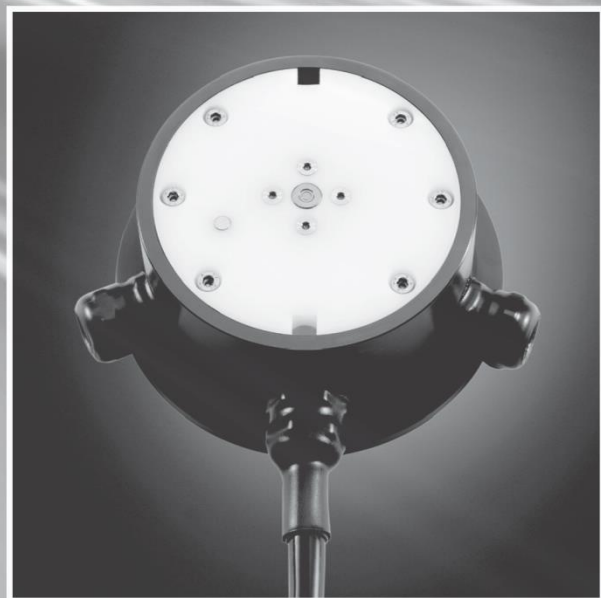


USER Manual ARS31Pro-UMB / ARS31-UMB

Active Road Sensor

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Version history:

| Version | Date | Edited by | Comments |
|---------|------------|-----------|---|
| 1 | 21.08.2012 | LA/BR/FS | First version |
| 2 | 17.09.2012 | LA/BR/FS | Technical data modified, adjustment to current public standards |
| 3 | 10.04.2013 | FS | Supplements to the cable length and to the installation |
| 4 | 18.04.2013 | FS | Extension cable table was added |
| 5 | 12.03.2014 | LA/BR/RR | Modification of Certificate of Conformity, clarification of the technical data (freezing temperature) |
| 6 | 04.06.2014 | LA/BR | Supplements to the cable length and power supply, integration of ARS31-UMB |
| 7 | 10.07.2015 | LA/BR | Calculation of saline concentration according to CEN/TC 15518-4, figures and channels updated |
| 8 | 14.03.2016 | LA | Technical data modified |
| 9 | 16.03.2017 | LA/BR | Technical data modified, chapter 7.3 updated |

1 Please read before commissioning

Before using the equipment, please read the operating manual carefully and follow the instructions in every detail.

This operating manual covers ARS31Pro-UMB/ARS31-UMB device version 9 and above and firmware 10.3 and above.

1.1 Symbols used



Important indication concerning possible hazards to the user



Important indication for the correct functioning of the equipment



1.2 Safety instructions

- Installation and commissioning must only be carried out by suitably qualified specialist personnel.
- Never take measurements on or touch live electrical parts.
- Pay attention to the technical data and storage and operating conditions.

1.3 Designated use

- The equipment must only be operated within the range of the specified technical data.
- The equipment must only be used under the conditions and for the purposes for which it was designed.
- The safety and operation of the equipment can no longer be guaranteed if it is modified or adapted.
- Do not continue to use equipment that is obviously defective.

1.4 Guarantee

The guarantee period is 12 months from the date of delivery. The guarantee is forfeited if the designated use is violated.



1.5 Incorrect use

If the equipment is installed incorrectly

- It may not function
- It may be permanently damaged



If the equipment is not connected correctly

- It may not function
- It may be permanently damaged
- There may be a possibility of an electrical shock

1.6 Nomenclature

Tg: Freezing temperature that the sensor identified

Tu: Road surface temperature, ambient temperature

Toi: Threat of icing

2 Order Numbers

| | |
|--|------------------|
| ARS31Pro-UMB .. 50 m cable length..... | 8810.U051 |
| ARS31-UMB 50 m cable length..... | 8610.U050 |

2.1 Accessories

| | |
|-----------------------------------|-----------|
| Power supply unit 24V/100VA | 8160.UISO |
| ISOCON-UMB | 8160.UISO |
| Surge protection | 8379.USP |
| DACON8-UMB | 8160.UDAC |

2.2 Additional Documents and Software

You can download the following documents and software via the Internet at www.lufft.de:

- Operating Manual This document
- UMB Config Tool Windows® software for testing, firmware upd
configuration of UMB devices
- UMB Protocol Communication protocol for UMB devices
- Firmware The current equipment firmware

3 Differences between ARS31Pro-UMB/ARS31-UMB

ARS31Pro-UMB compared with ARS31-UMB possesses the following features:

- Measurement of threat of icing by means of a direct measurement or freezing temperature.
- Exact measurement of road surface temperature with an external temperature sensor.



Figure 1: ARS31Pro-UMB with an external temperature sensor

4 Device description

Active Road Sensor ARS31Pro-UMB/ARS31-UMB serves to determine the freezing temperature of a liquid on the road surface. It can be used to measure the following data:

- Salt concentration (NaCl, CaCl and MgCl)
- Product concentration (potassium acetate, potassium)
- Freezing temperature (independent of mixture)

The sensor excels further due to the following features:

- Compact design and easy installation
- Low maintenance
- Parts can be replaced without uninstalling the device
- Data transfer via RS485
- Internal electrical isolation of power supply
- ESD protection on all interfaces
- Inverse-polarity protection

4.1 Method of operation ARS31Pro-UMB/ARS31-UMB

ARS31Pro-UMB/ARS31-UMB determines the freezing temperature of a liquid on the road surface by means of active cooling and heating. The Sensor allows precise determination of the freezing temperature in the absence of accurate knowledge of the type or mixture of salt.

The sensor operates in a temperature range described in the chapter 9.3 Operating conditions.

The freezing temperature is calculated for road surface temperatures of less than 5°C (adjustable between 2°C and 10°C). The lowest possible freezing temperature that can be calculated is about 20°C below the current road surface temperature, for details see chapter 9.1.1 Freezing temperature.

The sampling rate for freezing point measurement in the sensor is configurable and may be set to 20, 30 or 60 minutes (factory settings: 20 minutes). If the ambient conditions so require, the sensor extends its measurement cycle by up to 10 minutes if necessary.

To avoid measurement gaps due to interference during measurement, the sensor is equipped with an intelligent “hold measurement” function for freezing temperature. If there is no freezing temperature / salt concentration detected in a measuring cycle the last identified freezing temperature will be delivered for the following 40 minutes (default: 40 – interval can be adjusted). During this interval the freezing temperature can only move to 0°C if the sensor definitely detects clear water on the road.

The freezing temperature profile is smoothed by the sensor. This function can be disabled using the UMB-Config Tool.

Data polling takes place through any desired host computer which supports any of the communication protocols described in Section 6 and disposes of an RS485 interface.

Measurements are polled and transmitted over an RS485 interface.
The device is connected using a 4-core cable.
Windows PC software is available for configuration and measurement polling during commissioning.

4.2 Additional features of ARS31Pro-UMB

In addition, ARS31Pro-UMB determines the threat of icing as follows: for a dry road – by cooling to an adjustable temperature value ($\Delta T1$); for a wet road - by comparing the measured freezing temperature with the road surface temperature while taking account of the set temperature value ($\Delta T2$). If a threat of icing is determined using one of the methods described above, the sensor transmits “threat of icing”. “Threat of icing” is only transmitted as a result of a direct measurement if the road temperature is less than $+2^{\circ}\text{C}$. This function must be activated in Configuration of the sensor.

To avoid measurement gaps due to interference during measurement, the sensor is equipped with an intelligent “hold measurement” function also for threat of icing. If the condition “threat of icing” was triggered by the freezing temperature measurement and the freezing temperature enters the hold state, the condition “threat of icing” is also updated via the last determined freezing temperature and the current road temperature. In this case, updating of the threat of icing ends simultaneously with the updating of freezing temperature. However, if during updating the threat of icing is actively determined by means of a direct measurement, this condition is retained for the set period.

With external sensor the road surface temperature is determined exactly.

4.3 Availability of measurement values

After a successful measurement, the measurement values are available for query until new measurement values are available. Synchronization between query and measurement cycle is not needed. It is recommended to poll the sensor every minute. Within the measurement interval the measured values are immediately updated when they become available. Due to different environmental conditions the timing of the availability of measurements can alter in the measurement interval, the measurement values are therefore not necessarily updated in the grid of the selected measurement interval.

| Start measurement | | | TG 1 available | Start measurement | | | | TG 2 available | Start measurement | | | TG 3 available | Start |
|-------------------|-------|--------|----------------|-------------------|--------|--------|--------|----------------|-------------------|--------|--------|----------------|-------|
| 0 min | 5 min | 10 min | 15 min | 20 min | 25 min | 30 min | 35 min | 40 min | 45 min | 50 min | 55 min | 60 min | |
| | | | | | | | | | | | | | |

Figure 2: Example: Measurement interval 20 minutes

- 1) At time 15 min TG 1 is available and will be issued
- 2) In the next measurement cycle, at the time 25 min GT 2 is determined and issued. So TG1 was issued for 10 minutes.
- 3) In the next measurement cycle, at the time 25 min GT 3 determined and issued. So TG2 was issued for 30 minutes.

