Modbus RTU DATA PROTOCOL

M12 PLUG CONNECTOR

IP 65 PROTECTION RATING

9W 9W HEATED

Al METAL VANE

Al METAL CUP ROTOR

ARCO-Modbus · Features and Advantages

- Compact and extremely robust wind sensor for measuring wind direction and wind speed

- Friction-free measurement value acquisition through non-contact measuring principle

- Highest reliability by means of precision ball bearings and high quality measuring elements

- Seawater resistant surface finishes for high durability

- Low starting value of 0.3 m/s

- Very large measuring range from 0.3 to 75 m/s

- Quick and easy installation by pipe mounting and M12 plug connector

- Integrated, regulated heater for optimal heating of the sensor heads

- Thermal separation between sensor heads and the housing

- Changeable wind vane and three-armed cup anemometer

- Sensor head with integrated obstacles prevents infiltration of water

- Digital output (RS 485 - Modbus RTU)

- The compact design of the sensor reduces the effort with regard to components and their mounting times upon comparison with single instruments

1   Introduction

The sensors of the ARCO family are very robust, compact and extremely reliable. When developing these sensors particular consideration has been given to the fulfilment of meteorological requirements.

The system acquires the horizontal air flow and processes the measuring data to the meteorological parameters wind speed and wind direction.

The sensors and further system components are mounted in a splash water resistent and dustproof metal housing.

The measured data are output via a galvanically isolated RS 485 interface via Modbus RTU after switching on the supply voltage.

Due to their shock and vibration proof construction the sensors ARCO-Modbus are particularly qualified for use under severe environmental conditions. The housing and the measuring elements are made of seawater resistant aluminium alloys. The housing, the cup rotor and the wind vane are anodised. An electronically controlled sensor heating device allows for operation of the sensor over the wide range of -30...70 °C.

2   Start-up

Wind can be represented by a vector quantity. For a complete description of the wind it is necessary to specify its speed and direction. The two components are subject to spatial and temporal variations; thus, strictly speaking, the values are only valid for the site where the measuring instrument is installed. We therefore recommend selecting the place of installation very carefully.

2.1   Installation conditions

For professional wind measurements the location and height of the wind sensor are important for accurate, correct results and representative wind conditions. Ideally, the sensor should be installed 10 m above the ground on a mast. There should also be nothing affecting wind flow within a radius of 150 m around the sensor. This may be buildings, trees, tall towers, lifting cranes, moving vehicles, aircrafts, helicopters or other obstructions. In the case of mobile measurements on vehicles often the above mentioned conditions are not practicable. Then you have to find compromises.

Generally, wind measuring instruments should not measure the specific wind conditions of a limited area, but indicate the typical wind conditions of a wider area. The values measured at different places must be comparable. Thus, when installing the sensor you should make sure the place of installation is not under the lee of great obstacles. The distance between the obstacles and the sensor should be 10 times the height of the obstacles (this corresponds to the definition of an undisturbed terrain).

If an undisturbed terrain of this kind does not exist, the sensor must be put up at a height of at least 5 m above the obstacle height.

If the sensor must be installed on a roof top, the place of installation must be in the middle of the roof to avoid predominant wind directions. If you want to measure both wind direction and wind speed, if possible, the sensors should be mounted

at the same measuring point, with any mutual interference of the sensors being avoided. The sensor ARCO-Modbus meets this requirement.

⚠ The sensor must not be installed on to, or close to, transmitting plants or antennas. A minimum distance of 2 m is to be kept for interference-free signal transfer.

2.2   Tools and installation aids

There are no special tools or materials required for installation or maintenance. All work can be carried out with standard tools available in a regular workshop.

2.3   Unpacking the sensor

The sensor is packed in a separate box, carefully protected against mechanical influences, in order to avoid damage during transport. When securely installed, the sensor can withstand shock and vibration, which normally occurs on ships.

