uSonic-3 CLASS-A MP
(Multi Path)

3D Ultrasonic Anemometer

Manual

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

The uSonic-3 CLASS-A MP system is a 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 transducer 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 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 right-handed coordinate system.**
- **The uSonic-3 CLASS-A MP must always be used without any sensor head correction, 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.
Three identical parallel working threads, one for each of the output channels, for output of instantaneous data, averaging and output of averaged data.

- Output of instantaneous values on RS485, controlled by O1.
- Averaging controlled by A1, A1, A1 or A1.
- Output of averaged values on RS485, controlled by O1.

- Output of instantaneous values on network data port, controlled by O2.
- Averaging controlled by A2, A2, A2 or A2.
- Output of averaged values on network data port, controlled by O2.

- Output of instantaneous values for storing on SD-card, controlled by O3.
- Averaging controlled by A3, A3, A3 or A3.
- Output of averaged values for storing on SD-card, controlled by O3.

Driver

Coherent averaging

Calculation of instantaneous data

Signal analysis, calculation of sound travel times, radial and orthogonal wind components, wind speed and direction, radial raw temperatures, cross wind corrected temperature.

- Driver: "State machine" Interrupt driven routine for measurements.
- Coherent averaging:
  - fD = SFR / 1000;
  - (Addition of waveform samples)
- Calculation of instantaneous data:
  - ft = SFR / (CAV*1000);

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)

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.

![Diagram showing sensor head geometry and coordinate system](image)

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 $\phi$ and $\theta$.

- The tilt angle $\phi$ (roll) turns clockwise around the south-north axis when viewing from south to north. The signal for the roll angle $\phi$ is taken by the input channel P1.
- The tilt angle $\theta$ (pitch) turns clockwise around the east-west axis when viewing from east to west. The signal for the pitch angle $\theta$ is taken by the input channel P2.

The relation between the voltage reading of P1 and P2 and the corresponding tilt angles $\phi$ and $\theta$ are derived from a direct reference measurement by means of a calibrated spirit level with an accuracy $\leq 0.1^\circ$. 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 Connectors 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.
The USonic-3_CLASS-A_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**

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

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

<table>
<thead>
<tr>
<th>Pin</th>
<th>Color</th>
<th>Function</th>
<th>Pin</th>
<th>Color</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>white</td>
<td>+ analog out port C1</td>
<td>9</td>
<td>black</td>
<td>TxD-, Z (RS422)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bus-, Z (RS485)</td>
</tr>
<tr>
<td>2</td>
<td>brown</td>
<td>+ analog out port C2</td>
<td>10</td>
<td>purple</td>
<td>TxD+, Y (RS422)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bus+, Y (RS485)</td>
</tr>
<tr>
<td>3</td>
<td>green</td>
<td>+ analog out port C3</td>
<td>11</td>
<td>grey-pink</td>
<td>Power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Electronic +12...36 V</td>
</tr>
<tr>
<td>4</td>
<td>yellow</td>
<td>+ analog out port C4</td>
<td>12</td>
<td>red-blue</td>
<td>Power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Electronic GND</td>
</tr>
<tr>
<td>5</td>
<td>grey</td>
<td>GND analog out</td>
<td>13</td>
<td>white-green</td>
<td>Power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Heater +24 V</td>
</tr>
<tr>
<td>6</td>
<td>pink</td>
<td>RxD+, A (RS422)</td>
<td>14</td>
<td>brown-green</td>
<td>Power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bus+, Y (RS485)</td>
<td></td>
<td></td>
<td>Heater +24 V</td>
</tr>
<tr>
<td>7</td>
<td>blue</td>
<td>RxD-, B (RS422)</td>
<td>15</td>
<td>white-yellow</td>
<td>Power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bus-, Z (RS485)</td>
<td></td>
<td></td>
<td>Heater GND</td>
</tr>
<tr>
<td>8</td>
<td>NC</td>
<td></td>
<td>16</td>
<td>yellow-brown</td>
<td>Power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Heater GND</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td>NC</td>
<td></td>
</tr>
</tbody>
</table>
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 $\pm 160^\circ$ 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, **do not use the sensor arms as hooks for tools or jackets!!!**

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 sensor electronics requires a supply voltage of 9 ... 36 VDC and it takes - without activated sensor head heating - about 3 ... 5 W depending on the optional extensions (inclinometer).

