UMB Protocol 1.0
Universal Measurement Bus
Communication Protocol
for Meteorological Sensors

Status 03.05.2021
Protocol Version 1.0
Document Version 1.7

Table of Contents

1 Version History

Document Version	Date	Compiled by	Description of Amendment
0.0	24.11.2004	SR	Compilation
0.1	14.06.2005	EES	First edition
0.2	22.12.2005	EES	Update 2 wire interface hardware
0.3	07.02.2006	EES	Renaming to UMB, supplement “Automatic Readout of a Network” and device information
0.4	07.03.2006	EES	Nomenclature amended; BC command summary amended
0.5	09.03.2006	EES	- Device information command extended by addition of E2 variable and details of the type of information in the answer - Channel assignment extended by relative measurement values
0.6	04.04.2006	EES	List of units amended
1.0	12.04.2006	EES	- Measurement value types amended - Device information command extended by addition of measurement value type **First approved version**
1.1	19.05.2006	EES	- Status byte inserted in the answer of Readout Time/Date (28h) command
		SR	- Status 29h under-voltage defined
		EES	- Channel assignment per device class amended - Amendments to TLS coding in the channel assignment and the list of supported DE types per FG3 in the appendix - Logo included
1.2	18.07.2006	EES	- Status 2Ah hardware fault defined - Status 2Bh fault in the measurement defined - List of units amended (l/m²) - ASCII character set amended - Measurement value type ‘Sum’ 14h defined
		BEL	- RRS integrated
		EES	- Status 52h Channel over-range defined - Status 53h Channel under-range defined - List of units amended (hPa hectopascals)
		BEL	- Types of precipitation defined in accordance with the WMO on RRS channel 700
		EES	- General channel assignment 10500 defined for pulses and 2000 for further TLS channels - Measurement value type 15h defined for ‘vectoral mean value’ - TLS channels for ANACON amended (LD and 2nd channel) - Status codes for calibration amended - Change in the answer to the TLS channel request (adaptation to existing implementation)

1.3	08.08.2006	EES	- Response time of the calibration command (29h) changed from short to long - Status code 36h changed to 'Channel deactivated' - Data type of the TLS channels adapted in the general channel assignment of the device classes - Channel Assignment Chapter moved back to later in document - Response time for online data request (23h) changed to 'long' due to computing-intensive channels (e.g. ANACON) - Instructions for 'Multi-Channel Online Data Request' (2Fh) amended in relation to long response times - ANACON TLS channel DE type 66 TPT dewpoint amended - Various channel assignments amended - Command 29h renamed 'test command' as this is used not only for adjustment but also to test various device functions
1.4	12.09.2006	EES	- Comment expanded to state that no TLS channels are available in the ASCII protocol
		SR	- Road sensor channel assignment - Mil length unit added
1.5	14.12.2007	EES	- 'Set new id' command vers. 1.1 amended - Info added to status code 28h - Knots unit added
		BEL	- Non-metric units inch and mil / inch/h and mil/h added on R2S channels (chapters 3.9.3, 3.10.3 and 3.10.9)
		EES	- Channel list added for ANACON-UMB (abs. humidity and pressure) - Device class and channel list added for compact weather station - Product list amended - Channel assignment device class 6 universal measurement transmitter for precipitation and pulses amended
1.6	17.12.2010	EES	- Product designations for the compact weather station amended - Error code INIT_ERROR (2Ch) = Error on device initialization and OS_ERROR (2Dh) = Error in operating system added - Channel designations for absolute and relative air pressure amended - Error code
1.7	03.05.2021	RZ	- IRS31Pro-UMB added
		KRM	- Firmware update command (37_h) added - MARWIS-UMB supported commands
		RZF	- UMB-Tunnel command (36_h) added - corrected layer definition - corrected description of online data request ($2F_h$) - corrected description of broadcast - removed UMB-ASCII - definition of UMB-ASCII2.0 as separate document
		KRM	Reset subcommand 0x14 specified
		RZF	- added UMB binary data command (38_h)
		KRM	- documentation of UMB error CALC_ERROR
		KRM	- documentation of device specific version information command
		RZF	<status> added to command descriptions
		BR	Added new TLS-Channels

2 Preliminary Remarks

The protocols described here were developed for meteorological sensors and facilitate simplified communication with various devices such as IRS31-UMB, VS20-UMB and R2S-UMB.

2.1 Restricted Guarantee

The methods and settings described in this document allow device configuration exceeding the standard (ConfigTool.NET). The selection of incorrect settings can lead to the loss of the specified measurement accuracy and to device failure. OTT HydroMet reserves the right to restrict the guarantee to the products in the case of the application of the procedures described here.

2.2 Nomenclature

Device: The term “device” is used in this document as a synonym for the equipment family of meteorological sensors such as IRS31, VS20 and R2S.

Hexadecimal values are identified by the suffix ‘h’. Decimal values are identified by the suffix ‘d’.

‘BC’ identifies commands which can be transmitted by broadcast. ‘NBC’ stands for ‘not broadcast-able’ (please also see Comments on broadcast on page 34).

2.3 Data Format and Byte Order in the Communication Protocol:

LONG: LowLowByte LowHighByte HighLowByte HighHighByte
INT: LowByte HighByte
FLOAT: Per IEEE format (4 bytes)
DOUBLE: Per IEEE format (8 bytes)

2.4 Physical Connection and Hardware Structure

Usually the devices in a network are controlled via a half-duplex RS485 2 wire interface. The ISOCON additionally provides an RS232 interface. The factory-set baud rate is 19200 Baud with 8 data bits, one stop bit and no parity (8N1). Alternatively, messages can also be exchanged over TCP sockets or similar. In this case the connection to the sensor is established by an IP to serial adapter or, if supported by the sensor, directly through Ethernet of Wi-Fi. Port numbers for IP access can be found in the sensor manual.

2.5 Software Protocol

Configuration and polling of the device takes place in binary protocol. As the system operates without collision detection, the controller-device principle is strictly observed, i.e. a transaction is **always** initiated by the controller.

Alternatively, the human readable protocol UMB-ASCII 2.0 is provided **(although not all products currently support this feature)**. Please see the separate manual for UMB-ASCII 2.0.

3 UMB Binary Protocol (Version 1.0)

The OSI (Open Systems Interconnection) reference model of the International Standards Organization (ISO) can be used to abstract the logical steps of the header construction.

The datagrams pass through the individual layers of the protocol stack and in doing so are progressively provided with the header data. In this way a frame is created, the maximum length of which is limited to 255 bytes. 210 bytes are available for reference data.

3.1 Protocol Stack (Framing)

3.1.1 (7) Application Layer

The application layer is not directly part of the UMB protocol and is represented by the programs or functions using the UMB protocol respectively execute the transmitted commands. Examples are UMB ConfigTool.NET on the controller side and, on device side the functions provided for the acquisition of sensor measurement values.

3.1.2 (6) Presentation Layer

A command consists of a minimum of two characters: The command <cmd> and the version number of the command <verc>. The optional payload may contain up to 210 characters. The value range of one byte of the payload is 0 to 255. Response telegrams include the status byte in the payload

1	2	3 - 4	5 - 6	7	8	**9**	**10**	**11 ... (8 + len) optional**	9 + len	10 + len 11 + len	12 + len
						<cmd>	<verc>	<payload>			

3.1.3 (5) Session Layer

The session layer is not defined for the UMB protocol and therefore transparent.

3.1.4 (4) Transport Layer

The transport layer is not defined for the UMB protocol and therefore transparent.

3.1.5 (3) Network Layer

Addressing is performed by 16-bit addresses. Within the network layer the command and payload data received from the higher layer are provided with receiver (<to> and transmitter <from> addresses.

1	2	**3 - 4**	**5 - 6**	7	8	9	10	11 ... (8 + len) optional	9 + len	10 + len 11 + len	12 + len
		<to>	<from>								

3.1.6 (2b) Data-Link Layer / Logical Link Control

The data frame is marked by the two control characters (SOH, EOT). The version number <ver> denotes the further structure of the header and is the binary protocol version number (in this case Version 1.0). The upper nibble represents the version number and the lower nibble the revision number.

Example: Version 1.0 → <ver> = 10h = 16d

The number of bytes between the payload control characters (STX, ETX) is defined by <len>. The message is protected against transmission errors by verification against the payload <cs>.

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

3.1.7 (2a) Data Link Layer Media Access Control

Access control of the transmission media is provided by timeouts.

