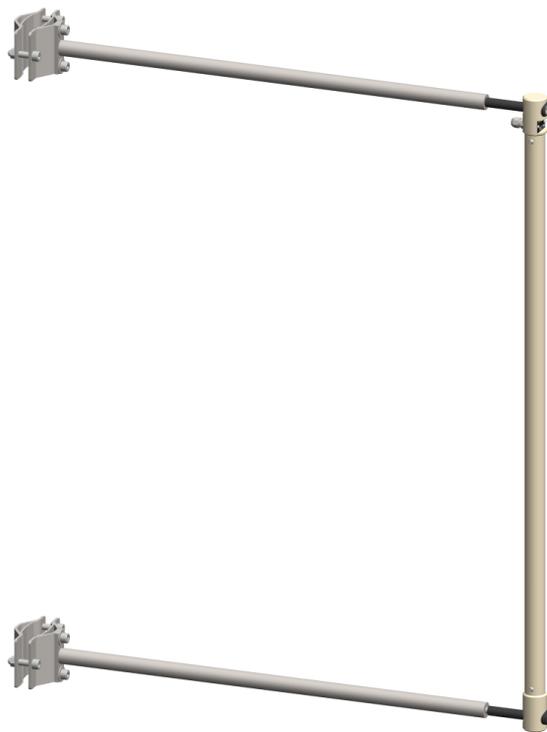# SandFlow SF4

Instrument for measuring
the aeolian flux of solid particles and wind speed

Full documentation
and User manual

Version 5.02

SandFlow™ SF4 is a Swiss made product of ISAW line of meteorological sensing instruments by IAV Technologies SARL, a Swiss based company and original manufacturer of the product since 1997. The ISAW instruments are ultra robust, high performance, very low-power consumption and near zero-maintenance instruments, ideal for a wide range of gravity or aeolian transported liquid or solid precipitations applications. This manual provides the technical characteristics and all the information required to procure, configure and operate the SandFlow SF4 instrument and its accessories. The configuration of the instrument can be done through various direct or remote serial connection methods, as well as by means of the ISAW Toolbox software utility, which is available anytime on our website www.isaw-products.com, this without functional restrictions on use or duration. The articles, dimensions and other technical or informational details described in this document may be subject to minor changes, but any change that could impact the operation of the instrument will lead to a new version of the documentation.

Note about the firmware: This document applies to all instruments with firmware 3.55 onwards. If your instrument operates with an earlier firmware version, we advise you to update it with the latest firmware. However, even if you keep the older firmware, almost all of the information in this manual remains valid.

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Contents

1.   THE ESSENTIAL IN BRIEF

1.1.   Introduction

SandFlow^{TM} SF4 is an advanced electro-acoustic device designed specifically to monitor real-time aeolian sand fluxes and wind speed. It is an extremely robust and reliable instrument for the monitoring and the characterization of saltating and blowing sand.

■   It is a very low-power, maintenance-free and totally sealed acoustic instrument with no mobile parts. It provides continuous online measurements, capturing bursts, storm events, and daily cycles.

■   The sensing part of the instrument is a cylindrical anti-abrasion hard coated tube supported by two strong stainless-steel arms.

■   Saltating or blowing sand and wind laminar air friction induce change in internal acoustic pressure. The two excitations are discriminated as independent signals as a result of a specific acoustic, mechanical and electronic design.

■   The instrument is universally interoperable, it can be connected conveniently to almost any external electrical or computerized interface (data logger, industrial module interface, instrumentation DAQ, USB port, etc.).
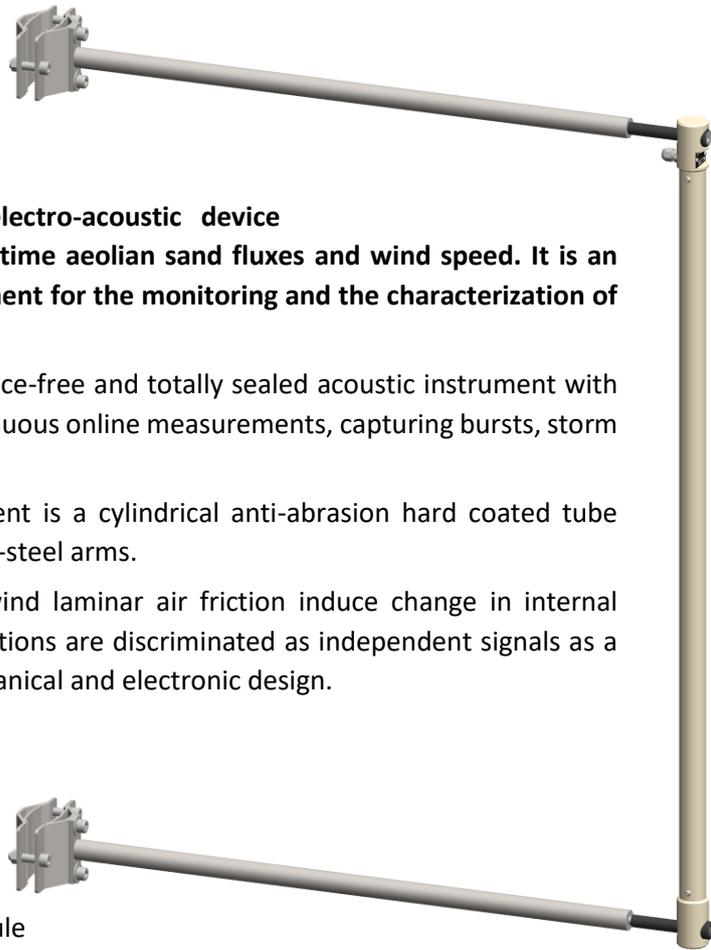
Typical applications:

■   Meteorology (blowing sand, sandstorms, lithometeors)

■   Roadside, railway, airport protection

■   Building and infrastructure surveillance and insurance

■   Land management

■   Applied scientific research

Sand Flux (g/m^2/s)

Wind (km/h)
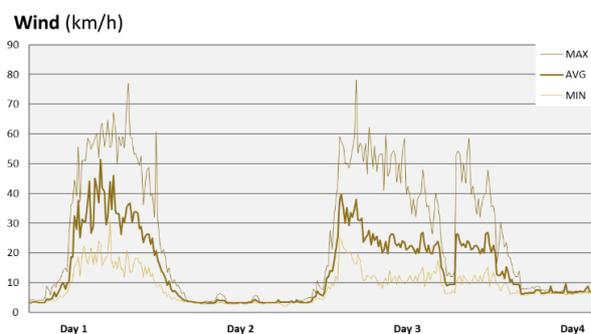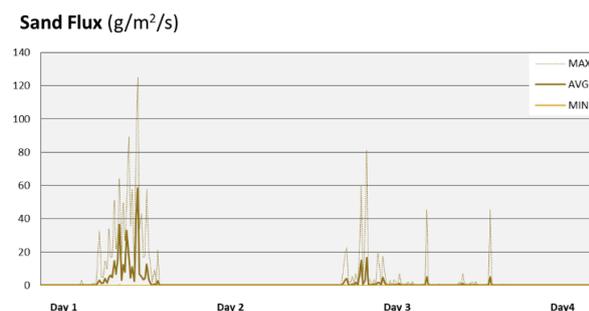
1.2. Operating principle and measurement range

Tip: For a quick start with the instrument, go directly to section 1.12.

Acoustic sensing technology for monitoring aeolian and sediment-driven particle transport has evolved significantly since its first introduction in the 1990s. The FlowCapt instrument, originally developed for snowdrift monitoring in alpine environments, has since become a family of rugged, autonomous environmental instruments capable of detecting and quantifying particle impacts and wind velocity, and —more recently— aeolian blowing sand, and precipitations.

The SandFlow SF4 instrument measures the impacts of the solid particles and the air friction on an omnidirectional aluminum tube, using an ultra-dedicated acoustic transducer, signal processing and calculation. The acoustic-mechanical sensing supports long-term environmental monitoring and the performance constraints and calibration considerations that influence quantitative flux measurements.

1.3. Aeolian sand transport

Wind-blown sand is a major environmental and engineering hazard in arid and semi-arid regions. It contributes to erosion, dune migration, infrastructure damage, and dangerous conditions on railways, highways, and industrial sites. Measuring sand transport—its intensity, vertical structure, and temporal variability—is therefore fundamental for hazard prevention and for designing mitigation systems.

The way sediment moves in the air is decided by the size of the sediment particles. The next figure explicitly summarizes the three transport regimes using classical aeolian literature:

- ▪ **Suspension** (<70 µm) for very fine dust
- ▪ **Saltation** (70–500 µm) dominating natural dune flux
- ▪ **Creep** (>500 µm) through rolling
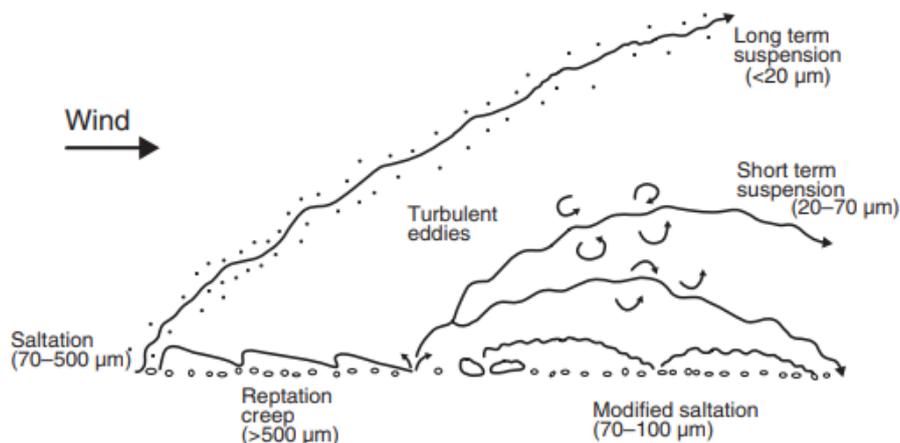
Aeolian sediment transport (Nickling and Neuman, 1994)

Particles that are light and small (up to 70 µm) can be suspended. Because these particles are so light they are easily transported by the wind for a longer period. The lightest particles can be suspended for even a couple of days. The medium sized particles (70-500 µm) are transported by the process that is called saltation. They bounce across the surface because they are too heavy to be transported through the air for a longer time. Creep occurs when particles are too heavy to be transported through the air

(> 500 μm). These particles are transported by rolling over the surface (Nickling and Neuman, 1984). For the experiment sediments are used that have a diameter in the range of sediments that are transported by saltation or creep.

1.3.1.   Realtime detection of saltation and sand drift

The SandFlow SF4 is built around a 1-meter cylindrical tube instrumented with sensitive electro-acoustic transducers that responds best to medium and coarse grains, i.e. the most dynamically relevant transport modes, especially saltation.

When medium to coarse sand grains impact the tube, they generate vibrations whose acoustic spectrum includes:

■   High-frequency pulses from collisions (proportional to particle momentum)

■   Low-frequency oscillations from wind friction around the tube

The air friction also induces some pressure change and acoustic signature that the instrument is able to discriminate. By differentiating these signals, SF4 outputs both:

■   Sand drift intensity (g/m²/s).

■   Wind speed (km/h).

1.3.2.   Early-warning system for storm events

By measuring flux intensities with a time-resolution granularity that can be as short as 1-second, SF4 enables operators and connected automated systems to very rapidly trigger **pre-storm protective actions** such as stowing trackers in a horizontal safe position, closing MVAC filters, reduce exposure of mirrors/panels to high-abrasion conditions, initiate automatic shutdown or protective mode for exposed systems, alert maintenance teams in case of rapid accumulation near critical structures. This capability had been highlighted in many monitoring use-cases where the instrument identified sand bursts and correlated them with problematic deposition events. Example with a railway surveillance on next page.

Using its very high temporal and frequential resolution (30 kHz bandwidth sampler), the SandFlow SF4 detects **the exact onset of sand transport episodes and bursts**, allowing for many indicators early activation of protective responses, in particular the MIN, AVG, MAX and STD statistics of the sand drift intensity (g/m^2/s), and the integrated, **cumulative sand load deposition** over minutes, hours, or days (g/m²).
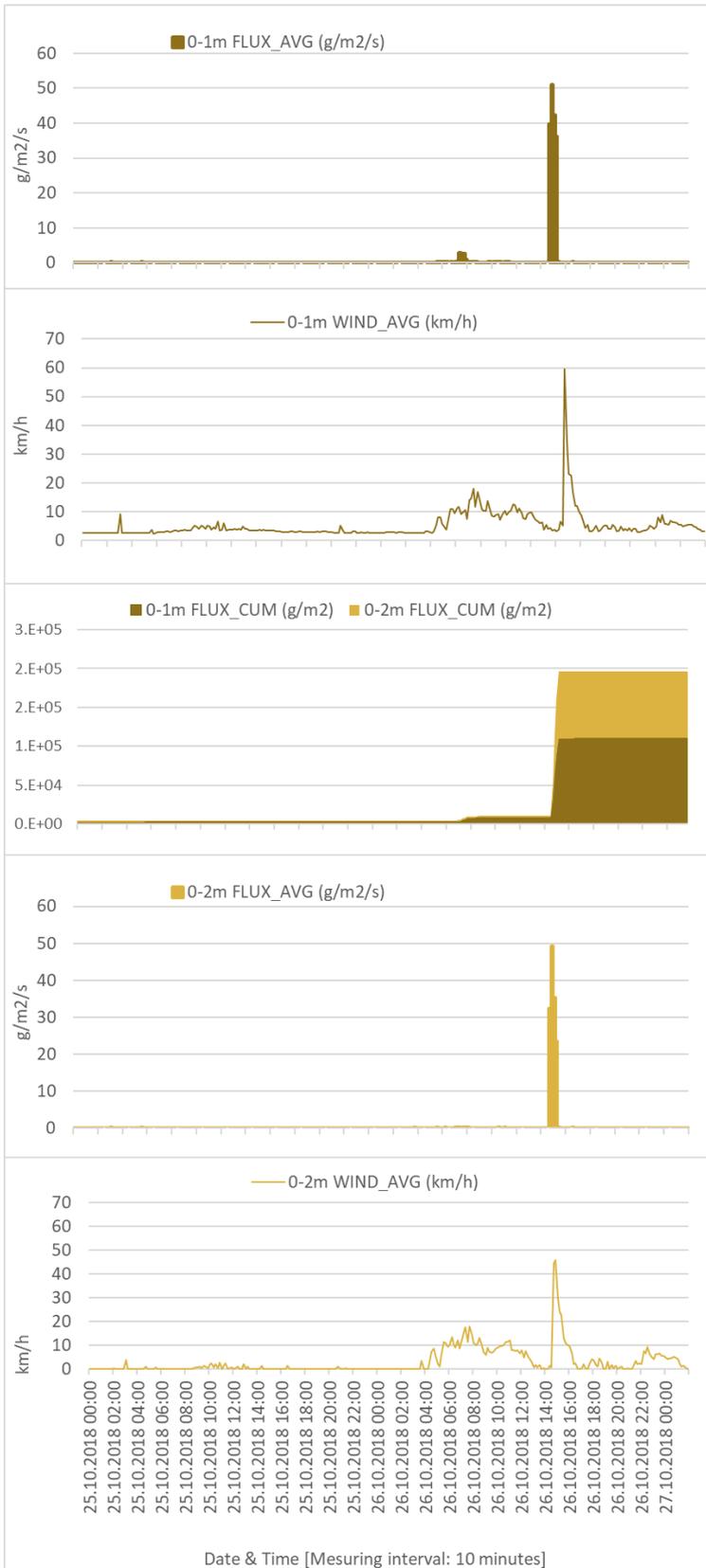
Dahana Desert (KSA) railway
KM173, 27.10 2018

Sand storm status/warning/alert:

< 5 g/m²/s: no or moderate sand flux during the last 10 minutes

5 < g/m²/s < 20: moderate to considerable sand flux occurrence during the 10 minutes

> 20 g/m²/s: strong to extreme sand flux during the last 10 minutes

1.4. Sensitivity to Sediment Texture

In natural dune and desert systems where grain sizes typically range 300–600 µm the SandFlow SF4 performs well. More precisely, controlled laboratory analysis of SF4 measurement efficiency have shown that efficiency depends on **grain size** with the following practical rules:

- **Medium to coarse sand above 300 µm**: efficiency ranging from 30 to 100%

- **Fine sand below 300 µm**: the efficiency rapidly decreases and falls to about only 5% at 100 µm

These results align with the physical principle: at equal velocity small grains deliver much smaller momentum upon impact than coarser grains and this until reaching the acoustic detection threshold. This indicates that in dust-prone or loess environments dominated by < 200 µm grains, the SandFlow SF4 can still be used in its very lower dynamic range, but requires to take account correction factors in the interpretation of the data.

1.5. Environmental robustness

The SF4 is engineered for extreme desert climates:

- Temperature tolerance from **–40°C to +80°C**

- **IP67** dust (and water) protection

- Abrasion-resistant composite tube

- Very low power draw (~2 mA average), suitable for solar-powered autonomous units

1.6. Multi-height installations

Depending on the application case the instrument can be used as a single instrument or in a staggered configuration:

- **Single instrument** at ground height for reptation and saltation detection

- **Two vertically stacked instruments** (0–1 m and 1–2 m) to separately capture reptation + saltation near the surface, and suspension above 1 m.

Multi-level setups reveal the vertical profile of sand transport, which can be useful for transport modeling and for estimating total flux.

1.7. Importance of data integration periods

The instrument can measure with an extremely high time scale resolution of as short as 1 sec, but then practically integrating the data over:

- 10 or 30 minutes or up to 1 hour (short-term average),

- or like 4, 6, 12, 24 hours (long-term average)

provides smoother metrics (and much less data storage need), the adaptation of the time integration being crucial depending the use-case:

- hazard-level thresholds in g/m^2 then set according to certain time integration,

- predictive modeling,

- automated infrastructure responses.

On the next graph (3rd graph) example, a warning/alert/alarm is chosen on the T=1H integration characteristic, with color indications green if < 10 kg/m^2, orange if between 10 and 30 kg/m^2/h and red if > 30 kg/m^2.
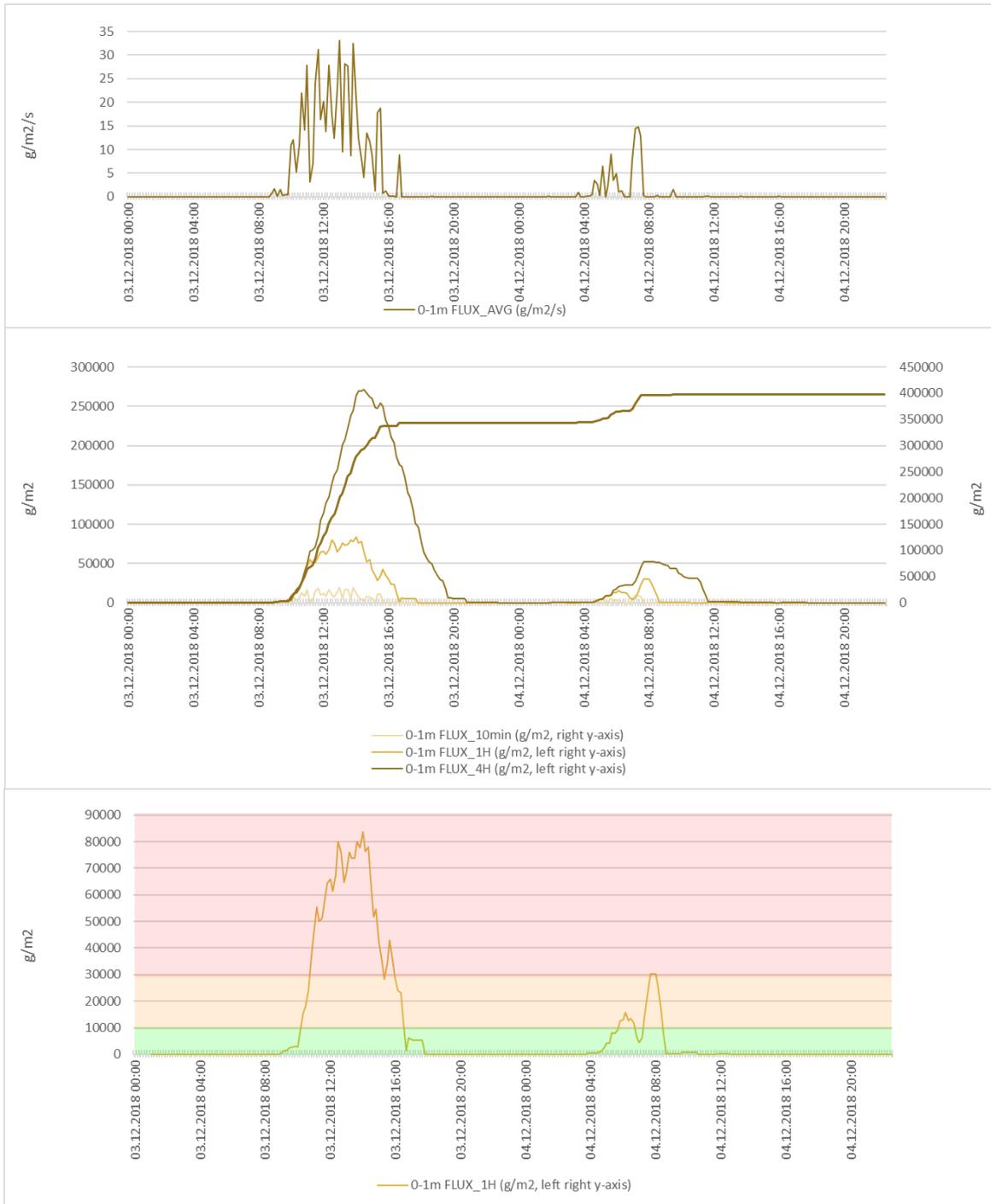
The second graph shows, left y-axis, the same data as the first graph, but integrated with respectively 10 minutes, 1H and 4H duration, and, right y-axis, the cumulative sum of the intensity of the first graph.

After a few wind episodes, one can rapidly acquire a more precise knowledge of the thresholds to fine-tune by examining a first set of data obtained from the default setting of the instrument.

The next example shows a record of over 2.5 months during a typical sandstorm season in the Middle-East region.

- **Green: no or moderate sand flux during** **Orange: moderate to considerable sand flux occurrence** **Red: strong to extreme sand flux**

For highest fluxes, the SandFlow SF4 instrument saturates at 435 $g/m^2/s$, so extreme transport events may partially exceed its dynamic range, though detection of occurrence remains accurate with this very high saturation limit.

For wind, the low limit of the dynamic range is around 5 m/s (which is the physical limit to induce a sufficient air friction vibroacoustic excitation of the sensing tube body of the instrument), and, theoretically, the upper limit is about 400 km/h, but a measurement which could never be reported to our knowledge.

To summarize the SandFlow SC4 technology is exceptionally suited for long-term, autonomous deployments in remote or energy-limited environments, withstanding abrasion and extreme winds, and with the following strengths and limitations:

- robust, continuous monitoring
- excellent detection of event timing
- good correspondence with reference instruments in temporal dynamics
- flux accuracy dependent on grain size (underestimation of the fluxes of finest sand particles)

Detection vs. Quantification: SandFlow SF4 excels at detecting the presence and timing of particle transport. For accurate quantification, sensitivity to particle size must be accounted for. The instrument performs best in coarse-grained environments where acoustic impact energies exceed detection thresholds.

Wind–Flux coupling: A major advantage of the SandFlow Sf4 instrument is simultaneous wind-speed measurement, enabling tighter analysis of the relationship between transport intensity and atmospheric forcing.

Interoperability: Compatibility with SDI-12, analog, serial, pulse, and Modbus outputs ensures integration with meteorological networks, industrial systems, and research platforms.

Note: For more information about the sediment fluxes physics, please refer to **Appendix E**.

1.8. Data example

The following example is a raw data file of a pair of two SandFlow SF4 instruments that recorded a 3-days blowing sand episode with a 10 minutes averaging and writing resolution (i.e. the instrument did record continuously the full episode and produced a data frame 10 minutes).
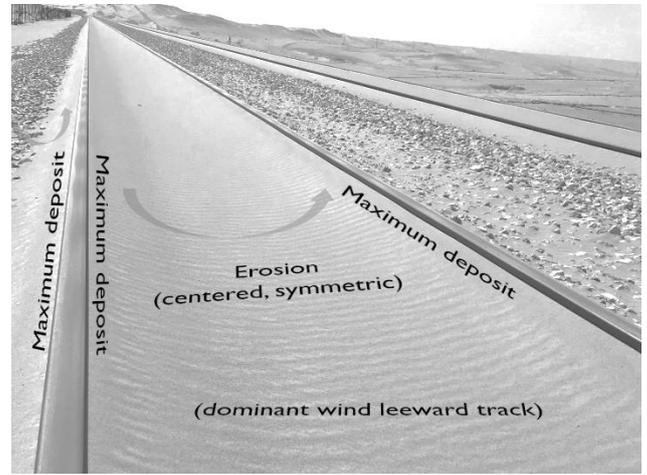
#	TIMESTAMP (s)	DATE & TIME	0-1m FLUX_MIN (g/m2/s)	0-1m FLUX_AVG (g/m2/s)	0-1m FLUX_MAX (g/m2/s)	0-1m FLUX_STD (g/m2/s)	0-1m FLUX_CUM (g/m2)	0-1m WIND_MIN (km/h)	0-1m WIND_AVG (km/h)	0-1m WIND_MAX (km/h)	0-2m FLUX_MIN (g/m2/s)	0-2m FLUX_AVG (g/m2/s)	0-2m FLUX_MAX (g/m2/s)	0-2m FLUX_STD (g/m2/s)	0-2m FLUX_CUM (g/m2)	0-2m WIND_MIN (km/h)	0-2m WIND_AVG (km/h)	0-2m WIND_MAX (km/h)
41	24600	26.08.2018 04:40	0.00	0.00	0.00	0.00	15608.03	3.18	3.34	3.46	0.00	0.00	0.00	0.00	3565.63	0.00	0.00	0.00
42	25200	26.08.2018 04:50	0.00	0.00	0.00	0.00	15608.03	3.22	3.38	3.58	0.00	0.00	0.00	0.00	3565.63	0.00	0.00	0.00
43	25800	26.08.2018 05:00	0.00	0.00	0.00	0.00	15608.03	3.36	3.63	4.18	0.00	0.00	0.00	0.00	3565.63	0.00	0.00	0.00
44	26400	26.08.2018 05:10	0.00	0.00	0.00	0.00	15608.03	3.66	4.25	6.57	0.00	0.00	0.00	0.00	3565.63	0.00	0.55	6.22
45	27000	26.08.2018 05:20	0.00	0.00	0.00	0.00	15608.03	3.88	4.96	6.80	0.00	0.00	0.00	0.00	3565.63	0.00	3.41	7.71
46	27600	26.08.2018 05:30	0.00	0.00	0.00	0.00	15608.03	4.51	6.17	10.27	0.00	0.00	0.00	0.00	3565.63	4.32	6.64	13.62
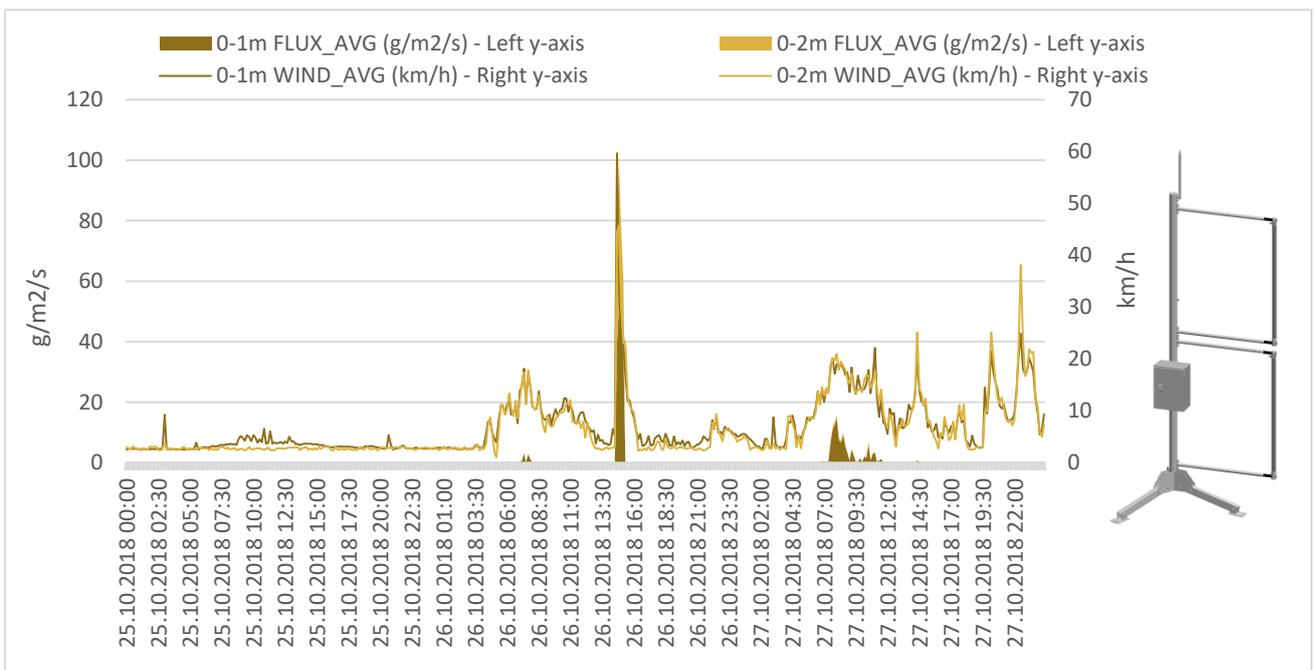
The graph shows respectively the reading of the episode in terms of flux intensity (g/m^2/s) and wind speed (km/h) recorded on each of the two instruments, the one at 0-1m above the ground and the one at 1-2 m above the ground.

The cumulative flux (g/m^2) is a value that represents the sum of the mass flux, i.e. a current value is calculated as the sum of the preceding cumulative value with the product of the current intensity (g/m^2/s) × the measurement interval M. For example, as per the table below, at line 16, we get M=9600-9000=600 sec with a flux average intensity of 0.17 g/m^2/s, which gives a cumulative flux increase of 600 × 0.17 = 102 g/m^2, which added to 760.82 g/m^2 gives the current updated value of 760.82 + 102 = 860.82 which is 99.833% of the displayed value 864.26 g/m^2. The 0.0017% (1/600) difference between the logged value and our calculated value comes from rounding's and the fact that in the internal calculation of the instrument, the last percentile outlier values and the self-noise values are removed from the cumulative calculation, so that the cumulative counter is more accurate and does not slightly increase because of long-term integration of non-significant values when the instrument detects only self and background noise.

