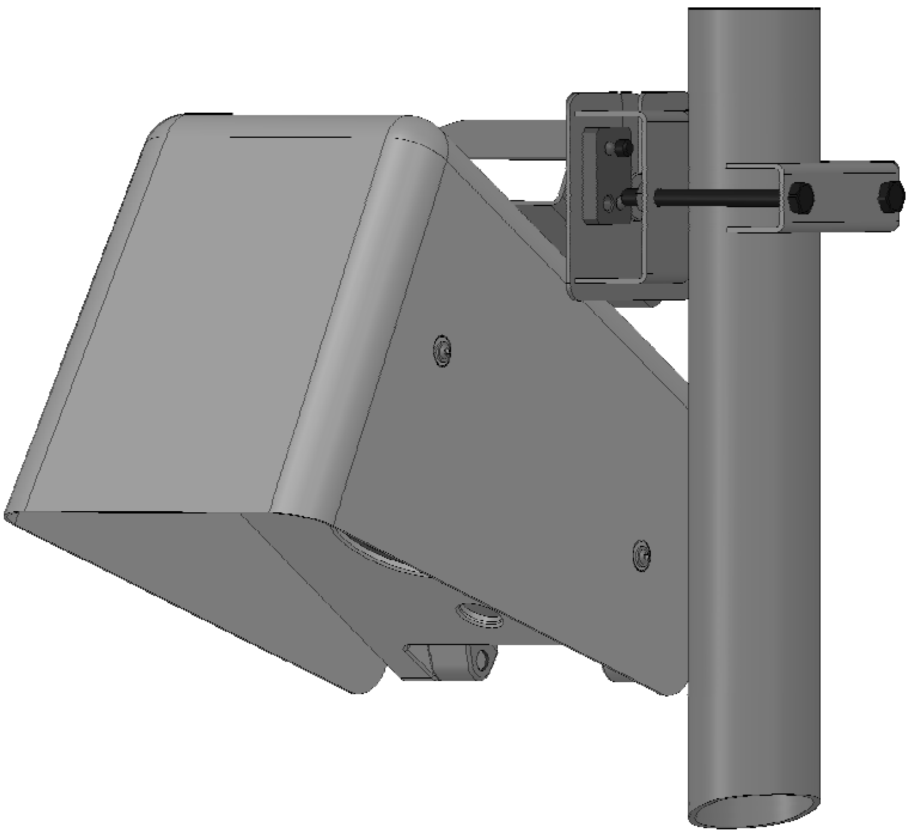
Operating Manual English

Non Invasive Road Sensor
NIRS31-UMB

Please read this Operating Manual in its entirety before commissioning the equipment.



www.lufft.com

Contents

1 Please Read Before Use

Please read this Operating Manual carefully and keep it handy for future reference. Please note that various components of the sensor and the described software may look somewhat different from those shown in the illustrations in this operating manual.

This manual is valid for devices of the Lufft NIRS31-UMB with device version 19 or higher (9/2012). Some functions or features specified in this manual may not be available or may not be valid with older device versions. The device version is indicated as the last number of the serial number printed on the type plate, e.g.: the device with SN: 063.1010.0707.**014** has the device version 14.

1.1 Symbols Used

Important information concerning potential hazards to the user

Important information concerning the correct operation 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.

1.4 Incorrect Use

If the equipment is not correctly installed:

- It may not function or its operation may be limited.
- It may be permanently damaged.
- Danger of injury may exist if the equipment is allowed to fall.

If the equipment is not correctly connected:

- It may not function.
- It may be permanently damaged.
- The possibility of an electrical shock may exist under certain circumstances.

1.5 Guarantee

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

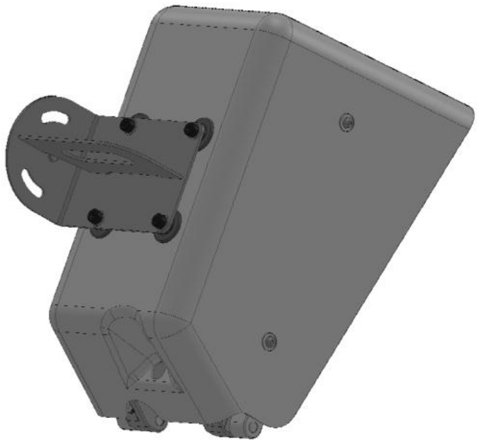
1.6 Brand Names

All brand names referred to are subject without limitation to the valid trademark and ownership rights of the respective owner.

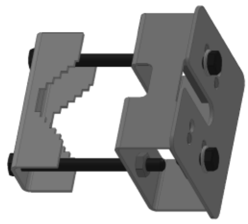
2 Scope of Delivery

The content of the delivery consists of the following components:

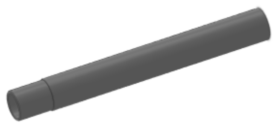
- Sensor NIRS31-UMB



- Mast clamp



- Sounding pipe



- Operating manual

Betriebsanleitung Deutsch

Berührungsloser Straßensensor
NIRS31-UMB

Bitte lesen Sie diese Betriebsanleitung vor der Inbetriebnahme des Gerätes vollständig durch.

- Transport packaging

Note: The delivery **does not include a connection cable**; this must be ordered to the required length (15 or 50 meters; see Accessories page 7).

Note: The sensor must always be transported in the original packaging, as otherwise it will be damaged.

3 Order Numbers

NIRS31-UMB **8710.UT01**

- Non-invasive road sensor including integrated road surface temperature sensor

3.1 Accessories

• 15m connection cable including connector	8371.UK015
• 50 m connection cable including connector	8371.UK050
• Power supply unit 24V/100VA	8366.USV1
• ISOCON-UMB	8160.UISO
• Surge protection	8379.USP

3.2 Spare Parts

• Reflector unit	8710.ULAMP

3.3 Additional Documents and Software

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

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

4 Equipment Description

Depending on the requirements of the road traffic meteorological monitoring network, sensors are installed in the roadways and / or "overhead". The Lufft NIRS31-UMB completes the product range to include a non-invasive, intelligent sensor. The NIRS31-UMB provides an alternative to the Lufft IRS31-UMB, especially for measuring points such as bridges, which do not always allow direct installation of sensors in the roadway. In addition, at points where asphalt repairs often take place, it is no longer necessary to remove the sensor technology during repair works. The optical measuring device NIRS31-UMB for the detection of water, ice and snow can be mounted on a bridge or mast. The measurement distance between the measuring device and the road surface can be from 6 to 15 meters.

The sensor delivers established and commonly used decision-making data to winter maintenance services, including water film height, road condition, road surface temperature and freezing temperature. In addition, the sensor provides ice percentage and snow depth readings. As the ice percentage on the road surface increases, the friction coefficient falls off and this can be used as a guide in preventive road gritting decision-making.

In contrast to built-in road sensors, non-invasive sensors are not able to measure underground soil temperature.
The equipment is connected by way of an 8 poleplug-interminal and associated connection cable (available in lengths of 15m and 50m).

The measured values can be requested over the RS485 interface in accordance with the UMB protocol.

During commissioning, configuration and measurement polling takes place using the UMB Config Tool (Windows®PC software).

4.1 Road Surface Temperature

Road surface temperature is measured by means of a non-invasive pyrometer, which is fully integrated into the sensor.

4.2 Water Film Height

Measurement of the water film height on the road surface takes place by means of non-invasive optical spectroscopy.

4.3 Road Condition

The current road condition is determined from the measurement of water film height and road surface temperature. The sensor calculates the following conditions: dry, damp, wet, snow / ice and critical wetness.

4.4 Ice Percentage

The proportions of frozen solution are determined from the measurement data provided by optical spectroscopy and transmitted as the ice percentage.

4.5 Freezing Temperature

The freezing temperature is determined on the basis of the current road surface temperature and the measured ice percentages.
Note: The freezing temperature can only be determined if ice percentages have already formed. Determination of freezing temperature is currently limited to the de-icing agent sodium chloride (NaCl).

4.6 Saline Concentration

The saline concentration is calculated from the current freezing temperature.

Note: The saline concentration can only be determined if ice percentages have already formed. Determination of saline concentration is currently limited to the de-icing agent sodium chloride (NaCl).

4.7 Snow Height

The sensor detects the snow height in the field of measurement.

4.8 Friction

Friction describes the grip of tires on the road surface. This can be reduced as a result of environmental influences such as rain or snow. The value of the friction is scaled between 0.1 and 1.0. High values indicate a good grip, and low values indicate a bad grip. The highest value is reached in dry road conditions. If there is water on ice the lowest value is the result.

4.9 Sensor Technology NIRS31-UMB

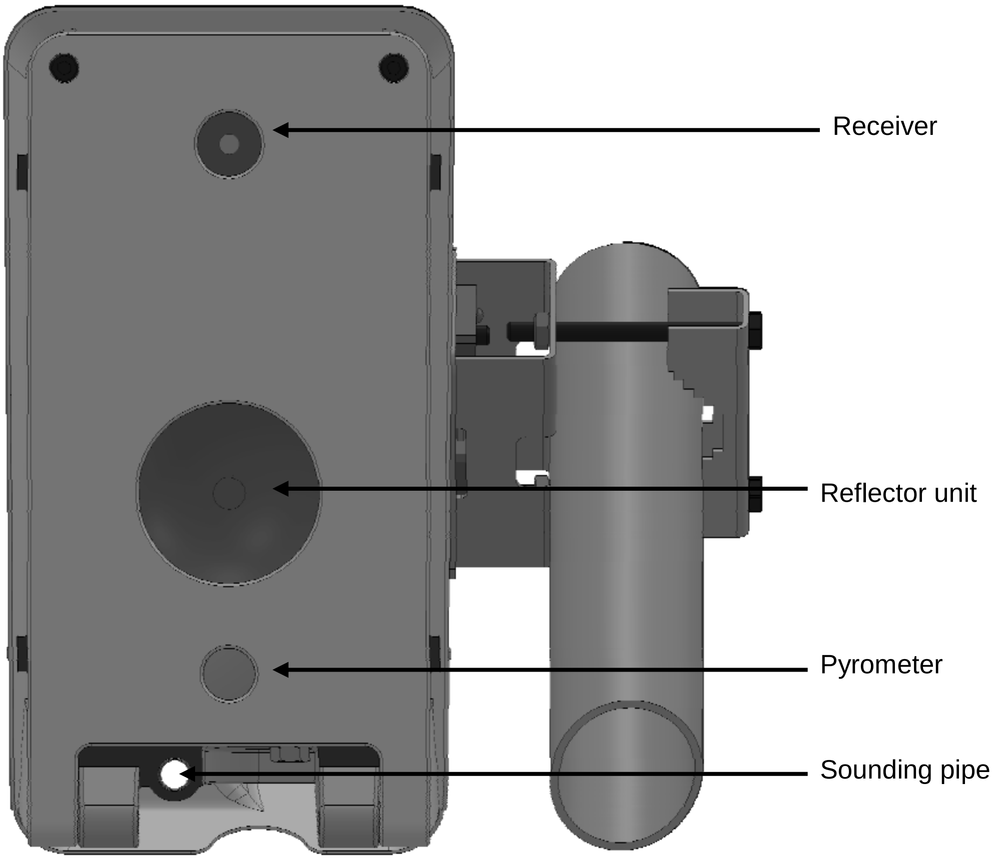


Fig. 1: Sensor Technology

5 Generation of Measurements

5.1 Current Measurement (act)

The value of the last measurement is transmitted when the current measurement value is requested.

6 Measurement Output

The factory default setting for the transmission of measurements is UMB binary protocol.

You can find an example of a measurement request for the various protocols and a complete summary of the list of channels in the Appendix.