3.1.7.1 Controller Side Timing

These rules are defined for controller side implementation of UMB protocol:

- strictly follow the **controller-device principle** (a transaction is always initiated by the controller, only one controller per system permitted
- the controller must pause for at least three characters time after receiving a device message before transmitting the next command
- after transmitting a broadcast command at least 500ms delay before the next command are required
- for certain sensor a retry may be required. The recommended maximum number of retries is 3. The minimum gap between retries is 500ms, but the total retry time may not exceed 3s.

If this time has passed the controller may consider the message to be lost and can start the retries. In case of a direct RS232 connection the response timeout is

- - commands with standard response time: 60ms
- - commands with long response time: 510ms

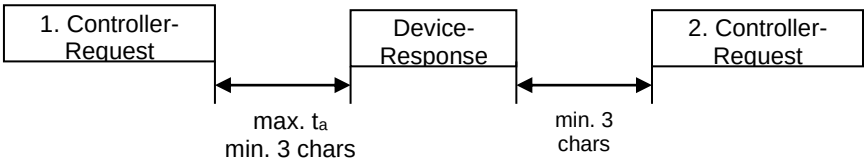
ATTENTION!! In case of Ethernet or mobile network connection the timeouts must be adjusted to the latency of the media in use. Therefore, the times should be configurable for the Controller software.

3.1.7.2 Device Side Timing

These rules are defined for device side implementation of UMB protocol:

- In case of critical measurements, the receive interrupt may be disabled
- After receiving a command, the sensor (device) must start the transmission of the response latest after the time t_a, but not before end of the minimum delay of 3 characters length. If, in case of an online request, the measurement takes longer, the latest stored value shall be transmitted, and the measurement performed afterwards.
- 2 classes of response times have been defined:
  - Standard: the maximal response time t_a is 50 ms
  - Long: certain commands require a longer execution time. In this case the maximal response time t_a is 500 ms. These commands are accordingly marked in the command definitions.

- If the command exceeds the maximal response time the device must suppress the transmission of the response. The controller will not get a response, but this doesn't give definite information if the command has been executed or not. It would be possible that the maximal response time was exceeded together with the completion of the command. This means that in any case the command must be repeated by the controller. (in case of procedures including sequences of commands it may even require terminating the procedure and restart it)



3.1.8 (1) Physical Layer

The physical medium is not part of the UMB protocol definition and basically free of choice. Usually 2 wire RS485 is used, with standard baud rate 19200 Baud, 8 data bits, 1 stop bit and no parity.

Additionally, UMB telegrams may be tunneled through other communication media, e.g. Ethernet, Wi-Fi, or Bluetooth.

3.1.9 Summary

The complete request frame is illustrated here in summary:

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

Response Frame:

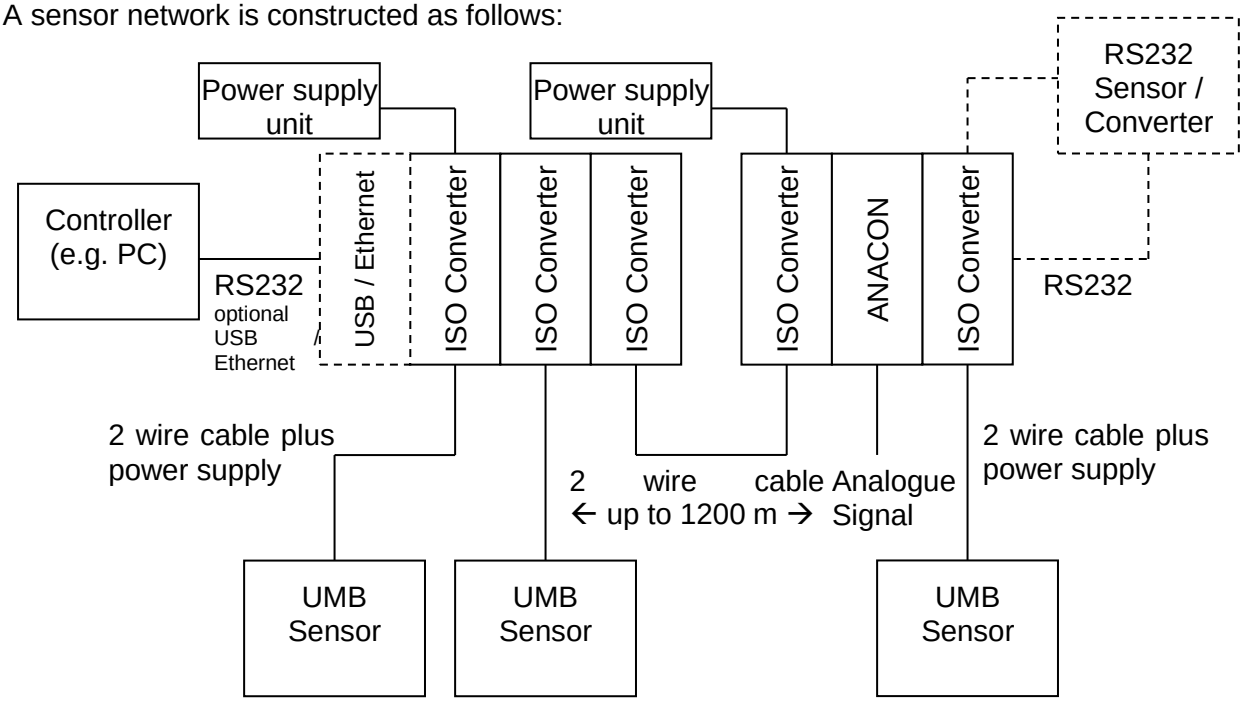
1	**2**	**3 - 4**	**5 - 6**	**7**	**8**	**9**	**10**	**11**	**12 ... (9 + len) optional**	**10 + len**	**11 + len 12 + len**	**13 + len**
SOH	<ver>	<to>	<from>	<len>	STX	<cmd>	<verc>	<status>	<payload>	ETX	<cs>	EOT

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>	Transmitter address, 2 bytes
<len>	Number of data bytes between STX and ETX; 1 byte
STX	Control character for the start of the user data transmission (02h); 1 byte
<cmd>	Command; 1 byte
<verc>	Version number of the command; 1 byte
<payload>	Data bytes; 0 – 210 bytes
ETX	Control character for the end of the user data transmission (03h); 1 byte
<cs>	Checksum, 16 -bit CRC; 2 bytes
EOT	Control character for the end of the frame (04h); 1 byte

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

3.2 Topology

A sensor network is constructed as follows:



Controller: The controller is connected to the RS232 interface built into the ISO converter. An interface module for USB and Ethernet via virtual COM port is also available as an option.

Sensor: The sensors are connected via a 2-wire connection plus power supply lines through one ISO converter each; the converter also provides the power supply for the sensor.

ISO Converter: The converters are connected by stackable plug-in connectors which can be arranged in sequence. To cover larger distances between ISO converters, they may be connected RS485 interface to RS485 interface.

Sensors from other Manufacturers

If sensors from other manufacturers also operate in accordance to the controller/device principle, they may be connected to the RS232 interface of an ISO converter; it is also conceivable that sensors with RS422/485/2 wire/4 wire could be connected to the measurement network via a suitable converter (e.g. Phoenix).

Measurement Modules

Intelligent measurement modules, which make the analogue signals available on the bus, are available for sensors without a data interface (e.g. 0 – 1V or 4 – 20mA).

3.3 Addressing with Class- and Device-ID

Addressing takes place by means of a 16-bit address. This is divided into a sensor 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)		**Reserved**	**Device ID** (0 – 255)		
0	Broadcast	For internal usage only, usually 0	0	Broadcast	
1	Road sensor (IRS31-UMB)		1 - 255	available	
2	Rain sensor (R2S-UMB)				
3	Visibility sensor (VSx-UMB)				
4	Active road sensor (ARS31-UMB)				
5	Non-invasive road sensor (NIRS31-UMB)				
6	Universal measurement transmitter (ANACON)				
7	Compact weather station (WSx-UMB)				
8	Wind sensor (VENTUS / V200A)				
9	Road sensor (IRS31Pro-UMB)				
10	Non-invasive mobile road sensor (MARWIS-UMB)				
11	Snow depth sensor (SHM)				
Class ID (12 to 14)		**Subclass-ID**			
12	Cloud Height Simulator	0			
	Reserved for additions	t.b.d			
13	div. protocol convertors	t.b.d			
14	Reserved for additions	t.b.d			
Class ID (15)		**Reserved**			
15	Controller / control devices	Must be 0			

ID = 0 is designated as broadcast for both classes and devices. This makes it possible to send a broadcast on a specific class. When a global broadcast is sent class and device ID must be 0.

3.3.1 Examples for the Creation of Addresses

If, for example, a road sensor is to be addressed with the device ID 3, this is achieved as follows:

Class ID for the road sensor is 1 = 1h
Device ID is 3 = 3h

Placing the class and device ID's together gives the 1003h = 4099d.

