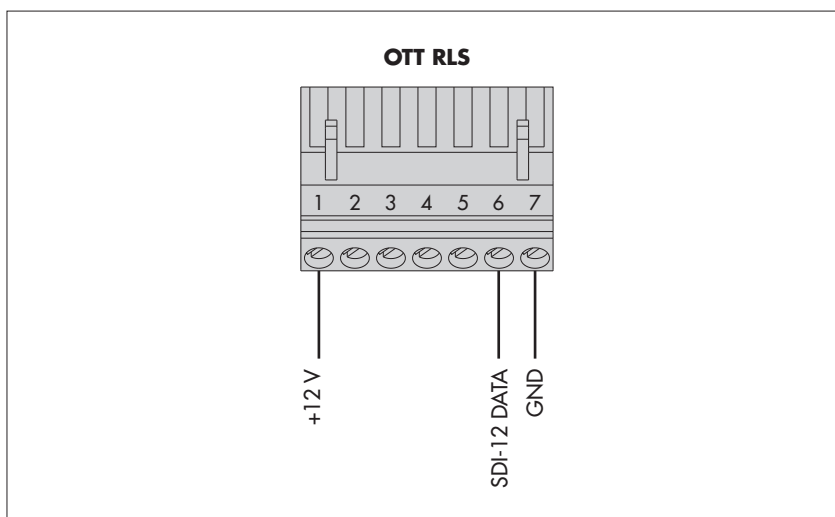
Fig. 5: OTT RLS – rotation range of swivel mount.



5.5 Connecting the OTT RLS to any datalogger using an SDI-12 interface

- Connect the OTT RLS to an SDI-12 input of the datalogger. Follow the datalogger handbook as you do this. Refer to Figure 6 for the connection assignments of the OTT RLS. The maximum length of the connecting cable is 100 m · 330 ft. Recommended wire cross-section: $0.5 \text{ mm}^2 \cdot \text{AWG } 20$. With separate voltage supply and point-to-point connection (no SDI-12 bus operation) a cable length of up to 300 m · 985 ft is possible.

Fig. 6: Connecting the OTT RLS to any datalogger using an SDI-12 interface. (Standard SDI-12 wiring via three-wire connecting cable).



You will find the SDI-12 commands for the OTT RLS in Chapter 6, *SDI-12 commands and responses*.

5.6 Connecting the OTT RLS to any datalogger using a 4 ... 20 mA interface

- Connect the OTT RLS to a 4 ... 20 mA input of the datalogger. Follow the datalogger handbook when doing this. Refer to Figure 7 for the connection assignments of the OTT RLS. The maximum connecting cable length/recommended wire cross-section: depending on the amount of voltage supply and the size of the burden (load resistor). Please note that the ohmic resistance of the connecting cable together with the eventually existing burden do not exceed the max. allowed load resistance (see Chapter 5.7)!

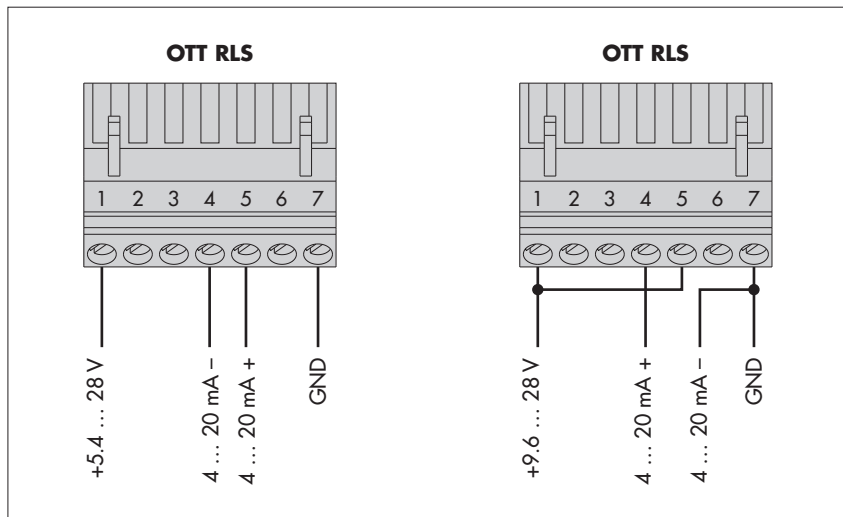
! **Please note:** The 4 ... 20 mA interface of the OTT RLS is passive. If needed the supply for the current loop must be injected by wire-linking the supply voltage. For this case the minimum supply voltage is 9.6 Volt.

• **Remark:** To connect the OTT RLS using the 4 ... 20 mA interface, a 4-wire cable is required. If the OTT RLS is also to be configurable via SDI-12 commands, → use 5-wire (cable length up to 100 m) or 6-wire cable (cable length up to 1000 m).

Fig. 7: Examples for connecting the OTT RLS to any datalogger via the 4 ... 20 mA interface.

Left: supplying the loop current from the datalogger.

Right: supplying the loop current to the OTT RLS supply voltage using wire bridges.



5.7 Determining the maximum load resistance at the 4 ... 20 mA interface

The load resistance (burden + ohmic resistance of the connection cable) connected to the OTT RLS must not exceed a specific maximum value. This value depends on the level of the supply voltage of the OTT RLS. If the load resistance is greater, the output current can no longer be evaluated. Smaller load resistances are allowed.

- Read off the maximum load resistance for your power supply from the following diagram.

Example: Power supply 18 volt → max. load resistance 450 ohm.

The OTT RLS delivers an output current corresponding to the measured value for a load resistance of up to 450 ohm.

