Operating Manual English

Intelligent Road Sensor
IRS31Pro-UMB

VERSION 2 (01/2014)

Please read this operating manual completely before commissioning the equipment.

www.lufft.de

Contents

Version history:

Version	Date	Edited by	Comments
V1	11.2013	RR/BR/LA	first version
V2	01.2014	LA/BR	IRS31-UMB compatibility mode, revised channel list for TLS.

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 the IRS31Pro-UMB from device version 7 (from January 2014). Some functions or features specified in this manual may not be available or may not be valid with older versions of the device. The device version is indicated as the last number of the serial number printed on the type plate, e.g.: the device with serial number: 063.1013.1203.0**14** has the device version 14.

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 safety and operation of the equipment can no longer be guaranteed if it is modified or adapted.
- The Sensor intended for flush-mounted installation in the road- or runway surface. It is used to determine the measurements described in chapter 6.1
- The Sensor can be used as a replacement part for IRS31-UMB. For this purpose the sensor should be appropriate configured. See chapter 11 for details.

1.4 Incorrect Use

If the equipment is installed incorrectly:

- It may not function or may only function to a limited extent
- 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

When connecting the power supply to the sensor, ensure the correct supply voltage (12VDC)

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

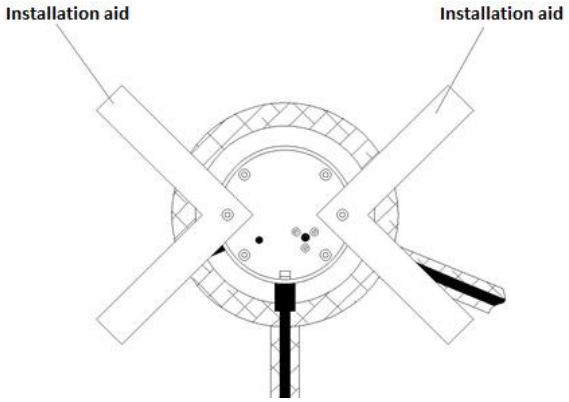
All brand names referred to are subject without limitation to the valid trademark and ownership rights of the respective owner.

2 Scope of Delivery

The content of the delivery consists of the following components:

- Sensor IRS31Pro-UMB

- Installation aid



- Installation instructions

- Transport packaging

3 Order Numbers

IRS31Pro-UMB..... 50 m cable length **8910.U050**
IRS31Pro-UMB..... 50 m cable length, 1 below-ground temperature sensor. **8910.U051**
IRS31Pro-UMB..... 50 m cable length, 2 below-ground temperature sensors **8910.U052**
IRS31Pro-UMB..... 100 m cable length **8910.U100**
IRS31Pro-UMB..... 100 m cable length, 1 below-ground temperature sensor. **8910.U101**
IRS31Pro-UMB..... 100 m cable length, 2 below-ground temperature sensors **8910.U102**

- Intelligent passive road sensor including integrated road surface temperature sensor

3.1 Accessories

Power supply unit 24V/100VA.....8366.USV1
ISOCON-UMB 8160.UISO
Surge protection 8379.USP
DACON8-UMB 8160.UDAC

3.2 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 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 IRS31Pro-UMB is intended for installation in the roadway. The passive measuring instrument IRS31Pro-UMB is used to determine the road surface temperature, the height of the water film above the sensor and the saline concentration on the sensor (from which the freezing temperature is derived). The built-in road condition models use these variables to determine the corresponding road conditions.

The sensor provides the following established and commonly used decision-making data for winter maintenance services: water film height, road condition, road surface temperature and freezing temperature. In addition, the sensor delivers an ice percentage reading. As the ice percentage increases on the surface, the friction coefficient falls and this can then be used to support preventive gritting decisions.

Depending on the sensor type, up to 2 below-ground temperatures can be measured, preferably at depths of 5 cm and 30 cm.

The equipment is connected by way of a 4-pin connection cable (with a length of 50 m or 100 m, depending on the type).

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

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

4.1 IRS31Pro-UMB Sensor

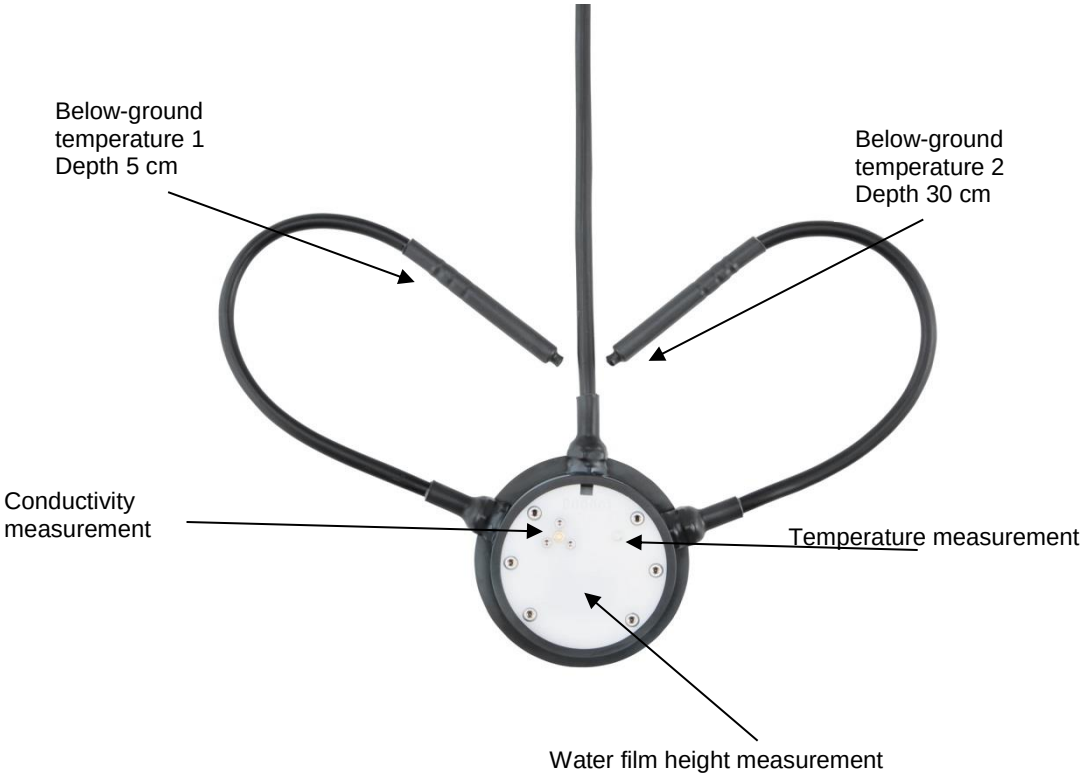


Figure 1: Sensor

5 Generation of Measurements

5.1 Current Measurement (act)

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

5.2 Average Value (avg)

The number of measurements that are included in the moving average can be configured between 1 and 20. In the factory setting, the sampling rate is 10 s and the moving average is generated from 6 measurements.

The "average" road condition is calculated from the average values of the underlying channels.

The average freezing temperature is calculated from the average saline concentration.

5.3 Sampling Rate

The sampling rate in the sensor is configurable and can be set at 10, 20, 30 or 60 seconds. Typically, measurement values are polled at intervals of 1, 2, 5 or 10 minutes. An average value is recommended if the measurement and sampling rates are different.

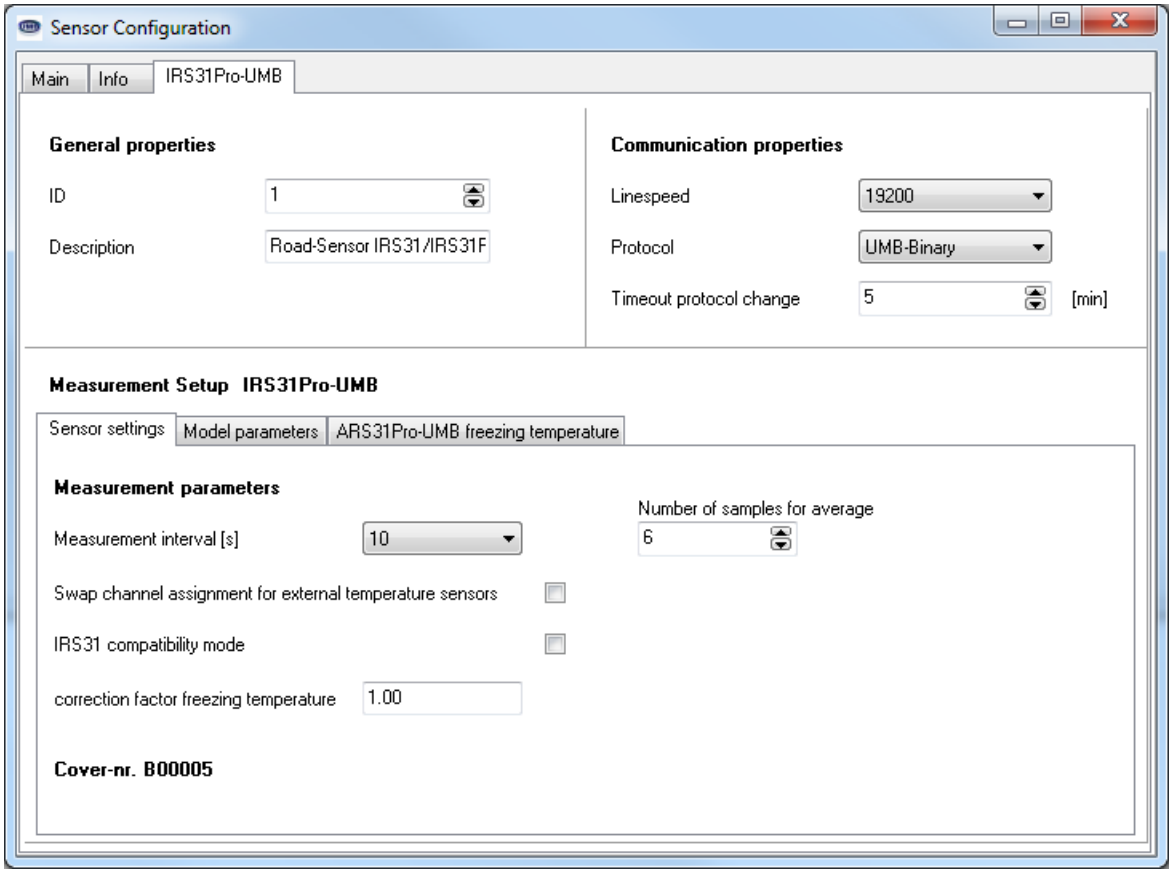


Figure 2: UMB Config Tool: Sensor Configuration / Sensor Settings Menu

6 Transmission of Measurements

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 (including TLS channels) in the Appendix.