6.1 Measurements

6.1.1 Road Surface Temperature

Sampling rate 1 minute

Units °C; °F

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
100				Road surface temperature	-40.0	70.0	°C
101				Road surface temperature	-40.0	158.0	°F

6.1.2 Freezing Temperature

Sampling rate <1 minute

Units °C; °F

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
110				Freezing temperature NaCl	-40.0	0.0	°C
111				Freezing temperature NaCl	-40.0	32.0	°F

6.1.3 Water Film Height

Sampling rate <1 minute

Units µm; mil

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
600				Water film height	0.0	2000.0	µm
605				Water film height	0.0	78.7	mil

6.1.4 Road Condition

Sampling rate <1 minute

Units logic coding

Request channels:

UMB Channel					Coding
act				Measurement Variable (uint8)	
900				Road condition	0 Dry 1 Damp 2 Wet 4 Snow / ice 6 Critical wet 99 Undefined

dry: on the road there is no liquid water, the water film height is less than the damp threshold

damp: on the road there is liquid water; the water film height is less than the wet threshold

wet: on the road there is liquid water; water film height is equal or greater than the wet threshold

snow / ice: frozen water is on the road; it’s in the form of snow or ice

critical wet: water film height is equal to or greater than the damp threshold and the road temperature is below 0 °C, so there is the risk of iceing

The thresholds for damp and wet in the factory settings are 30 and 10µm, they can be adjusted in the sensor configuration.

6.1.5 Ice Percentage

Sampling rate <1 minute

Units %

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
800				Ice percentage	0.0	100.0	%

6.1.6 Saline Concentration

Sampling rate <1 minute

Units %

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
810				Saline concentration NaCl	0.0	100.0	%

6.1.7 Snow Height

Sampling rate <1 minute

Units mm

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
610				Snow height	0.0	10.0	mm

6.1.8 Friction

Sampling rate <1 minute

Units none

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
820				Friction	0.0	1.0	none

6.2 Other Information

The sensor delivers further information about the condition and operation of the sensor.

6.2.1 Service Level

UMB Channel					Measuring Range		
act				Measurement Variable (sint16)	min	max	unit
4000				Service level	0	100	%

100% Equipment recently serviced

<30% Service due in less than 100 days

<10% Service due in less than 30 days

A negative value indicates that the due service period was exceeded.

6.2.2 Remaining Time to Next Service

UMB Channel					Measuring Range		
act				Measurement Variable (sint16)	min	max	unit
4001				Remaining time to next service			h

Indicates the number of hours to the next service. A negative value indicates that the due service period was exceeded.

6.2.3 Lamp Status

UMB Channel					
act				Measurement Variable (uint8)	
4002				Lamp status	0 Lamp OK 1 Lamp faulty

Note: In the event of a faulty lamp it is necessary to change the reflector unit to restore correct operation.

6.2.1 Measure Status

UMB Channel					
act				Measurement Variable (uint8)	
4003				Measure Status	

Bit 0	Status Transmitter	0 transmitter is working properly 1 transmitter is not working properly; contact hotline
Bit 1	Status Receiver	0 receiver is working properly 1 receiver is not working properly; contact hotline
Bit 2	Status Measurement	0 measurement is working properly 1 measurement does temporary not work properly; for example, it can be caused by a stationary vehicle under the sensor; after this failure the sensor is working properly again
Bit 3	Status Pyrometer	0 measurement is working properly 1 interference suppression is active; for example, it can be caused by a stationary vehicle under the sensor; after this failure the sensor is working properly again

7 Installation

The sensor bracket is designed for installation on a mast with a diameter of 60 – 76mm.

The following tools are required for the installation:

- 2 open-end or box wrenches, SW17

7.1 Fastening

Attach the bracket to the mast at the prescribed height using the bolts, nuts and washers provided. Hold the nut firmly with one wrench and tighten the bolts evenly and securely with the second wrench.

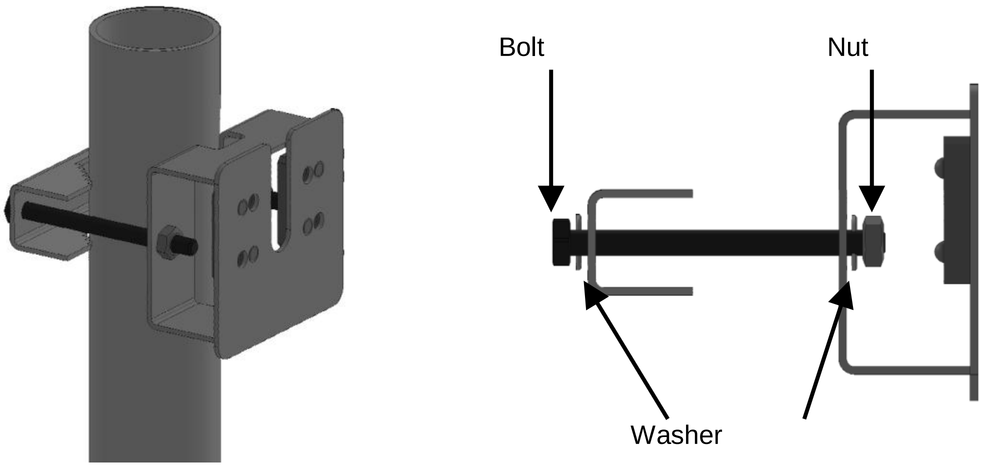


Fig. 2: Mast Bracket

Note: Select the correct bolts in accordance with the diameter of the mast:

60 – 69 mm mast diameter: 100 mm long bolts
70 – 76 mm mast diameter: 120 mm long bolts

Attach the sensor to the bracket from above and fasten using the bolts and washers provided. Tighten the bolts but make sure that the sensor can still be moved.

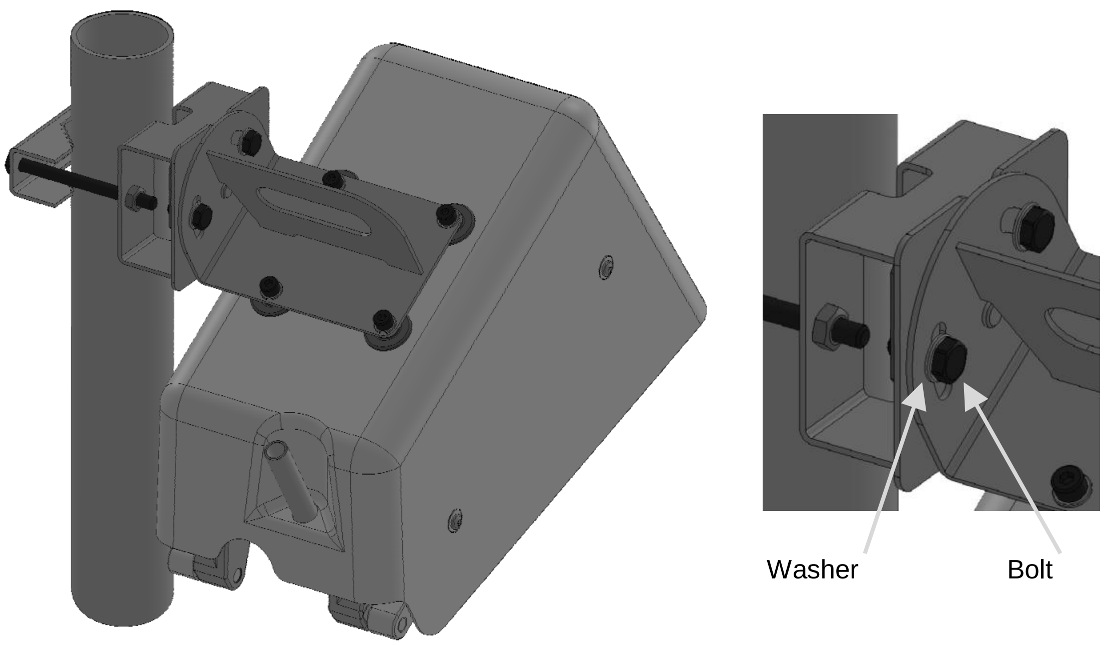


Fig. 3: Sensor Attachment

7.2 Aligning the Sensor

A look through the small tube (sounding pipe) on the bottom of the sensor indicates the center of the measurement field on the road surface. Align the sensor with the center of the roadway while retaining the angle of measurement (between 45 and 85°) and firmly tighten the bolts.

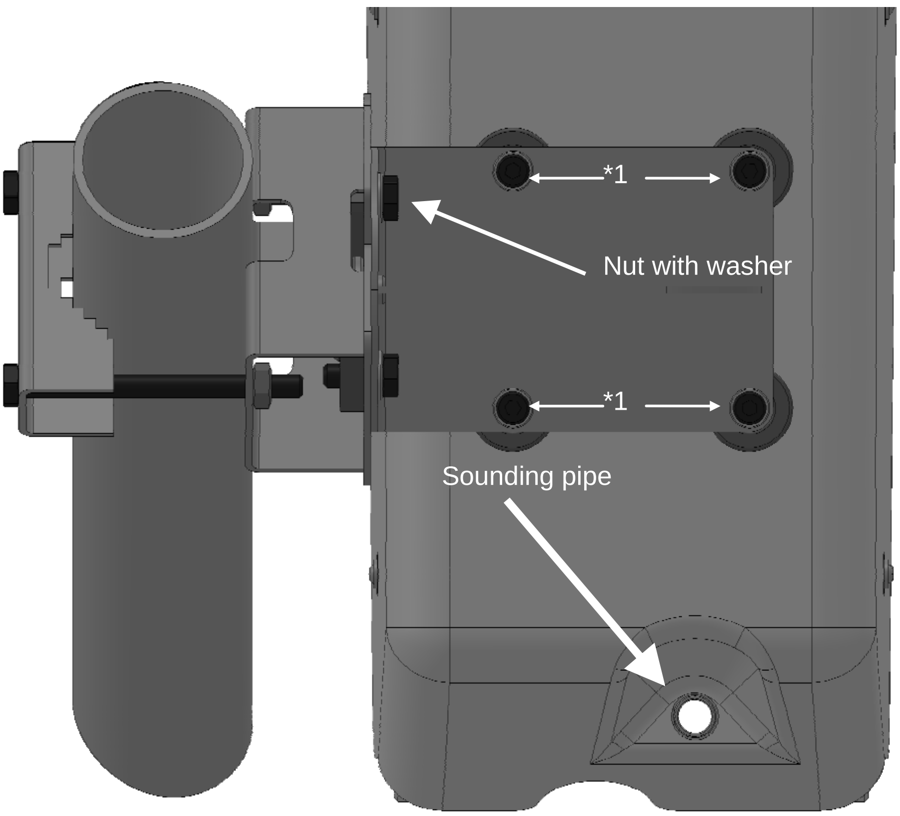


Fig. 4: Aligning the Sensor

Note: If you wish to attach the sensor to the opposite side of the mast, you can adjust the bracket on the sensor **prior to installation**. To do this, remove the 4 bolts marked *1, rotate the bracket by 180° and reattach with the 4 bolts.

7.3 Selecting the Installation Location

In order to guarantee long service life and correct equipment operation, please pay attention to the following points when selecting the installation location.

7.3.1 General Instructions

- Stable subsurface for installing the mast
- Free access to the equipment for maintenance works
- Reliable power supply for permanent operation
- Good network coverage when transmitting over a mobile communications network

Note: The computed measurements specifically apply to the equipment location only. No conclusions can be drawn with regard to the wider environment or a complete road section.

ATTENTION:

- Only approved and tested appliances (conductors, risers etc.) should be used to install the device on the mast.
- All relevant regulations for working at this height must be observed.
- The mast must be sized and anchored appropriately.
- The mast must be grounded in accordance with regulations.
- The corresponding safety regulations for working at road side and in the vicinity of the roadway must be observed.
- Special safety precautions are required when working on roadways in use.

If the equipment is not correctly installed:

- It may not function.
- It may be permanently damaged.
- Danger of injury may exist if the equipment is allowed to fall.

7.3.2 Roadway Condition

The measurement surface of the roadway should be as even, flat and level as possible.

Important note: The measurement surface of the roadway must be free of disturbances and flaws, e.g. road markings, manhole covers, potholes or cracks.