Please verify that the following parts and documents are enclosed:

· 1 sensor ARCO-Modbus

· 1 manual

Accessories: (dependant on order size, always separately packed)
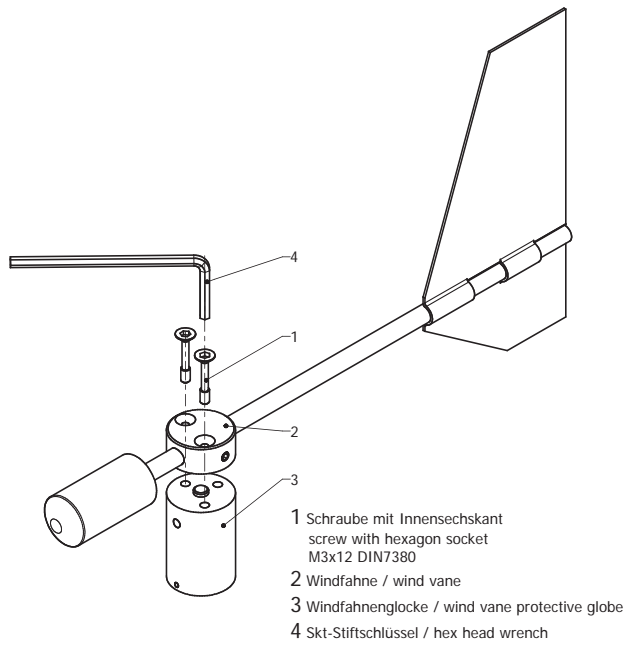
2.4   Goods inspection

Please thoroughly check the delivery with regard to completeness and eventual transport damages. In case of eventual claims please contact us in writing immediately.

2.5   Power supply

The sensor requires at the input connector a 24 volt nominal DC power source for operation. The sensor heating has a power consumption of 2·9 W.

2.6 Mounting the cup rotor on to the wind speed sensor

The bores at the cup rotor are provided in such a way that the cup rotor can only be installed in a certain, clear position. In each case all screws must be used to attach the cup anemometer and wind vane. Thus the correct direction of rotation is guaranteed. The necessary wrench is included in the delivery.

1 Schraube mit Innensechskant
  screw with hexagon socket
  M3x12 DIN7380
2 Windfahne / wind vane
3 Windfahnenglocke / wind vane protective globe
4 Skt-Stiftschlüssel / hex head wrench

2.7 Installation procedure (brief explanation)

The installation of the sensor involves 3 steps:

(1) Mounting the cable on the sensor and if necessary drawing the cable through the mast.

(2) Mounting the sensor on the mast, but before tightening the screws you must align the sensor to the north.

(3) Attaching the cable to the power supply and the signal acquisition system.

2.8 Mounting the sensor

The sensor can be installed on a standard pipe with an outer diameter of 50 mm and an inner diameter of at least 40 mm.

Before attaching the unit with the two 8 mm socket screws, the cable must be connected, by drawing it through the pipe and the sensor aligned to the north or in the forward driving direction. For this purpose the housing is marked accordingly (see drawing). Adjust the sensor to the north before tightening the screws.

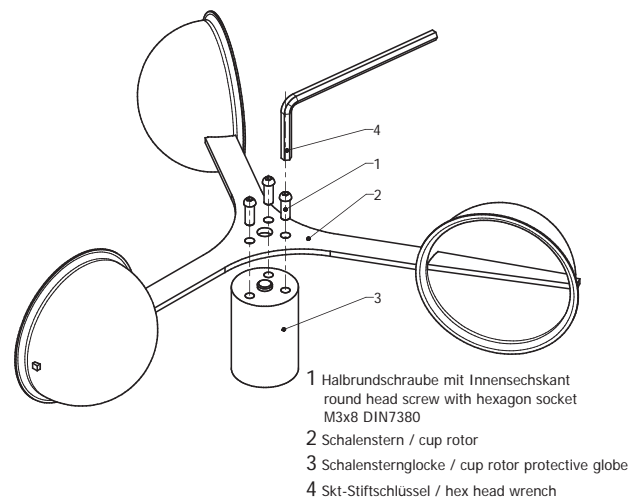Please make sure that the sensor is firmly attached to the mast!