6.1 Measurements

6.1.1 Data Types Used

uint8 unsigned char (8 bit unsigned integer)

uint16 unsigned short (16 bit unsigned integer)

float32 float (32 bit floating-point number according to IEEE-754)

6.1.2 Road Surface Temperature

Sampling rate adjustable 10, 20, 30, 60s; *see section 5.3 Sampling Rate, page 9*

Units normalized, °C; °F

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
100			105	Road temperature	uint16	0	65520	norm value
101			106	Road temperature	float32	-40.0	80.0	°C
102			107	Road temperature	float32	-40.0	176.0	°F

6.1.3 External Temperature 1 (5cm depth)

Sampling rate see section 6.1.2

Units normalized, °C; °F

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
110			115	External temperature 1	uint16	0	65520	norm value
111			116	External temperature 1	float32	-40.0	80.0	°C
112			117	External temperature 1	float32	-40.0	176.0	°F

6.1.4 External Temperature 2 (30cm depth)

Sampling rate see section 6.1.2

Units normalized, °C; °F

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
120			125	External temperature 2	uint16	0	65520	norm value
121			126	External temperature 2	float32	-40.0	80.0	°C
122			127	External temperature 2	float32	-40.0	176.0	°F

6.1.5 Freezing Temperature NaCl

Sampling rate see section 6.1.2

Units normalized, °C; °F

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
150			155	Freezing temp. NaCl	uint16	0	65520	norm value
151			156	Freezing temp. NaCl	float32	-40.0	0.0	°C
152			157	Freezing temp. NaCl	float32	-40.0	32.0	°F

6.1.6 Freezing Temperature $MgCl_2$[1]

Sampling rate see section 6.1.2

Units normalized, °C; °F

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
170			175	Freezing temp. MgCl2	uint16	0	65520	norm value
171			176	Freezing temp. MgCl2	float32	-40.0	0.0	°C
172			177	Freezing temp. MgCl2	float32	-40.0	32.0	°F

6.1.7 Freezing Temperature $CaCl_2$[1]

Sampling rate see section 6.1.2

Units normalized, °C; °F

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
190			195	Freezing temp. CaCl2	uint16	0	65520	norm value
191			196	Freezing temp. CaCl2	float32	-40.0	0.0	°C
192			197	Freezing temp. CaCl2	float32	-40.0	32.0	°F

6.1.8 Water Film Height

Sampling rate see section 6.1.2

Units normalized, µm; mil

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
600			605	Water film height	uint16	0	65520	norm value
601			606	Water film height	float32	0.0	10000.0	µm
602			607	Water film height	float32	0.0	393.70	mil

6.1.9 Saline Concentration NaCl

Sampling rate see section 6.1.2

Units normalized, % percentage by weight, g/m^2, lbs. p. l. mile'

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
800			805	Saline concent. NaCl	uint16	0	65520	norm value
801			806	Saline concent. NaCl	float32	0	100	%
910			915	Saline concent. NaCl	float32	0	100	g/m^2
920			925	Saline concent. NaCl	float32	0	1280	lbs.p.l.mile

6.1.10 Ice Percentage

Sampling rate see section 6.1.2

Units %

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
810			815	Ice percentage	float32	0.0	100	%

6.1.11 Friction

Sampling rate see section 6.1.2

[1] optional

Units none

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
820			825	Friction	float32	0.0	1.0	

6.1.12 Saline Concentration $MgCl_2$ [2]

Sampling rate see section 6.1.2

Units normalized, % percentage by weight, g/m^2, lbs. p. l. mile

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
830			835	Saline concent.MgCl2	uint16	0	65520	norm value
831			836	Saline concent.MgCl2	float32	0	100	%
911			916	Saline concent.MgCl2	float32	0	100	g/m^2
921			926	Saline concent.MgCl2	float32	0	1280	lbs.p.l.mile

6.1.13 Saline Concentration CaCl2 2

Sampling rate see section 6.1.2

Units normalized, % percentage by weight, g/m^2, lbs. p. l. mile

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
840			845	Saline concent.CaCl2	uint16	0	65520	norm value
841			846	Saline concent.CaCl2	float32	0	100	%
912			917	Saline concent.CaCl2	float32	0	100	g/m^2
922			927	Saline concent.CaCl2	float32	0	1280	lbs.p.l.mile

6.1.14 Road Condition

Sampling rate see section 6.1.2

Units logical coding

Request channels:

UMB Channel						
act	min	max	avg	Measured Value (uint8)	Data Type	
900			905	Road condition	uint8	10 Dry 15 Moist 20 Wet 25 Moist with salt 30 Wet with salt 35 Ice 40 Snow 45 Frost

Dry: There is no liquid water on the road;
the water film height is below the dry-moist threshold.

Moist: There is liquid water on the road;
the water film height is between the dry-moist and moist-wet thresholds.

Wet: There is liquid water on the road;
the water film height has reached the moist-wet threshold.

Moist with salt: Describes a moist road condition where the freezing temperature is lower than -0.1°C.

Wet with salt: Describes a wet road condition where the freezing temperature is lower than -0.1°C.

[2] optional

Ice: There is frozen water on the road, mostly in the form of ice or snow.

The factory settings for the moist and wet thresholds are 30 and 200 µm, respectively. These settings can be adjusted in the sensor configuration (see screenshot).

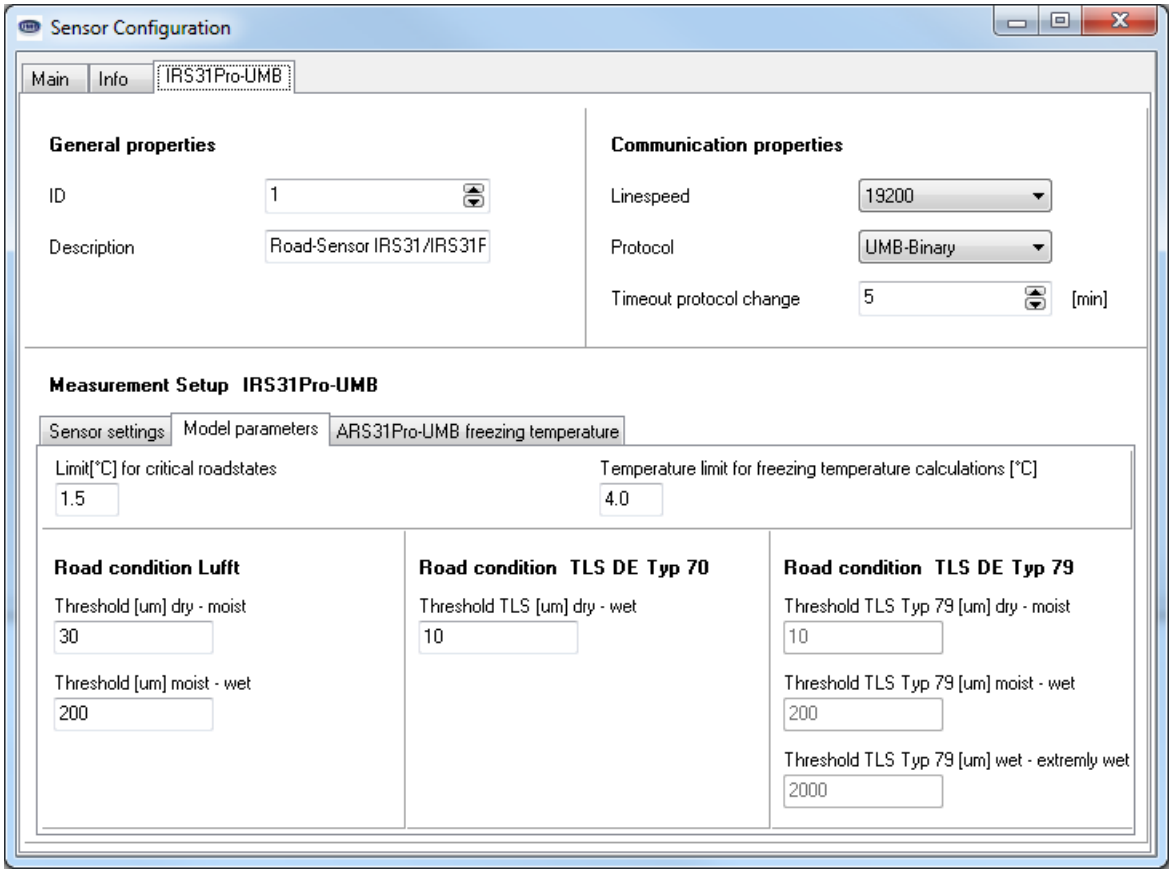


Figure 3: Set Moist / Wet Thresholds

6.1.15 Measurement Counter

Sampling rate see section 6.1.2

Units none

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
20001				Measurement counter	uint16	0	65520	

6.1.16 Resistance

Sampling rate see section 6.1.2

Units Ohm

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	Measured Value	Data Type	min	max	Unit
			32210	resistive_avg	float32	-1.0E15	1.0E15	ohm

7 Installation

The road sensor is installed in the centre of the road lane. On two lane carriageways installation takes place in the left-hand lane.

7.1 Preparation

A drill hole of diameter > 16 cm and depth 6 cm is required for inserting the sensor. For the connection cable, a slot of width 2 cm and depth 5 cm is cut into the road surface.

Attention! Be careful not to damage the insulation layer when working on bridges. (In this case it is not always possible to maintain a depth of 6 cm.)

For temperature sensor 1 (optional), a slot is required at an angle of approximately 68º in relation to the connection cable slot. The slot is cut into the road with a width of 2 cm, depth of 5 cm and length of 35 cm.

For temperature sensor 2 (optional), a drill hole is required with a depth of 30 cm and a diameter of 2 cm. In relation to the connection cable slot, this must be positioned at an angle of approximately -68º, approximately 20 cm from the outer rim of the road sensor drill hole (see Figures 2 and 3). A slot of width 2 cm must be cut between the two drill holes.

If necessary, the slot lengths must be adjusted in accordance with the installation conditions at the site.

For sensors with only one temperature sensor, temperature sensor 2 is omitted. In this case, temperature sensor 1 can also be installed at a depth of 30 cm (see installation instructions for temperature sensor 2).

The external temperature sensors are protected to IP67. Constant use under water must be avoided.

7.2 Installation

Warning: The cable connections must not be opened under any circumstances!

Shortening the supply cable is only permitted at the cabinet end of the cable. The supply cable must be placed in a protective tube that prevents any expansion of the road surface from being transmitted to the cable. Be careful not to expose the cables of the road sensor to tensile stress during the installation.

Warning: Damage to the sheathing of the supply cable or external sensors will lead to the ingress of water into the sensor! Sensors with damaged cables must not be installed and can only be repaired by Lufft.

Insert the road sensor into the designated drill hole in such a way that it is flush with the road surface. In order to achieve this, place the installation aid - which is already mounted on delivery - on the surface of the road. If necessary, adjust the sensor position by bending the installation aid.

Under no circumstances must the road sensor project beyond the surface of the road (possible damage due to snow-clearing vehicles!).

Fill the cavities with casting resin concrete.

Only such concrete casting systems may be used in which the temperature during the curing process remains below 80°C (176ºF), as otherwise the road sensor will be damaged. After the concrete has hardened, remove the installation aid and the green protective foil. Re-insert the fixing screws of the installation aid into the open holes of the sensor (torque 2 Nm).

7.2.1 Extending the Supply Cable (e.g. 100 m)

Important: The original cable **must** be shortened after the shortest possible distance (curbside 5 m) and extended from there. The loop impedance of the entire cable must not exceed 10 Ω.