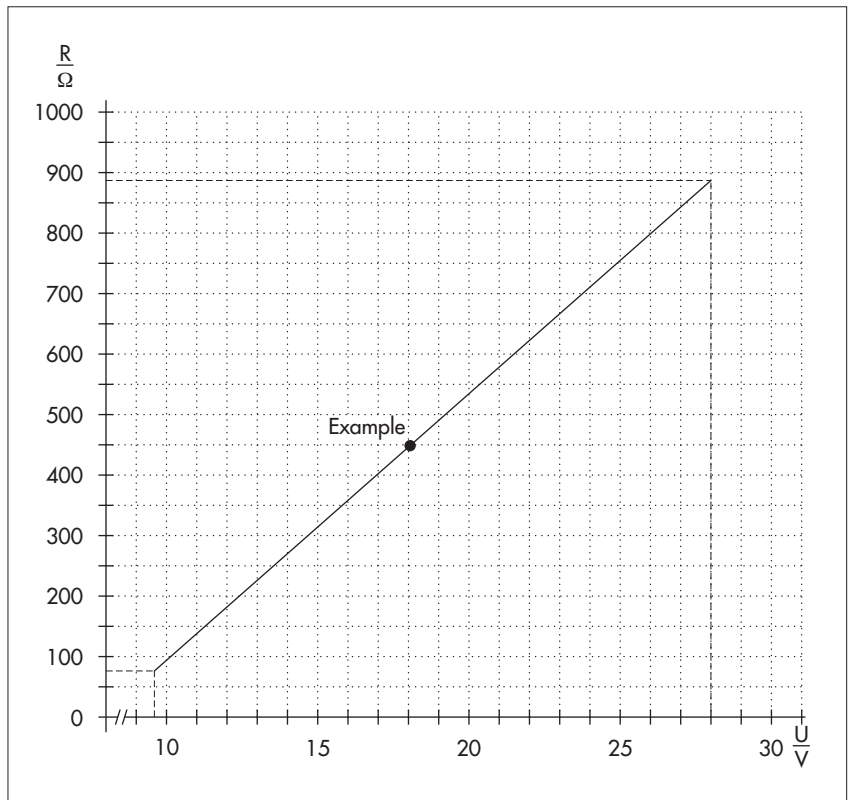
- Dimension the connected electrical circuit accordingly. Check the input resistance of the connected peripheral device for this purpose.

Figure 8: Diagram to determine the maximum load resistance as a function of the power supply.

Minimum power supply: 9.6 V

Maximum power supply: 28 V

Resistor tolerance: 0.1 %/15 ppm
(burden = load resistor).



5.8 Notes on using the 4 ... 20 mA interface

- ▶ Switching behaviour of the 4 ... 20 mA interface
After switching on the supply voltage, it takes approx. 20 seconds until the loop current takes on a value proportional to the water level. (In the first 20 seconds, the loop current is between 3 and 4 mA.) Afterwards, the radar sensor updates the loop current every 20 seconds.
- ▶ In case of failure, the loop current is also between 3 or 4 mA. For more information, please refer to Chapter 9, "Interface Status Messages/Output".



Please note: The 4 ... 20 mA interface cannot be used in parallel to the SDI-12 or RS-485 interfaces. (Exception: temporary configuration of the OTT RLS with SDI-12 commands.)

5.9 Note on using the RS-485 interface

The RS-485 interface is designed and tested to be used with the OTT dataloggers. In such a case, the transmission protocol used within the physical RS-485 interface is the SDI-12 protocol. Connecting the OTT RLS to OTT netDL using the RS-485 interface: → refer to Appendix A, option B.

OTT will not provide any performance guarantee when you use the RS-485 interface to connect the OTT RLS unit to a third-party datalogger!

6 SDI-12 commands and responses

6.1 Standard commands

All SDI-12 standard commands (SDI-12 version 1.1) are implemented in the OTT RLS: The following SDI-12 standard commands are relevant for the operation of the OTT RLS:

Command	Response	Description
a!	a<CR><LF>	Confirmation active a – sensor address; factory setting = 0
aI!	allccccccmmmmmm... ...vvvxxxxxx<CR><LF>	Send identification a – sensor address 11 – SDI-12 protocol version ccccccc – manufacturer's identification (company name) mmmmmm – sensor identification vvv – sensor version (here firmware version) xxxxxx – additional identification (here serial number) OTT RLS response = 011OTT HACH RLS200xxxxxx
aAb!	b<CR><LF>	Change sensor address a – old sensor address b – new sensor address
?!	a<CR><LF>	Query sensor address a – sensor address
aM! ¹⁾	atttn<CR><LF> and after a max. of 25 seconds a<CR><LF>	Start measurement a – sensor address ttt – time in seconds until the sensor has determined the measurement result OTT RLS response = 025 seconds n – number of measured values OTT RLS response = 2 a<CR><LF> – service request
aD0!	a<value1><value2><CR><LF>	Send data (after aM!) a – sensor address <value1> – level/distance value: pbbbb . eee [m] ²⁾ pbbbb [cm] ²⁾ pbbbb . ee [ft] ²⁾ <value2> – status of the last measurement; for details, see response to command aM! p – sign (+,-) b – digit before the decimal point; output without leading zeroes! e – digit after the decimal point; output in the case of invalid measurement value: +9999999 (can be changed with advanced command aOSI!)
aMC! ¹⁾	atttn<CR><LF> and after a max. of 25 seconds a<CR><LF>	Start measurement and request CRC (Cyclic Redundancy Check). For details, see command aM! . The response to the following aD0! command is extended by a CRC value: a<value1><value2><CRC><CR><LF>
aM1! ¹⁾	atttn<CR><LF> and immediately afterwards a<CR><LF>	Query status of the last measurement a – sensor address ttt – time in seconds until the sensor makes the status available; OTT RLS response = 000 n – number of measured values OTT RLS response = 2 a<CR><LF> – service request

¹⁾ do not use this command if OTT RLS is connected to a datalogger via the 4 ... 20 mA interface! OTT RLS would consequently interrupt the continuous measuring operation which is needed for the 4 ... 20 mA interface.