The uSonic-3 CLASS-A MP sensor head heating requires a supply voltage of 24 VDC, 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 **correct grounding of the system** 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](image-url)
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. The 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 character. 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 serial baud rate 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 serial baud rate 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_CLASS-A_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 always printed with 57600 baud:

```
---------------------------------------------------
| Flash-Loader V1.33                          |
| Date 2017-10-17 14:10:49                   |
|---------------------------------------------------
| The Unique Device Info:                     |
| Description : Class A Multipath RX63N       |
| Major-ID : 0x010A                            |
| Device-ID : 0110096856                       |
| MAC-Address : 70:B3:D5:A6:D0:0E             |
|---------------------------------------------------
| Current Firmware Info:                      |
| Version : 010A_011RX                        |
| Baud Rate : 115200                          |
```

*version of boot manager*

*date and time of system*

*Ultrasonic type*

*type identification*

*Device serial number*

*MAC address*

*firmware version number*

*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 configured 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:
<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XSncMP &gt; TZO=120</td>
<td>Setting of time zone offset</td>
</tr>
<tr>
<td>XSncMP &gt; SBR?</td>
<td>Enquiring of serial baud rate</td>
</tr>
<tr>
<td>SBR=57600</td>
<td>and system response</td>
</tr>
<tr>
<td>XSncMP &gt; ABC?</td>
<td>Invalid (unknown) command</td>
</tr>
<tr>
<td>XSncMP &gt; ?</td>
<td>unknown symbol and system re</td>
</tr>
<tr>
<td>XSncMP &gt; SBR=1234</td>
<td>Command with invalid value</td>
</tr>
<tr>
<td>XSncMP &gt; ?</td>
<td>parameter out-of-range and s</td>
</tr>
<tr>
<td>XSncMP &gt; VNR?</td>
<td>Enquiring of firmware version</td>
</tr>
<tr>
<td>XSncMP &gt; VNR=A.11RX</td>
<td>and system response</td>
</tr>
<tr>
<td>XSncMP &gt; DNR?</td>
<td>Enquiring the device serial</td>
</tr>
<tr>
<td>XSncMP &gt; DNR=0110096856</td>
<td>number and system response</td>
</tr>
</tbody>
</table>
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)
UserAccessLevel: KEY=1 (for most of the common parameters)
ServiceAccessLevel: 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:

\[ \text{ABC} = \text{<value>} \]

- ABC : identifier of the parameter
- = : equal sign for adjustment
- <value> : new value for parameter ABC

for example:  

\[ \text{KEY}=1 \]
set access level to UserAccessLevel

\[ \text{XSncMP} > \text{KEY}=1 \]
echo of command

\[ \text{O1}=6 \]
set O1 to 6  (configure instantaneous dataset on RS422 data channel)

\[ \text{XSncMP} > \text{O1}=6 \]
echo of command.