5 Installation

The road sensor is installed in the middle of the carriageway. If the road has two lanes, the sensor is installed in the left hand lane.

5.1 Preparation

The sensor ARS31Pro-UMB/ARS31-UMB requires a hole of diameter $D_m > 16$ cm and depth $D_p = 6$ cm. A slit of width $W = 2$ cm and depth $D_p = 5$ cm is cut into the road for the cable.

For ARS31Pro-UMB the external sensor requires an additional hole of diameter $D_m > 9$ cm and depth $D_p = 5$ cm.

Attention! When installing on bridges, make sure that the insulation layer is not damaged (it is not always possible to maintain a depth of 6 cm in these cases).

5.2 Installation

Warning: Do not undo the cable connections under any circumstances

You can only cut the cable at the control panel end.

The cable must be laid in a protective tube in such a way as to ensure that any expansion of the road covering does not affect the cable. The road sensor cables must not be subjected to tensile force during installation.



Warning: Damage to the cable sheath or external sensors causes water ingress into the sensor. Sensors with damaged cables must not be installed and can only be repaired by Lufft.

Install the road sensor in the hole provided in such a way that it is flush with the road surface. To do this, place the installation aid - which is already mounted on delivery - on the road surface. It may be necessary to align the sensor by bending the installation aid.



Under no circumstances must the road sensor project beyond the surface of the road covering (damage due to snow-clearers).

Fill the cavities with casting resin concrete.



Only use concrete bedding systems whose temperature remains below 80°C on hardening as otherwise the road sensor will be damaged.

After the casting resin concrete has hardened, remove the installation aid and the green protective film. Reinstall the fixing screws of the installation aid in the open holes of the sensor (torque 2 Nm).

5.2.1 Enlarging the cable (for example 100m):

Important: the original cable must be shortened and extended from the shortest possible distance (5m roadside). The loop resistance of the overall cable must not exceed 5 Ω!

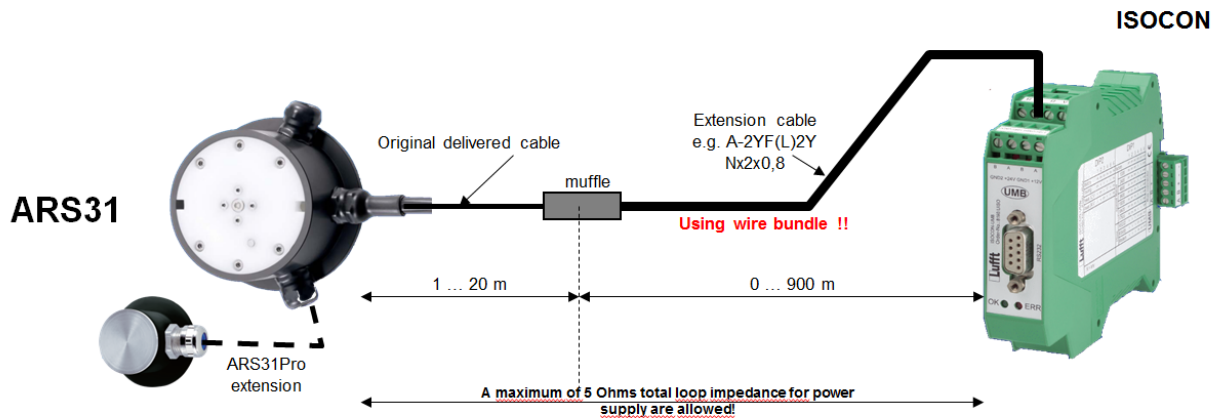


Figure 3: Cable Extension

For example, extension of 100 m with a 0.5 mm² cable of 73.2 Ω/km loop resistance and parallel connection of 4 cores each:

Per core 100 m cable results in a loop resistance of 7.3 Ω.

By parallel connection of 4 cores results in a loop resistance of $7.3 \Omega / 4 = 1.83 \Omega$

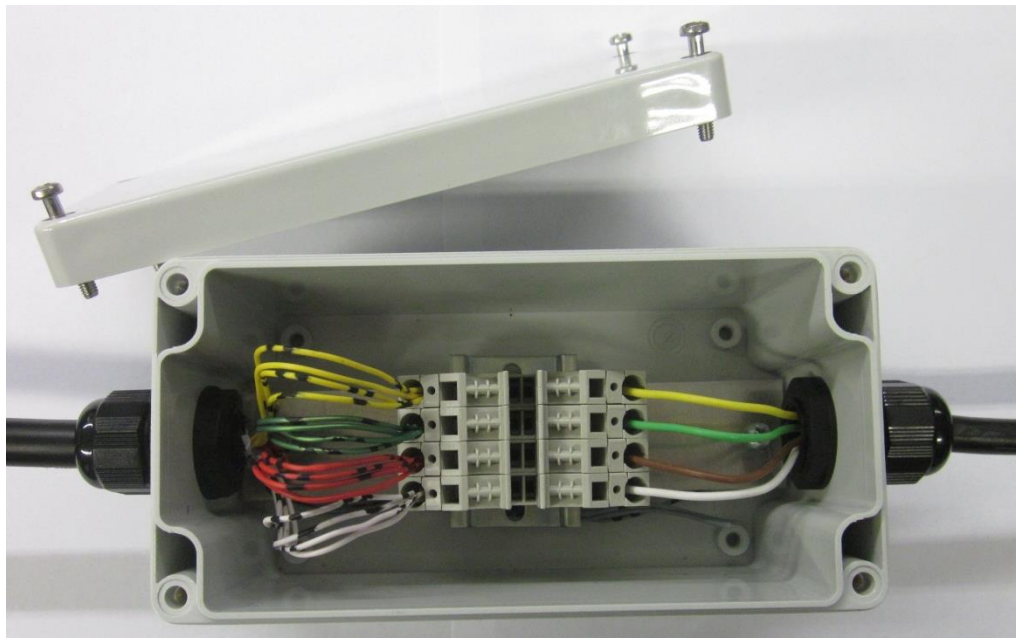


Figure 4: Example of an Extension Box

Extension Cable Table for ARS31Pro-UMB/ARS31-UMB Active Freezepoint Sensor

| Total Distance [m] | RS485 Terminator required | ARS31 original Cable | Extension Cable A-2YF(L)2Y Nx2x0,8 | | |
|--------------------|---------------------------|---------------------------------|--|-------------------------------------|-----------------------|
| wire range [m] | | 0,5 mm ² max. [m] | 0,8 mm ² up to...[m] | Power supply wire bundle x times | Total wire pairs N |
| 50 | | 50 | -- | -- | |
| 100 | | 20 | 80 | 2x | 4 |
| 200 | | 20 | 180 | 5x | 6 |
| 300 | | 20 | 280 | 7x | 10 |
| 400 | YES | 20 | 380 | 10x | 20 |
| 500 | YES | 20 | 480 | 12x | 20 |
| 600 | YES | 20 | 580 | 15x | 20 |
| 700 | YES | 20 | 680 | 17x | 20 |
| 800 | YES | 20 | 780 | 20x | 30 |
| 900 | YES | 20 | 880 | 22x | 30 |

Explanations:

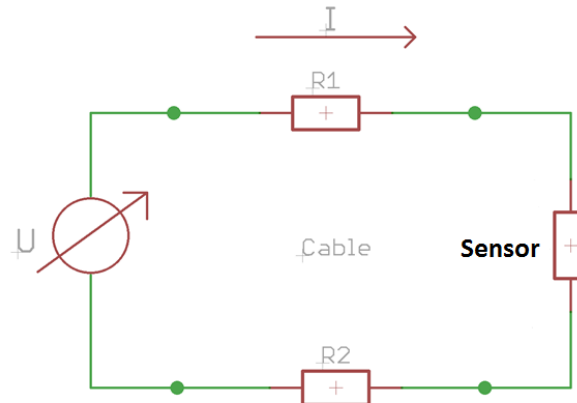
Recommended extension cable: A-2YF(L)2Y Nx2x0,8 or similar

Wirebundle 2x (2 times) means 2 pair of wires e.g. 2x2x0,8 because 2 single wires are 1 pair for power supply (+&-)!