²⁾ dependent on the units set (advanced command **aOSU<value>!**)

Command	Response	Description
aD0!	a<value1><value2><CR><LF>	Send data (after aM1!) a – sensor address <value1> – status of the last measurement +0 = measured value O.K. +2 = no target recognised +4 = internal error → device fault. See Chapter 8, <i>Repair</i> +8 = variance of individual measurements too large +16 = SDI-12 interface interruption (breach of the SDI-12 interface protocol, e.g. communication with the SDI-12 interface between commands aM! and aD0!) +32 = internal error (temperature calibration values missing) → device fault. See Chapter 8, <i>Repair</i> <value2> – signal-to-noise ratio in dB. Value ≥ 15 dB = good signal quality (well-chosen mounting location and parallel alignment)
aMC1!	atttn<CR><LF> and immediately afterwards a<CR><LF>	Query the status of the last measurement and request CRC (Cyclic Redundancy Check). For details, see command aM!. The response to the following aD0! command is extended by a CRC value: a<value1><value2><CRC><CR><LF>

More information on the SDI-12 standard commands can be found in the document *SDI-12; A Serial-Digital Interface Standard for Microprocessor-Based Sensors; Version 1.4* (see Internet page www.sdi-12.org).

6.2 Advanced SDI-12 commands

All advanced SDI-12 commands begin with an "O" for OTT. With these commands, it is possible to configure the OTT RLS using the transparent mode of a datalogger or with the OTT USB/SDI-12 Adapter (accessory).

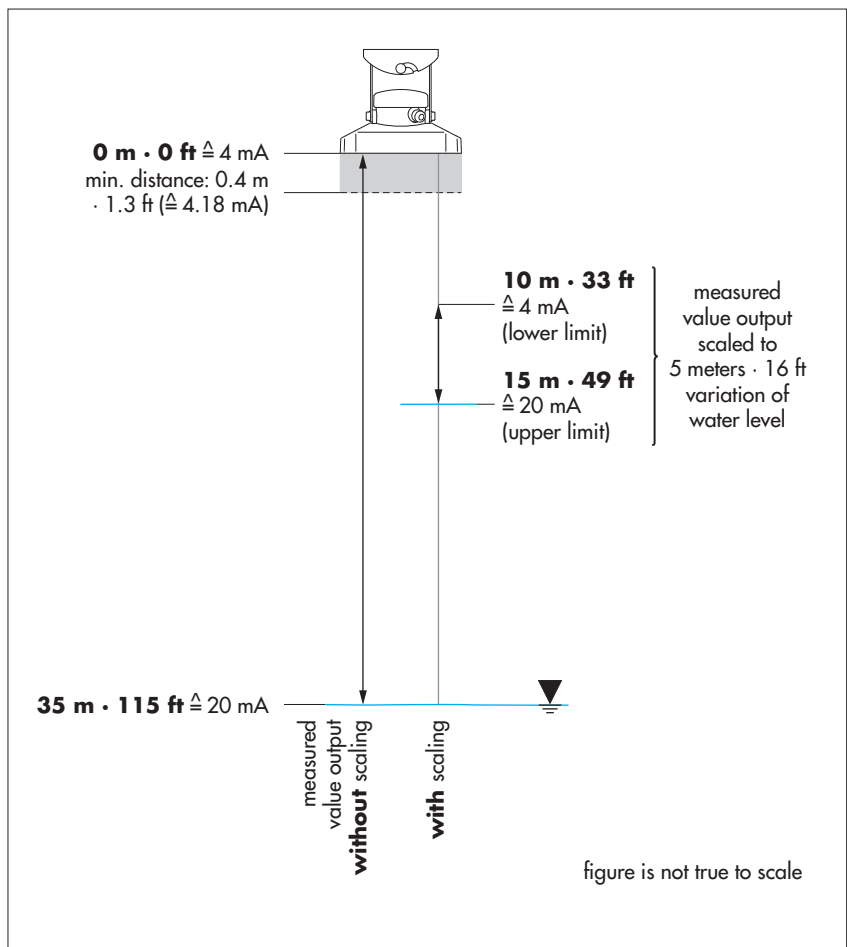
Command	Response	Description
▶ Query firmware version		
aOOV!	accccccc<CR><LF>	Query the firmware version of the OTT RLS. a – sensor address accccccc – firmware version. Example: V2.00.0
▶ 4 ... 20 mA interface – set/read units for measurements		
aOPF<value>!	a<value><CR><LF>	Set units for commands aOPA<value>! and aOPB<value>!. Read unit for commands aOPA<value>! and aOPB<value>!. a – sensor address <value> – +0 = m +1 = cm +2 = ft
aOPF	a<value><CR><LF>	
▶ SDI-12-/RS-485 interface – set/read units for measurements		
aOSU<value>!	a<value><CR><LF>	Set units for commands aM!; aMC!; aOAB<value>! and aOAC<value>!. Read unit for commands aM!; aMC!; aOAB<value>! and aOAC<value>!. a – sensor address <value> – +0 = m +1 = cm +2 = ft
aOSU!	a<value><CR><LF>	
! Please note: Changing the unit deletes any set • reference or offset value!		

Command	Response	Description
▶ Set/read measurement mode level or distance measurement		
aOAA<value>!	a<value><CR><LF>	Set measuring mode
aOAA!	a<value><CR><LF>	Read out measuring mode
		a – sensor address
		<value>– +0 = measuring mode <i>Level measurement</i> activated (water level related to a level zero)
		+1 = measuring mode <i>Distance measurement</i> activated (distance of OTT RLS ↔ water surface)
		Factory setting = +1
		! Please note: If entries have been made before
		• changing the measuring mode for the parameters aOAB<value>!, aOAC<value>!, aOPA<value>! or aOPB<value>!, these must be input again! There is no automatic conversion of the parameters entered.
▶ Set/read 4 ... 20 mA interface – operating status (activated/deactivated)		
aOPC<value>	a<value><CR><LF>	Set operating status
aOPC!	a<value><CR><LF>	Read operating status
		a – sensor address
		<value>– +0 = interface deactivated
		+1 = interface activated
		Factory setting = +1
		Use: the command aOPC+1! is helpful, if e.g. an aM! command unintended has interrupted the continuous operation which is needed for the 4 ... 20 mA interface.
▶ 4 ... 20 mA interface – setting/reading the lower limit		
aOPA<value>!	a<value><CR><LF>	Set lower limit
aOPA!	a<value><CR><LF>	Read lower limit
		a – sensor address
		<value>– pbbbb.eee [m]*
		– pbbbb [cm]*
		– pbbbb.ee [ft]*
		p – sign (+,-)
		b – digit before the decimal point
		e – digit after the decimal point
		Input/output without leading zeroes!
		Value range: -9999.999 ... +9999.999*
		Factory setting = +0.000
		* dependent on the units set (aOPF<value>!)
		! Remark: If the units are subsequently changed (aOPF<value>!), the OTT RLS resets the set limit to the factory setting.