5.2.1 List of all user relevant parameters

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Meaning</th>
<th>AccessLevel</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEM</td>
<td>Analog Error Mode (for optional analog output)</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>AIN</td>
<td>Switch for instantaneous analog output (optional)</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>AN1</td>
<td>Number of samples for averaging on RS422 data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>AN2</td>
<td>Number of samples for averaging on network data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>AN3</td>
<td>Number of samples for averaging for logging on SD-card</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>AOF</td>
<td>Analog Offset (for optional analog output)</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>AOM</td>
<td>Analog Output Mode (for optional analog output)</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>ART</td>
<td>Analog Range, Temperature (for optional analog output)</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>ARV</td>
<td>Analog Range, Velocity (for optional analog output)</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>ARZ</td>
<td>Analog Range, Z (vertical wind speed for optional analog output)</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>AT1</td>
<td>Averaging interval time for averaging on RS422 data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>AT2</td>
<td>Averaging interval time for averaging on network data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>AT3</td>
<td>Averaging interval time for averaging for logging on SD-card</td>
<td></td>
</tr>
<tr>
<td>ATV</td>
<td>Analog Test Value (for optional analog output)</td>
<td></td>
</tr>
<tr>
<td>AZA</td>
<td>Azimuth offset angle related to the north direction</td>
<td></td>
</tr>
<tr>
<td>BTC</td>
<td>Total number of boot sequences of the USonic_ClassA_MP</td>
<td></td>
</tr>
<tr>
<td>BVT</td>
<td>Battery voltage of the USonic_ClassA_MP</td>
<td></td>
</tr>
<tr>
<td>CAV</td>
<td>Number of coherent averaging of signal samples</td>
<td></td>
</tr>
<tr>
<td>DC1</td>
<td>Decimal sign for output on RS422 data channel</td>
<td></td>
</tr>
<tr>
<td>DC2</td>
<td>Decimal sign for output on network data channel</td>
<td></td>
</tr>
<tr>
<td>DC3</td>
<td>Decimal sign for output for logging on SD-card</td>
<td></td>
</tr>
<tr>
<td>DHC</td>
<td>Switch for using of DHCP (Network option)</td>
<td></td>
</tr>
<tr>
<td>DM1</td>
<td>Delimiter sign for output on RS422 data channel</td>
<td></td>
</tr>
<tr>
<td>DM2</td>
<td>Delimiter sign for output on network data channel</td>
<td></td>
</tr>
<tr>
<td>DM3</td>
<td>Delimiter sign for output for logging on SD-card</td>
<td></td>
</tr>
<tr>
<td>DNA</td>
<td>Device name of the USonic_ClassA_MP (Network option)</td>
<td></td>
</tr>
<tr>
<td>DNR</td>
<td>Device number of the USonic_ClassA_MP (serial number)</td>
<td></td>
</tr>
<tr>
<td>DNS</td>
<td>IP adress of the DNS server (Network option)</td>
<td></td>
</tr>
<tr>
<td>DOP</td>
<td>Device options of the USonic_ClassA_MP</td>
<td></td>
</tr>
<tr>
<td>DPN</td>
<td>Port number of network data port (Network option)</td>
<td></td>
</tr>
<tr>
<td>DPW</td>
<td>Password for user: data</td>
<td></td>
</tr>
<tr>
<td>DTI</td>
<td>Date and time of the USonic_ClassA_MP</td>
<td></td>
</tr>
<tr>
<td>EC1</td>
<td>Switch for echoing commands on the RS422 operating channel</td>
<td></td>
</tr>
<tr>
<td>EC2</td>
<td>Switch for echoing commands on the network operating port</td>
<td></td>
</tr>
<tr>
<td>FR1</td>
<td>Switch for “framing” of output data lines on RS422 data channel</td>
<td></td>
</tr>
<tr>
<td>FR2</td>
<td>Switch for “framing” of output data lines on TCP/IP data port</td>
<td></td>
</tr>
<tr>
<td>FR3</td>
<td>Switch for “framing” of output data lines for storing on SD card</td>
<td></td>
</tr>
<tr>
<td>GWY</td>
<td>IP adress of the gateway to internet</td>
<td></td>
</tr>
<tr>
<td>HTM</td>
<td>Heating operating mode (heating option)</td>
<td></td>
</tr>
<tr>
<td>HWR</td>
<td>Hardware release number</td>
<td></td>
</tr>
<tr>
<td>IPA</td>
<td>IP adress of the USonic_ClassA_MP</td>
<td></td>
</tr>
<tr>
<td>KEY</td>
<td>Access level parameter</td>
<td></td>
</tr>
<tr>
<td>LBT</td>
<td>Last boot time of the USonic_ClassA_MP</td>
<td></td>
</tr>
<tr>
<td>LCT</td>