RS485 Terminator resistor required means that either at Sensor input port or at muffle position a resistor of 120 Ohm should be connected parallel to the RS485 2-wire interface.

The power consumption changes with change in the cable length:

The sensor will have a capacity of max. $P = 30\text{W}$ needed.



$R1 + R2 =$ loop resistance

$U =$ Voltage in the cabinet at the end of the cable (24V)

$U_S =$ voltage at the sensor

$I =$ supply current

I is calculated with the equation $I^2 - I \frac{U}{(R1+R2)} + \frac{P}{(R1+R2)} = 0$

$$\text{or } I = \frac{\frac{U}{(R1+R2)} - \sqrt{\left(\frac{U}{(R1+R2)}\right)^2 - 4 * \frac{P}{(R1+R2)}}}{2}$$

For the calculated case with loop resistance 1,83 Ω :

$$\frac{\frac{24}{(1,83)} - \sqrt{\left(\frac{24}{(1,83)}\right)^2 - 4 * \frac{30}{(1,83)}}}{2} = 1,4 \text{ A}$$

Not considered here is the short piece of the standard cable!

5.3 Connecting the cable

The road sensor cable is connected in the control panel together with the power supply and the bus system, e.g. ISOCON-UMB.



The screening of the connection cable MUST be laid to ground.



Figure 5: Example of a Standard Lufft UMB Control Cabinet



Figure 7: Examples of the Earthing of the Cable Screening

There are two existing cables: color coded and numerical coded.

Connection to the road sensor cable:

- | | | |
|---|--------|-----------------------|
| 1 | White | Negative power supply |
| 2 | Brown | Positive power supply |
| 3 | Green | RS485_A |
| 4 | Yellow | RS485_B |

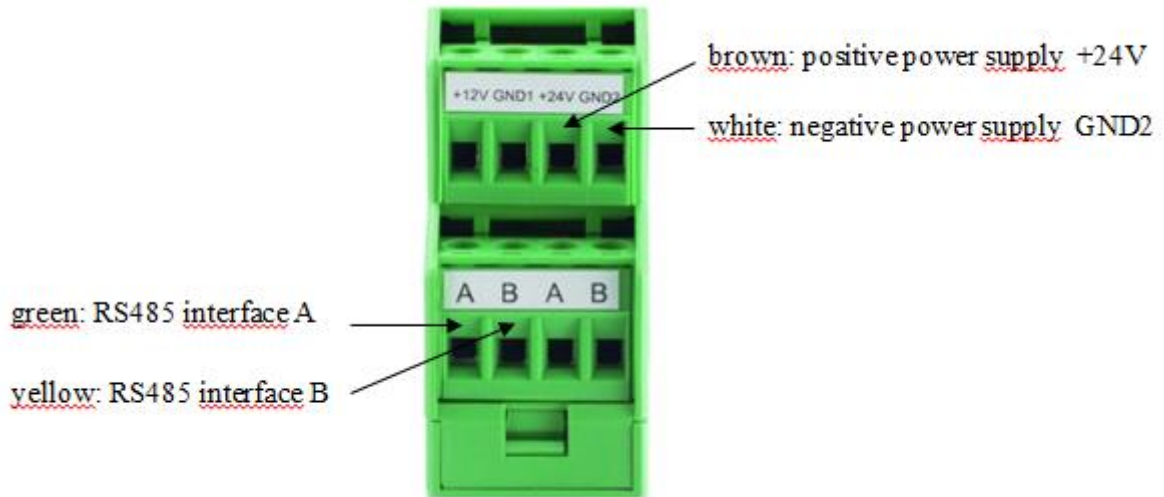


Figure 8: ISOCON-UMB Connection



Warning! Connecting the cables incorrectly will destroy the road sensor!

