uSonic-3 CLASS-A MP

(Multi Path)

3D Ultrasonic Anemometer

Manual

Table of Content

1   General information about uSonic-3 CLASS-A MP (Please, read this first!)

The uSonic-3 CLASS-A MP system is new technical approach for a state-of-the-art wind and turbulence sensor for scientific applications such as eddy flux set ups, spectral analysis of wind flows or long term climatologic studies. Due to its directional sensor head design and its unique multi-path technique it fits perfectly to all boom type installations which require a minimum of flow distortion effects. The allowed angle of attack in azimuth has been extended to 160 … 200 ° assuming the main mounting rod aligned to 180 °.

The uSonic-3 CLASS-A MP is a youngest member of the METEK uSonic-3 family, so a number of features and functions are applicable also to other METEK uSonic-3 versions. The uSonic-3 CLASS-A MP derives the 3D-wind vector and the acoustic temperature T_a from the measured acoustic velocity by means of short acoustic pulses at an acoustic frequency of about 36 kHz. The pulses are exchanged between each transducers and its three counterparts of the opposite transducers group forming 3 complete arrangements of one vertical and two tilted paths at elevation angles of about 53.2 ° and separated from each other by 120 ° in azimuth. The measuring paths are advantageously positioned providing low flow distortion and high accuracy for wind flows within incidence angles in azimuth within 20 … 340 ° and in elevation within +- 45 °over the whole measuring wind speed range 0 … 40 m/s with the main mounting rod aligned to 180 ° and the measuring volume positioned to north (system north).

The currently available "Standard Configuration" of the uSonic-3 CLASS (later referenced as "SC") outputs 6 tilted radial wind components plus 3 vertical radial wind components plus 9 corresponding sonic temperatures (6 tilted, 3 vertical) plus one averaged sonic temperature. Furthermore, cartesian wind components are derived from the radial wind components of the most advantageously positioned paths.

The system outputs the instantaneous data either via the Ethernet port and/or via a serial RS422/RS485 port at max. data output rate of 30 Hz. In addition, an integrated internal SD-card which is also part of the update concept can be used to log data.

As a further option a two-way inclinometer can be included inside the CLASS-A MP sensor head to monitor the correct horizontal/vertical alignment of the sensor head. Two of the 6 analog input channels are used to read the signals of this two-way inclinometer.

To connect the uSonic-3 CLASS-A MP all needed connecting plugs are part of the delivery, so the customer is able to configure cables easily according to his specific requirements. Optionally METEK provides complete cables with cable lengths configured to order.

An efficient sensor head heating (option) allows operation under icing conditions for all uSonic-3 sensors. The heating can be switched on or off by user command or can be operated in

automatic mode and a monitor function reports about its correct operation. The heating can be supplied separately from the sensor electronic. Neither the transducers nor the electronics require thermal heating, as all involved components have been tested down to -40 °C.

Metek's well-known "Turbulence Extension" will be available for the CLASS-A MP MP as an upgrade option in near future, but its functionalities are not included in this manual.

Because the uSonic-3 sensor has no moving parts it doesn't show aging of calibration factors or inaccuracies due to stress on bearings known for conventional cup anemometers or wind vanes. Thanks to its robust design and its optional sensor head heating the uSonic-3 performs reliably even in harsh environments and can be seen as an all-weather type sensor.

The correct system performance in view of the sensor head calibration is monitored by an extended number of embedded signal quality checks and is reported with the data output which helps the operator to check the system status.

The uSonic-3 CLASS-A MP is a member of the family of METEK ultrasonic sensors ("uSonic-3") and uses a number of the functions which might be known from other uSonic-3 sensor types. Two important characteristics must be regarded:

- **The x-, y- and z- wind components are given for the uSonic-3 CLASS-A MP in a Cartesian <u>right-handed</u> coordinate system.**
- **The uSonic-3 CLASS-A MP must always be used <u>without any sensor head correction</u>, i.e. the parameter HDC must be set to "Zero" (HDC=0).**

This manual helps to operate the uSonic-3 CLASS-A MP system and to avoid failures in installation and operation. It contains concise information about data output and system controlling. Due to the broad range of system capabilities some functions or features may be addressed repeatedly in different parts of the manual.

This manual of the uSonic-3 CLASS-A MP is a living thing and is under ongoing revision and extension. Any critics or comments will help us to improve the quality of this documents and are highly appreciated.

2   System Description

2.1   Measuring Principles

The acoustic transducers are grouped in a lower and an upper group of 3 transducers and operated alternatingly as transmitters or receivers. Each acoustic pulse transmitted by one transducer of one group is received by all 3 transducers on the opposite group and vice versa. From the travel times of sound pulses propagating along the measuring paths back and forth the sound velocity is determined for each of the 6 tilted and for each of the 3 vertical paths. The measured sound velocity depends on the air density (a scalar variable) and on the airflow (a vector) along the measuring path.

The difference of the travel times back and forth along the measuring path eliminates the scalar variable of air density and yields the radial component of the airflow parallel to each path. Assuming a homogeneous wind flow within the measuring volume the measured radial components can be transformed into an orthogonal right-handed Cartesian system with x-, y- and z-wind component.

The sum of the travel times back and forth along the measuring paths eliminates the vector component of the wind flow parallel to the paths and gives the air density or the so-called "acoustic temperature" as a good approximation for the virtual temperature which is commonly used in atmospheric application.

Each of the 6 tilted paths and 3 vertical paths shows an individual transfer function (or better: an individual time delay) when the incoming electrical impulse is transformed into an outgoing sound pulse (transmitter mode) or vice versa (receiver mode). These individual time delays must be determined in a calibration routine and the derived calibration values are used by system algorithms to eliminate their effects for all paths. As a part of this calibration the position of the 6 transducers relative to each other is determined by a xyz-positioner. From these the individual path lengths and angles in zenith and azimuth are determined.

The calibration numbers do not change within the lifetime of the transducer, so the correct geometry of the sensor head can be verified by an online system monitoring function. This function checks the ongoing measurements in view of any deviation between the calibration parameters and it will blank the output data in case of a mismatch adding an extra output line with an error message.

2.2   Communication channels for data output and system operation

The uSonic-3 CLASS-A MP has a combined operating and data interface on a serial RS422/RS485 interface. If the network option is selected, the system offers an additional operating channel and an additional data output channel via TCP/IP network ports (sockets). Furthermore, it is possible to use the internal SD-card for data logging.

The two possible operating channels uses the same syntax to operate to the system. If one of these operating channels is started, this channel is blocked for the other operating channel up to 1 minute after the last operating. After this time, it is possible for the other channel to take over.

2.3   Handling of instantaneous data and averaging concept

The three data output channels (RS422, network and SD-card) behave identically from a logical viewpoint. That's why a number of parameter commands, which can be used to configure instantaneous and averaged data output, are available three times and indexed with the numbers 1…3, where:

index 1:   means data output and optional averaging on RS422 data channel,

index 2:   means data output and optional averaging on network data channel,

index 3:   means data output and optional averaging on SD-card.

The optional averaging is provided by three independent operating averaging threads which receive every new set of instantaneous data to output it depending on the control parameters either as instantaneous data and/or to average these instantaneous data and to output the averaged data. Consequently, the three averaging threads can be configured independently.
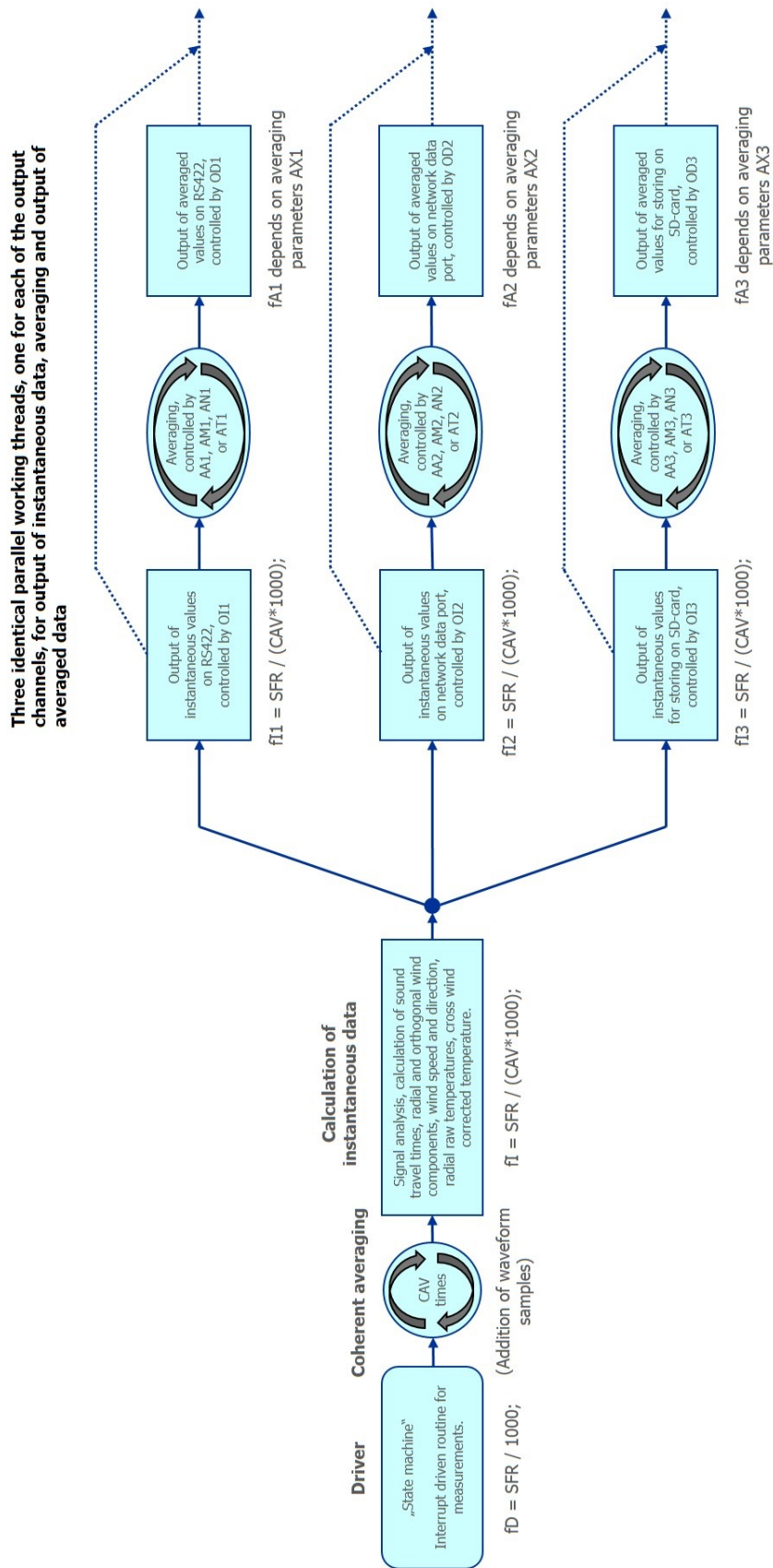
fig. 1: concept of data output of instantaneous and/or averaged data via communication ports

2.4   System Components

The uSonic-3 CLASS-A MP consists of the following main components (see fig. 2):

- sensor head (see 1a) with main mounting rod (see 1b), optional extension of mounting rod (see 1c) and junctions for sensor head cable (see fig. 2d) and optional inclinometer (see 1e),
  sensor head is optionally equipped with sensor head heating;
  the main mounting rod has a total length of 400 mm (with optional extensions by 250 mm).

- sensor electronics box (see 2)

- sensor head junction cable (see 4)

- non-configured plugs for cable of power supply and RS422/RS485 and for ethernet cable

- configured cable for power supply and RS422/RS485 (see 5; optional)

- configured ethernet cable (not shown in fig. 2, optional)

- inclinometer cable (see 3; optional)
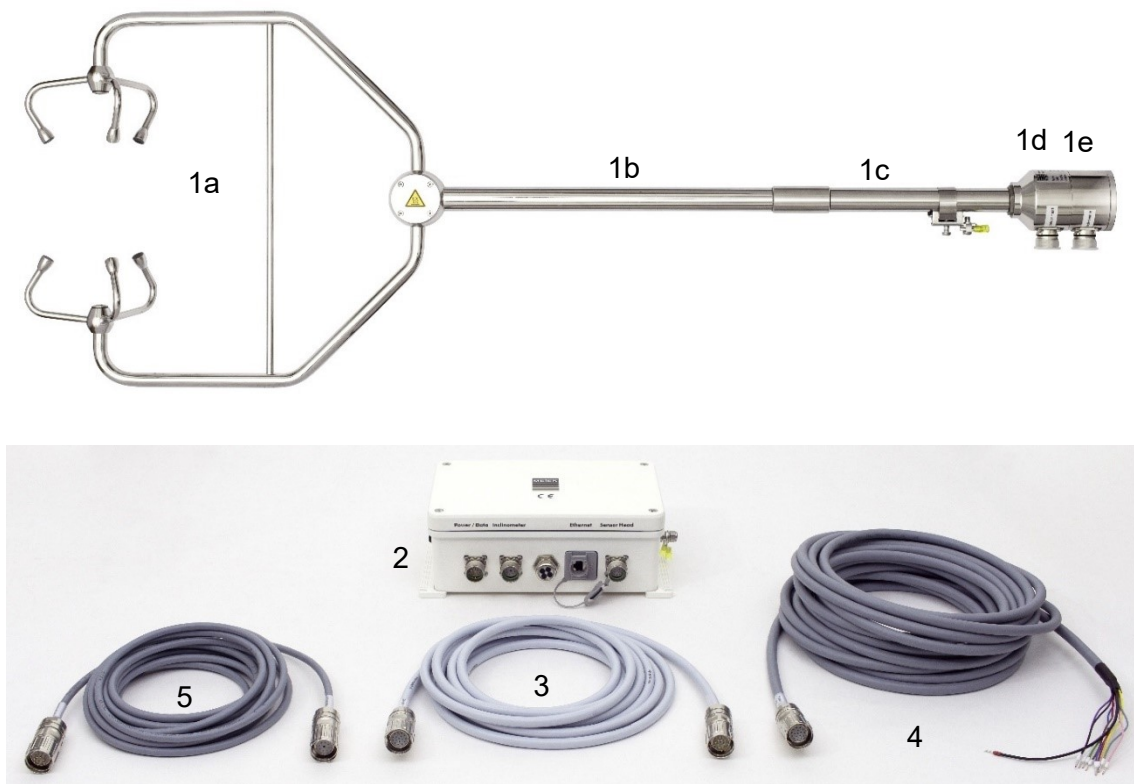
fig. 2: system components of uSonic-3 CLASS-A MP

All cable connected to the sensor electronics or to the sensor head use individually coded Coninvers plug/socket connectors to avoid any mismatch of the cables as long as the plugs and sockets and their assignments are not changed.