<td>Time of last sensor calibration of the USonic_ClassA_MP</td>
<td></td>
</tr>
<tr>
<td>MAC</td>
<td>MAC address of the USonic_ClassA_MP</td>
<td></td>
</tr>
<tr>
<td>MTD</td>
<td>Maximum allowed temperature difference of single paths temperatures</td>
<td></td>
</tr>
<tr>
<td>NB1</td>
<td>Newline behavior for data output on RS422 data channel</td>
<td></td>
</tr>
<tr>
<td>NB2</td>
<td>Newline behavior for data output on network data channel</td>
<td></td>
</tr>
<tr>
<td>NB3</td>
<td>Newline behavior for data output for logging on SD-card</td>
<td></td>
</tr>
<tr>
<td>OD1</td>
<td>Control parameter for output of averaged data on RS422 data channel</td>
<td></td>
</tr>
<tr>
<td>OD2</td>
<td>Control parameter for output of averaged data on network data channel</td>
<td></td>
</tr>
<tr>
<td>OD3</td>
<td>Control parameter for output of averaged data for logging on SD-card</td>
<td></td>
</tr>
<tr>
<td>OI1</td>
<td>Control parameter for output of instantaneous data on RS422 data channel</td>
<td></td>
</tr>
<tr>
<td>OI2</td>
<td>Control parameter for output of instantaneous data on network data channel</td>
<td></td>
</tr>
<tr>
<td>OI3</td>
<td>Control parameter for output of instantaneous data for logging on SD-card</td>
<td></td>
</tr>
<tr>
<td>OPN</td>
<td>Port number of operating network port</td>
<td></td>
</tr>
<tr>
<td>NLC</td>
<td>Switch for login procedure on network command port</td>
<td></td>
</tr>
<tr>
<td>NLD</td>
<td>Switch for login procedure on network data port</td>
<td></td>
</tr>
<tr>
<td>NT0</td>
<td>IP-adress of remote NTP time server</td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
<td>Access Level</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>NTP</td>
<td>Switch for activating the NTP</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>PN0</td>
<td>Name of current parameter set</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>PN1</td>
<td>Name of saved parameter set in bank 1</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>PN2</td>
<td>Name of saved parameter set in bank 2</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>PN3</td>
<td>Name of saved parameter set in bank 2</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>PR1</td>
<td>Protocol parameter for dataset on RS422 data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>PR2</td>
<td>Protocol parameter for dataset on network data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>PR3</td>
<td>Protocol parameter for dataset for logging on SD-card</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>SBR</td>
<td>Baudrate on RS422 serial interface</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>SFR</td>
<td>Internal sampling frequency of the USonic_ClassA_MP</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>SNR</td>
<td>Serial number of the USonic_ClassA_MP</td>
<td>Read only</td>
</tr>
<tr>
<td>SPW</td>
<td>Password for user: service</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>SUB</td>
<td>IP subnet mask of USonic_ClassA_MP</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>SY1</td>
<td>Switch for synchronized output of averaged data on RS422 data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>SY2</td>
<td>Switch for synchronized output of averaged data on network data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>SY3</td>
<td>Switch for synchronized output of averaged data for logging on SD-card</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>SO1</td>
<td>Offset for synchronized output of averaged data on RS422 data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>SO2</td>
<td>Offset for synchronized output of averaged data on network data channel</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>SO3</td>
<td>Offset for synchronized output of averaged data for logging on SD-card</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>TMD</td>
<td>Trigger mode for measuring (free running or external triggered)</td>
<td>ServiceAccessLevel</td>
</tr>
<tr>
<td>TYP</td>
<td>Type of USonic device</td>
<td>Read only</td>
</tr>
<tr>
<td>TZO</td>
<td>Time zone</td>
<td>UserAccessLevel</td>
</tr>
<tr>
<td>VNR</td>
<td>Version number of firmware of USonic_ClassA_MP</td>
<td>Read only</td>
</tr>
<tr>
<td>VTS</td>
<td>Creation date and time of firmware</td>
<td>Read only</td>
</tr>
</tbody>
</table>
5.2.2 Setting of KEY-parameter