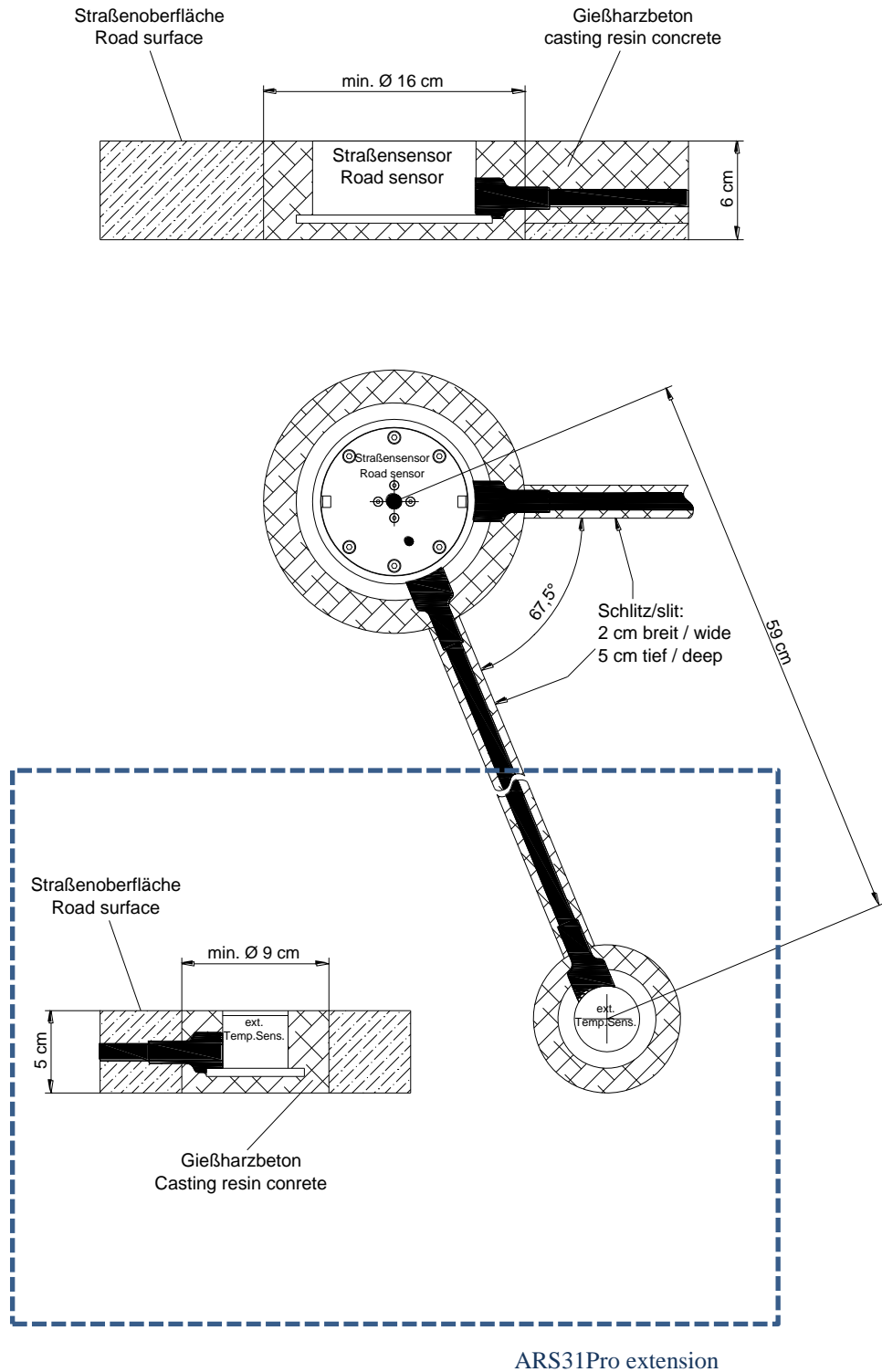


Figure 6: Installation of ARS31PRO-UMB/ARS31-UMB in the road

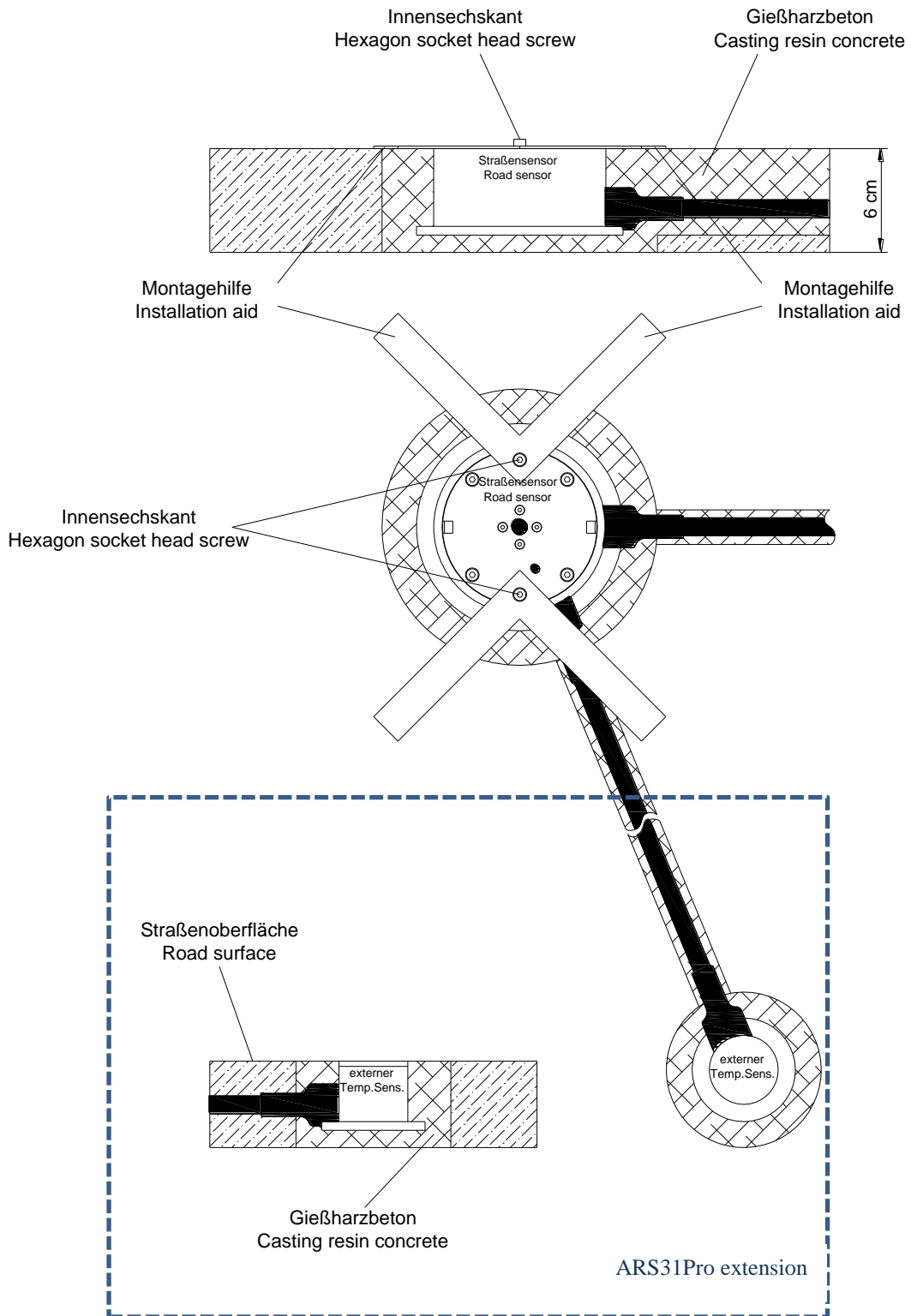


Figure 7: Installing the ARS31PRO-UMB/ARS31-UMB

5.4 Commissioning and testing

After the device has been installed and connected correctly, the ARS31Pro-UMB/ARS31-UMB is initialized and measurement begins. The first measurements are available after approximately 1 minute; after approximately 20 minutes, the measurements for freezing temperature and saline concentration / threat of icing are available (provided that the ambient conditions allow such measurements).

The functionality of the road sensor must be checked after it has been installed. The sensor must be connected to an evaluation unit (e.g. PC with UMB-Config Tool) for this purpose. Communication between sensor and evaluation unit must be checked for perfect operation.

6 Maintenance

Maintenance should be carried out on the road sensor once annually. This includes the visual inspection of the housing. It is recommended to clean the surface of the sensor if it is heavily soiled. Sensor replacement is recommended in the event of significant mechanical damage to the sensor. This also applies if the sensor's plastic insert is severely worn.

6.1 Replacing the sensor system

If the road sensor's plastic insert becomes unusable due to mechanical effects, or the sensor is damaged, the plastic insert can be replaced with no need to replace the entire housing.



Attention: Only replace the sensor system when the road is dry

To uninstall the plastic insert, remove all six hexagon socket head screws. There is a small opening on the edge of the cover suitable for inserting a screwdriver. This allows you to lift out the plastic insert. Make sure that the connection cable on the underside of the sensor has not broken off. The connectors must be pulled out without putting a strain on the cable.



The housing must be cleaned thoroughly before installing the new sensor. Even small impurities on the seat of the seal can cause the sensor to fail in the long term. No moisture must be trapped in the housing!

On connecting the connector to the new sensor, make sure that you do not touch the sensor electronics. Electrostatic discharge (ESD) destroys the sensor.



The seal must be greased with silicone grease prior to insertion. The seal must not bend out of line on installing the plastic cover. You should also make sure that the thermal conducting foil on the under edge of the housing is not displaced during installation. The plastic cover must be inserted into the housing without the use of force. There is only **one possible installation position**: The apertures on the copper head of the sensor must point in the direction of the cable glands on the housing. The threads of the fixing screws must be greased. First the screws are attached loosely and then tightened cross-wise (torque 2 Nm).

6.2 Connections

6.2.1 Cable

See Section 3.3 Installation – Connecting the cable

6.2.1.1 Power supply

The ARS31Pro-UMB/ARS31-UMB power supply is 24 VDC \pm 10% (for a cable length up to 15 meters).

For cable lengths over 15 meters see table below. The supply voltage must not exceed the value of 28 VDC.

| cable lengths [m] | recommended power supply [VDC] |
|----------------------|-----------------------------------|
| ≤ 15 | 24 |
| 20 | 24,6 |
| 25 | 25,1 |
| 30 | 25,7 |
| 35 | 26,3 |
| 40 | 26,8 |
| 45 | 27,4 |
| 50 | 28 |

The power supply unit used must be approved for operating devices of protection class III (SELV).

6.2.1.2 RS485 interface

The device has a half-duplex, 2-wire RS485 interface with the following settings:

Data bits: 8
 Stop bit: 1
 Parity: none
 Adjustable baud rates: 1200, 2400, 9600, 19200, 38400 (standard: 19200 bit/s)



Please do not change the baud rate of the sensor unless it is absolutely essential. If the sensor is operated via ISOCON-UMB, the baud rate of the sensor must match the set baud rate on the ISOCON-UMB.



The screened cable MUST be laid to ground in the control cabinet



If the device is not connected properly:

- It may not function correctly
- It may be permanently damaged
- There is a danger of electric shock under certain circumstances

6.2.2 Connections in the housing

There is a single 4-pole terminal block on the underside of the plastic insert. This serves to connect the power supply and the interface to the associated cable.

Power supply connection assignment/RS485:

Pin Assignment

| | | |
|---|----------|--------|
| 1 | GND | white |
| 2 | V+, 24 V | brown |
| 3 | A (Rx+) | green |
| 4 | B (Rx-) | yellow |

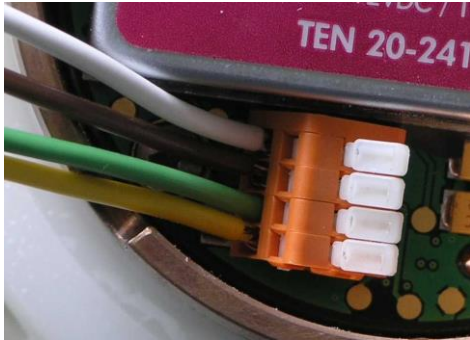
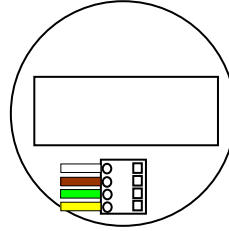


Figure 8: Connections in the housing

The data and power supply cables are connected via a 4-pole terminal block. Cable type LI-2YCYv2X2X0.5 is used.

Cable labeling on the pins is based on DIN 47100.

The screened cable must be laid to the ground circuit connector in the control panel.

7 Configuration

Lufft provides PC software for configuration purposes UMB-Config Tool. Using this software, the user can adjust the sensor according to his needs.



Starting from Firmware V10.3 the UMB-Config Tool version 2.2 or newer must be used.