#	TIMESTAMP (s)	FLUX_MIN (g/ m^2/s)	FLUX_AVG (g/ m^2/s)	FLUX_MAX (g/ m^2/s)	FLUX_STD (g/ m^2/s)	FLUX_CUM (g/ m^2)	WIND_MIN (km/h)	WIND_AVG (km/h)	WIND_MAX (km/h)
13	7800	0.06	0.08	0.09	0.01	624.41	161.43	173.18	181.51
14	8400	0.06	0.1	0.13	0.03	684.37	161.83	193.32	252.63
15	9000	0.07	0.13	0.19	0.04	760.82	167.06	218.69	258.09
16	9600	0.1	0.17	0.29	0.06	864.26	190.29	233.58	262.77
17	10200	0.12	0.23	0.56	0.14	999.92	200.66	232.47	251.38
18	10800	0.13	0.22	0.47	0.11	1131.67	219.78	238.89	258.31

The following graph shows an overlay of the cumulative flow value recalculated according to the formula explained earlier, and the native cumulative flow value produced by the instrument, over a total period of 47 days (6748 timestamps × 600 sec. / 24 h / 60 min / 60 sec = 46.86 days).
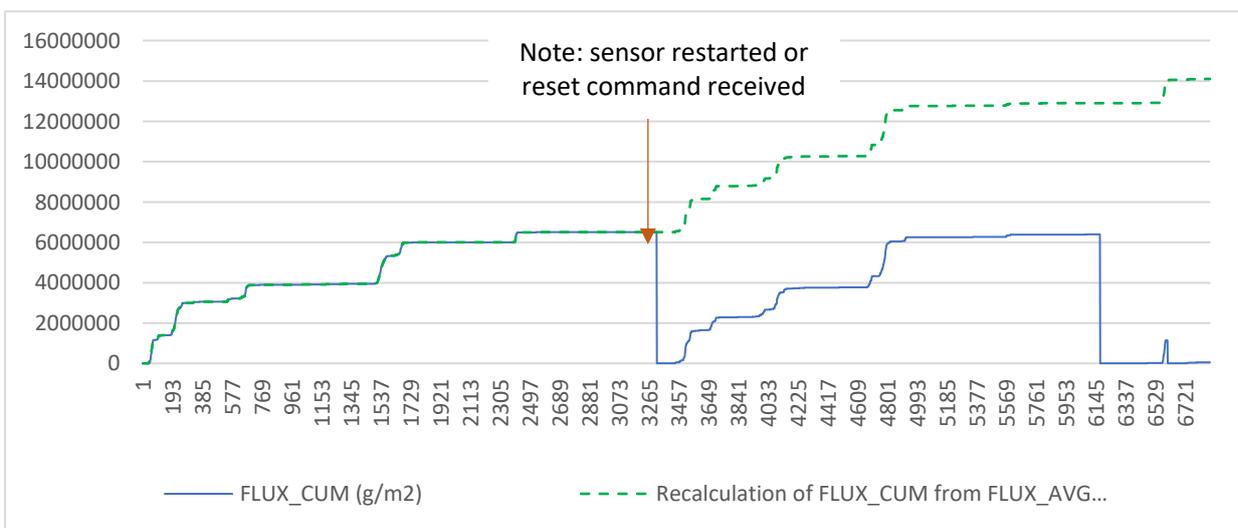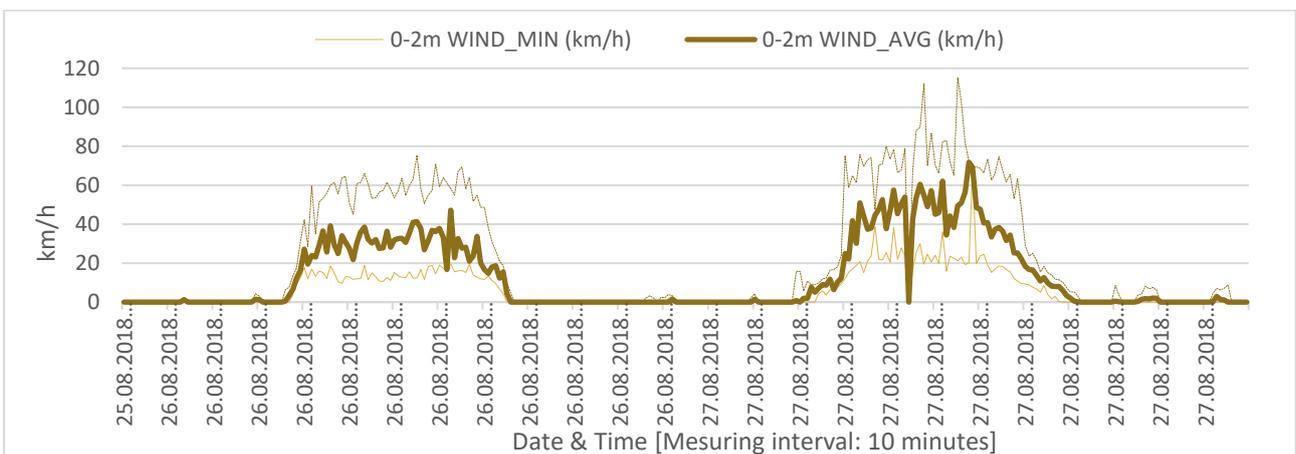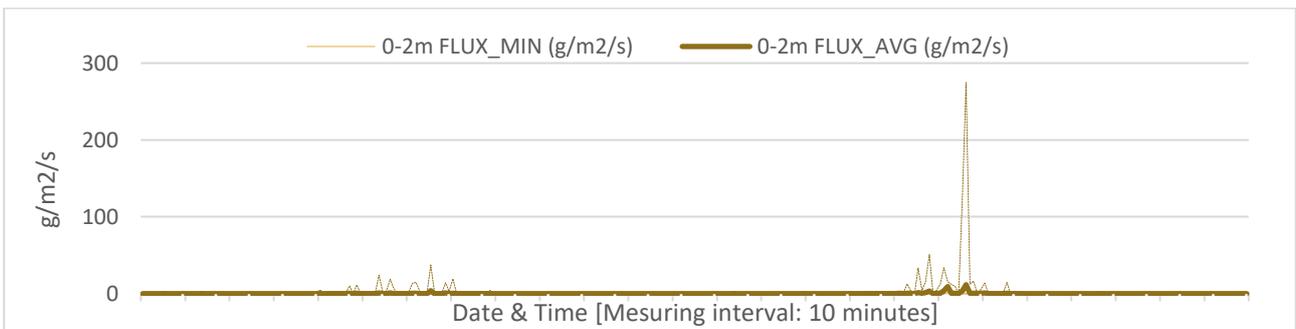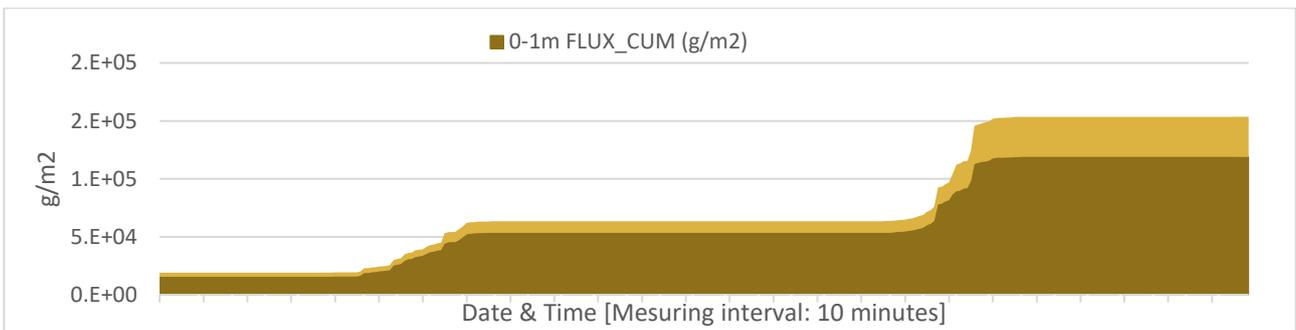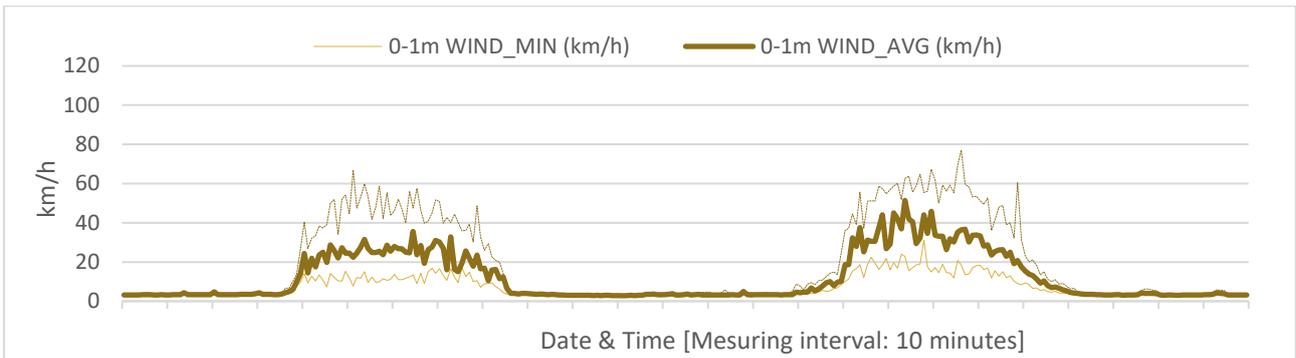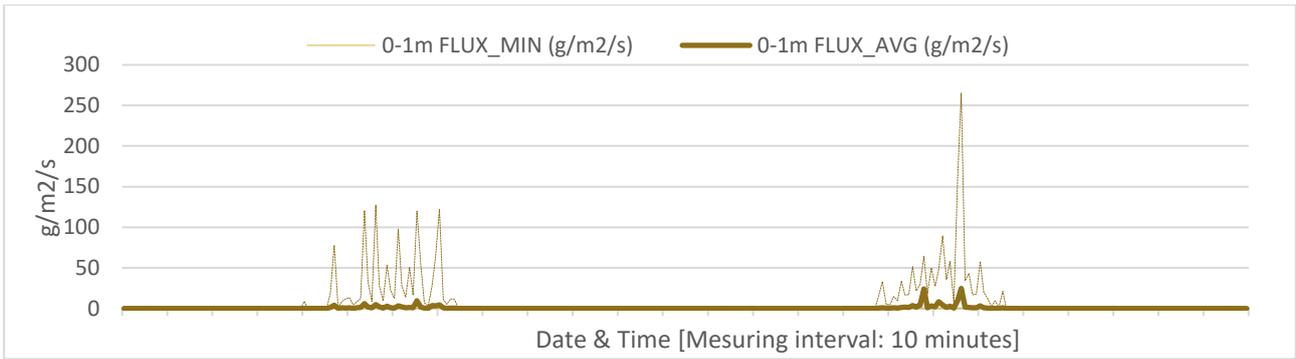
1.9. Communication protocols

The following serial and bus communication protocols can be used with all ISAW instruments:

Protocol	Notes
MODBUS-RTU over RS-485 (with Modbus adapter)	Modbus RTU is recommended for network installations. The device can operate on a Modbus RTU network, or in a point-to-point configuration with the Modbus RTU protocol.
Continuous ASCII over RS-422/485 (native)	The device can be configured to output serial data every "M" seconds. Necessarily, in this mode the device must be in a point-to-point arrangement. The output format is configurable by the user.
SDI-12	The device is certified SDI-12 v1.3 compliant, a multi-drop serial data bus interface, compatible with long-distance cabling (typically up to 150 m) and with possibility to connect several instruments.

The instrument can also be used in **analog mode**, i.e. through the reading of DC voltage outputs (+0 to +2.5 V or +0 to +5 V analog voltage; continuous or pulse), or, when using the AD420 accessory, adapting to a **4-20 mA current loop mode**.

1.10. Main operating modes

1.10.1. Smart adjustability for all uses

While the instrument is capable of producing very high-resolution data down to a 1-second integration time, in meteorology applications the data services often process and display the data averaged on relatively longer periods of time, like typically intervals of 1 minute, 5 minutes, 10 minutes, 30 minutes, 1 hour, 4 hours. When using and manipulating time series of meteorological data, there is thus always some risk of making averaging miscalculations when displaying a data with a certain time interval granularity, while the data was recorded with another production interval (i.e. the output measurement or writing interval).

There are indeed most often different temporizations at play in a measure, because when we observe a physical phenomenon with a system, several durations come into consideration:

- The actual observation time of the phenomenon: **Acquisition "A"**.

- The Stand-by time which allows to optimize the energy consumption when necessary.

- The observation **Cycle "C"** includes one acquisition period and one stand-by period.

- The **Measurement "M"** time is the interval between two consecutive data writings. It usually covers several cycles.

This is why it is necessary to make averages and it is over these periods that the statistical data must be calculated. For example, as per the scenario figure above, supposing we have an instrument operating as follows:

- With a duty-cycle of 50%, to cope with some power consumption limitations, and with a writing interval set to five minutes (so we will get a data frame every five minutes, which has to give the flux of the last five minutes, whereas the instrument was acquiring and measuring only 50% of that duration).

- Or at the extreme, the same scenario still with a writing interval set to five minutes but measured with a duty-cycle of only 10% (so a data frame every five minutes that has to give the prognosis (supposedly the phenomenon was stationary over the period) of the flux of these last five minute, while the instrument was acquiring and measuring only 10% of that duration, i.e. the phenomenon observed during one second every 10 seconds):

- As per the averaging calculation process described in the above example figure, and, again, with the assumption that the observed event (blowing sand) was stationary over the total period of a cycle (resp. 50% of 1 minute or 10% of 1 minute), the instrument will automatically process the averaging and the statistics accordingly.

The choice of the internal averaging and output writing and logging data rate of the instrument then depends on several contingencies, among them the memory capacity and/or the transmission baud rate of the receiving, storing and displaying infrastructures. Furthermore, in some cases, the total power consumption of the instrument can be an important concern, especially when operating in isolated remote locations.

To be able to cope very easily and smartly to every situation, the instrument can be adapted very largely to almost any desired averaging, data rate and total power consumption through **a very simple and immediate principle of operation that entirely relies on only three parameters of operation, and is called "the A,C,M setting" of the instrument**:
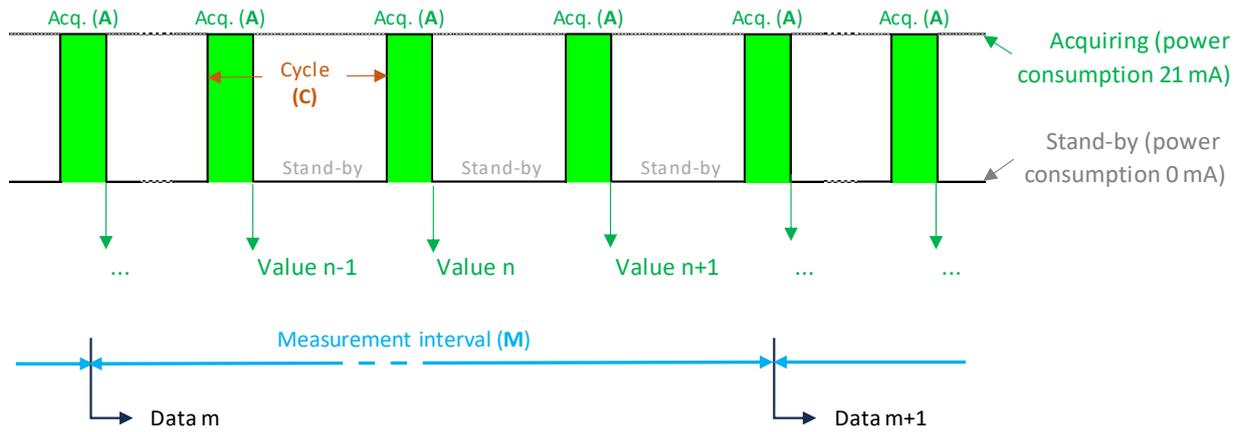
Measurement settings	Description	Default value
Measurement duration [M]	The measurement duration M is the period you would like to read a new measurement result, in other words, a data statistics of the period M. In other words, it is the time between the production by the instrument of two consecutive output data records. Depending on your need, it can vary from one second to several minutes, hours or even more. Whatever duration M you set, the instrument will internally aggregate and process all intermediate acquisitions and produce exactly the desired data.	10 minutes
Acquisition duration [A]	During the measurement period, the instrument will make some acquisitions and process them to produce the result. Acquisition can be continuous, or, in order to lower power consumption, it can also alternate with a certain percentage of stand-by periods where the instrument does not consume any current.	10 seconds
Cycle duration [C]	Sum of one acquisition duration A and one stand-by duration. If the instrument is set to operate continuously (i.e. no stand-by), we simply get A=C. When the stand-by duration A equals the measurement duration M, the instrument is continuously acquiring and there is no need for averaging (1 acquisition = 1 measurement). When the measurement duration M is greater than the acquisition duration A, the measurement result is produced as the MIN, AVG, MAX, and STD statistics of all the acquisitions produced during M.	10 seconds
Duty cycle	Ratio between acquisition duration A and cycle duration C, i.e. fraction of time in which the instrument is effectively active to the fraction of time it is in stand-by mode and drains no current. The greater the duty cycle, the more precise and accurate the data will be to the phenomenon being measured. For example, a duty-cycle of 10% means that over a period M (for example M=10 minutes) the instrument is 90% of the time in stand-by mode (54 seconds per minute) and the acquisition happens 6 seconds per minute.	100%

Note: This particularity is extremely useful to avoid any miscalculation in the time averaging of the output data, and it allows the instrument to be used even under severe power consumption constraints, with an accuracy that depends on how much the phenomenon is stationary over the measurement cycle.

The higher the duty-cycle, the higher the accuracy of the instrument (i.e. maximal accuracy reached for the duty-cycle set to 100%), so that, unless some power limitations reasons, the duty-cycle of the instrument shall be left to 100%.

For situations with power limitations and where the episodes of aeolian sand transport are well established, the duty-cycle can be lowered to 10% with only a minor loss of accuracy.

1.10.2. Standard continuous operation mode

The most standard – and also default factory – configuration of the SandFlow SF4 instrument is a setting of A,C,M = 6,60,600 s, i.e. the instrument continuously acquires sequences of A=6 seconds and the data statistics is produced every 10 minutes on 10 consecutive samples:

"The sensor is acquiring 6 seconds every minute (stand-by period of 54 second). It produces a data frame every 10 minutes that is a MIN, AVG, MAX and STD statistics on 10 consecutive acquisitions"

1.10.3. Maximum accuracy mode

To analyze the aeolian sand transport with the maximum time resolution of the instrument (1 second), set the instrument with the values A=C=M=1 second, which corresponds to the following processing:
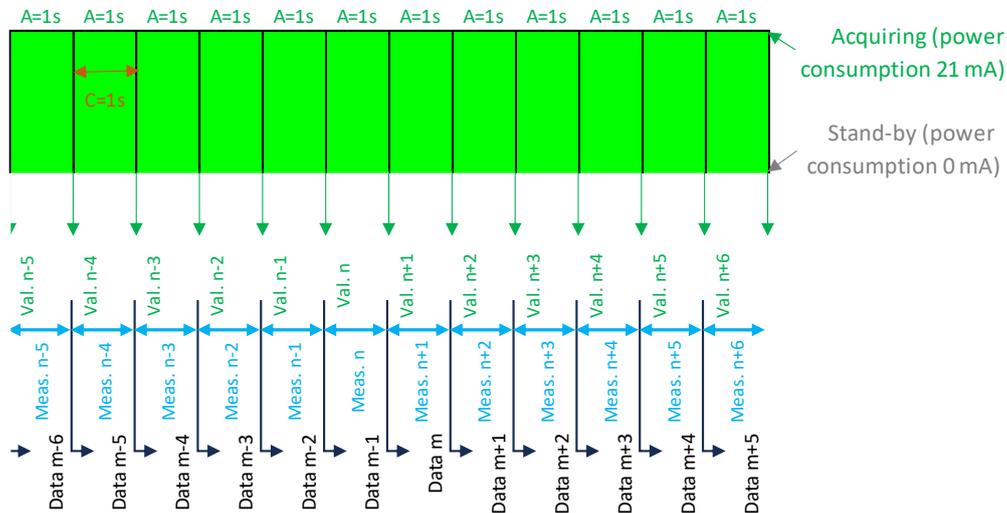
"The sensor is continuously acquiring (no stand-by periods). It produces a data frame every second, which is a statistic with MIN=AVG=MAX=Value n, and STD=0."

According to this diagram:

- The instrument will be continuously powered and acquiring, i.e. a duty-cycle of A/C = 1 = 100%.
- There is no need for any averaging nor statistics, as each acquisition of A=1 second is directly written in a data frame.

In summary, this configuration allows to be in continuous acquisition with a data logging every 1 second.

Note: With a setting of A=C=M=10 seconds, we would also have a continuous measurement, but with a data logging every 10 seconds, and still with AVG=MIN-MAX and STD=0. In this configuration, the data granularity is less precise, but it **saves space on the datalogger**.

1.10.4. Ultra-low power mode

At the cost of a greater probability of reducing the good coverage of the observed phenomenon, the consumption of the instrument can be reduced as much as desired by reducing the duty-cycle. In plain terms, with a small duty-cycle, the longer and more stationary the flux, the better the precision remains, because stationarity and duration mean that even if the phenomenon is observed only partially, the acquisition periods are faithful to the average intensity of the phenomenon.

Compared to the maximum accuracy mode of the preceding section, to reduce the consumption of the instrument say to a factor of 10, the duty cycle must be set to 10%. In this case, it seems wiser to establish this setting with the highest possible periodicity, i.e. better choose A = 1 second and C = 10 seconds than A = 1 minute and C = 10 minutes, because we have a better chance to catch possibly short duration bursts

1.10.5. Analog output mode

In analog output mode, just possibly set the Measurement interval "M" according to your reading device: if your reading device is programmed to periodically read a voltage or current from the instrument, set the Measurement interval to the same period. Then you will always get the expected data, whatever the synchronization between the reading device and the instrument, because the analog outputs of the instrument are persistent on the wire until refreshed by the next measurement.

For example, if you have configured your instrument with a 1-minute Measurement duration, and your reading instrument is configured to take one reading of the voltage or the current every minute, then, except for the residual internal clock drifts of both instruments (which may rarely cause a loss of data), you will always get the live current value of the last minute on the reading side.
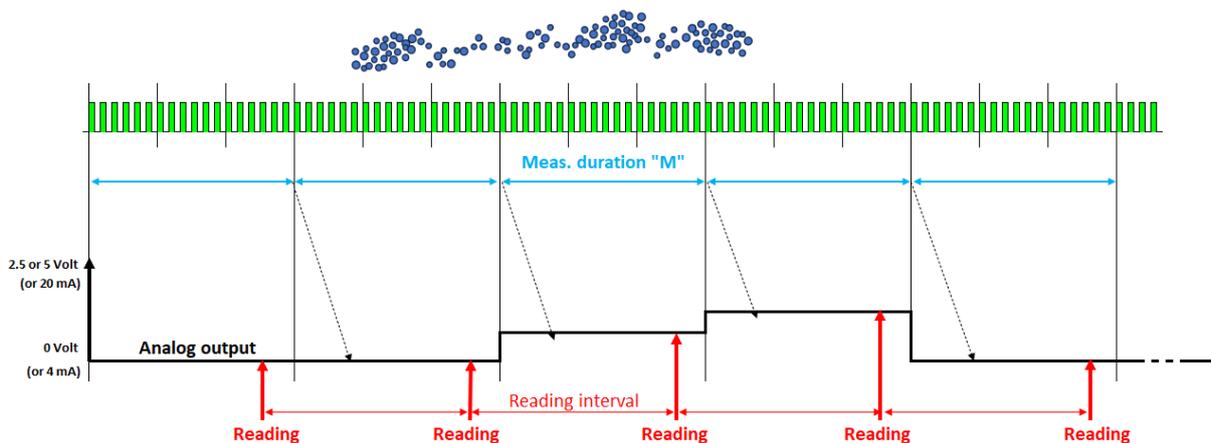
Also, in analog mode, note that the instrument is able to operate in **pulse mode**, i.e. a mode in which each time a certain accumulation of the physical phenomenon (aeolian sand transport) happens, a standardized pre-configured pulse is produced.

1.11. The ISAW Toolbox software suite

Download and install the free ISAW-Toolbox software suite from www.isaw-products.com.   Add an ISAW icon on your Desktop to ensure a direct access to the ISAW-Toolbox utilities.

Plug the instrument to your computer using the USB Link accessory (UDONG). Wait for the device driver to be automatically installed and completed.

Note: If the driver is not properly installed, download it from https://ftdichip.com/drivers/vcp-drivers/ and install it manually: in the "Configuration panel" of your computer, open the "Device manager", and in the "Ports (COM & LPT)" section, you will find a new serial communication port (e.g. COM7).

 The ISAW-Toolbox software suite includes a range of utilities and resources that you may need to configure, operate or maintain your ISAW instrument:
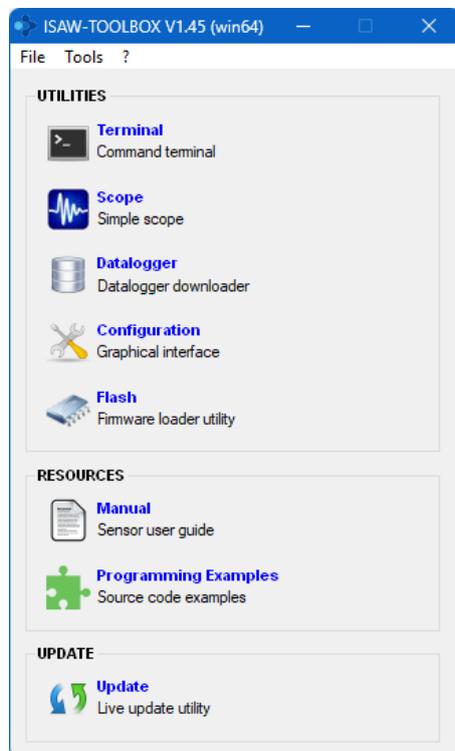
UTLITIES:

Terminal: Serial terminal emulator used for example to display the data produced by the instrument or to send a command to the instrument.

Scope: Simple scope tool allowing to check the live response of an instrument.

Datalogger: Download the data stored in the instrument's internal datalogger.

Configuration: Change the instrument's configuration parameters.

Flash: Update the instrument's firmware.

RESOURCES:

Manual: ISAW documentation (PDF files)

Programming Examples: Source code examples that you can use to interface your instrument with your acquisition equipment.

UPDATE: Check for new upgrades of the utilities or resources.

When opening one of the ISAW-Toolbox Utilities, select the **Serial port** the instrument is connected to, then press the **[Connect]** button. The connection procedure is completed when the [Connect] button is disabled and the [Disconnect] button is enabled.

Notes: If the instrument is plugged in after the start of the application and you can't find the serial port in the list, click on the reload button 🔄 to update the list, then select the right port.

When switching from one utility to another, first **[Disconnect]** the instrument from the first utility before connecting it to the other one.

IAV Technologies constantly improves its products and provides upgrades of the ISAW instruments firmware as well as for the ISAW Toolbox utilities. Each time you open the ISAW Toolbox, it automatically checks for new upgrades of tools and resources.

1.12. Getting acquainted with your instrument

In this section we propose two ways to get acquainted with the instrument in a few minutes: either with a computer, or with a smartphone (or tablet).

1.12.1. Quick start using a computer

You will need:

- your SandFlow SF4 instrument,
- the USB link accessory (UDONG) provided with the instrument,
- the ISAW-Toolbox software suite installed on your computer (PC or Mac with USB port).

Tip: To download and install the ISAW-Toolbox software suite and plug your instrument to your computer using the USB link accessory, see § 1.3.

Open the Scope utility and connect your instrument.

TO CHECK THE LIVE RESPONSE of your instrument, open the **Scope utility** of the ISAW Toolbox and connect your instrument. Scratch gently the surface of the tube with your fingernail, a pen or a screwdriver. A live signal appears on the scope window (see example hereafter).
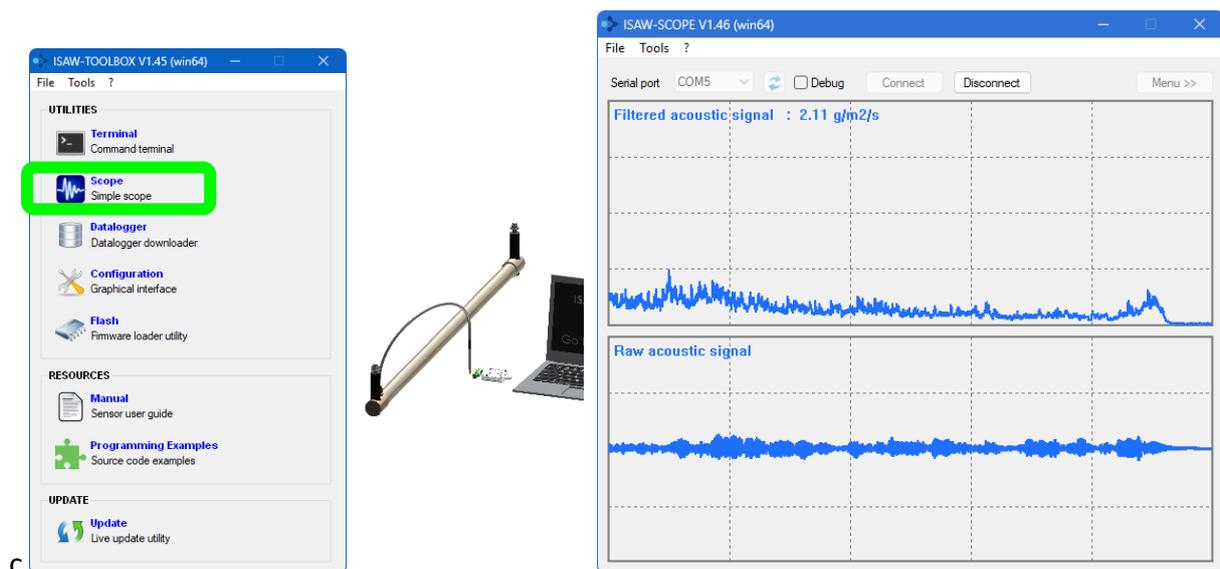
[Disconnect] your instrument when the test is over.

TO SEE THE DATA FRAMES produced by the instrument, open the **Terminal utility** of the ISAW Toolbox and connect your instrument. Scratch gently the surface of the tube with your fingernail, a pen or a screwdriver. The values in the displayed frames should increase according to the speed and force of the scratch.
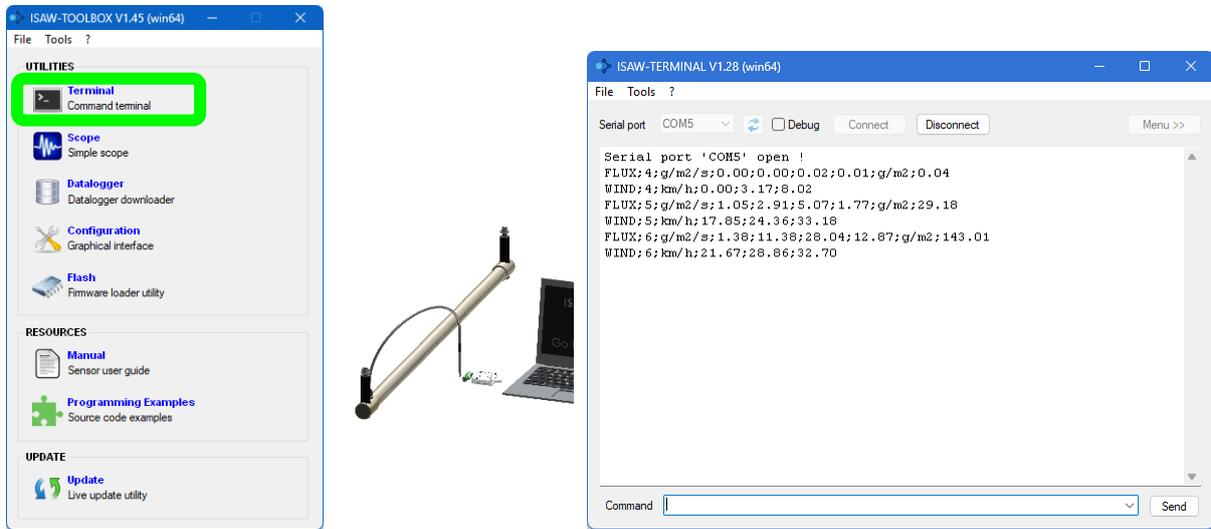
[Disconnect] your instrument when the test is over.

Note: In its default factory configuration, the instrument provides data **every 10 minutes**. To increase the data rate, adjust the averaging parameters of the instrument: in the **Configuration utility** of the ISAW Toolbox (see screenshots below), [Connect] your instrument [1], go to the Averaging panel [2] and set the values of parameters Acquisition (A), Cycle (C) and Measurement (M) respectively to 2 seconds, 2 seconds and 10 seconds [3], then press [Apply], [Disconnect], and go back to the Terminal utility. With this new configuration, the instrument measures continuously and produces a data frame every 10 seconds, and the MIN, AVG and MAX values are statistics on the 5 consecutives acquisitions of 2 seconds each (more explanation about data and averaging rate in section 1.3).
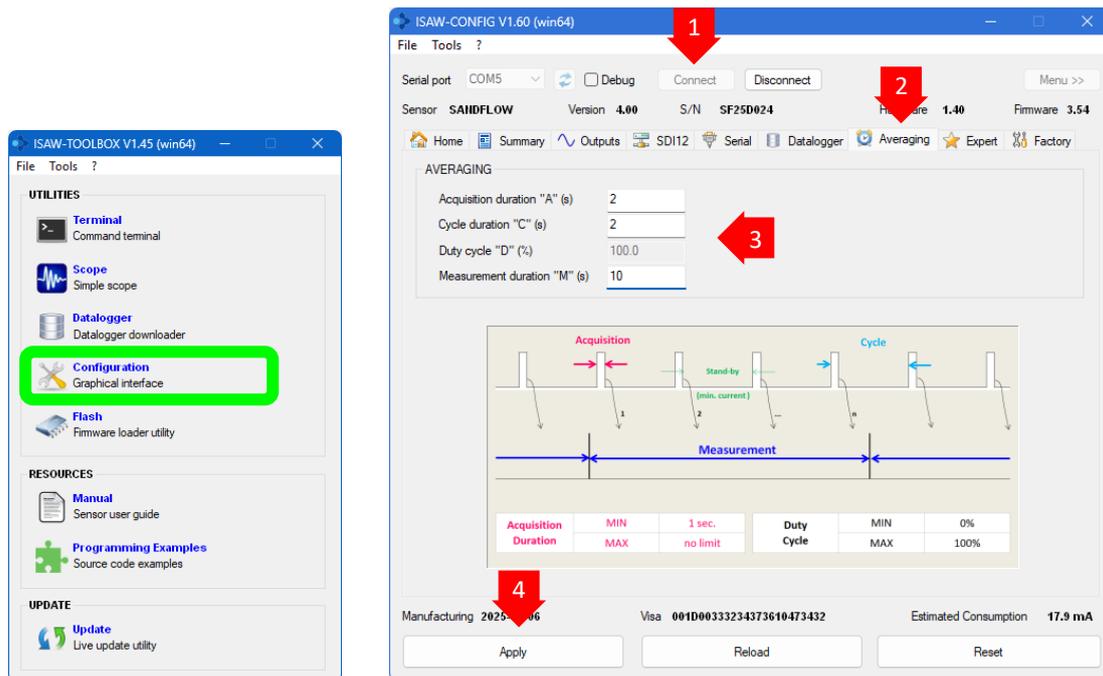
TO RECORD AND DOWNLOAD THE DATA: By default, the instrument's internal datalogger is set to **Cyclic** so the instrument has already recorded your test data and you can retrieve it by using the **Datalogger utility**:
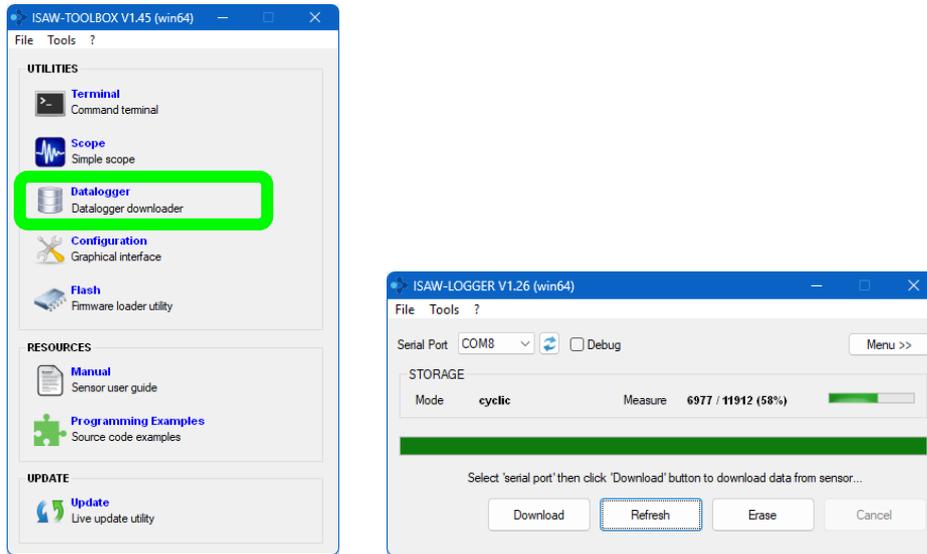
1.12.2. Quick start using a mobile device (smartphone, tablet)

You will need:

- Your SandFlow SF4 instrument.
- the USB link accessory (UDONG) provided with the instrument, with USB-to-USB-C adapter,
- a generic terminal / console app such as "Serial USB Terminal" installed on your mobile device (smartphone or tablet with USB-C interface).

Note: The instrument is directly powered by the USB-C connection.