Command	Response	Description
▶ 4 ... 20 mA interface – setting/reading the upper limit		
aOPB<value>!	a<value><CR><LF>	Set upper limit
aOPB!	a<value><CR><LF>	Read upper limit
		a – sensor address
		<value> – pbbbb.eee [m] *
		– pbbbb [cm] *
		– pbbbb.ee [ft] *
		p – sign (+,-)
		b – digit before the decimal point
		e – digit after the decimal point
		Input/output without leading zeroes!
		Value range: -9999.999 ... +9999.999 *
		Factory setting = +0.000
		* dependent on the units set (aOPF<value>!)
		<ul style="list-style-type: none"> Remark: If the units are subsequently changed (aOPF<value>!), the OTT RLS resets the set limit to the factory setting.

With the commands *setting/reading the lower/upper limit* you can scale the available measuring range of an OTT RLS to a smaller range. Where you do not require the whole measuring range, this has the advantage that a higher resolution for the 4 ... 20 mA interface can be achieved. Example: 16 mA measurement span stands for 5 m · 16 ft of water level change available (e.g. lower limit = +10,000 m · +33,00 ft; upper limit = +15,000 m · +49.00 ft; see Fig. 9).

Fig. 9: Scale the measured value output of the 4 ... 20 mA interface down to a smaller range.



Command	Response	Description
▶ SDI-12-/RS-485 interface – set/read offset for level/distance measurement		
aOAB<value>!	a0251<CR><LF> and after a max. of 25 seconds	Set offset value
aOAB!	a<CR><LF> a<value><CR><LF>	Read offset value
		<p>a – sensor address</p> <p><value> – pbbbb.eee [m] * – pbbbb [cm] * – pbbbb.ee [ft] *</p> <p>p – sign (+,-)</p> <p>b – digit before the decimal point</p> <p>e – digit after the decimal point</p> <p>a<CR><LF> – service request</p> <p>Input/output without leading zeroes!</p> <p>Value range: -9999.999 ... +9999.999 *</p> <p>Factory setting = +0.000</p> <p>* dependent on the units set (aOPF<value>!)</p> <p>With this command, you can add a linear offset (positive/negative) to a level/distance measurement. After setting the offset value, the OTT RLS automatically starts a measurement. After receiving the service request, check the measured value with command aDO!. If input is unsuccessful, the radar sensor replies with a new service request.</p> <p>! Please note: This command overwrites any set reference value.</p> <p>Example</p> <p>Measurement = +10.040 m Offset = -0.200 m Output = +9.840 m</p> <p>! Remark: If the units are subsequently changed (aOSU<value>!), the OTT RLS resets the set offset value to the factory setting.</p>
▶ SDI-12-/RS-485 interface – set/read reference value for the offset for level/distance measurement		
aOAC<value>!	a0251<CR><LF> and after a max. of 25 seconds	Set reference value
aOAC!	a<CR><LF> a<value><CR><LF>	Read reference value
		<p>a – sensor address</p> <p><value> – pbbbb.eee [m] * – pbbbb [cm] * – pbbbb.ee [ft] *</p> <p>p – sign (+,-)</p> <p>b – digit before the decimal point</p> <p>e – digit after the decimal point</p> <p>a<CR><LF> – service request</p> <p>Input/output without leading zeroes!</p> <p>Value range: -9999.999 ... +9999.999 *</p> <p>Factory setting = +0.000</p> <p>* dependent on the units set (aOPF<value>!)</p> <p>With this command, you can establish a reference to a level zero, for example, by entering a reference value for level/distance measurement. After setting the reference value, the OTT RLS automatically starts a measurement.</p>

Command **Response**

Description

After receiving the service request, check the measured value with command **aD0!**. After an unsuccessful entry, the radar sensor replies with a new service request.

! **Please note:** This command overwrites any set offset value.

Example

Measurement = +2.100 m
Reference value = +1.500 m
Output = +1.500 m
(offset calculated by the OTT RLS and applied to all other measured values = +0.600 m)

• **Remark:** If the units are subsequently changed (**aOSU<value>!**), the OTT RLS resets the set reference value to the factory setting.

► Set/read error indicator

aOSI<value>! **a<value><CR><LF>**
aOSI! **a<value><CR><LF>**

Set error indicator
Read error indicator
a - sensor address
<value> - error indicator that the OTT RLS outputs an invalid measurement
 - **pbbbbbbb** or **pbbbb.eee** [m] *
 - **pbbbbbbb** [cm] *
 - **pbbbbbbb** or **pbbbbb.ee** [ft] *
p - sign (+,-)
b - digit before the decimal point
e - digit after the decimal point
Value range: - 9999999 ... +9999999 [m] [cm] [ft] or
 - 9999.999 ... +9999.999 [m] [ft]
Factory setting = +9999999
* dependent on the units set (**aOSU<value>!**)

► Set/read measuring time

aOXM<value>! **aOXM<value>!**
aOXM! **aOXM!**

Set measuring time
Read measuring time
a - sensor address
<value> - **bb**
b - digit
In-/Output without leading zeros!
Value range: 2 ... 20 [s]
Factory setting = 20

In one second the OTT RLS makes approx. 16 single measurements of waterlevel. Depending on roughness of the water surface, wind influence, precipitation, turbulences and other factors, these single measurement values are subject to some variance. Occasionally, it might not be possible to obtain measured values due to insufficient reflexion. Averaging single values over a longer time (measuring time) will though provide measured values within the specified accuracy.