2.5   Sensor Head

The sensor head is made from stainless steel and has in its standard version with main mounting rod length of 450 mm a weight of approx. 3.2 kg for the standard (plus 0.6 kg for any extension of the mounting rod by a 250 mm length.

The main mounting rod points towards "system north", i.e. the sensor head with its transducers arrangement is located at "system south". The orientation to north is also indicated by the black arrow placed on main supporting rod.

The right-handed coordinate system of the wind components is defined as follows:

- A positive x-component points towards east and represents a west wind component.
- A positive y-component points towards north and represents a south wind component.
- A positive z-component points upwards and represents an upwind component.
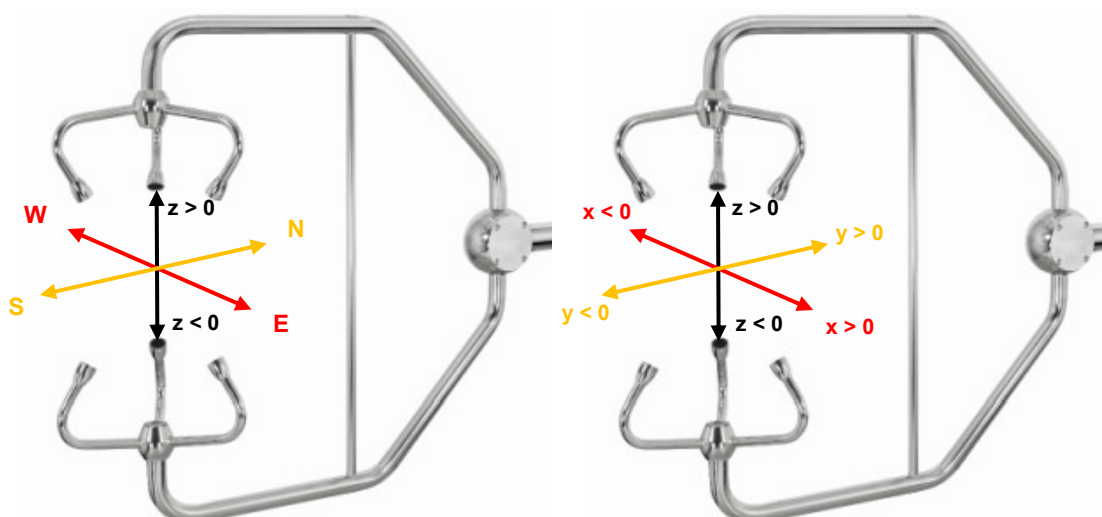
fig. 3: sensor head geometry and coordinate system (shown for a conventional CLASS-A)

The shown sensor head can be optionally equipped by a sensor head heating supplied either internally by the sensor supply voltage (max. 24 VDC is allowed for the sensor head heating) or separately via extra cable cores. The sensor head heating consists of direct heating of each transducer by PTC elements with temperature dependent power rating (approx.. 6 x 5 W @ 0 °C) and heating wires with constant heating power (approx. 70 W) inside the sensor head.

2.6   Inclinometer Integration

The optional inclinometer is housed in the junction box at the end of the mounting rod and yields two signals for the two tilt angles φ and θ.

fig. 4: end sleeve with sensor head cable socket (left) and appended inclinometer (right)

- The tilt angle φ (roll) turns clockwise around the south-north axis when viewing from south to north. The signal for the roll angle φ is taken by the input channel P1.
- The tilt angle θ (pitch) turns clockwise around the east-west axis when viewing from east to west. The signal for the pitch angle θ is taken by the input channel P2.
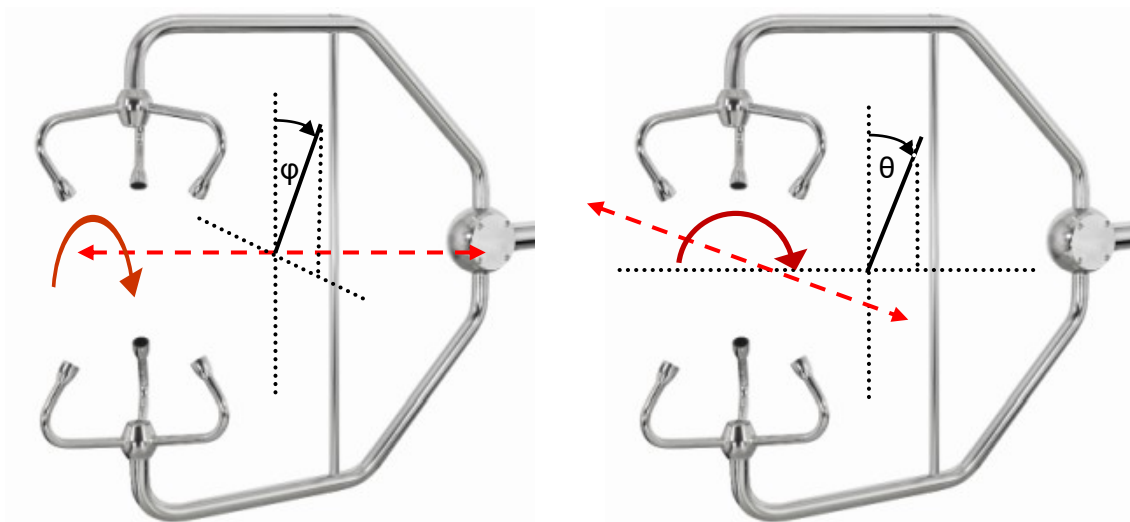
fig. 5: sensor head and tilt angles as measured by inclinometer, roll φ (left) and pitch θ (right)

The relation between the voltage reading of P1 and P2 and the corresponding tilt angles φ and θ are derived from a direct reference measurement by means of a calibrated spirit level with an accuracy ≤ 0.1 °. From this measurement gain and slope values are derived and entered to the USonic-3_ClassA_MP as calibration parameters to convert from the measured voltages to the tilt angles.

2.7   Sensor Electronic and Cable Connection

- The sensor electronic is housed in a white metal box with 5 inlets (see fig. 6) with:
- connector for power supply and data cable RS422/RS485 (see 1)
- inclinometer junction cable (see 2; option)
- grommets for input/output cables (see 3)
- RJ45 network connector (see 4; option)
- sensor head connector (see 5)

For correct grounding an extra grounding contact is available at the right side of the electronic box as seen from the front (see 6).
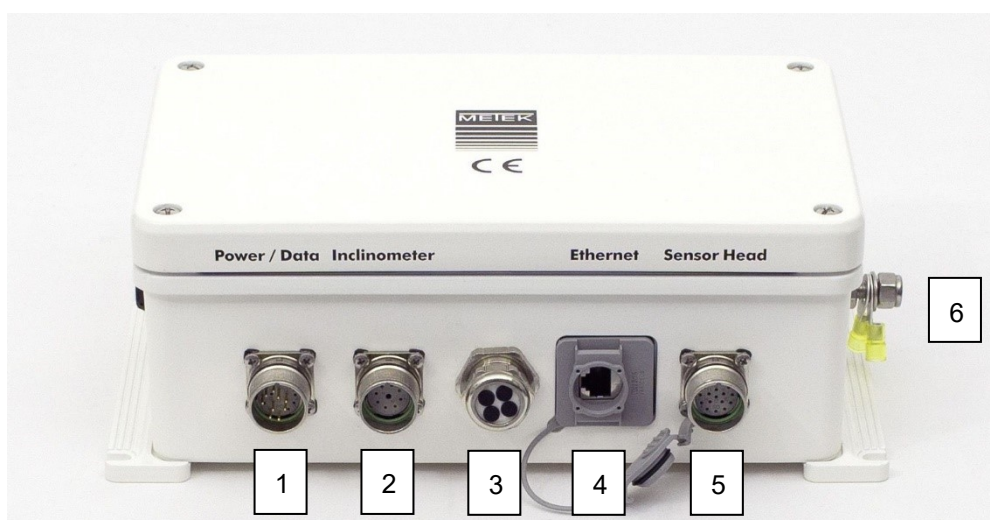
fig. 6: sensor electronic and cable connections (all without caps)

2.7.1   Power Supply and Serial Data Cable RS422/RS485 (Option)

For power supply, sensor head heating (option) and communication/data transfer by RS422/RS485 serial line a common cable is optionally provided with a Conivers plug on one end and open cores with end sleeves on the other.

A mismatch of the cores for positive voltage (9 … 36 VDC, 24 VDC max. with heating option) and for ground of the power supply will not harm the sensor electronic but the system will not start. After correct connection the system will start normal operation.

The supply voltage of the sensor head heating can be connected separately from the supply voltage of the sensor electronic which helps in case of a need for independent power supplies.

To extend the power cable to more than 12 m cable cores diameter of at least 1 mm must be used. The total cable length should not exceed (100+12) m without sensor head heating or 25 m with sensor head heating as significant power loss will occur at larger lengths.

Shield of the cable

Consider position of code slot. Use X-mark for coding !

Illustration: Cable connector (female), view at contact sockets
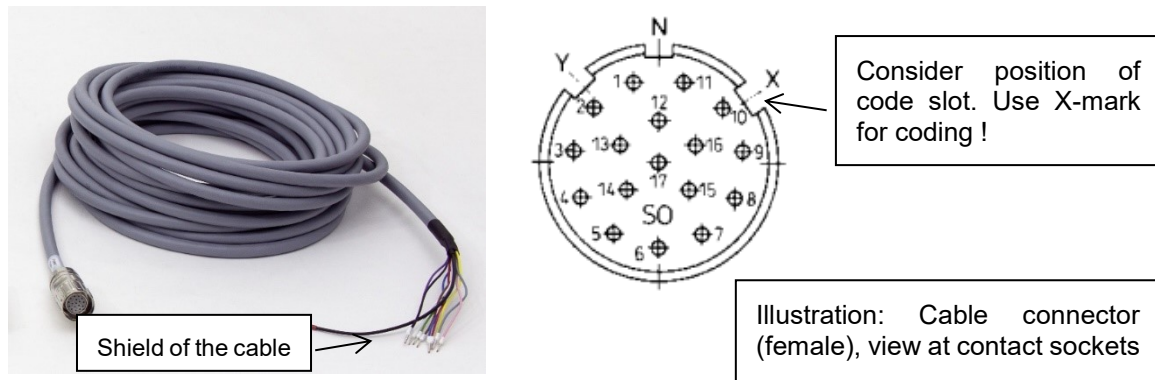
fig. 7: power supply and data cable RS422/RS485

The USonic-3_ClassA_MP is optionally delivered with a 10 wire connection cable with a length configured to order. See below the correct pinning of the power supply and data cable cores.

Tab. 1: Cable pinning for 10-wire cable without optional analog output channels

Pin	Color	Function	Pin	Color	Function
1	NC		9	green	TxD-, Z (RS422) Bus-, Z (RS485)
2	NC		10	yellow	TxD+, Y (RS422) Bus+, Y (RS485)
3	NC		11	grey	+ 12…36 V DC, power supply for electronic
4	NC		12	pink	GND, power supply for electronic
5	NC		13	blue	+24 V DC, power supply for heater
6	white	RxD+, A (RS422) Bus+, Y (RS485)	14	red	+24 V DC, power supply for heater
7	brown	RxD-, B (RS422) Bus-, Z (RS485)	15	black	GND, power supply for heater
8	NC		16	purple	GND, power supply for heater
			17	NC	

The longer, black wire is connected with the shield of the cable !

Tab. 2: Cable pinning for a 16-wire cable with optional analog output channels

Pin	Color	Function	Pin	Color	Function
1	white	+ analog out port C1	9	black	TxD-, Z (RS422) Bus-, Z (RS485)
2	brown	+ analog out port C2	10	purple	TxD+, Y (RS422) Bus+, Y (RS485)
3	green	+ analog out port C3	11	grey-pink	Power supply Electronic +12…36 V
4	yellow	+ analog out port C4	12	red-blue	Power supply Electronic GND
5	grey	GND analog out	13	white-green	Power supply Heater +24 V
6	pink	RxD+, A (RS422) Bus+, Y (RS485)	14	brown-green	Power supply Heater +24 V
7	blue	RxD-, B (RS422) Bus-, Z (RS485)	15	white-yellow	Power supply Heater GND
8	NC		16	yellow-brown	Power supply Heater GND
			17	NC	

3   Set Up

To get the best quality in the measured data the installation site should not show significant obstacles within the vicinity of the installation to avoid any shadow or tunnel effects on the wind flow. Best accuracy is provided if the sensor head with the measuring volume is positioned windward (luv) and the mounting bar (including mounting boom or mast) is positioned leeward. The allowed angle of attack is ± 160° when looking windward.

Sonic anemometers are often installed at sites exposed to severe weather conditions, esp. lightnings or wind gusts. During set-up the user should always observe the weather condition and should stop any further work in case that thunderstorms or fronts are approaching.

The accuracy of the sensor head is determined by the individual sensor calibration and its geometry should be preserved to the best extend that is possible. Do not carry the sensor at one of the sensor arms, <u>do not use the sensor arms as hooks for tools or jackets</u>!!!

The uSonic-3 system checks for each signal pulse whether the propagation times still fit to the calibration. In case of strong deviation, the system automatically rejects such instantaneous measurements. As a consequence the system will output either blanked characters (instantaneous mode) or will exclude these instantaneous data from the averaging procedures (averaging mode). For best performance the uSonic-3 MP systems would need in such case a new calibration which can be done currently only in the lab and no longer at the measuring site (as for the conventional uSonic-3 sensors).

The threshold for acceptance/rejection of the instantaneous measurements is determined by the system parameter MD. Its default value of "20" can be lowered or even set to zero in case that a de-calibrated system must be brought back to operation under any circumstances. The user must regard for this set-up that a significant offset in the wind components is likely. And in low wind speed situations any offset can cause large errors in the measured wind direction.

If a system has been operated under such conditions the user should note the used calibration parameters and should compare with the refreshed calibration parameters including the observed offset values in a zero-wind environment after a new calibration has been performed. This allows in most cases an offline correction of the measurements.

The uSonic-3 system is intended in general for an upright vertical position, so it should be installed accordingly. If the sensor is installed in a non-vertical way the deviation should be measured and applied later for offline correction.

The azimuth orientation is given by the black arrow on the main mounting bar and can be chosen according to the site conditions. By means of the parameter AZI any deviation of the alignment from north can be online compensated.