Further examples:

Class ID	Device ID	Address	Explanation
3h	1h (1d)	3001h (12289d)	Visibility sensor with device ID 1
0h	000h (0000d)	0000h (0d)	Broadcast to all devices and sensors
1h	000h (0000d)	1000h (4096d)	Broadcast to all road sensors

3.4 CRC Checksum

The CRC16-MCRF4XX checksum is formulated with the following polynomial:

$x^{16} + x^{12} + x^5 + 1$ (LSB first mode; start value FFFFh)

The checksum is formulated via all bytes prior to the checksum (1 ... 9 + len), i.e. from SOH to ETX inclusive.

The little-endian byte sequence is applicable to the checksum.

When a device receives a frame with an incorrect CRC, there is no reaction to this command.

Source code examples of a CRC calculation can be found in the Appendix.

3.5 Data Types

The following data types are used in this protocol, e.g. for the measurement value request:

<type>	Type Name	Define	Bytes	Range
10h (16d)	unsigned char	UNSIGNED_CHAR	1	0 ... 255
11h (17d)	signed char	SIGNED_CHAR	1	-128 ... 127
12h (18d)	unsigned short	UNSIGNED_SHORT	2	0 ... 65.535
13h (19d)	signed short	SIGNED_SHORT	2	-32.768 ... 32.767
14h (20d)	unsigned long	UNSIGNED_LONG	4	0 ... 4.294.967.295
15h (21d)	signed long	SIGNED_LONG	4	-2.147.483.648 ... 2.147.483.647
16h (22d)	float	FLOAT	4	±1.18E-38 ... ±3.39E+38 (7 digits)
17h (23d)	double	DOUBLE	8	±2.23E-308 ... ±1.79E+308 (15 digits)

Comment: float and double in IEEE format

3.6 Measurement Value Types

The following measurement value types are used for the measurement value enquiry:

<type>	Type Name	Define	Description
10h (16d)	current	MWT_CURRENT	Current measurement value
11h (17d)	min	MWT_MIN	Minimum value
12h (18d)	max	MWT_MAX	Maximum value
13h (19d)	avg	MWT_AVG	Mean value
14h (20d)	sum	MWT_SUM	Sum
15h (21d)	vct	MWT_VCT	Vectoral mean value

3.7 Status and Error Codes

Each response telegram contains a status byte. This gives information on the success or failure of the command. Further information is transmitted for certain error codes, which makes exact error analysis possible.

An error message is transmitted if a command was not processed successfully. This is constructed as follows:

<cmd>$_{<verc>}$<status>,[<info>^{n}]

If there is no further information about a status, <info>^{n} is omitted. In order that the frame control characters do not appear too often, 01h to 0Ah is dispensed with for these codes.

Codes:

<status>	<info>	Define	Description
00h (0d)		OK	Command successful; no error; all OK
10h (16d)		UNKNOWN_CMD	Unknown command; not supported by this device
11h (17d)		INVALID_PARAM	Invalid parameter
12h (18d)		INVALID _HEADER	Invalid header version
13h (19d)		INVALID _VERC	Invalid version of the command
14h (20d)		INVALID _PW	Invalid password for command
15h (21d)		INVALID _WERT	Invalid value
20h (32d)		READ_ERR	Read error
21h (33d)		WRITE_ERR	Write error
22h (34d)	<maxlength>	TOO_LONG	Length too great; max. permissible length is designated in <maxlength>
23h (35d)		INVALID_ADDRESS	Invalid address / storage location
24h (36d)	<channel>^{2} (1	INVALID_CHANNEL	Invalid channel
25h (37d)		INVALID_CMD	Command not possible in this mode
26h (38d)		UNKNOWN_CAL_CMD	Unknown calibration command
27h (39d)		CAL_ERROR	Calibration error
28h (40d)	<channel>^{2} (2	BUSY	Device not ready; e.g. initialization / calibration running
29h (41d)		LOW_VOLTAGE	Under-voltage
2Ah (42d)		HW_ERROR	Hardware error
2Bh (43d)		MEAS_ERROR	Measurement error
2Ch (44d)		INIT_ERROR	Error on device initialization
2Dh (45d)		OS_ERROR	Error in operating system
2Eh (46d)		COM_ERROR	Internal communication error
2Fh (47d)		HW_SW_MISMATCH	Hardware and software version do not match

(1info <channel>^{2} only in command ‘Online Data Request’

(2info <channel>^{2} only in command ‘Online Data Request’

30h (48d)		E2_DEFAULT_KONF	Configuration error, default configuration was loaded
31h (49d)		E2_CAL_ERROR	Calibration error / the calibration is invalid, measurement not possible
32h (50d)		E2_CRC_KONF_ERR	CRC error on loading configuration; default configuration was loaded
33h (51d)		E2_CRC_KAL_ERR	CRC error on loading calibration; measurement not possible
34h (52d)		ADJ_STEP1	Calibration Step 1
35h (53d)		ADJ_OK	Calibration OK
36h (54d)		CHANNEL_OFF	Channel deactivated
37h (55d)		SERVICE_MODE	Service mode active
38h (56d)		RESET_PENDING	Device reset is pending
39h (57d)		ADJ_DEFAULT	Adjustment invalid
50h (80d)	<channel>[2]	VALUE_OVERFLOW	Measurement variable (+offset) lies outside the set presentation range
51h (81d)	<channel>[2]	VALUE_UNDERFLOW	
52h (82d)	<channel>[2]	CHANNEL_OVERRANGE	Measurement value (physical) lies outside the measurement range (e.g. ADC over-range)
53h (83d)	<channel>[2]	CHANNEL_UNDERRANGE	
54h (84d)	<channel>[2]	DATA_ERROR	Data error in measurement data or no valid data available
55h (85d)	<channel>[2]	MEAS_UNABLE	Device / sensor is unable to execute valid measurement due to ambient conditions
56h (86d)	<channel>[2]	CALC_ERROR	Calculation error (NAN, division by zero)
0x60 (96d)		FLASH_CRC_ERR	CRC-Fehler in den Flash-Daten
0x61 (97d)		FLASH_WRITE_ERR	Error writing to Flash; e.g. memory cell not erased
0x62 (98d)		FLASH_FLOAT_ERR	Flash enthält ungültige Float-Werte
0x63 (99d)		FLASH_ERR	Flash defect, init error
0x64 (100)		CONFIG_ERR	Configuration invalid
FFh (255d)		UNKNOWN_ERR	Unknown error

3.8 Commands (Datagrams)

For reasons of clarity, the following list of commands is limited to the presentation layer. The following short form is used for better presentation:

<cmd>$_{<verc>}$[<payload0>^{n}, <payload1>^{n}, …]

<cmd>$_{<verc>}$<status>[<payload0>^{n}, <payload1>^{n}, …]

Hexadecimal values are identified by the suffix 'h'. Character strings are in double quotation marks and concluded by the null character (00h). The little-endian byte sequence (Intel, low byte first) applies to the transmission of words. Wildcards for syntactic units are identified by angle brackets. If the length of the variable is greater than 1 byte, this is designated 'n' in the index.

3.8.1 Summary of Commands

Sorted by <cmd>:

<cmd>	Description	BC	RT
20h	Hardware and software version		s
21h	Read out EEPROM		l
22h	Program EEPROM		l
23h	Online data request		l
24h	Offline data request		s
25h	Reset / default	●	s/l*
26h	Status request		S
27h	Set time / date	●	S
28h	Read out time / date		S
29h	Test command		l
2Ah	Monitor		l
2Bh	Protocol change	●	s
2Ch	Last fault message		s
2Dh	Device information		s
2Eh	Reset with delay	●	s
2Fh	Multi-channel online data request		l
30h	Set new device ID permanently (verc 1.0)	●	s
30h	Set new device ID temporarily (verc 1.1)	●	s
36h	UMB-Tunnel		l
37h	Transfer Firmware		l
38h	Transfer Binary Data		l
40h – 7Fh	Reserved for device-specific commands (see device description)		
80h – 8Fh	Reserved for development		
F0h	Program EEPROM with PIN		l

RT = response time; s = short; l = long

BC = broadcast-enabled command

*depending on sub cmd, see command specification

** request will be answered with "UNBEK_CMD": <cmd>$_{10h}$[10h]

ATTENTION!! A device (sensor) only accepts a command if it was sent **by a controller** (observance of controller-device principle).

3.8.2 Hardware and Software Version (20h)

Command <cmd>: **20h** (NBC)

Command version <verc>: **1.0**

Data <payload>: **none**

Description: This command requests the hardware and software version of the addressed device.