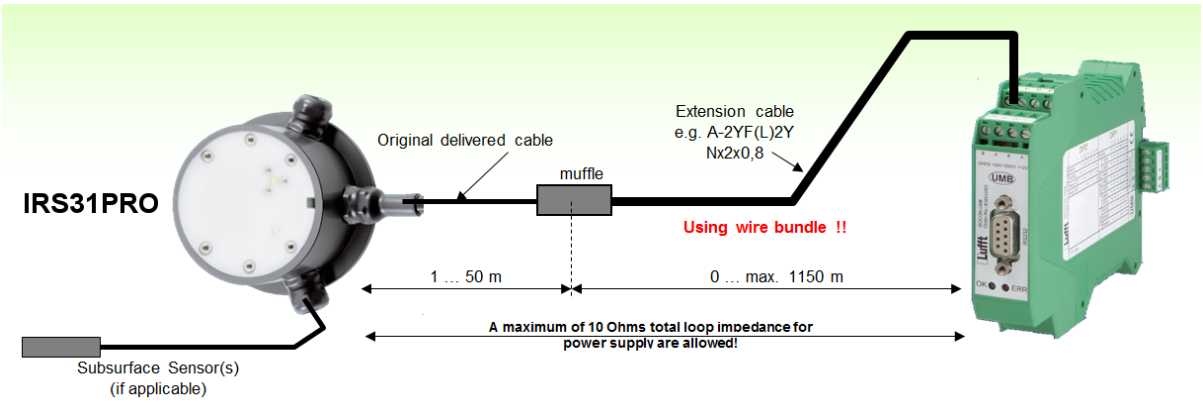


Figure 4: Cable Extension

Example: Extension to 100 m with a 0.5 mm² cable with loop impedance of 73.2 Ω/km and parallel connection of 4 wires in each case:
At 100 m the result per wire is a loop impedance of 7.3 Ω.
By connecting 4 wires in parallel the result is a loop impedance of 7.3 Ω / 4 = 1.83 Ω

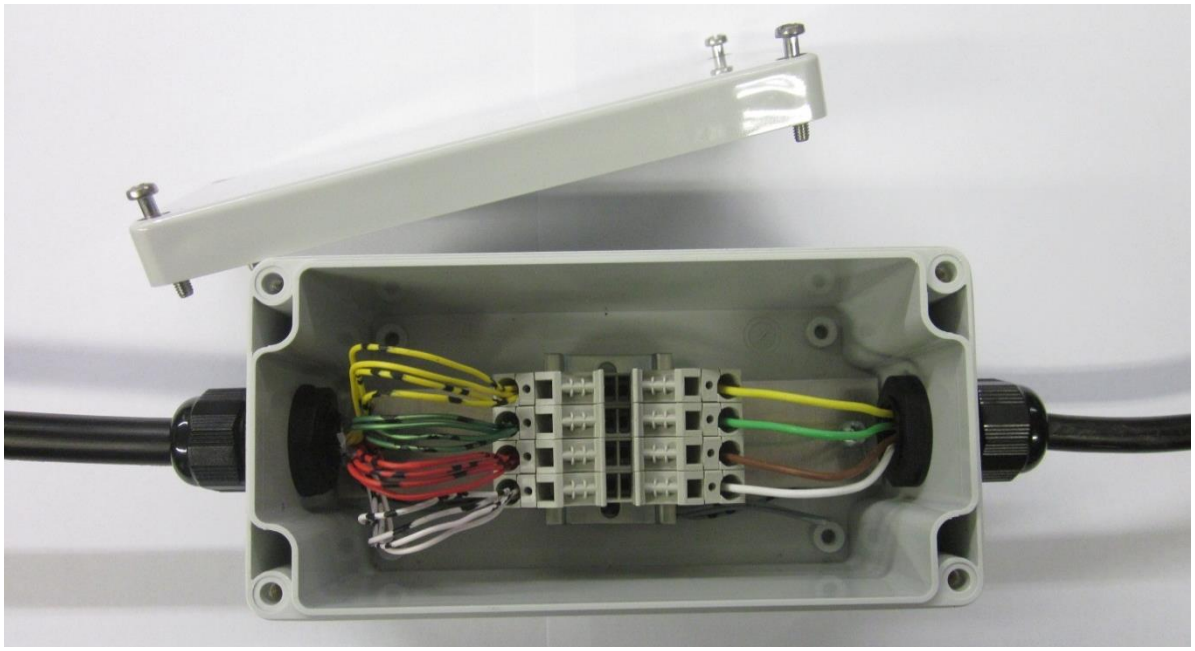


Figure 5: Example of an Extension Box

7.2.1.1 Extension Table for IRS31Pro-UMB Passive Road Sensor

Total Distance	RS485 Terminator Required	IRS31Pro-UMB Original Cable	Extension Cable A-2ZF(L)2Z **N**x2x0.8		
Wire Range		0.5mm^2	0.8mm^2	Power Supply Wire Bundle	Total Wire Pairs
[m]		max. [m]	up to…[m]	x times	N
100	-	100	--	--	
200	-	50	150	3x	4
300	-	50	250	4x	6
400	YES	50	350	6x	10
500	YES	50	450	7x	10
600	YES	50	550	9x	10
700	YES	50	650	10x	20
800	YES	50	750	11x	20
900	YES	50	850	13x	20
1000	YES	50	950	14x	20
1100	YES	50	1050	16x	20
1200	YES	50	1150	17x	20

Notes:
Recommended extension cable: A-2YF(L)2Y Nx2x0, 8 or similar;
Core pair 2x (2 times) means 2 pairs of wires, e.g. 2x2x0.8, because 2 individual wires are 1 pair for the power supply (+ & -).
RS485 termination resistance required means that a resistance of 120 ohms should be connected parallel to the RS485 2-wire interface, either on the sensor inlet or sleeve.

7.3 Connecting the Supply Cable

The road sensor supply cable is connected to the power supply and the bus system (e.g. ISOCON-UMB) in the control panel.

The screening of the connecting cable **MUST be laid to earth in the control panel!**

Figure 6: Example of a Standard Lufft UMB Control Cabinet

Figure 7: Examples of the Earthing of the Cable Screening

The sensors are delivered with two different cables: color coded or numerically coded.

Connection of the road sensor supply lead:
1.....white..... negative power supply
2.....brown..... positive power supply
3.....green ..... RS485_A
4.....yellow ..... RS485_B

If colored cables are not used, the numbers apply.

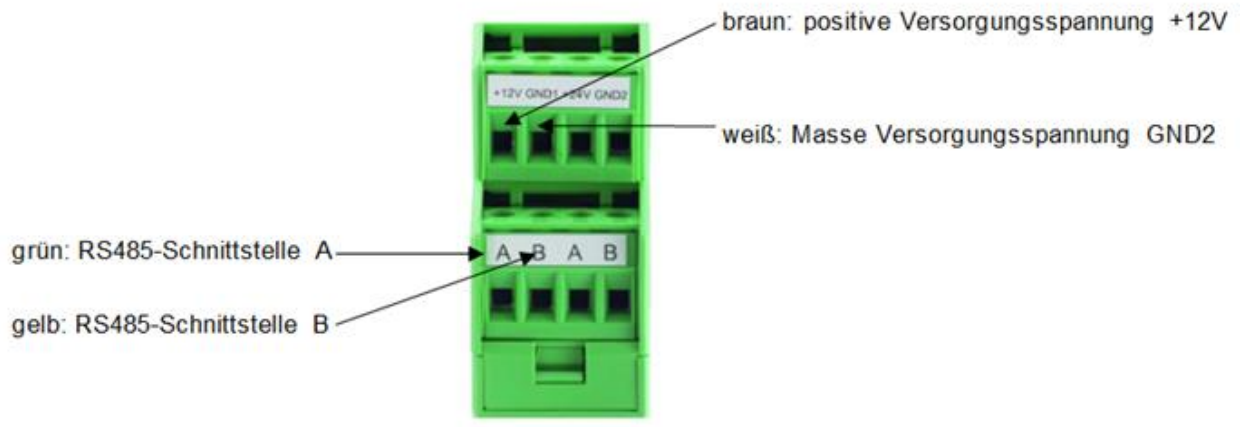


Figure 8: ISOCON-UMB Connection

Note: When installing the system, please also pay attention to the operating instructions for the ISOCON-UMB.

Attention: Errors in connection will destroy the road sensor!

Attention: A connection of the sensor to 24 VDC leads after a short time to the destruction of the sensor.

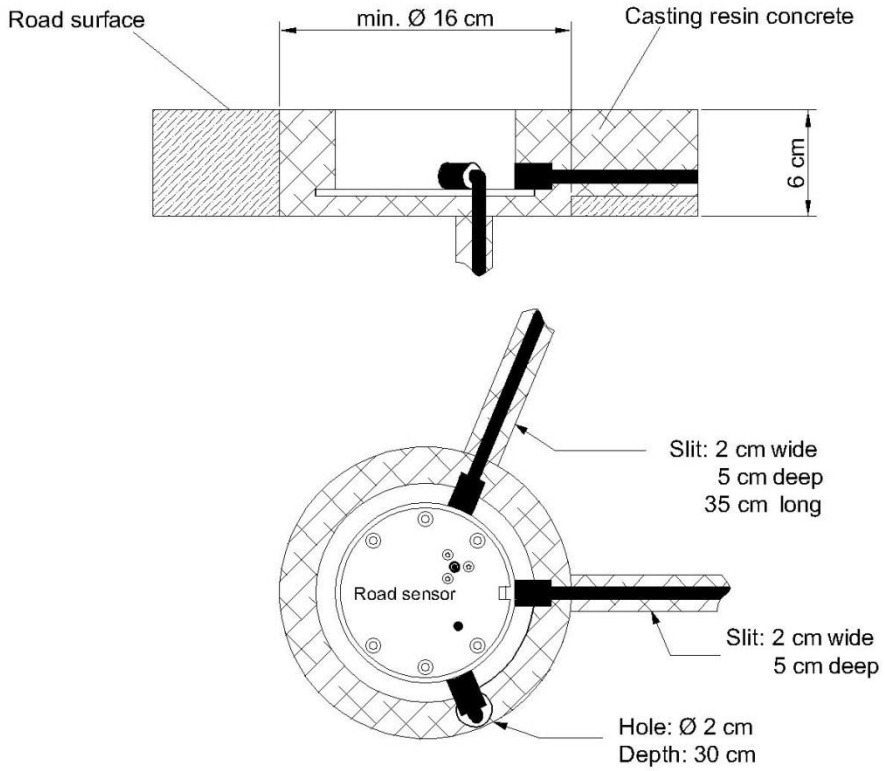


Figure 9: IRS31Pro-UMB Installation in the Road with 2 External Temperature Sensors