2.8.1 Alignment of wind vane

For wind direction measurements the north mark on the sensor must be aligned with the geographical north direction. To adjust the wind sensor in a firm and correct manner into the north direction this item is equipped with an integrated mounting aid. Inside the inner bottom of the sensor a small bolt pointing to the north is integrated to be set into a corresponding slot of the mounting pipe (if available). Thus the sensor is safely attached. If needed you can screw or unscrew the pin by means of an allen key.

You have to turn the marking on the wind vane so that it is exactly over the marking on the sensor shaft. Fix the position of the wind vane with, for example, a piece of adhesive tape. After alignment the adhesive tape has to be removed.

When you have fixed the wind vane you can locate the reference point by aiming at it over the axis. Now you must turn the sensor casing on the mounting tube until the tip of the wind vane points to the reference point in the north.

To set up the sensor's north orientation select a landmark which is as far as possible up north with regard to the final position of the wind direction sensor.

1 Halbrundschraube mit Innensechskant
  round head screw with hexagon socket
  M3x8 DIN7380
2 Schalenstern / cup rotor
3 Schalensternglocke / cup rotor protective globe
4 Skt-Stiftschlüssel / hex head wrench

The reference point can be selected using a topographical map (1:25000). The exact position of the reference point is determined using an amplitude compass that can be adjusted horizontally on a stand.

(!) The compass declination has to be considered!

A functional check at three points offset by 90° directions is recommended.

(!) Follow all safety instructions while setting up the sensor on to a mast.

2.8.2 Power and signal connection

If the sensor is mounted in the correct manner and connected with the right cable (accessory), you can attach the wires for the power supply and signal outputs to the data acquisition equipment (computer).

The ARCO sensor requires a 4-pole M12 plug connector. The cable shield should be connected with both ends at the ground wire (PE).

(!) To reduce the risk of inductive interference the sensor must be properly grounded (screening on both sides).

The external connection is carried out via a central connector which is located in the housing base. For further details about the electrical connection please see section "Electrical connections".

The typical power supply of the sensors is 24 VDC with a current consumption of max. 920 mA (incl. heating). The input voltage range can be 20...28 VDC. The heating of the ARCO-Modbus has a heating power of 2-9 W.

Under most climatological conditions the heating prevents blocking of the moving sensor parts. Neither the cup rotor nor the wind vane are heated. In the case of icing or formation of ice on the moving sensor element the function is restricted for the period of icing.

The output signal of the sensor conforms to the Modbus RTU to RS-485 standard.

2.8.3 Safety regulations

(!) Because the wind sensor is often mounted in exposed locations at dangerous heights the installation personnel have to pay attention to the relevant safety regulations. During the electrical installation work the external circuitbreaker must be switched off.

It is not permitted for unauthorized persons to open the housing!

3 Maintenance

3.1 Regular maintenance and calibration

The sensors are very low-maintenance and designed for a very long lifetime. Regular visual checks are recomended, regarding dirt build-up on the surface caused by the weather. Whenever this is the case, we strongly recommend that you clean it. A regular visual and functional check of the wind sensor is recommended.

(!) If reference measurements are necessary, it must be stringently noted that a comparison of the measured values is given only if the measurements take place under same conditions. I.e. the reference equipment must be used very close to the sensor!

The sensor is a measuring instrument and thus user specific standards apply regarding the period of recalibration.

Manufacturer's recommendation: 2 years.

For the long-term assurance of the function and accuracy of the proposed components, we are pleased to offer you our professional maintenance and calibration services.

3.2 Visual check and cleaning

The use of the sensor under the respective environmental conditions requires certain actions. It is thus recommendable to clean the outside of the housing and shelter within specific intervals. The intervals are dependant on the environmental conditions and the degree of soiling. We recommend a regular visual and functional check.