Request: $20h_{10h}$[ ]

Response: $20h_{10h}$<status>[<hardware>, <software>]

Response Time: short

Example: SW-Version 2.3 →<software> = 17h = 23d
HW-Version 6 →<hardware> = 06h = 6d

3.8.3 Device Information (2Dh)

Command <cmd>: **2Dh** (NBC)

Command version <verc>: **1.0**

Data <payload>: **<info>, <option>^{n}**

Description: This command returns the following device information:

Request: $2Dh_{10h}$[<info>, <option>^{n}]

<*info*> Type of information desired

<*option*>^{n} Option for further information required

Response: $2Dh_{10h}$[<status>, <info>, <answer>]

Response Time: short

<info>	<option>	Description	<Answer>
10h	none	Device identification	<ID>^{40} e.g. 'Visibility Sensor VS20'
11h	none	Device description	<desc>^{40} e.g. 'Visibility A92 West'
12h	none	Hardware and software version	<hardware>, <software> Version 2.3 = 17h = 23d
13h	none	Extended version info	<SerNo>², <MMYY>², <Project>², <PartsList>, <CircuitDiagram>, <hardware>, <software>, <e2version>, <DeviceVersion>²
14h	none	EEPROM size	<e2_size>²
15h	none	No. of channels available	<channels>², <blocks>
16h	<block>	Numbers of the channels	<block>, <channels>, [<channel>²]$^{<channels>}$
17h	none	Read number of device specific version information slots	<num-slot-ids>
18h	<slot-id>	Read device specific version information	<name>^{40},<major-version>,<minor-version>, <unixtime-date>^{4},<rc-version>
20h	<channel>²	Meas. variable of channel	<channel>², <variable>^{20} e.g. 'visibility'
21h	<channel>²	Meas. range of channel	<channel>², <min>^{n}, <max>^{n} n *)
22h	<channel>²	Meas. unit of channel	<channel>², <unit>^{15} e.g. 'm'
23h	<channel>²	Data type of channel	<channel>², <data_type> e.g. 16h for float
24h	<channel>²	Meas. value type	<channel>², <mv_type> e.g. 13h for mean value
30h	<channel>²	Complete channel info	<channel>², <variable>^{20}, <unit>^{15,} <mv_type>, < data_type >, <min>^{n}, <max>^{n} n *)
40h	none	Number of IP interfaces	<interfaces>
41h	<interface>	IP Information	<interface>, <name>^{20}, <ip>^{4}, <netmask>^{4}, <gateway>^{4}, <dns>^{4}, <link>, <tcp_port>^{2}

n *) The data type of min and max is the same as that of the measurement value. E.g. measurement value float → min, max float

Comment: Not all the device types provide the complete set of information. If an information is not available, the status will be set to “invalid parameter” (11h). <info> and <answer> of the response will be omitted.

All character strings are padded with blanks. There is no ‘\0’ termination!

On a request for the channel numbers (16h), up to 100 channels are consolidated in one block (beginning with block 0). If a sensor has more than 100 channels, there are correspondingly more blocks. The number of blocks is indicated in the request for the number of available channels (15h).

The device specific version information (18h) reports the versions / revisions of separate software modules. If <rc-version> = 0 the installed version is a public release, otherwise a release candidate. As a convention <slot-id> = 0 is reserved for the system software. The build time is formatted as Unix timestamp (UTC time).

On a request for the measurement range of a channel (21h) or the complete channel information (30h), the length n of min and max depends on the data type. (See 3.5 Data Types)

IP addresses, as in info 41h are transmitted as 32bit unsigned value (little endian).

3.8.4 Read Out EEPROM (21h)

Command <cmd>: **21h** (NBC)

Command version <verc>: **1.0**

Data <payload>: **<start>[2], <length>**

Description: With this command, the transmission of <length> bytes from the storage location <start> of the EEPROM is initiated.

Request: $21h_{10h}$[<start>[2], <length>]

Response: $21h_{10h}$<status>[<start>[2], <length>, <data<length>>]

Response time: long

Comment: The maximum number of bytes (<length>) is 200.

In case of error the fields <start>, <length> and <data> are omitted. If the error status is 22h (“TOO_LONG”) one byte with the permitted maximal <length> follows.

3.8.5 Program EEPROM (22h)

Command <cmd>: **22h** (NBC)

Command version <verc>: **1.0**

Data <payload>: **<start>[2], <length>, <data><length>**

Description: With this command, a data block <data> of length <length> bytes is transmitted to the receiver. This is written to the EEPROM with effect from the address <start>. When all bytes are programmed, the sender of the command is informed about the success of the action by means of an acknowledgement.

Request: $22h_{10h}$[<start>[2], <length>, <data><length>]

Response: $22h_{10h}$<status>[max_length]

Response time: long

Comment: As the device's maximum response time is limited to 500ms, the maximum number of bytes (<length>) is device depend because it can take varied lengths of time until the EEPROM is programmed. If a number of bytes is specified which the device is unable to process, the maximum number is specified after the error code (<max_length>).

There are write-protected storage locations in the EEPROM which cannot be written.

3.8.6 Program EEPROM with PIN (F0h)

Command <cmd>: **F0h** (NBC)

Command version <verc>: **1.0**

Data <payload>: **<pin>², <start>², <length>, <data><length>**

Description: As command 22h; but also facilitates the writing of protected E2 addresses.

Request: $F0h_{10h}$[<pin>², <start>², <length>, <data><length>]

Response: $F0h_{10h}$<status>[<max_length>]

Response time: long

ATTENTION!! This command is provided exclusively for internal use by OTT HydroMet for the factory setting. Non-designated use can render the device unusable (see also page 6 Restricted Guarantee). This command is not intended to be used by the end user. The end user can attend to all the necessary settings on the device using the PC software provided by OTT HydroMet.

3.8.7 Online Data Request (23h)

Command <cmd>: **23h** (NBC)

Command version <verc>: **1.0**

Data <payload>: **<channel>²**

Description: A measurement value of a certain channel is requested with this command.

Request: $23h_{10h}$[<channel>²]

Response: $23h_{10h}$<status><channel>²[<type>, <value>ⁿ]

Response time: long

<*channel*>² designates the channel number

<*type*> designates the data type of the output; the length of <*value*> depends on this (see page 12 - Data Types); omitted if <status> is not OK

<*value*>ⁿ requested value; omitted if <status> is not OK

Comment: The device description specifies the channel on which the transmission is to be made as well as the measurement value and format to be transmitted.

3.8.8 Multi-Channel Online Data Request (2Fh)

Command <cmd>: **2Fh** (NBC)

Command version <verc>: **1.0**

Data <payload>: **<number>, <channel>²*<number>**

Description: This command serves to request several channels with one call. A sub-telegram is transmitted for each channel.

Request: $2Fh_{10h}$[<number>, <channel>$^{2 \times <number>}$]

<*number*> number of channels requested

<*channel*>² designates the channel numbers

Response: $2Fh_{10h}$<status>[<number>,
{<sub-len>, <status>, <channel>²[<type>, <value>^{n}]}$^{<number>}$]

Response time: long

<*sub-len*> designates the number of bytes followed in this sub-telegram; if the subsequent status byte displays, for example, 'Value Overflow', <type> and <value>^{n} are omitted, and the next channel follows

<*type*> designates the data type of the output; the length of <*value*> depends on this (see page 12 - Data Types)

<*value*>^{n} requested value

Comment: When preparing the request care must be taken that the expected length of the response does not exceed the maximum payload length! The <sub-len> field must be evaluated in any case, even if the channel status is not '0', to make sure that the offset to the next channel data is correct.

Command <cmd>: **2Fh** (NBC)

Command version <verc>: **1.1**

Data <payload> (1. call): **<number>, <channel>²**

Data <payload> (from 2. call): **00h**

Description: This command is used to request several channels with one call. A sub-telegram is transmitted for each channel. In this version there are 2 different calls: With the first call the required channels are specified and stored within the device.

Beginning from the second call the new values of the channels specified in the first call are transmitted. The structure of the responses to both calls are identical. We recommend the second call, if you need to transmit many, but always the same channels with high polling rate.

First Call: $2Fh_{10h}$[<number>, <channel>$^{2 \times <number>}$]

<*number*> number of channels requested

<*channel*>² designates the channel numbers

From Second Call: $2Fh_{10h}$ 00h

Response: $2Fh_{10h}$<status>[<number>,
{<sub-len>, <status>, <channel>²[<type>, <value>^{n}]}$^{<number>}$]

Response time: long

<*number*>	number of channels requested in the first call
<*sub-len*>	designates the number of bytes followed in this sub-telegram; if the subsequent status byte displays, for example, 'Value Overflow', <type> and <value>^{n} are omitted, and the next channel follows
<*type*>	designates the data type of the output; the length of <*value*> depends on this (see page 12 - Data Types)
<*value*>^{n}	requested value

Comment: The device description specifies the channel on which the transmission is to be made as well as the measurement value and format to be transmitted. A maximum of 20 channels can be requested.