3.1   Power Supply

The uSonic-3 CLASS-A MP <u>sensor electronics</u> requires a supply voltage of <u>9 ... 36 VDC</u> and it takes - without activated sensor head heating - about 3 … 5 W depending on the optional extensions (inclinometer).

The uSonic-3 CLASS-A MP <u>sensor head heating</u> requires a supply voltage of <u>24 VDC</u>, it takes an additional nominal heating power of approx. 100 W @ 0°C.

- The PTC heating elements of the transducers have a temperature dependent rating, i.e. in case of a cold start under low temperature conditions the heating power can raise up to more than 100 W for some seconds. During the fast warming up of the PTC elements the consumed power will decrease significantly below the nominal value after some minutes.

- If the power voltage is higher than 24 VDC the sensor head heating could overheat and destroy the internal wiring causing further risks of fire or other danger to persons or systems. Never operate a uSonic-3 while it is stored in a (transportation box.

- In case the voltage is lower than 24 VDC the heating power will possibly become insufficient (for ex.: ½ of nominal voltage = ¼ of nominal heating power).

Note: The DC/DC converter of the uSonic-3 CLASS-A MP electronic balances the required system power in case of voltage fluctuations on the external power line. So, for low input voltage the DC/DC converter draws more current from the external power line. This extra load may result in a further decrease of the external voltage. As a consequence the input current may even raise further until the electronic fuse of the uSonic-3 CLASS-A MP electronic may trip. In such case a cold restart of the uSonic-3 CLASS-A MP (after a 10 sec. delay) must be performed to reset the electronic fuse. Tripping of the electronic fuse may occur especially if the uSonic-3 CLASS-A MP is supplied by a nearly flat battery.

3.2   PC connection

Any ultrasonic sensor uSonic-3 is equipped with a serial interface, featuring RS422 resp. RS485 communication. This interface is used for both, data output and communication to a host station (PC-unit) to configure the sensor.

Data output and configuration is accomplished on basis of ASCII codes and visible as plain text when connecting a terminal device, such as VT100.

For communication with a PC, the serial interface has to be connected to the PC`s serial interfaces such as COM1 or COM2 ... and a PC terminal program must be started with the uSonic-3 standard settings of 9600 baud, 8 bit, no parity, 1 stop bit and XON/XOFF handshake. For WINDOWS 95/98/NT/2000/XP the "Hyper Terminal" found in "accessories" and for

WINDOWS7 standard terminal programs (PUTTY, FOXTERM, ezc.) can be used (see www.putty.org, www.foxterm.net). Also the tcopy-freeware by Metek which comes with the sensor allows a simple set up of a communication via the serial line.

Each entered command must be terminated by a CR- or LF-character (Carriage Return or Line Feed). And correspondingly all data output lines of the uSonic-3 CLASS-A MP are terminated by a CR-LF character string.

Input characters or input commands are echoed and responded by the instrument not before a terminating CR-LF command has been entered. Nevertheless a "blind" editing is possible if a BS character (Backspace) is entered which erases the last entered key. By selecting a full duplex mode on the serial line, it is possible to read the entered command before the CR-or LF- termination, but then each entered input line appears doubled.

In case of a data overflow on the serial interface all uSonic-3 systems with software version 4.40 or higher restart automatically the data flow after a short break. So, the system stops the data retrieval for some seconds, but remains operational and accessible for the user.

3.3 XON/XOFF Handshake

The XON/XOFF handshake method controls the bi-directional data flow and prevents data loss in case of fast data flow between uSonic-3 CLASS-A MP and connected host station: the XOFF command (Strg-S, character 19) interrupts the data retrieval until the XON (Strg-Q, character 17) command signalizes that the unit is ready to continue the retrieval process. Both units, the uSonic-3 CLASS-A MP and the connected host station must use the XON/XOFF handshake for proper data flow in standard installations.

In some situations with spurious data interruptions it may be appropriate to disable the XON/XOFF handshake method. The data flow and communication will work correctly most of the time, but the user must ensure correct command reception and correct data format by other methods.

Besides the XON/XOFF handshake the uSonic-3 CLASS-A MP also offers a CHECKSUM algorithm which further ensures correct data transmission ("FR#" command).

3.4   Grounding

The uSonic-3 CLASS-A MP is equipped with an overvoltage protection by suppressor diodes for the serial ports and for the supply voltage. This concept requires a <u>correct grounding of the system</u> by means of the indicated grounding points at both, sensor head and electronic box (see 1 and 2 in fig. 8). If the grounding is not attached or not completely attached the overvoltage protection does not work correctly. Furthermore, external cross talk may enter the sensor head causing some extra noise floor on the signals and in the measured data.
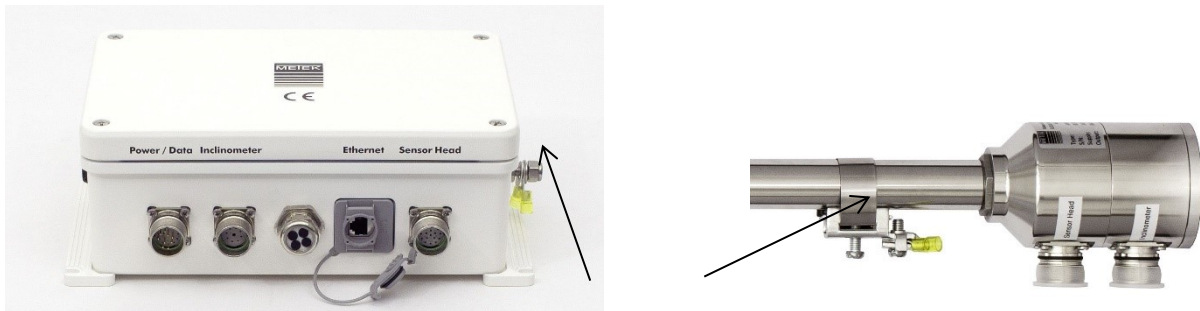
fig. 8: grounding contacts

4   Communication

The USonic-3_ClassA_MP Anemometer communicates through a serial bidirectional RS422-port and optional through a network operating port with the user.T he default parameters (factory settings) of the serial port for communication are 57600 baud, 8 bit, no parity and one stop bit. In addition a network data port is available. Its default parameters are: 192.168.178.123:5001, user: **service**, password: **8189035** (default) or user: **data**, password: **MetekGmbH** (default).

It is really important, that the newline behavior to establish the network connection(s) is set to **CRLF** !

The IP-address of the system, the port numbers for operating- and data-channel and the passwords of the two users **data** and **service** are adjustable by the user.

The USonic-3_ClassA_MP Anemometer uses the XON/XOFF-protocol (software-handshake) but does not support for hardware-handshake on the RS422-interface.

Each input lines (command line) on both the RS422- or the network operating port must be terminated by a CR (Carriage Return) or LF (Linefeed) character, all output lines of system messages are terminated by a CR LF sequence. The input characters are **not reflected** by the system, only the complete input sequence is reflected after termination for verification. "Blind" correction of false input characters is possible by using BS (Backspace). The CRLF behaviour of the output of measuring data is adjustable (CR, LF or CRLF).

4.1   Data input

The system accepts ASCII character strings, numbers and as special characters the equals sign (=) for setting of values for system parameters and question mark (?) for enquiring the actual setting of system parameters. Each input line must be terminated by a CR or LF charac-ter. The data input is provided to operate and control the system. Therefore, only commands for querying and adjust parameters and some control commands are expected. All these expected commands have a limited number of characters. For that reason there is a command line buffer to perform the commands with a depth of only 80 characters implemented. The command line buffer is filled and performed line by line from the serial receiving ring buffer which has a size of 1024 characters. The overflow of the serial receiving buffer and of the command line buffer against incorrect operation is intercepted.

The system offers the possibility to enquire and to adjust various parameters as listed and described in section 4. The command sequences use three-character abbreviations as identifier to specify a special parameter followed by the equals sign and the parameter setting.

Example: SBR=115200   *This sets the **s**erial **b**aud **r**ate to 115200.*

Parameter settings can be enquired by typing the parameter string followed by a question mark. Typing just a question mark without any parameter specified will show all parameter settings.

Example: SBR?   *The **s**erial **b**aud **r**ate of the system is enquired.*

4.2   Serial output

Each output line of system messages of the spinner anemometer system is terminated by a CR LF-sequence. The newline behaviour of the data output channels is adjustable.

4.3   Boot message

When the USonic-3_ClassA_MP Anemometer system starts after a power restart or after a soft reset command first it shows up the output of the boot manager, which is <u>always printed with 57600 baud</u>:

```
-------------------------------------------------
    Flash-Loader V1.33                              version of boot manager
    Date        2017-10-17 14:10:49                 date and time of system
-------------------------------------------------
    The Unique Device Info:
    Description : Class A Multipath RX63N           Ultrasonic type
    Major-ID    : 0x010A                            type identification
    Device-ID   : 0110096856                        Device serial number
    MAC-Address : 70:B3:D5:A6:D0:0E                 MAC address
=================================================
    Current Firmware Info:
    Version     : 010A_011RX                        firmware version number
    Baud Rate   : 115200                            serial baud rate of  application
-------------------------------------------------
```

Then the boot manager waits for five seconds for the input of a sequence of "ZZZ" to start the downloader.

If "ZZZ" is not entered to the system, the boot manager starts the USonic-3_ClassA_MP application after five seconds, the serial baud rate is changed according to the cinfigured parameter settings the boot message is printed out:

```
XSncMP > Class A Multi Path Ultrasonic Anemometer
```

4.4   System messages

System messages are sent from the USonic-3_ClassA_MP Anemometer to the user and respond to commands or enquiries of parameters. Further error messages are reporting about invalid commands or invalid parameter settings.

Every system message consists of 3 text parts separated by space characters:

-     the USonic-3_ClassA_MP identifier: **XSncMP**

      (If the address parameter ADR is
        unequal to zero the identifier will
        be *XSncMPxx* with xx as the address
        of the USonic-3_ClassA_MP Anemometer)

-     the prompt character: **>**

-     the message itself: **SBR=115200**

Possible system messages that might be observed are:

      ABC=value   value of a system parameter.

                                          ABC: identifier of the system parameter

      ? unknown symbol   *response to an unknown command*

? syntax error   *response to an invalid command*

? parameter out-of-range   *response to an invalid parameter value*

? access level too low   *response when trying to start a routine or to adjust a system parameter that needs a higher access level than the current*

? Restart serial transmission after buffer overflow!

this message appears only after an overflow occurred in the internal sending buffer of the serial RS422 interface of the USonic-3_ClassA_MP

? overflow of line buffer: "### . ###"   this message appears if a command line with more than 80 characters was found in the serial receiving buffer

? overflow of serial receive buffer --> Discard whole content !

this message appears if an overflow in the serial receiving buffer has occurred (more than 1024 characters without any CR/LF).

4.5   Prompting of commands

If the parameter EC1 (RS422) or EC2 (network operating port) is set to 1, which is the default value, every command that is sent to the USonic-3_ClassA_MP Anemometer is prompted with:

- the spinner anemometer identifier **XSncMP**   or   **XSncMPxx**
- followed by a   **SPACE** character
- and the ">" character   **>**

The next lines shows some responses to commands, for example:

XSncMP > TZO=120	Setting of time zone offset
XSncMP > SBR? SBR=57600	Enquiring of serial baud rate XSncMP > and system response
XSncMP > ABC? XSncMP > ? unknown symbol	Invalid (unknown) command and system response
XSncMP > SBR=1234 XSncMP > ? parameter out-of-range	Command with invalid value and system response
XSncMP > VNR? XSncMP > VNR=A.11RX	Enquiring of firmware version and system response
XSncMP > DNR? XSncMP > DNR=0110096856	Enquiring the device serial number and system response

5   System operation

The USonic-3_ClassA_MP Anemometer system offers a variety of adjustable parameters in order to optimize system performance and to simplify system operation also for untrained persons. There are also some commands to start some actions (for example collect sensor signal samples or save/restore of parameter sets or to read all available parameters with one command).

The syntax of the parameter adjustment and of the other commands is based on three-bar abbreviations, except for two exceptions. These two exceptions will be explained later in the document.

The parameter and other commands are sorted into several groups of access levels and thus form an access hierarchy. This is in general due to writing access to the parameters. To protect the parameters against unauthorized or unintentional changes a special parameter that is named **KEY** is used. The default value of the parameter KEY is 0. At this level only a very small number of parameters are changeable or of commands are usable. The parameter KEY itself is one of these parameters. There are existing 3 levels of access rights for the user. Each of these levels needs a number for the parameter KEY to reach the appropriate level.

> AlwaysAllowed: KEY=0   (this is the default state)
>
> UserAccesLevel: KEY=1   (for most of the common parameters)
>
> ServiceAccesLevel: KEY=29015 (for installation regarded parameters)

There are two more access levels for really system important parameters but they are reserved for the manufacturer:

> AdminAccessLevel: for device manufacturing and calibration
>
> SuperVisorAccessLevel: for really system important parameters like the unit
>   vector values, the coordinate calculation coefficients etc.

The adjusted value for KEY is retained until one minute after the last operation to the USonic-3_ClassA_MP. After this time its content is automatically reset to 0. The parameter KEY itself is protected against manipulation (e.g. testing of different values for KEY to find the magic numbers for AdminAccessLevel and SuperVisorAccessLevel).

5.1   Querying of parameters

The values of all of the parameters of the USonic-3_ClassA_MP can be retrieved. The general syntax is:

ABC?   ABC: identifier of the parameter   ?: question mark for query

for example:

SFR?   Querying for sampling frequency

XSncMP > SFR?   Echo of the command

XSncMP > SFR=10000   value of parameter SFR

5.2   Parameter adjustment

All system parameters of the USonic-3_ClassA_MP Anemometer are stored in the data flash memory of the used MCU and remain valid after a power failure or reset procedure. There are some additional parameters (e.g. battery voltage, date and time, hardware release …) that looks like usual parameters but they are stored or measured in different ways and they are all ReadOnly. Depending on the parameter the data types can be integer numbers, real numbers and Strings. Real number parameters will always be printed out with a '.' – sign (decimal point) as separator but can be assigned with a ','-sign (comma) too.

If the necessary access level has been set with the parameter KEY before, parameters can be adjusted with the general syntax:

ABC=<value>	ABC	: identifier of the parameter
	=	: equal sign for adjustment
	<value>	: new value for parameter ABC
for example:	KEY=1	set acces level to UserAccessLevel
	XSncMP > KEY=1	echo of command
	OI1=6	set OI1 to 6 (configure instantaneous dataset on RS422 data channel)
	XSncMP > OI1=6	echo of command.