In case you should be faced with any specific problems, which you are unable to solve, please contact the LAMBRECHT meteo service:
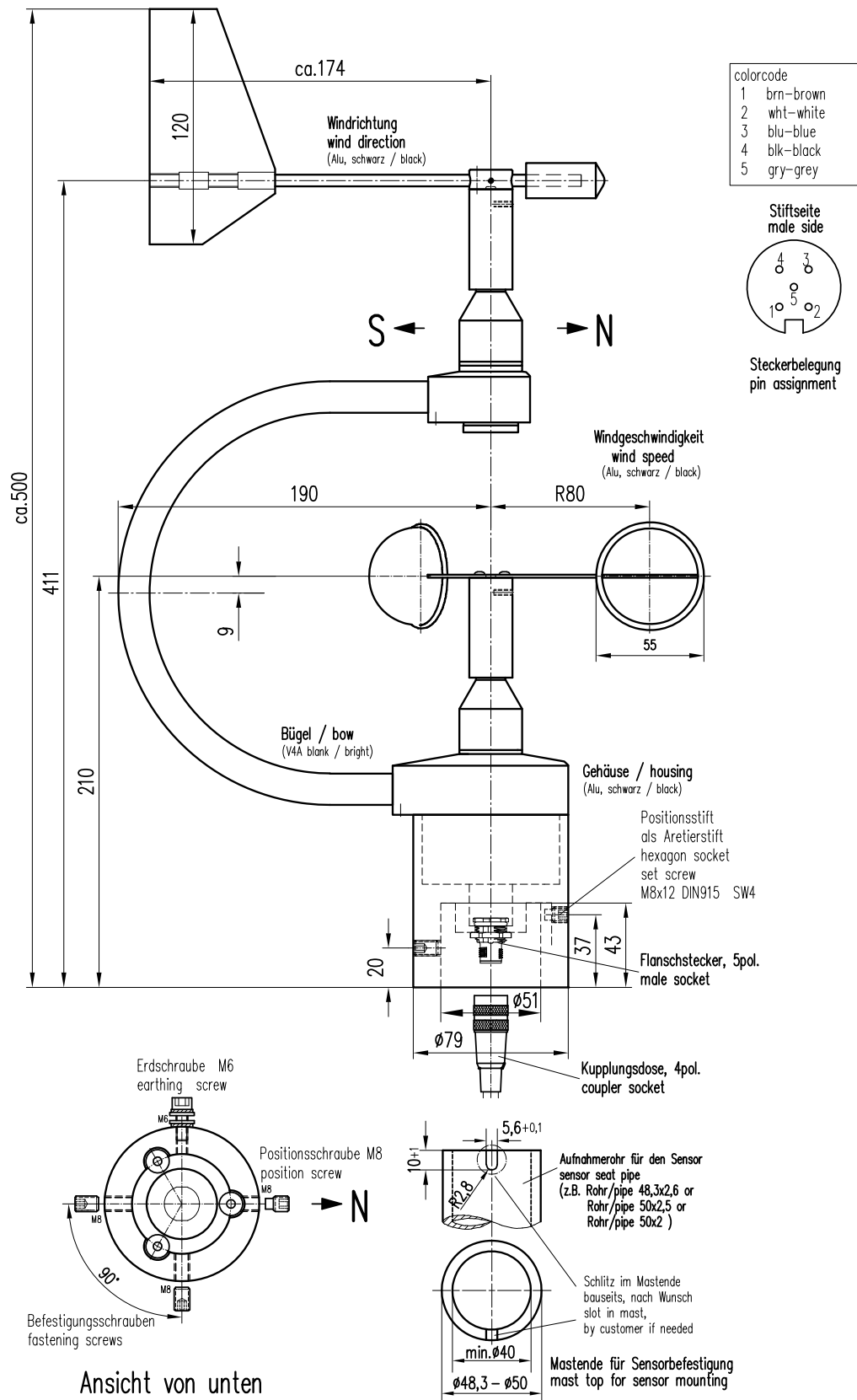
Tel.: +49-(0)551-4958-0