Direct USB-C connexion
to smartphone

Terminal app settings: Make sure to choose a baud rate of 115200. The SandFlow SF4 instrument is then immediately recognized and the data frames displayed in text mode. Frame example:

```
FLUX;4;g/m2/s;0.49;15.63;31.15;14.33;g/m2;156.93
WIND;4;km/h;67.15;80.47;89.76
```

The frame contains all the data for characterizing the flux and the wind speed. Its definition is provided in the § B.4.

Note: In its default factory configuration, the instrument provides data **every 10 minutes**. To increase the data rate, set the Acquisition, Cycle and Measurement parameters of the instrument to a shorter duration, for example every 10 seconds by typing the following commands:

set avg-a=2
set avg-c=2
set avg-m=10

With this new configuration, the instrument measures continuously and produces a data frame every 10 seconds, and the MIN, AVG and MAX values are a statistic on the 5 consecutives acquisitions of 2 seconds each (more explanation about data and averaging rate in section 1.3).

TO CHECK THE LIVE RESPONSE of your instrument, scratch gently the surface of the tube with your fingernail, a pen or a screwdriver. The values in the next displayed frame will increase according to the number and intensity of the hits.

TO RECORD AND DOWNLOAD THE DATA: By default, the instrument's internal datalogger is set to **Cyclic** so the instrument has already recorded your test data and you can retrieve it by typing the following command:

datalogger download

A .CSV text file is produced, containing all recorded data frames.

1.12.3. Stand-alone use without any peripheral

In the simplest way of use, just power the instrument with a standard USB charger using the USB link accessory, and let the instrument operate in **standalone** mode on its internal datalogger.

Tip: Make sure that the datalogger is enabled, which is the case in the default factory configuration.

No software installation is required, and when you need to collect the recorded data, just connect your instrument to a laptop or mobile device and retrieve the data file from the internal datalogger. Note that the device is not equipped with an RTC, thus the appended data is not timestamped with absolute date and time. In case of temporary power shutdown of the instrument, when the instrument is powered again, the data continues to be appended after the last record.

You can also indefinitely log the data of the instrument on a computer by the means of the *livelogger utility* which is a programming executable example available with the ISAW-Toolbox software suite. In this case, instead of connecting the USB link accessory to a USB charger, connect it to your computer and execute the *livelogger* program. This way the data will be timestamped and headed using with the computer clock.

Note: Of course, in more integrated ways of use, the instrument can as well be connected to most of the existing datalogging, peripheral, network or all other kind of external units to get remote unlimited monitoring. All these ways of use are explained in details later in this document.

1.12.4. Direct USB serial connection without UDONG

To connect the instrument to your computer without using the USB link accessory, you can do a custom connection as follows:

■   Do not directly connect RX and TX wires to a serial RS232 connector (like a DB9).

■   But use an **FTDI 3.3V serial USB converter/adapter** such as model https://ftdichip.com/products/ttl-232r-3v3-we/ (USB-to-TTL Serial Adapter Cable w/ Embedded Controller, 3.3V, Wire Ended), or equivalent (several other cable termination variants are available). Such an adapter is required to adapt the TTL 5V of the RS-232 to the 3.3V of the device.

2. SANDFLOW SF4 ACCESSORIES

Ref.		Description
C2BRA		Complete **mounting kit** for fastening the instrument anywhere. This item is included in the SFBRA reference.
UDONG		**USB Link accessory** for connecting the instrument to a computer or a mobile device with USB-A or USB-C port. Provided with each SandFlow SF4 instrument.
EXT10		**Cable extension, 10 meters**, including junction box (Note: you can chain several items, or ask for a specific cable length, on request).
MOBUS		**Modbus RTU-485 adapter** for connecting the instrument to a Modbus RTU-485 environment.
AD420		**4-20 mA adapter** for converting the analog voltage output of the instrument in 4-20 mA current loop.
TMAST		Supporting structure: Tripod mast

C2BRA – Fastening arms (mounting kit)

The SandFlow SF4 standard mounting kit is composed of 2 cylindrical arms fastened to V brackets adaptable to a mast of outer diameter between 16 and 86 mm. They can also be screwed directly onto a flat surface. See mounting examples on page 57.

UDONG – USB Link accessory

The UDONG is a **universal USB-to-serial TTL3V3 interface** for direct connection of any ISAW instrument to a PC, Mac, Linux, etc. It enables the instrument's power supply and the immediate use of all the software features of the ISAW-TOOLBOX freeware. The USB dongle is generic and can thus be used or interchanged with all ISAW instruments.

Main features:

- Immediate and standard consistent 8-pin connector and pinout

- Direct 12V (84 mA) power supply (from USB 5V 150 mA) of every ISAW instrument

- Genuine FTDI USB-Serial converter (FT232R). Reliable connection, drivers often already installed on Windows/Mac.

- USB port offering a solid and robust design. "Flex" micro-USB cables can be used. Reduces the risk of the USB connector breaking off the board.

- Bright LEDs for Power, RX, and TX.
  The **power LED** is on when the dongle is plugged into the computer's USB-port and switched on. The **TX LED** turns on when data is **T**ransmitted (sent out) through the USB port, while the **RX LED** turns on when data is **R**eceived from the USB port.

ISAW instrument cable   *USB COM port*
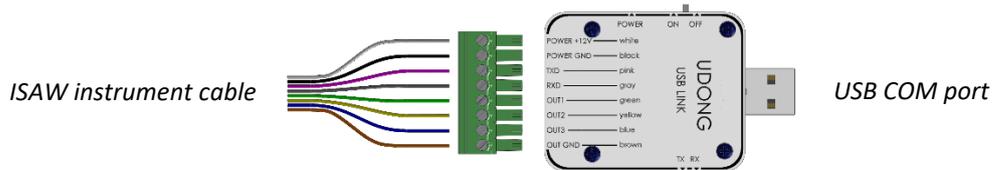
EXT10 – Cable extension, 10 meters

Each instrument is delivered with a 5-meter cable (see description and reference in § 4.1). Use one or several EXT10 cable extensions to extend this default length up to typically 200 m.
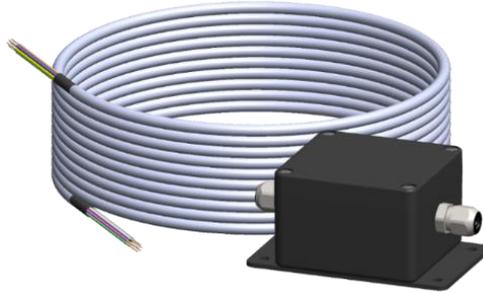
EXT10 is a **10 meters extension of the ISAW instrument cable**, equipped at one end with an IP68 aluminum enclosure **junction box**, which contains an 8-pin screw connector to connect any ISAW instrument or chaining several EXT10 extension cables.

Instrument cable
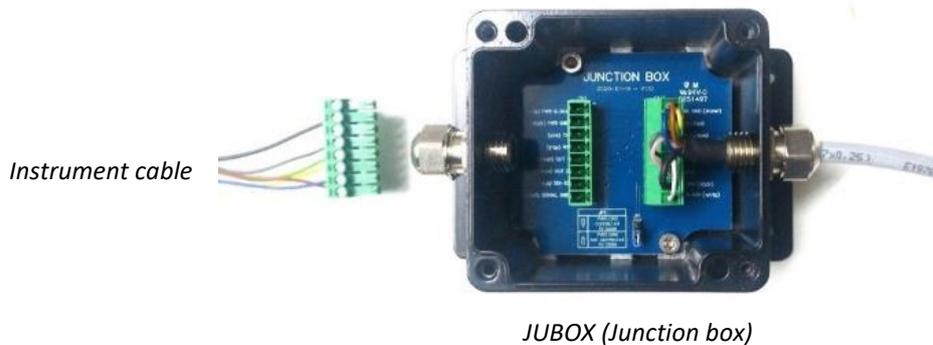
JUBOX (Junction box)

Plugging the cable extension:

Open the junction box (4 screws), disconnect the instrument wires from the terminal block plug, thread the instrument cable into the junction box through the cable gland, connect the instrument wires back into the terminal block plug, plug it into the junction box, tighten back the cable gland, tightly screw the lid back on the junction box.
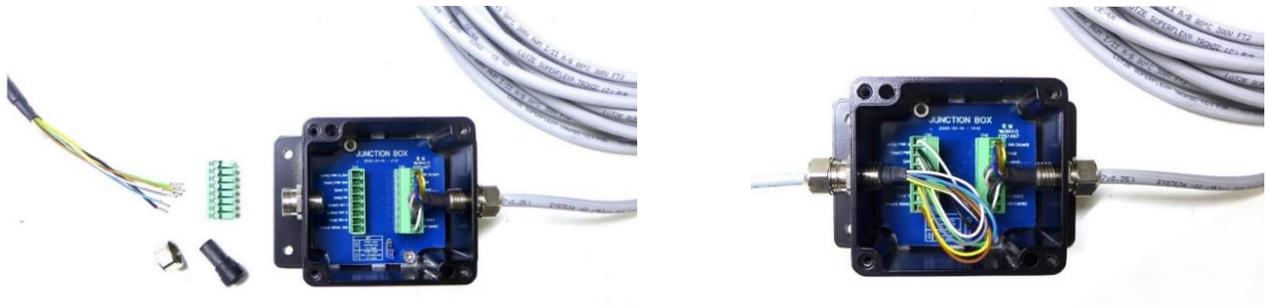
MOBUS – Modbus adapter

The ISAW **Modbus RTU RS485 Adapter** (MOBUS) enables the power supply and connection of any ISAW instrument to a Modbus network.

MOBUS is the recommended accessory to interconnect the instrument through the open serial Modbus RTU (RS485) protocol based on a master/slave or client/server architecture. The fieldbus environment is the base level group of digital networks in the hierarchy of plant networks.
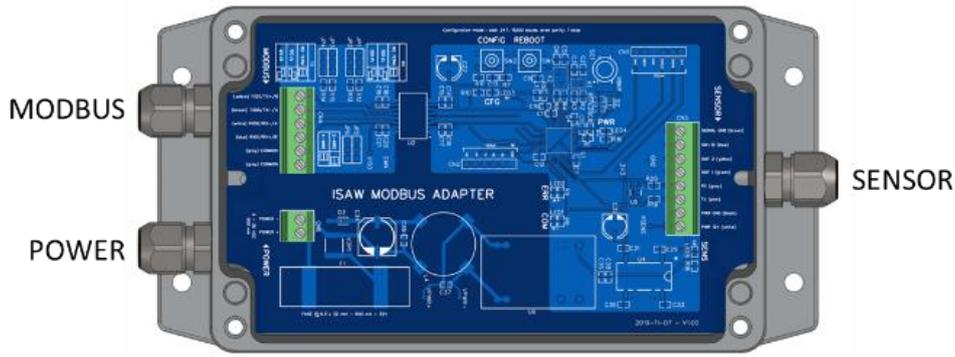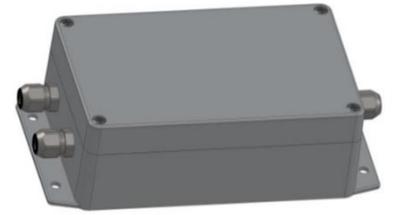
Complete description and instructions for use are given in Appendix D.

AD420 – 4-20 mA adapter

The ISAW **4-20 mA Adapter (AD420)** converts analog outputs voltages OUT1 and OUT2 of the SandFlow SF4 to a 4-20 mA current loop.

The enclosure is an IP68 aluminum box, with two cable glands, on one side with an 8-pin screw connector to connect your ISAW instrument, and on the other side a 4-pin screw connector to connect your power supply and your 4-20 mA current loop terminal.

SandFlow SF4		AD420 adapter	Your instrument	
Wire	**Signal**		**Pin**	**Signal**
White	Power		PWR+	Positive power supply
Brown	Signals GND			
Green	OUT1		PWR-	Negative/ground power supply
Yellow	OUT2			
Blue	SDI-12		LOOP-	4-20 mA output current loop -
Grey	RX			
Pink	TX		LOOP+	4-20 mA output current loop +
Black	Power GND (0V)			

TMAST – Tripod mast
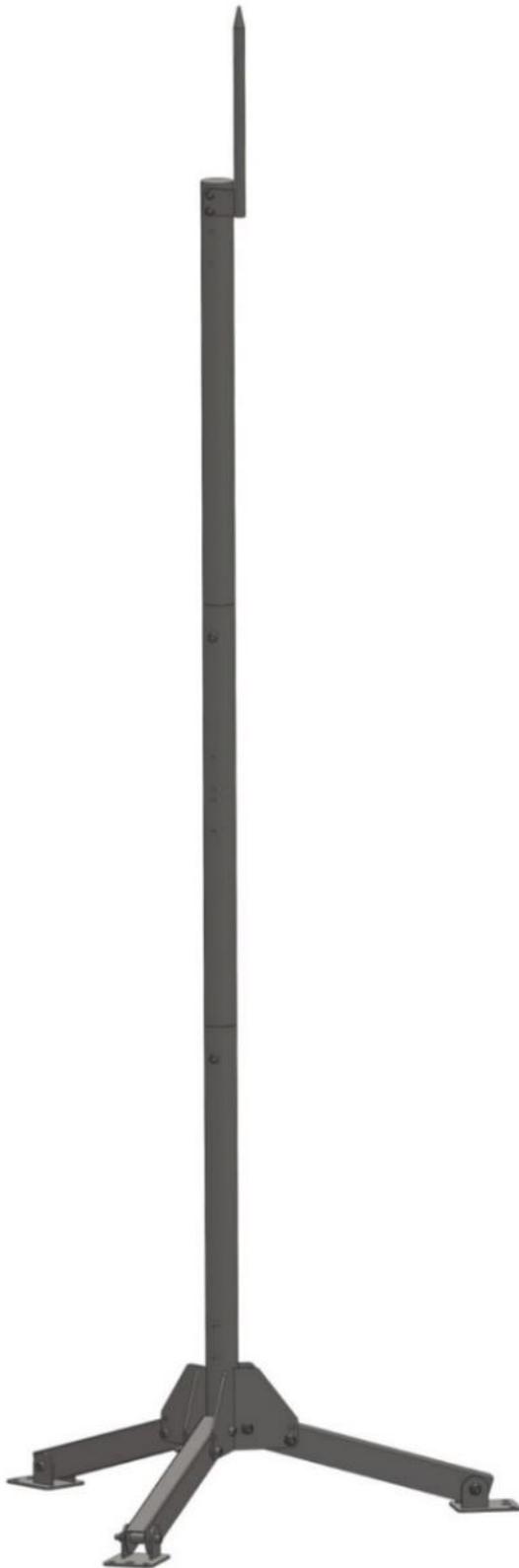
TMAST is a heavy-duty, modular, cost-effective stainless steel tripod mast, lightweight and easy to transport. It allows all the usual ISAW instrument mountings, as well as supporting additional instruments and other accessories or auxiliary equipment. The H=2.89m (from ground to top of lightning rod) mast is dismountable (3 parts) and equipped with 3 tiltable legs and a lightning rod.

The tripod mast is used in particular in the SF2MA configuration (Pair of SandFlow SF4 instruments fastened on a mast), with two instruments directly screwed one above the other on the mast.
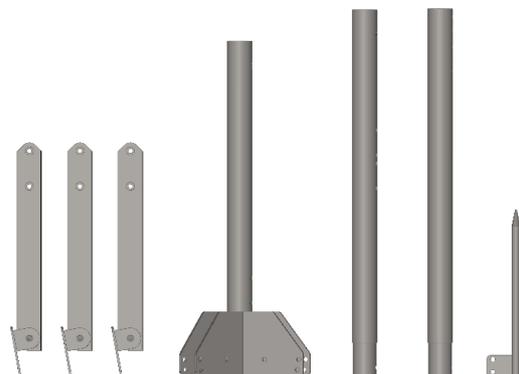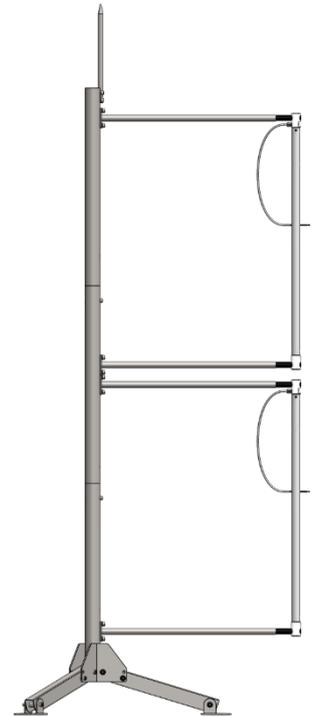
3. CONFIGURE THE SANDFLOW SF4

3.1. Introduction

Your SandFlow SF4 instrument is delivered **completely pre-configured** to **operate in continuous mode**. It is ready to be plugged into a power supply and into your reading peripheral (I/O module, data datalogger, automation server, controller, computer, etc.). See next page for an example of the full factory default configuration.

Configuration settings include:

- ■ Measuring settings (e.g., acquisition and averaging / logging /writing durations)
- ■ Power settings (e.g. automated duty-cycle of the instrument, in case of implementation with critical electrical consumption concerns)
- ■ Communication and mapping settings (e.g., analog and/or digital outputs, voltage scales, duty-cycle, bus address, etc.).

Note: The default configuration, as well as any other customized configuration, is **non-volatile**, i.e. your instrument **remains in the desired operating configuration whatever the powering scenario**. Thus, even in case of repeated power failures, **the instrument will always restart automatically in the desired configuration mode**. When adding or replacing an ISAW instrument, it is possible to pre-configure it in order to achieve Plug and Play functionality without any on-site configuration.

You can change and adjust anytime the configuration settings, either by using the ISAW Toolbox Configuration utility (see § 3.3) or directly in terminal mode (see § 3.4),), or even using an extended SDI-12 command (see Appendix C.2).

3.2. Operating parameters

The complete configuration of a SandFlow SF4 instrument consists in the following parameters:


```
ISAW-TERMINAL V1.28 (win64)                                    —  □  ✕

File   Tools   ?

Serial port  COM5    ⌄    ⟳   ☐ Debug    Connect    Disconnect          Menu >>

    sens-type       : SANDFLOW
    sens-version    : 4.00
    sens-date       : 2025-02-06
    sens-sn         : SF25D024
    hw-version      : 1.40
    hw-date         : 2025-02-06
    hw-sn           : 001D00333234373610473432
    hw-dev-id       : 0x429 (STM32L151CBT6-A)
    hw-extflash     : 0xC22013 (MX25L4006E)
    fw-version      : 3.54
    fw-build        : Mar 18 2025 at 09:24:04 by GCC 10.3.1
    cfg-ident       : _SF_
    cfg-version     : 0.29
    range-flux      : 5V
    range-wind      : 5V
    fscale-flux     : 250.000000
    fscale-wind     : 250.000000
    thld-flux       : 2
    out1-mode       : flux
    out2-mode       : wind
    sdi12-mode      : all
    sdi12-addr      : 0
    serial-mode     : all
    logger-mode     : cyclic
    logger-cfg      : 0x00FF
    logger-usage    : 12741
    logger-capa     : 14560
    avg-a           : 6
    avg-c           : 60
    avg-m           : 600
    pulse-thld      : 10000.000000
    pulse-to        : 3600
    pulse-ms        : 50
    pulse-lvl       : 5V
    lin-wc1         : 1.000000
    lin-wc3         : -1.000000
    lin-wc4         : 7.000000
    lin-wc5         : 0.000000
    lin-wc6         : 0.000000
    lin-we1         : 0.500000
    lin-we2         : 1.000000
    lin-xc1         : 0.000040
    lin-xe1         : 2.000000
    calib-date      : 2025-07-08
    calib-wind      : 0.682870
    calib-flux      : 1.043956
    cons-idle       : 10
    sys-clk         : external
    sys-speed       : 16MHz
    sys-uptime      : 606
    sys-status      : ok
    sys-watchdog    : on
    sys-reboot      : user
    misc-pwrdly     : 100
    misc-dbg        : 0x0000
    misc-admin      : no
    misc-scopeqry   : no
    misc-scopemode  : no

Command  [                                              ⌄ ]   Send
```

Default configuration of a SandFlow SF4 instrument

Parameter	Description	Type	Access[1]	Values / Format	Default value / *Example*
sens-type	Instrument type	string	ro	SANDFLOW	SANDFLOW
sens-version	Model version of the instrument	version	rw*	<major>.<minor> where major and minor cannot exceed 255	4.00
sens-date	Date of manufacturing/assembly of the full instrument	date	rw*	YYYY-MM-DD YYYY: Year, MM: Month, DD: Day	*2025-02-06*
sens-sn	Instrument serial number (matches instrument body engraving)	string	rw*	SFxxxxxxx	*SF25D024*
hw-version	Version of electronic hardware	version	rw*	<major>.<minor> where major and minor cannot exceed 255	*1.40*
hw-date	Date of electronic hardware manufacturing/assembly	date	rw*	YYYY-MM-DD YYYY: Year, MM: Month, DD: Day	*2025-02-06*
hw-sn	Electronic hardware's serial number	string	ro	xxxxxxxxxxxxxxxxxxxxxx	*001D00333234373610473432*
hw_dev_id					*0x429 (STM32L151CBT6-A)*
fw-version	Version of current firmware	version	ro	<major>.<minor> where major and minor cannot exceed 99	*3.54*
hw-extflash	Internal Flash memory identifier	string	ro	0xxxxxxx(<model>) (0x000000 if no Flash memory is soldered to the instrument electronic board)	*0xC22013 (MX25L4006E)*
fw-build	Compilation information of current firmware	string	ro	Not specified	*Mar 18 2025 at 09:23:39 by GCC 10.3.1*
cfg-ident	Eeprom configuration map identifier	string	ro	_SF_ eeprom identifier	*_SF_*
cfg-version	Eeprom configuration map version	version	ro	<major>.<minor> where major and minor cannot exceed 255	*0.29*
range-wind	OUT1 and/or OUT2 range for full-scale wind speed	string	rw	2V5　2.5 volts for 250 km/h full-scale 5V　5 volts for 250 km/h full-scale	5V
range-flux	OUT1 and/or OUT2 range for full-scale particle flux	string	rw	2V5　2.5 volts for 250 g/m^2/s full-scale 5V　5 volts for 250 g/m^2/s full-scale	5V
fscale-wind	OUT1 and/or OUT2 full scale wind, km/h	string	ro	250	250.000000
fscale-flux	OUT1 and/or OUT2 full scale particle flux, g/m^2/s	string	ro	250	250.000000
thld-flux	Flux noise threshold [mV]	integer	rw	0 to 3300	2

[1]　ro: read-only – rw: read/write – rw*: read/admin-write

Parameter	Description	Type	Access[1]	Values / Format	Default value / *Example*
out1-mode	OUT1 mode (green wire)	string	rw	off Disabled wind Wind speed (Persistent, 0 to full-scale) flux Particle flux (Persistent, 0 to full-scale) pulse Particle flux (Pulse, 0 or full-scale)	flux
out2-mode	OUT2 mode (yellow wire)	string	rw	off Disabled wind Wind speed (Persistent, 0 to full-scale) flux Particle flux (Persistent, 0 to full-scale) pulse Particle flux (Pulse, 0 or full-scale) raw Raw analog AC signal	wind
sdi12-mode	SDI-12 mode (blue wire)	string	rw	off Disabled wind Wind speed only flux Particle flux only all Wind speed and particle flux	all
sdi12-addr	SDI-12 address	string	rw	ASCII character (standard SDI-12 characters are 0 to 9)	0
serial-mode	Serial mode (pink wire)	string	rw	off Disabled wind Wind speed only flux Particle flux only all Wind speed and particle flux	all
logger-mode	Datalogger mode	string	rw	off No recording on Data are recorded until memory is full. cyclic Data are recorded and the oldest data are constantly overwritten when memory is full.	cyclic
logger-cfg	Datalogger field configuration	integer	rw	The value is expressed in hexadecimal. Each bit matches a field. If the bit value is 1, the field is logged. Bit 15: reserved Bit 7: min. flux Bit 14: reserved Bit 6: avg flux Bit 13: reserved Bit 5: max. flux Bit 12: N.A. Bit 4: std flux Bit 11: N.A. Bit 3: cum. flux Bit 10: N.A. Bit 2: min. wind Bit 9: N.A. Bit 1: avg wind Bit 8: N.A. Bit 0: max. wind	0x00FF
logger-usage	Datalogger record count usage	integer	ro	Number of recorded measurements.	0
logger-capa	Datalogger record count capacity	integer	ro	Maximum number of recordable measurements. Depends on the number of fields selected in logger-cfg.	0
avg-a	Acquisition duration (s)	integer	rw	Must be > 0 (see Averaging duration rules below)	6

Parameter	Description	Type	Access[1]	Values / Format	Default value / *Example*
avg-c	Cycle duration (s)	integer	rw	Must be >= avg-a and avg-m/avg-c is integer (see Averaging duration rules below)	60
avg-m	Measurement duration (s)	integer	rw	Must be >= avg-c and avg-c must be modulo avg-m (see Averaging duration rules below)	600
pulse-thld	OUT1/OUT2 flux pulse threshold (g/m^2)	float	rw	No limit	10000.0
pulse-to	OUT1/OUT2 flux pulse reset timeout (s)	integer	rw	Must be > avg-m	3600
pulse-ms	OUT1/OUT2 flux pulse duration (ms)	integer	rw	1 < pulse-ms < 500	50
pulse-lvl	OUT1/OUT2 flux pulse level	string	rw	2V5 Pulse level is 2.5 volts 5V Pulse level is 5 volts	5V
lin-wc1	Wind linearization coefficient WC1	float	rw	Default factory setting	1.000000
lin-wc3	Wind linearization coefficient WC3	float	rw	Default factory setting	-1.000000
lin-wc4	Wind linearization coefficient WC4	float	rw	Default factory setting	7.000000
lin-wc5	Wind linearization coefficient WC5	float	rw	Default factory setting	0.000000
lin-wc6	Wind linearization coefficient WC6	float	rw	Default factory setting	0.000000
lin-we1	Wind linearization exponent WE1	float	rw	Default factory setting	0.500000
lin-we2	Wind linearization exponent WE2	float	rw	Default factory setting	1.000000
lin-xc1	Particle flux intensity linearization coefficient XC1	float	rw	Default factory setting	0.000040
lin-xe1	Particle flux intensity linearization exponent XE1	float	rw	Default factory setting	2.000000
calib-date	Date of instrument calibration	date	rw*	YYYY-MM-DD YYYY: Year, MM: Month, DD: Day	*2025-07-08*
calib-wind	Wind calibration factor	float	rw*	Must be > 0	1.000000
calib-flux	Particle flux calibration factor	float	rw*	Must be > 0	1.000000
cons-idle[2]	Timeout of console to return in idle mode	integer	rw	Seconds	10
sys-clk	System clock (It's not recommended to change this parameter)	string	rw	internal Use internal clock external Use external clock	external
sys-speed	System speed (It's not recommended to change this parameter)	string	rw	4MHz Run at 4 MHz 8MHz Run at 8 MHz 16MHz Run at 16 MHz 32MHz Run at 32 MHz	16MHz
sys-uptime	Time elapsed since power on	integer	ro	Seconds	*2852*

---

[2] When you enter this command, the console temporarily hides the measurement message (to clear the display), and then returns, after the selected timeout, to idle mode (stop hiding message).

Parameter	Description	Type	Access[1]	Values / Format	Default value / *Example*
sys-status	System status	string	ro	OK No error ADC-OVERRUN ADC Error	ok
sys-watchdog[3]	Hardware watchdog timer status	string	rw	on Watchdog is enabled off Watchdog is disabled	on
sys-reboot	Last system reboot type	string	ro	user Instrument has been rebooted manually by the user (power or software) watchdog Instrument has been rebooted by the watchdog	user
misc-pwrdly	Analog stage power delay: time to wait after power on amplifier and start acquisition	integer	rw	Milliseconds. Must be < 500	100
misc-debug	Debug bit-field status	integer	ro	See "debug" command.	0x0000
misc-admin[4]	Current admin rights status	string	ro	yes User is admin, special parameters can be changed. no User is not admin, special parameters cannot be changed.	no
misc_scopeqry	Enable scope mode at next reboot, (automatically reset after startup)	integer	ro	yes or no, set by scopemode command (see appendix B.2)	no
misc_scopemode	Scope mode currently enabled	integer	ro	yes or no, set by scopemode command (see appendix B.2)	no

---

[3]   The **watchdog timer** is and independent hardware system which detects and recovers from sensor malfunctions due to software failure: if the sensor fails to reset the watchdog regularly (every 10 to 20 s) the timer will elapse, and the sensor will be restarted automatically.

[4]   You can change the admin status using the "admin" command. Admin status is automatically reset to default ("no") after reboot.

3.3. Configuration using the ISAW Toolbox software suite

The configuration of the SandFlow SF4 instrument can be done either with the ISAW Toolbox software suite (see section 1.3.), and/or by direct or remote connection methods. This section describes how to configure your SandFlow SF4 instrument using the ISAW Toolbox Configuration Utility.

1.   Open the ISAW-Toolbox by double-clicking on the ISAW icon on your desktop.

2.   Start the Configuration utility by clicking on the corresponding item.

3.   Select the Serial port the instrument is connected to and press the [Connect] button. Once the instrument is connected, the Configuration tabs appear and the control buttons are enabled.

Configuration panels	
Summary	Current configuration.
Outputs	Setting analog outputs, voltage ranges, and pulse settings.
Sdi12	Setting SDI-12 settings.
Serial	Serial settings.
Datalogger	Internal data recorder.
Averaging	Setting acquisition duration, cycle duration, duty cycle and measurement duration.
Expert	Setting coefficients of the polynomial linearization functions, internal clock and timeout parameter.
Factory	Reading the instrument's factory information.

Control buttons	
[Apply]	Sends the complete configuration displayed in all tabs to the instrument. After receiving the configuration, the instrument restarts.
[Reload]	Reloads the instrument's configuration.
[Reset]	Resets the instrument with the default factory configuration. To confirm that the configuration has been properly installed, the application then reloads the configuration and displays it again. See the "reset confirm" command in appendix B.2 for more information.

3.3.1. Summary panel

To quickly check the full configuration of your instrument, the summary panel lists all the settings and instrument information.

See § 3.2 for more details on the parameters.
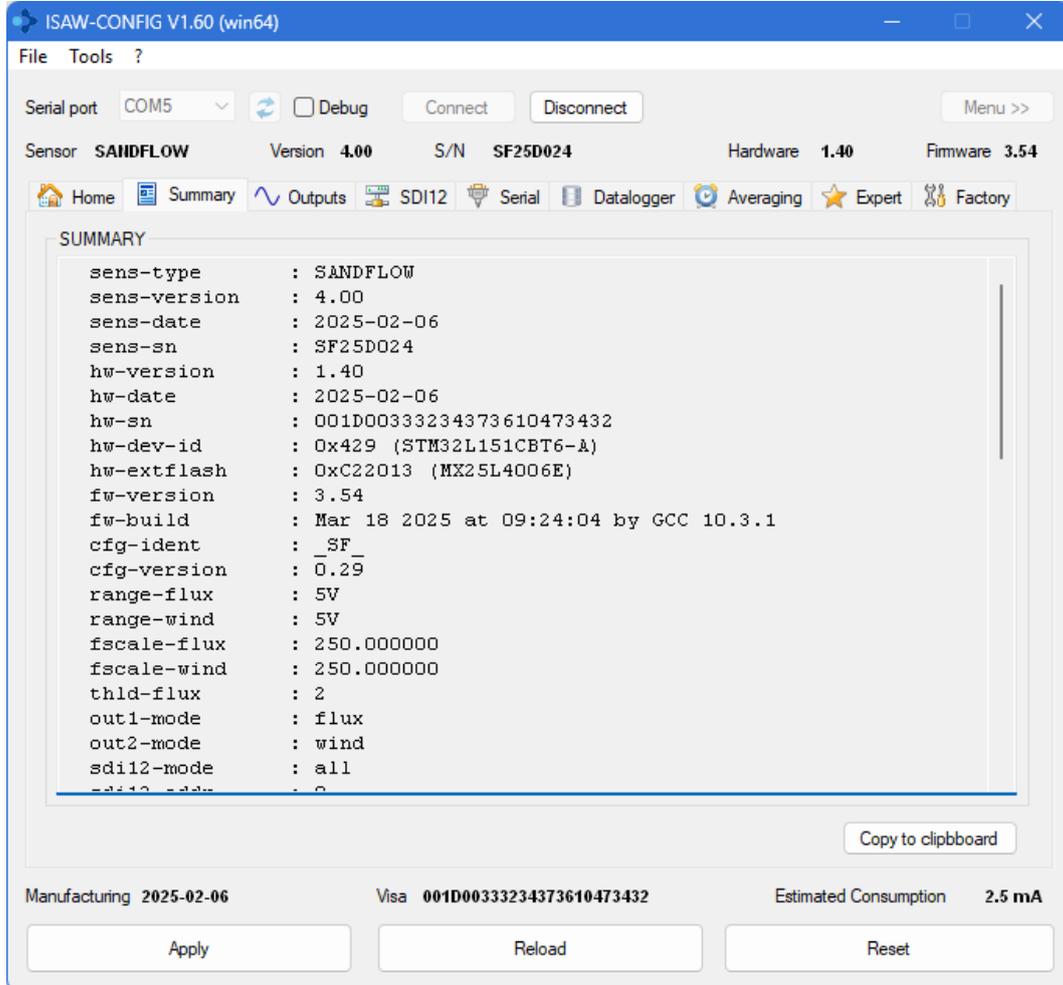
The [Copy to clipboard] button allows you to copy the whole configuration and paste it in another destination for example in case of concurrently testing different settings, or for diagnostic, reporting or backup purposes.

The [Copy to clipboard] button allows you to copy the whole configuration and paste it in another destination for example in case of concurrently testing different settings, or for diagnostic, reporting or backup purposes.