7.1 Factory settings

The factory settings of the ARS31PRO-UMB are as follows:

| | |
|-----------------|--------|
| Device ID: | 1 |
| Class ID | 4 |
| Baud rate: | 19200 |
| RS485 protocol: | binary |

7.2 Using PC configuration software

The main functions of the configuration software are described in detail in the Online Help. For this reason only the sensor-specific menus and functions are described here.

7.2.1 Configuration of ARS31Pro-UMB

After loading an ARS31PRO-UMB configuration, all relevant settings and values can be adjusted.

If several ARS31PRO-UMB devices are operated on a UMB network, the ID must be changed before connection to the network, as each device requires a unique ID. IDs are allocated in ascending order, beginning with number one.

The measuring rate indicates how often a new measuring cycle is started. This value is configurable and can be set to 20, 30 or 60 minutes (factory settings: 20 min.)

If there is no freezing temperature / salt concentration detected in a measuring cycle the last identified freezing temperature will be delivered for the following 40 minutes (default: 40 – interval can be adjusted). During this interval the freezing temperature can only move to 0 if the sensor definitely detects clear water on the road. The interval for maintaining the freezing temperature can be configured in the UMB-Config-Tool and can adopt values between 20 and 120 minutes (default 40 minutes). The function can be deactivated by unticking the option “FT data hold active”.

With the option "FT smoothing operator active", a smoothing function for the freezing temperature can be activated. The operator itself can be set between 0 (maximum smoothing, no change in the FT) and 100 (no smoothing). After activating this function a start value of 40 is set for the smoothing operator. This value can be adjusted if necessary.

Freezing temperature / threat of icing is detected when road temperatures are lower than the road temperature threshold. If the road temperature is higher than this threshold, freezing temperature / threat of icing is not detected. The threshold value is adjustable between 2°C and 10°C.

The dry threshold defines the measured value on the ARS31PRO-UMB from which a dry road is assumed and the freezing temperature is no longer measured; instead of the freezing point measurement, detection of threat of icing then takes place. In the factory

setting, the sensor adjusts its dry threshold daily. If this function is disabled, the dry threshold as set using the UMB-Config Tool applies.

If this value is too high, the ARS31Pro-UMB measures during dry conditions, which may lead to incorrect measurements caused by condensation on the sensor element.

The calculation of threat of icing can be activated in configuration of the sensor. The following parameters serve to configure detection of the threat of icing:

Time x describes the time for which the sensor cools down in order to cause the formation of dew or frost.

Delta T (ΔT) is the temperature difference by which the road surface temperature cools down in order to measure the threat of icing via the formation of dew or frost.

Delta T2 ($\Delta T2$): If the threat of icing is detected via the temperature difference between the road temperature and the freezing temperature, $\Delta T2$ describes the temperature difference for which, upon lower deviation, threat of icing is transmitted. A value of -50°C deactivates the calculation of threat of icing using the freezing temperature (available with firmware release 10.3).

Delta LFM% describes the required change in the critical measurement variable for the detection of the threat of icing. Higher numerical values reduce the probability of the sensor transmitting the threat of icing and increase the stability of this function.

The screenshot shows the configuration interface for the ARS31PRO-UMB sensor. The interface is divided into several sections:

- General properties:** ID is set to 1, and the description is 'Active-Road-Sensor ARS31f'.
- Communication properties:** Linespeed is set to 19200, Protocol is UMB-Binary, and Timeout protocol change is 10 minutes.
- Measurement parameters:**
 - Measurement interval [min]: 20
 - Ft data hold after measurement max. [min]: 40
 - Ft smoothing operator ($\times 0,01$): 40
 - Buttons: Factory settings, Ft data hold enabled (checked), Ft smoothing operator enabled (checked), and Activate threat of icing (unchecked).
- Model parameters:**
 - Road Temperature Threshold [$^{\circ}\text{C}$]: 5
 - Dynamic dry threshold enabled (checked)
 - Dry Threshold ($\times 250$): 200
 - Freezing Temperature limit [$^{\circ}\text{C}$]: 0
 - Time x [s]: 540
 - Delta T [$^{\circ}\text{C}$]: 2
 - Delta T2 [$^{\circ}\text{C}$]: 2
 - Delta LFM [%/10]: 20

Figure 9: Configuration of ARS31Pro-UMB

In the UMB-Config-Tool the temperature limit of the freezing temperature can be adjusted if necessary (factory setting: 0, this means no limit for freezing temperature). After the activation of the freezing temperature limit, the smoothed freezing temperature can be transitional-wise under the temperature limit (if the freezing temperature directly before the change was under the opposed limit).

7.2.2 Configuration of ARS31-UMB

After loading an ARS31-UMB configuration, all relevant settings and values can be adjusted.

If several ARS31-UMB devices are operated on a UMB network, the ID must be changed before connection to the network, as each device requires a unique ID. IDs are allocated in ascending order, beginning with number one.

The measuring rate indicates how often a new measuring cycle is started. This value is configurable and can be set to 20, 30 or 60 minutes (factory settings: 20 min.)

If there is no freezing temperature / salt concentration detected in a measuring cycle the last identified freezing temperature will be delivered for the following 40 minutes (default: 40 – interval can be adjusted). During this interval the freezing temperature can only move to 0 if the sensor definitely detects clear water on the road. The interval for maintaining the freezing temperature can be configured in the UMB-Config-Tool and can adopt values between 20 and 120 minutes (default 40 minutes). The function can be deactivated by unticking the option "FT data hold active".

With the option "FT smoothing operator active", a smoothing function for the freezing temperature can be activated. The operator itself can be set between 0 (maximum smoothing, no change in the FT) and 100 (no smoothing). After activating this function a start value of 40 is set for the smoothing operator. This value can be adjusted if necessary.

Freezing temperature is detected when road temperatures are lower than the road temperature threshold. If the road temperature is higher than this threshold, freezing temperature is not detected. The threshold value is adjustable between 2°C and 10°C.

The dry threshold defines the measured value on the ARS31-UMB from which a dry road is assumed and the freezing temperature is no longer measured.

If this value is too high, the ARS31-UMB measures during dry conditions, which may lead to incorrect measurements caused by condensation on the sensor element.

In the UMB-Config-Tool the temperature limit of the freezing temperature can be adjusted if necessary (factory setting: 0, this means no limit for freezing temperature).

After the activation of the freezing temperature limit, the smoothed freezing temperature can be transitional-wise under the temperature limit (if the freezing temperature directly before the change was under the opposed limit).

The screenshot shows the configuration window for ARS31-UMB. It is divided into several sections:

- General properties:** ID is set to 1, and Description is 'Active-Road-Sensor ARS31-'. There are up/down arrows next to the ID field.
- Communication properties:** Linespeed is 19200, Protocol is UMB-Binary, and Timeout protocol change is 10 [min].
- Measurement parameters:** Measurement interval [min] is 20. Ft data hold after measurement max. [min] is 40, with a checked box for 'Ft data hold enabled'. Ft smoothing operator (*0,01) is 40, with a checked box for 'Ft smoothing operator enabled'.
- Model parameters:** Road Temperature Threshold [°C] is 5, Dry Threshold (* 250) is 164, Pure water Threshold (* 250) is 163, and Freezing Temperature limit [-°C] is 0. A 'Factory settings' button is located to the right of these parameters.

Figure 10: Configuration of ARS31-UMB

7.2.3 Measurement polling channels

You can activate the measurement polling channels for the UMB-Config-Tool by clicking on the respective channel. This setup has no influence on the channels which can be queried by the user software.

The 'Select active Channels' dialog box contains the following table:

| ChNr. | Measurement | Unit | Range | active |
|-------|---------------------------|------------|------------------|----------|
| 110 | Act. Road Temperature | norm value | 0.00 .. 65520.00 | inactive |
| 111 | Act. Road Temperature | °C | -40.00 .. 80.00 | active |
| 112 | Act. Road Temperature | °F | -40.00 .. 176.00 | inactive |
| 150 | Act. Freezing Temperature | norm value | 0.00 .. 65520.00 | inactive |
| 151 | Act. Freezing Temperature | °C | -40.00 .. 0.00 | active |
| 152 | Act. Freezing Temperature | °F | -40.00 .. 32.00 | inactive |
| 153 | Act. FreezT no smoothing | norm value | 0.00 .. 65520.00 | inactive |
| 154 | Act. FreezT no smoothing | °C | -40.00 .. 0.00 | inactive |
| 155 | Act. FreezT no smoothing | °F | -40.00 .. 32.00 | inactive |
| 160 | Act. FreezT. corrected | norm value | 0.00 .. 65520.00 | inactive |
| 161 | Act. FreezT. corrected | °C | -40.00 .. 0.00 | inactive |
| 162 | Act. FreezT. corrected | °F | -40.00 .. 32.00 | inactive |

On the right side of the dialog, there is a vertical scrollbar and a note: 'Click on Channel to toggle active'.