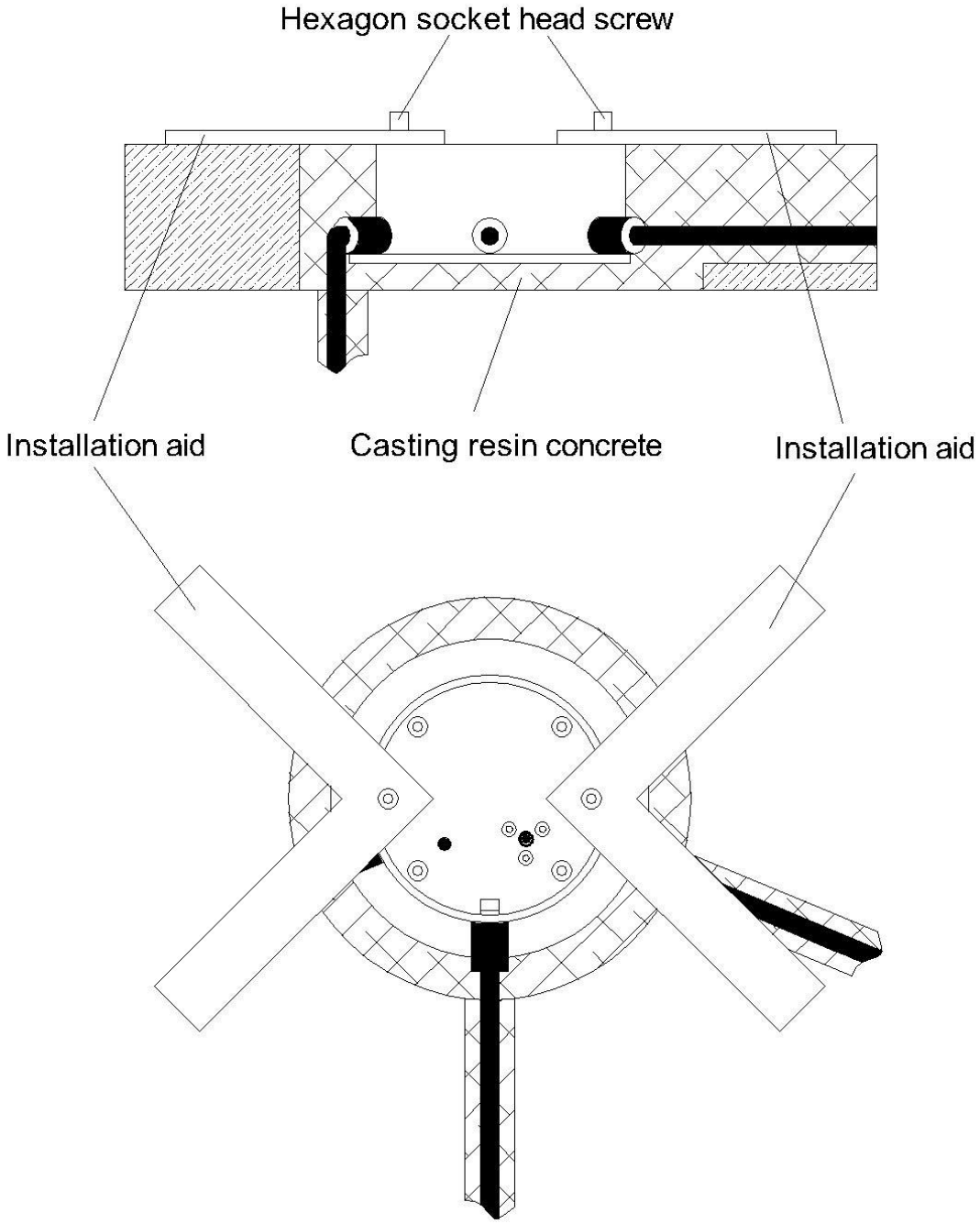


Figure 10: Installing the IRS31Pro-UMB

7.4 Use of Surge Protection (8379.USP)

When using surge protection (order no.: 8379.USP), please note the connection example in the operating instructions for surge protection.

7.5 Commissioning and Testing

Once the device has been properly installed and connected to the permissible supply voltage, initialization takes place and measuring begins.

After successful installation of the road sensor, its correct functioning must be checked. To do this, connect the sensor to an evaluation device. Check that communication between the sensor and the evaluation unit is working properly. The road condition determined by the sensor should be checked with dry and wet sensor.

The functional test is described in section 10, Configuration and Testing.

8 Maintenance

The road sensor should be serviced annually. This includes the visual inspection of the housing. It is recommended to clean the sensor surface when very dirty. Where there is significant mechanical damage to the sensor, which could influence the tightness of the housing, it is recommended to exchange the sensor. This also applies in the case where the plastic assembly of the sensor is heavily degraded by wear and tear.

8.1 Replacing the Sensor

If the plastic assembly of the road sensor becomes unusable due to mechanical effects, or the sensor electronics are damaged, the plastic assembly can be replaced without the need to change the entire housing.

Attention: Replacement must only be carried out when the road is dry!

To uninstall the plastic assembly, remove all six hexagonal screws. On the edge of the cover there is a small opening that serves to provide access for a screwdriver. This allows the plastic assembly to be lifted out. Take care not to pull out the connection cables on the underside of the sensor. The plug connections must be removed without tensile strain on the cables.

Important: when changing the sensor, the ring gasket must always be replaced and a new drying agent bag must be inserted.

The housing must be cleaned carefully before inserting a new sensor. Even tiny dirt particles in the seal may lead to sensor failure in the long term. No moisture must be trapped in the housing. The new drying agent bag must be taken out of the sealed protection cover only shortly before being placed in the housing. The sticker indicates its functionality (blue: ok, pink: the drying agent is spent).

When connecting the plug connectors to the new sensor, be careful not to touch the electronics of the sensor. Electrostatic discharge can destroy the sensor.

The seal must be fitted using silicone grease. It must not cant when the plastic cover plate is inserted. The plastic cover plate must fit into the housing without the use of force. Grease the thread of the fixing screws. First lightly fasten the screws and then tighten evenly (torque 2 Nm).

9 Connections

9.1 Supply Cable

See section 7.3 Connecting the Supply Cable

9.1.1.1 Power Supply

The IRS31Pro-UMB is supplied by a voltage of 12 V DC. The power supply unit used must be approved to operate devices of protection class III (SELV).

9.1.1.2 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
*=factory setting and baud rate for firmware update

The screening of the supply cable MUST be laid to earth in the control cabinet.

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

9.1.2 Connections in the Housing

There are two 4-pin connectors on the underside of the plastic insert. These are used to connect the supply voltage and the interface to the associated cable, as well as the optional connection of external temperature sensors.

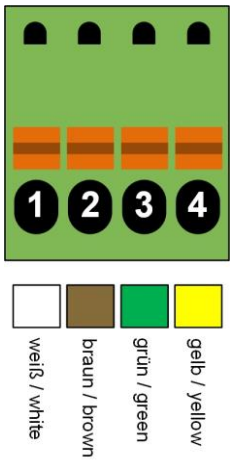
Pin assignment supply voltage / RS485 (uncoded):

1..... white ..... negative supply voltage

2..... brown..... positive supply voltage

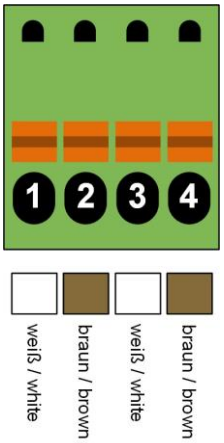
3..... green ..... RS485_A

4..... yellow ..... RS485_B



Pin assignment external temperature sensors (coding Pin1):

1..... white ..... ext. temperature right 1
2..... brown..... ext. temperature right 2
3..... white ..... ext. temperature left 1
4..... brown..... ext. temperature left 2



The cable markings are based on DIN 47100.

10 Configuration and Testing

Lufft provides PC software for configuration purposes. With the aid of this software the device can be adjusted in accordance with the user's requirements.

10.1 Factory Settings

The IRS31Pro-UMB is delivered with the following settings:

Class ID: ..... 9 (cannot be modified)
Device ID: ..... 1 (gives address 9001h = 36865d)
Baud rate: 19200
RS485 protocol: ..... UMB binary
Calculation interval: ..... 10 measurements
Water film moisture threshold: ..... 30 µm
Water film wetness threshold: ..... 200 µm

Note: The device ID must be changed if several IRS31Pro-UMB 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.

10.2 Configuration with PC Configuration Software UMB Config Tool

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

10.2.1 Sensor Selection

In 'Sensor Selection', the road sensor is displayed as IRS31Pro-UMB (Class ID 9).

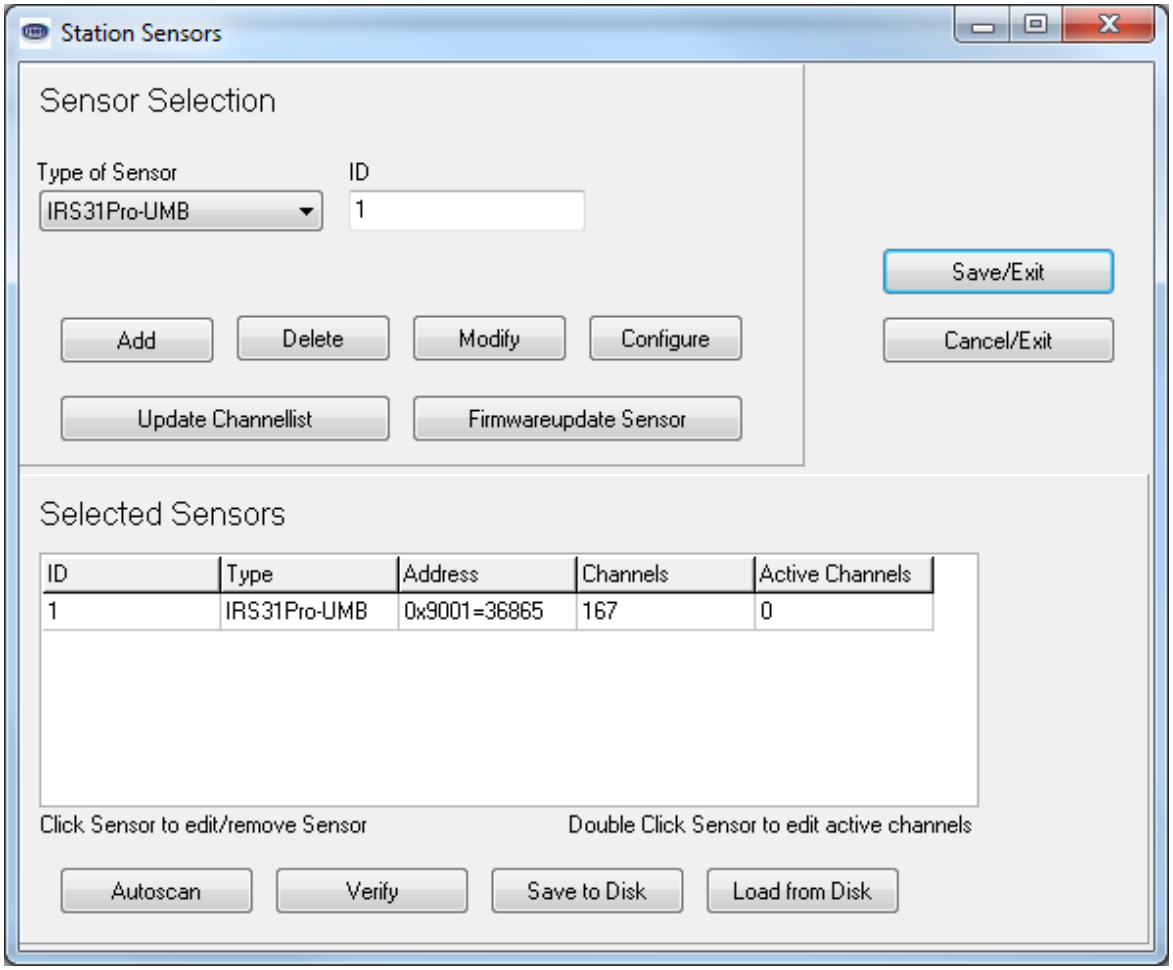


Figure 11: Sensor Selection

10.2.2 Configuration

After an IRS31-UMB configuration has been loaded, all relevant settings and values can be adjusted.