For special applications it is possible to reduce the measuring time according to your individual needs. Please take into account that this could impair the measuring accuracy!

7 Carrying out maintenance work

The OTT RLS radar sensor is almost maintenance free. No setting or calibration work is necessary. There are likewise no parts that need replacing regularly.

Carry out the following maintenance work at regular frequencies based on the local circumstances:

- Check the OTT RLS for dirt (e.g. thick, dewy spider's webs or insect nests can lead to impairment of the measured results). In this case, carefully clean the sensor (if necessary use commercial, gentle and non-erasing cleaners and a soft sponge). At the same time, ensure that the setting of the swivel mount does not change.
- Check for obstructions in the measurement beam (for example, for flotsam or branches of trees and bushes growing into this area). In this case, remove all obstructions.
- Check the plausibility of the measured values by comparing with a second sensor or with a staff gauge.

! **Please note:** Never open the housing of the OTT RLS (exception: connection area)! There are no adjustment or operating elements inside the housing.

8 Repair

- With a device defect, use Chapter 9, *Troubleshooting* to see if you can resolve the problem yourself.
- In case of device defects, please contact the repair center of OTT:

OTT HydroMet GmbH
Repaircenter
Ludwigstrasse 16
87437 Kempten · Germany
Telephone +49 831 5617-433
Fax +49 831 5617-439
repair@ott.com

! **Please note:** Only have a defective OTT RLS checked and repaired by the OTT HydroMet repair center. Never make any repairs yourself under any circumstances. Any repairs or attempted repairs carried out by the customer will result in the loss of any guarantee rights.

9 Troubleshooting

Sensor does not respond to the SDI-12 interface

- ▶ Fuse in the power supply input side defective?
→ Replace fuse.
- ▶ Sensor correctly connected to a datalogger with SDI-12 input?
→ Correct connection assignment.
- ▶ Polarity of the power supply reversed?
→ Correct connection assignment.
- ▶ Power supply $< 5.4 V_{DC}$ or $> 28 V_{DC}$?
→ Correct level of voltage supplied (check the length and cross-section of the connection cable).
- ▶ Is the power supply direct current?
→ Only operate sensor with direct current.

4 ... 20 mA signal not present

- ▶ Sensor correctly connected to a datalogger or peripheral device to 4 ... 20 mA input (check polarity)?
→ Correct connection assignment.
- ▶ 4 ... 20 mA current loop correctly supplied through datalogger or OTT RLS (internal/external supply)?
→ Correct connection assignment.
- ▶ Power supply $< 9.6 V_{DC}$ or $> 28 V_{DC}$?

Measured value varies or is not present

- ▶ Sensor (front plate) dirty?
→ Carefully clean the sensor; see Chapter 7, *Carrying out maintenance work*
- ▶ Obstruction in the measurement beam?
→ Remove obstructions.
- ▶ Sensor aligned at right angles to the water surface?
→ Correct sensor alignment.
- ▶ Mounting location of the sensor steady (e.g. bridge movement)?
→ Optimize mounting location.
- ▶ Large metal surfaces near the sensor beam (e.g. piling)?
→ Optimize mounting location.

Status messages/output of interfaces

SDI-12 ¹⁾	4 ... 20 mA	Status message/output
+0	measured value	measured value OK
+2	3.0 mA	no target recognized
+4	3.1 mA	internal error → device defect; see Chapter 8, <i>Repair</i>
+8	3.2 mA	variance of individual measurements too large
+16	3.3 mA	SDI-12 interface break (infringement of SDI-12 interface protocol, e.g. communication via SDI-12 interface between the commands aM! and aD0!)
-	3.4 mA	value below or above measuring range
+32	3.5 mA	internal error → device defect; see Chapter 8, <i>Repair</i>

¹⁾ response to commands **aM!**, **aM1!** and **aD0!**

10 Note about the disposal of old units



Within the member countries of the European Union

In accordance with the European Union guideline 2012/19/EC, OTT takes back old devices within the member countries of the European Union and disposes of them in an appropriate way. The devices concerned by this are marked with the symbol shown aside.

- For further information on the return procedure, please contact your local sales contact. You will find the addresses of all sales partners in the internet on www.ott.com. Please take into consideration also the national implementation of the EU guideline 2012/19/EC of your country.

For all other countries

- Dispose of the OTT RLS properly after taking out of service.
- Observe the regulations valid in your country for the disposal of electronic devices.
- Never put the OTT RLS into the normal household waste.