3.3.2. Outputs panel

The outputs panel allows you to set the so-called OUT1 and OUT2 analog outputs, which mapping is user-selectable as explained in the next paragraph.
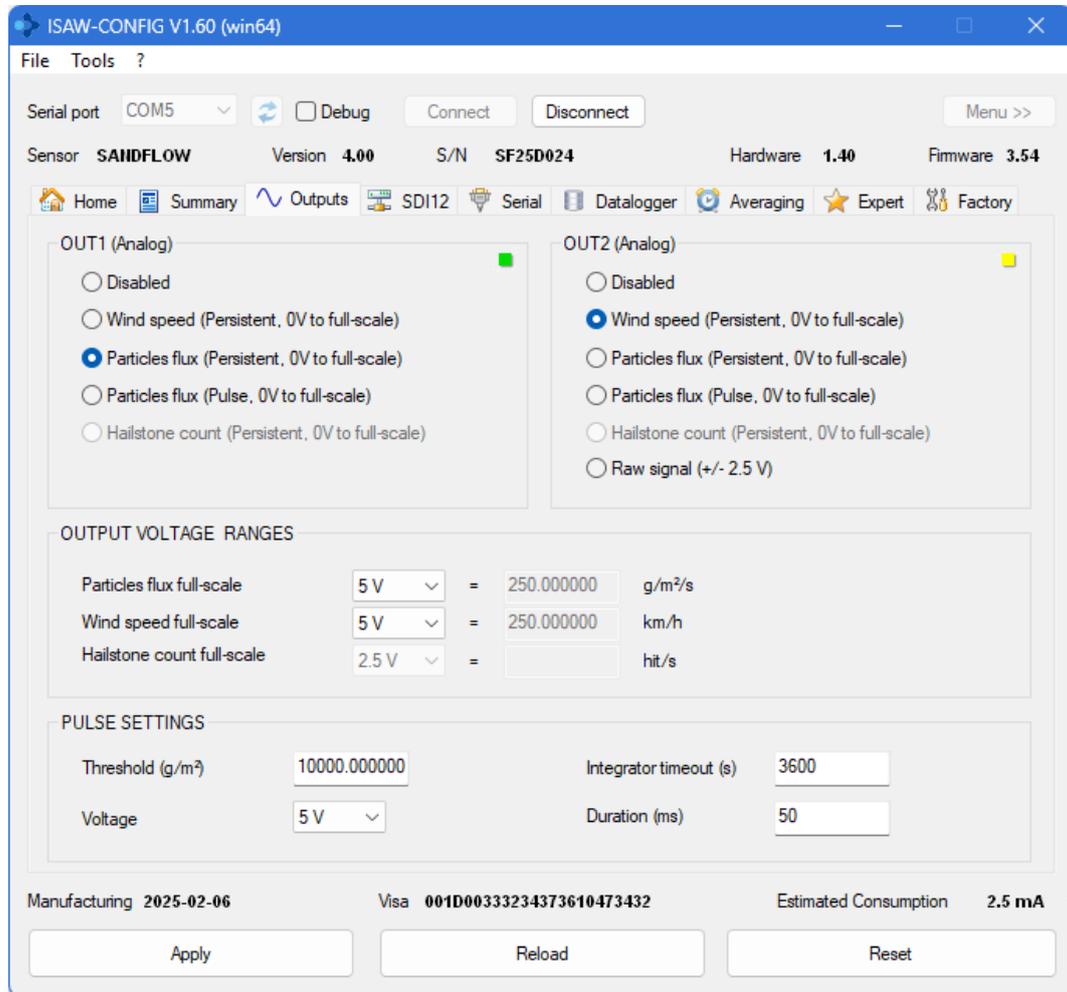
When choosing to connect your instrument to the analog input(s) of a reading device (so the reading device reads positive continuous voltage or counts pulses from either the green or the yellow wire of the instrument), you can decide which output signal you want to be physically present on each of the wires.

This functionality, called the *output mapping*, is a facility that allows the instrument to be adapted to almost any reading device.

To understand the output mapping, the only thing to consider is that the instruments have two generic analog outputs, called OUT1 and OUT2. OUT1 is always carried by the green wire, OUT2 is always carried by the yellow wire. You decide which signal is attributed to OUT1 and OUT2 by selecting one of the options in this panel.

Further settings available in the output panel are the voltage ranges and the pulse settings, so that you can also adapt these to the characteristics of your reading device.

Tip: The **average power consumption** corresponding to your selected settings is displayed at the bottom right of the panel.

3.3.3. SDI-12 panel

When choosing an SDI-12 interface for your instrument, its positive voltage is always physically carried by the blue wire. You can select in the SDI-12 panel the data frame content you need and set the instrument address of your choice. For more instructions about the use of the SDI-12 interface, please refer to Appendix C.
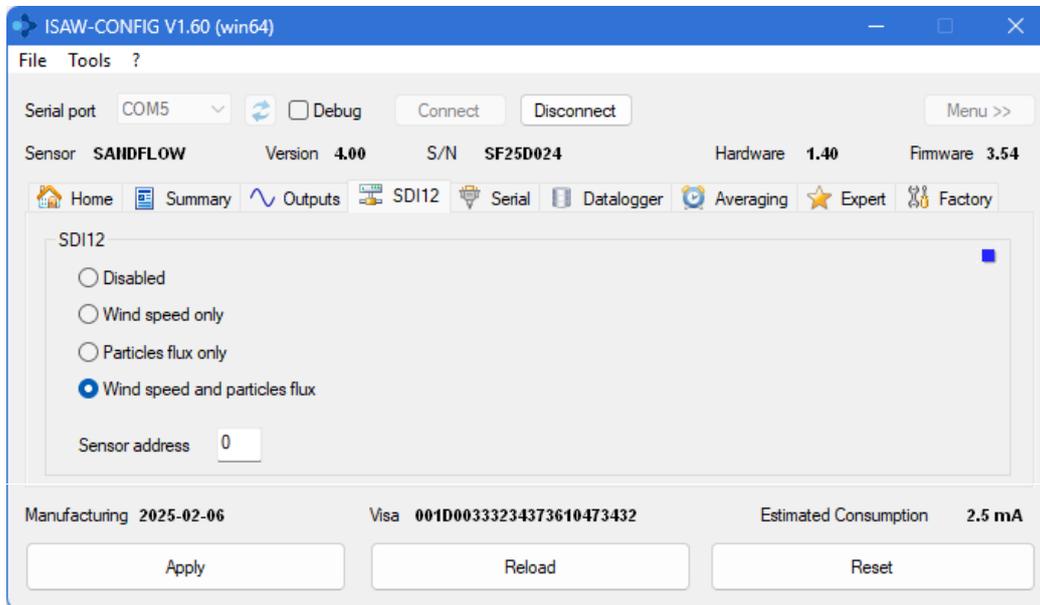
3.3.4. Serial panel

Serial communication is always available and, unless disabled by the user, physically carried by the pink (TX) and grey (RX) wires in all ISAW instruments. You can select the data frame content you need in the Serial panel and set the idle timeout of your console.
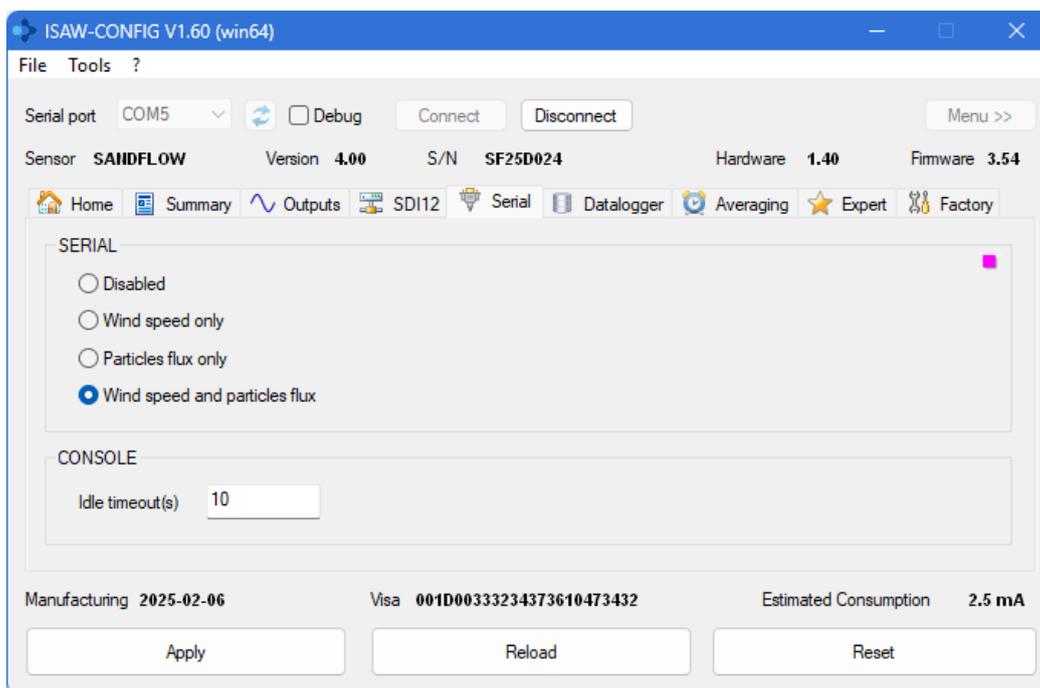
For more instructions on the use of the serial communication, please refer to Appendix B.

3.3.5. Datalogger panel

The internal datalogger can be configured as follows:

Disabled: No data is recorded.

Enabled: Data are recorded until the memory is full.

Cyclic: Data are recorded and the oldest data are constantly overwritten when the memory is full.

The logging frequency matches the measurement duration (see next section).
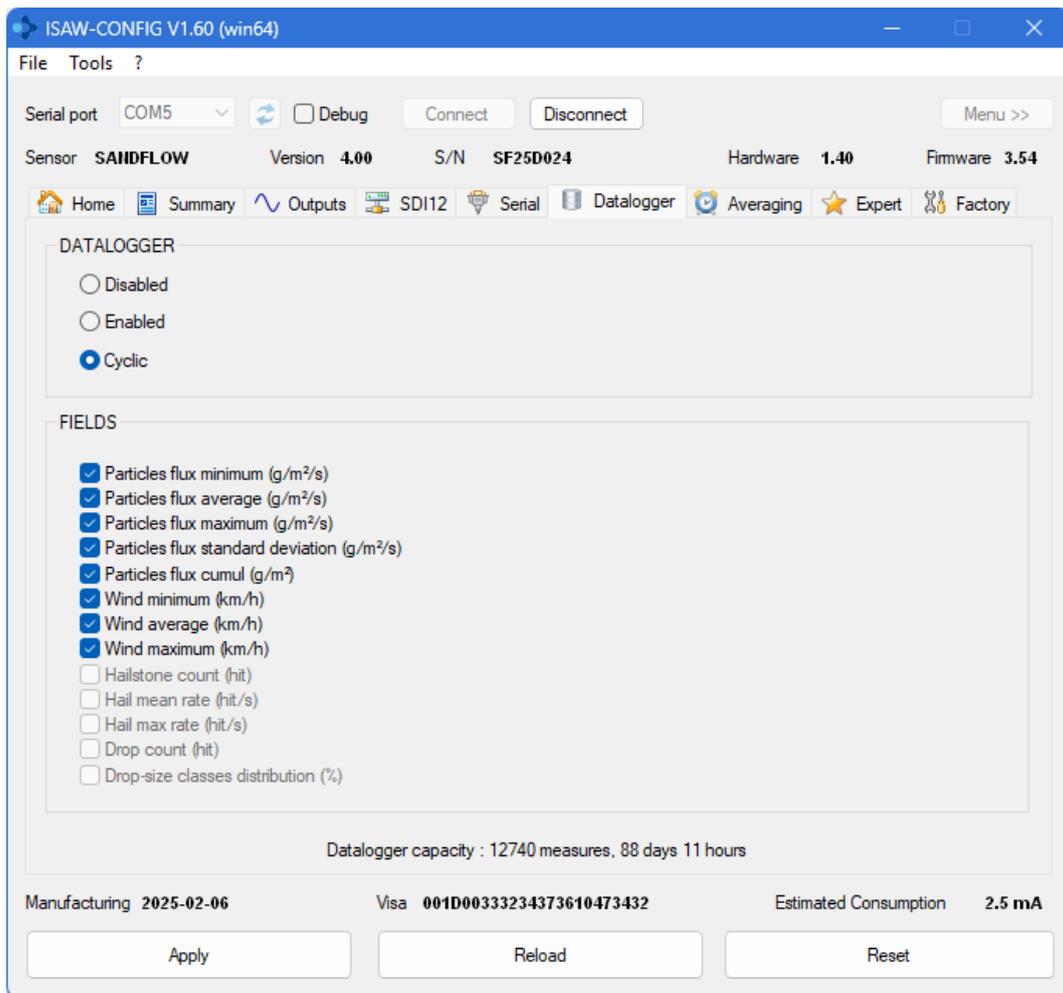
You can individually select the fields you want to record.

Note: The more fields you select, the fewer measurements you can record.

The datalogger capacity indicates the estimated number of measurements and the duration of the measurement session based on the measurement duration.

WARNING: The datalogger must be erased after changing the configuration fields (see § 5.2).

3.3.6. Averaging panel

The averaging panel allows you to set all the measurement settings, i.e.

- Acquisition duration (true observation time of the physical phenomena, also called *time integration window*),

- Cycle duration (the sum of the acquisition duration and a stand-by duration),

- Duty cycle (ratio between acquisition duration and cycle duration, the fraction of time in which the instrument is effectively active),

- Measurement duration or also called the *averaging duration* (the reading or writing data interval you want).

These parameters are explained in details in section 1.3.
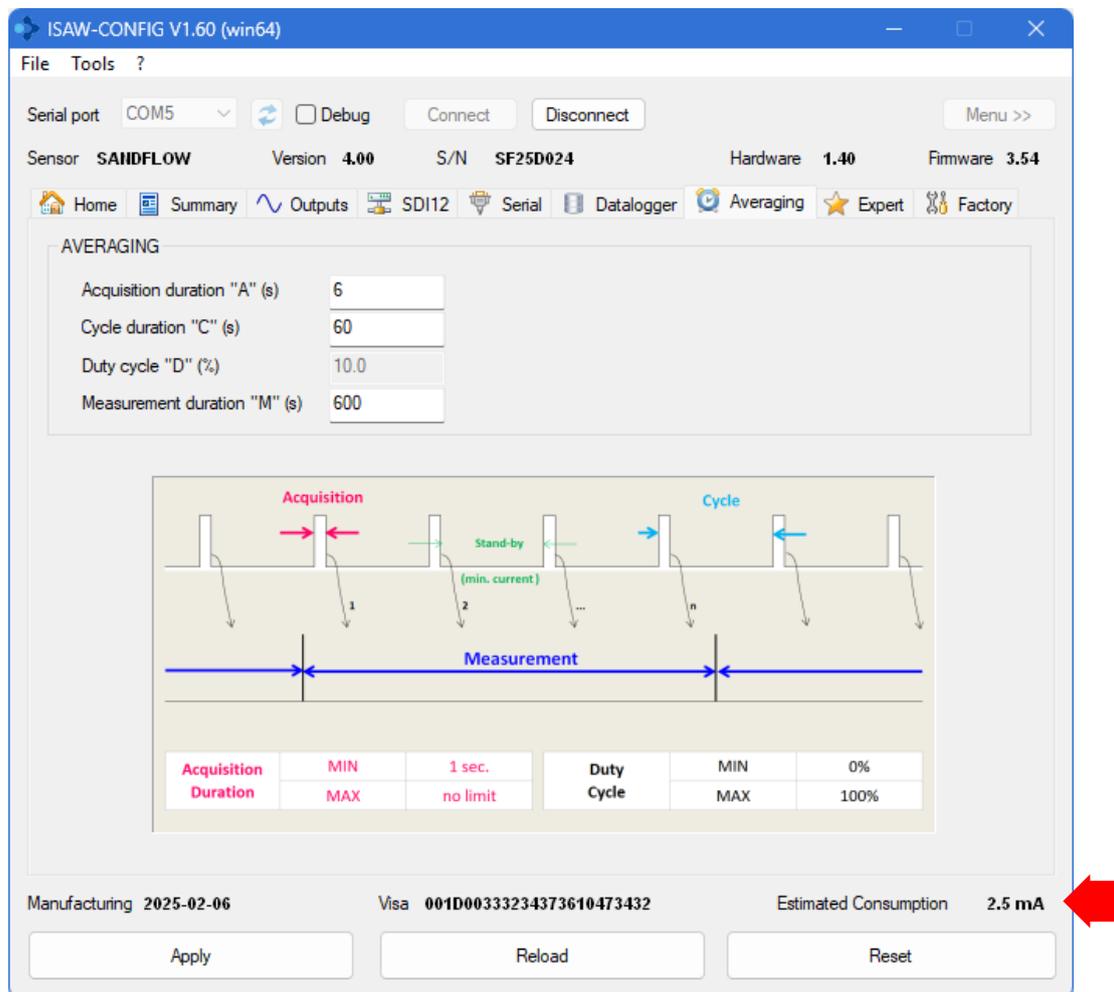
| **Tip:** | The **average power consumption** corresponding to your selected settings is displayed at the bottom right of the panel. |

Averaging duration rules:

The parameters "avg-a", "avg-c" and "avg-m" are interdependent and must satisfy the following rules:

> `avg-a`, `avg-c` and `avg-m` are integers
> $0 <$ `avg-a` $\leq$ `avg-c` $\leq$ `avg-m`
> `avg-m` / `avg-c` is an integer

The rules are checked each time a parameter is changed. Therefore, in some cases, the user is unable to set the requested value.

In this case, set the requested averaging parameters in the following order:

1. Set the `avg-a` parameter to 1.

2. Set the `avg-c` parameter to 1.

3. Set the `avg-m` parameter to the requested value.

4. Set the `avg-c` parameter to the requested value.

5. Set the `avg-a` parameter to the requested value.

3.3.7. Expert panel

The Expert panel, reserved for scientific users or customized use of the instruments, allows you to set advanced linearization parameters, i.e. changing the internal calculation mode of the instrument.
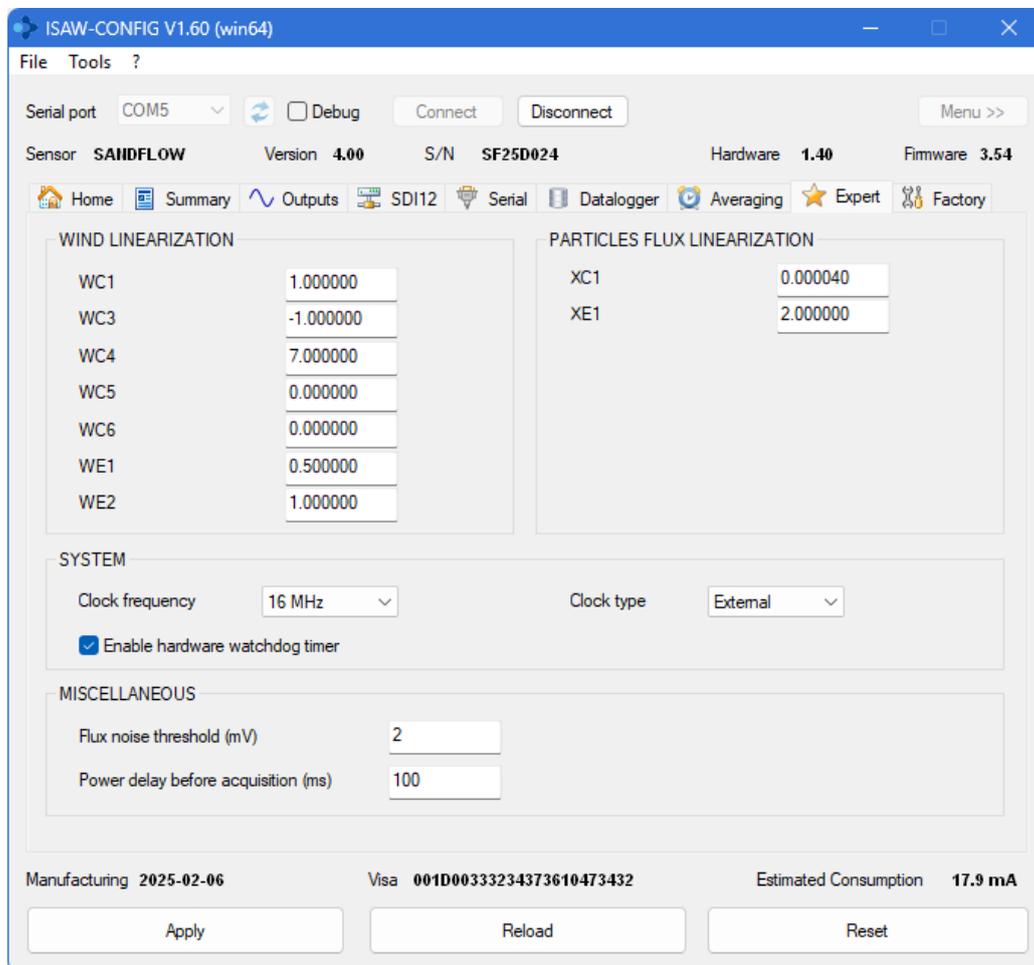
For example, you can turn the instrument into pass-through mode, change the internal noise threshold or implement different coefficients to the internal calculation functions of the instrument.

WARNING: Changing these parameters is not recommended.

The [Reset] button allows you to always return to the default factory settings.

3.3.8. Factory panel

The factory panel displays, in a read-only mode, the factory identifiers and calibration settings of your instrument.

Note: Only the manufacturer or the integrator can modify these parameters.
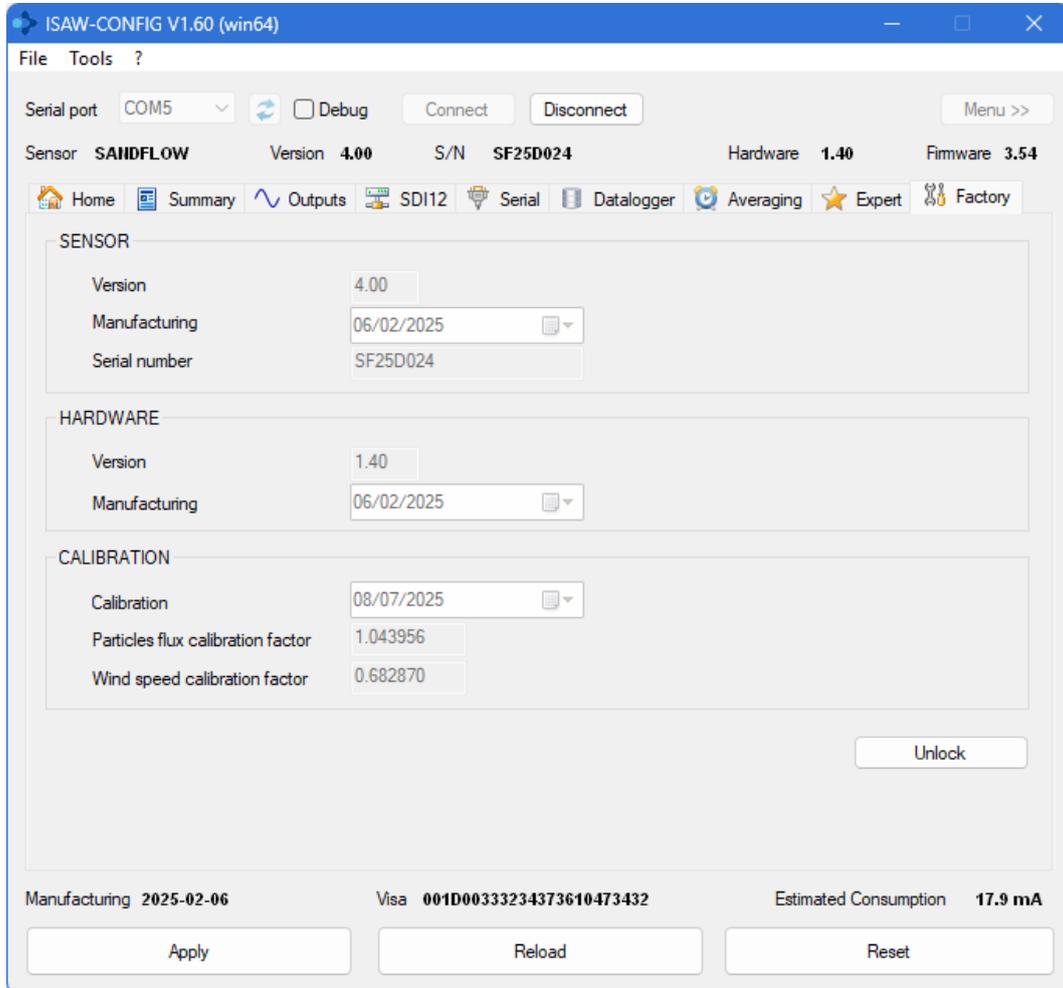
In case of failure of your instrument or when contacting the support, it is recommended to keep a copy of this information at hand to facilitate the identification of your instrument.

3.4. Configuration in Terminal mode (serial communication)

This section describes how to change a parameter of your SandFlow SF4 sensor using a serial terminal utility.

To use the ISAW Toolbox Configuration Utility, refer to section 3.3.

In the following explanations we use the terminal emulator provided with the free ISAW Toolbox software suite (available at www.isaw-products.com), but you can also use any serial terminal like Putty, TeraTerm, HyperTerminal, or other.

1.   Open the ISAW-Toolbox by double-clicking on the ISAW icon on your desktop.

2.   Start the Terminal utility by clicking on the corresponding item.

3.   Select the Serial port the instrument is connected to and press the [Connect] button.

4.   Optional: To check the current configuration, enter the `Config` command in the Command entry field and press the [Send] button.

The values of all parameters are displayed[5].


```
ISAW-TERMINAL V1.28 (win64)                          —    □    ✕
File   Tools   ?

Serial port   COM5    ∨   ⭮  ☐ Debug    Connect     Disconnect              Menu >>

Serial port 'COM5' open !
config
CONFIGURATION

  sens-type       : SANDFLOW
  sens-version    : 4.00
  sens-date       : 2025-02-06
  sens-sn         : SF25D024
  hw-version      : 1.40
  hw-date         : 2025-02-06
  hw-sn           : 001D0033234373610473432
  hw-dev-id       : 0x429 (STM32L151CBT6-A)
  hw-extflash     : 0xC22013 (MX25L4006E)
  fw-version      : 3.54
  fw-build        : Mar 18 2025 at 09:24:04 by GCC 10.3.1
  cfg-ident       : _SF_
  cfg-version     : 0.29
  range-flux      : 5V
  range-wind      : 5V
  fscale-flux     : 250.000000
  fscale-wind     : 250.000000

Command  config                                             ∨    Send
```

5.   To change the required parameter, enter the command `set <parameter> <value>` in the Command entry field, then press the [Send] button.

Note: More serial commands are available in Appendix B.

---

[5]   All parameters are detailed in section 3.1.

3.5. Import/export configuration

3.5.1. Import configuration

This function allows you to reload the previously exported configuration of an instrument.

Open the ISAW Toolbox Configuration Utility.

Open the Import window: select the "File > Import Configuration" menu. The Import window is displayed.
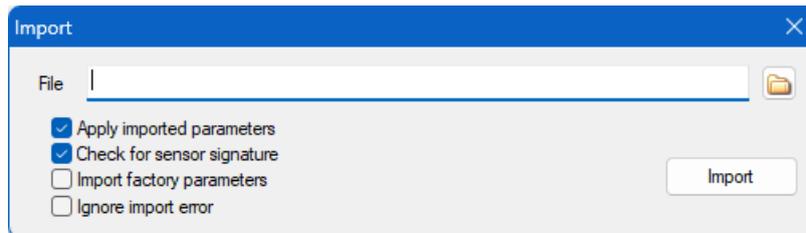
Select the file to import (*.isawcfg file): either enter the file name in the field, or click on the selection button, or drag and drop the file directly on the entry field.

Choose the import options. The default settings cover most of the situations, but you can change any of the following options:

Option	Description
Apply imported parameters	Send the imported configuration directly to the instrument when the import is completed.
Check for instrument signature	Check if the imported file has been exported from the same instrument (check the instrument's physical address).
Import factory parameters	Include the factory parameters in the import. This operation requires a password to unlock the factory parameters.
Ignore import error	Continue the import even if an import error occurs. If this option is not activated, the import stops at the first error.

Start importing by clicking on the [Import] button.

Note: If the option "Apply imported parameters" is unchecked, you will need to click on the [Apply] button once the import is completed to send the imported configuration to the instrument.

3.5.2. Export configuration

The export function operates the same way. It allows saving the instrument current configuration into a file.

Open the ISAW Toolbox Configuration Utility.

Open the Export window: select the "File > Export Configuration" menu. The Export window is displayed.

Enter the name of the export file. The default file name is the instrument's serial number with a .isawcfg extension.

Start the export by clicking on the [Save] button.

4. INSTALL THE SandFlow SF4

4.1. Conditions of use

Always remember that the SandFlow SF4 instrument is an acoustic instrument and could thus potentially be affected by structure-borne vibrations issuing from the supporting structure (for example, a steel cable impacting repetitively on a metal mast when subjected to wind); or to a lesser extent by parasitic low-frequency noise from the immediate environment (for example, excessive proximity to heavy traffic or machinery could lead to parasitic signals). It is recommended that you pay attention to avoiding possible parasitic noise when mounting the project.

4.2. Wiring & I/O mapping

4.2.1. Instrument cable

Each instrument is delivered with a **5 m cable** prepared with bootlace ferrules at each of its 8 conducting wires, ready to be plugged into the 8-pin screw terminals of the ISAW accessories or any other terminal of your choice.

Cable reference:

> **LÜTZE SUPERFLEX ® TRONIC (C) PUR 7×0.25**, ref. 117103with 7 conductors AWS 24 / 0.25 mm^2

The 8th conductor (color: BLACK) is a 10 cm length termination welded on the shield.

WARNING: It is strongly advised **not to shorten the factory cable**. Should you be obliged to, you must absolutely treat the shield as the BLACK (POWER GND) conductor, that is, protect the nude shield with a black thermo sleeve, crimp a terminal, and make sure to connect it to the GND of your connected device.

Wire	Signal	User selectable	Plug and play Default factory settings
White	Power +	No	Positive power supply (6 to 30) VDC
Black	Power GND (0V)	No	Power GND (0V)
Pink	TX	■ Disabled ■ Wind speed only ■ Particle flux only ■ Wind speed and particle flux	RS-232 active, Wind speed and particle flux
Grey	RX		
Green	OUT1	■ Disabled ■ Wind speed (Persistent, +0V to full-scale +2.5V or +5V) ■ Particle flux (Persistent, +0V to full-scale +2.5V or +5V) ■ Particle flux (Pulse, +0V to full-scale +2.5V or +5V)	Particle flux, persistent, +0V to +5V
Yellow	OUT2	■ Disabled ■ Wind speed (Persistent, +0V to full-scale +2.5V or +5V) ■ Particle flux (Persistent, +0V to full-scale +2.5V or +5V) ■ Particle flux (Pulse, +0V to full-scale +2.5V or +5V) ■ aw signal (±2.5V) (Note: direct, unfiltered AC output of the instrument)	Wind speed, persistent, +0V to +5V
Blue	SDI-12	■ Disabled ■ Wind speed only ■ Particle flux only ■ Wind speed and particle flux	SDI 12 bus active, address: 0, Wind speed and particle flux
Brown	Signals GND	No	OUT1 GND, OUT2 GND and SDI-12 GND

The instrument can simply be used by reading DC outputs (+0 to +2.5V or +0 to +5V continuous or pulse analog voltages available). Note that the continuous DC analog voltages are persistent on the outputs so that output voltages can be read at any time (the reading interval from your peripheral is independent from the duration of the time integration of the instrument).