10.2.3 General Settings

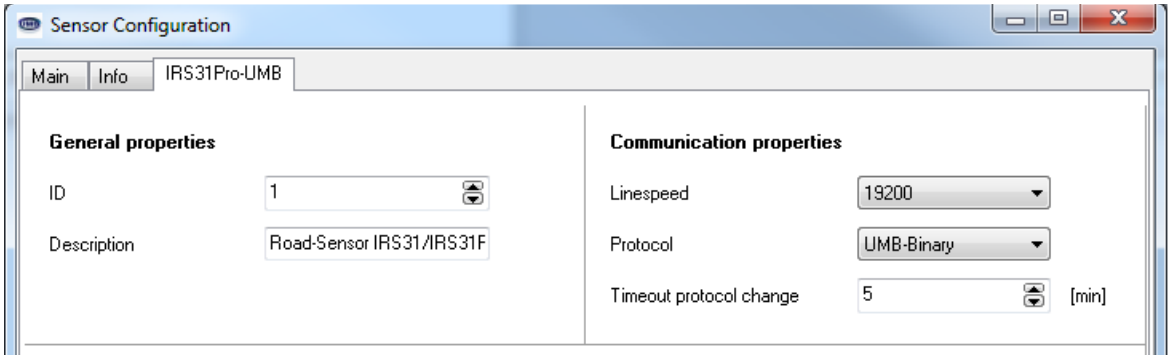


Figure 12: Sensor Configuration – General Settings

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.

Baud rate: 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)

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). For further information, please consult the operating manual of the UMB Config Tool.

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.

10.2.4 Device Settings

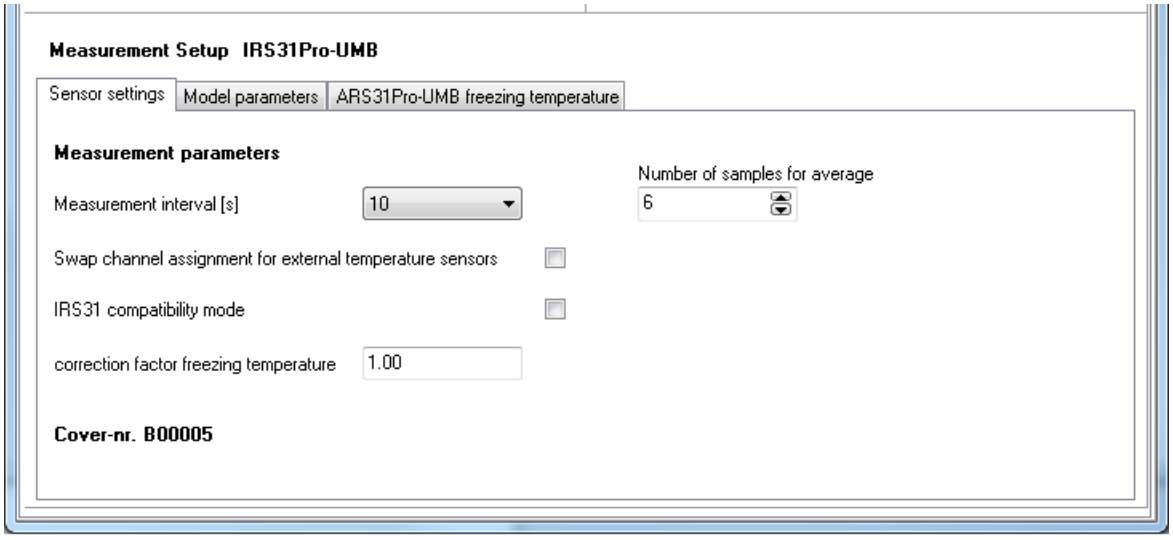


Figure 13: Sensor Configuration: Sampling Rate, Averaging and Freezing Temperature Correction Factor

Sampling rate: The sampling rate indicates how often a new measurement cycle is started. This value is configurable and can be set at 10, 20, 30 or 60 seconds. (Factory setting: 10 seconds)

Number of measurements for average: The number of measurements that are used to generate the moving average. This can be configured between 1 and 20. (Factory setting: 6)

Swap channel assignment of external temperature sensors:	This option is used to swap the assignment of the external temperature sensors.
IRS31 compatibility mode:	switches the Sensor into compatibility mode to IRS31-UMB. The setting compatibility mode to IRS31-UMB changes the class ID of the sensor to the class ID of an IRS31-UMB.In the IRS31-UMB compatibility mode the sensor possesses an IRS31-UMB compatible channel list and road condition coding. See chapter 11
Freezing temperature correction factor:	This factor influences the calculation of the freezing temperature. (Factory setting: 1) A factor between 0 and 1 increases the freezing temperature. A factor greater than 1 reduces the freezing temperature. Example: Measured freezing temperature -7°C Factor 0.5: Freezing temperature -2.69°C This influence of this factor on the calculation of the freezing temperature is non-linear.

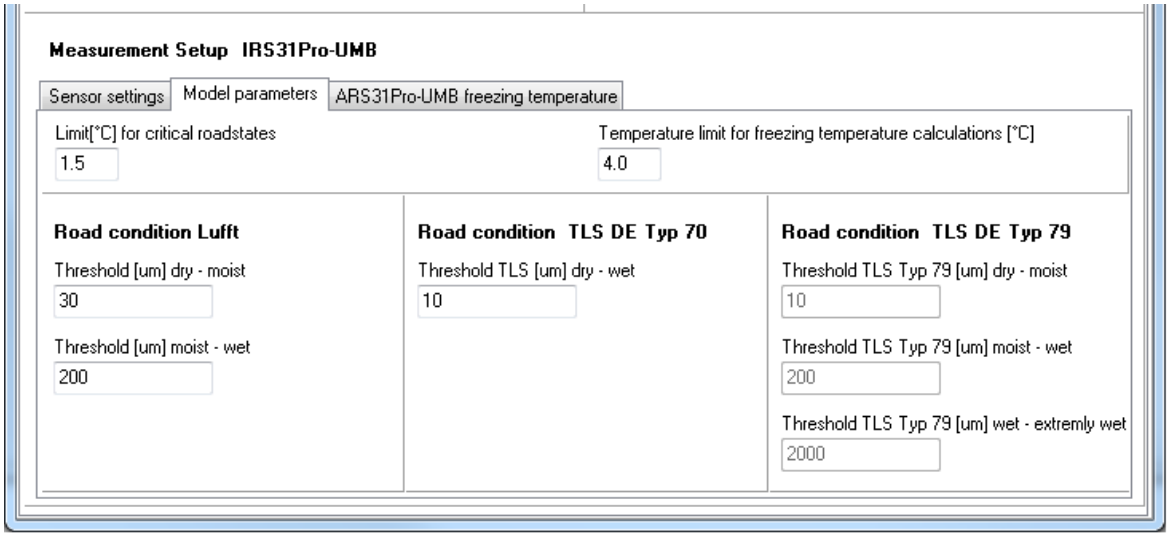


Figure 14: Sensor Configuration: Setting Thresholds

Threshold [°C] for critical road conditions:	Critical road conditions such as ice, wet / moist with salt can occur below this threshold.
Threshold temperature for determining freezing temperature [°C]:	The freezing temperature is calculated when the measured road surface temperature is less than or equal to the set threshold temperature. (Factory setting 4°C)
Threshold [µm] dry-moist:	When the water film height lies below the threshold set here, the IRS31PRO-UMB transmits the road surface condition "dry" (provided that no ice is detected) and no longer calculates the freezing temperature.
Threshold [µm] moist-wet:	Threshold between the Lufft road surface conditions "moist" and "wet".
Threshold TLS[µm] dry-wet:	For adaptation to the different thresholds in the different versions of TLS; for TLS2012: 10µm, for TLS 2003 and older: 30µm.

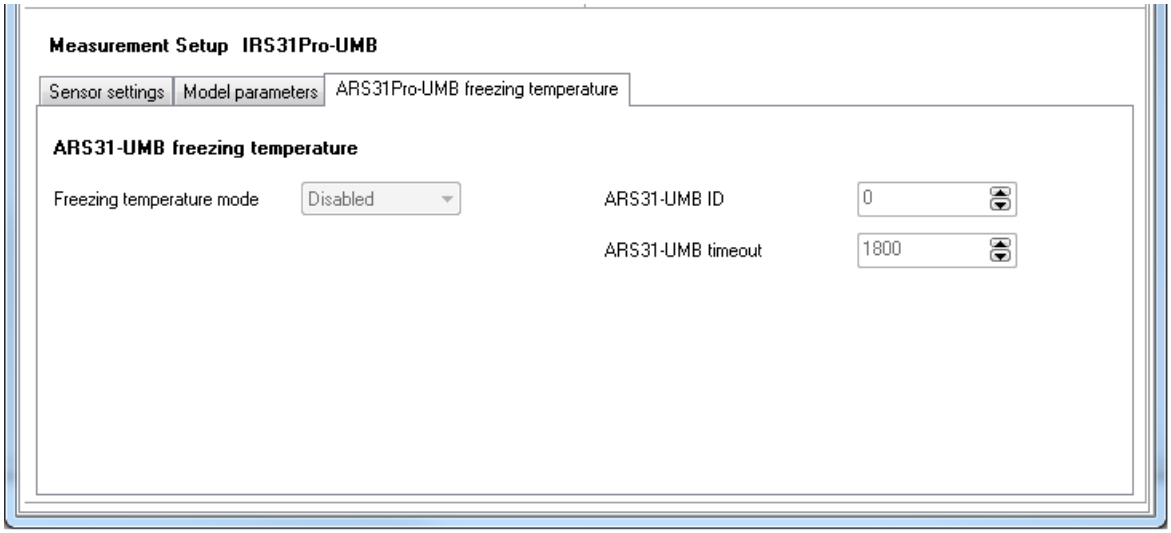


Figure 15: Sensor Configuration: Coupling of IRS31Pro-UMB with ARS31

Coupling with the ARS31Pro-UMB is not yet available.

10.2.5 Measurement Polling Channels

Each channel can be enabled for measurement polling by clicking the respective channel.

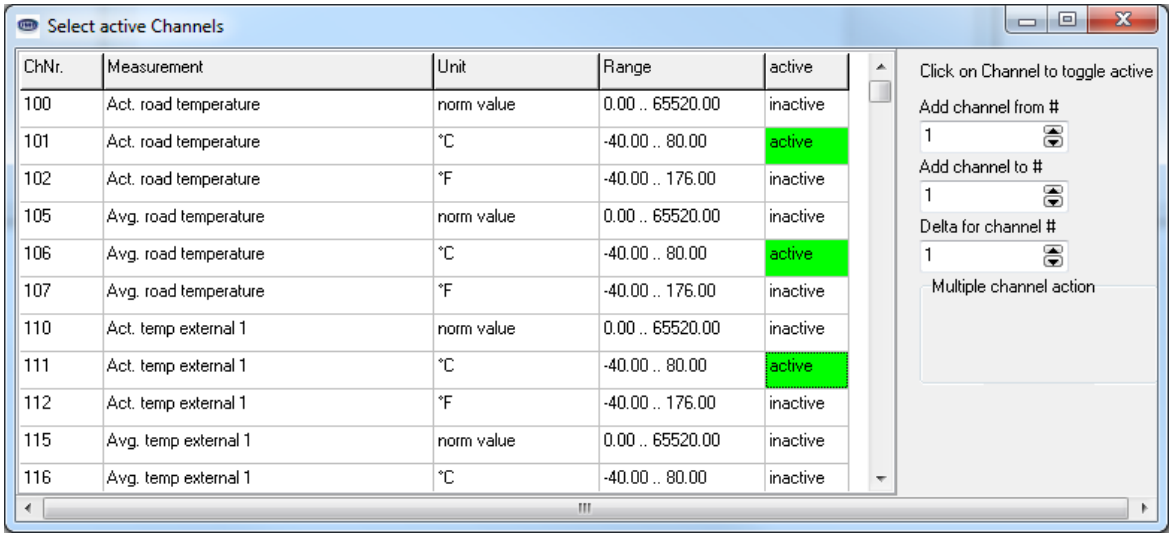


Figure 16: Select the Channels for Measurement Polling

10.2.6 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.de and install it on a Windows® PC. You can find the instructions in the installation directory of the UMB-Config-Tool.