5.2.1   List of all user relevant parameters

Identifier	Meaning	AccessLevel
AEM	Analog Error Mode (for optional analog output)	ServiceAccessLevel
AIN	Switch for instantaneous analog output (optional)	ServiceAccessLevel
AN1	Number of samples for averaging on RS422 data channel	UserAccessLevel
AN2	Number of samples for averaging on network data channel	UserAccessLevel
AN3	Number of samples for averaging for logging on SD-card	UserAccessLevel
AOF	Analog Offset (for optional analog output)	ServiceAccessLevel
AOM	Analog Output Mode (for optional analog output)	ServiceAccessLevel
ART	Analog Range, Temperature (for optional analog output)	ServiceAccessLevel
ARV	Analog Range, Velocity (for optional analog output)	ServiceAccessLevel
ARZ	Analog Range, Z (vertical wind speed for optional analog output)	ServiceAccessLevel
AT1	Averaging interval time for averaging on RS422 data channel	UserAccessLevel
AT2	Averaging interval time for averaging on network data channel	UserAccessLevel

AT3	Averaging interval time for averaging for logging on SD-card	UserAccessLevel
ATV	Analog Test Value (for optional analog output)	ServiceAccessLevel
AZA	Azimuth offset angle related to the north direction	ServiceAccessLevel
BTC	Total number of boot sequences of the USonic_ClassA_MP	Read only
BVT	Battery voltage of the USonic_ClassA_MP	Read only
CAV	Number of coherent averaging of signal samples	UserAccessLevel
DC1	Decimal sign for output on RS422 data channel	UserAccessLevel
DC2	Decimal sign for output on network data channel	UserAccessLevel
DC3	Decimal sign for output for logging on SD-card	UserAccessLevel
DHC	Switch for using of DHCP (Network option)	ServiceAccessLevel
DM1	Delimiter sign for output on RS422 data channel	UserAccessLevel
DM2	Delimiter sign for output on network data channel	UserAccessLevel
DM3	Delimiter sign for output for logging on SD-card	UserAccessLevel
DNA	Device name of the USonic_ClassA_MP (Network option)	ServiceAccessLevel
DNR	Device number of the USonic_ClassA_MP (serial number)	Read only
DNS	IP adress of the DNS server (Network option)	ServiceAccessLevel
DOP	Device options of the USonic_ClassA_MP	Read only
DPN	Port number of network data port (Network optiuon)	ServiceAccessLevel
DPW	Password for user: **data**	ServiceAccessLevel
DTI	Date and time of the USonic_ClassA_MP	UserAccessLevel
EC1	Switch for echoing commands on the RS422 operating channel	UserAccessLevel
EC2	Switch for echoing commands on the network operating port	UserAccessLevel
FR1	Switch for "framing" of output data lines on RS422 data channel	UserAccessLevel
FR2	Switch for "framing" of output data lines on TCP/IP data port	UserAccessLevel
FR3	Switch for "framing" of output data lines for storing on SD card	UserAccessLevel
GWY	IP adress of the gateway to internet	ServiceAccessLevel
HTM	Heating operating mode (heating option)	ServiceAccessLevel
HWR	Harware release number	Read only
IPA	IP address of the USonic_ClassA_MP	ServiceAccessLevel
KEY	Acces level parameter	AlwaysAllowed
LBT	Last boot time of the USonic_ClassA_MP	Read only
LCT	Time of last sensor calibration of the USonic_ClassA_MP	Read only
MAC	MAC address of the USonic_ClassA_MP	Read only
MTD	Maximum allowed temperature difference of single paths temperatures	ServiceAccessLevel
NB1	Newline behavior for data output on RS422 data channel	UserAccessLevel
NB2	Newline behavior for data output on network data channel	UserAccessLevel
NB3	Newline behavior for data output for logging on SD-card	UserAccessLevel
OD1	Control parameter for output of averaged data on RS422 data channel	UserAccessLevel
OD2	Control parameter for output of averaged data on network data channel	UserAccessLevel
OD3	Control parameter for output of averaged data for logging on SD-card	UserAccessLevel
OI1	Control parameter for output of instantaneous data on RS422 data channel	UserAccessLevel
OI2	Control parameter for output of instantaneous data on network data channel	UserAccessLevel
OI3	Control parameter for output of instantaneous data for logging on SD-card	UserAccessLevel
OPN	Port number of operating network port	ServiceAccessLevel
NLC	Switch for login procedure on network command port	ServiceAccessLevel
NLD	Switch for login procedure on network data port	ServiceAccessLevel
NT0	IP-adress of remote NTP time server	ServiceAccessLevel

NTP	Switch for activating the NTP	ServiceAccessLevel
PN0	Name of current paramter set	ServiceAccessLevel
PN1	Name of saved parameter set in bank 1	ServiceAccessLevel
PN2	Name of saved parameter set in bank 2	ServiceAccessLevel
PN3	Name of saved parameter set in bank 2	ServiceAccessLevel
PR1	Protocol parameter for dataset on RS422 data channel	UserAccessLevel
PR2	Protocol parameter for dataset on network data channel	UserAccessLevel
PR3	Protocol parameter for dataset for logging on SD-card	UserAccessLevel
SBR	Baudrate on RS422 serial interface	ServiceAccessLevel
SFR	Internal sampling frequency of the USonic_ClassA_MP	UserAccessLevel
SNR	Serial number of the USonic_ClassA_MP	Read only
SPW	Password for user: **service**	ServiceAccessLevel
SUB	IP subnet mask of USonic_ClassA_MP	ServiceAccessLevel
SY1	Switch for synchronized output of averaged data on RS422 data channel	UserAccessLevel
SY2	Switch for synchronized output of averaged data on network data channel	UserAccessLevel
SY3	Switch for synchronized output of averaged data for logging on SD-card	UserAccessLevel
SO1	Offset for synchronized output of averaged data on RS422 data channel	UserAccessLevel
SO2	Offset for synchronized output of averaged data on network data channel	UserAccessLevel
SO3	Offset for synchronized output of averaged data for logging on SD-card	UserAccessLevel
TMD	Trigger mode for measuring (free running or external triggered)	ServiceAccessLevel
TYP	Type of USonic device	Read only
TZO	Time zone	UserAccessLevel
VNR	Version number of firmware of USonic_ClassA_MP	Read only
VTS	Creation date and time of firmware	Read only

5.2.2 Setting of KEY-parameter

Identifier   meaning / action

KEY access level for parameter access and commands

write access level:	AlwaysAllowed	
data type:	integer	
unit:	[ ]	
allowed values:	0, 1, 29015	
	<AdminAccessLevel>,	(actual value not documented)
	<SuperVisorAccessLevel>	(actual value not documented)
Default:	0	
Note:	After one minute without operation the value of KEY is automatically reset to 0 !	

5.2.3 Setting of parameters with UserAccessLevel (KEY=1)

Identifier   meaning / action

AN1 number of samples for averaging on RS422 data channel.

write access level:	UserAccesLevel
data type:	integer
unit:	[ ]
allowed values:	1 … 65535
Default:	1
Note:	The value of AN1 is used only if the corresponding averaging interval time AT1 is set to 0 !
	The resulting frequency for averaged output depends on RS422 data channel depends on:
	The sampling frequency SFR, the number of coherent averaging CAV and AN1: $fa1 = SFR/(1000*CAV*AN1)$

AN2 number of samples for averaging on network data channel.

write access level:	UserAccesLevel
data type:	integer
unit:	[ ]
allowed values:	1 … 65535
Default:	1
Note:	The value of AN2 is used only if the corresponding
	Averaging interval time AT2 is set to 0 !
	The resulting frequency for averaged output depends on
	The sampling frequency SFR, the number of coherent
	averaging CAV and AN2: $fa2 = SFR/(1000*CAV*AN2)$

AN3 number of samples for averaging for logging on SD-card

write access level:	UserAccesLevel
data type:	integer
unit:	[ ]
allowed values:	1 … 65535
Default:	1
Note:	The value of AN3 is used only if the corresponding
	Averaging interval time AT3 is set to 0 !
	The resulting frequency for averaged output depends on
	The sampling frequency SFR, the number of coherent
	averaging CAV and AN3: $fa3 = SFR/(1000*CAV*AN3)$

AT1 Interval length time for averaging on RS422 data channel.

write access level:	UserAccesLevel
data type:	integer
unit:	[seconds]
allowed values:	0 … 3600
Default:	10

Note: If the value AT1 is set to 0 the parameter AN1 is used for
                            averaging.

                            The resulting frequency for averaged output on RS422
                            data channel is: $fa1 = 1/AT1$.

AT2 Interval length time for averaging on network data channel.

   write access level: UserAccesLevel

   data type: integer

   unit: [seconds]

   allowed values: 0 … 3600

   Default: 10

   Note: If the value AT2 is set to 0 the parameter AN2 is used for
                            averaging.

                            The resulting frequency for averaged output on RS422
                            data channel is: $fa2 = 1/AT2$.

AT3 Interval length time for logging of averaged data on SD-card.

   write access level: UserAccesLevel

   data type: integer

   unit: [seconds]

   allowed values: 0 … 3600

   Default: 10

   Note: If the value AT3 is set to 0 the parameter AN3 is used for
                            averaging.

CAV Number of coherant averaging of sensor signal samples.

   write access level: UserAccesLevel

   data type: integer

   unit: [ ]

   allowed values: 1 … 30

   Default: 1

   Note: CAV can be used for applications with high wind speeds.

The coherent averaging of signal samples reduces turbulences in the sensor signals.

The resulting frequency for instantaneous data output is

fI = SFR / (CAV * 1000) and must be a minimum of 1 Hz!

DC1 Decimal sign for output on RS422 data channel

write access level:	UserAccesLevel
data type:	ASCII-char
unit:	[ ]
allowed values:	'.' or ','
Default:	'.'
Note:	DC1 will only affect the data output on RS422 data channel and must not be the delimiter sign of that data channel.
	The decimal sign on the RS422 command interface is always a '.' !

DC2 Decimal sign for data output on network data channel

write access level:	UserAccesLevel
data type:	ASCII-char
unit:	[ ]
allowed values:	'.' or ','
Default:	'.'
Note:	DC2 will only affect the data output on network data channel and must not be the delimiter sign of that data channel.
	The decimal sign on the network command interface is always a '.' !

DC3 Decimal sign for data output on network data channel

    write access level: UserAccesLevel

    data type: ASCII-char

    unit: [ ]

    allowed values: '.' or ','

    Default: '.'

    Note: DC3 will only affect the data output for logging on SD-card and must not be the delimiter sign of that data channel.

DM1 Delimiter sign for data output on RS422 data channel

    write access level: UserAccesLevel

    data type: ASCII-char

    unit: [ ]

    allowed values: Any visible sign but not the decimal sign !

    Default: ';'

    Note: DM1 is used to separate measurands within the data telegram on RS422 data channel.

DM2 Delimiter sign for data output on network data channel

    write access level: UserAccesLevel

    data type: ASCII-char

    unit: [ ]

    allowed values: Any visible sign but not the decimal sign !

    Default: ';'

    Note: DM2 is used to separate measurands within the data telegram on network data channel.

DM3 Delimiter sign for data output for logging on SD-card

    write access level: UserAccesLevel

    data type: ASCII-char

    unit: [ ]

allowed values:	Any visible sign but not the decimal sign !
Default:	';'
Note:	DM3 is used to separate measurands within the data telegram

DTI Date and time of the USonic-3_ClassA_MP

write access level:	UserAccesLevel
data type:	Time string
unit:	[ ]
allowed format:	yyyy-mm-dd hh:MM:ss
	(year-month-day hour:minute:second)
example:	2017-10-20 13:47:30

EC1 Switch for echoing commands on the RS422 operating channel

write access level:	UserAccesLevel
data type:	integer
unit:	[ ]
allowed values:	0, 1
Default:	1
Note:	switching off the command echo on the RS422 command interface with EC1=0 might be useful for operating on a RS485 bus.

EC2 Switch for echoing commands on the network operating channel

write access level:	UserAccesLevel
data type:	integer
unit:	[ ]
allowed values:	0, 1
Default:	1

FR1 Switch for framing of output data lines on RS422 data channel

    write access level: UserAccesLevel

    data type: integer

    unit: [ ]

    allowed values: 0, 1

    Default: 0

    Note: See chapter 6.1.6 for description of framing

FR2 Switch for framing of output data lines on network data channel

    write access level: UserAccesLevel

    data type: integer

    unit: [ ]

    allowed values: 0, 1

    Default: 0

    Note: See chapter 6.1.6 for description of framing

FR3 Switch for framing of output data lines for storing on SD card

    write access level: UserAccesLevel

    data type: integer

    unit: [ ]

    allowed values: 0, 1

    Default: 0

    Note: See chapter 6.1.6 for description of framing

NB1 Newline behavior for data output on the RS422 data channel

    write access level: UserAccesLevel

    data type: integer

    unit: [ ]

    allowed values: 1=CR, 2=LF, 3=CRLF

    Default: 3 (CRLF)

Note: NB1 affects the newline behavior on the RS422 data channel only. Output lines on the RS422 command interface are always terminated with CRLF !

NB2 Newline behavior for data output on the network data channel

write access level: UserAccesLevel

data type: integer

unit: [ ]

allowed values: 1=CR, 2=LF, 3=CRLF

Default: 3 (CRLF)

Note: NB2 affects the newline behaviour on the network data channel only. Output lines on the network command interface are always terminated with CRLF !

NB3 Newline behavior for data output for logging on SD-card

write access level: UserAccesLevel

data type: integer

unit: [ ]

allowed values: 1=CR, 2=LF, 3=CRLF

Default: 3 (CRLF)

OD1 Control parameter for output of averaged data on the RS422 data channel

write access level: UserAccesLevel

data type: integer, bit code

unit: [ ]

allowed values: 0 or any combination of the bit values 1, 2, 4, 8, 16, 32, 64 and 128

Default: 0

Note: OD1 is interpreted as a bit field while every bit represents a particular group of output measurands. The meaning of every bit value is described later in this document.

OD2 Control parameter for output of averaged data on the network data channel

write access level: UserAccesLevel

data type: integer, bit code

unit: [ ]

allowed values: 0 or any combination of the bit values 1, 2, 4, 8, 16, 32, 64 and
                          128

Default: 0

Note: OD2 is interpreted as a bit field while every bit represents a
                          particular group of output measurands. The meaning of every bit
                          value is described later in this document.

OD3 Control parameter for output of averaged data for logging of on SD-card

write access level: UserAccesLevel

data type: integer, bit code

unit: [ ]

allowed values: 0 or any combination of the bit values 1, 2, 4, 8, 16, 32, 64 and
                          128

Default: 0

Note: OD3 is interpreted as a bit field while every bit represents a
                          particular group of output measurands. The meaning of every bit
                          value is described later in this document.