Fax: +49-(0)551-4958-327
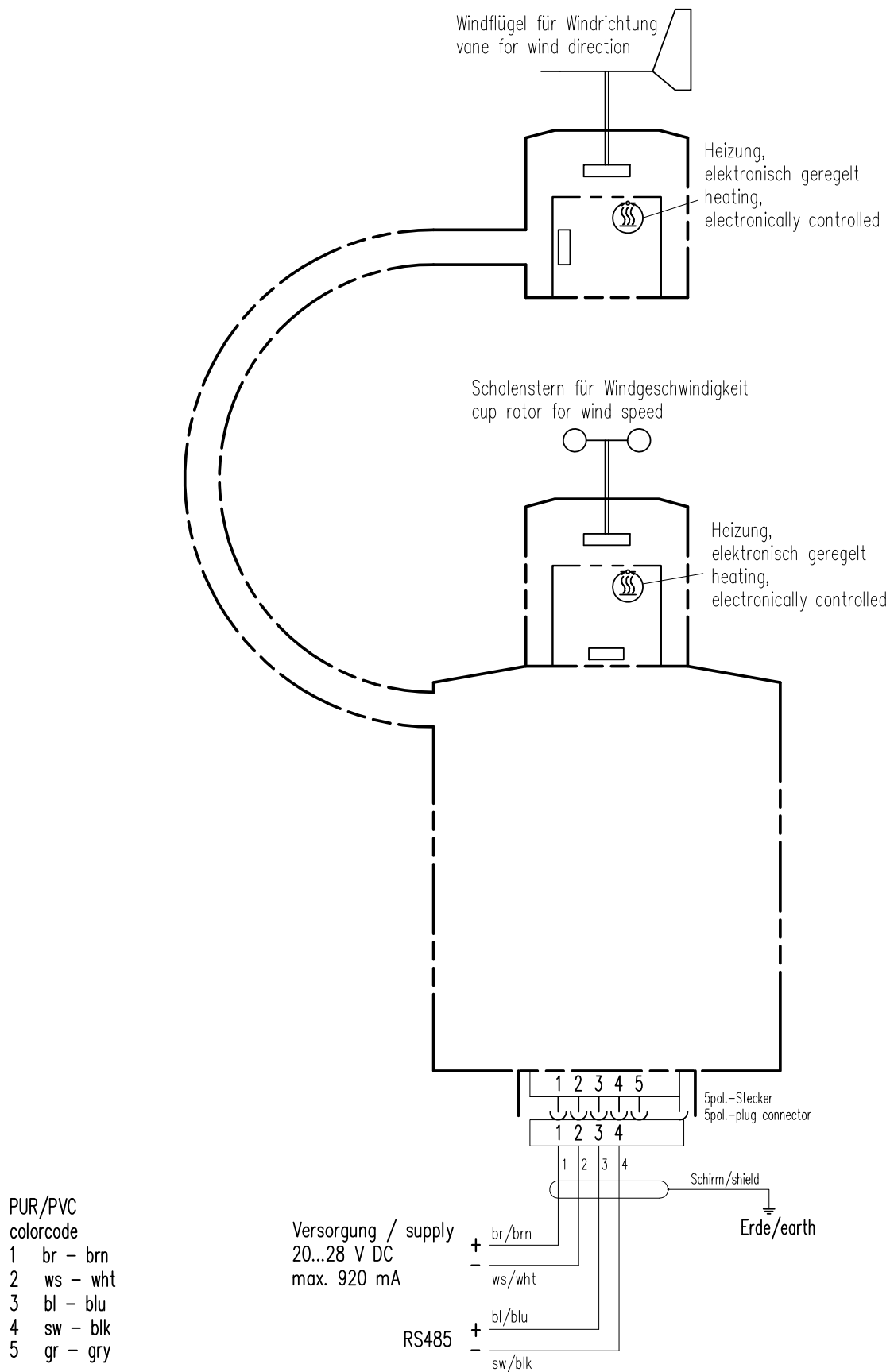
E-Mail: support@lambrecht.net

4 Transport

In case it is necessary for you to ship or transport the sensor, it must be carefully packed to prevent damages during transport.