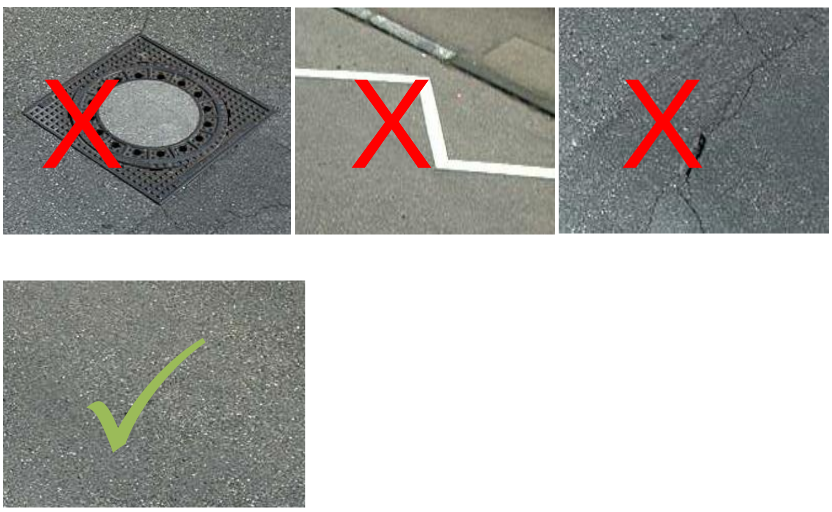


Fig. 5: Roadway Condition

7.3.3 Installation Sketch Mast

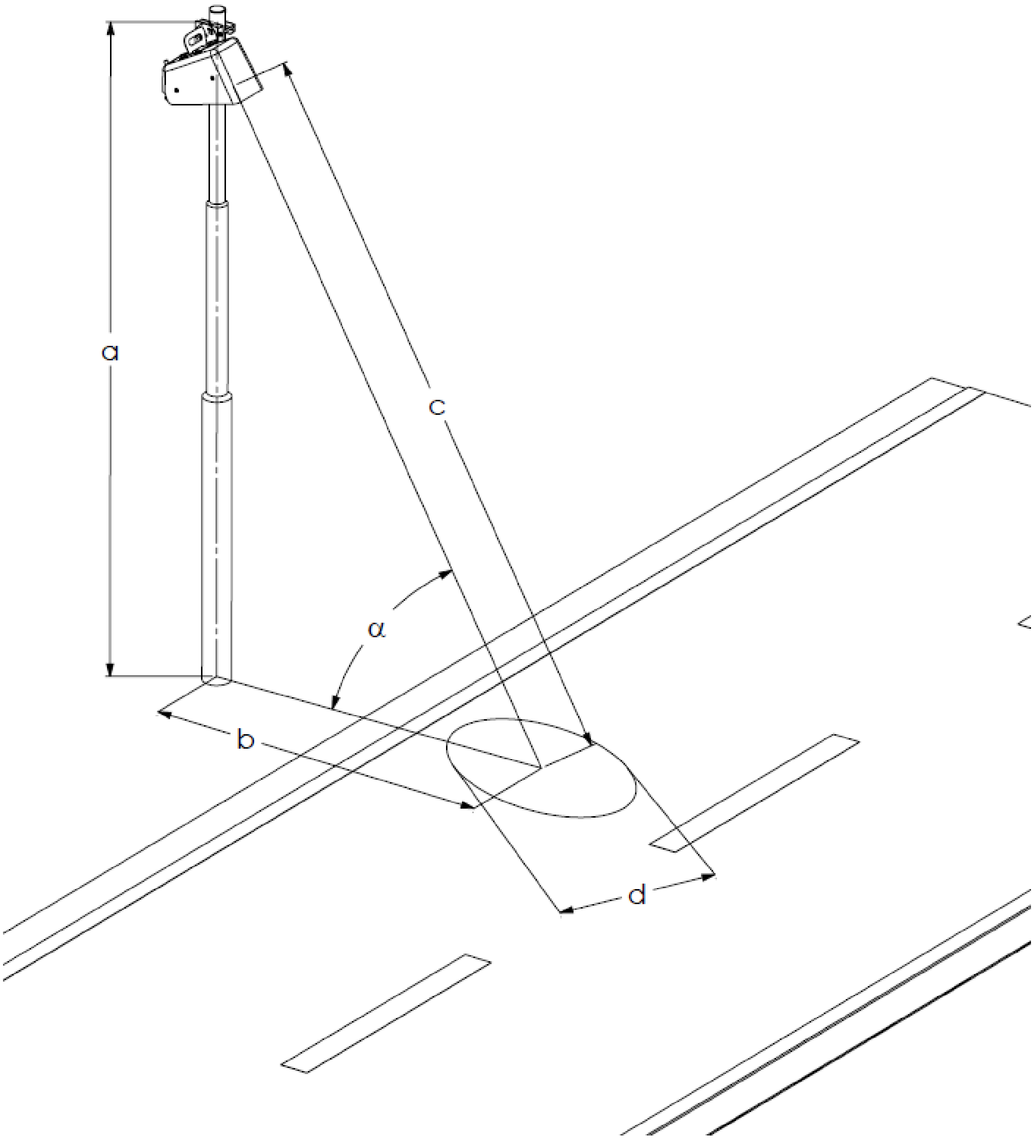


Fig. 6: Installation Sketch Mast

Measurement distance c: 6 to 15m
Measurement angle α: between 45 and 85°
Measurement surface diameter d = measurement distance c / 10

7.3.4 Installation Sketch Gantry

Lateral view from the side of the road.

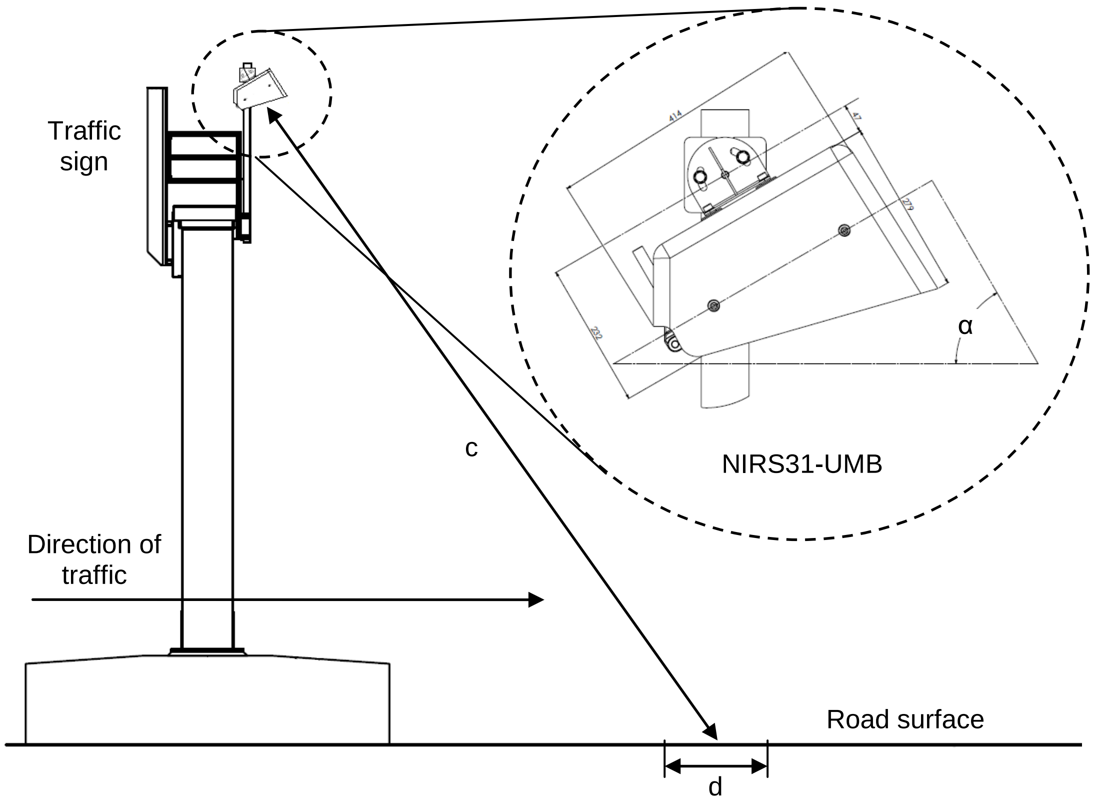


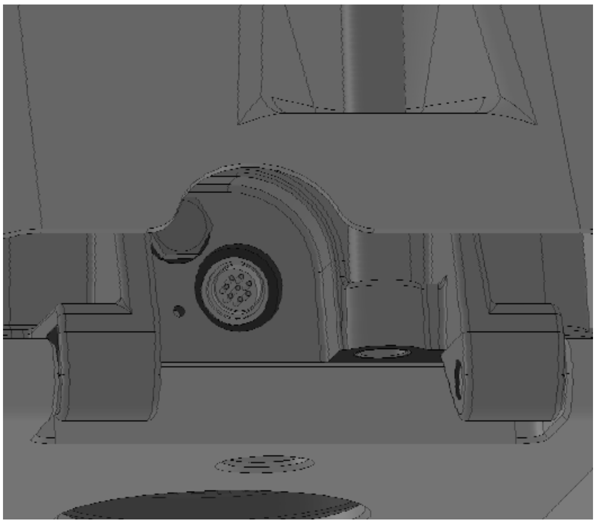
Fig. 7: Installation Sketch Gantry

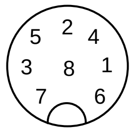
Measurement distance c: 6 to 15m
Measurement angle α: between 45 and 85°
Measurement surface diameter d = measurement distance c / 10

8 Connections

There is an 8 pole plug-in terminal on the bottom of the equipment. This serves to connect the supply voltage and interface. The connection cable must be ordered separately in the desired length (15 or 50 meters) (see page7).

8.1 Equipment Connector





View on cable socket solder connection

Fig. 8: Connector

8.2 Pin Assignment

White	Ground supply voltage	(7)
Brown	Positive supply voltage	(8)
Green	RS485_A / SDI-12 GND	(5)
Yellow	RS485_B/ SDI-12 Data Line	(2)
Grey	Not used	(4)
Pink	Not used	(1)
Blue	Not used	(6)
Red	Not used	(3)

Cable markings are in accordance with DIN 47100.

Note: the connection cable screen must NOT be laid to ground in the control panel.

If the equipment is not connected correctly:

- It may not function.
- It may be permanently damaged
- The possibility of an electrical shock may exist under certain circumstances

8.3 Supply Voltage

The supply voltage for the sensor is 24VDC. The power supply unit used must be approved for operation with equipment of protection class III (SELV).

8.4 RS485 Interface

The equipment has an electrically isolated, half-duplex, 2 wire RS485 interface for configuration, measurement polling and the firmware update.

See page 31 for technical details.

8.5 Connection to ISOCON-UMB (8160.UISO)

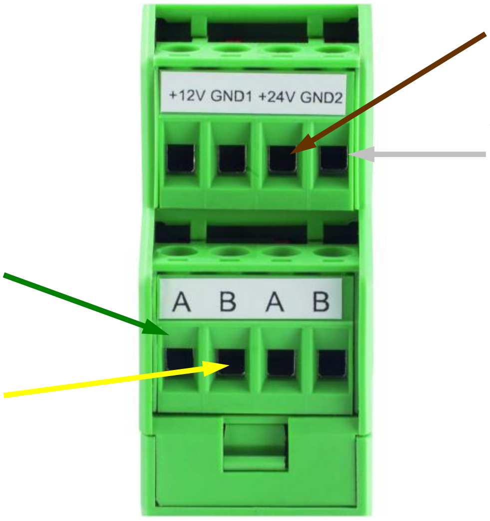


Fig. 9: Connection to ISOCON-UMB

Note: Please refer to the ISOCON-UMB operating manual when assembling the system.

8.6 Use of Surge Protection (8379.USP)

When using surge protection (order no.: 8379.USP), please refer to the connection example in the surge protection operating manual.

9 Commissioning

A Windows® PC with serial interface, UMB Config Tool software and interface cable (SUB-D 9 pole; jack - socket; 1:1) are required for configuration and test purposes.