Figure 11: Select the Channels for Measurement Polling

7.3 Firmware update

The description of the firmware update can be found in the instructions for the UMB configuration tool.

New firmware is uploaded via the RS485 interface. It is not necessary to open the housing for this purpose. However, firmware uploads must take place at a temperature between 0 and 60°C. The update is controlled by means of PC software.



A firmware update can only be applied if a baud rate of 19200 BD is set on the sensor interface.

8 Communication

Communication takes place with the ARS31PRO-UMB/ARS31-UMB over a 2-wire half-duplex RS485 interface with the aid of the ISOCON-UMB. The bus is not terminated with a resistor due to dissipation in the sensor. The use of PC software from Lufft for purposes of maintenance and diagnosis makes an RS485-RS232 or RS485-USB converter superfluous.

The protocol is based on meteorological sensor communications protocol. This contains bus-compatible binary protocol which requires a strict master-slave principle and is enabled on delivery. The sensor is a slave and only responds to requests. AN ASCII protocol is available for rudimentary measurement polling only.

Depending on the device configuration, the calculated freezing point can be requested in binary or ASCII protocol.

8.1 Binary protocol

This operating manual only includes one example of an online data request. Please refer to the current version of the document *Communications Protocol for Meteorological Sensors (UMB protocol)* for details of the mode of operation.

8.1.1 Framing

The data frame is constructed as follows:

| 1 | 2 | 3 - 4 | 5 - 6 | 7 | 8 | 9 | 10 | 11 ... (8 + len) optional | 9 + len | 10 + len 11 + len | 12 + len |
|-----|-------|-------|--------|-------|-----|-------|--------|------------------------------|---------|----------------------|----------|
| SOH | <ver> | <to> | <from> | <len> | STX | <cmd> | <verc> | <payload> | ETX | <cs> | EOT |

SOH Control character for the start of a frame (01h) 1 byte
 <ver> Header version number, e.g.: V 1.0 → <ver> = 10h = 16d; 1 byte
 <to> Receiver address, 2 bytes
 <from> Sender address, 2 bytes
 <len> Number of data bytes between STX and ETX; 1 byte
 STX Control character for the start of payload data transmission (02h); 1 byte
 <cmd> Command; 1 byte
 <verc> Version number of the command; 1 byte
 <payload> Data bytes; 0 – 210 bytes
 ETX Control character for the end of payload data transmission (03h); 1 byte
 <cs> Checksum, 16 bit CRC; 2 bytes
 EOT Control character for the end of the frame (04h); 1 byte
 Control character: SOH (01h), STX (02h), ETX (03h), EOT (04h).

8.1.2 Addressing of class and device ID

Addressing takes place using a 16 bit address. This is divided into sensor class ID and device ID.

| Address (2 bytes = 16 bits) | | | |
|-----------------------------|--|------------------------------|-----------|
| Bits 15 – 12 (top 4 bits) | | Bits 11 – 0 (bottom 12 bits) | |
| Class ID (0 to 15) | | Device ID (0 – 4095) | |
| 0 | Broadcast | 0 | Broadcast |
| 4 | ARS31PRO-UMB/ARS31-UMB Active Road Sensor | 1 - 4095 | Available |
| 15 | Master or control devices | | |

ID = 0 is provided as broadcast for classes and devices respectively. Hence it is possible to transmit a broadcast on a specific class. However, this only makes sense if there is only one device of this class on the bus.

8.1.3 Examples for creating addresses

If, for example, an ARS31PRO-UMB/ARS31-UMB is to be given device address ID 0001, this is done as follows:

Class ID for ARS is 4d = 4h

Device ID is e.g. 001d = 001h

Putting the class and device IDs together gives an address of 4001h (16385d).

8.1.4 Example of a binary protocol request

If, for example, a request for the current freezing temperature (measurement range -40 ... 0) is to be placed from a PC to a road sensor with device ID 0001, this is done as follows:

Sensor:

Class ID for **road sensor** is 4 = 4h

Device ID (serial number) is 0001 = 001h

Putting the class and device IDs together gives a destination address of 4001h.

PC:

Class ID for **PC (master device)** is 15 = Fh

PC ID is e.g. 1 = 001h

Putting the class and PC IDs together gives a sender address of F001h

The length <len> for the online data request command 4d = 04h,

the command for the online data request is 23h and

the version number of the command is 1.0 = 10h.

The channel number is shown under <payload>; as can be seen from the channel list, the current freezing temperature (-40°C ... 0°C) in channel 151d = 97h

The calculated CRC is C4D6h

The request to the device:

| SOH | <ver> | <to> | | <from> | | <len> | STX | <cmd> | <verc> | <channel> | | ETX | <cs> | | EOT |
|-----|-------|------|-----|--------|-----|-------|-----|-------|--------|-----------|-----|-----|------|-----|-----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 01h | 10h | 01h | 40h | 01h | F0h | 04h | 02h | 23h | 10h | 97h | 00h | 03h | D6h | C4h | 04h |

The response from the device:

| SOH | <ver> | <to> | | <from> | | <len> | STX | <cmd> | <verc> | <status> | <channel> | | <typ> |
|-----|-------|------|-----|--------|-----|-------|-----|-------|--------|----------|-----------|-----|-------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 01h | 10h | 01h | F0h | 01h | 40h | 0Ah | 02h | 23h | 10h | 00h | 97h | 00h | 16h |

| <value> | | | | ETX | <cs> | | EOT |
|---------|-----|-----|-----|-----|------|-----|-----|
| 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 66h | 66h | 96h | C1h | 03h | FFh | EAh | 04h |

<status> = Device o.k.

<typ> = Data type of the following value; 16h = float (4 bytes, IEEE format)

<value> = C1966666h corresponds to float value -18.8°C.

The freezing temperature is -18.8°C .

Correct data transmission can be checked with the aid of the checksum (EAFFh).



Important: Little endian (Intel, lowbyte first) applies when transmitting word and float variables of such as, for example, addresses or the CRC. This means first the LowByte, then the HighByte.

8.1.5 CRC calculation

The CRC is calculated in accordance with the following rules:

Standard: CRC-CCITT

Polynomial: $1021\text{h} = x^{16} + x^{12} + x^5 + 1$ (LSB first mode)

Start value: FFFFh

(Attention: Contrary to earlier Lufft protocols, the start value for CRC calculations is not 0h but rather FFFFh in accordance with CCITT)

Further information is available in the description of a CRC calculation in UMB Protocol.

8.2 ASCII protocol

Easy communication with devices is provided by using the ASCII protocol.

ASCII protocol serves exclusively for online data requests and is not secured by a CRC.

The device does not respond to incomprehensible ASCII commands.

Using ASCII protocol, the measurements can be polled in a simple, insecure manner with the aid of a terminal program. However, the sensor can only be configured by way of the binary protocol. The output format is fixed and not user-configurable. You can find an exact description in the document Communication Protocol for Meteorological Sensors.

After the HyperTerminal has started, select File -> Properties -> Settings -> ASCII Configuration. Enter 1 ms for the character delay.

8.2.1 Construction

ASCII commands are introduced by the character '&' and ended with the character CR (0Dh). There is always a blank space (20h) between the individual blocks; this is represented by an underscore '_'. Characters which represent an ASCII value are in simple inverted commas.

8.2.2 Example of an ASCII request

If, for example, you want to request the current freezing temperature of a road sensor with device ID (serial number) 0001 from a PC, this is done as follows:

A measurement of a specific channel is requested with command "M".

Request: '&'_<ID>⁵'M'_<channel>⁵ CR

Response: '\$'_<ID>⁵'M'_<channel>⁵'_<value>⁵ CR

<ID>⁵ Device address (5-digit decimal with leading zeros)

<channel>⁵ Gives the channel number (5-digit decimal with leading zeros)

<value>⁵ Measurement (5-digit decimal with leading zeros); a standardized measurement from 0 – 65520d. 65521d – 65535d define various error codes

Example:

Request: & 16385 M 00151

This request polls channel 151 of the device with the address 4001h.

Response: \$ 16385 M 00151 62899

With the standardization for the freezing temperature the following calculation then results:

62899d corresponds to $-40 + (0 + 40) * 62899 / 65520 = -1.6^{\circ}\text{C}$

8.3 Channel assignment for the data request

The channel assignment described here applies to the online data request in binary protocol.