5 Dimensional drawing ARCO-Modbus

colorcode
1 brn–brown
2 wht–white
3 blu–blue
4 blk–black
5 gry–grey

Stiftseite
male side

Steckerbelegung
pin assignment

ca.174

120

Windrichtung
wind direction
(Alu, schwarz / black)

S ← → N

ca.500

411

Windgeschwindigkeit
wind speed
(Alu, schwarz / black)

190   R80

9

55

Bügel / bow
(V4A blank / bright)

210

Gehäuse / housing
(Alu, schwarz / black)

Positionsstift
als Aretierstift
hexagon socket
set screw
M8x12 DIN915 SW4

37   43

20

Flanschstecker, 5pol.
male socket

ø51

ø79

Kupplungsdose, 4pol.
coupler socket

Erdschraube M6
earthing screw

M6

Positionsschraube M8
position screw

M8

M8

→ N

90°

M8

Befestigungsschrauben
fastening screws

Ansicht von unten

5,6 +0,1

10+

R2,8

Aufnahmerohr für den Sensor
sensor seat pipe
(z.B. Rohr/pipe 48,3x2,6 or
Rohr/pipe 50x2,5 or
Rohr/pipe 50x2)

Schlitz im Mastende
bauseits, nach Wunsch
slot in mast,
by customer if needed

min.ø40

ø48,3 – ø50

Mastende für Sensorbefestigung
mast top for sensor mounting

Gewicht : ca. _,_kg
weigth   : approx. __kgs
Maßstab/scale : 1:3

Electrical connection ARCO-Modbus

Windflügel für Windrichtung
vane for wind direction

Heizung,
elektronisch geregelt
heating,
electronically controlled

Schalenstern für Windgeschwindigkeit
cup rotor for wind speed

Heizung,
elektronisch geregelt
heating,
electronically controlled

1 2 3 4 5

5pol.–Stecker
5pol.–plug connector

1 2 3 4

1 2 3 4

Schirm/shield

Erde/earth

PUR/PVC
colorcode
1   br – brn
2   ws – wht
3   bl – blu
4   sw – blk
5   gr – gry

Versorgung / supply
20...28 V DC
max. 920 mA

br/brn
+
–
ws/wht

RS485
bl/blu
+
–
sw/blk

6 Modbus protocol

The Lambrecht meteo Modbus sensors and the met[LOG] follow the specification of the Modbus organization: "MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3". (See www.modbus.org).

6.1 Data encoding

MODBUS uses the "big-endian" format for addresses and data. This means that if a value is transmit-ted with a number format that is larger than a single byte, the "most significant byte" is sent first. For values that go beyond one register (e.g. 32 bit) this is not clearly specified for the Modbus. In these cases (32 bit or 64 bit) the LAMBRECHT Modbus sensors follow the big-endian number format.

Example Big-Endian:
Register size value

16 - bits 0x1234 is transmitted in the order: 0x12 0x34.

Example Big-Endian (32 bit or 64 bit):
Register size value

32 - bits 0x12345678 is transmitted in the order: 0x12 0x34 0x56 0x78.

6.2 Device address

The addresses 1...247 are permitted for Modbus.

6.3 Standard configuration - Default

Baud rate: 19200 Baud
Address: Each sensor type (or family) has its own default address.

Default addresses of the LAMBRECHT sensors:

Address	Sensor
1	Wind speed
2	Wind direction
3	Precipitation rain[e]
4	THP
5	EOLOS IND
6	com[b]
7	PREOS
8	ARCO
9	u[sonic]
10	Pyranometer 2nd Class
11	Secondary standard Pyranometer
12	PT100 to Modbus converter (temperature)

Byte frame according to MODBUS standard for RTU mode:
8E1 (1 start bit, 8 data bits, 1 parity bit (even parity), 1 stop bit)

6.4 Modbus command set

The LAMBRECHT Modbus sensors support the following commands:
• Read Input Register" command: 0x04 (Read out measured data)
• Write Multiple Register" command: 0x10 (Write sensor data)

6.5 Measured value and parameter registers

The register range 30001 to 35000 of the LAMBRECHT sensors is intended for measured values.

Register for wind speed and wind direction.