9.1 Conditions for the Initial Commissioning

During the initial commissioning of the sensor and the associated adaptation, the following conditions must be met for the period of commissioning (10 minutes):

- Completion of installation / assembly / sensor alignment
- **Dry roadway**
- No traffic jam on the road
- No interruption to the power supply

9.2 Important Instructions for Commissioning

Please pay attention to the following points:

- Acquaint yourself with the functionality of the UMB Config Tool.
- Only switch on the power supply after the installation is complete.
- Readjustment is necessary in the event of any change to the position, alignment and measurement distance or installation location.
- **Commissioning / adjustment are not possible if the roadway is not dry; this must be performed manually at a later time at a dry roadway using the UMB Config Tool.**
- It may take longer to complete the adjustment if commissioning takes place during a period of heavy traffic.
- Readjustment is necessary if the power supply is interrupted during adjustment.
- Additional restarts after adjustment has been completed do not affect the measurements as the adjustment data are permanently stored.
- The equipment should be checked for correct operation on site by performing a measurement request with the aid of the UMB Config Tool (see page 27).
- If several NIRS31-UMB devices are operated on a UMB network, a unique device ID must be assigned to each device (see page26).

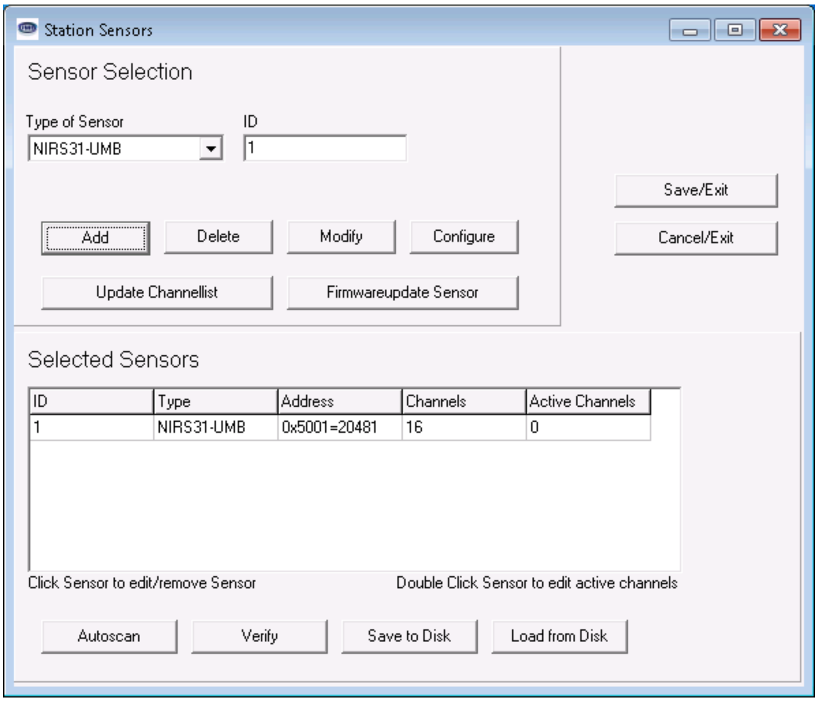
10 Sensor Adjustment

An adjustment is required during commissioning in order to correctly adapt the sensor to the conditions at the installation location.

Note: Please refer to the conditions and instructions on page 23.

10.1 Readjustment using the UMB Config Tool

In sensor selection, select a NIRS31-UMB with associated ID (ID 1 in this example):



Check the sensor in the list with a mouse click and select the ‘Configure’ function.

In sensor configuration, now select the ‘Load profile from sensor’ function.

Select the ‘NIRS-UMB’ tab and in ‘Device parameters’ check ‘renew Adaption’:

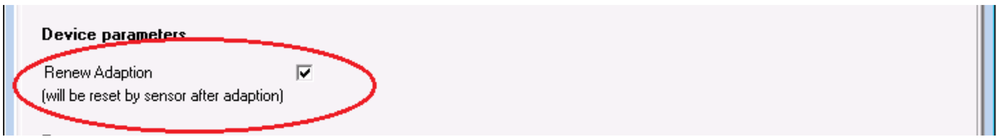


Fig. 10: New Adjustment

In the ‘Main’ tab, now select the ‘store profile on sensor’ function.

The sensor automatically commences the adjustment after a restart.

10.2 Adjustment during Operation

The adjustment is checked permanently during operation and adjusted automatically, where appropriate, for example to compensate for changes to the asphalt due to deterioration.

11 Configuration and Testing

Lufft provides Windows®PC software (UMB Config Tool) for configuration purposes. The sensor can also be tested and the firmware updated with the aid of this software.

11.1 Factory Settings

The sensor is delivered with the following settings:

Class ID:	5 (cannot be modified)
Device ID:	1 (gives address 5001h = 20481d)
Baud rate:	19200
RS485 protocol:	UMB binary
Calculation interval:	10 measurements
Pyrometer offset:	0°C
Pyrometer emissivity:	0.95
Water film moisture threshold:	30 µm
Water film wetness threshold:	100 µm

Note: The device ID must be changed if several non-invasive road sensors are operated on a UMB network, as each device requires a unique ID. It makes sense to start from ID 1 and continue in ascending order.

11.2 Configuration with the UMB Config Tool

The operation of the UMB Config Tool is described in detail in the operating instructions for the Windows® PC software. For this reason only the menus and functions specific to this sensor are described here.

11.2.1 Sensor Selection

In 'Sensor Selection', the road sensor is displayed as NIRS31-UMB (Class ID 5).

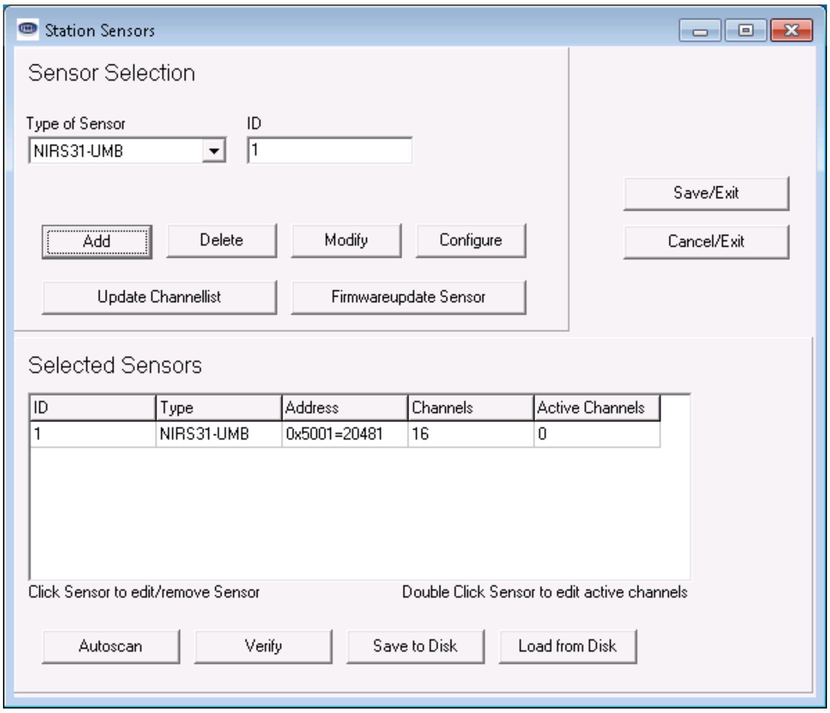


Fig. 11: Sensor Selection

Note: All other devices which are used in the polling process, e.g. modems, LCOM etc., must be disconnected from the UMB network during configuration.

11.2.2 Configuration

After a configuration has been loaded, all relevant settings and values can be adjusted.

11.2.3 General Settings

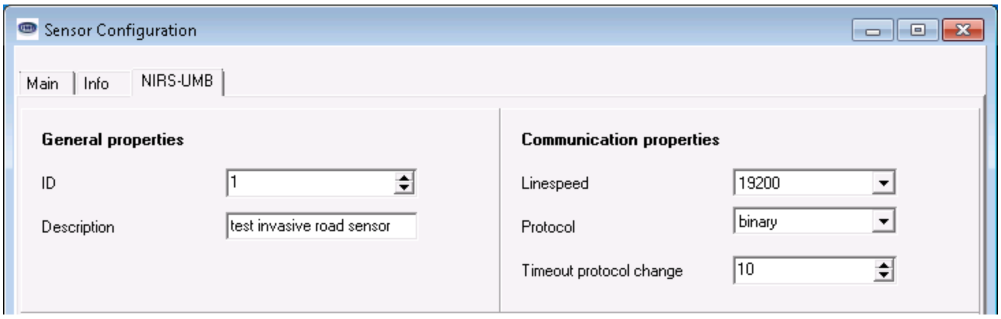


Fig. 12: General Settings

ID: Device ID (factory setting 1; assign device IDs to additional devices in ascending order).

Description: In order to differentiate the devices you can enter a description here, e.g. location.

Linespeed: Transmission speed of the RS485 interface (factory setting 19200; **DO NOT CHANGE for operation with ISOCON-UMB**).

Protocol: Sensor communications protocol (UMB-Binary, UMB-ASCII, SDI-12).

Timeout: In the event of a temporary changeover of the communications protocol, the system switches back to the configured protocol after this time (in minutes).

Important note: If the baud rate is changed, after saving the configuration on the sensor, the sensor communicates at the new baud rate. When operating the sensor in a UMB network with ISOCON-UMB, **this baud rate must not be changed**; otherwise the sensor **is no longer addressable** and can no longer be configured.

11.2.4 Device Settings

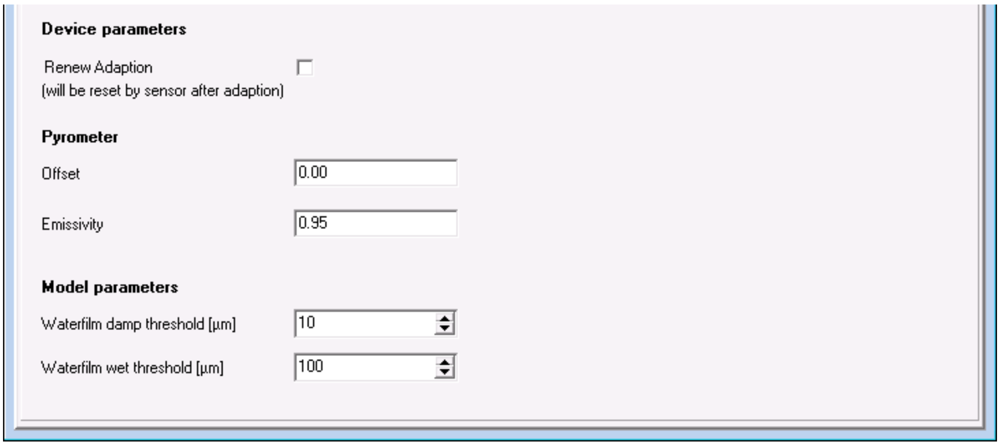


Fig. 13: Equipment Settings

Renew Adaption: The sensor performs a one-time new adjustment to the conditions prevailing at the installation.

Offset: Absolute offset of the temperature measurement in °C.

Emissivity: Emissivity of the road surface for the temperature measurement; the default setting 0.95 is an average value for all road surface types.

Water film damp threshold: The road condition “damp” is transmitted with effect from this water film height.
Note: On polling the TLS channel the condition 32 is transmitted with effect from this threshold.

Water film wet threshold: The road condition “wet” is transmitted with effect from this water film height.