OI1 Control parameter for output of instantaneous data on the RS422 data channel

write access level: UserAccesLevel

data type: integer, bit code

unit: [ ]

allowed values: 0 or any combination of the bit values 1, 2, 4, 8, 16, 32, 64 and
                          128

Default: 0

Note: OI1 is interpreted as a bit field while every bit represents a
                          particular group of output measurands. The meaning of every bit
                          value is described later in this document.

OI2   Control parameter for output of instantaneous data on the network data channel

write access level:	UserAccesLevel
data type:	integer, bit code
unit:	[ ]
allowed values:	0 or any combination of the bit values 1, 2, 4, 8, 16, 32, 64 and 128
Default:	0
Note:	OI2 is interpreted as a bit field while every bit represents a particular group of output measurands. The meaning of every bit value is described later in this document.

Identifier   meaning / action

OI3   Control parameter for output of instantaneous data for logging of on SD-card

write access level:	UserAccesLevel
data type:	integer, bit code
unit:	[ ]
allowed values:	0 or any combination of the bit values 1, 2, 4, 8, 16, 32, 64 and 128
Default:	0
Note:	OI3 is interpreted as a bit field while every bit represents a particular group of output measurands. The meaning of every bit value is described later in this document.

PR1   Protocol parameter for data format of instantaneous and averaged data on RS422 data channel

write access level:	UserAccesLevel
data type:	integer
unit:	[ ]
allowed values:	1 (ASCII), 2 (binary)
Default:	1

Note: PR1 is provided to select between different data formats.

So far two variants have been implemented!

PR2 Protocol parameter for data format of instantaneous and averaged data on network data channel

write access level:	UserAccesLevel
data type:	integer
unit:	[ ]
allowed values:	1 (ASCII), 2 (binary)
Default:	1
Note:	PR2 is provided to select between different data formats. So far two variants have been implemented!

PR3 Protocol parameter for data format of instantaneous and averaged data for logging on SD-card

write access level:	UserAccesLevel
data type:	integer
unit:	[ ]
allowed values:	1 (ASCII), 2 (binary)
Default:	1
Note:	PR3 is provided to select between different data formats. So far two variants have been implemented!

SFR Internal sampling frequency of the interrupt driven measuring routine.

write access level:	UserAccesLevel
data type:	integer
unit:	[1/1000 Hz]
allowed values:	100, 125, 200, 250, 500, 1000, 2000, 2500, 3000, 4000, 5000, 6000, 7500, 8000, 10000, 12500, 15000, 16000, 20000, 24000, 25000, 30000
Default:	10000

Note: SFR/1000 is the maximum instantaneous data output rate on
                         every of the three data channels. If CAV>1 is used for coherent
                         averaging of the sensor signal samples the resulting output rate
                         will be: fI = SFR / (CAV*1000) !

SY1 Switch for time synchronized output of averaged data on the RS422 data channel

write access level: UserAccesLevel

data type: integer

unit: [ ]

allowed values: 0, 1

Default: 1

Note: If SY1 is switched to 1 and the averaging interval length is
                         adjusted for example to 600 than averaged data are determined
                         and printed out to every full 600 seconds (10 minutes) limit of
                         the USonic-3_ClassA_MP RTC.

SY2 Switch for time synchronized output of averaged data on the network data channel

write access level: UserAccesLevel

data type: integer

unit: [ ]

allowed values: 0, 1

Default: 1

Note: If SY1 is switched to 1 and the averaging interval length is
                         adjusted for example to 600 than averaged data are determined
                         and printed out to every full 600 seconds (10 minutes) limit of
                         the USonic-3_ClassA_MP RTC.

SY3 Switch for time synchronized output of averaged data for logging on SD-card

write access level:	UserAccesLevel
data type:	integer
unit:	[ ]
allowed values:	0, 1
Default:	1
Note:	If SY3 is switched to 1 and the averaging interval length is adjusted for example to 600 than averaged data are determined and written to the SD-card to every full 600 seconds (10 minutes) limit of the USonic-3_ClassA_MP RTC.

SO1 Offset for time synchronized output of averaged data on the RS422 data channel

write access level:	UserAccesLevel
data type:	integer
unit:	[seconds]
allowed values:	0 … AT1
Default:	0
Note:	In addition to SY1 SO1 can be used to time shift calculation and output of averaged data within the averaging interval. If for example AT1 is adjusted to 600 and SY1 is adjusted to 480, than averaged data will be printed out to every hh:x8 minute.

SO2 Switch for time synchronized output of averaged data on the network data channel

write access level:	UserAccesLevel
data type:	integer
unit:	[seconds]
allowed values:	0 … AT2
Default:	0
Note:	In addition to SY2 SO2 can be used to time shift calculation and output of averaged data within the averaging interval. If for example AT2 is adjusted to 600 and SY1 is adjusted to 480, than averaged data will be printed out to every hh:x8 minute.

SO3   Switch for time synchronized output of averaged data for logging on SD-card

write access level:	UserAccesLevel
data type:	integer
unit:	[seconds]
allowed values:	0 … AT3
Default:	0
Note:	In addition to SY3 SO3 can be used to time shift calculation and logging of averaged data within the averaging interval. If for example AT3 is adjusted to 600 and SY3 is adjusted to 480, than averaged data will be logged to every hh:x8 minute.

TZO   Time zone of the USonic-3_ClassA_MP

write access level:	UserAccesLevel
data type:	integer
unit:	[hours or minutes]
allowed values:	-12 … 12 (hours) or
	-720 … 720 (minutes; in steps of 30!)
Default:	+01
Note:	TZO is an additional information for the usage with time stamps of the USonic-3_ClassA_MP. TZO can be adjusted in hours or minutes. The time zone within time stamps is always used in the format ±hh[mm] (minutes only if necessary).

5.2.4   Setting of parameters with ServiceAccessLevel (KEY=29015)

Parameters with ServiceAccessLevel requires more knowledge about installation and system integration of the USonic-3_ClassA_MP. This is why they have a higher level of access rights.

AEM   Analog Error Mode for analog output   (option)

write access level:	ServiceAccesLevel
data type:	integer
unit:	[°]

allowed values:	0:	the last true value will be hold
	1:	(maximum value * AOF)/100
	2:	(maximum value * AOF)/200
	3:	maximum value
Default:	0	

AIN Switch for instantaneous analog output   (option)

write access level:	ServiceAccesLevel
data type:	integer
unit:	[ ]
allowed values:	0, 1
Default:	0
Note:	If AIN is set to 1 the 4 analog output ports C1 … C4 will be refreshed with every new set of instantaneous data.
	See 7. Analog output of data

AOF Analog offset value   (option)

write access level:	ServiceAccesLevel
data type:	integer
unit:	[%]
allowed values:	0 … 50
Default:	0
Note:	The percentage analog offset value defines a range which will not be used for normal data output but can be used for error representation. See 7.2.1 for detailed information

AOM Analog Output Mode   (option)

write access level:	ServiceAccesLevel
data type:	integer
unit:	[ ]
allowed values:	0:	no analog output
	1:	analog output of x, y, z, t

2:	analog output of vel, dir, z, t
3:	analog output of vel, dirh (with hysteresis), z, t
32:	analog output of test values

Default: 0

Note: See 7.2.3 for detailed information

ART Analog Range for analog temperature output   (option)

write access level:	ServiceAccesLevel
data type:	integer
unit:	[1/100 °C]
allowed values:	0 … 6000
Default:	0
Note:	The temperature range from
	(+10°C-ART/100) … (+10°C+ART/100)
	will be display to the analog output range from
	maximum value *AOF/100 … maximum value.
	See 7.2.2 for detailed information

ARV Analog Range for analog horizontal windspeed output   (option)

write access level:	ServiceAccesLevel
data type:	integer
unit:	[cm/sec.]
allowed values:	0 … 6000
Default:	6000
Note:	ARV is used to scale the analog output of x, y and vel.
	The output range for x and y will be: ±ARV/100.
	The output range for vel will be 0 … ARV/100.
	See 7.2.2 for detailed information

ARZ Analog Range for analog vertical windspeed output   (option)

write access level:	ServiceAccesLevel
data type:	integer
unit:	[cm/seconds]
allowed values:	0 … 6000
Default:	100
Note:	ARZ is used to scale the analog output of only z.
	The output range for z and y will be: ±ARV/100.
	See 7.2.2 for detailed information

ATV Analog test value(s)   (option)

write access level:	ServiceAccesLevel
data type:	integer
unit:	[%]
allowed values:	0 … 100(%) for percentage output of analog values on all of the 4 analog output ports C1 … C4.
	101 for graded output on analog output ports C1 … C4 (25%, 50%, 75%, 100%)
Default:	0
Note:	The analog offset value AOF must be taken into account!
	See 7.2.3 for detailed information

AZA Azimuth offset angle of the USonic-3_ClassA_MP related to the north direction

write access level:	ServiceAccesLevel
data type:	integer
unit:	[°]
allowed values:	0 … 359
Default:	0
Note:	The azimuth offset angle AZA is used to calculate the wind direction.

DHC Switch for DHCP (network option)

write access level: ServiceAccesLevel

data type: integer

unit: [ ]

allowed values: 0, 1

Default: 0

Note: If DHC is set to 0 an IP address as defined by the parameter IPA
                         used. If DHC is set to 1 the IP address is determined and send
                         by the DHCP server of the network.

DNA Device name of the USonic-3_ClassA_MP (network option)

write access level: ServiceAccesLevel

data type: string

unit: [ ]

allowed values: 0, 1

Default: uSonic-3_ClassA_MP_*0123456789*

                         (*01232456789* is the device serial number)

DNS IP address of the DNS server of the network (network option)

write access level: ServiceAccesLevel

data type: IP address string

unit: [ ]

allowed values: Any valid IP4 address

Default: 192.168.178.254

DPN Port number of the network data port (network option)

write access level: ServiceAccesLevel

data type: integer

unit: [ ]

allowed values: 5000 … 65535, but not OPN or 50021 !

Default: 5001

DPW Password for user *data* (network option)

write access level:	ServiceAccesLevel
data type:	string
unit:	[ ]
allowed values:	any visible string with up to 15 Byte length
Default:	MetekGmbH

GWY IP address of the gateway to internet of the network (network option)

write access level:	ServiceAccesLevel
data type:	IP address string
unit:	[ ]
allowed values:	Any valid IP4 address
Default:	192.168.178.247
Note:	The gateway IP address might be useful for NTP synchronization

HTM Heating mode of the USonic-3_ClassA_MP (heating option)

write access level:	ServiceAccesLevel		
data type:	integer		
unit:	[ ]		
allowed values:	0	:	heating off
	1	:	heating on
	2	:	heating automatically controlled regarding ambient temperature.
	3	:	heating automatically controlled regarding ambient temperature and data quality.
Default:	0		

IPA IP address of the USonic-3_ClassA_MP (network option)

write access level:	ServiceAccesLevel
data type:	IP address string
unit:	[ ]

allowed values:	Any valid IP4 address
Default:	192.168.178.123

MTD Maximum allowed temperature difference of single paths temperatures

write access level:	ServiceAccesLevel
data type:	RealType
unit:	[°]
allowed values:	0.0 … 25.0
Default:	5.0
Note:	MTD is used to check the data quality of every of the 9 measuring path. The measured temperature of every of the 9 paths is compared to the average of the last 10 valid temperature measurements of the USonic-3_ClassA_MP. MTD defines which difference is allowed. MTD should be changed only for trouble shooting and very carefully!

NLC Switch for login on network command port

write access level:	ServiceAccesLevel
data type:	integer
unit:	[ ]
allowed values:	0, 1
Default:	1
Note:	If NLC is set to 0 (OFF) it is no longer necessary to log in to the network command port.

NLD Switch for login on network data port

write access level:	ServiceAccesLevel
data type:	integer
unit:	[ ]
allowed values:	0, 1
Default:	1

Note: If NLD is set to 0 (OFF) it is no longer necessary to log in to the network data port.

NT0 IPv4-Address of the remote NTP-server

write access level: ServiceAccesLevel

data type: IP address string

unit: [ ]

allowed values: Any valid IP4 address

Default: 178.63.9.212

Note: See 9.3 for further information

NTP Switch for enabling/disabling of synchronization of time during the boot procedure

write access level: ServiceAccesLevel

data type: integer

unit: [ ]

allowed values: 0, 1

Default: 0

Note: See 9.3 for further information

OPN Port number of the network data port (network option)

write access level: ServiceAccesLevel

data type: integer

unit: [ ]

allowed values: 5000 … 65535, but not DPN or 50021 !

Default: 5000

PN0 Name of the current parameter set of the USonic-3_ClassA_MP

write access level: ServiceAccesLevel

data type: string

unit: [ ]

allowed values: any visible string with up to 31 Byte length

Default: Default parameter set

PN1 Name of the parameter set, saved in parameter bank1 of the USonic-3_ClassA_MP

write access level: ServiceAccesLevel

data type: string

unit: [ ]

allowed values: any visible string with up to 31 Byte length

Default:

PN2 Name of the parameter set, saved in parameter bank2 of the USonic-3_ClassA_MP

write access level: ServiceAccesLevel

data type: string

unit: [ ]

allowed values: any visible string with up to 31 Byte length

Default:

PN3 Name of the parameter set, saved in parameter bank3 of the USonic-3_ClassA_MP

write access level: ServiceAccesLevel

data type: string

unit: [ ]

allowed values: any visible string with up to 31 Byte length

Default:

SBR Serial baud rate on RS422 data and operating channel

write access level: ServiceAccesLevel

data type: integer

unit: [Bits per second]

allowed values: 4800, 9600, 19200, 38400, 57600, 115200, 230400

Default: 57600

SPW Password for user *service* (network option)

write access level:	ServiceAccesLevel
data type:	string
unit:	[ ]
allowed values:	any visible string with up to 15 Byte length
Default:	8189035

SUB IP subnet mask of the USonic-3_ClassA_MP (network option)

write access level:	ServiceAccesLevel
data type:	IP address string
unit:	[ ]
allowed values:	Any meaningful IP4 address mask
Default:	255.255.255.0

TMD Switch for external triggering of the USonic-3_ClassA_MP measurements

write access level:	ServiceAccesLevel
data type:	integer
unit:	[ ]
allowed values:	0, 1
Default:	0
Note:	If TMD is set to 0 (default) the USonic-3_ClassA_MP is running free and the measurements are triggered automatically by an internal state machine depending on the parameter SFR.
	If otherwise TMD is set to 1 the USonic-3_ClassA_MP waits for an external digital pulse (TTL) to start one cycle of measurement. In that case the parameter SFR doesn't play a role.