Register address	Parameter name	Unit	Factor	Description	
30001	Wind speed instantaneous value	m/s	10	1 decimal place	INT
30002	Wind speed average value since last retrieval	m/s	10	1 decimal place	INT
30003	Wind speed maximum value	m/s	10	1 decimal place	INT
30004	Wind speed minimum value	m/s	10	1 decimal place	INT
30201	Wind direction instantaneous value	°	10	1 decimal place	INT
30202	Wind direction average value since last retrieval	°	10	1 decimal place	INT
30203	Wind direction maximum value	°	10	1 decimal place	INT
30204	Wind direction minimum value	°	10	1 decimal place	INT

Note: The values from the registers with the maximum values and minimum values are automatically reset as soon as the register with the average values has been read out.

The registers addresses 30001 to 35000 apply to all LAMBRECHT meteo Modbus sensors, but are only available or valid if the respective sensor supports the corresponding values (e.g. a pure temperature sensor does not provide any wind speed)..
The LAMBRECHT sensors give 0xD8F1= 9999(16bit) as error code or invalid value.

6.6 Sensor parameters / Configuration parameters

Register address 40001 to 46000 contains the configuration parameter of the sensor.

Register address	Parameter name	Unit	Divisor	Description	
40001	Modbus device address		1	The addresses 1...247 are allowed.	
40200	Baud rate		0,01	96=9600 192=19200 384=38400	
46000	Number of mapping registers		1	Contains the number of occupied mapping registers for the autoconfiguration	INT

6.7 Mapping register for autoconfiguration

Registers address 46001-49000 containing for each sensor the available registers with measured values and sensor data from the range 30001-35000.

The registers can only be read out as a block! The length of the block or the number of available mapping registers is in holding register 46000.

For example, in the ARCO-Modbus wind sensor, registers 46001 to 46004 contain valid addresses. The holding register 46000 contains the number of registers 8. All 8 registers must be read out in the block with the instruction **0x04**. Too many registers or too few lead to an error message.

6.8   Autoconfiguration

The Modbus sensors from LAMBRECHT meteo offer the possibility of auto-configuration. This is supported e.g. by the data logger met[LOG].

For the autoconfiguration, the register addresses of the measured values and sensor data available in the register range 30001 to 35000 are listed as consecutive values in the LAMBRECHT sensors in register range 46001 to 49000. Registers 46001 to 49000 can only be read out as a block! The length of the block or the number of available mapping registers is in holding register 46000.

Since the addresses from the range 30001 to 35000 apply to all LAMBRECHT sensors, an address from this range is also representative of a measured value type.

For example, register 30401 always contains the current value of the air temperature. If this register address is not included in the list in register range 46001 to 49000, the connected Modbus sensor does not supply an air temperature.

If the autoconfiguration is started with the data logger met[LOG], it queries the available mapping registers on each COM interface in the device address range 1...25. For this purpose, the number of mapping registers is read from register 46000 and the register range from 46001 is read out as a block.

The following table contains the assignment of the configuration to the individual (possible) instantaneous value registers of the sensors. Some sensors deliver registers with mean, minimum and maximum values or additional values beyond this specification. Unknown register addresses (or registers that are not required) must therefore be ignored during autoconfiguration.

Register address	Parameter name	Unit	Factor	Description	Data type	Func- tion code	Storage- type >16 bit
30001	Wind speed instanta- neous value	m/s	10	1 decimal place	INT	0x04	Big-Endian WORD
30201	Wind direction instan- taneous value	°	10	1 decimal place	INT	0x04	Big-Endian WORD
30401	Air temperature in- stantaneous valuet	°C	10	1 decimal place	INT	0x04	Big-Endian WORD
30601	Humidity instantane- ous value	% r.F.	10	1 decimal place	INT	0x04	Big-Endian WORD
30701	Dew point instantane- ous value	°C	10	1 decimal place	INT	0x04	Big-Endian WORD
30801	Air pressure instanta- neous value	hPa	10	1 decimal place	INT	0x04	Big-Endian WORD
31001	Precipitation amount total	mm	10	1 decimal place	INT	0x04	Big-Endian WORD
31101	Precipitation amount total (High-WORD)	mm	1000	3 decimal places Registers 31101 + 31102 can only be read out together. (func- tion code 0x04)	uLONG	0x04	Big-Endian WORD
31102	Precipitation amount total (Low-WORD)					0x04	Big-Endian WORD
31201	Precipitation intensity 1-minute (sliding)	mm/ min	1000	= average (1-min.) 3 decimal places Time base = 1 min. Meas. rate = 6x per min.	INT	0x04	Big-Endian WORD
31401	Global radiation in- stantaneous value	W/m²	10	1 decimal place	INT	0x04	Big-Endian WORD
31501	Global radiation instantaneous values (High-WORD) (temperature compen- sated)	W/m²	100	2 decimal places Registers 31501 + 31502 can only be read out together (function code 0x04)	LONG	0x04	Big-Endian WORD
31502	Global radiation instantaneous values (Low-WORD) (temperature compen- sated)					0x04	Big-Endian WORD