ATTENTION!! A maximum number of 20 channels may be requested by the 2Fh command, provided the payload length of the response does not exceed 20 bytes. E.g. with data type double a maximum of 16 channels can be handled by one request.

ATTENTION!! In the case of computing-intensive channels, such as the calculation of the average for wind in the ANACON, under certain circumstances the response time 'long' may not be sufficient for the transmission of several channels. If the sensor does not respond to the request, either the number of channels or the number of values in the average value calculation must be reduced.

3.8.9 Offline Data Request (24h)

Command <cmd>: **24h** (NBC)

Command version <verc>: **1.0**

Currently not specified.

3.8.10 Reset / Default (25h)

Command <cmd>: **25h** (BC)

Command version <verc>: **1.0**

Data <payload>: **<reset>**

Description: This command triggers a software reset. Alternatively, a specified condition can be restored prior to the reset.

Request: $25h_{10h}$[<reset>]

<reset>	10h	Restart device. On Linux-based systems, only the measurement application is restarted (see reset command 14h)
	11h	restore factory settings + reset 10h
	12h	restore device ID to factory settings + reset 10h
	13h	Device specific reset command (see device manual)
	14h	On Linux-based systems, the whole system is restarted

Response: $25h_{10h}$[<status>]

Response time: **up to 4 x long!**

Comment: The response takes place directly prior to the reset.

3.8.11 Reset with Delay (2Eh)

Command <cmd>: **2Eh** (BC)

Command version <verc>: **1.0**

Data <payload>: **<delay>**

Description: This command triggers a software reset after expiry of the delay period <delay> (e.g. for firmware update).

Request: $2Eh_{10h}$[<delay>]

<delay> Delay period in seconds (max. 255)

Response: $2Eh_{10h}$<status>

Comment: The response takes place at the beginning of the delay period.

3.8.12 Status Request (26h)

Command <cmd>: **26h** (NBC)

Command version <verc>: **1.0**

Data <payload>: **none**

Description: Readout of the current status and/or error codes; thus, the device can be asked if it is operating free from error.

Request: $26h_{10h}$[ ]

Response: $26h_{10h}$<status>[<device-status>]

3.8.13 Last Error Message (2Ch)

Command <cmd>: **2Ch** (NBC)

Command version <verc>: **1.0**

Data <payload>: **none**

Description: Indicates the error code of the last response of the device regarding communication. E.g. invalid parameter

Request: $2Ch_{10h}$[ ]

Response: $2Ch_{10h}$<status>[<error>]

3.8.14 Set Time / Date (27h)

Command <cmd>: **27h** (BC)

Command version <verc>: **1.0**

Data <payload>: **<unixtime>[4]**

Description: Sets the date and time of the addressed device.

Request: $27h_{10h}$[<unixtime>[4]]

Response: $27h_{10h}$[<status>]

Comment: Unixtime is the 4-byte hexadecimal number with the lowest value byte (LSB) first, which corresponds to the seconds since 1.1.1970 0:00 UTC.

3.8.15 Readout Time / Date (28h)

Command <cmd>: **28h** (NBC)

Command version <verc>: **1.0**

Data <payload>: **none**

Description: Reads out the date and time of the addressed device.

Request: $28h_{10h}$[ ]

Response: $28h_{10h}$[<status>, <unixtime>[4]]

Comment: Unixtime is the 4-byte hexadecimal number with the lowest value byte (LSB) first, which corresponds to the seconds since 1.1.1970 0:00 UTC.

3.8.16 Test / Calibration Command (29h)

Command <cmd>: **29h** (NBC)

Command version <verc>: **1.0**

Data <payload>: **<pin>², <function>, <data>ⁿ**

Description: This command serves to calibrate and test the device

Request: $29h_{10h}$[<pin>², <function>, <data>ⁿ]

Response: $29h_{10h}$[<status>, ..., ...] (device-specific)

Response time: **4 x long!**

ATTENTION!! This command is provided exclusively for internal use by OTT HydroMet for the factory setting. Non-designated use can render the device unusable (see also page 6 Restricted Guarantee). The test functions are described in the device specification.

3.8.17 Monitor (2Ah)

Command <cmd>: **2Ah** (NBC)

Command version <verc>: **1.0**

Data <payload>: **<monitor>ⁿ**

Description: Device-specific functions can be executed through the PC software with the aid of monitor commands (see respective device specification).

Request: $2Ah_{10h}$[<monitor command>ⁿ]

Response: $2Ah_{10h}$[<status>, <answer>ⁿ]

Response time: long

ATTENTION!! This command is provided exclusively for internal use by OTT HydroMet for the factory setting. Non-designated use can render the device unusable. This command is specified in the device specification.

3.8.18 Protocol Change (2Bh)

Command <cmd>: **2Bh** (BC)
Command version <verc>: **1.0**
Data <payload>: **<type>**
Description: Temporarily switches the device into another protocol.
Request: $2Bh_{10h}$[<type>]

<type>	00h	UMB-Binär
	01h	UMB-ASCII
	02h	Terminal Protocol
	03h	SDI-12
	05h	MODBUS-RTU
	06h	MODBUS-ASCII
	07h	XDR (NMEA)
	09h	UMB-ASCII 2.0
	0Ah	Raingauge-Simulation (internal use only)
	0Bh	MODBUS-TCP
	0Ch	High-Speed-Mode (internal use only)
	10h	UMB-ASCII (for compatibility reasons)

Response: $2Bh_{10h}$[<status>]

ATTENTION!! Immediately following the response, the device can only be addressed in the new protocol. If the device is required to operate again in, for example, binary mode, the corresponding command must be given for a change of protocol to binary mode.

The protocol changeover is **temporary**!! Following a reset or device-specific timeout the device communicates again in the previously set mode. If the device is to be operated permanently in, for example, XDR mode, the device specification must be changed in the EEPROM.

Not all devices support all listed protocols. See the device description for details.

3.8.19 Set New Device ID (30h)

Command <cmd>: **30h** (BC)
Command version <verc>: **1.0**
Data <payload>: **<ID>²**
Description: Gives the device **permanently** a new ID.
Request: $30h_{10h}$[<ID>²]

<ID>²	new device ID (1 – 255)

Response: $30h_{10h}$[<status>]

ATTENTION!! A reset takes place immediately following the response and after this the device can only be addressed with the new ID. Attention! This command is broadcast-enabled. This enables devices of unknown ID to be provided with a new ID. However, this only makes reasonable sense if a maximum of one device is connected to the bus.

Command version <verc>: **1.1**

Data <payload>: **<ID>²**

Description: Gives the device **temporarily** until the next reset a new ID.

Request: $30h_{11h}$[<ID>²]

<ID>² new device ID (1 – 255)

Response: $30h_{11h}$[<status>]

ATTENTION!! A reset takes place immediately following the response and after this the device can only be addressed with the new ID. Attention! This command is broadcast-enabled. This enables devices of unknown ID to be provided temporarily with a new ID. However, this only makes reasonable sense if a maximum of one device is connected to the bus.

3.8.20 UMB-Tunnel (36h)

Command <cmd>: **36h** (NBC)

Commandversion <verc>: **1.0**

Data <payload>: **<int_bus>,<data>ⁿ**

Description: Hands a command over to an internal bus (see device manual). The payload holds the original command-frame for the receiving sensor. The response contains the sensor's original frame as payload.

Request: $36h_{10h}$[<int_bus>,<data>ⁿ]

<int_bus> *internal bus number* (0 – 255)

Response: $36h_{10h}$<status>[<answer>ⁿ]

Response Time: **4x long!**

ATTENTION!! This command is provided exclusively for internal use by OTT HydroMet for the factory setting. Non-designated use can render the device unusable (see also page 6 Restricted Guarantee). The test functions are contained in the device specification.

The command is specified by the individual device description.

3.8.21 Firmware update (37h)

Command <cmd>: **37h** (BC)

Command version <verc>: **1.0**

Data <payload>: **<sub-command><parameter>^{n}**

Description: Initiate firmware update respectively firmware transfer. The payload data depends on the corresponding sub-command.