Figure 17: Operating instructions UMB-Config-Tool

10.3 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.

10.3.1 Channels for Measurement Polling

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

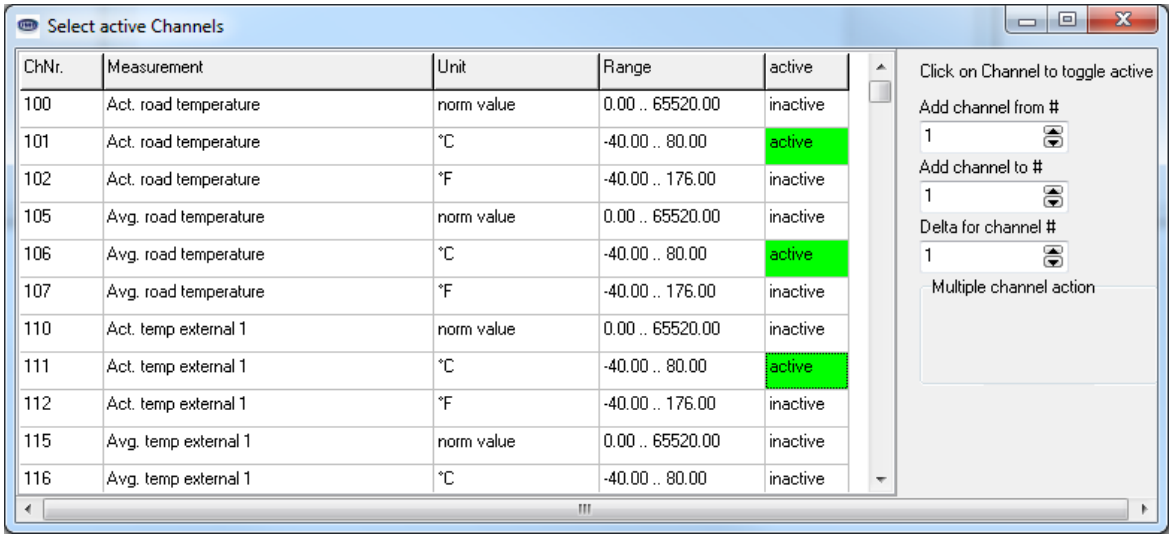


Figure 18: Channel Selection in the UMB Config Tool

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.

10.3.2 Example of Measurement Polling

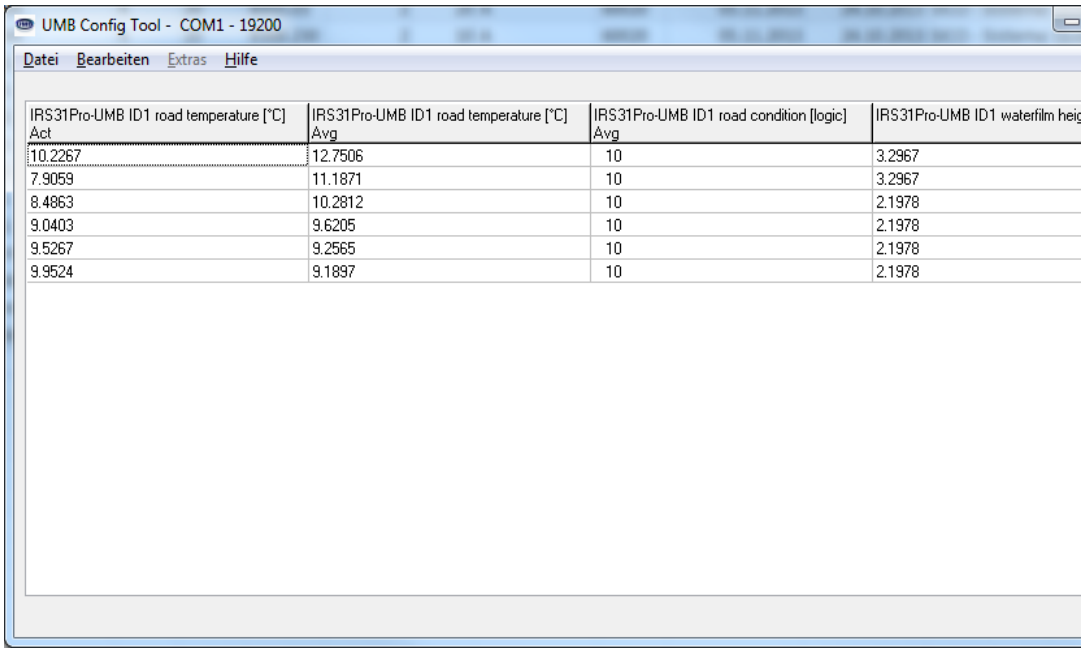


Figure 19: Measurement Polling with the UMB Config Tool

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.

11 IRS31-UMB Compatibility mode

The compatibility mode to the IRS31-UMB allows:

- the addressing of the sensor with the class ID of an IRS31-UMB
- the query of measurement channels of an IRS31-UMB
- the query of IRS31 encoded road conditions

11.1 Important notes for using Sensor in compatibility mode

- When an IRS31Pro-UMB is set to IRS31-UMB compatibility mode, you have to add an IRS31-UMB to your measurement setup to configure or test the sensor.
- When a firmware update should be carried out on an IRS31-UMB, make sure that the sensor is not an IRS31Pro-UMB in the IRS31-UMB compatibility mode.
- It is possible to carry out a firmware update of an IRS31Pro-UMB in the IRS31-UMB compatibility mode directly (without switching off the IRS31-UMB compatibility mode first).
- If an IRS31-UMB firmware is programmed to the IRS31Pro-UMB Sensor, the adjustment data of the sensor is lost, and the sensor must be adjusted new at the factory.

11.2 Configuration possibilities

With the option "IRS31 compatibility mode", the compatibility mode to IRS31-UMB can be activated and deactivated.

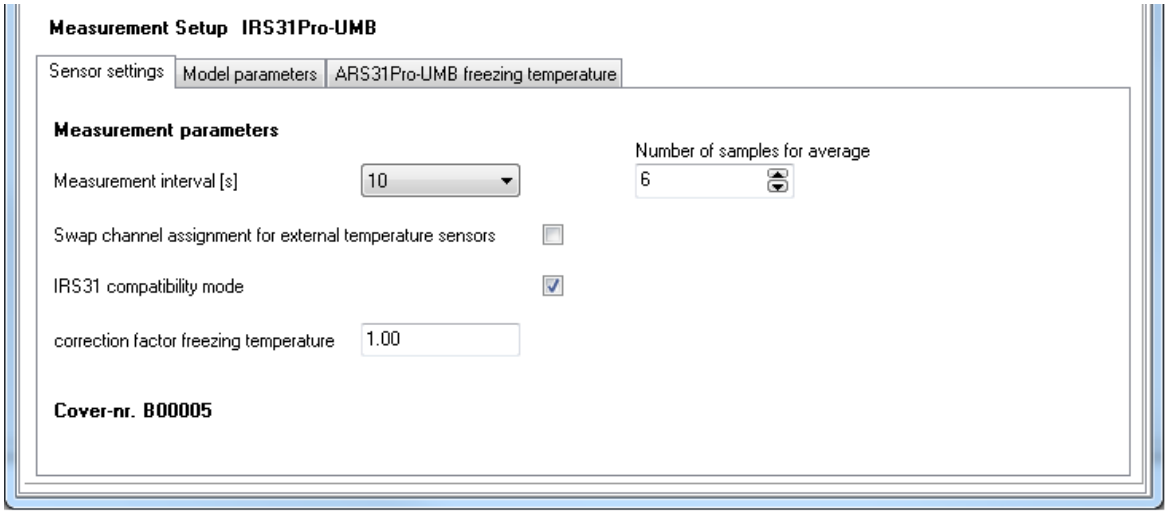


Figure 20: Sensor settings for IRS31-UMB compatibility mode

After the activation of this function and storing the profile on the sensor, the sensor can be addressed or tested only with the class ID of an IRS31-UMB (the class-ID for the road sensor IRS31-UMB is 1).

When configuring a measurement station with IRS31-UMB sensors, please make sure that the activation of the compatibility mode of an IRS31Pro-UMB doesn't cause double addressing (if necessary change the ID).

With the option "Number of samples for Average" the number of measurements that are used to generate the moving average can be configured (Factory setting: 6, Setting Range: 1…20).

Setting this number to 1 deactivates the moving average.

"Limit (°C) for critical roadstates" is relevant for the determination of the road condition states.

The road sensor detects the conditions “dry”, “damp” and “wet” above this limit (factory setting 1,5 °C). Below this limit, there are, in addition, the conditions of “freezing wet” and “critical“ (Figure 21).

For other device settings see chapter 10.2.4

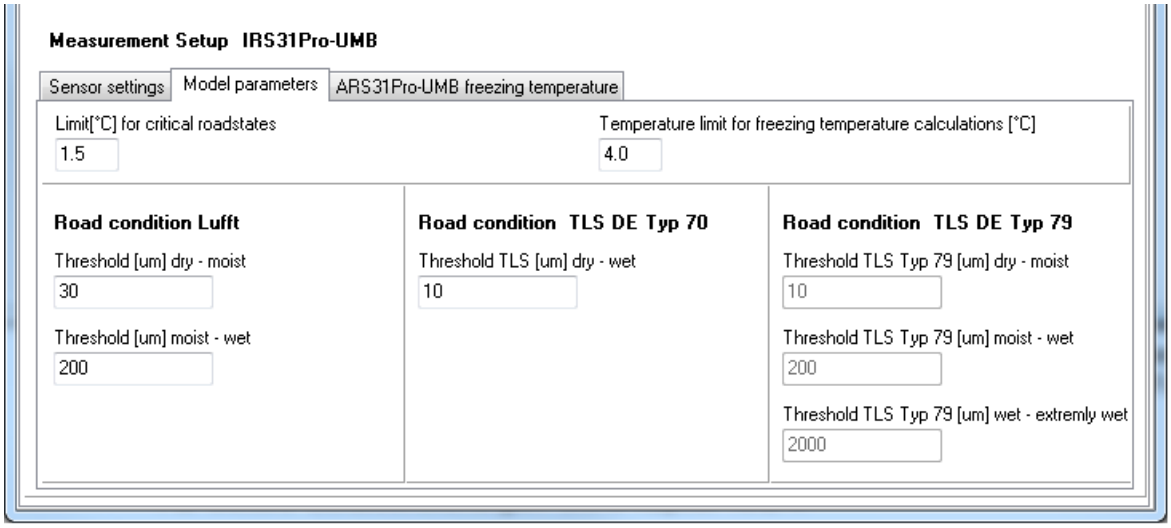


Figure 21: Model parameters

11.3 Examples for the Creation of Addresses

If, for example, a road sensor IRS31Pro-UMB is to be addressed with the device ID 1, this is achieved as follows:

Class ID for the road sensor IRS31Pro-UMB is 9 = 9h

Device ID is 1= 1h

Placing the class and device ID's together gives the following address 9001h = 36865d.

Activating compatibility mode changes the class ID to 1.

Class ID for the road sensor IRS31Pro-UMB is 1 = 1h

Device ID is 1= 1h

Placing the class and device ID's together gives the following address 1001h = 4097d.

11.4 Firmware-Update

With an IRS31Pro-UMB in the compatibility mode it is very slightly possible that mistakenly an IRS31-UMB firmware is programmed into the sensor. The adjustment data of the sensor thereby becomes useless, and the sensor delivers no longer correct measuring values. The sensor can be repaired only by a new calibration at the manufacturing plant.