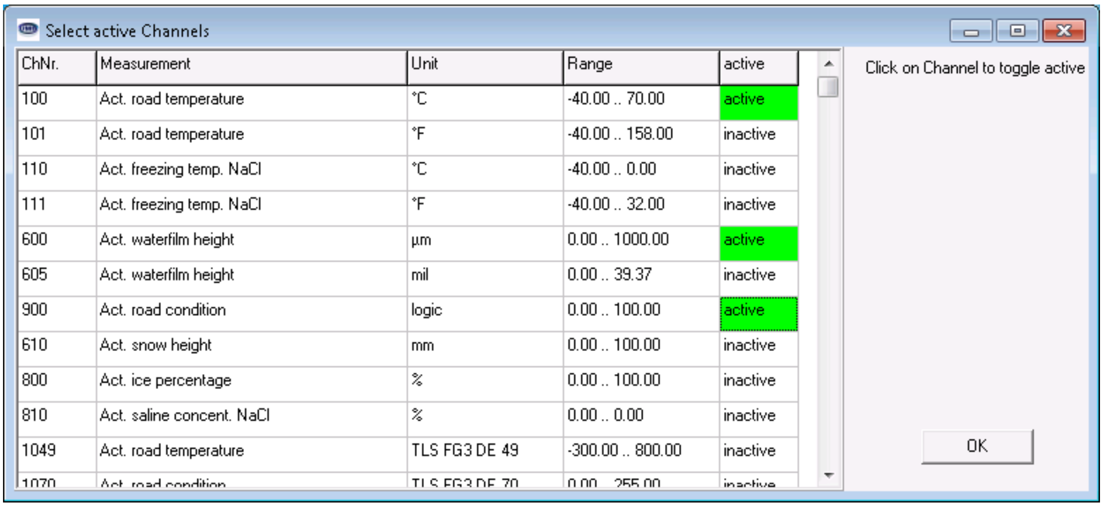
11.3 Function Test with the UMB Config Tool

The function of the sensor can be tested with the UMB Config Tool by polling various channels.

Note: All other devices which are used in the polling process, e.g. modems, LCOM etc., must be disconnected from the UMB network during the function test.

11.3.1 Channels for Measurement Polling

You can select the channel for measurement polling by the UMB Config Tool by clicking on the respective channel.

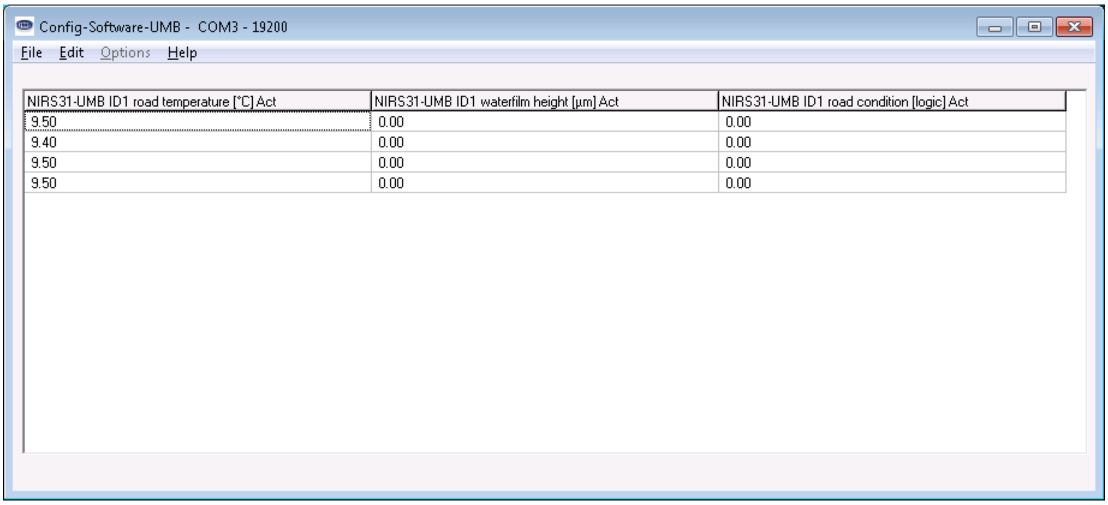


ChNr.	Measurement	Unit	Range	active
100	Act. road temperature	°C	-40.00 .. 70.00	active
101	Act. road temperature	°F	-40.00 .. 158.00	inactive
110	Act. freezing temp. NaCl	°C	-40.00 .. 0.00	inactive
111	Act. freezing temp. NaCl	°F	-40.00 .. 32.00	inactive
600	Act. waterfilm height	µm	0.00 .. 1000.00	active
605	Act. waterfilm height	mil	0.00 .. 39.37	inactive
900	Act. road condition	logic	0.00 .. 100.00	active
610	Act. snow height	mm	0.00 .. 100.00	inactive
800	Act. ice percentage	%	0.00 .. 100.00	inactive
810	Act. saline concent. NaCl	%	0.00 .. 0.00	inactive
1049	Act. road temperature	TLS FG3 DE 49	-300.00 .. 800.00	inactive
1070	Act. road condition	TLS FG3 DE 70	0.00 .. 255.00	inactive

Fig. 14: Measurement Polling Channels

Note: Channel selection relates to measurement polling for the UMB Config Tool only. In general, all channels are always available for polling and do not need to be enabled in the sensor.

11.3.2 Example of Measurement Polling



NIRS31-UMB ID1 road temperature [°C] Act	NIRS31-UMB ID1 waterfilm height [µm] Act	NIRS31-UMB ID1 road condition [logic] Act
9.50	0.00	0.00
9.40	0.00	0.00
9.50	0.00	0.00
9.50	0.00	0.00

Fig. 15: Example of Measurement Polling

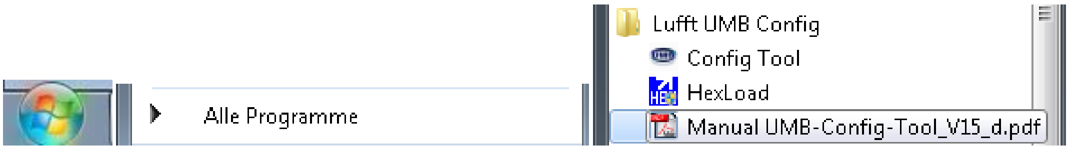
Note: The UMB Config Tool is provided for test and configuration purposes only. It is not suitable for the permanent acquisition of measurement data. We recommend the use of professional software solutions for this purpose, e.g. SmartView3.

12 Firmware Update

To keep the sensor in accordance with the latest state-of-the-art, it is possible to carry out a firmware update on site with no need to remove the sensor and return it to the manufacturer.

The firmware update is carried out with the aid of the UMB Config Tool.

The description of the firmware update can be found in the instructions for the UMB Config Tool. Please download the latest firmware and UMB Config Tool from our website www.lufft.com and install it on a Windows® PC. You can find the instructions here:



13 Maintenance

The following are required for maintenance:

- Hexagon socket wrench, size 6
- Reflector unit (spare part)

Maintenance on the sensor must be performed in accordance with the indication ‘Remaining Time to Next Service’; this is due approximately once annually. The following works must be carried out:

- Replace the reflector unit
- Clean the transmitter and receiver plate
- Function test / renew Adaption

Note: Maintenance works must be performed by trained specialists only and in dry weather (no precipitation), as the housing has to be opened. Otherwise the equipment can be damaged due to the presence of moisture inside the unit.

Important note: When carrying out maintenance, the same conditions that are required for commissioning (see page 23) must be met and the instructions for commissioning must be observed, as a new adjustment of the sensor takes place automatically after maintenance.

13.1 Replacing the Reflector Unit

To replace the reflector unit it is necessary to open the device by loosening the two screws on the front.

Note: Hold the front of the sensor while loosening the screws to ensure that the front of the sensor does not fall downwards.

Remove the reflector unit connection cable and the 3 retaining springs. Lock the new reflector unit into position with the retaining springs and plug the connection cable back into the main board.

13.2 Cleaning the Transmitter and Receiver Plates

If the transmitter and receiver plates are dirty, clean them with a damp, wrung out cloth. Then dry the plates with a dry, dust-free cloth.

Also remove any dust and dirt on the housing.

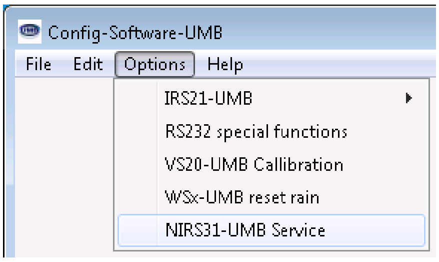
Do not use solvents such as benzene, thinner, alcohol, kitchen cleaners, etc. to clean the sensor as these can damage the housing and optical parts.

If you use a chemical cleaning cloth, please refer to the associated instructions.

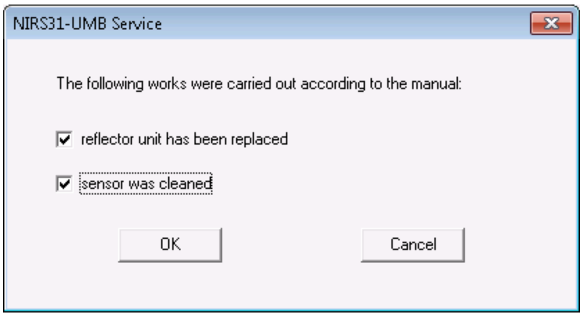
13.3 Resetting the Service Level

After carrying out maintenance and replacing the reflector unit, the sensor must be informed about this procedure using the UMB Config Tool.

In the menu under 'Options', select the entry 'NIRS31-UMB Service':



Confirm the performance of maintenance with 'OK'.



Important note: Only use this function if maintenance was actually carried out and the reflector unit was actually replaced.

Important note: When carrying out this function, the same conditions that are required for commissioning (see page 23) must be met and the instructions for commissioning must be observed, as a new adjustment of the sensor takes place automatically after maintenance.

13.4 Function Test

To check the function of the sensor after maintenance, a function test must be performed as described in Section11.3.

14 Technical Data

Power supply:	24VDC +/- 10%
Current consumption and power input:	approx. 1.65 A / 40 VA at 24VDC
Sensor dimensions:	Height 425 mm Width 225 mm Depth 285 mm
Sensor weight:	approx. 9.9 kg
Mast bracket weight:	approx. 1.0 kg
Fastening:	Mast bracket for Ø 60 - 76mm
Protection class:	III (SELV)
Protection type:	IP65
Storage conditions	
Permissible storage temperature:	-40°C ... +70°C
Permissible relative humidity:	0 ... 95% R.H. non-condensing
Operating conditions	
Permissible ambient temperature:	-40°C ... +60°C
Permissible relative humidity:	0 ... 100% R.H.
Permissible altitude above sea level:	N/A
RS485 interface, 2 wire, half-duplex	
Data bits:	8 (SDI-12 Mode: 7)
Stop bit:	1
Parity:	No (SDI-12 Mode: even)
Tri-state:	2 bits after stop bit edge
Adjustable baud rates:	1200, 2400, 4800, 9600, 14400, 19200[1], 28800, 57600 (SDI-12 Mode: 1200 fixed)
Housing:	Aluminium; plastic cover

[1] Factory setting and baud rate for firmware update

14.1 Measurement Range / Accuracy

14.1.1 Road Surface Temperature

Measurement process:	Pyrometer
Measuring range:	-40°C ... +70°C
Resolution:	0.1°C
Accuracy:	+/- 0.8°C
Sampling rate:	1 minute
Units:	°C; °F

14.1.2 Water Film Height

Measurement process:	Spectroscopic
Measuring range:	0 ... 2000 µm
Resolution:	0.01 µm
Accuracy:	+/- 0.1 mm +/- 20% of measurement
Sampling rate:	<1 minute
Units:	µm, mil

14.1.3 Freezing Temperature

Measurement process:	Spectroscopic
Measuring range:	-40°C ... 0°C
Resolution:	0.1°C
Sampling rate:	<1 minute
Units:	°C; °F

14.1.4 Ice Percentage

Measurement process:	Spectroscopic
Measuring range:	0% ... 100%
Resolution:	0.1%
Sampling rate:	<1 minute
Units:	%

14.1.5 Saline Concentration

Measurement process:	Spectroscopic
Measuring range:	0% ... 100%
Resolution:	0.1%
Sampling rate:	<1 minute
Units:	%