**Identifier**  meaning / action

**KEY** access level for parameter access and commands

<table>
<thead>
<tr>
<th>write access level:</th>
<th>AlwaysAllowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>data type:</td>
<td>integer</td>
</tr>
<tr>
<td>unit:</td>
<td>[ ]</td>
</tr>
<tr>
<td>allowed values:</td>
<td>0, 1, 29015</td>
</tr>
<tr>
<td></td>
<td>&lt;AdminAccessLevel&gt;, (actual value not documented)</td>
</tr>
<tr>
<td></td>
<td>&lt;SuperVisorAccessLevel&gt; (actual value not documented)</td>
</tr>
<tr>
<td>Default:</td>
<td>0</td>
</tr>
<tr>
<td>Note:</td>
<td>After one minute without operation the value of KEY is automatically reset to 0 !</td>
</tr>
</tbody>
</table>

5.2.3 Setting of parameters with UserAccessLevel (KEY=1)

**Identifier**  meaning / action

**AN1** number of samples for averaging on RS422 data channel.

<table>
<thead>
<tr>
<th>write access level:</th>
<th>UserAccessLevel</th>
</tr>
</thead>
<tbody>
<tr>
<td>data type:</td>
<td>integer</td>
</tr>
<tr>
<td>unit:</td>
<td>[ ]</td>
</tr>
<tr>
<td>allowed values:</td>
<td>1 ... 65535</td>
</tr>
<tr>
<td>Default:</td>
<td>1</td>
</tr>
</tbody>
</table>
| 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: UserAccessLevel
   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: \( f_{a2} = \frac{SFR}{1000 \times CAV \times AN2} \)

AN3  number of samples for averaging for logging on SD-card
   write access level: UserAccessLevel
   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: \( f_{a3} = \frac{SFR}{1000 \times CAV \times AN3} \)

AT1  Interval length time for averaging on RS422 data channel.
   write access level: UserAccessLevel
   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: \( f_{a1} = \frac{1}{AT1} \).

**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: \( f_{a2} = \frac{1}{AT2} \).

**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 coherent 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

\[ f_I = \frac{SFR}{CAV \times 1000} \]

and must be a minimum of 1 Hz!

**DC1** Decimal sign for output on RS422 data channel

- **write access level:** UserAccessLevel
- **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:** UserAccessLevel
- **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: UserAccessLevel
- 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: UserAccessLevel
- 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: UserAccessLevel
- 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: UserAccessLevel
- 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_CLASS-A_MP

write access level: UserAccessLevel
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: UserAccessLevel
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: UserAccessLevel
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:** UserAccessLevel
- **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:** UserAccessLevel
- **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:** UserAccessLevel
- **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: UserAccessLevel
- 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: UserAccessLevel
- 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: UserAccessLevel
- 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: \( f_1 = \frac{SFR}{(CAV \times 1000)} \) !

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

- **write access level:** UserAccessLevel
- **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:** UserAccessLevel
- **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_CLASS-A_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: ServiceAccessLevel
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: ServiceAccessLevel
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: ServiceAccessLevel
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_CLASS-A_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 is used. If DHC is set to 1 the IP address is determined and sent by the DHCP server of the network.

**DNA**  Device name of the USonic-3_CLASS-A_MP (network option)
- **write access level:** ServiceAccesLevel
- **data type:** string
- **unit:** [ ]
- **allowed values:** 0, 1
- **Default:** uSonic-3_CLASS-A_MP_0123456789
  *(0123456789 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: ServiceAccessLevel
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: ServiceAccessLevel
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: ServiceAccessLevel
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: ServiceAccessLevel
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_CLASS-A_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_CLASS-A_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_CLASS-A_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_CLASS-A_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 (3600 mV 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

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

### 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)

010xxxx113033: instantaneous values, telegram control value = xxxxx, heating is always switched on and is fine, 3 radial components (033%) were not usable.

011xxxx220000: 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.

011xxxx211002: averaged values, telegram control value = xxxxx, 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.

011xxxx003019: averaged values, telegram control value = xxxxx, heating always switched off (and just switched off), three radial components 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

Control bit values for configuration of the data telegram:

\(\text{a} \cdot 1\): 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!

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

\(\text{c} \cdot 4\): Radial temperatures (9 values); \([\degree \text{C}; \ x.3f]\)

\(\text{d} \cdot 8\): Voltages of the inclinometer/compass (3 values) \([\text{V}; x.3f]\)

ADC inputs 1, 2 a. 3
(Sequence: Roll, pitch, azimuth; azimuth not yet realized)

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

resp. up to 8 additional voltages.