31591	Global radiation instantaneous values (High-WORD) (uncompensated)	W/m²	100	2 decimal places Registers 31591 + 31592 can only be read out together (function code 0x04)	LONG	0x04	Big-Endian WORD
31592	Global radiation instantaneous values (Low-WORD) (uncompensated)					0x04	Big-Endian WORD

6.8.1 Mapping register ARCO-Modbus

Register address	Register value	Unit	Factor	Description	
46001	30001	Register address	1	Wind speed instantaneous value	INT
46002	30002	Register address	1	Wind speed average value since last retrieval	INT
46003	30003	Register address	1	Wind speed maximum value	INT
46004	30004	Register address	1	Wind speed minimum value	INT
46005	30201	Register address	1	Wind direction instantaneous value	INT
46006	30202	Register address	1	Wind direction average value since last retrieval	INT
46007	30203	Register address	1	Wind direction maximum value	INT
46008	30204	Register address	1	Wind direction minimum value	INT

7 Technical data

ARCO-Modbus   Id-No. 00.14581.030430

Ranges of
application: temperatures -40...+70 °C heated* •
                     wind speed 0...80 m/s • rel. humidity
                     0...100 % r. h.

Interface: RS 485

Protocol: Modbus RTU

Supply voltage: sensor 20...28 VDC/ max. 920 mA at
                     24 VDC incl. heating 24 VDC/ 2·9 W

Housing: seawater resistant aluminium · spe-
                     cially coated • IP 65 in upright position

Dimensions: see dimensional drawing

Weight: approx. 1.7 kg

Parameter wind direction

Measuring range: 0...360°

Accuracy: ± 1 %

Resolution: < 1°

Starting value: 0.3 m/s

Damping ratio: 0.5...0.6

Parameter wind speed

Measuring range: 0.3...75 m/s

Accuracy: ± 2 % FS at 0.3...50 m/s

Resolution: < 0.1 m/s

Starting value: 0.3 m/s

Delay distance: 4 m

*) Remark: In the case of icing and fromation of ice at the moveable sensor measuring
element, the function is restricted for the period of icing.

Heating status:
On request the corresponding NMEA-protocol can
be activated by LAMBRECHT.
Id.-no. for activating the protocol: 97.14581.000 000
(Please quote when ordering!)

Accessories: (please order separately)
Sensor cable, 15 m, 4-pole M12 plug
Id-No. 32.14567.060010 (various lengths possible)

Options:
(9340)   Visualisation and evaluation software
         "MeteoWare-CS-3 Basic"
         Id-No. 36.09340.000000

Standards

- EMC/EMI: EN 60945
- Low voltage guideline 73/23/EWG and VDE 0100
- WMO No. 8
- VDI 3786 part 2
- NMEA 0183

8 Warranty

**Please note the loss that unauthorised manipulation
of the system shall result in the loss of warranty and
non-liability. Changes to system components require
express written permission from LAMBRECHT meteo
GmbH. These activities must be performed by a qualified
technician.**

The warranty does not cover:

1. Mechanical damage caused by external impacts (e. g.
   icefall, rockfall, vandalism).

2. Impacts or damage caused by over-voltage or
   electromagnetic fields which are beyond the standards
   and specifications of the device.

3. Damage caused by improper handling, e. g. by using
   the wrong tools, incorrect installation, incorrect electrical
   installation (incorrect polarity) etc.

4. Damage caused by using the device outside the specified
   operation conditions.