4.2.2. Wiring diagrams

Direct USB-Link Serial connection to computer COM port

SandFlow SF4			EXT10 cable extension and junction box (optionnal)		UDONG USB-Link		Computer
POWER (6-30V)	White			POWER +12V			
POWER GND	Black			POWER GND			
TXD (Tx)	Pink			TXD (Tx)			
RXD (Rx)	Grey			RXD (Rx)		USB	
Analog Signal OUT1	Green			Analog Signal OUT1			
Analog Signal OUT2	Yellow			Analog Signal OUT2			
SDI-12 or Analog OUT3	Blue			SDI-12 or Analog OUT3			
Analog Signal GND	Brown			Analog Signal GND			

SDI-12 Data Logger (or other SDI-12 Interface)

SandFlow SF4			EXT10 cable extension and junction box (optionnal)		SDI-12 Master
POWER (6-30V)	White			PWR+ (6-30V)	
POWER GND	Black			PWR- (0V, GND)	
TXD (Tx)	Pink				
RXD (Rx)	Grey				
Analog Signal OUT1	Green				
Analog Signal OUT2	Yellow				
SDI-12 or Analog OUT3	Blue			SDI-12	
Analog Signal GND	Brown				

Modbus RTU RS-485

MODBUS RTU RS-485 2-wires

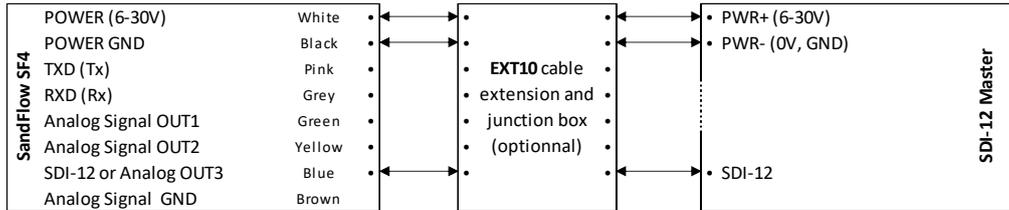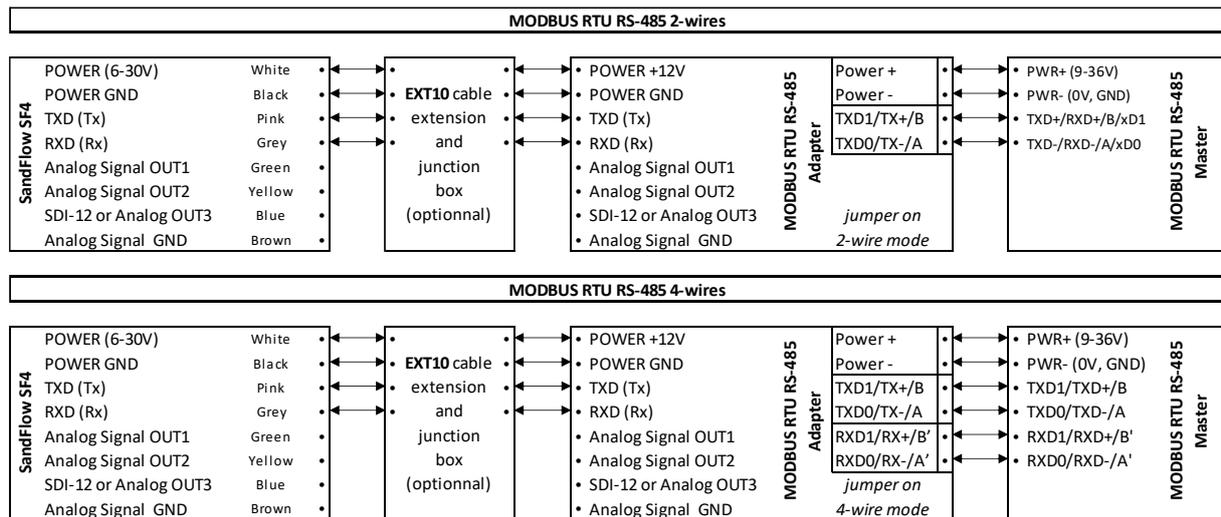| SandFlow SF4			EXT10 cable extension and junction box (optionnal)		POWER +12V section		MODBUS RTU RS-485 Adapter			MODBUS RTU RS-485 Master
POWER (6-30V)	White			POWER +12V		Power +			PWR+ (9-36V)	
POWER GND	Black			POWER GND		Power -			PWR- (0V, GND)	
TXD (Tx)	Pink			TXD (Tx)		TXD1/TX+/B			TXD+/RXD+/B/xD1	
RXD (Rx)	Grey			RXD (Rx)		TXD0/TX-/A			TXD-/RXD-/A/xD0	
Analog Signal OUT1	Green			Analog Signal OUT1						
Analog Signal OUT2	Yellow			Analog Signal OUT2						
SDI-12 or Analog OUT3	Blue			SDI-12 or Analog OUT3		*jumper on*				
Analog Signal GND	Brown			Analog Signal GND		*2-wire mode*				

MODBUS RTU RS-485 4-wires

SandFlow SF4			EXT10 cable extension and junction box (optionnal)				MODBUS RTU RS-485 Adapter			MODBUS RTU RS-485 Master
POWER (6-30V)	White			POWER +12V		Power +			PWR+ (9-36V)	
POWER GND	Black			POWER GND		Power -			PWR- (0V, GND)	
TXD (Tx)	Pink			TXD (Tx)		TXD1/TX+/B			TXD1/TXD+/B	
RXD (Rx)	Grey			RXD (Rx)		TXD0/TX-/A			TXD0/TXD-/A	
Analog Signal OUT1	Green			Analog Signal OUT1		RXD1/RX+/B'			RXD1/RXD+/B'	
Analog Signal OUT2	Yellow			Analog Signal OUT2		RXD0/RX-/A'			RXD0/RXD-/A'	
SDI-12 or Analog OUT3	Blue			SDI-12 or Analog OUT3		*jumper on*				
Analog Signal GND	Brown			Analog Signal GND		*4-wire mode*				

4-20 mA Current Loop

SandFlow SF4			EXT10 cable extension and junction box (optionnal)				AD420 adapter			Single-ended analog reading
POWER (6-30V)	White			POWER +12V		PWR+			PWR+ (6-30V)	
POWER GND	Black			POWER GND		PWR-			PWR- (0V, GND)	
TXD (Tx)	Pink			TXD (Tx)		LOOP-			Loop+	
RXD (Rx)	Grey			RXD (Rx)		LOOP+			Loop-	
Analog Signal OUT1	Green			Analog Signal OUT1						
Analog Signal OUT2	Yellow			Analog Signal OUT2						
SDI-12 or Analog OUT3	Blue			SDI-12 or Analog OUT3						
Analog Signal GND	Brown			Analog Signal GND						

RS232 Serial (ex. DB9 on computer)

SandFlow SF4			EXT10 cable extension and junction box (optionnal)			RS232 to TTL3V3 converter/adapter		Power supply / RS232 Device (DB9)
POWER (6-30V)	White							PWR+ (6-30V) Power supply
POWER GND	Black							PWR- (0V, GND)
TXD (Tx)	Pink			TXD (Tx)				
RXD (Rx)	Grey			RXD (Rx)				
Analog Signal OUT1	Green							
Analog Signal OUT2	Yellow							
SDI-12 or Analog OUT3	Blue							
Analog Signal GND	Brown							

4.3. Mounting instructions

4.3.1. SandFlow SF4 package content

Item ref.	Description	Quantity	
		SFBRA	SF2MA
SF4	SandFlow instrument	1	2
UDONG	USB dongle	1	1
CYARM	Cylindrical arm	2	4
BRARF	Front bracket	2	
BRARB	Back bracket	2	
BRASH	Reduction shim	4	
SLEEVE	Plastic sleeve	2	4
BN 611 M10x110	M10 × 110 mm screw	2	4
BN 611 M10X70	M10 × 70 mm screw	4	
BN 610 M10X40	M10 × 40 mm screw	4	
BN 610 M10x25	M10 × 25 mm screw		8
BN 675 M10	M10 serrated lock washer		8
BN 13289 M10x25x4	M10 washer 4 mm thick	8	
BN 33010 M10	M10 securing nut	8	
TMAST	Tripod mast (see TMAST Package content)		1

Instrument	Mounting kit	Tripod mast

CYARM

Bracket kit

BRARB + 2xBRASH + BRARF

USB dongle

UDONG

Screw kit

BN 611 M10x110   BN 611 M10x70   BN 610 M10x40   BN 610 M10x25   SLEEVE

BN 675 M10   BN 13289 M10x25x4   BN 33010 M10

SF4

TMAST
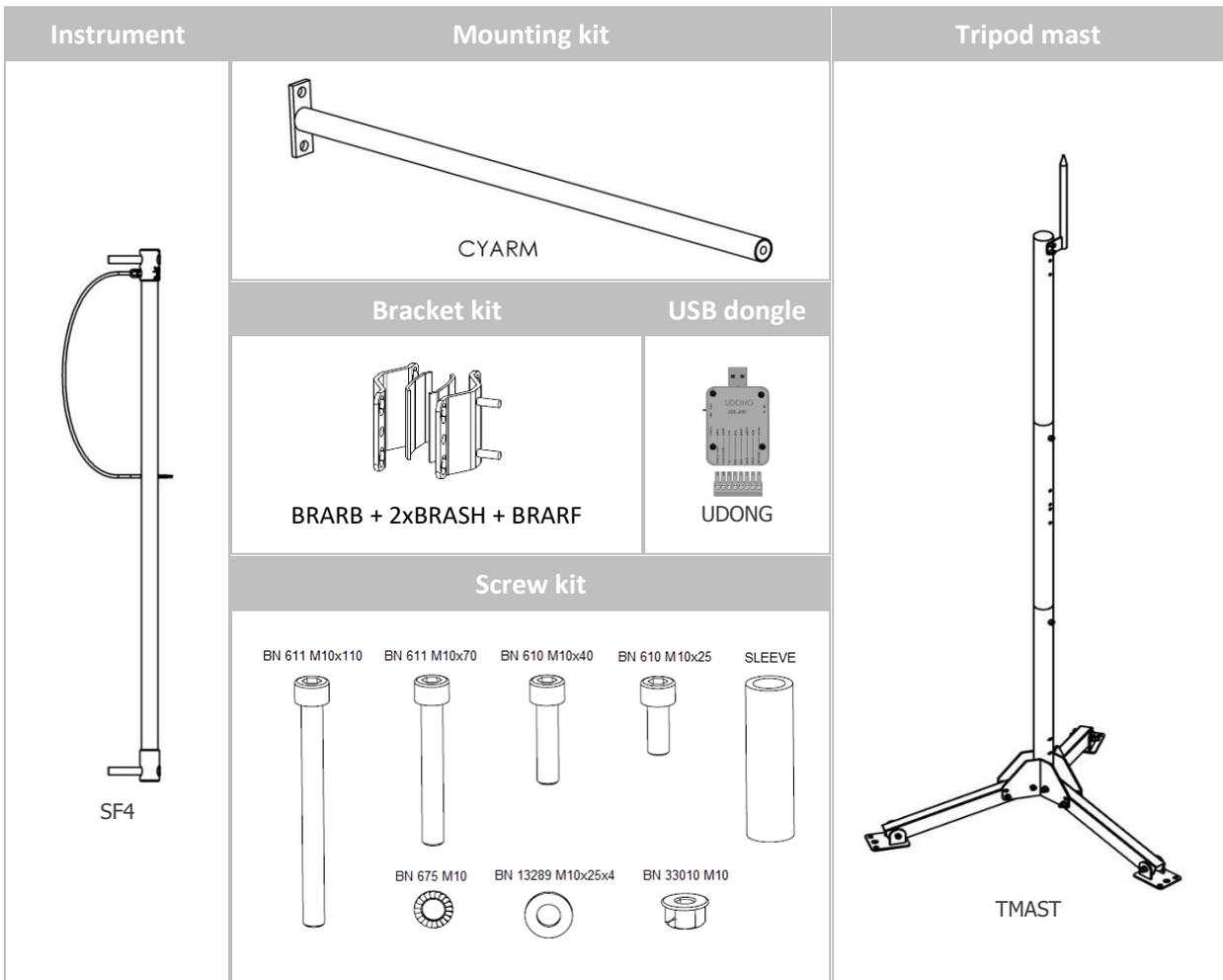
4.3.2. SFBRA Mounting instructions
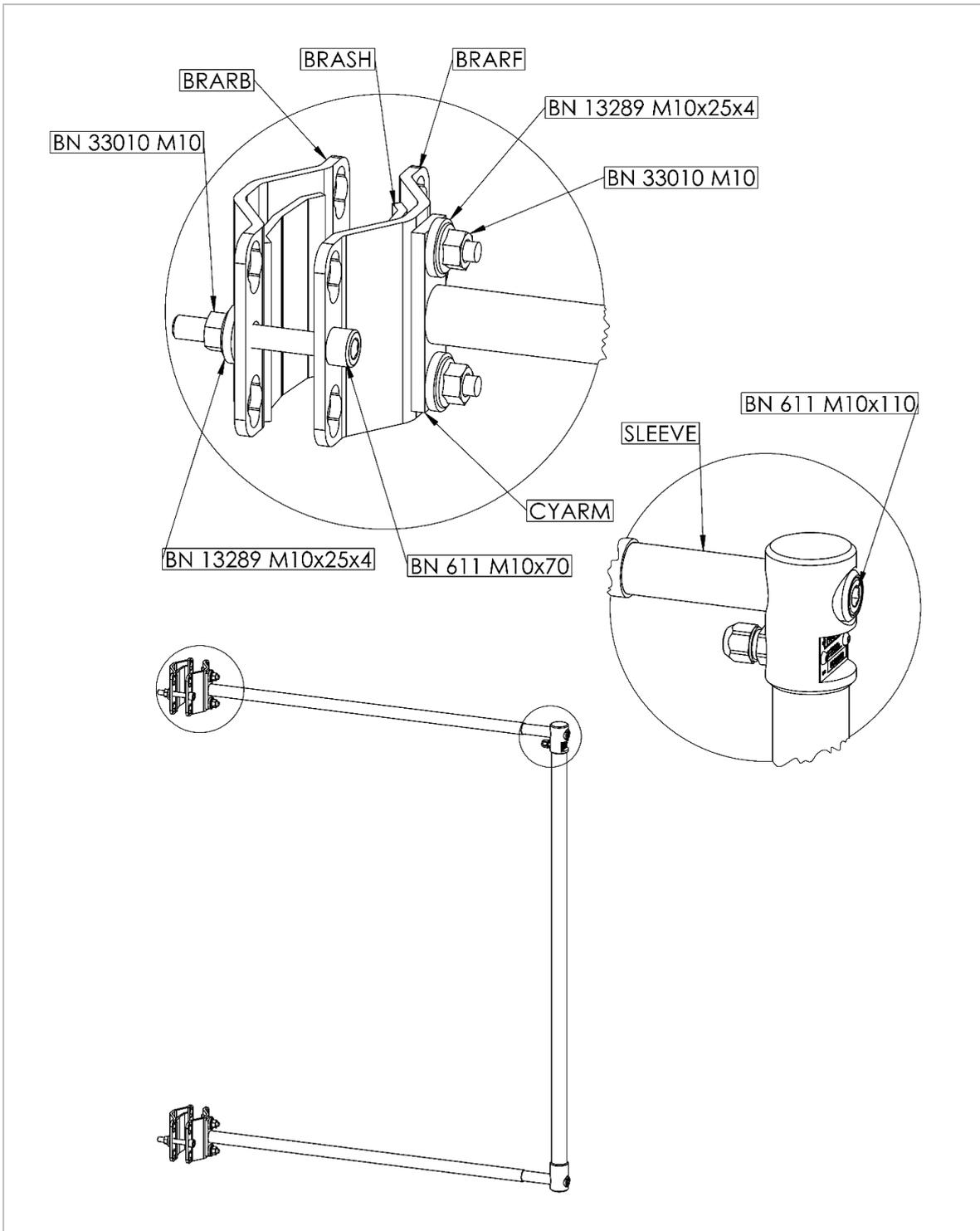
- Always mount the **INSTRUMENT HEAD** (end with cable) **ON TOP**.
- For a **MAST OF OUTER DIAMETER ≥ 60 mm**, replace the screws BN 610 M10X40 with BN 611 M10X70.
- For a **MAST OF OUTER DIAMETER ≥ 65 mm**, remove the reduction shims (BRASH).
- To fasten the instrument on a **FLAT SURFACE**, screw the front brackets (BRACF) directly onto the surface.
- The instrument's cable must be **tightly secured** to the arm and mast using tie wraps.

4.3.3. SF2MA Mounting instructions

- See **TMAST Mounting Instructions** to assemble the tripod mast (TMAST).
- Always mount the **INSTRUMENT HEAD** (end with cable) **ON TOP**.
- The instrument's cable must be **tightly secured** to the arm and mast using tie wraps.
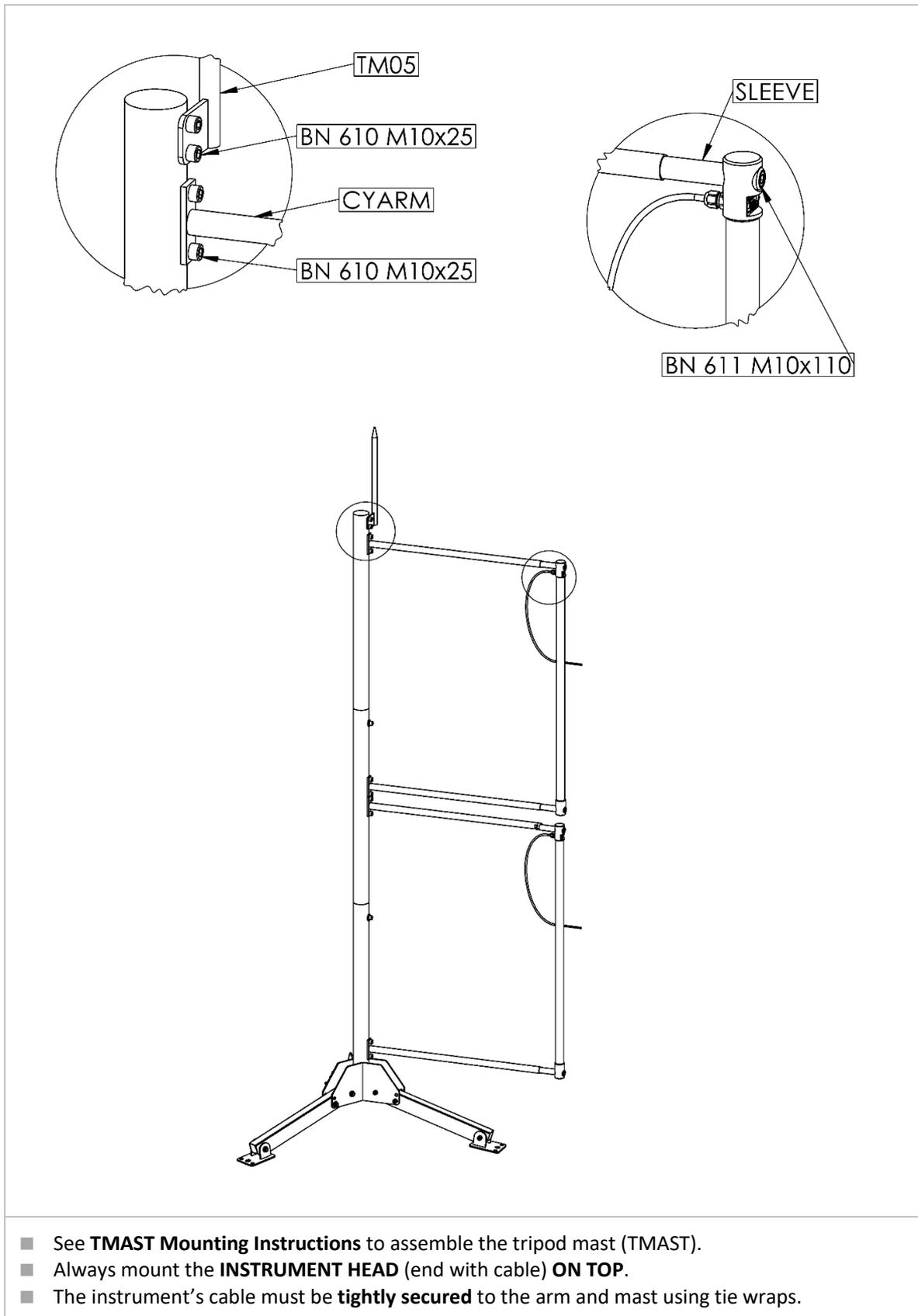
4.3.4. TMAST Package content

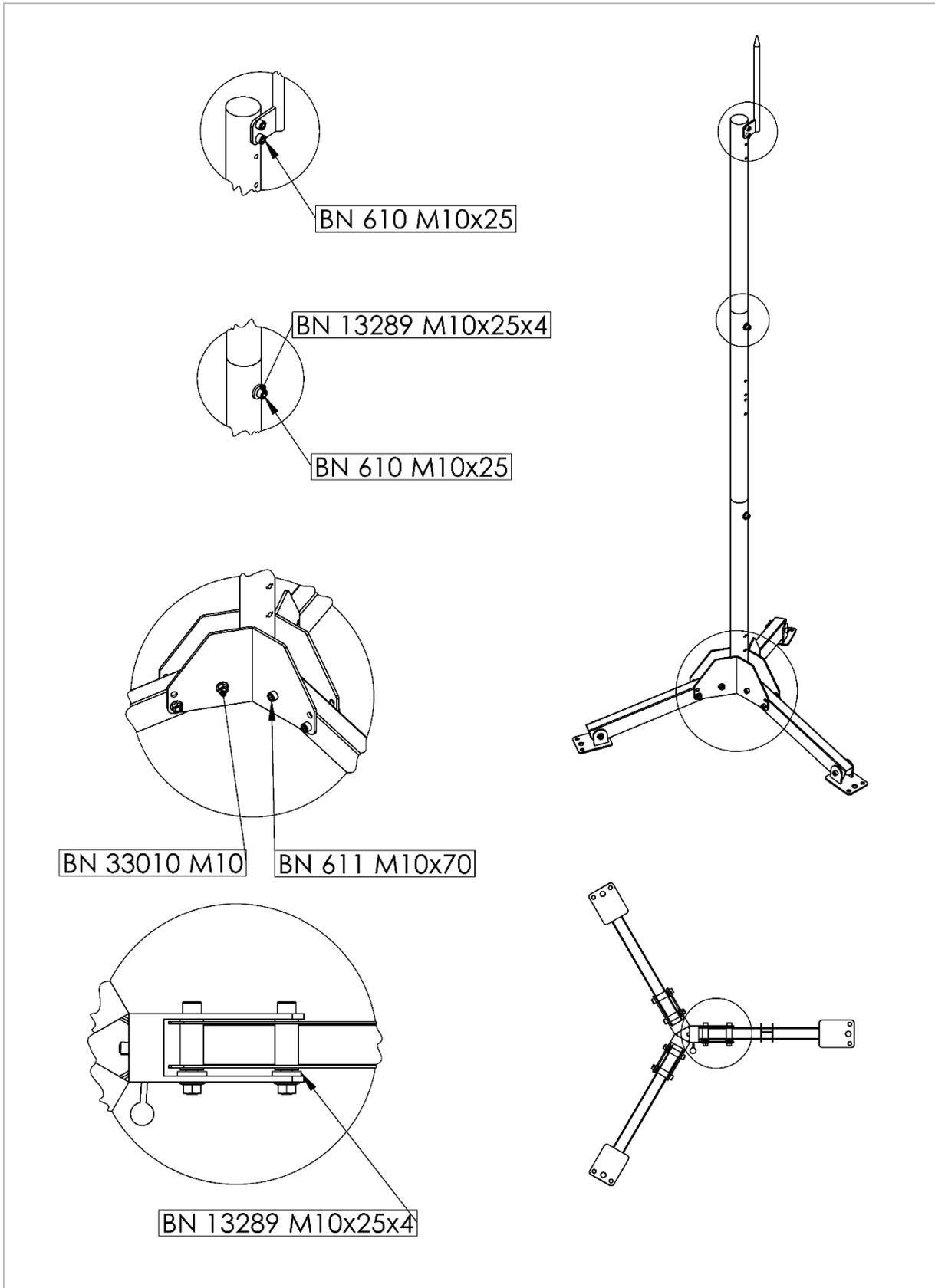| Ref.	Description	Quantity
TM01	Leg with inclinable foot	3
TM02	Base tube	1
TM03	Mid tube	1
TM04	Top tube	1
TM05	Lightning rod	1
BN 610 M10x25	M10 × 25 mm screw	4
BN 611 M10x70	M10 × 70 mm screw	9
BN 675 M10	M10 serrated lock washer	2
BN 13289 M10x25x4	M10 washer 4 mm thick	11
BN 33010 M10	M10 securing nut	9

Mast kit

| TM01 | TM01 | TM03 | TM04 | TM05 |
| x 3 | x 1 | x 1 | x 1 | x 1 |

Screw kit

| BN 611 M10X70 | BN 610 M10x25 | BN 675 M10 | BN 13289 M10x25x4 | BN 33010 M10 |
| x 9 | x 4 | x 2 | x 11 | x 9 |

4.3.5. TMAST Mounting instructions

BN 610 M10x25

BN 13289 M10x25x4

BN 610 M10x25

BN 33010 M10   BN 611 M10x70

BN 13289 M10x25x4
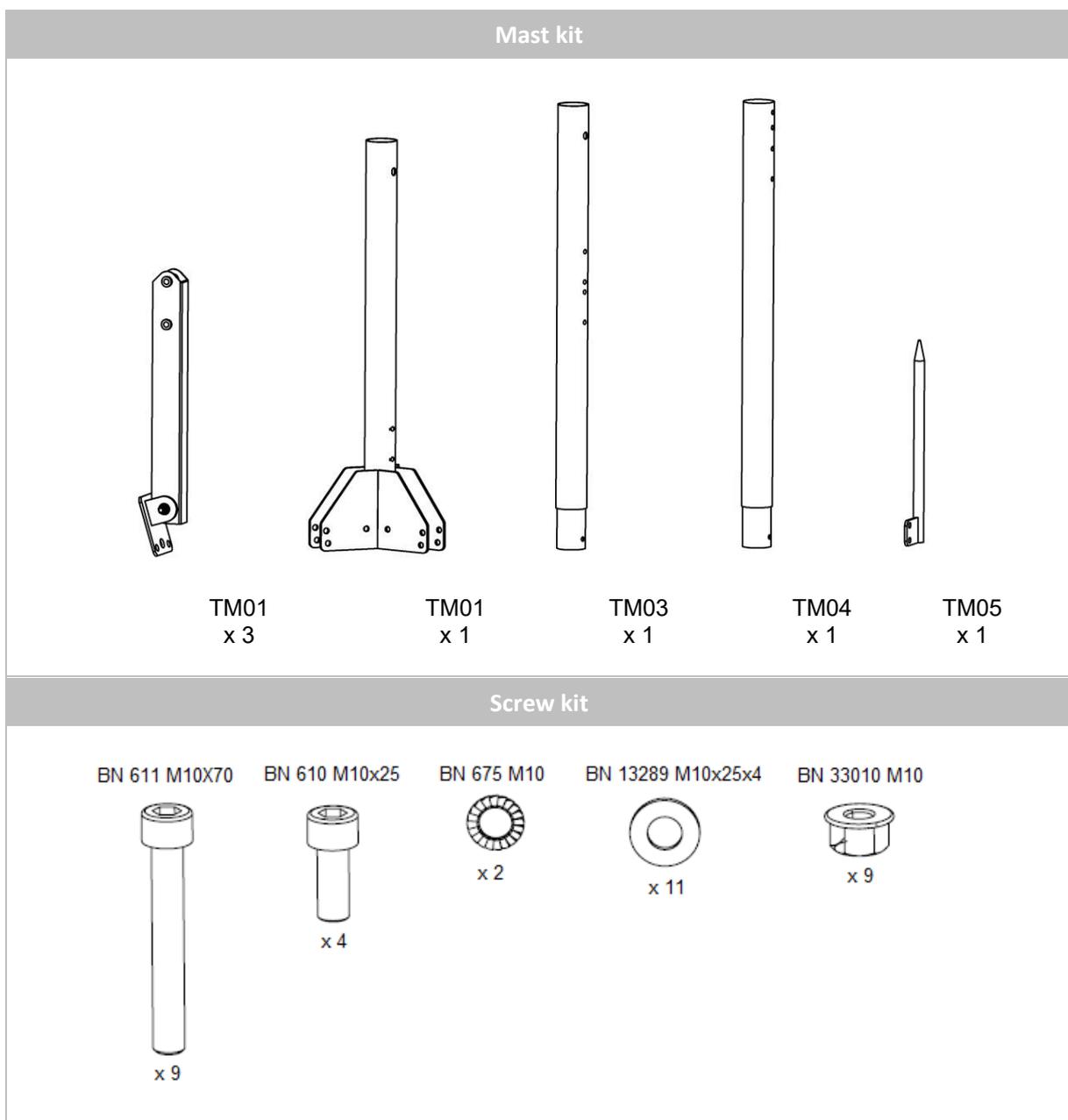
4.3.6. Mounting examples
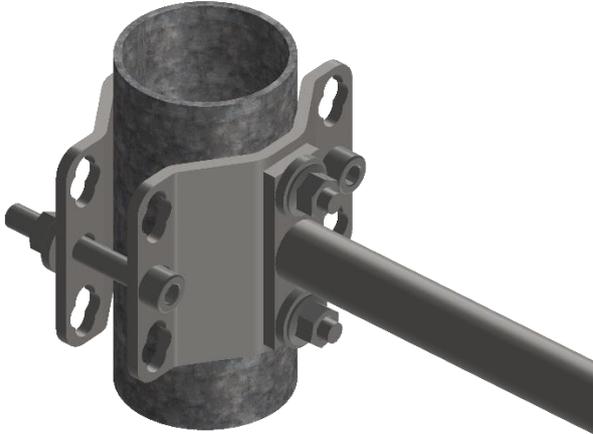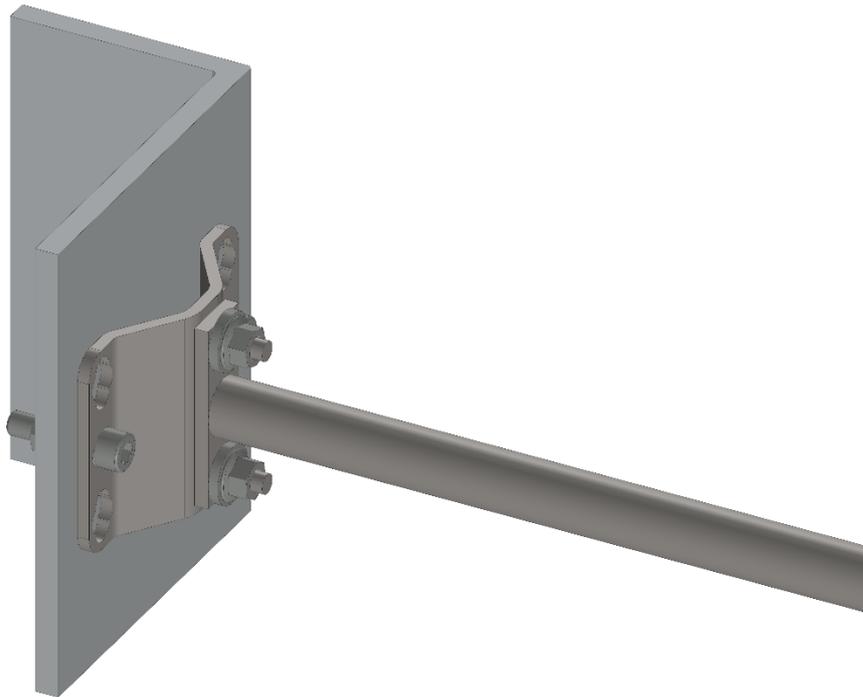
On a vertical, horizontal (or oblique) **cylindrical mast** with an outer diameter of **40 mm**, use the provided V brackets.
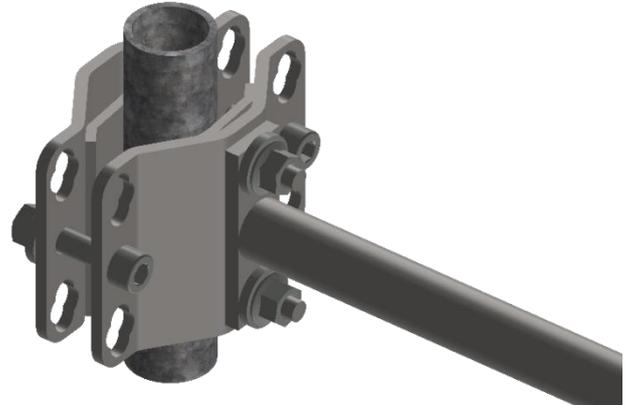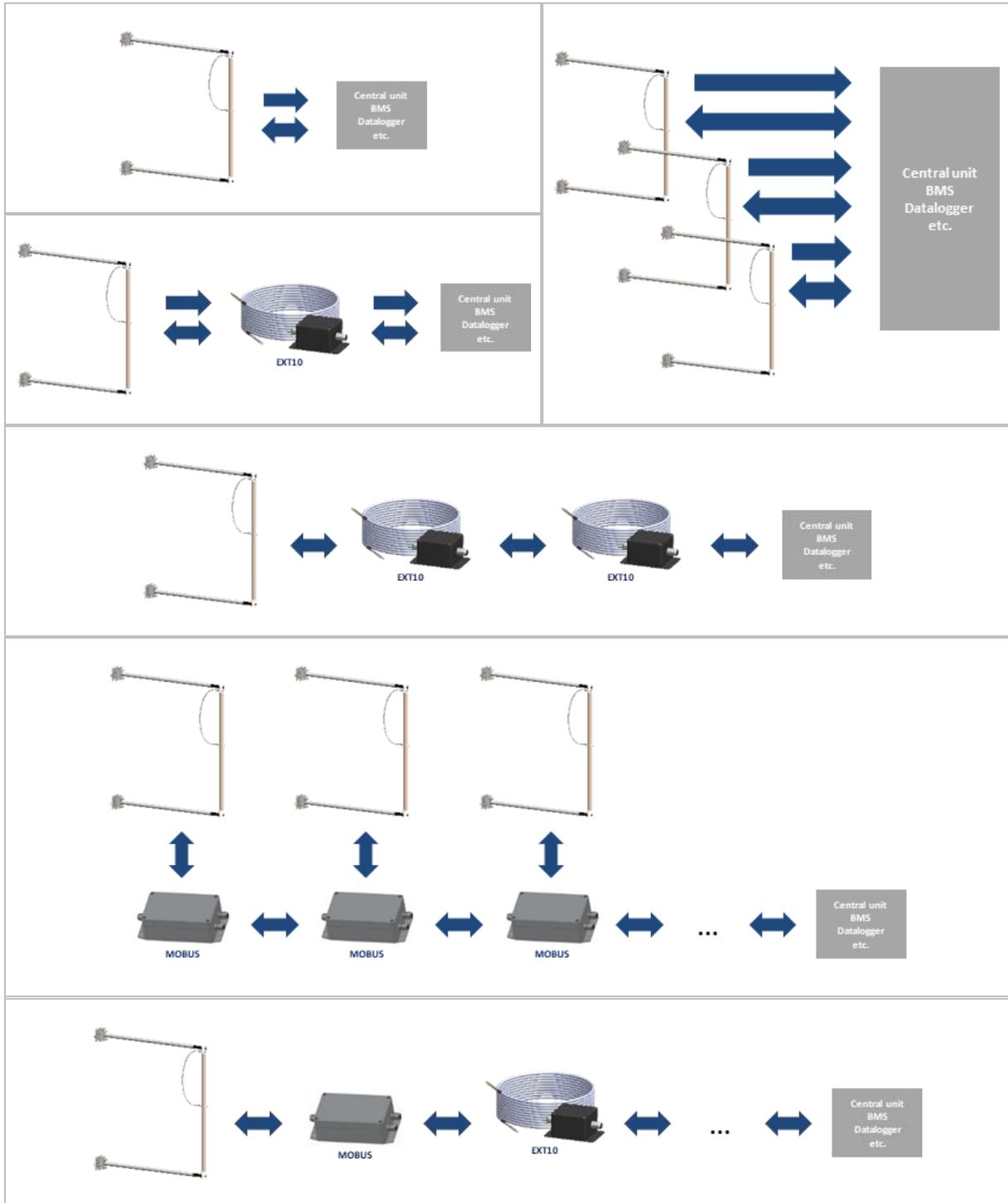
On a vertical, horizontal (or oblique) **cylindrical mast** with an outer diameter of **25 mm**, use the provided V brackets and reduction shims.

On a **flat surface**, screw the V brackets (or the arms directly) onto the surface.

4.3.7. Chaining examples

5. OPERATE THE SandFlow SF4

5.1. Disclaimer

When using the SandFlow SF4, IAV Technologies SARL is not responsible for the choice, selection, relevance and usage appropriateness of the instrument installation site; nor for the usage, interpretation, and extrapolation of the information made available to the users. Any known system issues that may induce dysfunction or skew the measurements are reported to the users through documentation updates. To continually improve the system, the ISAW Products division of IAV Technologies SARL reserves the option to upgrade the instrument hardware, software, and user recommendations anytime.

5.2. Recording data using the internal datalogger

By default, the internal datalogger is activated in cyclic mode, i.e. the newest data constantly overwrites the oldest ones when the memory is full.

To change the recording mode or the content of the data frames, please refer to section 3.3.5.