\(\text{f} \cdot 32\): \(x, y, z, T, v, d, vs, ds\) (8 values) \([\text{m/sec. resp. } \degree; \ x.3f]\)

\(z\) 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) \([\degree; \times.3f]\)

(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:

- 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.
  \textbf{Up} means: (e.g. 1-2) 1 (below) was sending, 2 (above) receiving

- 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.

- 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.
  \textbf{Down} means: (e.g. 1-2) 2 (above) was sending, 1 (below) receiving
○ 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.

○ 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.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>means less than</td>
<td>20.0%</td>
</tr>
<tr>
<td>1</td>
<td>means 20.0</td>
<td>25.1%</td>
</tr>
<tr>
<td>2</td>
<td>means 25.1</td>
<td>31.6%</td>
</tr>
<tr>
<td>3</td>
<td>means 31.6</td>
<td>39.8%</td>
</tr>
<tr>
<td>4</td>
<td>means 39.8</td>
<td>50.1%</td>
</tr>
<tr>
<td>5</td>
<td>means 50.1</td>
<td>63.1%</td>
</tr>
<tr>
<td>6</td>
<td>means 63.1</td>
<td>79.4%</td>
</tr>
<tr>
<td>7</td>
<td>means 79.4</td>
<td>100.0%</td>
</tr>
<tr>
<td>8</td>
<td>means 100.0</td>
<td>125.9%</td>
</tr>
<tr>
<td>9</td>
<td>means more than</td>
<td>125.9%</td>
</tr>
</tbody>
</table>

(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;timezone;state;x;y;z;T;vel;dir;vels;dirs
2017-08-10 08:25:45;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#: Delimeter) 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

Decimal character: (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)]

NEWLINE (CR,LF or CRLF); (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 Text0x03
<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;0.040;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;010000970000000;...

... 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:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Byte</td>
<td><strong>&lt;SOH&gt;</strong> Start of Header</td>
<td>0x01</td>
</tr>
</tbody>
</table>
| 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).
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.

<table>
<thead>
<tr>
<th>Number</th>
<th>Means</th>
<th>Less Than</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>means</td>
<td>less than</td>
<td>20.0%</td>
</tr>
<tr>
<td>1</td>
<td>means</td>
<td>20.0</td>
<td>25.1%</td>
</tr>
<tr>
<td>2</td>
<td>means</td>
<td>25.1</td>
<td>31.6%</td>
</tr>
<tr>
<td>3</td>
<td>means</td>
<td>31.6</td>
<td>39.8%</td>
</tr>
<tr>
<td>4</td>
<td>means</td>
<td>39.8</td>
<td>50.1%</td>
</tr>
<tr>
<td>5</td>
<td>means</td>
<td>50.1</td>
<td>63.1%</td>
</tr>
<tr>
<td>6</td>
<td>means</td>
<td>63.1</td>
<td>79.4%</td>
</tr>
<tr>
<td>7</td>
<td>means</td>
<td>79.4</td>
<td>100.0%</td>
</tr>
<tr>
<td>8</td>
<td>means</td>
<td>100.0</td>
<td>125.9%</td>
</tr>
<tr>
<td>9</td>
<td>means</td>
<td>more than</td>
<td>125.9%</td>
</tr>
</tbody>
</table>

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 (Analog OFset) 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

Example: uSonic-3 MP, 0…10V, AOF=0

0mA | 4mA | 20mA

Example: uSonic-3 MP, 0…20mA, AOF=20

0V | 3V | 10V

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 AO, 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 AO) output range.