Used materials

see Chapter 11, *Technical Data*

11 Technical Data

Measuring range	0.4 ... 35 m	40 ... 3500 cm	1.3 ... 115 ft
Resolution SDI-12 interface	0.001 m	1 cm	0.01 ft
Accuracy (SDI-12) ¹⁾			
0.4 ... 2 m · 1.3 ... 6.6 ft	±10 mm · ±0.03 ft		
2 ... 30 m · 6.6 ... 98.5 ft	±3 mm · ±0.01 ft		
30 ... 35 m · 98.5 ... 115 ft	±10 mm · ±0.03 ft		
Average temperature coefficient (range: -20 ... +60 °C · -4 ... +140 °F)	0.01 % of full scale/10 K		
Accuracy (4 ... 20 mA) ¹⁾	±0.1% of full scale		
Average temperature coefficient (at +20 °C · +68 °F)	10 ppm of full scale/K		
Possible deviation at the 4 ... 20 mA output due to strong, high-frequency electromagnetic fields relating to the Standard "CENELEC EN 61000-6-2"	< ±180 µA		
Measuring time	2...20 seconds; factory setting: 20 seconds		
Power supply	5.4 ... 28 V _{DC} , typ. 12/24 V _{DC}		
Power consumption ²⁾			
Measurement operation	< 290 mW (< 24 mA at 12 V)		
Rest mode	< 0.6 mW (< 0.05 mA at 12 V)		
Interfaces	4 ... 20 mA (measurement update every 20 seconds); SDI-12; RS-485, two-wire (SDI-12 protocol)		
Beam angle of antenna	12 ° (±6 °)		
Transmission frequency	25.3 GHz		
Transmission power	< 5 mW		
Materials			
Housing	ASA (UV-stabilized ABS)		
Radom (front plate)	TFM PTFE		
Mounting	1.4301 (V2A)		
Weight (including mounting)	approx. 2.1 kg · 4.63 lb		
Cable gland sealing range			
with inlet (min. Ø ... max. Ø)	4.0 ... 7.0 mm · 0.16 ... 0.28"		
without inlet (min. Ø ... max. Ø)	7.0 ... 11.0 mm · 0.28 ... 0.43"		
Connection capacity of screw terminal strip			
Solid conductor	0.25 ... 2.5 mm ² · AWG 24 to 12		
Wire with end cap and plastic collar	0.25 ... 1.5 mm ² · AWG 24 to 16		
Terminal assignment screw terminal strip			
Terminal 1	power supply		
Terminal 2	RS-485 B		
Terminal 3	RS-485 A		
Terminal 4	4 ... 20 mA -		
Terminal 5	4 ... 20 mA +		
Terminal 6	SDI-12 DATA		
Terminal 7	GND		
Rotation range of swivel mount			
Lateral axis	±90 °		
Longitudinal axis	±15 °		
Type of protection at horizontal installation	IP 67 (submersion depth max. 1 m · 3.3 ft; Submersion duration max. 48 h)		
Dimensions L x W x H	222 mm x 152 mm x 190 mm · 8.74" x 5.98" x 7.48"		

¹⁾ at +20 °C · +68 °F ambient temperature; 1013 mbar · 29.9 inHg air pressure; 45 % to 65 % relative humidity; ideal reflector; without interfering reflector in the sensor beam; measuring time: 20 seconds

²⁾ power consumption of OTT RLS with SDI-12, RS-485 or externally supplied 4 ... 20 mA interface

³⁾ condensation on the front plate of the antenna (Radom) can disturb measuring accuracy

Temperature range	
Operation	-40 ... +60 °C · -40 ... +140 °F
Storage	-40 ... +85 °C · -40 ... +185 °F
Relative humidity	0 ... 100 % ³⁾
Performance classification in accordance with DIN EN ISO 4373	
Measurement reliability	Performance class 1
Temperature range	Temperature class 1
Relative humidity	Class 1
Product certifications	
CE (EU)	This device complies with the essential requirement of RED 2014/53/EU.
FCC (US) ¹⁾	FCC 47 CFR Part 15; This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device. FCC ID: OA6RLS253
IC (CA) ¹⁾	Canadian Radio Interference-Causing Equipment Regulation. This device complies with the Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device. IC: 7253A-RLS253

¹⁾ see also Chapter 3.4

Annex A – Connecting the OTT RLS via SDI-12 or RS-485 interface to OTT netDL

There are two ways to connect the OTT RLS:

- ▶ Method A: using the SDI-12 interface
(protocol and physical interface: SDI-12).
- ▶ Method B: using the RS-485 interface
(SDI-12 protocol via physical RS-485 interface).

Recommendation: method B (longer range, more resistant to faults)

Method A: Connecting the OTT RLS via the SDI-12 interface (protocol and physical interface: SDI-12). The maximum length of the connecting cable is 100 m · 330 ft. Recommended wire cross-section: 0.5 mm² · AWG 20:

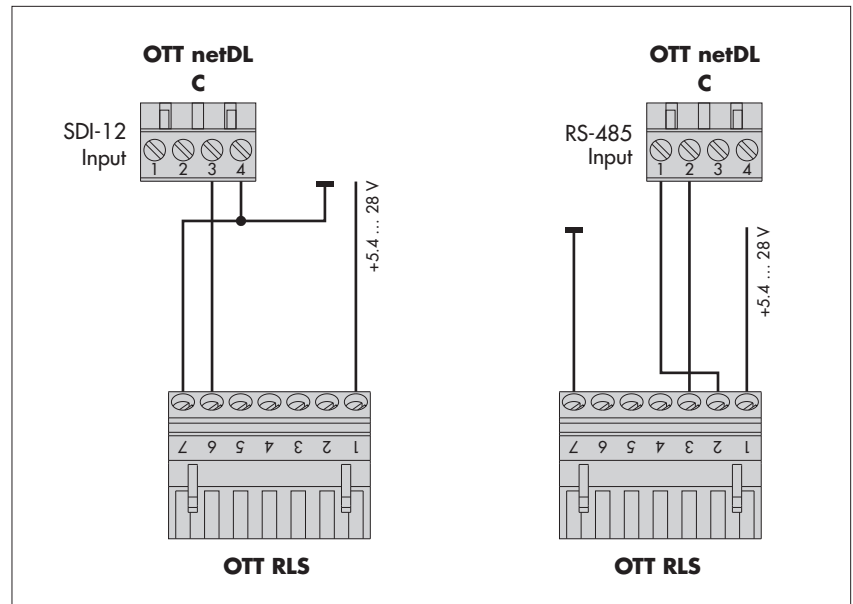
- Connect the OTT RLS to the IP Datalogger OTT netDL as shown in Figure 10 (left). Take note of the operating instructions for the OTT netDL.

Method B: Connect OTT RLS using the physical RS-485 interface (SDI-12 protocol via physical RS-485 interface). Refer to Chapter 5.3 for the maximum connecting cable length and the recommended wire cross-section:

- Connect the OTT RLS to the IP Datalogger OTT netDL as shown in Figure 10 (right). Take note of the operating instructions for the OTT netDL.

Fig. 10: Connecting the OTT RLS to OTT netDL using an SDI-12 or RS-485 interface.

The letters above the screw terminal strip identify the possible connections on the OTT netDL.