To check the status of the datalogger, open the Datalogger utility of the ISAW-Toolbox (see § 1.11).
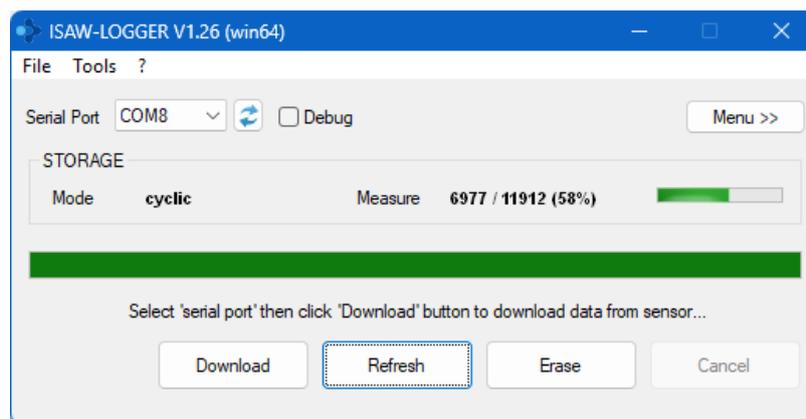
The mode can be: **Disabled** (no data is recorded), **Enabled** (data are recorded until the memory is full) or **Cyclic** (data are recorded and the oldest data are constantly overwritten when the memory is full).

Measure is the number of recorded measurements / Total number of recordable measurements.

The **gauge** shows the datalogger's memory status.

Press the [Refresh] button to update this information.

To download data from the datalogger, press the [Download] button. The content of the datalogger is saved into a .CSV file. This operation does not clear the datalogger.

To clear the datalogger (i.e. delete all logged data), use the [Erase] button.

WARNING: This operation is irreversible: deleted data are definitely lost.

5.3. Recording data on a computer

If connected to a computer with the USB link accessory, you can also log indefinitely the data produced by the instrument and without installing any software by means of the **livelogger utility** which is an executable program example available with the ISAW-Toolbox software suite.

Open the **Programming Examples** folder from the ISAW Toolbox to get the full pathname of the livelogger executable.
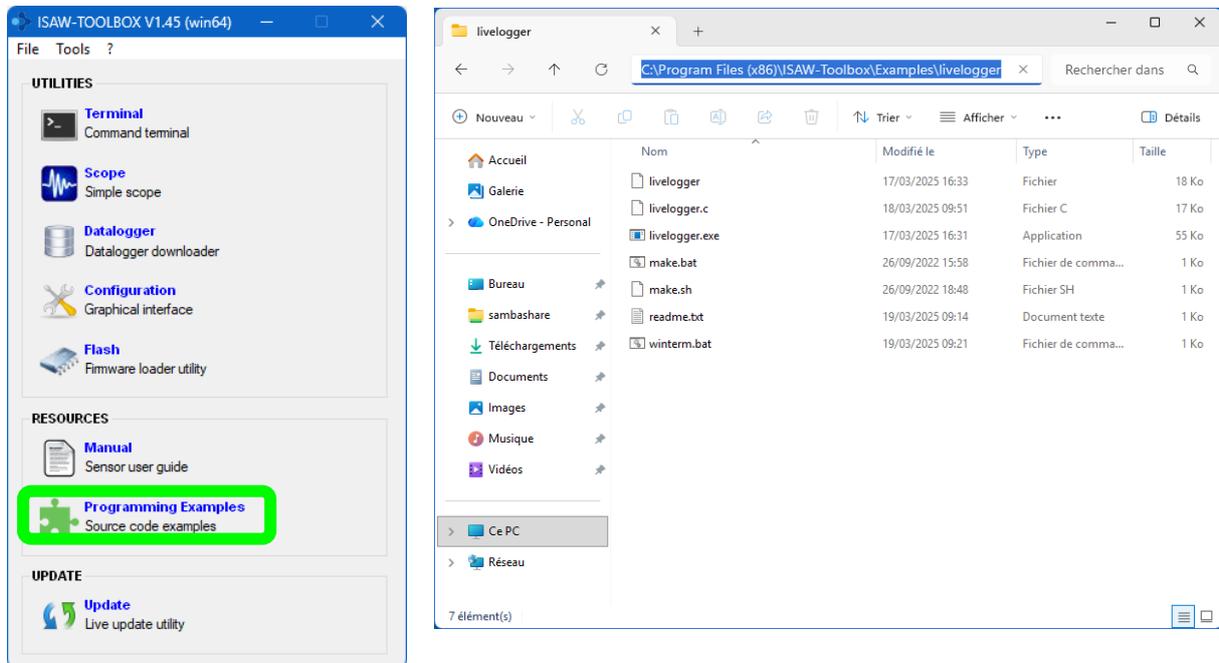
Open a command prompt, go to the right directory and execute livelogger.exe on the COM port the instrument is connected to.

The data is displayed according to the specified A,C,M setting of the instrument (cf. § 0), and a .CSV file is also produced in the same directory. The data is timestamped according to the clock of your computer.
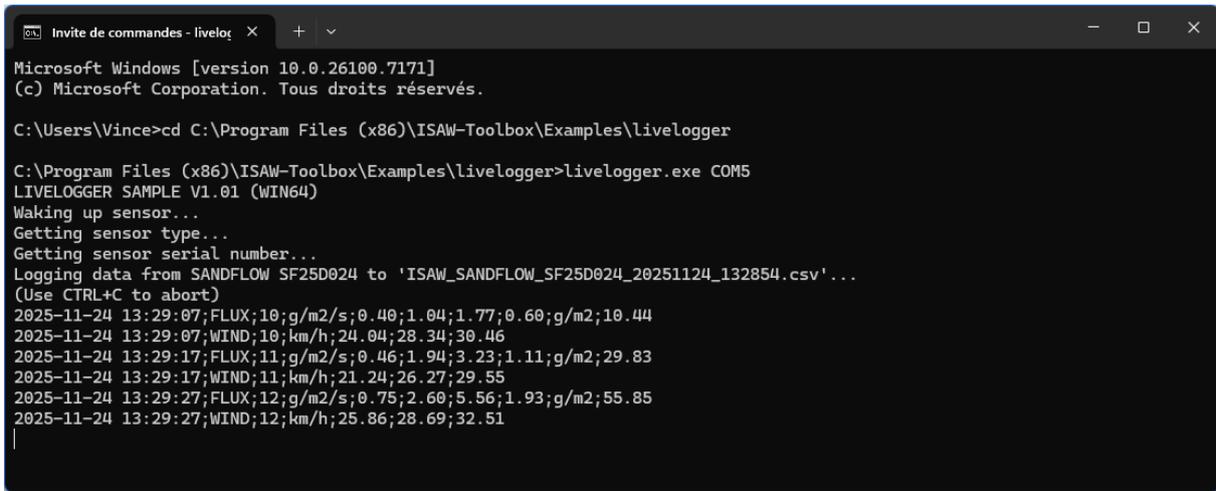
```
Invite de commandes - livelog   ×   +   ∨                                    —  □  ×

Microsoft Windows [version 10.0.26100.7171]
(c) Microsoft Corporation. Tous droits réservés.

C:\Users\Vince>cd C:\Program Files (x86)\ISAW-Toolbox\Examples\livelogger

C:\Program Files (x86)\ISAW-Toolbox\Examples\livelogger>livelogger.exe COM5
LIVELOGGER SAMPLE V1.01 (WIN64)
Waking up sensor...
Getting sensor type...
Getting sensor serial number...
Logging data from SANDFLOW SF25D024 to 'ISAW_SANDFLOW_SF25D024_20251124_132854.csv'...
(Use CTRL+C to abort)
2025-11-24 13:29:07;FLUX;10;g/m2/s;0.40;1.04;1.77;0.60;g/m2;10.44
2025-11-24 13:29:07;WIND;10;km/h;24.04;28.34;30.46
2025-11-24 13:29:17;FLUX;11;g/m2/s;0.46;1.94;3.23;1.11;g/m2;29.83
2025-11-24 13:29:17;WIND;11;km/h;21.24;26.27;29.55
2025-11-24 13:29:27;FLUX;12;g/m2/s;0.75;2.60;5.56;1.93;g/m2;55.85
2025-11-24 13:29:27;WIND;12;km/h;25.86;28.69;32.51
```

Note: If the internal datalogger of the instrument is activated, in case of unwanted interruption of the livelogger communication you will still be able to retrieve a backup of the data.

5.4. Getting a .WAV signal from the instrument

The instrument has a function that allows the direct recording of the raw measurement signal in the format of a .WAV sound file. To activate this function, open the **Scope utility** of the ISAW-Toolbox (see § 1.11) and check the "Record to wav" item in the "File" menu.
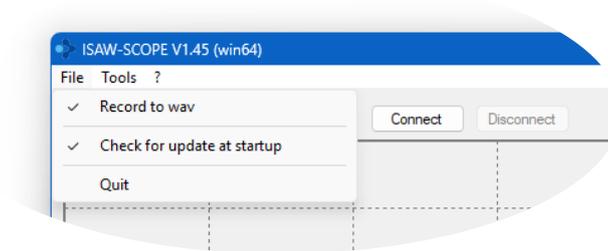
To open the .WAV file, use the "Tools > Open wav directory..." menu of the Scope utility.
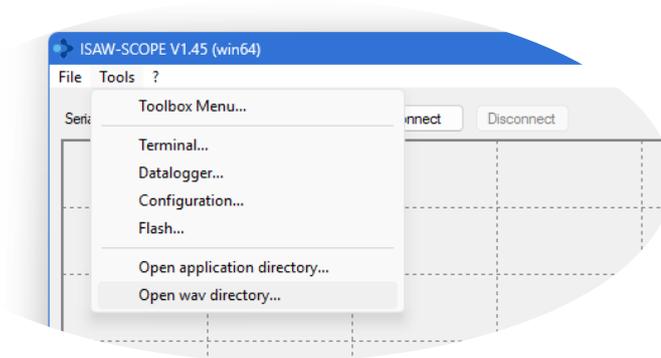
The .WAV file is 16 bits, PCM, 2000 Hz sampling rate stereo file, which contains in the left channel the RMS, unfiltered envelop of the raw AC signal, and in the right channel the unfiltered raw AC signal. The following example shows a reading of such .WAV file in the Audacity® freeware, the capture showing a 30 seconds time history recording obtained while grabbing the tube with the fingers.

5.5. Update the instrument firmware

IAV Technologies constantly improves its products and provides upgrades of the ISAW firmware for all instruments. This section describes the procedure for upgrading the ISAW firmware.

Note: The instrument's configuration is not affected by the firmware update: existing parameters keep their value and new parameters, introduced with the new firmware's version, are set to their default value (see section 3.1).

Prerequisites:

- The ISAW-Toolbox is installed (see § 1.11).
- The last versions of the instrument firmware are installed (use the Update utility to check).
- The instrument is plugged to your computer using the USB Link accessory.

Open the ISAW Toolbox **Flash** Utility
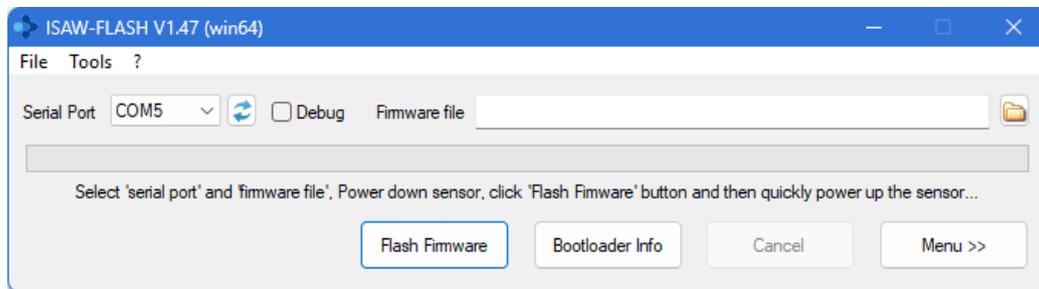
Select the Serial Port the USB link is connected on.

Note: If you don't see the USB link serial port, it may be that another application is using it, so close all applications and restart ISAW-Flash.

Select the firmware file: Select the last version of the firmware corresponding to your instrument:

ISAW-SandFlow-x.xx.bin (where x.xx is the version number)

WARNING: The firmware folder contains all instruments firmware files. Make sure you select the one dedicated to your instrument!

Shut down the instrument power supply: set the USB Link power switch to OFF.

Press the [Flash Firmware] button. At this stage, ISAW-Flash will automatically search for a powered instrument during ten seconds.

Power-on the instrument: Switch the USB link power back to ON. As soon as ISAW-Flash has found the powered instrument, the firmware upload starts automatically.
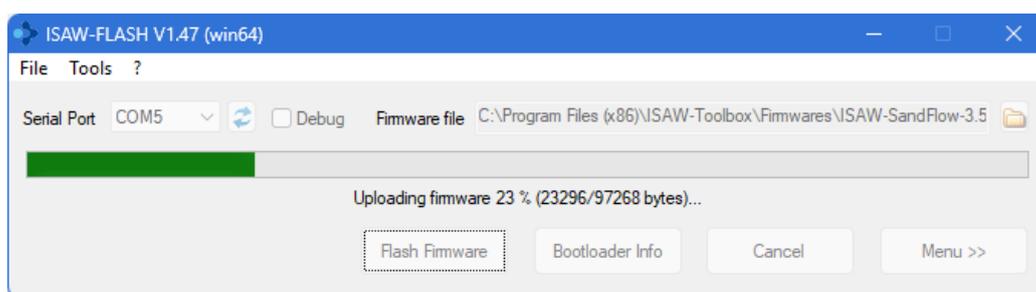
Wait during the firmware upload. This may take a few minutes.

WARNING: Do not disconnect the power supply during firmware upload.

When the firmware upload is successfully completed, a confirmation message is displayed.

The instrument is now ready to use.

Note: The [Bootloader Info] command button retrieves the information of the bootloader installed on the instrument.

5.6. Troubleshooting

5.6.1. USB connection problem

Not or no longer recognizing the COM port when the UDONG is plugged to the computer. The port is not auto-selected, nor available in the pull-down menu.

■ Power off the UDONG. Unplug the UDONG from the computer and unplug the instrument from the UDONG.

■ Plug the UDONG alone back to the computer. The TX and RX (red and orange) LEDs on the UDONG should blink for a few milliseconds. Then, when powering "ON" the UDONG, the green led on the UDONG should switch on. If not, either the UDONG or the USB port is defective.

■ If you have a multimeter, connect the instrument (or just the terminal block alone) to the UDONG and check on the terminal block screws if you really get 12 V between "POWER +12V (white)" and "POWER GND (black)". If not, this means that the USB port of your computer is not providing the standard 12V, 500 mA USB powering.

■ Double-check the wiring of the instrument to the terminal block pins (cut cable, untightened screw, cable(s) on the wrong terminal pin(s)).

■ If the LEDs are working properly and the wiring is correct, it may happen that the COM port is preempted by another application, for example if another USB-to-serial device has been installed, which can cause driver conflict. In this case, try to choose an alternate driver in the "Device Manager", or fully uninstall and reinstall the driver. In both cases, unplug and re-plug the device after to re-enumerate USB and/or reinstall the driver.

As another simple test of the full chain (UDONG and instrument), try to connect the instrument to another computer or smartphone (see introduction chapter). If the instrument is recognized, this means that the issue is most probably on the USB side of your computer.

Tip:	While testing the USB connection, seize the opportunity to upgrade the ISAW-Toolbox software suite (just open it) as well as the instrument firmware (see § 5.5). This is not a requirement, but may help to solve the issue.

5.6.2. Avoid parasitic noise

In the case of an instrument placed in a particularly noisy environment or for example rigidly attached to a structure subject to high vibrations, it is possible to set a threshold below which the signals will be automatically converted to zero by the instrument in the internal calculations of wind flux and speed.
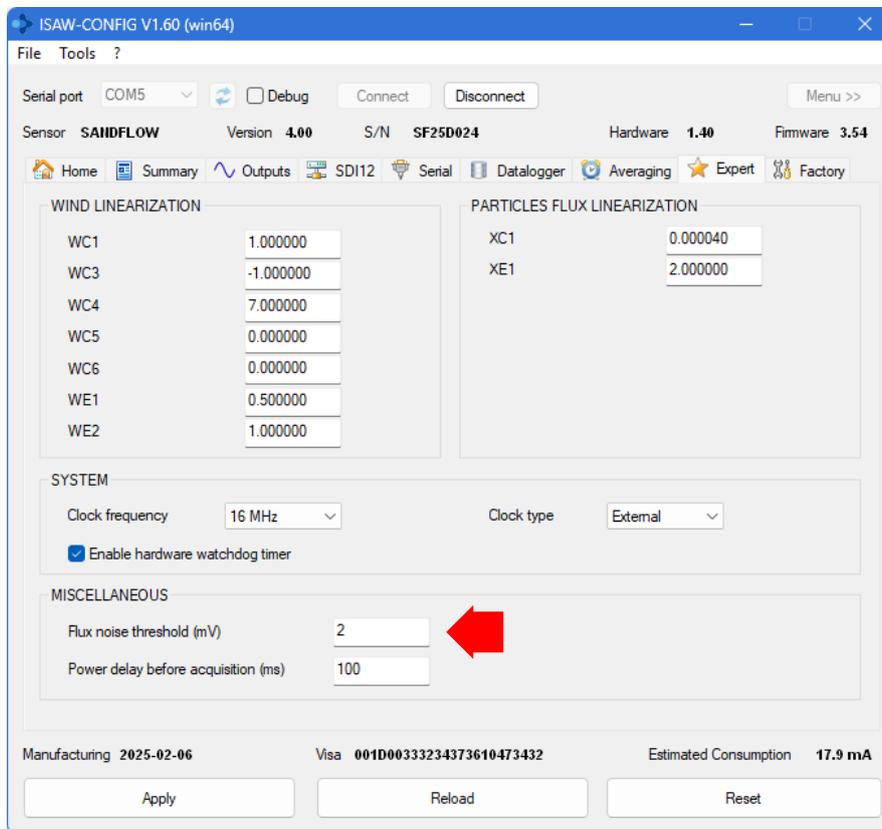
6. ORDERING, MAINTENANCE & SUPPORT

Ordering references

The SandFlow SF4 instrument is available with its fastening arm, and a set of complementary accessories allows you to select the equipment that perfectly matches your operating situation:

Ref.	Description
SFBRA	SandFlow SF4 instrument with mounting kit
SF2MA	Pair of SandFlow SF4 instruments fastened on a mast
UDONG	USB Link accessory (provided with SFBRA)
EXT10	Cable extension, 10 meters, including JUBOX junction box. (Note: You can chain several items, or ask for a specific cable length.)
MOBUS	Modbus RTU-485 adapter
AD420	4-20 mA adapter
TMAST	Supporting structure: tripod mast

Shipping

Eco-friendly packaging, worldwide shipping within 1-5 days a.r.o., URGENT BUSINESS shipping mode.

Safety and care

The full instrument and fastening elements is a heavy and plain device, it must always be fastened very cautiously and all the nuts tightened to avoid any possible looseness. The nuts are all with an integrated anti-unscrewing washer flange so apart from an improper assembly they cannot loosen themselves.

Cleaning and handling

There is no specific recommendation for cleaning or handling the instrument. The only soft material of the instrument are the cable and the elastomer damper of the mounting kit. They only require the standard state-of-art of protecting cables and connections, and visual check of the integrity of the material.

Product Repair

In the event of an instrument breakdown or damage, IAV Technologies SARL provides all the support and spare parts necessary for a repair, either remotely or by returning the instrument to the factory, if the repair requires a recalibration of the instrument.

Warranty

The SandFlow SF4 instrument is a repairable products and benefits of a two-year warranty. The instrument, the USB dongle accessory and the mounting accessories are designed and produced with the highest standards. In case of failure, DO NOT TRY to open the instrument. Opening is destructive unless it is done at the factory for repair. None of the moving or user-serviceable parts requires routine maintenance. Opening the unit will void the warranty.

In the event of failure, before returning the unit, we recommend that you:
1. Check all cables and connectors for continuity, bad contacts, corrosion, etc.
2. Conduct a bench test e.g. using the Scope utility.
3. Contact us directly for advice.

Disposal

The instrument and mounting accessories are made of detachable and separable plain metals parts (stainless steel and aluminum), plastic or elastomer elements, a PUR cable and one electronic PCB circuit.

To recycle the instrument and its entire assembly kit, all screws must be disassembled, all the unit elements listed above must be recognized and separated, and placed in the appropriate recycling bins or circuits.

C€

Factory return address:	Assistance:
IAV TECHNOLOGIES SARL	isaw@iav.ch
ISAW Products Division	+41 (0)22 960 11 04
Chemin des Couleuvres 4A	
1295 TANNAY	
SWITZERLAND	

www.isaw-products.com

Spare parts

	Item ref.	Short name		Full description	Quantity			
					SFBRA	SF2MA	EXT10	TMAST
Instrument	SF4	SandFlow instrument		SandFlow SF4 instrument	1	2		
Mounting parts	CYARM	Cylindrical arm		ISAW - Cylindrical arm	2	4		
	SLEEVE	Cylinder sleeve		ISAW - Plastic sleeve for instrument	2	4		
	BRARF	Front bracket		Front bracket for fastening arm	1			
	BRARB	Back bracket		Back bracket for fastening arm	1			
	BRASH	Reduction shim		Reduction shim	2			
Mast	TM01	Leg with inclinable foot		Leg with inclinable foot for supporting structure TMAST		3		3
	TM02	Base		Base for supporting structure TMAST		1		1
	TM03	Mid tube		Mid tube for supporting structure TMAST		1		1
	TM04	Top tube		Top tube for supporting structure TMAST		1		1
	TM05	Lightning rod		Lightning rod for supporting structure TMAST		1		1
Acc.	JUBOX	Junction box		Junction box for cable extension EXT10			1	
Standard	BN 610 M10x25	M10 × 25 mm screw		Hex socket head cap screws fully threaded (DIN 912, ISO 4762), stainless steel A2, M10x25 (e.g., Bossard BN 610 Art. No. 1233505)		8		4
	BN 610 M10X40	M10 × 40 mm screw		Hex socket head cap screws fully threaded (DIN 912, ISO 4762), stainless steel A2, M10x40 (e.g., Bossard BN 610 Art. No. 1032860)	4			
	BN 611 M10X70	M10 × 70 mm screw		Hex socket head cap screws partially threaded (DIN 912, ISO 4762), stainless steel A2, M10x70 (e.g., Bossard BN 611 Art. No. 1113356)	4			9
	BN 611 M10x110	M10 × 110 mm screw		Hex socket head cap screws partially threaded (DIN 912, ISO 4762), stainless steel A2, M10x110 (e.g., Bossard BN 611 Art. No. 1488759)				

Item ref.	Short name		Full description	Quantity			
				SFBRA	SF2MA	EXT10	TMAST
BN 13289 M10x25x4	M10 washer 4 mm thick		Flat washers without chamfer, for bolts with heavy duty type spring pins (DIN 7349), A2, M10/10.5/25/4 (e.g., Bossard BN 13289 Art. No. 3062099)	8			9
BN 33010 M10	M10 securing nut		Hex flange nuts (DIN 6923; EN 1661), stainless steel A2, M10 (e.g., Bossard BN 14476 Art. No. 1329359)	8			9
TERM BLOCK PLUG 8POS STR 5.08MM	Terminal block plug		8 Position Terminal Block Plug, Male Pins 0.200" (5.08mm) 180° Free Hanging (In-Line)	1	2	2	

Appendix A: TECHNICAL DATA

Specifications

Measuring characteristics	
Measuring surface	Ø32 × 920 mm cylindrical tube
Physical phenomena detected by the instrument	**Flux** of solid particles transported by the wind (aeolian sand transport, and more generally all kind of solid particle fluxes of the same range of kinetic energy generating **impacts** on the measuring surface). **Wind** speed (more generally, an estimation of the average speed of the laminar aeolian flux generating **friction** on measuring surface).
Measurement accuracy	**Flux:** For a given controlled flux homogeneously distributed along the measuring surface of the instrument (such as particles of a given shape profile, density, Young modulus, falling speed and incidence angle), the response of the instrument varies of $\pm$ 5% and the variability between two instruments is below $\pm$ 10%. **Wind:** In laminar established conditions and without external parasitic turbulences or low-frequency noise, the wind speed accuracy is $\pm$ 15%.
Particle velocity	Not measured. Can only be an interpretation of the wind speed measurement.

Voltage ranges and measuring scales	
Voltage outputs	Continuous analog voltage or pulse analog voltage, user selectable +0 to +2.5V or +0 to +5V are available. Pulse threshold, integrator timeout and duration are also user selectable. The continuous analog voltage persists on the outputs so that output voltages can be read at any time.
Wind speed scaling	Sensitivity @voltage range +2.5V: [10 mV/(km/h)] i.e. +2.5V corresponds to 250 km/h
	Sensitivity @voltage range +5V: [20 mV/(km/h)] i.e. +5V corresponds to 250 km/h
Particles flux scaling	Sensitivity @voltage range +2.5V: [10 mV/(g/m^2/s)] i.e. +2.5V corresponds to 250 g/m^2/s
	Sensitivity @voltage range +5V: [20 mV/(g/m^2/s)] i.e. +5V corresponds to 250 g/m^2/s

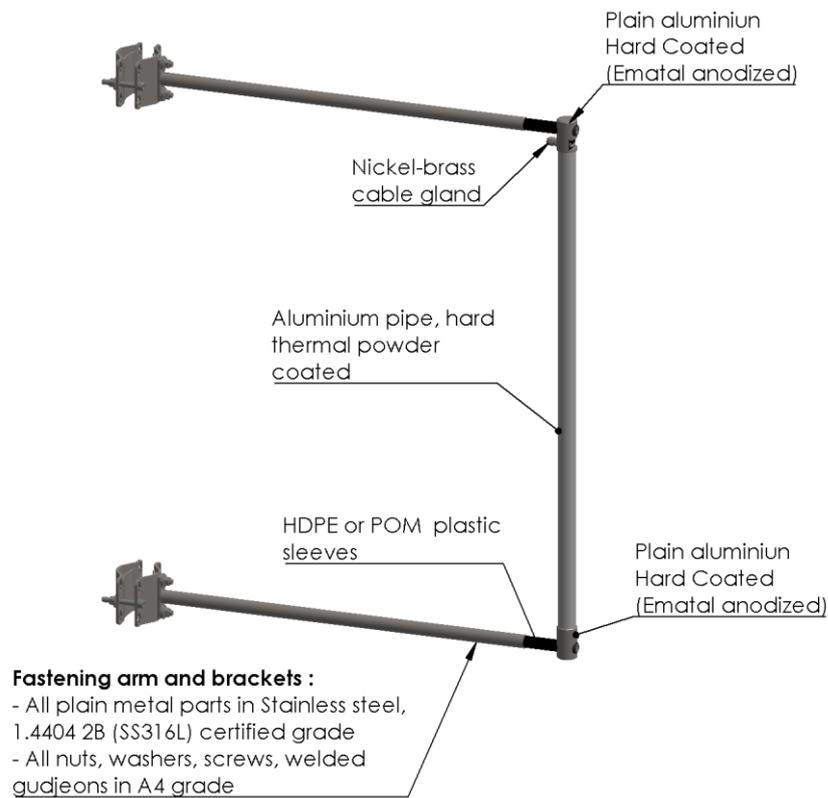| Mechanical data	
Material	Plastic and aluminum
Installation	Universal mounting kit provided (ordering reference: SFBRA)
Weight	1 kg without mounting kit 5 kg with mounting kit
Dimensions (H×W×D)	Sensor alone: 1040 mm × ⌀32 mm With mounting kit: 1040 mm × 874 mm × 40 mm

Interfaces	
Analog	Pulse and continuous (and persistent) voltages, 0-2.5V or 0-5V
SDI-12	Yes, 1.3 certified (fully complies with the NR Systems SDI-12 Verifier)
Serial 3V3 TTL	Yes
Modbus RTU (RS485)	Yes, with the Modbus adapter accessory

Supply	Ratings
Voltage	6 V to 30 V DC (9.6 V and 16 V DC in case of powering through the SDI-12 terminals)
Current	< 1 mA in stand-by mode and 20 mA max in acquisition mode. For a typical nominal duty-cycle of 10%: 2.1 mA (20 mA for duty-cycle of 100%).

Environmental conditions	
Temperature range	-40°C to +80°C. Can even operate over this range.
Relative humidity	0 to 100%
Protection	IP67
Standards	EN 61326-1: 2013, CE compliant 2014/30/EU, CE compliant

Materials

The sensing of the instrument is a 32 mm outer diameter hard coated aluminum pipe terminated by two plain aluminum hard coated body ends, the sensing head containing the embedded electronics of the device. Both ends are mounted through an elastomer damper and plastic sleeves on a rigid cylindrical high grade stainless-steel fastening arm.

Plain aluminiun
Hard Coated
(Ematal anodized)

Nickel-brass
cable gland

Aluminium pipe, hard
thermal powder
coated

HDPE or POM plastic
sleeves

Plain aluminiun
Hard Coated
(Ematal anodized)

Fastening arm and brackets :
- All plain metal parts in Stainless steel,
1.4404 2B (SS316L) certified grade
- All nuts, washers, screws, welded
gudjeons in A4 grade

Dimensions

SFBRA
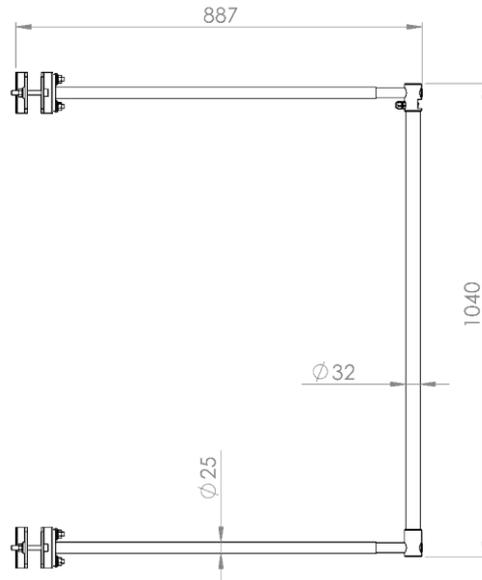
C2BRA
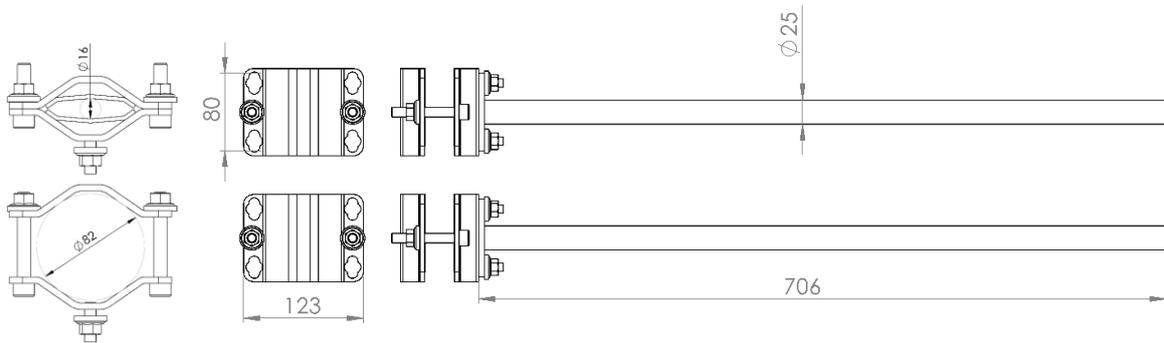
UDONG

MOBUS

EXT10 / AD420

TMAST	SF2MA
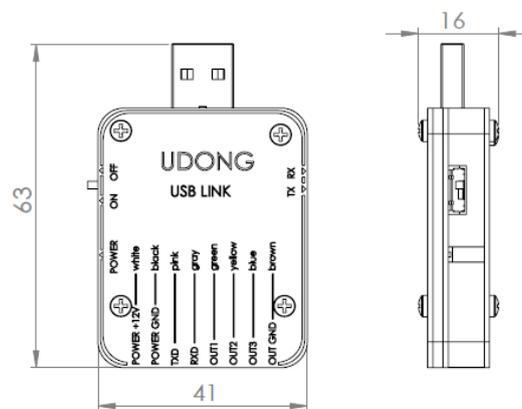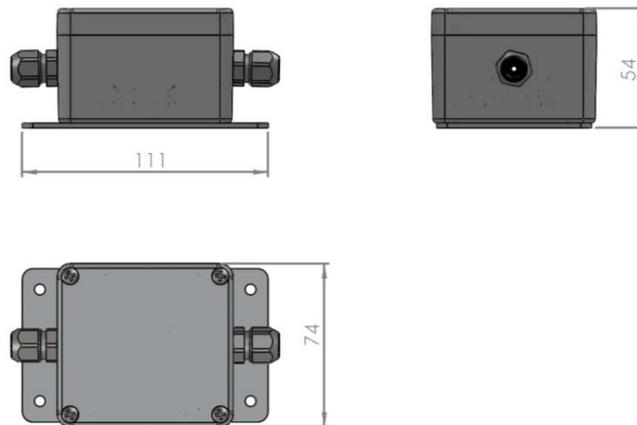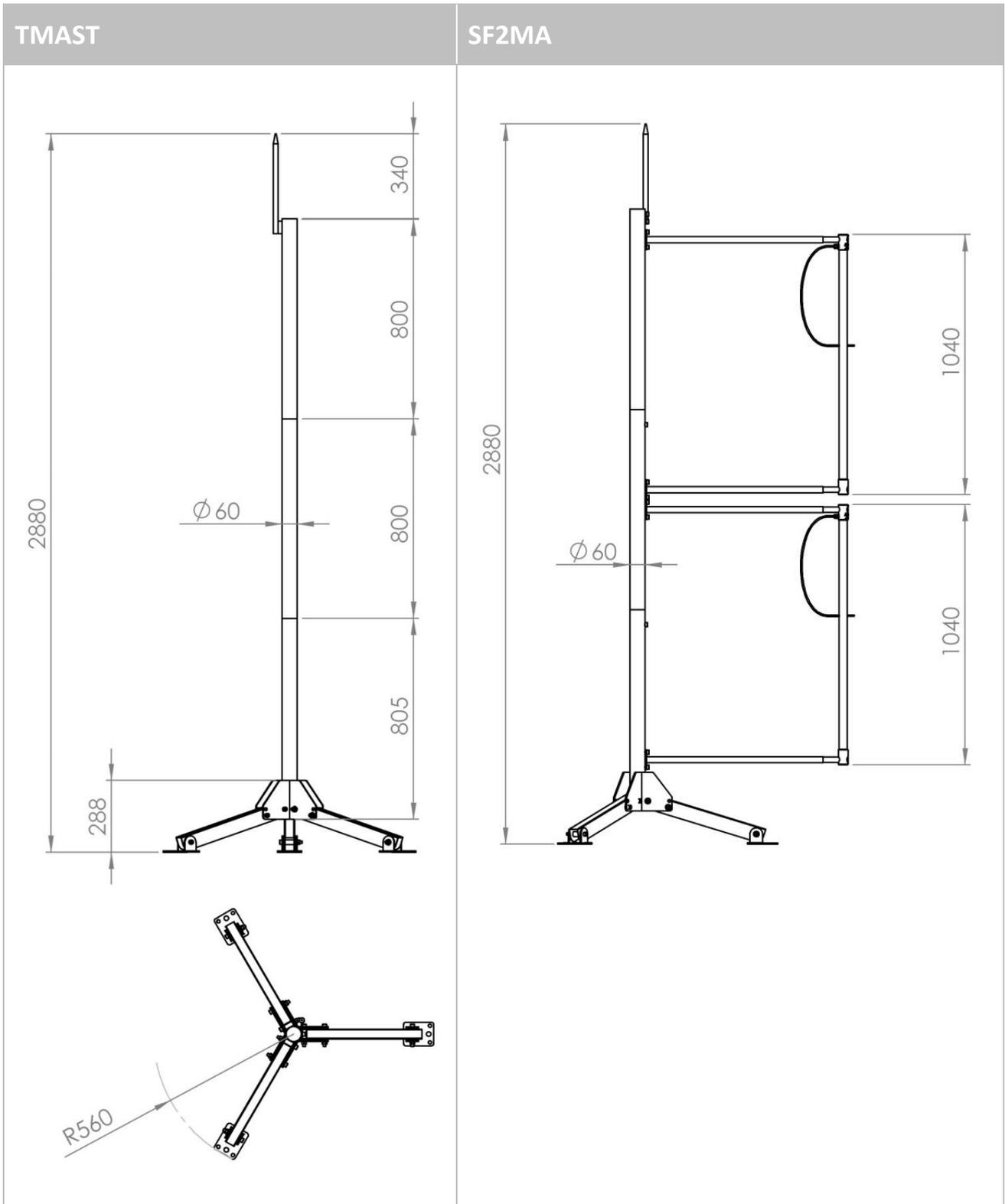
Appendix B: SERIAL COMMUNICATION

ISAW provides a serial communication with the instrument with any serial terminal utility like Putty, TeraTerm, HyperTerminal, or other.