14.1.6 Snow Height

Measurement process:	Spectroscopic
Measuring range:	0 ... 10mm
Resolution:	0.1mm
Sampling rate:	<1 minute
Units:	mm

14.1.7 Friction

Measurement process:	Spectroscopic
Measuring range:	0 ... 1
Resolution:	0.01
Sampling rate:	<1 minute

14.2 Drawings

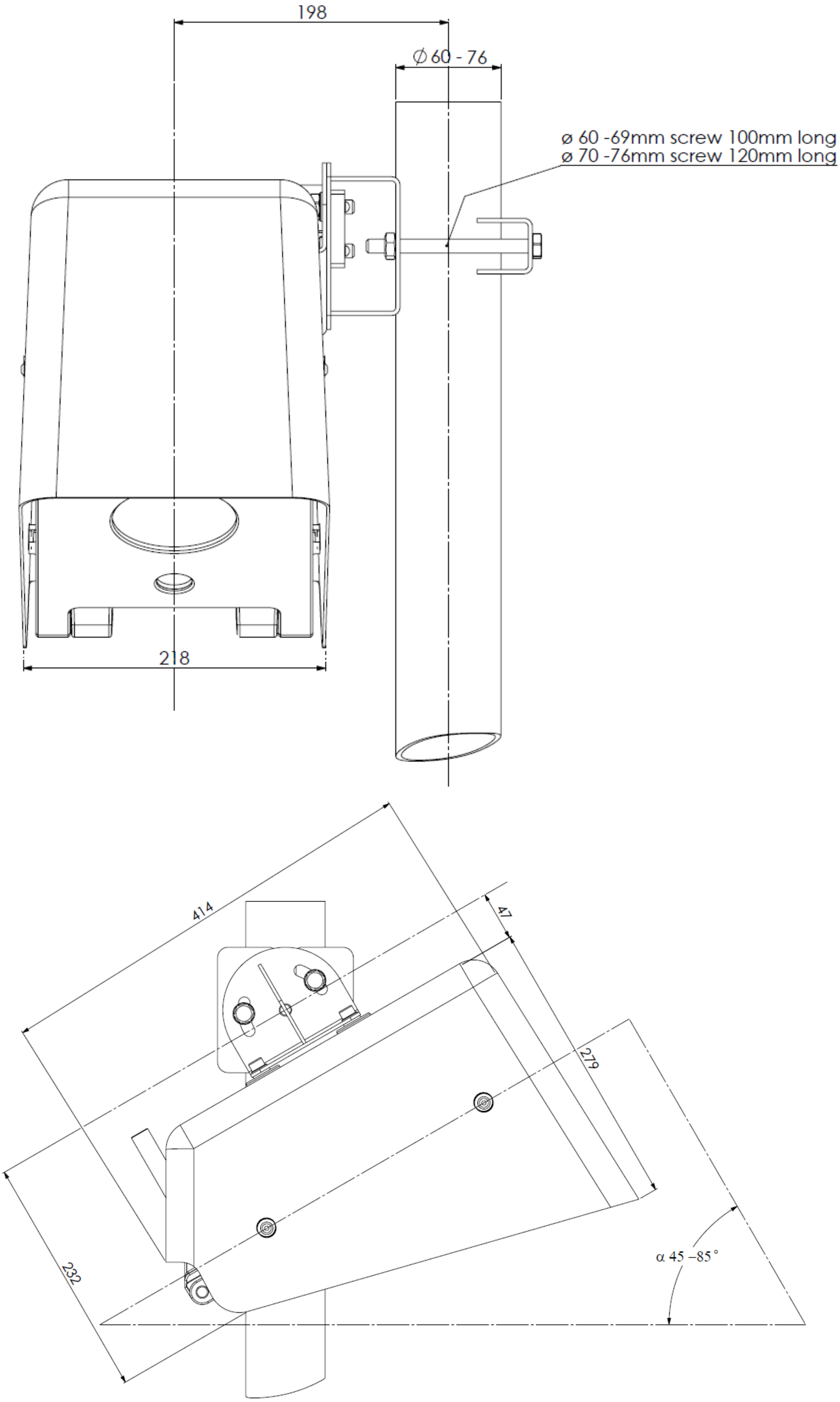


Fig. 16: NIRS31-UMB

15 EC Certificate of Conformity

Product: Non-Invasive Road Sensor

Type: NIRS31-UMB (Order No.: 8710.UT01)

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/EC.

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

<u>EN 61000-6-2:2005 Part 6-2: Generic Standards - Immunity for Industrial Environments</u>

EN 61000-4-2 (2009)	ESD
EN 61000-4-3 (2011)	Radiated electromagnetic field
EN 61000-4-4 (2010)	Burst
EN 61000-4-5 (2007)	Surge
EN 61000-4-6 (2009)	Conducted disturbances, induced by radio-frequency fields
EN 61000-4-8 (2010)	Power frequency magnetic field immunity
EN 61000-4-16 (2010)	conducted, common mode disturbances
EN 61000-4-29 (2001)	Short interruptions and voltage variations on d.c. input

<u>EN 61000-6-3:2007 Part 6-4: Generic Standards - Emission Standard for Industrial Environments</u>

EN 55011:2009 + A1:2010 (2011) Line-conducted disturbances
IEC / CISPR 11:2009 and changes 1:2010 Class A
prEN 50147-3:2000 Radiated emission

Fellbach, 22.08.2011 Axel Schmitz-Hübsch

16 Fault Description

Fault Description	Cause - Remedy
Device does not allow polling or does not respond	- Check supply voltage - Check interface connection - Incorrect device ID →check ID; devices are delivered with ID 1.
Device delivers implausible values	- Check for compliance with the sensor installation instructions - Adaptation not suitable for the installation location→repeat the adaptation using the UMB Config Tool
Device transmits error value 24h (36d)	A channel was requested that is not available on this device.
Device transmits error value 28h (40d)	Device is in initialization phase after start-up →wait until first measurement is complete.
Device transmits error value 50h (80d)	Device is being operated above the specified measuring range.
Device transmits error value 51h (81d)	Device is being operated below the specified measuring range.
Device transmits error value 55h (85d)	The device is unable to execute a valid measurement due to the ambient conditions. This may be due to the following reasons: - in the measurement field stands a vehicle for a certain time e.g. traffic jam
Device transmits an error value not listed here	There may be several reasons for this behaviour → contact the manufacturer's technical support service.

17 Disposal

17.1 Within the EC

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.

17.2 Outside the EC

Please comply with the applicable regulations for the proper disposal of waste electrical and electronic equipment in your respective country.

18 Repair / Corrective Maintenance

Please arrange for any faulty equipment to be checked and, if necessary, repaired by the manufacturer exclusively. Do not open the equipment and do not under any circumstances attempt to carry out your own repairs.

In matters of guarantee or repair please contact:

G. Lufft Mess- und Regeltechnik GmbH

Gutenbergstraße 20
70736 Fellbach

PO 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.

18.1 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 www.lufft.com (menu header: Support → FAQs).

19 Appendix

19.1 Channel List Summary

The channel assignment described here applies to online data requests in UMB protocol.

<table>
<tr><th colspan="4">UMB Channel</th><th></th><th colspan="3">Measuring Range</th></tr>
<tr><th>act</th><th>min</th><th>max</th><th>avg</th><th>Measurement Variable (float32)</th><th>min</th><th>max</th><th>unit</th></tr>
<tr><td colspan="8">Road surface temperature</td></tr>
<tr><td>100</td><td></td><td></td><td></td><td>road temperature</td><td>-40.0</td><td>70.0</td><td>°C</td></tr>
<tr><td>101</td><td></td><td></td><td></td><td>road temperature</td><td>-40.0</td><td>158.0</td><td>°F</td></tr>
<tr><td colspan="8">Freezing temperature</td></tr>
<tr><td>110</td><td></td><td></td><td></td><td>freezing temp. NaCl</td><td>-40.0</td><td>0.0</td><td>°C</td></tr>
<tr><td>111</td><td></td><td></td><td></td><td>freezing temp. NaCl</td><td>-40.0</td><td>32.0</td><td>°F</td></tr>
<tr><td colspan="8">Water film height</td></tr>
<tr><td>600</td><td></td><td></td><td></td><td>water film height</td><td>0.0</td><td>2000.0</td><td>µm</td></tr>
<tr><td>605</td><td></td><td></td><td></td><td>water film height</td><td>0.0</td><td>393.7</td><td>mil</td></tr>
<tr><td colspan="8">Snow height</td></tr>
<tr><td>610</td><td></td><td></td><td></td><td>snow height</td><td>0.0</td><td>10.0</td><td>mm</td></tr>
<tr><td colspan="8">Ice percentage</td></tr>
<tr><td>800</td><td></td><td></td><td></td><td>ice percentage</td><td>0.0</td><td>100.0</td><td>%</td></tr>
<tr><td colspan="8">Saline concentration</td></tr>
<tr><td>810</td><td></td><td></td><td></td><td>salineconcent. NaCl</td><td>0.0</td><td>100.0</td><td>%</td></tr>
<tr><td colspan="8">Road condition</td></tr>
<tr><td>900</td><td></td><td></td><td></td><td>road condition (uint8)</td><td colspan="3">0 Dry
1 Damp
2 Wet
4 Snow / ice
6 Critical wetness
99 Undefined</td></tr>
<tr><td colspan="8">Friction</td></tr>
<tr><td>820</td><td></td><td></td><td></td><td>friction</td><td>0.0</td><td>1.0</td><td>none</td></tr>
<tr><td>910</td><td></td><td></td><td></td><td>road wather index (uint8)</td><td colspan="3">0 normal road weather
1 bad road weather
2 very bad road weather</td></tr>
<tr><td colspan="8">Service level</td></tr>
<tr><td>4000</td><td></td><td></td><td></td><td>service level</td><td>-500.0</td><td>100.0</td><td>%</td></tr>
<tr><td colspan="8">Remaining time to service</td></tr>
<tr><td>4001</td><td></td><td></td><td></td><td>rem. time to service</td><td>-10000.0</td><td>10000.0</td><td>h</td></tr>
<tr><td colspan="8">Lamp Status</td></tr>
<tr><td>4002</td><td></td><td></td><td></td><td>lamp status</td><td colspan="3">0 Lamp OK
1 Lamp faulty</td></tr>
<tr><td>4003</td><td></td><td></td><td></td><td>measure status</td><td colspan="3">See page 15</td></tr>
</table>

19.2 Channel List Summary per TLS2002 FG3

The following channels are available specifically for data requests for further processing in TLS format. These channels are available in binary protocol only.

DE Type	UMB Channel	Meaning	Format	Range	Resolution	Coding
49	1049	Result message Road surface temperature FBT	16 bit	-30 ... +80°C	0.1°C	80.0 = 800d = 0320h 0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h
52	1052	Result message Residual salt NaCl RS	8 bit	0 … 100%	1%	0 = 0d = 00h 100 = 100d = 64h 255 = 255d = FFh
65	1065	Result message Frezing temperature NaCl GFT	16 bit	-30 … 0°C	0.1°C	0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h
70	1070	Result message Road surface state FBZ	8bit	0 ... 255		0 Road is completely dry and free of snow and ice. 32 Road is wet with liquid water / aqueous solution. 64 Road is covered with frozen water/ solid aqueous solution. 255 Sensor is unable to determine the state of the road surface due to the prevailing conditions.
72	1072	Result message Water film height WFD	16 bit	0.00...10.00 mm	0.01 mm	0 = 0d = 0000h 10.00 = 1000d = 03E8h 65535 = 65535d = FFFFh
75	1075	Result message Snow film height SFD	8 bit	0 … 50 mm	1 mm	0 = 0d = 00h 50 = 50d = 32h 255 = 255d = FFh
77	1077	Result message Friction GR	8 Bit	0.00…1.00	0.01	0,00 = 0d = 00h 1,00 = 100d = 64h
79	1079	Result message Road surface state for winter services FZW	8 Bit	0 … 255		0 Dry 16 Damp 32 Wet 48 Extremely Wet 64 Slippery
129	1129	Result message Ice percentage EP	8 Bit	0…100 %	1%	0 = 0d = 00h 100 = 100d = 64h 255 = 255d = FFh

19.3 Communication in Binary Protocol

Only one example of an online data request is described in this operating manual. Please refer to the current version of the UMB Protocol for all commands and the exact mode of operation of the protocol (available for download at www.lufft.com).