Configuring the OTT netDL for the OTT RLS with SDI-12 interface

- Create an OTT netDL channel with *SDI-12 Recorder* or *OTT SDI RS485* function block (*serial sensors* tab).
- Apply the following settings:

Fig. 11: Adjusting the operating parameters of the OTT netDL *SDI-12 Recorder* function block. The function block *OTT SDI RS485* is set in the same way.

SDI-12 Recorder		Measurement mode	M!
Terminal block	C 3-4	<input type="checkbox"/> Concurrent Mode	
Sensor address	0	<input type="checkbox"/> Instantaneous value (Sensor)	
Value no.	1	Virtual Terminal ID	V02
	+	Value no.	2

- ▶ Terminal block
 - OTT netDL *OTT SDI RS485*: C 1-2 (default)
 - OTT netDL *SDI-12 Recorder*: C 3-4 (default)
 Terminal block (screw terminal strip) of the OTT netDL to which the OTT RLS unit is connected.
- ▶ Sensor address

SDI-12 bus address. Each address may only be allocated once to an SDI-12 bus feed! (Checking/setting: see operating instructions OTT netDL, Chapter *SDI-12 transparent mode*; alternatively with OTT USB/SDI-12 Adapter). Factory setting of the OTT RLS: 0
- ▶ Value no.

Identifies which value from the OTT RLS is recorded in this channel.

 - In *M!* *Measurement Mode*: Level/Distance value = 1, Status of the last measurement = 2
 - In *M1!* *Measurement Mode*: Status of the last measurement = 1, Signal/noise ratio = 2
- ▶ Measurement mode
 - *M!* for Level/Distance value and Status of last measurement or
 - *M1!* for Advanced status of the last measurement
- ▶ Concurrent Mode

The OTT RLS unit does not support Concurrent Mode!
- ▶ Instantaneous value

: Upon an instantaneous value request (via LCD display and jog shuttle), the OTT netDL unit sends a command to the OTT RLS unit to start a current measurement. Until this measurement is complete, the LCD display refers to the last measured value (or the instantaneous value last displayed, whichever is the most recent one). On the display, this is identified by an "s" to the right of the channel number (sensor number). After completing the measurement, the new measured value appears without additional identification.

: Shows the last measured value of the sensor (measured value of the last sample interval) for an instantaneous value request. On the display, this is identified by an "s" to the right of the channel number (sensor number), (also refer to the OTT netDL IP Datalogger Operating Instructions, Chapter 9.1). For an OTT RLS unit (extended measuring time), the setting is useful for a short sample interval.
- ▶ Value no./ Virtual terminal ID

Allocation of the additional OTT RLS measured values – those not recorded on this channel – to virtual terminals.
- In the relevant *Channel* function blocks, adjust the required units and number of digits after the decimal place (m: 3; cm: 0; ft: 2; status information: 0).

• **Remarks:**

- ▶ To record the measurements and status information of an OTT RLS, two channels in the OTT netDL are thus necessary. The first channel contains the function block *SDI-12 Recorder* or *OTT SDI RS485* as the input signal. The second channel contains a function block *Virtual Sensor (V02)* as the input signal. If the recording of status information is not required, no entry is necessary in the *Value no./Virtual terminal ID* field.
- ▶ The measuring mode *M1!* supplies extended status information. If required, this can also be recorded in an additional channel with function block *SDI-12 Recorder/OTT SDI RS485*.
- ▶ You will find further information on the used SDI-12 commands and responses in Chapter 6, *SDI-12 commands and responses*.

! **Please note:** The OTT RLS makes the measurement results available a maximum of 25 seconds after the SDI-12 command **am!**!

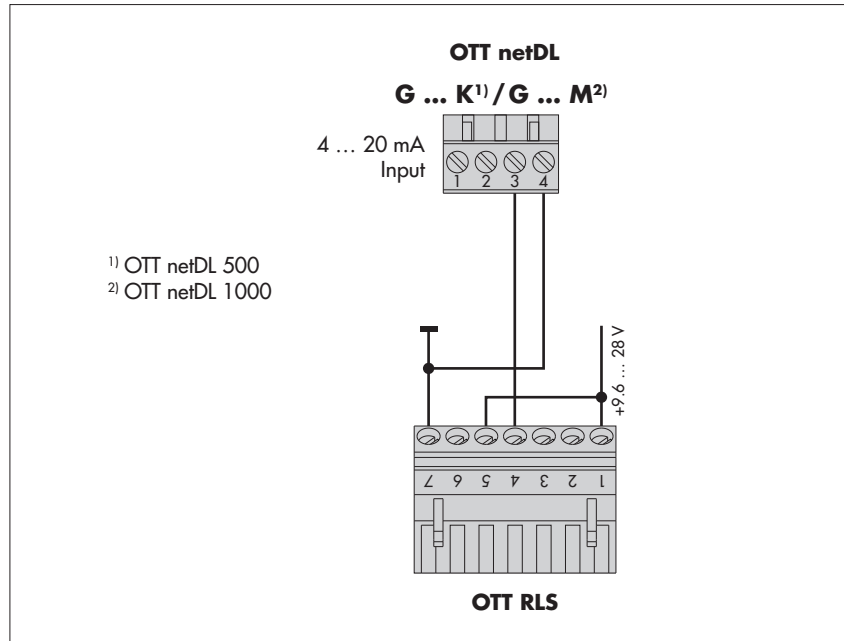
Annex B – Connecting the OTT RLS via 4 ... 20 mA interface to OTT netDL

- Connect the OTT RLS to the OTT netDL IP Datalogger as shown in Figure 12. Take note of the operating instructions for the OTT netDL. Maximum connecting cable length/recommended wire cross-section: depending on the amount of voltage supply. Please note that the ohmic resistance of the connecting cable does not exceed the max. allowed load resistance (see Chapter 5.7)!

Fig. 12: Connecting the OTT RLS to OTT netDL using a 4 ... 20 mA interface

The OTT netDL unit requires the optional Analog Input Card.