B.1. Connect in terminal or console mode

First you need to connect the instrument to a computer with the USB dongle accessory (or using a FTDI 3.3V serial USB converter/adapter).

WARNING: Do not connect the instrument directly to a non-TTL serial port like standard RS232 (DB9 connector). You must use a 3.3V serial adapter; otherwise, you may cause permanent damage to the instrument!

Connect your Terminal software
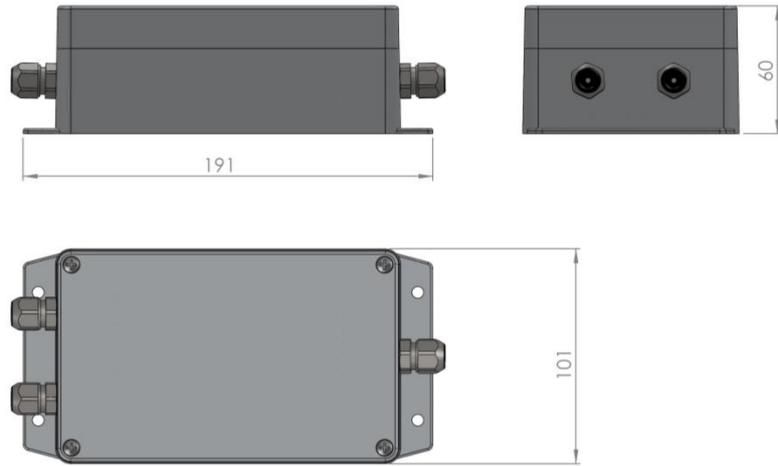
Open your favorite serial terminal on the serial port (*e.g.: COM23*) at 115200 bauds, 8 bits, 1 stop, no parity. Input terminator is <CR>, Output terminator is <CRLF>.

Example: You can use the lightweight and non-intrusive "putty.exe" freeware available at http://www.putty.org:
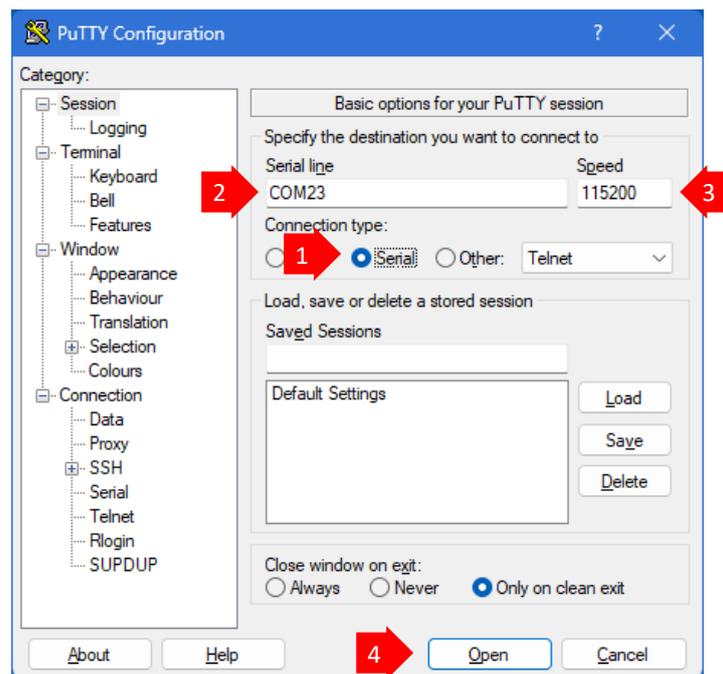
Type "help" and press [Enter] to display all available commands:

Execute ISAW command

Once connected, you can enter any one of the following commands.

B.2. Console commands

All command results share the same format:

`OK`   : Successful command.

`OK=<value>`   : Successful command with return value.

`ER=<message>` : Command error with error message.

Command	Result / Description
`help`	Displays the list of all available commands.
`reboot`	After changing the instrument configuration, you need to reboot the instrument by using the "reboot" command.
`reset confirm`	Recovers the default factory configuration and reboots the instrument. All parameters are reinitialized, except the following ones (internal factory parameters): sens-type hw-version cfg-ident sys-uptime sens-version hw-date cfg-version sys-status sens-date hw-sn calib-date misc-dbg sens-sn fw-version calib-wind fw-build calib-flux
`config`	Displays the instrument current configuration (list of all parameters and corresponding values).
`admin <password>`	Activates the admin rights and allows changing special parameters. This command is reserved for factory parameters initialization and requires a password.

Command	Result / Description
`debug <module> <on|off>`	Activates / deactivates the debug mode for a given module. Debug messages are available on the serial console. **Note:** It is not recommended to activate the debug mode in production as it may result in ADC overrun. `<module>` can be: `all` Enable/disable all debug messages (very verbose). `console` Enable/disable console debug messages. `acq` Enable/disable acquisition buffer output. `measure` Enable/disable measurement calculation debug messages. `power` Enable/disable power status. `board` Enable/disable board debug messages. `sdi12` Enable/disable SDI-12 debug messages. Example: `debug sdi12 on` OK
`get <parameter>`	Allows getting a parameter value from the configuration. Example: `get sens-date` OK=2016-01-28
`set <parameter> <value>`	Allows changing a parameter value of the configuration. The list of all parameters and corresponding values is given in § 3.2. **Note:** Remember you need to reboot the instrument after changing the instrument configuration. Example: `set sdi12-addr 7` OK
`datalogger <command>`	Control the datalogger: `<command>` can be: `download` Download the data. `clear` Delete all logged data.
`datalogger <field> <on|off>`	Activates/deactivates the logging of a value: `<field>` can be: `flux_min` Minimum flux (g/m^2/s) `flux_avg` Average flux (g/m^2/s) `flux_max` Maximum flux (g/m^2/s) `flux_std` Standard flux deviation (g/m^2/s) `flux_cum` Cumulative flux (g/m^2) `wind_min` Minimum wind (km/h) `wind_avg` Average wind (km/h) `wind_max` Maximum wind (km/h) **Note:** The datalogger must be cleared after changing the configuration fields . Example: `datalogger wind_min off`
`scopemode`	Reboots the instrument in scope mode. This command is used by the Scope Utility. It toggles the "misc_scopeqry" flag and reboots the instrument, which then restarts with the streams activated via the serial port. **Note:** Streams are transmitted in binary. If you execute this command in a text console, it may display strange characters or behave oddly.

B.3. Error messages

Error message	Description
Parameter is read-only	You cannot change this parameter.
Need admin permission	You need to use the "admin" command before executing the present command.
Busy	Command currently executed. Retry later.
Invalid unsigned integer value/argument	Value or argument is not a valid integer (only digits and <+> (plus) character are allowed).
Invalid integer value/argument	Value or argument is not a valid integer (only digits, <+> (plus) and <-> (minus) character are allowed).
Invalid float value/argument	Value or argument is not a float (only digits, <+> (plus), <-> (minus) and <.> (dot) characters are allowed).
Invalid value/argument size	Value or argument size is too long or empty.
Invalid value/argument	Value or argument is not valid.
Invalid dependent value/argument	Value or argument is not valid and depends on another parameter.
Value/argument out of range	Value or argument is out of range.
Invalid internal function	Internal error.
Invalid internal parameter type	Internal error.
Invalid internal limit type	Internal error.
Unknown command	Command is unknown.
Unknown parameter	Parameter is unknown.
Forbidden	Operation is forbidden with these parameters.
Invalid password	Password is not valid.

B.4. Serial measurement frame

Get a measurement result in a CSV formatted parameter after each "avg-m" on the serial port (TX: pink wire).

The serial result is computed and reset every [Measurement duration] interval.

FLUX

        `FLUX;<counter>;<unit>;<min>;<avg>;<max>;<std>;<unit>;<sum>`

        `<counter>` is a frame counter incremented at each result
        `<unit>`   is the unit of the following values in the frame: "g/m²/s"
        `<min>`   is the minimum of the flux measurement [g/m²/s]
        `<avg>`   is the average of the flux measurement [g/m²/s]
        `<max>`   is the maximum of the flux measurement [g/m²/s]
        `<std>`   is the standard deviation of the flux measurement [g/m²/s]
        `<unit>`   is the unit of the following value in the frame: "g/m²"
        `<sum>`   is the cumulative flux [g/m²]

Example: `FLUX;987;g/m2/s;247.24;262.41;288.12;4.80;g/m2;98652.94`

WIND

        `WIND;<counter>;<unit>;<min>;<avg>;<max>`

        `<counter>` is a frame counter incremented at each result
        `<unit>`   is the unit of the following values in the frame:" km/h"
        `<min>`   is the minimum of the wind measurement [km/h]
        `<avg>`   is the average of the wind measurement [km/h]
        `<max>`   is the maximum of the wind measurement [km/h]

Example: `WIND;987;km/h;57.63;68.74;89.32`

Appendix C: SDI-12 – SERIAL DIGITAL INTERFACE

The ISAW firmware supports Serial Digital Interface (SDI-12) standard V1.3 (the SDI-12 V1.3 standard specification can be found at http://www.sdi-12.org).

SDI-12 stands for "serial data interface at 1200 baud" [Source: www.sdi-12.org]. It is recommended for applications of the ISAW instruments that you intend to interface with battery powered data recorders with minimal current drain and/or long-distance cabling (typically up to 150 m).

It is possible to connect more than one ISAW instrument (as well as other SDI instruments) to a single data recorder thanks to the fact that SDI-12 is a multi-drop interface that can communicate with multiple and multi-parameter instruments. The SDI-12 bus supports having ten or more connected instruments. "Multi-parameter" means that a single instrument may return more than one measurement.

This serial-digital interface is thus a logical choice for interfacing your ISAW instrument with a distant data recorder.

This has advantages for instruments and data recorders:

- Unique and complex self-calibration algorithms are executed in the microprocessor-based ISAW instrument.
- The instruments can be interchanged without reprogramming the data recorder with calibration or other information.
- Power is supplied to instruments through the interface.
- The use of a standard serial interface eliminates significant complexity in the design of data recorders.
- SDI-12 data recorders interface with a variety of instruments.
- SDI-12 instruments interface with a variety of data recorders.
- Personnel trained for SDI-12 will have skills to work with a variety of SDI-12 data recorders and SDI-12 instruments.

C.1. SDI-12 standard commands

Name	Command	Description/Response		
Acknowledge Active	`a!`			
Instrument Identification	`aI!`	`13IAV-TECSANDFLO354`		
Change Address	`aAb!`	*No need to reboot instrument*		
Address query	`?!`	`a`		
Start Measurement	`aM!`	*Always reset measure*		
		sdi12-mode=wind	`a0003`	
		sdi12-mode=flux	`a0005`	
		sdi12-mode=all	`a0008`	
Start Measurement and request CRC	`aMC!`	*Always reset measure*		
		sdi12-mode=wind	`a0003`	
		sdi12-mode=flux	`a0005`	
		sdi12-mode=all	`a0008`	
Send Data	`aD0! … aD9!`	sdi12-mode=wind	`aD0!`	Min. wind (km/h)
			`aD1!`	Avg wind (km/h)
			`aD2!`	Max. wind (km/h)
		sdi12-mode=flux	`aD0!`	Min. particle flux (g/m^2/s)
			`aD1!`	Avg particle flux (g/m^2/s)
			`aD2!`	Max. particle flux (g/m^2/s)
			`aD3!`	Std particle flux (g/m^2/s)
			`aD4!`	Cumulative flux (g/m^2)
		sdi12-mode=all	`aD0!`	Min. particle flux (g/m^2/s)
			`aD1!`	Avg particle flux (g/m^2/s)
			`aD2!`	Max. particle flux (g/m^2/s)
			`aD3!`	Std particle flux (g/m^2/s)
			`aD4!`	Cumulative flux (g/m^2)
			`aD5!`	Wind min (km/h)
			`aD6!`	Wind avg (km/h)
			`aD7!`	Wind max (km/h)
Additional Measurements	`aM1! … aM9!`	***No additional measurement*** `a0000`		
Additional Measurements and request CRC	`aMC1! … MC9!`	***No additional measurement*** `a0000`		
Start Verification	`aV!`	No verification `a0000`		
Start Concurrent Measurement	`aC!`	*Always reset measure*		
		sdi12-mode=wind	`a0003`	
		sdi12-mode=flux	`a0005`	
		sdi12-mode=all	`a0008`	
Start Concurrent Measurement and request CRC	`aCC!`	*Always reset measure*		
		sdi12-mode=wind	`a0003`	
		sdi12-mode=flux	`a0005`	
		sdi12-mode=all	`a0008`	
Additional Concurrent Measurements	`aC1! … aC9!`	*No additional measurement* `a00000`		
Additional Concurrent Measurements and request CRC	`aCC1! … aCC9!`	*No additional measurement* `a00000`		

Name	Command	Description/Response		
Continuous Measurements	`aR0!` … `aR9!` `aRC0!` … `aRC9!`	sdi12-mode=wind	`aR0!`	Min. wind (km/h)
			`aR1!`	Avg wind (km/h)
			`aR2!`	Max. wind (km/h)
		sdi12-mode=flux	`aR0!`	Min. particle flux (g/m^2/s)
			`aR1!`	Avg particle flux (g/m^2/s)
			`aR2!`	Max. particle flux (g/m^2/s)
			`aR3!`	Std particle flux (g/m^2/s)
			`aR4!`	Cumulative flux (g/m^2)
		sdi12-mode=all	`aR0!`	Min. particle flux (g/m^2/s)
			`aR1!`	Avg particle flux (g/m^2/s)
			`aR2!`	Max. particle flux (g/m^2/s)
			`aR3!`	Std particle flux (g/m^2/s)
			`aR4!`	Cumulative flux (g/m^2)
			`aR5!`	Min. wind (km/h)
			`aR6!`	Avg wind (km/h)
			`aR7!`	Max. wind (km/h)

Notes: Wildcard character "?" is supported.

Start Measurement (aM!) and Send Data (aD0!...aD9!) always send measurement since last request. So in this mode, measurement is reinitialized after each request.

Continuous Measurement (aR0!...aR9!) sends the current measurement. So in this mode, measurement is reinitialized after M duration.

The interval used for the calculation of the min, max and average statistical values starts either with each SDI-12 command, or after the avg-m parameter's duration, depending on which of these two conditions occurs first.

The behavior of the SDI depends on the sdi12-mode setting.

C.2. SDI-12 extended commands

ISAW firmware can handle an extended SDI-12 command that allows instrument configuration from SDI-12 bus.

All SDI-12 extended commands derivate from console commands.

All SDI-12 extended commands, in compliance with SDI-12 standard V1.3, have a generic format like:

```
aXcooo…!
```

```
a    : Instrument address
c    : Extended command identifier
ooo… : Optional argument
!    : Command terminator
```

For each SDI-12 extended command, the instrument answers with a response formatted in the same way:

`aOK`	: Command success
`aOK:vvvv…<CR><LF>`	: Command success with value
`aER:mmmm…<CR><LF>`	: Command error with error message
`a`	: Instrument address
`vvvv…`	: Value
`mmmm…`	: Error message (see p. 78)
`<CR><LF>`	: Response terminator

Notes: Writing to eeprom to store a new parameter can take some time, which is why the "aXS!" command is delayed.

When the "aXS!" command is received, the instrument checks if the parameter and the value are correct and then sends the "aOK" response before the value is written on eeprom. Sending another "aXS!" while the instrument is currently writing a previous parameter value may result in a "Busy" error. Waiting at least 20 ms between two "aXS!" commands is recommended.

To be assured of the integrity of the parameter's writing in the memory read the parameter value (aXG!) after each "aXS!" command.

Remember that you need to reboot the instrument after changing instrument configuration.

Name	Description	Command	Response

reboot (aXR!)	After changing the instrument configuration, you need to reboot the instrument by using this command.	`aXR!`
		
		a : Instrument address
		! : Command terminator
			`aOK<CR><LF>`
			`aER=mmmm…<CR><LF>`
			
			a : Instrument address
			mmmm… : Error message (see p. 78)
			`<CR><LF>` : Response terminator

reset (aXZ…!)	Use this command if you want to recover the default factory configuration and reboot the instrument. All parameters are reinitialized, except internal factory parameters.	`aXZccccccc!`
		
		a : Instrument address
		ccccccc : Reset confirmation "confirm"
		! : Command terminator
			`aOK<CR><LF>`
			`aER=mmmm…<CR><LF>`
			
			a : Instrument address
			mmmm… : Error message (see p. 78)
			`<CR><LF>` : Response terminator

admin (aXA…!)	This command activates the admin rights and allows changing special parameters.
	This command is reserved for the initialization of factory parameters.
		`aXAwwwwwwww!`
		
		a : Instrument address
		wwwwwwww : Admin password
		! : Command terminator
			`aOK<CR><LF>`
			`aER=mmmm…<CR><LF>`
			
			a : Instrument address
			mmmm… : Error message (see p. 78)
			`<CR><LF>` : Response terminator

get (aXG…!)	The get command allows getting a parameter value from configuration.	`aXGpppppp…!`
		
		a : Instrument address
		pppppp… : Parameter name (see § 3.1)
		! : Command terminator
			`aOK=vvvv…<CR><LF>`
			`aER=mmmm…<CR><LF>`
			
			a : Instrument address
			vvvv… : Parameter value (see § 3.1)
			`<CR><LF>` : Response terminator

set (aXS…!)	This command allows changing parameter values of the configuration.	`aXSpppp…=vvvv…!`
		
		a : Instrument address
		pppppp… : Parameter name (see § 3.1)
		vvvv… : Parameter value (see § 3.1)
		! : Command terminator
			`aOK<CR><LF>`
			`aER=mmmm…<CR><LF>`
			
			a : Instrument address
			mmmm… : Error message (see p. 78)
			`<CR><LF>` : Response terminator

disdrometer (aXD!)	This command allows getting disdrometry results	`aXD!`
		
		a : Instrument address
		! : Command terminator
			`aOK=vvvv…<CR><LF>`
			`aER=mmmm…<CR><LF>`
			
			a : Instrument address
			vvvv… : Disdrometry value
			mmmm… : Error message (see p. 78)
			`<CR><LF>` : Response terminator

C.3. SDI-12 Synchronous vs. Asynchronous mode

Reminder about the instrument configuration:

[A]   Acquisition duration
[C]   Cycle duration
[M]   Measurement refresh interval

Typical values: [A] = 6 s, [C] = 60 s, [M] = 600 s

The instrument acquires data for 6 seconds, then sleeps for 54 seconds, then wakes up for 6 seconds, etc. The **duty cycle** is 10% (= 6 / 60 seconds).

After 600 seconds, the measurement (min, max, avg, std, cum, etc.) is refreshed; the statistics are therefore calculated over 10 acquisitions of 6 seconds.

Note: Turning off the power of the instrument resets all measurements: cumulative values and counters are reset to zero.

Datalogger – SDI-12 Interrogation:

SDI-12 commands always wake up the instrument immediately and generate a response according to SDI-12 specification v.1.4, within 15 milliseconds.

The instrument can be interrogated in two ways: **asynchronous** mode or **synchronous** mode.

Asynchronous mode: "aM!/aDx!"

The data datalogger retrieves data at a customized, possibly variable frequency, which can be different from the one the instrument measures with (DATALOGGER is master).

Command:

aM! // Stores instrument measurements (min, max, avg, std, cum, etc.) for being retrieved by aDx! command, and resets measurements.

aDx!   //   Retrieves last measurements being stored by previous aM! Command.

Notes:

In this mode, the instrument parameter [M] is not taken into account.

In this mode, the instrument measurements are updated after each acquisition (at [C] interval rate).

Datalogger retrieve rate scenario (e.g., [C] = 60):

If the data datalogger retrieves data every 5 seconds, it receives 12 times the same value of the last cycle C (OVERSAMPLING).

If the data datalogger retrieves data every 60 seconds, it receives measurements integrated over the last 60 seconds, i.e., one cycle and one acquisition. So, all the values (min, max, avg, std, cum, etc.) are identical.

If the data datalogger retrieves data once a day, it receives measurements integrated over 86400 / 60 = 1440 cycles. All the statistical values (min, max, avg, std) are estimated over 1440 values; the cumulative result is integrated over the last 24 hours.

Synchronous mode: "aRx!"

The data datalogger should be programmed to send a "retrieve" command every [M] interval to acquire all instrument data.

Measurements (min, max, avg, std, cum, etc.) are automatically updated after [M] interval.

Command:

```
aRx!// Retrieves the last measurements available (min, max, avg, cum,
      etc.)
```

Datalogger retrieve rate scenario (e.g., [M] = 600):

■ If the data datalogger retrieves data more frequently than every [M] seconds, for example every 60 seconds, the instrument will respond with 10 successive identical values (OVERSAMPLING).

■ If the data datalogger retrieves data less frequently than every [M] seconds, for example every 6000 seconds, it will only receive 1 value in 10 (UNDERSAMPLING).

Notes:

■ If the data datalogger command frequency is set to [M], the measurement retrieved in asynchronous mode "aM!/aDx!" will correspond to the measurement retrieved in synchronous mode "aRx!".

■ The asynchronous mode is generally preferred when the user wants to update the sampling interval according to the previous measurement. For example, if the last average instrument intensity exceeds a certain threshold, the command frequency is increased.

C.4. SDI-12 Campbell datalogger program example

Read wind and aeolian sand transport values for a SandFlow SF4 with SDI-12 address 4 connected to a Campbell CR800 / CR1000 port C1:

```
'***    variable definition
Public SF(8)
Alias SF(1) = FluxMin
Alias SF(2) = FluxMean
Alias SF(3) = FluxMax
Alias SF(4) = FluxStd
Alias SF(5) = FluxSum
Alias SF(6) = WindMin
Alias SF(7) = WindMean
Alias SF(8) = WindMax


'***    reading instrument
SDI12Recorder (SF(),1,4,"M!",1.0,0)
```

In this example, the second parameter is the port (C1) and the third one is the SDI-12 address (4).

How often you call the SDI-12 measurement command depends on the configuration of your instrument (power cycling, measurement interval, storage interval).

Measure the analog voltage output on your datalogger's ports SE1 (flux) and SE2 (wind):

```
VoltSe(SF_Flux,1,mV5000,1,False,0,_50Hz,0.05,0)
VoltSe(SF_Wind,1,mV5000,2,False,0,_50Hz,0.05,0)
```

The values of the multiplier (second last parameter) and the offset (last parameter) depend on your analog output settings.

In this example the settings are: out1-mode = flux   out2-mode = wind
                                        range-flux = 5V   range-wind = 5V
                                        fscale-flux = 250   fscale-wind = 250

so `VoltSe` multiplier (second last parameter) is 250/5000 = 0.05. If you set OUT range to 2V5, multiplier must be 250/2500 = 0.1.

Appendix D: MODBUS RTU 485 – INSTRUCTIONS FOR USE

D.1. Introduction to using Modbus

Modbus is one of the most widely adopted industrial communication protocols for interfacing field instruments with supervisory control and data acquisition (**SCADA**) systems. Designed for simplicity, robustness, and interoperability, it provides a standardized method for exchanging real-time measurements, status information, and configuration data between instruments, controllers, and central monitoring platforms. When integrated into **SCADA** infrastructures, Modbus ensures deterministic polling, structured register mapping, and straightforward compatibility with **PLCs, RTUs, and industrial data loggers**.

In its **Modbus RTU** implementation – operating over **RS-485 twisted-pair cabling** – the protocol supports long-distance, multi-drop networks of up to 247 addressable devices, making it well suited for distributed environmental and industrial monitoring architectures.

Modbus RTU is also widely used in **Building Management Systems (BMS)**. The ISAW Modbus adapter therefore enables direct integration of all ISAW instruments into auxiliary such as HVAC controllers, facility automation units, and centralized building monitoring infrastructures. This allows **ISAW instruments data and risk indicators** to be natively incorporated into building protection strategies, automated procedures, and alert systems.

D.2. The ISAW Modbus adapter
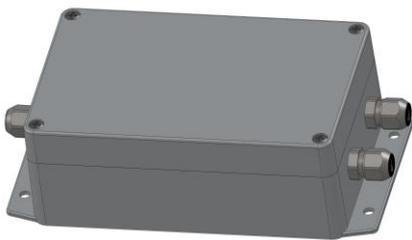
Because of its low overhead, minimal hardware requirements, and universal support in **SCADA software suites**, the **ISAW Modbus adapter** is often a preferred interface for transmitting instrument data into supervisory dashboards, alarm systems, and automated decision sequences. It provides access to measurement frames, configuration registers, and diagnostic functions through standardized Modbus function codes, ensuring consistent and reliable data acquisition.

The **ISAW Modbus adapter** is housed in a cast-aluminum enclosure, offering excellent mechanical robustness, strong electromagnetic shielding, and high resistance to outdoor exposure and sealing constraints. Its internal electronics are designed and assembled to demanding industrial standards, with reinforced isolation, comprehensive electrical protections, and high-quality components that ensure long-term reliability in harsh and mission-critical field deployments.
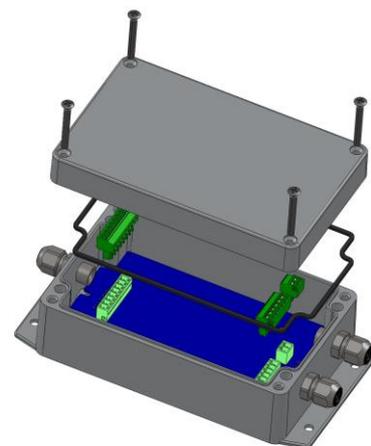
CHARACTERISTICS	
Protocol	MODBUS RTU (V1.1b3)
Physical Layer	EIA/TIA-485 (RS485) 2-wire and 4-wire
Galvanic isolation	Power 3kV RMS, Bus 5kV RMS
Unit load	1/8-unit load, up to 256 nodes on the bus
Startup time	1 s
Power supply	9 to 36 VDC (Typ. 100 mA, Max. 500 mA)
Implemented function codes	0x04 Read Input Registers 0x03 Read Holding Registers 0x06 Write Single Register 0x10 Write Multiple Registers 0x64 Pass-through 0x08 Diagnostic 0x17 Report Server ID
Configurable Baud rate	9600, 19200, 38400, 57600, 115200, 128000, 256000
Configurable Parity	No, Odd, Even
Configurable Stop Bit	1 or 2
Configurable Address	1 to 247

DEFAULT COMMUNICATION PARAMETERS	
Address	247
Baudrate	19200 bauds
Parity	Even
Stop bits	1 bit
Response timeout	1000 ms

MECHANICAL DATA	
Material	Aluminum box Nickel-plated brass cable glands
Protection	IP 68 (up to 10 bar) IP 69 for the cable glands
Dimensions (L×W×H)	160 mm × 100 mm × 60 mm Box thickness: 2.5 mm
Operating temperature	-40°C / +85°C (most sensitive electronic component)
Manufacturer references	Box: Bud Industries, product number AN-2866-AB Cable glands: AGRO, product number 1160.12.065

D.3. Description
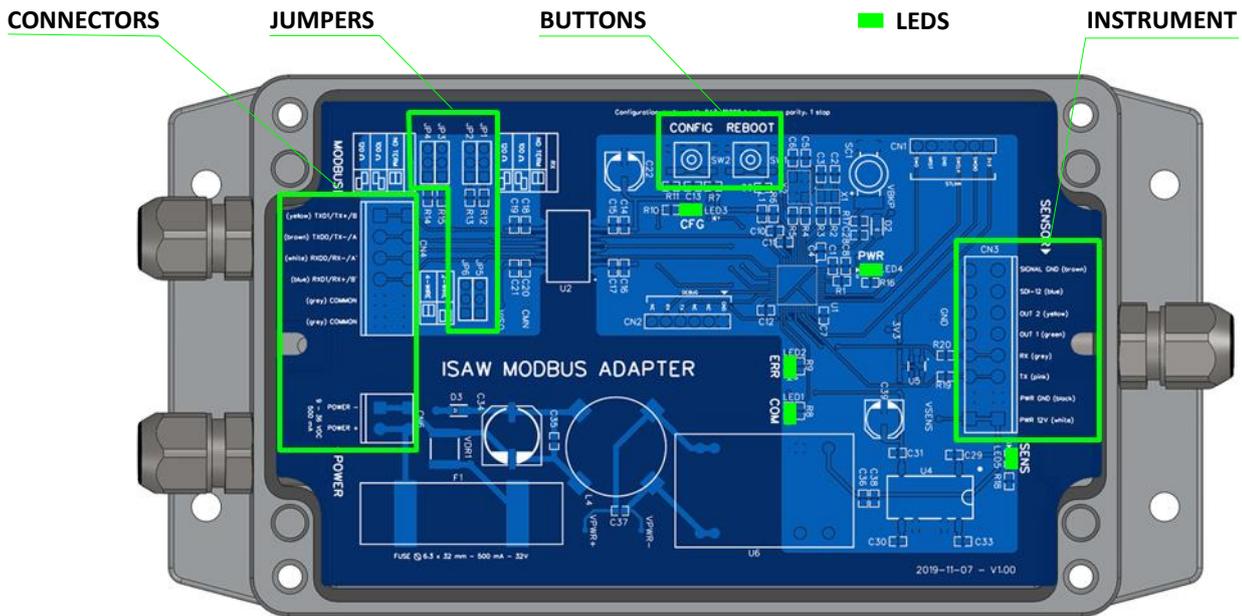
BUTTONS

BUTTONS	
REBOOT	Restarts the Modbus adapter with the Holding register's parameters. **Note:** Switching the power OFF/ON also restarts the Modbus adapter.
CONFIG	Holding the CONFIG button pressed while starting (or restarting) the Modbus adapter starts (or restarts) the adapter with the default communication parameters (cf. previous page). **Note:** This operation does not change the parameters stored in the Holding register.

LEDS

LEDS	
COM	Flashing during a Modbus communication.
ERR	Flashing when a Modbus communication error occurs. Steady when a critical error occurs requiring a restart.
CFG	Flashing when the instrument is in CONFIG mode (started with the CONFIG button pressed).
PWR	Steady when input power OK.
SENS	Steady when output 12 V instrument power OK.

CONNECTORS

INSTRUMENT			
#	Name	Color	Description
1	PWR 12V	White	Power output 12VDC – 300 mA
2	PWR GND	Black	Power ground
3	TX	Pink	Serial input 3V3
4	RX	Grey	Serial output 3V3
5	OUT 1	Green	Not connected
6	OUT 2	Yellow	Not connected
7	SDI-12	Blue	Not connected
8	Signal GND	Brown	Not connected

POWER			
#	Name	Color	Description
1	PWR -	Black	Power ground
2	PWR +	Red	Power input 9…36VDC (500 mA)

MODBUS 4-WIRE			
#	**Name**	**Color**	**Description**
1	TXD1/TX+/B	Yellow	Output terminal 1, Vb voltage (Vb > Va for binary 1)
2	TXD0/TX-/A	Brown	Output terminal 0, Va voltage (Va > Vb for binary 0)
3	RXD0/RX-/A'	White	Input terminal 0, Va' voltage (Va' > Vb' for binary 0)
4	RXD1/RX+/B'	Blue	Input terminal 1, Vb' voltage (Vb' > Va' for binary 1)
5	COMMON	Grey	Signal ground
6	COMMON	Grey	Signal ground

MODBUS 2-WIRE			
#	**Name**	**Color**	**Description**
1	TXD1/TX+/B	Yellow	Transceiver terminal 1, Vb voltage (Vb > Va for binary 1)
2	TXD0/TX-/A	Brown	Transceiver terminal 0, Va voltage (Va > Vb for binary 0)
3	RXD0/RX-/A'	White	Not connected
4	RXD1/RX+/B'	Blue	Not connected
5	COMMON	Grey	Signal ground
6	COMMON	Grey	Signal ground

Note: TXD0-RXD0 and TXD1-RXD1 are connected.

The polarity of the "A" and "B" wires can be reversed. Please check in the datasheet of your RS485/RS422 converter the polarity "+" or "-" ("1" or "0") affected to the "A" and "B" labels.

If you don't find this information in your converter documentation, try to plug "A" and "B" wires and if you get no communication, just invert the wiring.