Note: Communication with the sensor takes place in accordance with the master-slave principle, i.e. there may only be ONE requesting unit on a network.

19.3.1 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 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 transmission (03h); 1 byte
<cs>	Check sum, 16 bit CRC; 2 bytes
EOT	Control character for the end of the frame (04h); 1 byte

Control characters: SOH (01h), STX (02h), ETX (03h), EOT (04h).

19.3.2 Addressing with Class and Device ID

Addressing takes place by way of a 16 bit address. This breaks down into a Class ID and a Device ID.

Address (2 bytes = 16 bit)				
Bits 15 – 12 (upper 4 bits)		**Bits 11 – 8 (middle 4 bits)**	**Bits 7 – 0 (lower 8 bits)**	
Class ID (0 to 15)		**Reserve**	**Device ID** (0 – 255)	
0	Broadcast		0	Broadcast
5	Non-Invasive Road Sensor		1 - 255	Available
15	Master or control devices			

ID = 0 is provided as broadcast for classes and devices. Thus 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; or in the case of a command, e.g. reset.

19.3.3 Example for Creating Addresses

If, for example, you want to address a NIRS31-UMB device with the device ID 001, this takes place as follows:

The class IDfor theNIRS31-UMB is5d = 5h

The device ID is e.g. 001d = 01h

Putting the class and device IDs together gives the address 5001h (20481d).

19.3.4 Example of a Binary Protocol Request

If, for example, a NIRS31-UMB device with the device ID 001 is to be polled from a PC for the current road surface temperature, this takes place as follows:

Sensor:

The class ID for theNIRS31-UMB is5 = 5h

The device ID is 001 = 01h

Putting the class and device IDs together gives a target address of 5001h.

PC:

The class ID for the PC (master unit**)** is 15 = Fh

The PC ID is e.g. 001d = 01h

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

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

The command for the online data request is 23h

The version number of the command is 1.0 = 10h

The channel number is in <payload>; as can be seen from the channel list (page37); the current road surface temperature in °C in the channel is 100d = 0064h.

The calculated CRC is 75D4h.

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	50h	01h	F0h	04h	02h	23h	10h	64h	00h	03h	D4h	75h	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	50h	0Ah	02h	23h	10h	00h	64h	00h	16h

<value>				ETX	<cs>		EOT
15	**16**	**17**	**18**	**19**	**20**	**21**	**22**
8Fh	00h	45h	41h	03h	38h	B1h	04h

Interpretation of the response:

<status> = 00h device o.k. (≠ 00h signifies error code; see page41)

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

<value> = 4145008Fh corresponds to a float value of 1.23126E+0001 = 12.3

The road surface temperature is therefore 12.3°C.

Correct data transmission can be checked with the aid of the check sum (B138h).

Note: Little Endian (Intel, low byte first) applies when transmitting word and float variables of addresses or the CRC, for example. This means first the low byte and then the high byte.

19.3.5 Status and Error Codes in Binary Protocol

If a measurement request delivers the <status> 00h, the sensor is working correctly. You can find a complete list of additional codes in the description of the UMB protocol.

Extract from list:

<status>	Description
00h (0d)	Command successful; no error; all o.k.
10h (16d)	Unknown command; not supported by this device
11h (17d)	Invalid parameter
24h (36d)	Invalid channel
28h (40d)	Device not ready; e.g. initialization / calibration running
50h (80d)	Measurement variable (+offset) is outside the set display range
51h (81d)	
52h (82d)	Measurement value (physical) is outside the measuring range (e.g. ADC over range)
53h (83d)	
54h (84d)	Error in measurement data or no valid data available
55h (85d)	Device /sensor unable to carry out valid measurements due to ambient conditions

19.3.6 CRC Calculation

CRC is calculated according to the following rules:

Norm: CRC-CCITT

Polynomial: 1021h = x16 + x12 + x5 + 1 (LSB first mode)

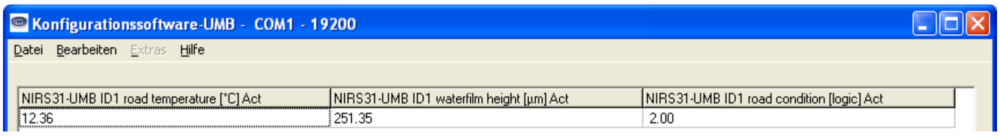
Start value: FFFFh

You can find further information in the description of a CRC calculation in the UMB Protocol.

19.3.7 Recording of a Communication with the UMB Config Tool

The UMB Config Tool uses the command 'Online data request multiple channels' (2Fh) for the data request.

Example of request to 3 channels (100, 600 and 900):



Communication (in hex):

```
Request by UMB Config Tool:
01 10 01 50 16 F0 09 02 2F 10 03 64 00 58 02 84 03 03 D4 FA 04
Response from NIRS31-UMB Sensor:
01 10 16 F0 01 50 1C 02 2F 10 00 03 08 00 64 00 16 8F C2 45 41 08 00 58 02
16 9A 59 7B 43 05 00 84 03 10 02 03 28 A4 04
```

19.4 Communication in ASCII Protocol

Text-based communication with devices is possible using ASCII protocol.

To do this, in the device configuration, interface settings, the protocol mode must be set to ASCII (see page26).

ASCII protocol is network-compatible and serves exclusively for online data requests. The device will not respond to incomprehensible ASCII commands.

Note: The use of binary protocol is recommended for lengthy transmission routes (e.g. network, GPRS/UMTS), as ASCII protocol is unable to detect transmission errors (not CRC-secured).

Note: TLS channels are not available in ASCII protocol.

19.4.1 Structure

An ASCII command is introduced by the ‘&’ character and completed by the CR (0Dh) sign. There is a space character (20h) between the individual blocks in each case; this is represented by an underscore character ‘_’. Characters that represent an ASCII value are in ordinary inverted commas.

19.4.2 Summary of ASCII Commands

Command	Function	BC	AZ
M	Online data request		l
X	Switches to binary protocol		k
R	Triggers software reset	●	k
D	Software reset with delay	●	k
I	Device information		k

These operating instructions describe the online data request only. You can find the description of the other commands in the UMB protocol.

19.4.3 Online Data Request (M)

Description: By way of this command, a measurement value is requested from a specific channel.

Request: ‘&’_<ID>^{5}_‘M’_<channel>^{5} CR

Response: ‘$’_<ID>^{5}_‘M’_<channel>^{5}_<value>^{5} CR

<ID>^{5} Device address (5 decimal places with leading zeros)

<channel>^{5} Indicates the channel number (5 decimal places with leading zeros)

<value>^{5} Measurement value (5 decimal places with leading zeros); a measurement value standardized to 0 – 65520d. Various error codes are defined from 65521d – 65535d.

Example:

Request: `&_20481_M_00100`

By way of this request, channel 100 of the device with address 20481 (NIRS31-UMBwith device ID 001) is requested.

Response: `$_20481_M_00100_34785`

This channel outputs a temperature from –40 to +70°C; this results in the following calculation:

0d	corresponds to	-40°C
65520d	corresponds to	+70°C
36789d	corresponds to	[+70°C – (-40°C)] / 65520 * 34785 +(-40°C) = 18.4°C

Note: TLS channels are not available in ASCII protocol.

19.4.4 Standardization of Measurement Values in ASCII Protocol

The standardization of measurement values from 0d – 65520d corresponds to the measuring range of the respective measurement variable.

Measurement Variable	Measuring Range		
	min	max	unit
Temperature			
Road surface temperature	-40.0	70.0	°C
	-40.0	158.0	°F
Freezing temperature	-40.0	0.0	°C
	-40.0	32.0	°F
Water film height			
Water film height	0.0	2000.0	µm
Snow depth			
Snow depth	0.0	10.0	mm
Percentage			
Ice percentage	0.0	100.0	%
Saline concentration	0.0	100.0	%
Friction	0.0	1.0	none

19.4.5 Status and Error Codes in ASCII Protocol

Various error codes are defined from 65521d – 65535d in addition to the standardization of measurement values.

Codes:

<code>	Description
65521d	Invalid channel
65523d	Measurement value outside measuring range (too high)
65524d	Measurement value outside measuring range (too low)
65525d	Measurement data error or no valid data available
65526d	Device / sensor unable to execute valid measurement due to ambient conditions
65534d	Invalid calibration
65535d	Unknown error

19.5 Communication in SDI-12 Mode

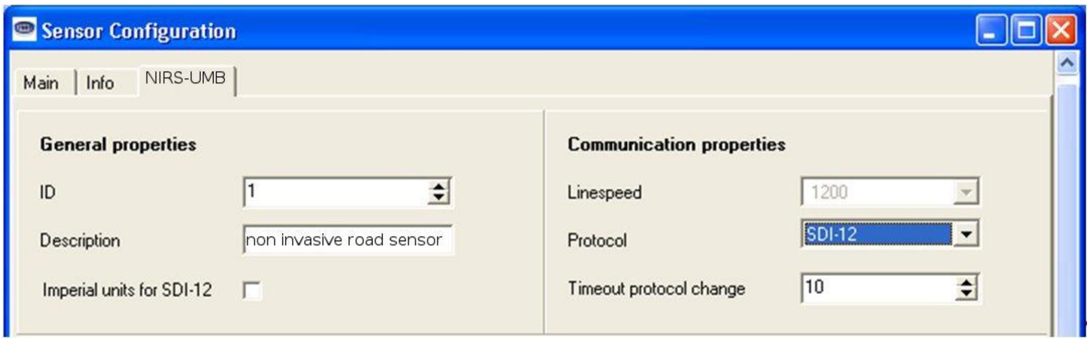
The communication in SDI-12 mode of the NIRS31-UMB is conforming to the standard defined in ‘SDI-12 A Serial-Digital Interface Standard for Microprocessor-Based Sensors Version 1.3 January 12, 2009‘. The sensor may be operated in bus mode together with other SDI-12 sensors, connected to one SDI master (logger).

19.5.1 Preconditions for SDI-12 Operation

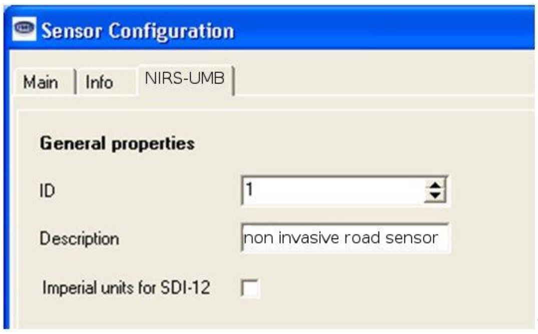
As the interface settings defined in the SDI-12 standard are significantly different from the UMB default settings, some preconditions have to be met for operation:

- Setting for SDI-12 mode in the configuration with UMB Config Tool (at least V1.2)

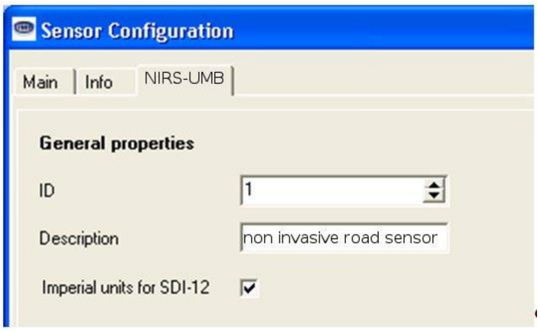
Using the UMB Config Tool the protocol mode of the station has to be set to “SDI-12”. This will automatically set the baud rate to 1200.



Measurement data can be transmitted alternatively in metric or US units. The selection is done by the UMB Config Tool.