Example:

uSonic-3 MP variant 0…10VDC, ARZ=100, AO=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:

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

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):

\[
\text{maximum value} \times \left( \frac{\text{AOF}}{100} + (1 - \frac{\text{AOF}}{100}) \times \frac{\text{ATV}}{100} \right)
\]

Examples:

<table>
<thead>
<tr>
<th>ATV</th>
<th>AOM</th>
<th>uSonic-3 MP variant</th>
<th>C1...C4 value</th>
<th>AOF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>32</td>
<td>0...10 VDC</td>
<td>0 VDC</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>32</td>
<td>0...5 VDC</td>
<td>2.5 VDC</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>32</td>
<td>0...10 VDC</td>
<td>6 VDC</td>
<td>20</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>ATV</th>
<th>AOM</th>
<th>uSonic-3 MP variant</th>
<th>C1 value</th>
<th>C2 value</th>
<th>C3 value</th>
<th>C4 value</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>32</td>
<td>0...10 VDC</td>
<td>2.5 VDC</td>
<td>5.0 VDC</td>
<td>7.5 VDC</td>
<td>10.0 VDC</td>
</tr>
</tbody>
</table>

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 (Analog Error Mode) 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 their 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 a 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 possibilities 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:

<table>
<thead>
<tr>
<th>Sampling Frequency in [Hz]</th>
<th>SFR=</th>
<th>in [mHz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,1</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>0,125</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>0,2</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>0,25</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>0,5</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>2,5</td>
<td>2500</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4000</td>
<td></td>
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<tr>
<td>5</td>
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<td>6</td>
<td>6000</td>
<td></td>
</tr>
<tr>
<td>7,5</td>
<td>7500</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8000</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10000</td>
<td></td>
</tr>
<tr>
<td>12,5</td>
<td>12500</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>15000</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>16000</td>
<td></td>
</tr>
</tbody>
</table>
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.

\[
\text{instantaneous output rate} = \frac{\text{SFR}}{1000 \times \text{CAV}}
\]
13 Packing

The correct packing of the uSonic-3 CLASS-A MP is essential for 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>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MP_A.20-1</td>
<td>20180814</td>
<td>MP_A.20-0</td>
<td>2.4 ff all</td>
<td>M: new figures of sensor head</td>
<td></td>
<td></td>
<td></td>
<td>A.20RX</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MP_A.20-0</td>
<td>20180808</td>
<td>MP_A.11-1</td>
<td>4.3</td>
<td>C: Additional &quot;==&quot; line in boot message</td>
<td>A: FR#, NLC, NLD, NT0, NTP, SUB, AEM, AIN,</td>
<td></td>
<td></td>
<td>A.20RX</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.1.1</td>
<td></td>
<td>AOM, AOF, ART, ARV, ARZ and ATV added.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.1.3</td>
<td></td>
<td>A: FR1, FR2, FR3 added</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.1.3</td>
<td></td>
<td>C: PR#2 added</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.1.4</td>
<td></td>
<td>C: allowed sampling frequencies SFR</td>
<td></td>
<td></td>
<td>A.20RX</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.1.4</td>
<td></td>
<td>A: NLC, NLD, NT0, NTP, SUB, AEM, AIN,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.1.4</td>
<td></td>
<td>AOM, AOF, ART, ARV, ARZ and ATV added.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.2.1</td>
<td></td>
<td>A: RP4 and SP4 in command list added</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.2.4</td>
<td></td>
<td>A: Description of RP4 and SP4 added</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.1</td>
<td></td>
<td>A: ASCII data output (former 6.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.2</td>
<td></td>
<td>A: Binary data output</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.1.6</td>
<td></td>
<td>A: Framing of data lines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.1.7</td>
<td></td>
<td>C: Differences between instantaneous and averaged data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7.</td>
<td></td>
<td>A: Analog data output (all following chapters are shifted up)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.3</td>
<td></td>
<td>A: Simple NTP-client</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12.</td>
<td></td>
<td>C: List of allowed sampling frequencies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>..._Ki</td>
<td>20180218</td>
<td>ongoing</td>
<td>all text</td>
<td>Wording and typing errors</td>
<td></td>
<td></td>
<td></td>
<td>..._Ki</td>
</tr>
<tr>
<td>MP_A.11-1</td>
<td>20171218</td>
<td>MP_A.11-0</td>
<td>3.3</td>
<td>D: Removed link to none existing chapter</td>
<td></td>
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<td>A.11RX</td>
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