The channels in the mapping standard are transmitted in ASCII protocol.

| Channel no. | Measurement variable | Unit | Data Type | Measuring Range |
|-------------|--------------------------------|---------------|----------------|-----------------|
| 100 | Act. Cu Temperature | AN | unsigned short | 0 ... 65520 |
| 101 | Act. Cu Temperature | °C | float | -40 ... +80 °C |
| 102 | Act. Cu Temperature | °F | float | -40 ... 176 °F |
| | | | | |
| 110 | Act. Road Temperature | MS | unsigned short | 0 ... 65520 |
| 111 | Act. Road Temperature | °C | float | -40 ... +80 °C |
| 112 | Act. Road Temperature | °F | float | -40 ... 176 °F |
| | | | | |
| 150 | Act. Freezing Temperature | MS | unsigned short | 0 ... 65520 |
| 151 | Act. Freezing Temperature | °C | float | -40 ... 0 °C |
| 152 | Act. Freezing Temperature | °F | float | -40 ... +32 °F |
| | | | | |
| 153 | Act. FreezT no smoothing | MS | unsigned short | 0 ... 65520 |
| 154 | Act. FreezT no smoothing | °C | float | -40 ... 0 °C |
| 155 | Act. FreezT no smoothing | °F | float | -40 ... +32 °F |
| | | | | |
| 160 | Act. FreezT. corrected | MS | unsigned short | 0 ... 65520 |
| 161 | Act. FreezT. corrected | °C | float | -40 ... 0 °C |
| 162 | Act. FreezT. corrected | °F | float | -40 ... +32 °F |
| | | | | |
| 801 | Act.SalineConcentr.NaCl | % | float | 0 ... 100 |
| 803 | Act.SalineConcentr.CaCl | % | float | 0 ... 100 |
| 805 | Act.SalineConcentr.MgCl | % | float | 0 ... 100 |
| 816 | Act. Cryotech E36 by wgt | % | float | 0 ... 100 |
| 817 | Act. Cryotech E36 by vol | % | float | 0 ... 100 |
| 818 | Act. Safeway KF Hot | % | float | 0 ... 100 |
| | | | | |
| 821 | Act.SalineConcentr.NaCl corr. | % | float | 0 ... 100 |
| 823 | Act.SalineConcentr.CaCl corr. | % | float | 0 ... 100 |
| 825 | Act.SalineConcentr.MgCl corr. | % | float | 0 ... 100 |
| 836 | Act. Cryotech E36 by wgt corr. | % | float | 0 ... 100 |
| 837 | Act. Cryotech E36 by vol corr. | % | float | 0 ... 100 |
| 838 | Act. Safeway KF Hot corr. | % | float | 0 ... 100 |
| | | | | |
| 900 | Act. Status GFT-Measuring | n/a | unsigned short | 0 ... 5 |
| 901* | Act. Threat of icing* | n/a | unsigned char | 0 ... 2 |
| | | | | |
| 1049 | Act. Road Temperature | TLS FG3 DE 49 | signed short | -300 ... +800 |
| 1052 | Act. Saline Concentr.NaCl | TLS FG3 DE 52 | unsigned char | 0 ... 100/255 |
| 1065 | Act. Freezing Temperature | TLS FG3 DE 65 | signed short | -300 ... 0 |
| 1073 | Act.Saline Concentr. NaCl | TLS FG3 DE 73 | unsigned char | 0...100/255 |
| 3001 | Act.Saline Concentr.MgCl | TLS FG3 DE 52 | unsigned char | 0...100/255 |
| 3002 | Act.Saline Concentr. CaCl | TLS FG3 DE 52 | unsigned char | 0...100/255 |
| 3011 | Act.Saline Concentr.MgCl | TLS FG3 DE 73 | unsigned char | 0...100/255 |
| 3012 | Act.Saline Concentr. CaCl | TLS FG3 DE 73 | unsigned char | 0...100/255 |

| | | | | |
|-------|-------------------------|-----|----------------|-----------|
| 20001 | Act.Measurement Counter | n/a | unsigned short | 0...65535 |
| 20800 | Act. Lfm Raw Value | n/a | unsigned short | 0...65535 |
| 20826 | Act. Peltier Phase | n/a | unsigned char | 0...255 |

Legend:

MS ... Mapping standard
 * Channel 901 is only available with ARS31Pro-UMB Sensor.

The channels 101, 20001, 20800 and 20826 are used for diagnostics. It is recommended this channels are queried and recorded.

Difference between the “saline concentration” channels 801, 803, 805, 816, 817, 818, 821, 823, 825, 836, 837, 838, 1073, 3011, 3012 and the channels 1052, 3001, 3002:

The channels 801, 803, 805 etc. deliver saline concentration in percent by weight. For example a solution of NaCl with a freezing temperature of -5.3°C reports a measurement value of 8% on the saline concentration channel 801. The channels 1052, 3001 and 3002 are based on the saturation of salt in liquid. For example a solution of NaCl with a freezing temperature of -5.3°C reports a measurement value of approx. 36% (8/22 in [%]) o channel 1052. The maximum saturation of NaCl in water is about 22 percent by weight.

Difference between corrected and uncorrected measurement channels:

In the case of uncorrected channels, the status of the channel in the UMB protocol is used to classify the measurements; if, for example, the ambient temperature is too high the status can not be 0 (e.g.: 84, the possible error codes are specified in the document *Communication Protocol for Meteorological Sensors*); in this case the freezing temperature is neither calculated nor transmitted.

In the case of corrected channels the status is transmitted on channel 900. If it is not possible to calculate the freezing temperature, this is then transmitted as 0°C (or its equivalent in other units).

Status generation and freezing temperature on the corrected channel:

- If it is not possible to calculate the FT status because the ambient temperature is greater than the temperature set for the sensor (factory setting 5°C), the FT status is set to 0 and the freezing temperature value is set to 0°C .
- If it is not possible to calculate the FT status because the road is dry, the FT status is set to 1 and the freezing temperature value is set to 0°C .
- When a valid FT is calculated, the FT status is set to 2 and the freezing temperature value is set to the calculated value.
- If it is not possible to calculate the FT for other reasons the FT status is set to 3 and the freezing temperature value is set to 0°C .
- If it is not possible to calculate the FT status because the ambient temperature is lower than -30°C , the FT status is set to 4 and the freezing temperature value is set to 0°C .
- If it is not possible to detect the freezing temperature, because it is below the limits of the sensor, the FT status is set to 5, freezing temperature below road temperature -20°C ($T_g < (T_u - 20^{\circ}\text{C})$)

If it is not possible to calculate the freezing temperature, “0” is transmitted for freezing temperature and “255” is transmitted for “residual salt” on the TLS channel.

A sensor with factory settings will deliver a value of -0.1°C in channel 1065 (freezing temperature TLS) whenever the road is wet and without salt. The reason for this output is that in the (German) “Bundesdatenverteiler” (12/2010) the TLS compliant combination of 0°C freezing temperature and 0% residual salt are causing errors in the visualization.

**Description of the coding of channel 901 “Act. threat of icing”
(Channel 901 is only available with ARS31Pro-UMB Sensor!)**

- If no threat of icing was detected via either the freezing temperature or the direct measurement, channel 901 delivers the value 0.
- If a threat of icing was detected via either the freezing temperature or the direct measurement, channel 901 delivers the value 1
- Before the first measurement, if the road temperature is too high and there is an error in detecting the threat of icing, channel 901 delivers the value 2.

8.4 Mapping standards

| Mapping standard | Temperature measurement range |
|------------------|---|
| 0 – 65520 | -40 ... +80°C |
| | -40 ... +176°F |
| | Freezing temperature measurement range |
| | -40 ... +0°C |
| | -40 ... +32°F |

9 Technical data

9.1 Measurements

9.1.1 Freezing temperature

| | |
|--------------------|--|
| Measurement range: | -40 ... 0, however $T_g \geq T_u - 20^\circ\text{C}$ ¹⁾ |
| Accuracy: | $\pm 0.5^\circ\text{C}$ for $T_g > -15^\circ\text{C}$ (with NaCl, according to CEN/TC 15518-4) $\pm 1.5^\circ\text{C}$ for $T_g < -15^\circ\text{C}$ (with NaCl, according to CEN/TC 15518-4) |
| Resolution: | 0.1°C |
| De-icing agent: | Any desired de-icing agent; however the electrical conductivity of the solution must be $> 1\text{ mS/cm}$ |

9.1.2 Saline concentration

| | |
|--------------------|--|
| Measurement range: | 0 ... 100% |
| Accuracy: | Computed from the freezing temperature according to CEN/TC 15518-4 |
| Resolution: | 0.1% |
| De-icing agent: | Any desired de-icing agent; however the electrical conductivity of the solution must be $> 1\text{ mS/cm}$ |

9.1.3 Status of freezing temperature measurement

Transmitted on Channel 900:

- 0 -> Start conditions not fulfilled
- 1 -> Sensor surface dry
- 2 -> Freezing temperature was calculated
- 3 -> Freezing temperature was not calculated
- 4 -> Too cold to measure
- 5 -> Freezing temperature below road temperature minus 20°C ($T_g < (T_u - 20^\circ\text{C})$)

9.1.4 Status of "threat of icing"

Transmitted on Channel 901:

- 0 -> No threat of icing
- 1 -> Threat of icing
- 2 -> Threat of icing was not determined

Channel 901 is only available with ARS31Pro-UMB Sensor.