Important Note: Before implementing any update, please check the name of Sensor.

To do this, load the current configuration via 'Load profile from Sensor'. The current name of the sensor is shown under 'Name' on the 'Info' page.

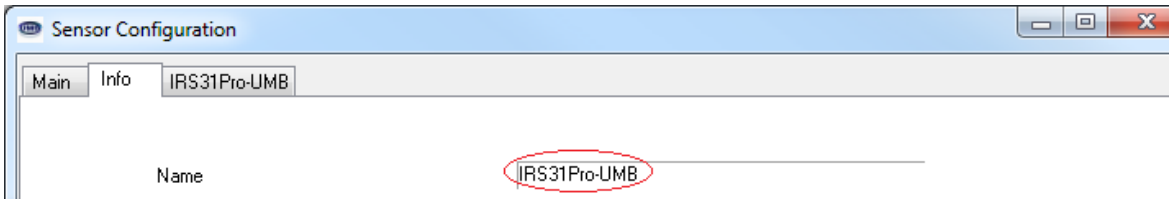


Figure 22: Name of the sensor

11.5 Overview channel list of an IRS31-UMB (IRS31Pro-UMB in IRS31-UMB compatibility mode)

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

The data types used are described in section 6.1.1

The change between average value and current measurement is done on an IRS31-UMB with the sensor configuration.

UMB-Channel						Measuring Range		
act	min	max	avg	Measurement Variable	Data type	min	max	Unit
Road surface temperature								
100			100	Road Temperature	uint16	0	65520	norm value
101			101	Road Temperature	float32	-40,0	80,0	°C
102			102	Road Temperature	float32	-40,0	176,0	°F
External temperature								
110			110	Temperature 1	uint16	0	65520	norm value
111			111	Temperature 1	float32	-40,0	80,0	°C
112			112	Temperature 1	float32	-40,0	176,0	°F
120			120	Temperature 2	uint16	0	65520	norm value
121			121	Temperature 2	float32	-40,0	80,0	°C
122			122	Temperature 2	float32	-40,0	176,0	°F
Freezing temperature								
150			150	Freezing Temperature	uint16	0	65520	norm value
151			151	Freezing Temperature	float32	-40,0	0,0	°C
152			152	Freezing Temperature	float32	-40,0	32,0	°F
160			160	Freezing Temp. NaCl	uint16	0	65520	norm value
161			161	Freezing Temp. MgCl[1]	uint16	0	65520	norm value
162			162	Freezing Temp. CaCl	uint16	0	65520	norm value
170			170	Freezing Temp. NaCl	float32	-40,0	0,0	°C
171			171	Freezing Temp. MgCl	float32	-40,0	0,0	°C
172			172	Freezing Temp. CaCl	float32	-40,0	0,0	°C
180			180	Freezing Temp. NaCl	float32	-40,0	32,0	°F
181			181	Freezing Temp. MgCl	float32	-40,0	32,0	°F
182			182	Freezing Temp. CaCl	float32	-40,0	32,0	°F
Water film height								
600			600	Water Film Height	uint16	0	65520	norm value
601			601	Water Film Height	uint16	0,0	10000,0	µm
602			602	Water Film Height	float32	0,0	393,70	mil
Saline concentration								
800			800	Saline Concentration	uint16	0	65520	norm value
801			801	Saline Concentration	float32	0	100	%
810			810	Saline Concentr.NaCl	uint16	0	65520	norm value
811			811	Saline Concentr.MgCl	uint16	0	65520	norm value
812			812	Saline Concentr.CaCl	uint16	0	65520	norm value
820			820	Saline Concentr.NaCl	float32	0	100	%
821			821	Saline Concentr.MgCl	float32	0	100	%
822			822	Saline Concentr.CaCl	float32	0	100	%
910			910	Salinity NaCl	float32	0	1000	g/m2
911			911	Salinity MgCl	float32	0	1000	g/m2
912			912	Salinity CaCl	float32	0	1000	g/m2
920			920	Salinity NaCl	float32	0	1000	lbs.p.l.mile
921			921	Salinity MgCl	float32	0	1000	lbs.p.l.mile
922			922	Salinity CaCl	float32	0	1000	lbs.p.l.mile
Ice percent								
830			830	Percent Ice NaCl	uint16	0	65520	norm value
831			831	Percent Ice MgCl	uint16	0	65520	norm value
832			832	Percent Ice CaCl	uint16	0	65520	norm value
840			840	Percent Ice NaCl	float32	0	100	%
841			841	Percent Ice MgCl	float32	0	100	%
842			842	Percent Ice CaCl	float32	0	100	%

Road condition								
900			900	Road Condition def.	uint8	0 dry 1 moist 2 wet 3 ice 4 snow 5 residual salt 6 freezing wet 7 critical >90 undefined		
902			902	Road Condition	uint8	0 dry 1 moist 2 wet 3 ice 4 snow 5 residual salt 6 freezing wet 7 critical >90 undefined		
Supply Voltage								
10000				Supply Voltage	float32	0	18,05	V

[1] optional (not yet available)

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 Error (32767d = 7FFF)
52	1052	Result message Residual salt (NaCl) RS	8 bit	0 … 100%	1%	0 = 0d = 00h 100 = 100d = 64h Error (255d = FFh)
65	1065	Result message Freezing temperature (NaCl) GFT	16 bit	-30 … 0°C	0.1°C	0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h Error (32767d = 7FFF)
67	1067	Result message Below-ground temperature at depth 1 TT1 (5 cm)	16 bit	-30 … +80°C	0.1°C	80.0 = 800d = 0320h 0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h Error (32767d = 7FFF)
68	1068	Result message Below-ground temperature at depth 2 TT2 (0…30 cm)	16 bit	-30 … +80°C	0.1°C	80.0 = 800d = 0320h 0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h Error (32767d = 7FFF)
69	1069	Result message Below-ground temperature at depth 3 TT3 (30cm)	16 bit	-30 … +80°C	0.1°C	80.0 = 800d = 0320h 0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h Error (32767d = 7FFF)

70	1070	Result message Road surface condition FBZ	8 bit	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. 66 Road is covered with ice (solid, frozen water and frozen aqueous solution) 255 Sensor is unable to determine the road surface condition 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 Error (65535d = FFFFh=
73	1073	Result message Thawing material concentration TSK	8 bit	0…100	1%	0 = 0d = 00h 100 = 100d = 64h Error (255d = FFh)
74	1074	Result message Thawing material per square meter TSQ	8 bit	0…100	1g/m^2	0 = 0d = 00h 100 = 100d = 64h Error (255d = FFh)

12 Technical Data

Power supply:	12 VDC
Operating voltage range:	0.75 .. 1.15 * operating voltage
Current consumption:	Typically approx. 8.5 mA (sampling rate 10 s) Typically approx. 5 mA (sampling rate 1 min.) at 12VDC
Inrush current:	Approx. 1A (5ms) at 12VDC
Sensor dimensions:	Height 50 mm ∅ 120 mm
Sensor weight:	Approx. 800g without cable and without external Temperature sensor
Protection class:	III (SELV)
Protection type:	IP68

Storage conditions

Permissible storage temperature:	-40°C … +70°C (in packing)
Permissible relative humidity:	0 … 95% RH non-condensing (in packing)

Operating conditions

Permissible ambient temperature:	-40°C … +80°C
Permissible relative humidity:	0 … 100% RH
Permissible altitude above sea level:	3000 m

RS485 interface, 2 wire, half-duplex

Data bits:	8
Stop bit:	1
Parity:	None
Adjustable baud rates:	1200, 2400, 9600, 19200[1], 38400

12.1 Measuring Range / Accuracy

12.1.1 Road Surface Temperature

Measurement process:	ntc
Measuring range:	-40°C … +80°C
Resolution:	< 0.02°C (-20…+20), otherwise +/-0.1
Accuracy:	+/- 0.1°C (-20…+20), otherwise +/-0.2
Sampling rate:	Variable (10 s….60 s)
Units:	°C; °F

12.1.2 Water Film Height

Measurement process:	Radar
Measuring range:	0 … 10000 µm
Resolution:	Better than 0.01mm
Accuracy:	0.2mm to 3mm: better than +/-30%
Sampling rate:	Variable (10 sec….60 sec)
Units:	µm, mil

12.1.3 Freezing Temperature

Measurement process:	Calculated from saline concentration
Measuring range:	-40°C … 0°C
Resolution:	0.1°C

[1] Factory setting and baud rate for firmware update

Sampling rate:	Variable (10 sec….60 sec)
Units:	°C; °F

12.1.4 Ice Percentage

Measurement process:	Passive
Measuring range:	0% … 100%
Resolution:	0.1%
Sampling rate:	Variable (10 sec….60 sec)
Units:	%

12.1.5 Saline Concentration

Measurement process:	Passive
Measuring range:	0% … 100%
Resolution:	0.1%
Sampling rate:	Variable (10 sec….60 sec)
Units:	%

12.1.6 Friction

Measurement process:	Calculated from ice percentage
Measuring range:	0 … 1
Resolution:	0.01
Sampling rate:	Variable (10 sec. ….60 sec.)

13 EC Certificate of Conformity

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

Type: **IRS31Pro-UMB (Order no.: 8910.Uxxx)**
UMB ISO Converter ISOCON-UMB (Order no.: 8160.Uxxx)

We herewith certify that the designated 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:

EN 61000-4-2 (2009-12) .....ESD
EN 61000-4-3 (2011-04) .....Immunity to radiated electromagnetic fields
EN 61000-4-4 (2011-10).....Immunity to electrical fast transients / burst
EN 61000-4-5 (2007-06) .....Immunity to electrical fast transients / surge
EN 61000-4-6 (2009-12).....Immunity to line-conducted interferences, induced by radio frequency fields
EN 55022 Rad (2011-12) .....Radio interference characteristics ITE
EN 55022 Cond (2011-12) .....Radio interference characteristics ITE

Fellbach, 18.11.2013 Axel Schmitz-Hübsch

14 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
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: - The road surface temperature is too high to perform the freezing temperature measurement - The water film height is too low to perform the freezing temperature measurement - The freezing temperature cannot be determined, because of an firm layer of ice on the sensor
Device transmits error value (43d)	The device returns this error value in the channel because there is a fault on one of the variables on which this channel is based.
Device transmits error value 54h (84d)	Internal measurement error. Can be ignored for one-time occurrence. In case of permanent occurrence, check whether the installation notes / power supply correspond to the specifications in the operating instructions.
Device transmits an error value not listed here	There may be several reasons for this behavior → contact the manufacturer's technical support service
Device transmits error value 32h (50d)	contact the manufacturer's technical support service
Device transmits error value 33h (51d)	contact the manufacturer's technical support service
Device transmits no freezing temperature	- The Sensor is too warm - The Sensor is dry - The sensor is covered with ice

15 Disposal

15.1 Inside the EU

The equipment 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.

15.2 Outside the EU

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

16 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

Postfach 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.

16.1 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.de (Menu header: Support → FAQs).

17 Appendix

17.1 Channel List Summary

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

The data types used are described in section **Fehler! Verweisquelle konnte nicht gefunden werden.**.