Request: $37h_{10h}$[<sub-command>, <data>^{n}]

Response: $37h_{10h}$[<status>, <sub-command>, <answer>^{n}]

Response time: **up to 4 x long!**

<sub-command>	<data>	Description	<answer>
01h	<FW-size>^{4}<FW-version><FW-time>^{4}<crc>^{2}<reboot><force>	Initiate firmware update	<blocklen>^{2}
02h	None	Request update status	<update-state><error-status><progress>
03h	None	Max. baudrate	<maxBaudrate>^{4}
04	<useHS>	Use HighSpeed	None
10h	<blocklen>^{2}<data-offset>^{4}<data>$^{<blocklen=1…N>}$	Transfer firmware data	none

Comment: Install (Update) new firmware using a binary image. Firmware will be transferred to the device and installed by the bootloader on the next boot cycle.

First the sub-command **01_h** is used in initiate the firmware transfer mode. After processing this command successfully with status OK, the device informs about the maximum block length to be used for data transfer (<blocklen>^{2}). When initiating the update, there are also additional flags available to decide actions that should be performed automatically after firmware has been transferred successfully. Using the <reboot> flag, the device can be instructed to reboot automatically. Setting the <force> flag will skip all version checks in bootloader and always install the transferred firmware (e.g. reinstall or downgrade).

Afterwards the, complete binary image can be transferred in several blocks of <blocklen>^{2} bytes using the sub-command **10_h** until the complete firmware has been transmitted. Transfer data blocks shorter than <blocklen> are allowed. Each frame also includes the offset address <data-offset> of the corresponding data, to be able to detect package loss. Each block will be acknowledged with status OK.

Transfer can be re-initiated at any time with sub-command **01_h**. This will automatically reset data transfer. Erroneous transmission of data will also reset the transfer.

Transmission may be executed with higher baud rate. If the device supports this feature subcommand **03_h** reports the maximum baud rate permitted as a uint32 value. Subcommand **04_h** turns the high-speed mode on or off. The high-speed mode should be turned off after completion of the transfer. Alternatively, the device will reset to the standard baud rate after 5s of not receiving a valid telegram. High-speed mode should be activated **before** initializing the transfer by subcommand **01_h**.

The update process of the device as such, after successful upload of the new firmware image, may take some time. Information about the progress of the function is provided by subcommand **02_h**.

<*update-state*>	00h	Idle
	01h	Uploading
	02h	Flashing. <percentage> shows the progress
	FEh	Finished
	FFh	Failed. The reason for the failure is indicated by <error-status> (UMB error status)
<*error-status*>	information about the reason in case of failure	
<*percentage*>	progress of the flash write procedure	

3.8.22 Transmission of Binary Data (38h)

Command <cmd>: **38h** (NBC)

Command version <verc>: **1.0**

Data <payload>: **<sub-command><parameter>^{n}**

Description: Transmission of binary data, e.g. graphics files. Payload data depends on the <sub-command>

Request: $38h_{10h}$[<sub-command>, <parameter>^{n}]

Response: $38h_{10h}$<status>[<sub-command>, <answer>^{n}]

Response Time: **up to 4 x long!**

<sub-command>	<parameter>	Beschreibung	<answer>
10h	none	Block length	<blockLen>
11h	<objectNr>	Object Information	<locked><objectSize>^{4}<maxSize>^{4}<checksum>^{4}<name>^{40}<mime-type>^{100}
12h	<objectNr>	Lock object	none
13h	<objectNr>	Unlock object	none
14h	<objectNr>	Calculate CRC	none
20h	<objectNr><data-offset>^{4}<length>	Read object from sensor	<length><data>$^{<length>}$
30h	<objectNr><data-offset>^{4}<length> <data>$^{<length>}$	Transmit object to sensor	none

Comment: The meaning of the data contents of <objectNr> can be found in the device description.

Subcommand **10_h** requests the maximum block length the sensor can handle (max. 204 bytes). Subcommand **11_h** is used to determine the characteristics of the data object, e.g. length in bytes. A check sum of 0 means that no CRC calculation is available. Subcommand **12_h** allows to protect the data object against modification to ensure consistent data over the time of the transmission process.

The transmission of data from sensor to controller is performed with subcommand **20_h**. By incrementing the <data-offset>^{4} parameter the controller can request data in blocks, whereas <data-offset> + <length> should not exceed <objectSize>. A failed block transmission can be corrected by repeating the request with appropriate offset.

In a similar way data can be transmitted to the sensor using subcommand **30_h**. This subcommand is not supported for all data objects.

Optionally, subcommand **14_h** triggers the calculation of the CRC-32 checksum of the data object. The checksum can be read by requesting the object information (subcommand **11_h**). This calculation may take some time, in this case the device will respond with status *Busy* (**28_h**).

ATTENTION!! After end of the transmission it is essential to unlock the data object by subcommand **13_h**! Otherwise the correct function of the sensor cannot be guaranteed.

3.9 Channel Assignment

A maximum of 65535 measurement channels can be addressed. The channel assignment described here is applicable to the online data request in binary protocol. The channel assignment of the individual UMB devices is described in the operating manuals.

3.9.1 Channel Assignment – General Allocation

The following allocation of channels is recommended to identify the measurement variable more easily:

Channel	Measurement Variable
0 – 99	Reserved
100 – 199	Temperature
200 – 299	Humidity
300 – 399	Pressure (e.g. air)
400 – 499	Velocity (e.g. wind, flow)
500 – 599	Direction (e.g. wind)
600 – 699	Metric values (e.g. water film level in mm, visibility in m)
700 – 799	Logic conditions (e.g. door contact 0 / 1 = open / closed)
800 – 899	Relative measurement values (e.g. salt concentration)
900 – 999	e.g. used for road condition
1000 – 1999	TLS coding (see also page 38 Chapter 4.3)
2000 – 2999	TLS coding for 2nd channel (e.g. ANACON)
4000 – 4999	Diagnostics and service (for customer)
10000 – 10099	Voltage
10100 – 10199	Current
10200 – 10299	Resistance
10300 – 10399	Frequency
10400 – 10499	Capacity
10500 – 10599	Pulses
20000 – 29999	Device-specific
65535	Reserved

3.9.2 TLS Channel Assignment

These channels are provided for the transmission of data corresponding to the TLS types per TLS2002 DE-FG3 (weather and environment data). The channel numbers correspond to DE types FG3 with an offset of 1000 (see also 4.3 Data Types in UMB Products per TLS2002 FG3).

E.g. Visibility:

FG3 DE-Type 60 Result Message Visibility SW Channel 1060

3.10 Units List

The following units are used for measurement values for all UMB products. These are transmitted, among other occasions, at the time when device information is transmitted.

3.10.1 Temperature

Unit	Description	Comment
°C	Degrees Celsius	
°F	Degrees Fahrenheit	
K	Kelvin	

3.10.2 Humidity

Unit	Description	Comment
%rH	Relative Humidity	
g/kg	Absolute Humidity	
g/m³	Absolute Humidity	

3.10.3 Lengths

Unit	Description	Comment
µm	Micrometers	
mm	Millimeters	
cm	Centimeters	
dm	Decimeters	
m	Meters	
km	Kilometers	
in	Inches	1 inch = 25.4 mm
mil	Milli-inches	1 mil = 1/1000 inch = 0.0254 mm
ft	Foot, feet	1 foot = 0.3048 Meter
mi	Miles	1 US statute mile = 1.609344 km

3.10.4 Velocities

Unit	Description	Comment
m/s	Meters per second	
km/h	Kilometers per hour	
mph	Miles per hour	One mph corresponds to 1.609344 km/h or 0.44704 m/s
kts	Knots	1 knot = 1 sea mile/hour = 1.852 km/h = 0.51444 m/s

3.10.5 Electrical Variables

Unit	Description	Comment
µV	Microvolts	
mV	Millivolts	
V	Volts	
nA	Nanoamperes	

mA	Milliamperes	
A	Amperes	
Ohm	Ohm	

3.10.6 Frequency

Unit	Description	Comment
Hz	Hertz	
kHz	Kilohertz	
MHz	Megahertz	
GHz	Gigahertz	

3.10.7 Pressure

Unit	Description	Comment
bar	Bars	
mbar	Millibars	
Pa	Pascals	
mPa	Millipascals	
hPa	Hectopascals	
inHg	Inch of mercury	