Metric units



US units

When operating the device in SDI-12 mode it is basically no more possible to access the device with the UMB Config Tool, due to the different interface parameter settings. To enable configuration access nevertheless the interface is operated in standard UMB mode (19200 8N1) for the first 5 seconds after reset / power on. If a valid UMB telegram is received within this time, the device will stay in UMB mode for the configured time out (several minutes) so that the configuration can be modified.

- Connect the PC to the NIRS31-UMB through an RS-485 converter (e.g. ISOCON)
- Start the UMB Config Tool and create a NIRS31-UMB with the address of the actual device and activate at least one sensor. Start the measurement (will report connection error at first)
- Reset the device (Power off / on)
- When measurement values are received the measurement can be terminated, the interface is now open for configuration.

19.5.2 Command Set

For details of the SDI-12 protocol please refer to the above mentioned standard document.

Following commands are available for the NIRS31-UMB:

Note: The examples in the following sections use italics to print the requests from the logger (*0V!*)

Command	Function
?!	Address search (Wildcard request, one device only on bus!)
a!	Request device active?
aI!	Request device identification
aAb!	Address change to b (0 … 9, A …Z, a … z)
aM!	Measurement, basic data set
aMC!	Measurement, basic data set, transmit values with CRC
aC!	Concurrent measurement, basic data set
aCC!	Concurrent measurement, transmit values with CRC
aD0!	Data request buffer 0
aD1!	Data request buffer 1
aD2!	Data request buffer 2
aV!	Command verification: Evaluate sensor, data request with aD0!, aD1!
aXU<m/u>!	Change the unit system for SDI data
aXM+nnn!	Set device parameters: RC limit “Damp”
aXW+nnn!	Set device parameters: RC limit “Wet”
aXO+nn.n!	Set device parameters: Temperature offset pyrometer
aXE+n.nn!	Set device parameters: Road surface emissivity
aXRr!	Device reset
aXRa!	Device reset with renewal of adjustment
aXRs!	Device reset with reset of service level and renewal of adjustment

The composition of the basic data set depends on the variant (with / without pyrometer) of the actual device (see below).

Due to the applied measurement processes the NIRS31-UMB will, different from other sensors described in the SDI-12 document, always measure continuously. During certain phases of the measurement process the availability of the device for communication is limited. This causes some special properties:

- The device does not need a “Wakeup” and does not have a sleep mode. So the reactions to “Break” signals and any related timings are inapplicable. “Break” will be ignored by NIRS31-UMB.
- M- and C- commands only differ in the number of values made available in the buffers (in both cases up to the maximum permitted by the standards of 9 resp. 20).
- R-Commands are not available.

19.5.3 Address Configuration

UMB Device-ID and SDI-12 Address are related, but the different address ranges and the fact, that UMB ID's are integer numbers, while SDI-12 addresses are ASCII characters, have to be considered.

UMB Device ID1 (default) corresponds to SDI-12 Address '0' (SDI-12 default).

Valid Address Ranges:

UMB (dec)			SDI-12 (ASCII)		
1	to	10	'0'	to	'9'
18	to	43	'A'	to	'Z'
50	to	75	'a'	to	'z'

19.5.4 Data Messages

In the interest of simplified evaluation the assignment of measurement values to data buffers '0' ... '9' has been defined unified for all measurement commands. For this reason the responses to C-requests have been restricted to 35 characters, not using the 75 characters permitted for these requests

Currently buffers '0' to '3' are in use.

The buffer assignment depends on the device variant (with / without pyrometer). Buffers '1' to '3' are available only from devices with pyrometer.

If the measurement value is not available for some reason, e.g. sensor failure, this is indicated by a value of +999.0. or -999.9 The logger can then evaluate the reason of failure by a aV! verification request.

The following tables show the measurement values in the sequence they are arranged in the telegram (see example).

Depending on the configuration of the device the values will be transmitted in metric or US units.

Note: The configured system of units is not indicated in the data messages. The logger may request this setting with the I-command and adjust the evaluation of the data messages accordingly

Example: M Request

0M!

00009<CR><LF> 9 measurement values are available

0D0!

0+251.4+30.0+2<CR><LF>

Water film 251.4µm, ice percentage 30.0, road condition 2

0D1!

0+12.4-5.1<CR><LF>

Road surface temperature 12.4°C, freezing temperature -5.1°C

0D2!

0+3.4+25.3<CR><LF>

snow height 3.4mm, saline concentration 25.3%

0D3!

0+0.4+1<CR><LF>

friction 0,4, road weather index 1

(values for illustration purposes only)

Example: C Request

0C!

000009<CR><LF> 9 measurement values are available

0D0!

0+251.4+30.0+2<CR><LF>

Water film 251.4µm, ice percentage 30.0, road condition 2

0D1!

0+12.4-5.1<CR><LF>

Road surface temperature 12.4°C, freezing temperature -5.1°C

0D2!

0+3.4+25.3<CR><LF>

snow height 3.4mm, saline concentration 25.3%

0D3!

0+0.4+1<CR><LF>

friction 0,4, road weather index 1

(values for illustration purposes only)

19.5.4.1 Buffer assignment Basic Data Set

Device configured for measurement values in metric units:

Measurement value	UMB Channel	Min	Max	Unit
Buffer '0'				
Water film height	600	0.0	2000.0	µm
Ice percentage	800	0.0	100.0	%
Road condition	900	0 1 2 4 6 99	Dry Damp Wet Snow / Ice Critical wetness Undefined	
Buffer '1'				
Road surface temperature	100	-40.0	70.0	°C
Freezing temperature (NaCl)	110	-40.0	70.0	°C
Buffer '2'				
Snow height	610	0.0	10.0	mm
Saline concentration NaCl	810	0.0	100.0	%
Buffer '3'				
Friction	820	0.0	1.0	
Road Weather Index	910	0, 1, 2		Code

Device configured for measurement values in US units:

Measurement value	UMB Channel	Min	Max	Unit
Buffer '0'				
Water film height	600	0.0	2000.0	µm
Ice percentage	800	0.0	100.0	%
Road condition	900	0 1 2 4 6 99	Dry Damp Wet Snow / Ice Critical wetness Undefined	
Buffer '1'				
Road surface temperature	101	-40.0	150.0	°F
Freezing temperature (NaCl)	111	-40.0	32.0	°F
Buffer '2'				
Snow height	610	0.0	10.0	mm
Saline concentration NaCl	810	0.0	100.0	%
Buffer '3'				
Friction	820	0.0	1.0	
Road Weather Index	910	0, 1, 2		Code

19.5.5 Message Device Identification

The device responds to the identification request with following message (example for SDI-12 device address ‘0’):

```
0I!
013Lufft.NIRSxynnn
```

x: device type (P: with pyrometer, N: without pyrometer)

y: Metric / US units (m = metric, u = US)

nnn: Software version

i.e. for a NIRS31-UMB with pyrometer, configured for US units:

```
0I!
013Lufft.deNIRSPu022
```

19.5.6 Message Verification

The command verification aV! is used to evaluate status information of the device. The device responds with

```
a0004<CR<LF>
```

to the request, i.e. 4 values are available in the buffers.

The first “measurement value”, transmitted in buffer ‘0’ contains the status information of the measurement channels.

The status data of the channels are assembled to form “fake measurement values”, where each digit represents one status. See below for the coding of states.

Buffer ‘0’	
Status buffer ‘0’: +nnnn	Pyrometer status: 0 = OK, other codes see below Lamp status: 0 = OK, 1 = failure Chopper speed status: 0 = OK, 1 = failure Chopper failure status: 0 = OK, 1 = failure, 2 = not yet started, 3 = starting
Filter failure status	0 = OK, otherwise failure
Buffer ‘1’	
Remaining time to service	-10000h ... +10000h
Service-Level	-500.0% ... 100.0%

Example (SDI-12 Address ‘0’, chopper wheel starting, 4000h to service):

```
0V!
00004<CR><LF>
0D0!
0+0013+0<CR><LF>
0D1!
0+50.0+4000<CR><LF>
```

Sensor status codes:

Sensor status	Code
OK	0
UNGLTG_KANAL	1
E2_CAL_ERROR E2_CRC_KAL_ERR FLASH_CRC_ERR FLASH_WRITE_ERR FLASH_FLOAT_ERR	2
MEAS_ERROR	3
MEAS_UNABLE	4
INIT_ERROR	5
VALUE_OVERFLOW CHANNEL_OVERRANGE	6
VALUE_UNDERFLOW CHANNEL_UNDERRANGE	7
BUSY	8
other sensor status	9

19.5.7 Message Change of Unit System

The command is used to change the unit system used for the SDI-12 data between metric and US units. It is implemented as manufacturer specific X command.

Command: `aXU<u/m>!`

Response: `aU<u/m><CR><LF>`

u: US units, m: metric units

Example: change to metric units, SDI-12 address ‘0’

`0XUm!`

`0Um<CR><LF>`

19.5.8 Message: Setting of the Threshold for Road Condition “Damp”

If the water film height is above the threshold the road condition is identified as “damp”.

Command: `aXM+nnnn!`

nnnn: “damp” threshold in µm water film

Response: `aXM+nnnn<CR><LF>`

The response to the attempt of setting of an invalid value (1<threshold<100) is

`aXMf<CR><LF>`

Example: The “damp” threshold shall be set to 30µm

`0XM+30!`

`0XM+30<CR><LF>`

19.5.9 Message: Setting of the Threshold for Road Condition “Wet”

If the water film height is above the threshold the road condition is identified as “wet”.

Command: `aXW+nnnn!`

nnnn: “wet” threshold in µm water film

Response: `aXW+nnnn<CR><LF>`

The response to the attempt of setting of an invalid value (30<threshold<500) is

`aXWf<CR<<LF>`

Example: The “wet” limit shall be set to 200µm

0XW+200!

`0XW+200<CR><LF>`

19.5.10 Message: Setting of the Road Surface Temperature Offset

The offset is used to calibrate the pyrometric temperature measurement.

Command: `aXO<+/->nn.n!`

nn.n: offset in °C

Response: `aXO<+/->nn.n<CR><LF>`

The response to the attempt of setting of an invalid value is

`aXOf<CR><LF>`

Example: The offset shall be set to -3.5°C

0XO-3.5!

`0XO-3.5<CR><LF>`

19.5.11 Message: Setting of the Road Surface Emissivity

The emissivity setting is used to calibrate the pyrometric temperature measurement.

Command: `aXE+>n.nn!`

nn.n: offset in °C

Response: `aXE+n.nn<CR><LF>`

The response to the attempt of setting of an invalid value is

`aXEf<CR><LF>`

Example: The emissivity shall be set to 0.97

0XE+0.97!

`0XE+0.97<CR><LF>`

19.5.12 Message: Station Reset

The command initiates a station reset.

Command: `aXRr!`

Response: `aXRok<CR><LF>`

The response is followed by the station reset, i.e. the station will be offline for a few seconds.

Example:

0XRr!

`0XRok<CR><LF>`

19.5.13 Message: Station Reset with Reset of Service Level and Lamp Operating Hours, Renew Adjustment

This command shall only be executed after replacement of the lamp unit. It clears service level and lamp operating hours, then initiates a station reset. After the reset a new automatic adjustment will be executed.

Important note: For the automatic adjustment, the same conditions that are required for commissioning (see page 23) must be met and the instructions for commissioning must be observed, otherwise the new adjustment of the sensor cannot be completed successfully.

Command: `aXRs!`

Response: `aXRok<CR><LF>`

The response is followed by the station reset, i.e. the station will be offline for a few seconds.

Example:

0XRs!

0XRok<CR><LF>

19.5.14 Message: Station Reset with New Adjustment

This command initiates a station reset. After the reset a new automatic adjustment will be executed.

Important note: For the automatic adjustment, the same conditions that are required for commissioning (see page 23) must be met and the instructions for commissioning must be observed, otherwise the new adjustment of the sensor cannot be completed successfully.

Command: `aXRa!`

Response: `aXRok<CR><LF>`

The response is followed by the station reset, i.e. the station will be offline for a few seconds.

Example:

0XRa!

0XRok<CR><LF>

20 List of Figures

21 Index

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