UMB Channel						Measuring Range		
act	min	max	avg	Measurement Variable	Data Type	min	max	Unit
Road surface temperature								
100			105	Road temperature	uint16	0	65520	norm value
101			106	Road temperature	float32	-40.0	80.0	°C
102			107	Road temperature	float32	-40.0	176.0	°F
External temperature								
110			115	External temperature 1	uint16	0	65520	norm value
111			116	External temperature 1	float32	-40.0	80.0	°C
112			117	External temperature 1	float32	-40.0	176.0	°F
120			125	External temperature 2	uint16	0	65520	norm value
121			126	External temperature 2	float32	-40.0	80.0	°C
122			127	External temperature 2	float32	-40.0	176.0	°F
Freezing temperature								
150			155	Freezing temp. NaCl	uint16	0	65520	norm value
151			156	Freezing temp. NaCl	float32	-40.0	0.0	°C
152			157	Freezing temp. NaCl	float32	-40.0	32.0	°F
170			175	Freezing temp. MgCl2[1]	uint16	0	65520	norm value
171			176	Freezing temp. MgCl2	float32	-40.0	0.0	°C
172			177	Freezing temp. MgCl2	float32	-40.0	32.0	°F
190			195	Freezing temp. CaCl2[1]	uint16	0	65520	norm value
191			196	Freezing temp. CaCl2	float32	-40.0	0.0	°C
192			197	Freezing temp. CaCl2	float32	-40.0	32.0	°F
Water film height								
600			605	Water film height	uint16	0	65520	norm value
601			606	Water film height	float32	0.0	10000.0	µm
602			607	Water film height	float32	0.0	393.70	mil
Saline concentration								
800			805	Saline concent. NaCl	uint16	0	65520	norm value
801			806	Saline concent. NaCl	float32	0	100	%
910			915	Saline concent. NaCl	float32	0	100	g/m^2
920			925	Saline concent. NaCl	float32	0	1280	lbs.p.l.mile
830			835	Saline concent.MgCl2[1]	uint16	0	65520	norm value
831			836	Saline concent.MgCl2	float32	0	100	%
911			916	Saline concent.MgCl2	float32	0	100	g/m^2
921			926	Saline concent.MgCl2	float32	0	1280	lbs.p.l.mile
840			845	Saline concent.CaCl2[1]	uint16	0	65520	norm value
841			846	Saline concent.CaCl2	float32	0	100	%
912			917	Saline concent.CaCl2	float32	0	100	g/m^2
922			927	Saline concent.CaCl2	float32	0	1280	lbs.p.l.mile
Ice percentage								
810			815	Ice percentage	float32	0.0	100	%
Friction								
820			825	Friction	float32	0.0	1.0	
Road condition								
900			905	Road condition	uint8	10 Dry 15 Moist 20 Wet 25 Moist with salt 30 Wet with salt 35 Ice 40 Snow 45 Frost		
Measurement Counter								

20001				Measurement counter	uint16	0	65520	
Resistance								
			32210	resistive_avg	float32	-1.0E15	1.0E15	ohm

[1] optional (not yet available)

17.2 Channel List Summary per TLS2012 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 Error (32767d = 7FFF)
52	1052	Result message Residual salt (NaCl) RS	8 bit	0 … 100%	1%	0 = 0d = 00h 100 = 100d = 64h Error (255d = FFh)
65	1065	Result message Freezing temperature (NaCl) GFT	16 bit	-30 … 0°C	0.1°C	0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h Error (32767d = 7FFF)
67	1067	Result message Below-ground temperature at depth 1 TT1 (5 cm)	16 bit	-30 … +80°C	0.1°C	80.0 = 800d = 0320h 0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h Error (32767d = 7FFF)
68	1068	Result message Below-ground temperature at depth 2 TT2 (0…30 cm)	16 bit	-30 … +80°C	0.1°C	80.0 = 800d = 0320h 0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h Error (32767d = 7FFF)
69	1069	Result message Below-ground temperature at depth 3 TT3 (30cm)	16 bit	-30 … +80°C	0.1°C	80.0 = 800d = 0320h 0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h Error (32767d = 7FFF)
70	1070	Result message Road surface condition FBZ	8 bit	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. 66 Road is covered with ice (solid, frozen water and frozen aqueous solution) 255 Sensor is unable to determine the road surface condition 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 Error (65535d = FFFFh=
73	1073	Result message Thawing material concentration TSK	8 bit	0…100	1%	0 = 0d = 00h 100 = 100d = 64h Error (255d = FFh)
74	1074	Result message Thawing material per square meter TSQ	8 bit	0…100	1g/m^2	0 = 0d = 00h 100 = 100d = 64h Error (255d = FFh)

75	1075	Result message Snow film height SFD	8 bit	0 … 50 mm	1 mm	0 = 0d = 00h 50 = 50d = 32h Error (255d = FFh)
76	1076	Result message Ice film height EFD	16 bit	0.00…2.00 mm	0.01 mm	0 = 0d = 0000h 2.00 = 200d = 00C8h Error (255d = FFh)
77	1077	Result message Road grip GR	8 bit	0.00…1.00	0.01	0.00 = 0d = 00h 1.00 = 100d = 64h Error (255d = FFh)
79	1079	Result message Road surface condition for winter services FZW	8 bit	0 … 255		0 Dry 16 Moist 32 Wet 48 Extremely wet 64 Icy
129	1129	Result message Ice percentage EP	8 bit	0…100 %	1%	0 = 0d = 00h 100 = 100d = 64h Error (255d = FFh)

17.3 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.de).

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.

17.3.1 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).

17.3.2 Addressing with Class ID 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 bits)				
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
9	IRS31Pro-UMB Road Sensor		1 – 255	Available
15	Master / 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.

17.3.3 Example for Creating Addresses

If, for example, you want to address an IRS31Pro-UMB device with the device ID 001, this takes place as follows:

The class ID for IRS31Pro-UMB is 9d = 9h

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

Putting the class and device IDs together gives the address 9001h (36865d).

17.3.4 Example of a Binary Protocol Request

If, for example, an IRS31Pro-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 the IRS31Pro-UMB is 9 = 9h

The device ID is 001 = 01h

Putting the class and device IDs together gives a target address of 9001h.

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 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 (page 39), the current road surface temperature in °C in channel 101d = 0065h.

The calculated CRC is 85DCh.

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	90h	01h	F0h	04h	02h	23h	10h	65h	00h	03h	85h	DCh	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	90h	0Ah	02h	23h	10h	00h	65h	00h	16h

<value>				ETX	<cs>		EOT
15	**16**	**17**	**18**	**19**	**20**	**21**	**22**
ECh	F2h	C4h	41h	03h	24h	51h	04h

Interpretation of the response:

<status> = 00h device o.k. (≠ 00h signifies error code; see chapter 17.3.5)

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

<value> = 41C4F2ECh corresponds to a float value of 2.46186E+0001 = 24.6

The road surface temperature is therefore 24.6°C.

Correct data transmission can be checked with the aid of the check sum (5124h).

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.

17.3.5 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
2Bh (43d)	Error in measurement
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

17.3.6 CRC Calculation

CRC is calculated according to the following rules:

Norm: CRC-CCITT

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

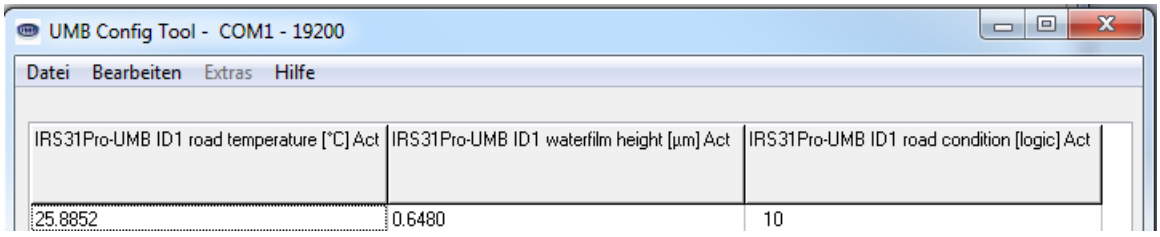
Start value: FFFFh

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

17.3.7 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 (101, 601 and 900):




```
Request by UMB Config Tool:
01 10 01 90 01 F0 09 02 2F 10 03 65 00 59 02 84 03 03 D2 6C 04
Response from IRS31Pro-UMB sensor:
01 10 01 F0 01 90 1C 02 2F 10 00 03 08 00 65 00 16 ED 14 CF 41 08 00 59 02 16 80 E3
25 3F 05 00 84 03 10 0A 03 FC A2 04
```

17.4 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 Configuration with PC Configuration Software UMB Config Tool, 10.2.3 page 25).

ASCII protocol is network-compatible and serves exclusively for online data requests. The device does 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.

17.4.1 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.

17.4.2 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.

17.4.3 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 normalized to 0 – 65520d. Various error codes are defined from 65521d – 65535d.

Example:

Request: `&_36865_M_00100`

By way of this request, channel 100 of the device with address 36865 (IRS31Pro-UMB with device ID 001) is requested.

Response: `$_36865_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	+80°C
34785d	corresponds to	[+80°C – (-40°C)] / 65520 * 34785 +(-40°C) = 23.7°C

Note: TLS channels are not available in ASCII protocol.

17.4.4 Switch to Binary Protocol (X)

Description: This command is used to switch temporarily into the binary mode.

Request: '&'_<ID>_'X' CR

Response: '$'_<ID>_'X' CR

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

Note: ATTENTION!! Immediately after the response, the device can only be accessed via the binary protocol. If you want the device to work in ASCII mode again, it must be switched to ASCII mode using the binary command for a protocol change.

After a reset or device-specific timeout, the device communicates again in the previously set mode. If the device is to operate permanently in the binary mode, for example, the device configuration in the EEPROM must be changed.

17.4.5 Software Reset (R)

Description: This command is used to trigger a software reset. Alternatively, the factory settings can be restored before the reset.

Request: '&'_<ID>_'R'_<reset> CR

Response: '$'_<ID>_'R' CR

<ID>5 device address (5 decimal places with leading zeros)

<reset>3 010: Reset; 011: Reset with default

Note: The response occurs immediately before the reset.

17.4.6 Software Reset with Delay (D)

Description: This command is used to trigger a software reset after a delay <delay> (e.g. for firmware update).

Request: '&'_<ID>_'D'_<delay> CR

Response: '$'_<ID>_'D' CR

<ID>5 device address (5 decimal places with leading zeros)

<delay>3 Delay time in seconds (max. 255)

Note: The response occurs at the start of the delay time.

17.4.7 Device Information (I)

Description: This command is used to transmit device information.

Request: '&'_<ID>_'I' CR

Response: '$'_<ID>_'I'_<Ser.no.>_<MMYY>_<Project>_<PartsList>_<SPlan>_<hardware>_<software>_<e2version>_<deviceversion> CR

<ID>[5] device address (5 decimal places with leading zeros)
<Ser.no.>[3]
<MMYY>[4]
<Project>[4] <PartsList>3
<SPlan>[3]
<hardware>[3]
<software>[3]
<e2version>[33]
<deviceversion>[5]

17.4.8 Normalization of Measurement Values in ASCII Protocol

The normalization 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	80.0	°C
	-40.0	176.0	°F
External temperatures	-40.0	80.0	°C
	-40.0	176.0	°F
Freezing temperature	-40.0	0.0	°C
	-40.0	32.0	°F
Water Film Height			
Water film height	0.0	10000.0	µm
Percentage			
Ice percentage	0.0	100.0	%
Saline concentration	0.0	100.0	%
Friction	0.0	1.0	none

17.4.9 Status and Error Codes in ASCII Protocol

In addition to the normalization of the output of measurement values, various error codes are defined from 65521d – 65535d.

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
65527d	Measurement error
65534d	Invalid calibration
65535d	Unknown error

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