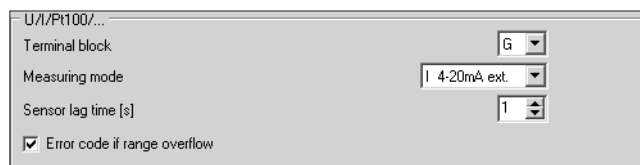
The letters above the screw terminal strip identify the possible connections on the OTT netDL.



Configuring the OTT netDL for OTT RLS with 4 ... 20 mA interface

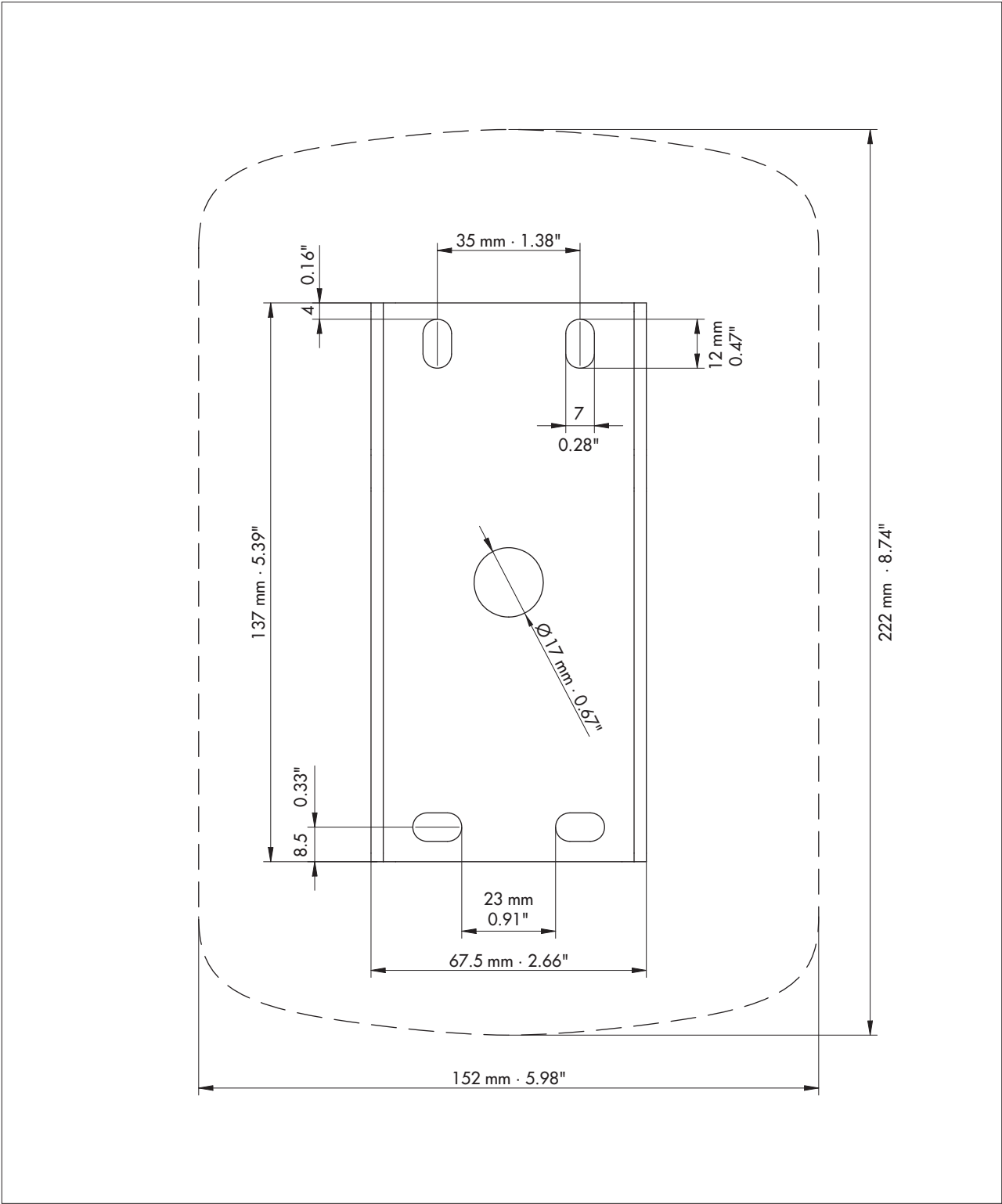
- Create an OTT netDL channel including a $U/I/Pt100/...$ functional block (*Analog sensors tab*).
- Apply the following settings:

Fig. 13: Setting operating parameters of the OTT netDL function block I 4-20 mA.



- ▶ Terminal block
OTT netDL 500: G ... K
OTT netDL 1000: G ... M
terminal block used (screw terminal strip) of the OTT netDL.
- ▶ Measuring mode
Set to I 4-20 mA ext.
- ▶ Sensor lag time (s)
switches on the OTT netDL input 1 second before the actual measurement process
- ▶ Error code if range overflow
if required: record error codes on range overflow
- Insert a *2-point scaling* function block into this channel and adjust the relating distance values for the outputted current values (e. g. Point 1: 4 0; Point 2: 20 35 m · 115 ft). This function also enables the referencing to a level zero.
- In the *Channel* function block, set the unit and number of digits after the decimal place (m: 3; cm: 0; ft: 2).

Annex C - Dimensions of wall bracket/position of fixing bores



Annex D – Radio Approval USA: Grant of Equipment Authorization

If necessary, you can download the current version of the "Radio Approval USA: Grant of Equipment Authorization" of the OTT RLS from our website as PDF file: "www.ott.com/resources"!

Annex E – Note on the Declaration of Conformity

If necessary, you can download the current version of the "Declaration of Conformity" of the OTT RLS from our website as PDF file: "www.ott.com/resources"!

Annex F – Declaration concerning to the health of the user

If necessary, you can download the current version of the "Declaration concerning to the health of the user" of the OTT RLS from our website as PDF file: "www.ott.com/resources"!

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OTT HydroMet GmbH
Ludwigstrasse 16
87437 Kempten · Germany
Phone +49 831 5617-0
Fax +49 831 5617-209
euinfo@otthydromet.com
www.otthydromet.com