5.2.5 Read only parameters

There are a number of parameters that are only readable but not adjustable.

BTC Boot count of the USonic-3_ClassA_MP

write access level:	ReadOnly
data type:	integer
unit:	[ ]
allowed values:	1
meaning / action	

BVT Battery voltage of the USonic-3_ClassA_MP

write access level:	ReadOnly
data type:	integer
unit:	[mV]
allowed values:	0 … 4000 (3600mV is the nominal voltage)

DNR Device serial number of the USonic-3_ClassA_MP

write access level:	ReadOnly
data type:	string
unit:	[ ]
allowed values:	10 numerical digits
Note:	The device serial number is programmed by the manufacturer of the USonic-3_ClassA_MP and stored in a secured area of the data flash of the MCU.

DOP Device options of the USonic-3_ClassA_MP

write access level:	ReadOnly
data type:	integer[] field of 32-Bit values
unit:	[ ]
example:	2017-10-18 09:47:03 : DO1=0x00000fff

Note: The device options are programmed by the manufacturer of the USonic-3_ClassA_MP and stored in a secured area of the data flash of the MCU. The device options determine the capabilities of the USonic-3_ClassA_MP (for example network option)

HWR Hardware release of the USonic-3_ClassA_MP

write access level: ReadOnly

data type: integer

unit: [ ]

allowed values: 10 … 25

Note: The hardware release of the USonic-3_ClassA_MP is the revision number of the used electronic board and it is defined by the board itself.

LBT Last boot time of the USonic-3_ClassA_MP

write access level: ReadOnly

data type: time string

unit: [ ]

example: 2017-10-20 09:24:52

LCT Time of last sensor calibration of the USonic-3_ClassA_MP

write access level: ReadOnly

data type: time string

unit: [ ]

example: 2017-10-18 12:04:57

MAC MAC address of the USonic-3_ClassA_MP (network option)

write access level: ReadOnly

data type: MAC address string

unit: [ ]

example: 0X70;B3;D5;A6;D0;04

SNR   Serial number of the USonic-3_ClassA_MP

write access level:	ReadOnly
data type:	string
unit:	[ ]
allowed values:	10 numerical digits
Note:	The serial number is programmed by the manufacturer of the USonic-3_ClassA_MP and stored in a secured area of the data flash of the MCU.
	In case of the USonic-3_ClassA_MP the serial number SNR and the device serial number DNR are the same.

TYP   Type of the USonic

write access level:	ReadOnly
data type:	string
unit:	[ ]
content:	Metek USonic-3 ClassA MP

VNR   Version number of the firmware of the USonic-3_ClassA_MP

write access level:	ReadOnly
data type:	string
unit:	[ ]
example:	A.11RX
Note:	The version number of the firmware is part of the firmware and it is set by the developers of the USonic-3_ClassA_MP software.

VTS   Creation date of the firmware of the USonic-3_ClassA_MP

write access level:	ReadOnly
data type:	time string
unit:	[ ]
example:	2017-10-20 08:49:57

Note: The creation date of the firmware of the USonic-3_ClassA_MP

is set when the firmware is compiled by the IDE.

5.3   Control Commands

Besides of the parameter settings there are further commands which control the general system performance or inform about the system status. These commands are defined similar to the parameter settings by three-characters, but they do not define any values.

5.3.1   List of all user relevant commands

Identifier	Meaning	AccessLevel
?	List of all parameters related to the current access level	AlwaysAllowed
??	List of all parameters of the USonic_ClassA_MP in a comprehensive form	AlwaysAllowed
CSS	Capture one set of all sensor signal samples for analyzing	ServiceAccessLevel
LI1	List identifier line before next data line on RS422 data channel	AlwaysAllowed
LI2	List identifier line before next data line on network data channel	AlwaysAllowed
LI3	List identifier line before next data line for logging on SD-card	AlwaysAllowed
PSS	Print out captured sensor signal samples	ServiceAccessLevel
RP1	Restore current parameter set from save bank 1	ServiceAccessLevel
RP2	Restore current parameter set from save bank 2	ServiceAccessLevel
RP3	Restore current parameter set from save bank 3	ServiceAccessLevel
RP4	Restore current parameter set from SD card	ServiceAccessLevel
RST	Soft RESET of the USonic-3_ClassA_MP	UserAccessLevel
RTE	RAM test of the additional external RAM	ServiceAccessLevel
SP1	Save current parameter set into save bank 1	ServiceAccessLevel
SP2	Save current parameter set into save bank 2	ServiceAccessLevel
SP3	Save current parameter set into save bank 3	ServiceAccessLevel
SP4	Save current parameter set on the SD card	ServiceAccessLevel

5.3.2   Always allowed commands

?   read out all parameters of the USonic-3_ClassA_MP and print it out in a short listed form.

>   Note: only parameters are listed which are ReadOnly or which access rights are less than or equal to the current content of KEY!

??   read out all parameters and commands of the USonic-3_ClassA_MP and print it out in a comprehensive form.

LI1   List data identifier line before the next data line on RS422 data channel.

LI2   List data identifier line before the next data line on network data channel.

LI3   List out data identifiers before the next data line for logging on SD-card.

5.3.3   Commands with UserAccessLevel (KEY=1)

RST   Soft reset of the USonic-3_ClassA_MP

5.3.4   Commands with ServiceAccessLevel (KEY=29015)

CSS   Capture one set of all sensor signal samples of USonic-3_ClassA_MP for analyzing.

PSS   Print out captured sensor signal samples of the USonic-3_ClassA_MP

RP1   Restore current parameter set from saved parameter set in parameter bank1

RP2   Restore current parameter set from saved parameter set in parameter bank2

RP3   Restore current parameter set from saved parameter set in parameter bank3

RP4   Restore current parameter set from saved parameter set on SD card

SP1   Save current parameter set in parameter save bank1

SP2   Save current parameter set in parameter save bank2

SP3   Save current parameter set in parameter save bank3

SP4   Save current parameter set onto SD card

6   Data format and selection of Data Output Variables

For each of the three available data output channels a corresponding parameter PR# is provided to select the protocol variant. That means the type of the used data telegrams. Up to now only two types of protocol are realized. An ASCII data protocol and a binary data protocol.

6.1   ASCII data output (PR#=1)

The structure of the data telegrams for PR#=1 is as follows:

The data telegram of instantaneous and of averaged data is configurable by the user. To select one or more of the possible groups of meaningfully combined measured values control values are used. These values are assigned to bit values. To configure the data telegram for instantaneous data the parameter OI# can be used. For averaged data it is the parameter OD#.   (OI#; #: 1,2,3) / (OD#; #: 1,2,3)

The indexing # is used to select one of three possible data output channels, where:

1   the serial RS422 output line,   (PR1, OI1, OD1)

2   the network data port (TCP/IP socket) and   (PR2, OI2, OD2)

3   the storing of data on an internal data logger means. (PR3, OI3, OD3)

Control values for output of instantaneous resp. averaged measured values (OI#; #: 1,2,3) / (OD#; #: 1,2,3)

In general each group of meaningfully combined measured values is assigned to one control bit. These bits can be combined almost arbitrarily. The value of the control bit determines the sequence of the groups of measured values in the data telegram, where groups with lower value control bits are at the beginning of the telegram and with higher value control bits more to the end of the telegram. There are control bits with the values 1, 2, 4, 8, 16, 32, 64 and 128. They have the same meaning for instantaneous and for averaged data. The assembly of a specific data telegram means adding of these control bit values.

The data telegram consists of ASCII characters and are printed out in form of single data lines. Between the single measured values, that are printed out, a configurable ASCII-character is used as delimiter. The data telegram line ends with one or two configurable NEWLINE characters. The data telegram contains no identifiers and no blanks (excepting in the time stamp) !

6.1.1 Combined type- and status information

Every printable data line, that means OI# resp. OD# is unequal to zero, contains a combined type and status information. This is independent of the adjustment of OI# resp. OD#. If the data telegram contains a time stamp the status information is printed out directly after the time stamp (separated by a configurable separator sign). In cases with no time stamp the data telegram starts with the status information.

The combined type- and status information builds up as follows:

2 characters, protocol value, here: 01 (Protocol variant)

1 character, data type: ‚0' for instantaneous data and ‚1' for averaged data

5 digits number, data composition   The number with leading zeros is generated as

$$a \cdot 1 + b \cdot 2 + c \cdot 4 + d \cdot 8 + e \cdot 16 + f \cdot 32 + g \cdot 64 + h \cdot 128$$

Each letter assumes the values 0 or 1 and stands for the selection of data

that are described in 6.1.2. "1" means "selected", "0" means "not selected".

2 characters, heating status, consisting of:

Heating operation mode	0 : always OFF;
	1 : always ON;
	2 : automatic, controlled by temperature;
	3 : as for 2, but also controlled data quality;
Heating state:	0 : switched off;
	1 : switched on and operational;
	2 : switched on and faulty;
1 character, state of the sensor paths:	0 … 9, shows how many of the 9 paths were unusable;

3 characters, state of all sensor paths;   001 … 100, percentage of failed radial components

in relation to all tries (with leading

zeroes), helpful in case of #OD,

redundant in case of #OI.

Examples of combined type and status information: (14 characters)

010xxxxx113033:   instantaneous values, telegram control value = xxxxx, heating is

always switched on and is fine, 3 radial components (033%) were

not usable.

011xxxxx220000 :   averaged values, telegram control value = xxxxx, heating in automatic

mode, just switched on and defective!, all of the radial components

were usable,   000% of the complete averaging interval failed.

011xxxxx211002 :   averaged values, telegram control value = xxxx, heating in automatic

mode, just switched on and fine, one radial component was, at least

temporarily not usable to 002% of all radial components of the

averaging interval.

011xxxxx003019 :   averaged values, telegram control value = xxxxx, heating always

switched off (and just switched off), three radial componenst were, at

least temporarily not usable. 019% of all radial components of the

averaging interval could not be used for further evaluation.

For a more accurate error analysis it is possible, in case of need, to select a more comprehensive status as part of the data telegram (see following table "128, Extended Status")

6.1.2   Configuration of the data set

<u>Control bit values for configuration of the data telegram</u>:

$a \cdot 1$:   Time stamp in format of: yyyy-mm-dd HH:MM:SS;mmm;UTC±HHMM

e.g..: ***2016-09-29 16:01:47;123;UTC+0200***   means

September, 29th in 2016 16:01:47; 123 milliseconds; time zone = UTC+2hours (MESZ)

The eparator between HH:MM:SS and the milliseconds and between the milliseconds and the   time zone corresponds to the configurable separator sign (in this example „;" semicolon).

If the time stamp is selected as part of the data telegram, directly after that the combined type- and status information follows, separated by the separator character. Otherwise it is printed at the   beginning of the data telegram!

$b \cdot 2$:   Radial wind components (9 values);   [m/sec.; x.3f]

$c \cdot 4$:   Radial temperatures (9 values);   [°C; x.3f]

$d \cdot 8$:   Voltages of the inclinometer/compass (3 values)   [V;x.3f]
              ADC inputs 1, 2 a. 3
              (Sequence: Roll, pitch, azimuth; azimuth not yet realized)

$e \cdot 16$:   Analog voltages of ADC inputs 4, 5, 6, 7 u. 8   [V;x.3f] upgrade-option

              resp. up to 8 additional voltages.

$f \cdot 32$:   ***x***, ***y, z***, ***T***, ***v***, ***d***, ***vs***, ***ds***   (8 values)   [m/sec. resp. °; x.3f]
              (***z*** derived only from vertical paths)
              The orthogonal components ***x***, ***y*** and ***z*** are related to the device coordinates!

In *d* resp. *ds* a possible azimuth offset is taken into account.

v and *d* are vectorial averages, *vs* and *ds* are scalar averages.

$g \cdot 64$:   Tilt- resp. rotation angle of *x* - ,*y* - and *z* -axis (3 values)   [°; x.3f]

             (Sequence: Roll, pitch, azimuth; azimuth not yet realized)

$h \cdot 128$:   Extended status: (45 characters)

- Paths_status: 9 times, each of 5 characters;

                  stands for transducer pairs: 1-2, 1-4, 1-6, 3-2, 3-4, 3-6, 5-2, 5-4, 5-6,

                  (each block of 5 characters separated by the delimiter)

Contents of:

o Amplitude-Status, up: (1 char.)
Ratio of the current signal amplitude to the amplitude at time of the last calibration.
Logarithmic representation by the numbers 1 … 9; 0: signal too low.
Up means: (e.g. 1-2)   1 (below) was sending, 2 (above) receiving

o Trigger-Peak-Status, up: (1 char.)
Ratio of the current „trigger peak" to the „trigger peak" at time of the last calibration.
„trigger peak" is the 1st. amplitude that triggers the measurement.
Logarithmic represented by the numbers 1 … 9; 0: signal too low.

o Amplitude-Status, down: (1 char.)
Ratio of the current signal amplitude to the amplitude at time of the last calibration.
Logarithmic represented by the numbers 1 … 9; 0: signal too low.
Down means: (e.g. 1-2)   2 (above) was sending, 1 (below) receiving

o Trigger-Peak-Status, down: (1 char.)

Ratio of the current „trigger peak" to the „trigger peak" at time of the last calibration.

„ trigger peak " is the 1st. amplitude that triggers the measurement.

Logarithmic represented by the numbers 1 … 9; 0: signal too low.

o Plausibility of measurement: (1 char.)

„0":   measurement was fine.

„1":   runtime counter toward upper transducer not plausible

„2":   runtime counter toward lower transducer not plausible

„3":   both runtime counters are not plausible

„4":   temperature difference to median of all radial temperatures is higher than allowed (parameter MTD)

„5":   implausibility of radial wind component:

The calculated radial wind speed deviates too strongly

to the theoretically expected !

„6" … „9"   (Future) TBD (not used up to now)

The level ratios in relation to the last calibration are non-linear and represented by the numbers 1…9.

0:	means	less than	20.0%
1:	means	20.0 …	25.1%
2:	means	25.1 …	31.6%
3:	means	31.6 …	39.8%
4:	means	39.8 …	50.1%
5:	means	50.1 …	63.1%
6:	means	63.1 …	79.4%
7:	means	79.4 …	100.0%
8:	means	100.0 …	125.9%
9:	means	more than	125.9%

(7 and 8 are the expected values if signal levels are not changed.)

Every time when the system starts or one of the control values OI# resp. OD# has been changed, a so called identifier line is printed out before the next data line. This identifier line consist only of the identifiers (the names) of the following measuring values. This supports a better allocation of the values in data files.