9.1.5 Road surface temperature ARS31Pro-UMB

| | |
|--------------------|---|
| Principle: | NTC |
| Measurement range: | -40 ... 80°C |
| Accuracy: | $\pm 0.2^\circ\text{C}$ (-10...10°C), otherwise $\pm 0.5^\circ\text{C}$ |
| Resolution: | 0.1°C |

9.1.6 Road surface temperature ARS31-UMB

| | |
|--------------------|--|
| Principle: | NTC |
| Measurement range: | -40 ... 80°C |
| Accuracy: | Quantitative statement only as errors arise due to selfheating |
| Resolution: | 0.1°C |

9.2 Storage conditions (complete sensor)

Permissible storage temp.: -40°C ... +70°C (in packing)

Permissible relative humidity: 0 ... 98% RH due to packing

9.3 Operating conditions

Permissible operating temp.: -40°C ... +80°C ¹⁾
 0°C... +60°C for firmware update only
 Permissible relative humidity: 0 ... 100% RH
 Perm. height above sea level: 3000 m

9.4 Electrical data

Power supply: 24 VDC ± 10% (for a cable length up to 15 meters).
 For cable length over 15 meters see chapter 6.2.1.1.
 Current- and power consumption: approx. 1,25A / 30 W at 24VDC at the sensor
 Protection class: III (SELV)

Attention: the power input increases with the cable length !

For example: with the 50-meter-cable (8810.U051):
 current consumption: approx. 1,7 A

For more details about enlarging the cable please read chapter 5.2.1.

9.5 Interfaces

4-core connection cable with power supply and RS485 (2-wire, half-duplex) for configuration and measurement requests. Ex works cable type LI-2YCYv2X2X0.5.

9.6 Mechanical data (excluding cable)

Dimensions (W x H x D): Ø 120mm; height: 50mm
 Weight ARS31Pro-UMB: approx. 1100g
 Weight ARS31-UMB: approx. 900g
 Protection class: IP68

¹⁾ The sensor only measures freezing temperature and threat of icing in the road surface temperature range -30°C ... +5°C (adjustable up to 10°C). Above 60°C an error code is transmitted.

10 EC Certificate of Conformity

Product: Active Road Sensor in combination
with UMB ISO Converter ISOCON-UMB

Type: ARS31Pro-UMB (Order No.: 8810.Uxxx)
ARS31-UMB (Order No.: 8610.Uxxx)
UMB ISO- Converter ISOCON-UMB (Order –No.: 8160.Uxxx)

We herewith certify that the above mentioned equipment complies in design and construction with the Directives of the European Union and specifically the EMC Directive in accordance with 2004/108/EG.

The above mentioned equipment conforms to the following specific EMC Standards:

EN 61000-4-2 (2009-12)ESD
 EN 61000-4-3 (2011-04)Radiated electromagnetic field
 EN 61000-4-4 (2011-10).....Burst
 EN 61000-4-5 (2007-06)Surge
 EN 61000-4-6 (2009-12).....Conducted disturbances, induced by
 radio-frequency fields
 EN 55022 Rad (2011-12)Radio Frequency Disturbance ITE
 EN 55022 Cond (2011-12)Radio Frequency Disturbance ITE



Fellbach, June 4th, 2014

Axel Schmitz-Hübsch

11 Troubleshooting

| Description | Cause / remedy |
|--|--|
| The sensor will not allow polling requests. | <ul style="list-style-type: none"> - Sensor (no dummy cover) installed - Check power supply voltage in the connection (terminal) box and on the sensor - Check interface connection - False device ID → check ID - RS485 cable A / B reversed - False baud rate set (sensor, ISOCON-UMB) - False protocol set or used (binary, ASCII) |
| Freezing temperature is not calculated. | <ul style="list-style-type: none"> - Start conditions not fulfilled (road temperature above set temperature) - Sensor surface dry - Measurement cycle not yet completed (lasts up to 20 minutes) - Interference during calculation of freezing temperature due to external influences in critical phases of the measurement cycle - Sensor surface heavily soiled -> clean sensor surface with water - Green protective foil not removed -> remove green protective foil |
| Determined freezing temperature is reset after a few minutes | <ul style="list-style-type: none"> - Sensor is resetting. Query channel 20001 and check that the value is incremented. After reaching 60000 the counter starts again from "0". If the value goes to "0" earlier, the sensor has made a restart. Power supply must be checked (see chapter 6.2.1.1) - Power supply overloaded - Unstable power supply - Related to an LCOM-UMB: Misconfiguration of LCOM, thereby resetting the UMB-Modules every x minutes (default is 15 Minutes) |
| Salt concentration channel delivers error message | <ul style="list-style-type: none"> - Start conditions not fulfilled (road temperature above set temperature) - Sensor surface dry - Measurement cycle not yet completed (lasts up to 20 minutes) - Interference during calculation of freezing temperature due to external influences in critical phases of the measurement cycle - Sensor surface heavily soiled -> clean sensor surface with water - Green protective foil not removed-> remove green protective foil |
| Threat of icing channel delivers error FC:36 | <ul style="list-style-type: none"> - Threat of icing is disabled or not supported (ARS31-UMB) |

The description of the UMB-errorcodes you can find in the document "UMB-Protocol" under www.Lufft.com in the sector Support – Downloads – Manuals – UMB Technology.

12 Service and maintenance

Service and maintenance should only be carried out by trained specialist personnel. The recommended service interval is 12 months.

The device must be disconnected from the power supply whilst service and maintenance work is being carried out.

13 Disposal

The device must be disposed of in accordance with European Directives 2002/96/EC and 2003/108/EC (waste electrical and electronic equipment). Waste equipment must not be disposed of as household waste. For environmentally sound recycling and the disposal of your waste equipment please contact a certified electronic waste disposal company.

14 Manufacturer

In matters of guarantee or repair please contact:

G. Lufft Mess- und Regeltechnik GmbH

Gutenbergstraße 20

70736 Fellbach

P.O. Box 4252

70719 Fellbach

Germany

Phone: +49 711 51822-0

Hotline: +49 711 51822-52

Fax: +49 711 51822-41

E-mail: info@lufft.de

or your local distributor.

14.1 Technical support

Our hotline is available for technical questions via the following e-mail address:

hotline@lufft.de

You can also consult frequently asked questions at <http://www.lufft.com/> (menu header: FAQs).

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**G. LUFFT Mess- und
Regeltechnik GmbH**

Lufft Germany:

Fellbach Office:

Postal Address:

Gutenbergstrasse 20

D-70736 Fellbach

Address:

P.O. Box 4252

D-70719 Fellbach

Tel.: +49 (0)711 51822-0

Fax: +49 (0)711 51822-41

www.lufft.com

info@lufft.de

Berlin Office:

Carl-Scheele-Strasse 16

D-12489 Berlin

Phone: +49 711 51822-831

Fax: +49 711 51822-944

a passion for precision · passion pour la précision · pasión por la precisión · passione per la precisione

Lufft North America:

Lufft USA, Inc.

1110 Eugenia Place Unit B

Carpinteria California,

93013 USA

Tel.: +01 919 556 0818

Fax: +01 805 845 4275

E-Mail: sales@lufftusainc.com

www.lufft.com

Lufft China:

Shanghai Office:

Lufft (Shanghai)

Measurement & Control

Technology Co., Ltd.

Room 507 & 509, Building No.3,

Shanghai Yinshi Science and

Business Park,

No. 2568 Gudai Road,

Minhang District,

201199 Shanghai, CHINA

Tel: +86 21 5437 0890

Fax: +86 21 5437 0910

E-Mail: china@lufft.com

www.lufft.cn