3.10.8 Volumes

Unit	Description	Comment
m³	Cubic meters	
µl	microliters	
l	Liters	

3.10.9 Time

Unit	Description	Comment
h	Hours	
s	Seconds	
ms	Milliseconds	
µs	Microseconds	

3.10.10 Precipitation

Unit	Description	Comment
mm/m	Millimeter per minute	Precipitation intensity
mm/h	Millimeter per hour	Precipitation intensity
mm/d	Millimeter per day	Precipitation intensity
l/m²	Liters per square meter	Amount of precipitation
l/m²/h	Liters per square meter per hour	Precipitation intensity
in/m	Inch per minute	Precipitation intensity
in/h	Inch per hour	Precipitation intensity

mil/h	milli-inch per hour	Precipitation intensity

3.10.11 Miscellaneous

Unit	Description	Comment
%	Percent	Relative proportion
°	Degree	Angle details
kJ/kg	Kilojoule per Kilogram	
kg/m³	Kilogram per cubic meter	
Byte	Byte	
kByte	Kilobyte	
MByte	Megabyte	
GByte	Gigabyte	
logic		Logical state e.g. road conditions, precipitation type
events	number of Events	z. B. measurement counter
norm value	normalized value	0 ... 65520
raw	raw value	
digits		
count	Counter value	
rpm	Rotations per minute	Fan speed
lx	Lux	
klx	Kilolux	
W/m²	Watt per square meter	Global radiation
dB	Dezibel (level)	
dBm	Power level	Bluetooth, Wi-Fi
IPv4	IPv4 address	IP address as 4-byte raw value

Character set is coded in accordance with the ISO-8859-1 (latin-1). See also page 42

3.11 Example of a Binary Protocol Request

If, for example, the current air temperature of a weather sensor with the device ID 1 is to be requested by a PC, the procedure is as follows:

Sensor:

Class ID for **weather sensor** is 7d = 07h
Device ID is 1d = 01h

Putting class and device ID's together results in a target address of 7001h

PC:

Class ID for **PC (controller)** is 15d = 0Fh
PC-ID is 1d = 01h

Putting class and PC ID's together results in a transmitter address of F001h

The length <len> of the "online data request" command is 4d = 04h, as the command consists of 2 bytes.

The command "online data request" is 23h
The version number of the command is 1.0 = 10h
The command has the channel number (100d) as <payload>: 0064h
The CRC is 61D9h

The complete 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	70h	01h	F0h	04h	02h	23h	10h	64h	00h	03h	D9h	61h	04h

The complete response from the device:

SOH	<ver>	<to>		<from>		<len>	STX	<cmd>	<verc>	<status>
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
01h	10h	01h	F0h	01h	70h	0Ah	02h	23h	10h	00h

<channel>		<type>	<value>				ETX	<cs>		EOT
12	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**17**
64h	00h	16h	F5h	54h	E1h	41h	03h	90h	86h	04h

Thus, the current temperature is 28.16°C and is transmitted as IEEE float.

The correct data transmission can be checked against the checksum (8690h).

ATTENTION!! Little endian (Intel, lowbyte first) applies to the transmission of word variables, e.g. device addresses. This means first the LowByte and then the HighByte.

3.12 Comments on broadcast messages

If a device is addressed directly with class and device ID, the answer described in the command is returned.

If a device is addressed with broadcast (device ID ‘0’ or class and device ID ‘0’), the command is **NOT** answered, as in the case of broadcast it must be assumed that several units are addressed simultaneously and there would be collisions otherwise.

Not all commands are broadcast-enabled, as it makes no sense, for example, to send a measurement value request to all devices because they do not answer in the case of a broadcast. ‘BC’ identifies whether a command is broadcast-enabled. ‘NBC’ stands for not broadcast-enabled.

A sensible application of broadcast commands is, for example, the setting of date and time. In doing so, the entire network can be updated with a single telegram.

4 Appendix

4.1 CRC Calculation

The CRC is calculated in accordance with the following rules:

Norm: CRC16-MCRF4XX

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

Start value: FFFFh

ATTENTION!! In contrast to earlier Lufft protocols, the start value for the CRC calculations in this case is not 0h but FFFFh in accordance with CCITT!

4.1.1 Example of a CRC-CCITT Calculation in C

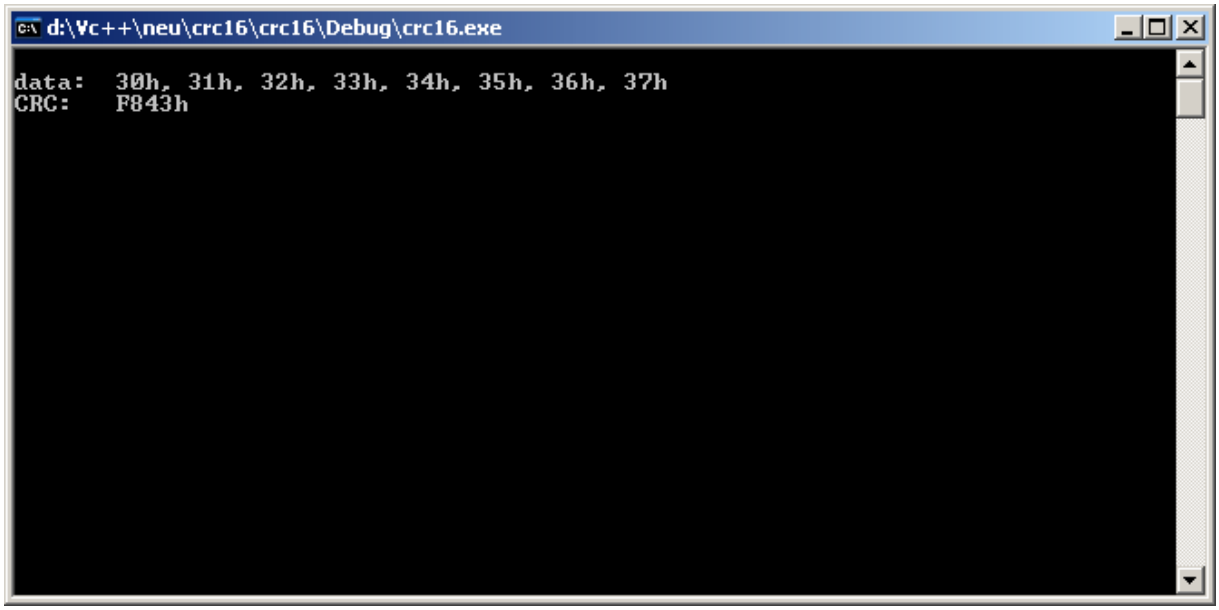
If the CRC calculation is to be made for several bytes, the previously calculated CRC must be buffered in an unsigned short variable (which must be initialized at FFFFh at the beginning of a test sequence).

```
/*****************************************************************************
*  DESCRIPTION:    UMB Crc (CRC16_MCRF4XX) function
*                  polynomial:     X^16+X^12+X^5+1
*                                  0x8408
*                  Initial Value:  suggested 0xFFFF
*                  Final Xor Value: 0x0 (not applied)!
*                  Example:        See http://www.sunshine2k.de/coding
*                                            /javascript/crc/crc_js.html
*                                  "123456789" --> 0x6F91
*                                  "CRC16_MCRF4XX"
*  PARAMETERS:     crc             16-bit start value (recursive CRC value)
*                  *pData          Pointer to data buffer (source buffer)
*                  length          Length of data [bytes]
*****************************************************************************/
uint16 calcCrc16(uint16 crc, const uint8* pData, uint32 length)
{
    while(length)
    {
        uint8 byte = *pData;
        for(uint8 b = 0; b < 8; b++)
        {
            crc ^= (byte & 0x01u);
            crc = (crc & 0x01u) ? ((crc >> 1) ^ 0x8408u) : (crc >> 1);
            byte >>= 1;
        }

        pData++;
        length--;
    }
    return crc;
}
```

```
// ******************* MAIN ************************************
void main(void)
{
      // example: CRC for 8 Bytes
      unsigned char values[8] =
            {0x30, 0x31, 0x32, 0x33, 0x34, 0x35, 0x36, 0x37};
      // calculation with start value FFFFh
      unsigned short crc = calcCrc16(0xFFFF, values, sizeof(values));
      // output
      printf("\ndata:  30h, 31h, 32h, 33h, 34h, 35h, 36h, 37h");
      printf("\nCRC:   %04Xh\n", crc);
}
```

Output:



4.2 Automatic Readout of a Network

This section describes a mechanism which makes it possible to analyze an existing network and thereby configure the controller software.

4.2.1 Background

As this is a half-duplex network on RS485 basis without collision recognition, the controller / device principle must be observed. To scan a network, the controller would have to scan the entire address space which, with more than 30,000 possible addresses, would take too long.

Instead of this, the system is configured in the way described below for the controller software to be able to scan the network in a short period of time.

4.2.2 Necessary ID Configuration of the Sensors

The sensors are provided with device ID's per network and device class, beginning at 1. This also corresponds to the factory settings. Additional sensors in a device class are provided with IDs in ascending order (2, 3, 4, 5 ....).