Example of print out at boot time (comes up with OI1==32):

```
XSncMP > Class A Multi Path Ultrasonic Anemometer
state;x;y;z;T;vel;dir;vels;dirs
01000032000000;-0.001;-0.036;0.012;23.602;0.036;1.525;0.036;1.525
```

Example of print out when control value changes (here from 32 to 33):

```
01000032000000;0.064;-0.022;0.004;23.665;0.067;289.295;0.067;289.295
XSncMP > OI1=33
YYYY-MM-DD HH:mm:ss;msec.;timezone;state;x;y;z;T;vel;dir;vels;dirs
2017-08-10          08:25:45;122;UTC+0000;01000033000000;0.057;-
0.061;0.039;23.643;0.084;317.024;0.084;317.024
```

(the line feeds is not! part of the data line)

6.1.3 Faulty measuring values

Representation of faulty resp. not determinable measuring values:

In case of an invalid value it will be omitted in the output. That means there will be no character between two following delimiters or between delimiter and NEWLINE.

6.1.4 Configurable separation of single measurands

Delimiter: (parameter DM#; DeliMiter)   adjustable for each of the data channels

All of the single measuring values in the data telegram are separated by a configurable ASCII character. This ASCII character has to be „visible", must not be SPACE neither number nor letter and must not be equal to the used decimal character !

 [default = „;" (semicolon)]

6.1.5   Configurable decimal sign

<u>Decimal character</u>:   (Parameter DC#; DeCimal)   adjustable for each of the data channels

The ASCII-character for the usage as decimal sign can be switched between a dot („.") an a comma („"). At the moment of adjustment it must not be equal to the used delimiter character !

 [default = „." (dot)]

<u>NEWLINE (CR,LF or CRLF):</u> (Parameter NB#; Newline Behaviour), adjustable for each of the data channels

The NEWLINE behavior can be chosen by the parameter NB# between CR, LF or CRLF.

6.1.6   Framing of data lines

To secure the data transmission on the data output channels a so called „framing" can be used. It can be switched on by setting the corresponding framing parameter FR# to 1.

If it is switched on, every data line is embraced by <STX> and <checksum><ETX> tokens.

The structure is as follows:

<STX>data_1<DLM>data_2<DLM>…<DLM>data_n<TERM><checksum><ETX>

<STX>	Start of Text	0x02
<ETX>	End of Text	0x03
<DLM>	delimiter (configurable)	

<checksum>   8Bit-XOR-conjunction of all bytes that builds the data telegram (without the framing). The checksum is printed out in 2 digits, hexadecimal.

<TERM>   Line terminating group of characters, configurable (LF, CR or CRLF)

6.1.7   Differences between instantaneous and averaged data

Basically nearly all of the instantaneous measured values can be averaged and so used for averaged output. But there are some differences:

- The time stamp marks the end of the averaging interval
- The extended status:

  Up to now it is not definitively defined how the 9 „plausibilities of measurement" as part of the extended status can be used meaningful for averaged data !

6.1.8   Examples:

OI#=33

```
2017-01-26 08:48:01;901;UTC+0000;01000033000000; …
    … 0.048;0.152;0.075;24.242;0.159;197.425;0.159;197.425
```

Instantaneous data:

    time stamp; status; x-component; y-component; z-component; …

            …, temperature; vel; dir; vels; dirs

(vel and vels and also dir and dirs are equal because of instantaneous data)

OI#=6

```
01000006000000;0.060;0.131;0.092;-.081;0.060;040;0.010;0.052;0.000;…
… ;22.900;23.790;23.030;23.920;24.380;23.870;23.680;23.860;24.040
```

Instantaneous data: status;r12;r14;r16;r32;r34;r36;r52;r54;r56; …

        … T12;T14;T16;T32;T34;T36;T52;T54;T56

(9 radial wind components + 9 radial temperatures; the line feed is not! part of the data line)

OI#=97

```
2017-01-26 08:48:01;202;UTC+0000;01000097000000;…
    … 0.113;0.201;0.092;23.981;0.230;209.374;0.230;209.374; …
        … 2.539;0.927;0.000
```

Instantaneous data:

Timestamp; status; …

    … x-component; y-component; z-component; temperature; vel; dir;vels; dirs; …

        … inclX; inclY; rotation

    (vel and vels and dir and dirs are equal because of instantaneous data; the line feeds are not! part of the data line)

6.2   Binary data output (PR#=2)

The structure of the binary data telegrams for PR#=2 is as follows.

The data telegram of the binary data output for instantaneous and for averaged data is configurable by the user. To select one or more of the possible groups of meaningfully combined measured values control values are used. These values are assigned to bit values. To configure the data telegram for instantaneous data the parameter OI# can be used. For averaged data the corresponding parameter is OD#.

- (OI#; #: 1,2,3) / (OD#; #: 1,2,3)

The indexing # is used to select one of three possible data output channels, where:

- PR1, OI1, OD1   stand for the serial RS422 output line,
- PR2, OI2, OD2   stand for the network data port (TCP/IP socket)
- PR3, OI3, OD3 stand for the storing of data on an internal data logger (SD card).

Control values for output of instantaneous resp. averaged measured values are OI#/OD# (#: 1,2,3).

Basically, every group of meaningfully combined measured values is assigned to one control bit. These bits can be combined almost arbitrarily. The value of the control bit determines the sequence of the groups of measured values in the data telegram, where groups with lower value control bits are at the beginning of the telegram and with higher value control bits more to the end of the telegram. There are control bits with the values 1, 2, 4, 8, (16 optional,) 32, 64 and 128. They have the same meaning for instantaneous and for averaged data. The assembly of a specific data telegram means adding of these control bit values.

The data telegram consists of binary (hexadecimal) 8-Bit values which represents status- and the measuring values.

6.2.1 Combined type and status information

Every printable data telegram, that means OI# resp. OD# is unequal to zero, begins with a combined type and status information that can be understood as "header". The structure of this header is independent of the adjustment of OI# resp. OD#.

The header (combined type- and status information) builds up as follows:

1 Byte	<SOH>	Start of Header 0x01
1 Byte	protocol type	0x32 (ASCII: '2') for instantaneous data
		0x72 (ASCII: 'r') for averaged data
2 Bytes	16 Bit value:	Length of the complete data telegram;
		(1. Low Byte, 2. High Byte)
1 Byte	<EOT>	here: End of Header 0x04
1 Byte	8 Bits:	selection of data set

Bit0: Timestamp information

Bit1: radial wind components

Bit2: radial path temperatures

Bit3: Voltages of the three analog inputs for roll, pitch and rotate

Bit4: Not used yet! (reserved using for add. analog inputs)

Bit5: orthogonal/vectorial wind components: x, y, z, T, v, d, vs, ds

Bit6: inclination resp. rotation angles of x- y- and z-axis

Bit7: extended status (described below)

1 Byte   8 Bits: Heating and sensor state:

Bits 0…1: Heating operation mode: 00…11   (0…3)

0: always OFF;

1: always ON;

2: automatic, controlled by temperature;

3: automatic, controlled by temperature and data quality;

Bits 2…3:   Heating state: 00…10   (0…2)

    0: switched off;

    1: switched on and ready;

    2: switched on and faulty;

Bits 4…7:   sensor paths state   0000…1001   (0…9)

shows how many of the 9 paths were not usable;

1 Byte	percentage of failed radial components in relation to all tries (0…100)
n Bytes	<data output as configured by OI#/OD#>
1 Byte	checksum of the complete data telegram excluding checksum Byte.

Values, that needs more than 1 Byte to represent (2 or 4 Bytes) are always transmitted directly from the memory of the uSonic-3 ClassA MP with lowest significant Byte first and highest significant Byte last.

On the serial RS422 data line the 8 Bits are transmitted with LSB (lowest significant Bit first)!

6.2.2   Configuration of binary data sets

NOTE: The following information is not relevant for standard ASCII data sets.

Output of measuring values depending on control bit values (configuration of the data telegram):

Control Bit value:

1: Time stamp: 2 * 32Bit values:

Time stamp in UNIX Epoch format (seconds since 1st. of January 1970, 00:00:00)

Sub seconds

(means: milliseconds [mSec.] in a standard uSonic-3 ClassA MP

2: Radial wind components (9 values of IEEE-32 floating point);   [m/sec.]

4: Radial temperatures (9 values of IEEE-32 floating point);   [°C]

8: Voltages of the accelerometers (3 values of IEEE-32 floating point);   [V]

ADC inputs 1, 2 a. 3

32: *x*, *y, z*, *T*, *v*, *d*, *vs*, *ds*   (8 values of IEEE-32 floating point);   [m/sec. resp. °]

(*z* averaged of the vertical paths)

Die orthogonal components *x*, *y* and *z* are related to the device coordinates!

In *d* resp. *ds* an azimuth offset is taken into account.

v and *d* are vectorial averaged, *vs* and *ds* are scalar averaged.

64: Tilt- resp. rotation angle of *x* - ,*y* - and *z* -axis (3 values of IEEE-32 floating point); [°]

128: Extended status: (27 Bytes)

Paths_status: 9 times each of 3 Bytes;   stands for transducer pairs:

          1<->2, 1<->4, 1<->6, 3<->2, 3<->4, 3<->6, 5<->2, 5<->4 and 5<-

Contents of:

Byte 1:   path state of *Up* direction:

          Bits 0…3: Ratio of the current signal amplitude to the amplitude at time of the last calibration.

               Logarithmic represented by the numbers 1 … 9; (see below)
               0: signal too low.

               Up means: (e.g. 1->2) (below) was sending, 2 (above) receiving

          Bits 4…7: Ratio of the current „trigger peak" to the „trigger peak" at time of the Last calibration. „trigger peak" is the 1st. significant amplitude that triggers the measurement.

               Logarithmic represented by the numbers 1 … 9; 0: signal too low.

Byte 2:   path state of *Down* direction:

          Bits 0…3: Ratio of the current signal amplitude to the amplitude at time of the last calibration.

               Logarithmic represented by the numbers 1 … 9; (see below)
               0: signal too low.

               Up means: (e.g. 1->2) (below) was sending, 2 (above) receiving

          Bits 4…7: Ratio of the current „trigger peak" to the „trigger peak" at time of the Last calibration. „trigger peak" is the 1st. significant amplitude that triggers the measurement.

               Logarithmic represented by the numbers 1 … 9; (see below)
               0: signal too low.

Byte 3:   Bits 0…3: plausibility of path:

               „0":   measurement was fine.

               „1":   runtime counter toward upper transducer is implausible.

               „2":   runtime counter toward lower transducer is implausible.

               „3":   both runtime counters are implausible.

               „4":   temperature difference to median of all radial temperatures is higher than allowed (parameter MTD).

„5":　implausibility of radial wind component:

The calculated radial wind speed deviates too strongly to the theoretically expected !

„6" … „9"　TBD (not used up to now)

Bits 4…7:　0000 (up to now: always 0 !)

The level ratios of the max. amplitudes and of the amplitude of the "trigger peak" in relation to the last calibration are logarithmic represented by the numbers 1…9.

0:	means		less than		20.0%
	1:	means	20.0	…	25.1%
	2:	means	25.1	…	31.6%
	3:	means	31.6	…	39.8%
	4:	means	39.8	…	50.1%
	5:	means	50.1	…	63.1%
	6:	means	63.1	…	79.4%
	7:	means	79.4	…	100.0%
	8:	means	100.0	…	125.9%
	9:	means	more than		125.9%

So 7 and 8 will be the expected values if signal levels are not changed.

6.2.3　Identifier line

Every time when the system starts up or one of the control values OI# resp. OD# has been changed, a so called identifier line is printed out before the next data line. This identifier line consist only of the identifiers (the names) of the following measuring values. This supports a better allocation of the values in data files. The identifier line is printed out in ASCII, uses adjustable delimiter characters (default: ';') and ends with adjustable NEWLINE character/s (default: CRLF).

6.2.4   Representation of faulty resp. not determinable measuring values:

In case of an invalid value (of always 32 Bit values) the value FFFFFFFF (hex) will be printed out. This will lead to *1.#QNAN* for IEEE-32 floating point values.

6.2.5   Receiving and interpretation of binary data telegram:

The receiver of the binary data telegram should look for the occurrence of the 1st. Byte of a binary data telegram (0x01; SOH: Start Of Header). Then 4 Bytes after the SOH the value 0x04 (EOT; here: End of Header) should be found. In that case the complete length of the data telegram is placed in the 3. and 4. Byte regarding the position of SOH (low Byte, high Byte). If these length value is added to the position of SOH and decremented by 1 that points to the checksum of the data telegram. The checksum was built by XORing all Bytes of the complete data telegram excluding the checksum Byte itself (start value=0x00). The checksum value marks the end of the data telegram. If this transmitted checksum value is equal to the recalculated ("Offline"), a valid data telegram has been found. Otherwise the receiver has to look for the next occurrence of a SOH (0x01) and to check again.

7   Analog data output (option)

If ordered as an option, the uSonic-3 MP provides 4 analog output signals. Variants of 0...5 VDC, 0...10 VDC or 0…20 mA are available.

The 4 analog output signals are called C1...C4. The resolution is 12bit.

7.1   General function of analog output

The 4 analog output signals will stay at the last indicated value until the signals will be refreshed. The actualization is depending on the averaging time. The refresh of the signals will proceed at the end of this time (simultaneous to the serial output). If output of instantaneous analog data is chosen, the analog output signals will be refreshed with every new data set.
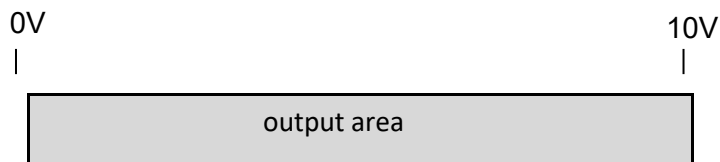
7.2   Configuration of analog output

The analog output function supports a variety of parameter to configure the analog output signals exactly.
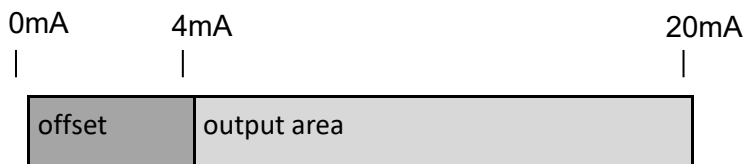
7.2.1   Limitation of range (Offset)

The command AOF (**A**nalog **OF**fset) configures an offset. This offset configures a range which is not used for data output. The not used range supports i.e. an error indication.
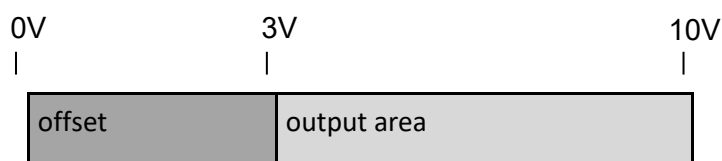The possible setting is 0…50 (% of the whole possible range)

0V   10V

output area

Example: uSonic-3 MP, 0…10V, AOF=0

0mA   4mA   20mA

offset	output area

Example: uSonic-3 MP, 0…20mA, AOF=20

0V   3V   10V

offset	output area

Example: uSonic-3 MP, 0…10V, AOF=30

7.2.2   Scaling of analog output

To optimize the resolution, the range of the analog output signals can be configured. The commands ARV, ARZ and ART configure the whole possible range (consider also command AOF, chapter 7.2.1).