Example:

Sensors	Class ID	Recommended Device ID
Road sensor 1	1	1
Road sensor 2	1	2
Rain sensor 1	2	1
Rain sensor 2	2	2
Visibility sensor 1	3	1
Visibility sensor 2	3	2
NIRS 1	5	1
Weather sensor 1	7	1
Weather sensor 2	7	2
Weather sensor 3	7	3

As the different sensors have different class IDs and the address is made up of class ID and device ID, each subscriber has its own address.

4.2.3 Scanning the Network

When scanning, the controller begins to poll the sensors in ascending order of class and device ID. For this purpose, a command is used which is understood by each sensor, e.g. status request (26h).

The device ID is increased until no further reply is received to the status request. The class ID is then incremented, beginning again with device ID 1.

4.3 Data Types in UMB Products per TLS2002 FG3

The transmission of TLS data is based on the DE block structure. The TLS output is limited to the TLS-compliant data standardization per FG3. The answer to a measurement value request for TLS data contains the UMB channel and the measurement value. The UMB channels receive an offset of +1000 compared with DE type FG3. For multi-channel devices the offset increases by 1000 respectively.

8-bit measurement value:

Position	Designation	Explanation
Byte 1	Measurement value	

16-bit measurement value:

Position	Designation	Explanation
Byte 1	Measurement value	low Byte
Byte 2	Measurement value	high Byte

4.3.1 Example of a TLS Measurement Value Request

A visibility measuring device is to transmit the visibility in accordance with TLS (16-bit measurement value).

DE type 60 (SW) gives UMB channel 1060 = 0424h

Request: $23h_{10h}$[<channel>²]

$23h_{10h}$[24h, 04h]

Response: $23h_{10h}$<status>[<channel>², <low byte>, <high byte>]

$23h_{10h}$<status>[24h, 04h, E8h, 03h]

High Byte = 03h; Low Byte = E8h; gives 03E8h = 1000d = 1000 meters visibility

4.3.2 Supported TLS-DE Types FG3

The following examples illustrate the mapping of TLS types to UMB channels. See device manuals for the types supported by each device.

DE Type	UMB Channel	Meaning	Format	Range	Res.	Coding
49	1049	Result message Road Surface Temperature RST	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 RS	8-bit	0%...100%	1%	0% = 0d = 00h 100% = 100d = 64h FFh = can't be determined
65	1065	Result message Freezing Temperature FT	16-bit	-30...0 °C	0.1°C	0.0 = 0d = 0000h -0.1 = -1d = FFFFh -30.0 = -300d = FED4h

4.3.3 Derived variables

1153	float	Precipitation intensity in inch/h Derived from channel 1053 (TLS code DE type 53 FG3)	0…..7.874 inch/h
1253	float	Precipitation intensity in mil/h Derived from channel 1053 (TLS code DE type 53 FG3)	0…..7 874 mil/h

4.3.4 DE Type 70 “Road Surface Condition” (RSC)

Content / Characteristics	Definition
0	Road is completely dry (< approx. 30 ml/m² = 0.03 mm), free of snow and ice
1	Road is moist or wet or covered in snow or ice. The wetness or coverage is greater than approx. 30 ml/m² = 0.03 mm. No further differentiation of the type of coverage is possible.
2 … 31	Free for extensions
32	Road is wet with liquid water or watery solution. The quantity is greater than approx. 30 ml/m² = 0.03 mm No further differentiation is possible.
33 … 63	Free for extensions
64	Road is covered with freezing water or watery solution in solid form. No further differentiation is possible.
65	Road is covered with snow or slush. Mixture of liquid and frozen water or watery solution.
66	Road is covered with ice (solid, frozen water or frozen watery solution).
67	Road is covered with frost. Ice crystals sublimated from the air without covering surface with ice. The dewpoint temperature is close to the road surface temperature and below the freezing temperature.
68 … 127	Free for extensions
128 … 254	Free for codes specific to the manufacturer or user.
255	The sensors are unable to determine the status due to the prevailing conditions.

It should be noted in relation to the road section that the measurement can only ever be at one specific location and the results must therefore be interpreted accordingly.

Wetness and coverage always relate to a smooth, even surface. The estimate concerning the hazardousness of wetness or coverage in relation to the condition of the road surface (unevenness etc.) and the specific conditions of the section of road in question must be made at the control center.

It is not necessary for the sensor technology to be able to directly detect all the conditions. Rather, it is sufficient that the influences contributing to the formation of the conditions can be measured in order that the condition in question can be assumed to be probable.

It is not necessary for all characteristics to be supported by a road measuring station.

The degree of wetness or coverage, as far as can be defined, is indicated by the “water film level” (mm or l/m²).

4.3.5 DE Type 71 “Precipitation Type” (PT)

Content / Characteristics	Definition
All	Precipitation falling in the atmosphere. If precipitation intensity is to be determined, this is carried out at the same location. The classification and codes are used in accordance with WMO Table 4680.
0	No precipitation
1 … 39	Do not use
40	Precipitation of all types Cannot be classified or quantified further or sensors not designed for this purpose.
41	Light or average precipitation of all types (< 50 particles per minute)
42	Heavy precipitation of all types (> 50 particles per minute)
43 … 49	Free for extensions
50	Drizzle (no further classification of drizzle is possible)
51 … 59	Further classification of drizzle per WMO
60	Rain or liquid precipitation (no further classification of rain is possible)
61 … 69	Further classification of rain per WMO
70	Snow or frozen precipitation (no further classification of frozen precipitation is possible)
71 …73	Further classification of snow per WMO
74 … 76	Further classification of graupel per WMO
77 … 79	Further classification of hail per WMO
80 … 127	Free for extensions
128 … 254	Free for codes specific to the manufacturer or user.
255	The sensors are unable to determine the status due to the prevailing conditions.

Not all characteristics require to be supported by the road measuring station or sensor technology. The degree of differentiation which is necessary and reasonable depends on the application. For simple applications, characteristics 0 and 40 may be sufficient; for normal requirements 0, 60 and 70 (corresponds to the characteristics 00, 01 and 02 of type 63 used previously).

4.3.6 DE Type 140 “Door Contact” (DC)

As this system is limited to FG3 data but the door contact is defined in FG6 as DE type 48, DE type 140 is used as a door contact message in FG3 if this message is to be present as the only operating message.

DE Type	UMB Channel	Meaning	Format	Range	Res.	Coding
140	1140 2140	Operating message Door Contact DC	8-bit	0 ... 1	1	00 = 0d = 00h 01 = 1d = 01h

Content	Definition	Switch Contact
0	Door closed	open
1	Door open	closed

4.3.7 DE Type 140 Inverted “Door Contact” (DC)

DE Type	UMB Channel	Meaning	Format	Range	Res.	Coding
140	1145 2145	Operating message Inverted Door Contact DC	8-bit	0 ... 1	1	00 = 0d = 00h 01 = 1d = 01h

Content	Definition	Switch Contact
0	Door closed	closed
1	Door open	open

4.4 Strings and Character encoding

4.4.1 Character arrays

Strings within UMB frames are not \0 terminated as they are handled as character array with fixed length. Hence all strings and char arrays should be padded with space characters.

4.4.2 ASCII-Encoding

The output of the characters for texts of all types takes place in accordance with the ASCII Code Table with the extension per ISO-8859-1 (Latin-1) or Windows-1252:

Code	…0	…1	…2	…3	…4	…5	…6	…7	…8	…9	…A	…B	…C	…D	…E	…F
0…	*NUL*	*SOH*	*STX*	*ETX*	*EOT*	*ENQ*	*ACK*	*BEL*	*BS*	*HT*	*LF*	*VT*	*FF*	*CR*	*SO*	*SI*
1…	*DLE*	*DC1*	*DC2*	*DC3*	*DC4*	*NAK*	*SYN*	*ETB*	*CAN*	*EM*	*SUB*	*ESC*	*FS*	*GS*	*RS*	*US*
2…	SP	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3…	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4…	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5…	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6…	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7…	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	*DEL*
8…	*PAD*	*HOP*	*BPH*	*NBH*	*IND*	*NEL*	*SSA*	*ESA*	*HTS*	*HTJ*	*VTS*	*PLD*	*PLU*	*RI*	*SS2*	*SS3*
9…	*DCS*	*PU1*	*PU2*	*STS*	*CCH*	*MW*	*SPA*	*EPA*	*SOS*	*SGCI*	*SCI*	*CSI*	*ST*	*OSC*	*PM*	*APC*
A…	NBSP	¡	¢	£	¤	¥	¦	§	¨	©	ª	«	¬	SHY	®	¯
B…	°	±	²	³	´	µ	¶	·	¸	¹	º	»	¼	½	¾	¿
C…	À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
D…	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
E…	à	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï
F…	ð	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	ÿ