The command ARV (velocity range) sets the analog output range for the values x,y,v and v.

The possible setting is 1…6000 (cm/s).

The command ARZ (z-range) sets the analog output range for the value z.

The possible setting is 1…6000 (cm/s).

The command ART (temperature range) sets the analog output range for the value t.

The possible setting is 1…6000 (0,01°C).

The point of reference is always +10°C, (+10°C-ART/100....+10°C+ART/100).

If ART=4000, the range displays -30°C…+50°C.

Examples:

ARV=4000   Analog output range at uSonic-3 MP variant 0...10VDC

                  v or vs= 0m/s...40 m/s corresponding 0...10VDC

                  x and y= -40 m/s...+40m/s corresponding 0...10VDC

ARZ=100   Analog output range at uSonic-3 MP variant 0...5VDC

                  z= -1m/s...+1m/s corresponding 0...5VDC

ART=3000   Analog output range at uSonic-3 MP variant 0...10VDC

                  T= -20°C…+40°C corresponding 0...10VDC

The values of ARZ, ARV und ART always correspond to the limited (parameter AOF) output range.

Example:

uSonic-3 MP variant 0…10VDC, ARZ=100, AOF=20

z= -1m/s…..1m/s   corresponding 2….10VDC

7.2.3   Assignment of variables to the analog output

The 4 analog output ports C1…C4 can display different values. The following index shows the supported values:

variable	max. range	meaning	scale
x	±60 m/s	x-component of wind	m/s
y	±60 m/s	y- component of wind	m/s
z	±60 m/s	z- component of wind	m/s
t	-40 ... +60 °C	temperature	°C
v	0 ... 60 m/s	horizontal windspeed	m/s
d	0 ... 359.999°	winddirection	°
dh	-90.0 ... 449.999 °	winddirection (with hysteresis)	°

The command AOM (Analog Output Mode) configures the variables which are displayed on the analog output ports. Following settings are possible:

AOM=1:   C1:   x: Range determined by parameter ARV

        C2:   y: Range determined by parameter ARV

        C3:   z: Range determined by parameter ARZ

        C4:   t: Range determined by parameter ART

AOM =2:   C1:   v: Range determined by parameter ARV

        C2:   d: 0° ≙ setting AOF, 360° ≙ maximum value

        C3:   z: Range determined by parameter ARZ

        C4:   t: Range determined by parameter ART

AOM =3:   C1:   v: Range determined by parameter ARV

        C2:   dh: -90°   ≙ setting AOF

                 +180°   ≙ setting AOF + (maximum value – AOF)/2

                 +450°   ≙ maximum value

        C3:   z: Range determined by parameter ARZ

        C4:   t: Range determined by parameter ART

AOM=32:   Test values

The analog output ports can be checked with test values. With AOM=32 the analog output signals are fixed to constant values. The level of the signals depends on the hardware configuration of the uSonic-3 MP (0... 5 VDC, 0...10 VDC or 0…20mA) and on the parameter settings of ATV und AOF.

The possible percentage setting of ATV is 0…100 (%).

The output values will then be equal on all 4 analog ports (C1 … C4):

maximum value * (AOF/100 + (1 − AOF/100)*ATV/100)

Examples:

ATV=0	uSonic-3 MP variant 0...10VDC
AOF=0	C1...C4 value: 0VDC
AOM=32	

ATV=50	uSonic-3 MP variant 0...5VDC
AOF=0	C1...C4 value: 2,5VDC
AOM=32	

ATV=50	uSonic-3 MP variant 0...10VDC
AOF=20	C1...C4 value: 6VDC
AOM=32	

An additional possible value for the test values is ATV=101. In this case different values are given out on the ports C1 … C4 to check the alignment.

Example:

ATV=101	uSonic-3 MP variant 0...10VDC	
AOF=0	C1: value 2,5VDC	(25% of the usable range)
AOM=32	C2: value 5,0VDC	(50% of the usable range)
	C3: value 7,5VDC	(75% of the usable range)
	C4: value 10,0VDC	(100% of the usable range)

Attend also the parameter AOF(see chapter 7.2.1) in this case.

7.2.4   Indicating of errors by analog output

The command AEM (**A**nalog **E**rror **M**ode) defines, which values will appear on the Analog ports if an error is located.

If one or more of the values which are used for analog output is INVALID the corresponding analog ports will be set to the error value depending on the setting of AEM:

AEM=0   C1…C4 the last true value will be hold

AEM=1   C1…C4 0VDC or 0mA, if available: the value for AOF

AEM=2   C1…C4 0VDC or 0mA, if available: the value for AOF/2

AEM=3   C1…C4 maximum value

8   Logging of data on the internal SD-card

TBA.

9   Network capabilities

The network option of the USonic-3_ClassA_MP opens advanced capabilities to the user. A network data port and a network operating port are usable. Both ports are available as TCP/IP sockets. The port number for the data port is *5001* as default but can be changed by the user. The port number for the operating port is *5000* as default and can also be changed by the user. Furthermore a FTP server is available, that can be used to access to logged data or to handle firmware or system files on the internal SD-card of the system.

9.1   Connecting to the USonic-3_ClassA_MP via network

To use the offered ports and/or the internal FTP server the user must log on to the system. For that purpose two users are provided. These two users are primarily intended to use the FTP server but can also be used for the data and the operating port. The two users and there default passwords are:

- User: *data*   default password: *MetekGmbH*

    The user *data* has read-only access to the files on the SD-card

    The password for the user *data* can be changed by the user. The password should only be changed very consciously and the new password should be remembered well.

- User: *service*   default password: *8189035*

    The user *service* has read- and write- access to all of the files on the SD-card

    The password for the user *service* can be changed by the user (with ServiceAccessLevel). The password should only be changed very consciously and the new password should be remembered well.

9.2   Additional notes on logging in

To establish a connection successfully, the newline behavior must be set to CRLF. Otherwise the log on will not work.

The access to the data- and the operating port will work with both of the provided users.

9.3   Simple NTP-client

NTP stands for Network Time Protocol. It is the basic mechanism for synchronizing time on a local machine with s remote NTP-server over the network.

Features of Simple NTP-Client:

Since the firmware version V20RX, a simple NTP-client has been introduced to the uSonic-MP devices. It provides the ability to retrieve the current date and time from a certain NTP - server once during the starting procedure of the firmware for setting the local RTC.

In the current firmware version, the provided accuracy of the time synchronization is about 0.5 sec. The accuracy depends also on the network load. Therefore, the closest NTP server, maybe one on the local network should be selected to keep the influence caused by the possible high loaded network as small as possible.

9.4   Future planned options

It is planned to have the functionality as a FTP client available in the near future. In that case the logged data on the SD-card will be sent regularly to an external FTP server.

It is also planned to integrate a web server, at least to configure the USonic-3_ClassA_MP.

10 Updating of software

The update concept of the USonic-3_ClassA_MP is based on firmware files that are stored on the internal SD-Card and on the boot manager which will run through every time when the system starts.

Up- or downgrading of the USonic-3_ClassA_MP firmware is handled by the boot manager software, which is stored in a specially reserved area of the program flash of the MCU. Every time when the system starts up the boot manager looks to the firmware files on the SD-card and finds out if the latest version of the firmware files (with the highest version number) is different to the version that is stored in the program flash of the MCU. If this is the case, the boot manager replaces the version in the program flash with the latest version from the SD-card. If the versions in program flash and on SD-card are equal the boot manager waits for 5 seconds before the application (the program in the program flash of the MCU) is started. If during these 5 seconds the string "***ZZZ***" is sent to the serial RS422 interface of the USonic-3_ClassA_MP, the boot manager switches to the so called download mode. The download mode is intended to handle the firmware files on the SD-card over the serial RS422 interface. In this way firmware files can be copied to and deleted from the SD-card.

So updating of firmware of the USonic-3_ClassA_MP is done in two steps:

- 1. Handling of firmware files on SD-Card (copy or delete)

    There are different possibillities die access to the firmware files on the SD-card.
- 2. Take over by the boot manager after next RESET.

10.1 Using of Download mode and serial protocol for updating firmware

In cases where the USonic-3_ClassA_MP has no network option or it was installed without a network connection the serial protocol within the download mode can be used to access to the firmware files. There are two different ways to use this possibility:

10.1.1 Using of a Windows-PC software tool for updating firmware files

Metek offers a Windows GUI program tool to handles firmware files on the SD-card of the USonic-3_ClassA_MP. It is using the download mode and the serial protocol on the RS422 interface. This software tool is called ***FirmwareUpdater*** and it is largely self-explanatory.

10.1.2 Using of available Python scripts for updating firmware files

There is a collection of Python 2.7 scripts available to use the download mode via the serial line. Before these scripts can be used they have to be adapted to the used COM port interface on the PC. To use these scripts the serial RS422 interface of the USonic-3_ClassA_MP should be connected to a PC. With a terminal program the USonic-3_ClassA_MP should be resetted by the command RST. Then within 5 seconds after the boot message of the boot manager has been shown up "ZZZ" has to be typed in. The boot manager will switch to the download mode. The terminal program should then be disconnected from the system and the Python scripts can be used. At the end the script for resetting the system should be used to end the session and to take over the changed version file into the system by the boot manager.

10.2 Using of FTP server for updating firmware.

If the USonic-3_ClassA_MP was delivered with the network option the integrated FTP server can be used to access to the firmware files on the SD-card. In that case the FTP user: ***service*** with it's password (default: 8189035) should be used. There is a directory named ***FWIMAGES*** on the SD-card where the firmware files are expected from the boot manager. After copying a new firmware file to the SD-card or deleting an existing one from the SD-card the USonic-3_ClassA_MP should be reset by the reset command (RST) on one of the available operating channels.

10.3 Upgrading of firmware

Upgrading of a USonic-3_ClassA_MP means copying a firmware file of a version that is newer than the one that is installed to the SD-card and then RESET the system.

10.4 Downgrading of firmware

The update concept of the USonic-3_ClassA_MP allows to downgrade the firmware to an older one. In this case the firmware file of the version that is used on the system has to be deleted from the system. If there is a firmware file of an older version on the SD-card this version will be taken over after RESET. Otherwise a firmware file of an older version has to be copied to the SD-Card before RESET.

11 Checking System Accuracy

If the user suspects that a deformation of the sensor head geometry has occurred, the first step should be a check of the measuring accuracy.

This test can be done in the field by housing the sensor head in a box or covering the sensor head by a cloth or blanket or the Metek calibration hood. Make sure that there are no reflections inside the box and that the sound paths are not covered. Both effects can cause a considerable bias of the wind components of more than 15 cm/s. Reflections can be recognized by observing the time series of 1 sec means while changing the sensor head position (for example, rotation of 60 degree). The wind components must not vary more than some cm/s.

Measuring the wind speed or wind components in a non-moving medium would ideally show wind speed zero, but a deviation of up to 10 cm/s can be accepted (The acceptance limit depends strongly on the user requirements, naturally). If the bias of the wind components exceed the acceptable range a recalibration must be performed.

12 Adjustable Internal Sample Frequencies

The sample rate of the internal interrupt driven measuring routine is derived by dividers from a clock rate of an crystal oscillator that defines also the clock rate of the electronic. Therefore not all theoretically possible clock rates are available.

The internal sampling frequency can be adjusted with the parameter command SFR=<value>, where <value> is the sampling frequency in [mHz].

The USonic-3 ClassA MP offers the following available sampling frequencies:

Sampling Frequency in [Hz]	SFR= in [mHz]
0,1	100
0,125	125
0,2	200
0,25	250
0,5	500
1	1000
2	2000
2,5	2500
3	3000
4	4000
5	5000
6	6000
7,5	7500
8	8000
10	10000
12,5	12500
15	15000
16	16000

20	20000
24	24000
25	25000
30	30000

The current setting of the internal sampling frequency defines the maximum possible output rate for instantaneous data. This is true if the parameter to define the number of averaging of sensor signal samples (CAV) is set to 1. Otherwise the output rate must be divided by CAV.

instantaneous output rate = SFR / (1000 * CAV) !

13 Packing

The correct packing of the uSonic-3 CLASS-A MP is essential for as safe transportation. Use exclusively the original packing devices delivered with the system to avoid damage or de-calibration of the sensor head.

fig. 9: packing of uSonic-3 CLASS-A MP

14 Manual Revisions

In order to support the efficient use of our manuals a table of manual revisions has been added which lists all changes applied to the relevant documents.

In case of a support request regarding usage or content of a manual pls. let us know which manual release has been delivered with the system you are operating.

Table of Manual Revisions					
Manual version released	Date of manual release	Manual version replaced	Modified parts	Correction: C Modification: M Addition: A Deletion: D	Current SW version
MP_A.20-1	20180814	MP_A.20-0	2.4 ff all	M: new figures of sensor head M: Formatting	A.20RX
MP_A.20-0	20180808	MP_A.11-1	4.3 5.1.1 5.1.3 5.1.4 5.2.1 5.2.4 6.1 6.2 6.1.6 6.1.7 7. 9.3 12.	C: Additional "==" line in boot message A: FR#,NLC,NLD,NT0,NTP,SUB, AEM, AIN, AOM, AOF, ART, ARV, ARZ and ATV added. A: FR1, FR2, FR3 added C: PR#=2 added C: allowed sampling frequencies SFR A: NLC, NLD, NT0, NTP, SUB, AEM, AIN, AOM, AOF, ART, ARV, ARZ and ATV added. A: RP4 and SP4 in command list added A: Description of RP4 and SP4 added A: ASCII data output (former 6.) A: Binary data output A: Framing of data lines C: Differences between instantaneous and averaged data A: Analog data output (all following chapters are shifted up) A: Simple NTP-client C: List of allowed sampling frequencies	A.20RX
…_Ki	20180218	ongoing	all text	Wording and typing errors	…_Ki
MP_A.11-1	20171218	MP_A.11-0	3.3	D: Removed link to none existing chapter	A.11RX
MP_A.11-0	20171026	-	all text	A: first release	A.11RX