JUMPERS

MODE	
Jumper position	**Description**
	2-WIRE MODE [default] (TXD0-RXD0 et TXD1-RXD1 are connected)
	4-WIRE MODE
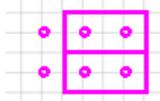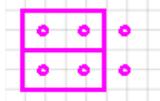
Notes:

1. If the ISAW Modbus adapter node is the last one of the bus, the jumper RX must be set to "100 Ω" or "120 Ω".

2. In 4 wire mode only, if the ISAW Modbus adapter node is the last one of the bus, the jumper TX must be set to "100 Ω" or "120 Ω".
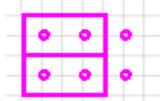
TX TERMINATION	
Jumper position	**Description**
	NO TERM. [default] No termination resistor on TX pair
	120 Ω Standard 120 Ω termination resistor wired on TX pair
	100 Ω 100 Ω termination resistor wired on TX pair
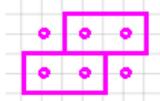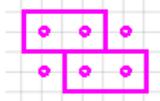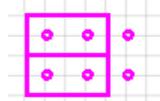
RX TERMINATION	
Jumper position	**Description**
	NO TERM. [default] No termination resistor on RX pair
	120 Ω Standard 120 Ω termination resistor wired on RX pair
	100 Ω 100 Ω termination resistor wired on RX pair
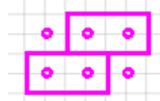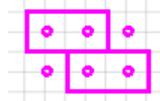
D.4. Modbus function / Register definition

D.4.1. INPUT Registers

The Input registers contain measurements. The content of these registers is updated each time the instrument sends new measurements to the Modbus adapter.

Modbus function: READ INPUT REGISTER   (0x04)

Address	Type*	Bytes	Offset	Alias	Comment
0x0000	UINT32	4	0	Counter	Flux measurement frame counter
0x0002	STRING8	8	2	Unit	Flux measurement unit: "g/m^2/s"
0x0006	FLOAT	4	6	Min	Flux measurement minimum
0x0008	FLOAT	4	8	Avg	Flux measurement average
0x000A	FLOAT	4	10	Max	Flux measurement maximum
0x000C	FLOAT	4	12	Std	Flux measurement standard deviation
0x000E	STRING8	8	14	Unit	Cumulative flux measurement unit: "g/m^2"
0x0012	FLOAT	4	18	Sum	Cumulative flux measurement
0x0014	UINT32	4	20	Counter	Wind measurement frame counter
0x0016	STRING8	8	22	Unit	Wind measurement unit: "km/h"
0x001A	FLOAT	4	26	Min	Wind measurement minimum
0x001C	FLOAT	4	28	Avg	Wind measurement average
0x001E	FLOAT	4	30	Max	Wind measurement maximum
0x0057	UINT16	2	87	UINT16 Test	Fixed value: 54321 (0xD431)
0x0058	UINT32	4	88	UNIT32 Test	Fixed value: 1234567890 (0x499602D2)
0x005A	FLOAT	4	90	FLOAT Test	Fixed value: 3,14159265 (0x40490FDB)
0x005C	UINT16	2	92	VERmaj	Major version of Modbus adapter firmware (since V1.19)**
0x005D	UINT16	2	93	VERmin	Minor version of Modbus adapter firmware (since V1.19)**

*   Note: String are zero-padded.
**   If not present, Modbus adapter firmware is V1.18

D.4.2. HOLDING Registers

Holding resisters are mainly used to configure the Modbus adapter communication.

Note: Restart the Modbus adapter after changing the configuration.

Modbus functions: READ HOLDING REGISTERS   (0x03)
                          WRITE SINGLE REGISTER   (0x06)
                          WRITE MULTIPLE REGISTERS   (0x10)

Address	Type	Bytes	Offset	Name	Values
0x0000	UINT32	4	0	Serial speed	9600, 19200 [default], 38400, 57600, 115200, 128000, 256000
0x0002	UINT16	2	2	Parity	0: No parity, 1: Even [default], 2: Odd
0x0003	UINT16	2	3	Stop Bit	1 [default] or 2 (if no parity)
0x0004	UINT16	2	4	Device address	1 to 247 [default]
0x0005	UINT16	2	5	Response timeout (ms)	Default: 1000

Total bytes: 12
Nb. REG: 6

D.4.3. DATA TYPE Format

| UINT16 (Big Endian) | | High Byte | Low Byte | | |

| UINT32 (Big Endian) | High Byte | | | Low Byte |

| FLOAT (IEEE-754) | SEEEEEEE | EMMMMMMM | MMMMMMMM | MMMMMMMM |

(S: Sign, E: Exponent, M: Mantissa)

| RAW | Char 1 | Char 2 | Char 3 | ... |

EXAMPLES:	**Decimal**	**Hexadecimal**	**Register N**	**Register N+1**
UINT16 (Big Endian)	54321	0xD431	0xD431	
UINT32 (Big Endian)	1234567890	0x499602D2	0x02D2	0x4996
FLOAT (IEEE-754)	3.14159265	0x40490FDB	0x0FDB	0x4049
RAW	"hit"	0x68697400	0x6869	0x7400

D.5. Modbus function PASS-THROUGH (0x64)

This user-defined Modbus function, available for Modbus firmware version V1.19 and higher, allows to send an ISAW command through the Modbus (see Appendix B for more information about the ISAW console commands). For example, use this function with the "set" or "get" ISAW command to access the instrument's configuration.

Note: The use of this function is limited by the request and answer lengths.

Request:

Address	Function	ISAW console command	CRC

Modbus PDU

Field	Size (bytes)	Description
Address	1	Device address (target)
Function	1	0x64
ISAW Command	N	ISAW command as ASCII string
CRC	2	CRC16

Response:

Address	Function	ISAW command result	CRC

Modbus PDU

Field	Size (bytes)	Description
Address	1	Device address (same as request)
Function	1	0x64
Result	N	ISAW command result as ASCII string
CRC	2	CRC16

Note: The response timeout of this command must be > 2 seconds to allow instrument wake-up.

D.6. Modbus frame examples

Raw examples of Modbus communication.

READ HOLDING REGISTER (all registers)

TX > 0xF7 0x03 0x00 0x00 0x00 0x06 0xD1 0x5E
RX > 0xF7 0x03 0x0C 0x4B 0x00 0x00 0x00 0x00 0x01 0x00 0x01 0x00 0xF7 0x03 0xE8 0x9D
RX > 0x9E

READ INPUT REGISTERS (All registers)

TX > 0xF7 0x04 0x00 0x00 0x00 0x5E 0x65 0x64
RX > 0xF7 0x04 0xBC 0x00 0x01 0x00 0x00 0x68 0x69 0x74 0x2F 0x73 0x00 0x00 0x00 0x00
RX > 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x68
RX > 0x69 0x74 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
RX > 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
RX > 0x00 0x00 0x00 0x00 0x01 0x00 0x00 0x68 0x69 0x74 0x00 0x00 0x00 0x00 0x00 0x00
RX > 0x00 0x00 0x00 0x25 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
RX > 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
RX > 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
RX > 0x00 0x00 0x00 0x00 0x00 0x4A 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
RX > 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
RX > 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
RX > 0x00 0xD4 0x31 0x02 0xD2 0x49 0x96 0x0F 0xDB 0x40 0x49 0x00 0x01 0x00 0x13 0x14
RX > 0xC6

READ INPUT REGISTERS (read adapter version only)

Available on firmware version V1.19 or higher. If you receive a Modbus exception, firmware version is V1.18.

TX > 0xF7 0x04 0x00 0x5C 0x00 0x02 0xA5 0x4F
RX > 0xF7 0x04 0x04 0x00 0x01 0x00 0x13 0x7D 0x86

PASSTHROUGH (get avg-a)

TX > 0xF7 0x64 0x67 0x65 0x74 0x20 0x61 0x76 0x67 0x2D 0x61 0xEC 0x5D
RX > 0xF7 0x64 0x4F 0x4B 0x3D 0x31 0xD3 0x12

PASSTHROUGH (get avg-c)

TX > 0xF7 0x64 0x67 0x65 0x74 0x20 0x61 0x76 0x67 0x2D 0x63 0x6D 0x9C
RX > 0xF7 0x64 0x4F 0x4B 0x3D 0x32 0x93 0x13

PASSTHROUGH (get avg-m)

TX > 0xF7 0x64 0x67 0x65 0x74 0x20 0x61 0x76 0x67 0x2D 0x6D 0xEC 0x58
RX > 0xF7 0x64 0x4F 0x4B 0x3D 0x38 0x13 0x14

PASSTHROUGH (get hw-sn)

TX > 0xF7 0x64 0x67 0x65 0x74 0x20 0x68 0x77 0x2D 0x73 0x6E 0x68 0x12
RX > 0xF7 0x64 0x4F 0x4B 0x3D 0x30 0x30 0x32 0x45 0x30 0x30 0x34 0x30 0x33 0x36 0x33
RX > 0x32 0x33 0x30 0x33 0x36 0x30 0x43 0x34 0x37 0x33 0x34 0x33 0x31 0x1E 0xDF

PASSTHROUGH (get fw-build)

TX > 0xF7 0x64 0x67 0x65 0x74 0x20 0x66 0x77 0x2D 0x62 0x75 0x69 0x6C 0x64 0x0A 0xE0
RX > 0xF7 0x64 0x4F 0x4B 0x3D 0x4A 0x75 0x6C 0x20 0x32 0x32 0x20 0x32 0x30 0x32 0x30
RX > 0x20 0x61 0x74 0x20 0x31 0x36 0x3A 0x17 0x3A 0x30 0x36 0x20 0x62 0x79 0x20
RX > 0x47 0x43 0x43 0x20 0x37 0x2E 0x32 0x2E 0x31 0xF8 0x2C

PASSTHROUGH (set avg-m 8)

TX > 0xF7 0x64 0x73 0x65 0x74 0x20 0x61 0x76 0x67 0x2D 0x6D 0x20 0x38 0x14 0xD8
RX > 0xF7 0x64 0x4F 0x4B 0x07 0x88

PASSTHROUGH (reboot)

TX > 0xF7 0x64 0x72 0x65 0x62 0x6F 0x6F 0x74 0x6F 0xC7
RX > 0xF7 0x64 0x4F 0x4B 0x07 0x88

NOTES: Some useful tools to manually forge and decode your Modbus frames:

Compute CRC16 for Modbus online: https://crccalc.com/?method=CRC-16/MODBUS

Convert ASCII to HEX online: https://www.rapidtables.com/convert/number/ascii-to-hex.html

Convert HEX to ASCII online: https://www.rapidtables.com/convert/number/hex-to-ascii.html

Parse and decode MODBUS frame online (remove 0x prefix on the previous examples): https://rapidscada.net/modbus/

D.7. Test procedure

Communication example between an ISAW instrument and a PC using the Modbus Adapter.

D.7.1. Hardware setup
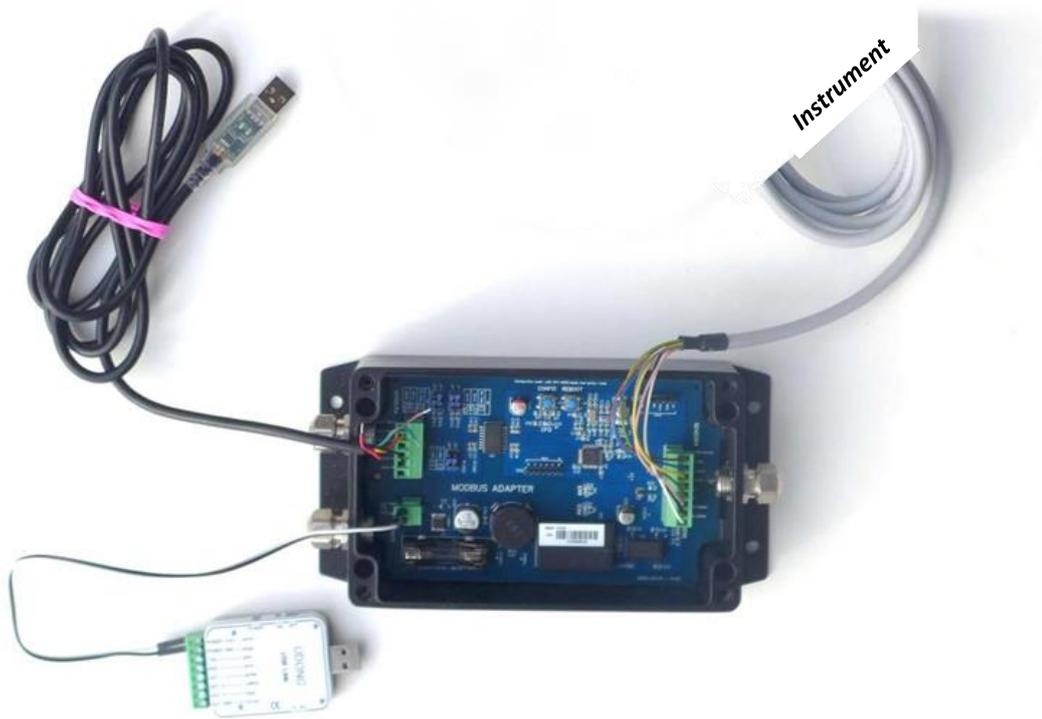

Picture 1: Hardware setup

The **instrument** is connected directly to the "INSTRUMENT" connector of the Modbus adapter as per Picture 2.

To **power** both the Modbus adapter and the instrument we simply use the white and black wires of the UDONG accessory, connected to the "POWER" connector of the Modbus adapter. The UDONG is plugged to the PC either directly or via a USB Hub (see Picture 2 and Picture 3).

To **communicate** between the MODBUS ADAPTER and the PC we use an RS485/422 adapter (e.g. FTDI USB-RS485-WE-1800-BT) connected to the "MODBUS" connector of the MODBUS adapter on one side, and to the USB hub (or directly to the PC) on the other side.
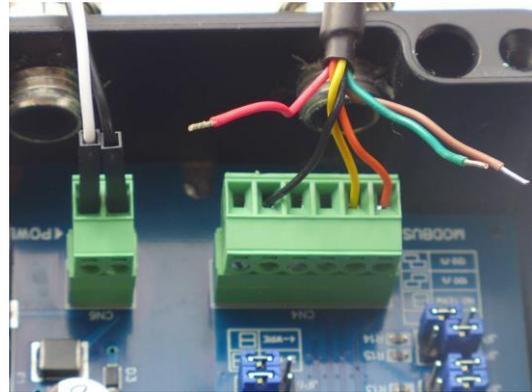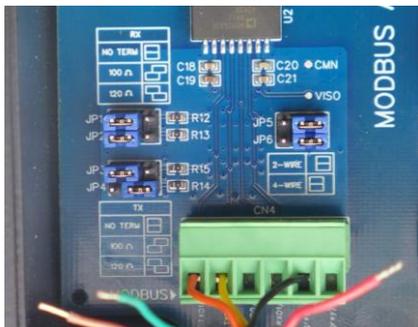

USB-to-RS485
Serial Converter Cable
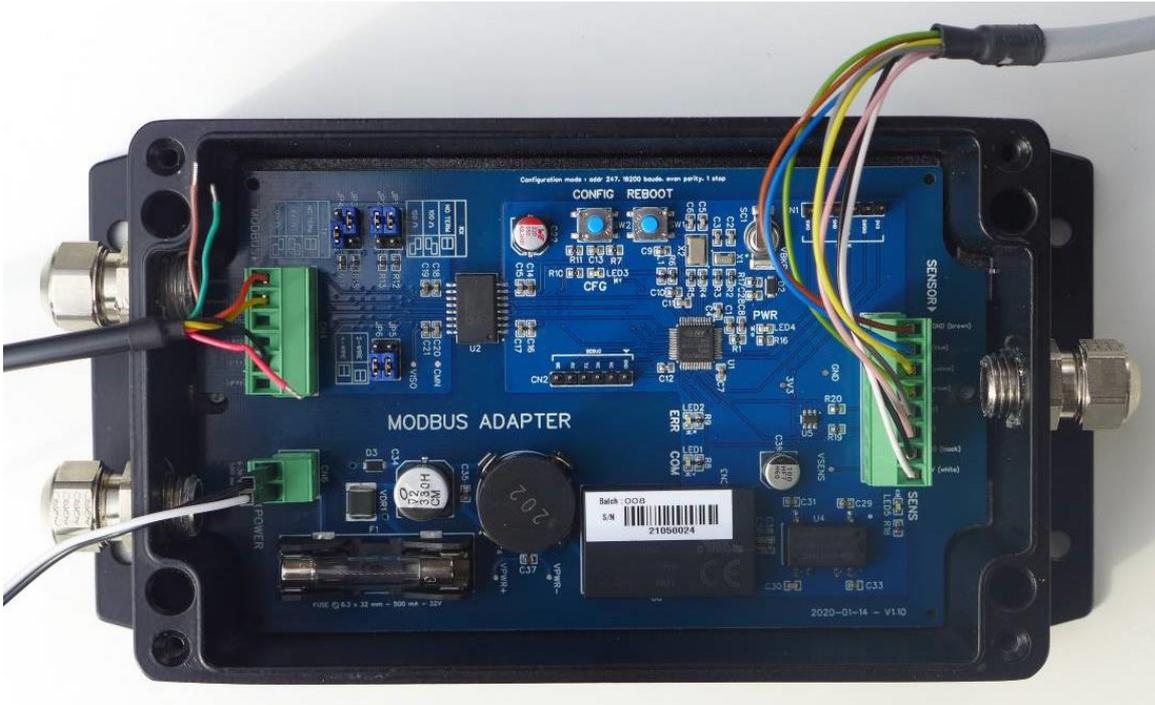
Picture 2: Modbus adapter connectors. Left: MODBUS and POWER connectors.
Right: INSTRUMENT connector.

Picture 3: USB hub with UDONG on the left and RS485/422 adapter on the right

Picture 4: POWER connector (on the left), MODBUS connector (on the right)
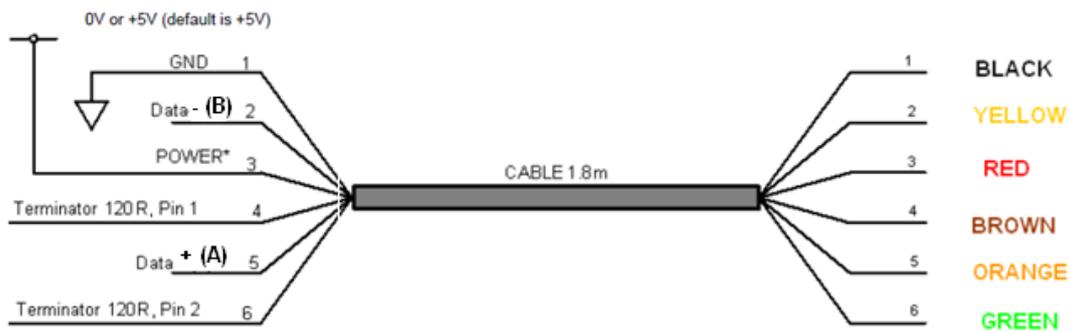

Picture 5: Jumpers

Picture 6: Modbus adapter LEDs

Cable signals and wire colors are detailed on the following figure:

(Source: https://www.ftdichip.com/Support/Documents/DataSheets/Cables/DS_USB_RS485_CABLES.pdf)

If needed, download the driver according to your operating system: https://ftdichip.com/drivers/vcp-drivers.

Then, on the Modbus adapter side, connect the USB-RS485 FTDI as per Picture 4, i.e. only black, yellow and orange wires (thus leaving the red, green and brown wires unused).

Set the jumpers of the Modbus adapter as per Picture 5.

Set the UDONG power switch to ON which activates the UDONG green led (see Picture 3) and also two green LEDs on the Modbus adapter (see Picture 6).

The hardware setup is complete. We can now communicate.

## D.7.2. Communicating with the SandFlow SF4 instrument

Download a communication software, for example QModMaster. QModMaster is a free Qt-based implementation of a Modbus master application. A graphical user interface allows easy communication with Modbus RTU and TCP slaves. QModMaster also includes a bus monitor for examining all traffic on the bus. See https://sourceforge.net/projects/qmodmaster/.

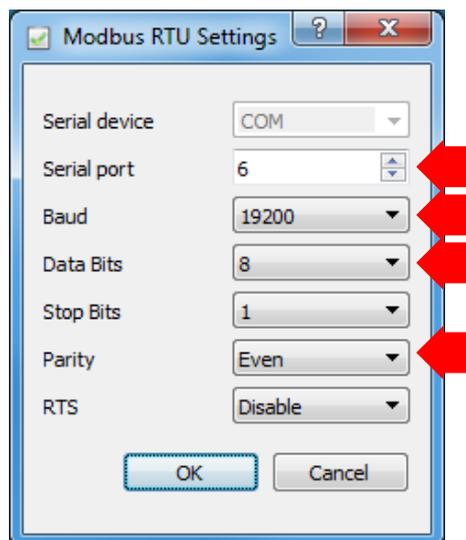Open the « Device Manager » on your computer.

Plug the RS485/422 adapter USB connector to the USB hub or PC and install the required drivers. When the drivers are successfully installed, a new serial port appears (here: COM6).
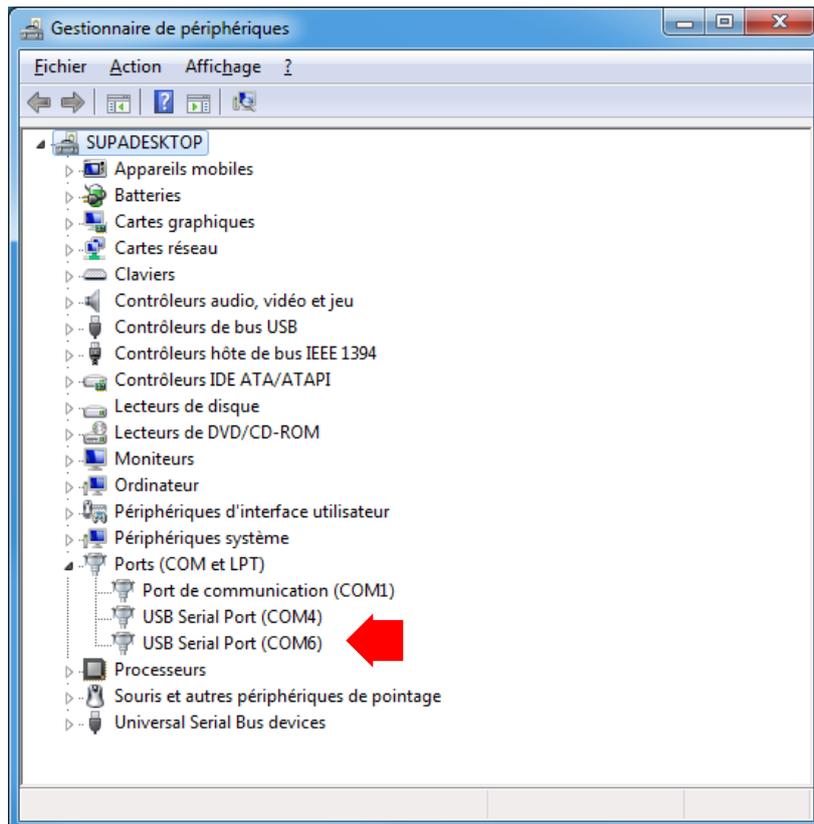
Start QModMaster and open the Configuration Panel.
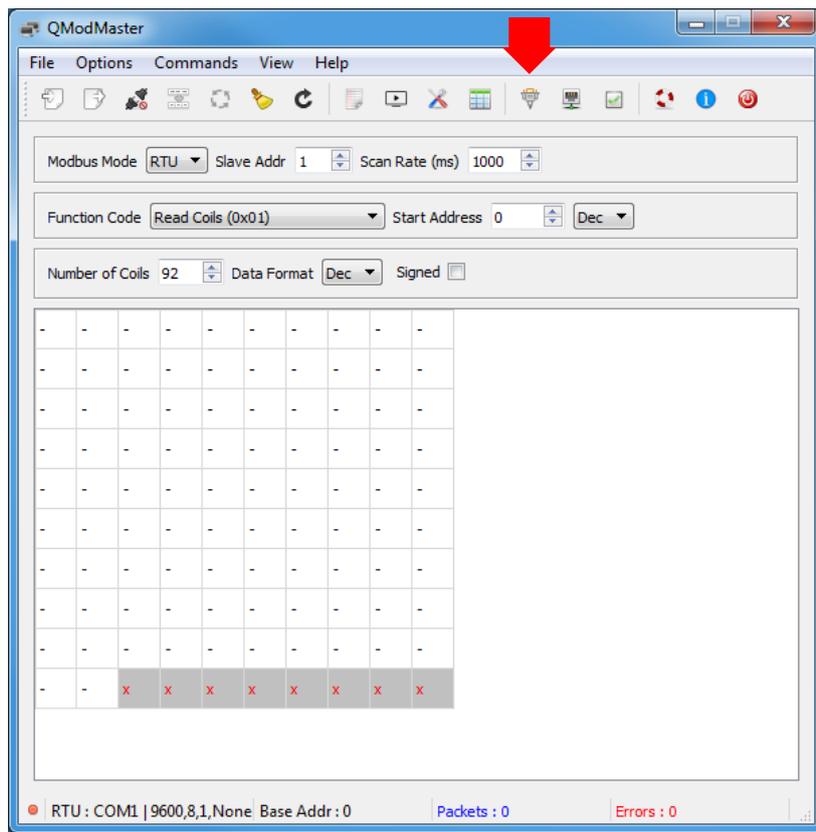
Set the serial communication parameters. Use the relevant serial port number (here: 6).

Connect the MODBUS adapter:

[1] Open the QModMaster serial port.
[2] Set the Modbus address (e.g. 247).
[3] Display grid header if needed.
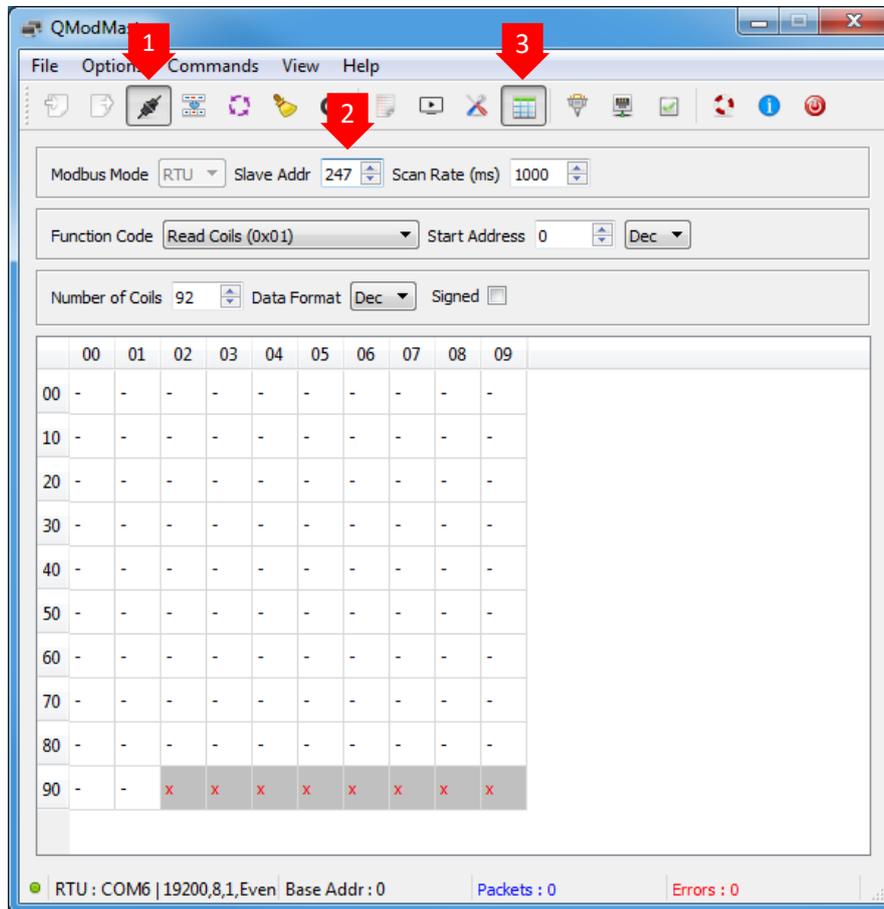
Tip :   If you receive the « Connection failed » message below, your serial port is probably already opened by another application. Stop the other application and retry.

Connection failed
Could not connect to serial port.   ☒

To read the configuration:

[1] Select the function code « Read Holding Registers ».
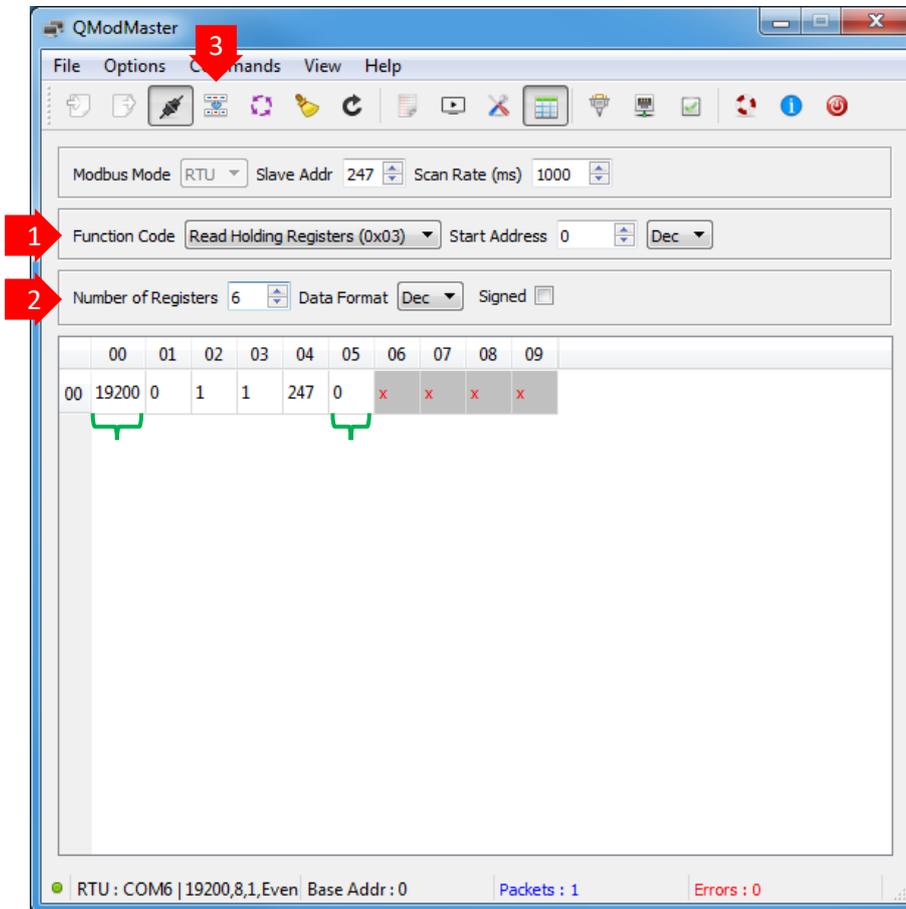
[2] Set the number of registers (e.g., 6 for the whole configuration).

[3] Click on the [Read/Write] button.

You can see for example the « Baudrate » (Register 0) and « Address » (Register 4). To understand the registers definitions, values and formats please refer to § D.4.


Tip : If you receive « Read data failed » message below (Timeout or CRC), please check your hardware wiring (especially data wire swapping), jumper position and QModMaster serial configuration (especially baud rate and parity).

To read the measurements:

[1] Select the function code « Read Input Registers ».

[2] Set the number of registers (e.g. 92 for the whole measurement).

[3] Click on the [Read/Write] button.
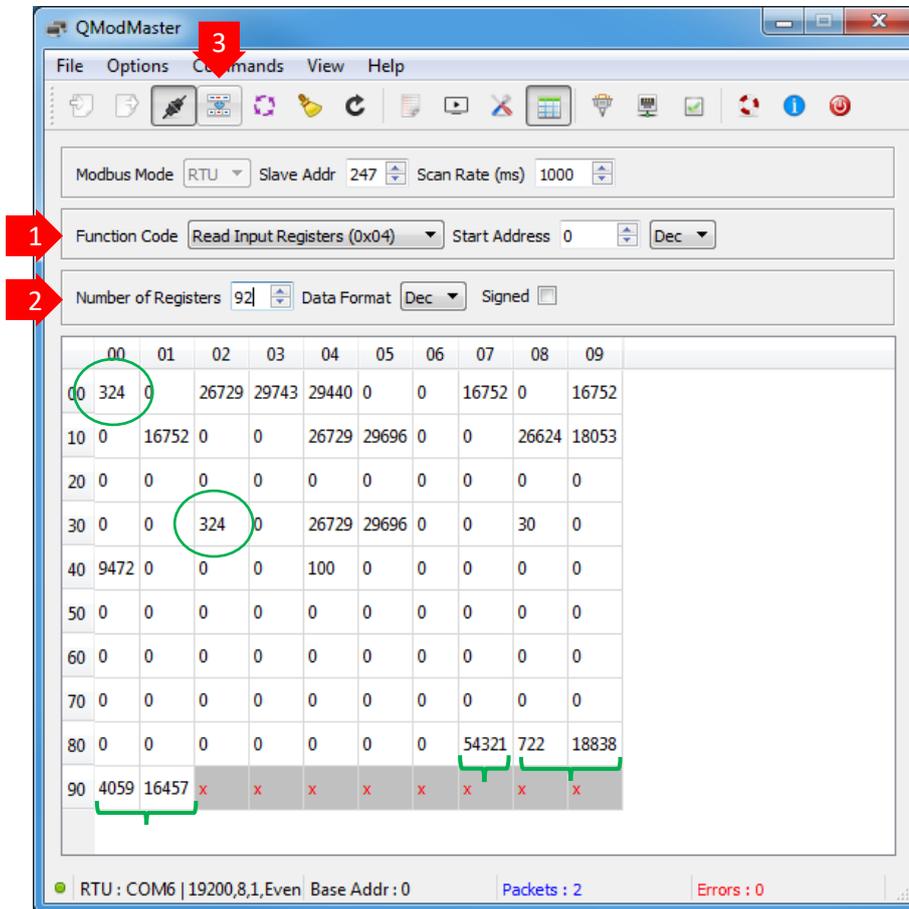
You can see for example « Frame counters » (Registers 0 & 32) and « Test fixed values » (Registers 87, 88 & 90).

To understand the registers definitions, values and formats please refer to § D.4.3.

Tip: The interval between two measurements of the instrument depends on the instrument's "Averaging" setting: by default, the instrument sends one measurement every 600 seconds, i.e. a refresh of the displayed data every 10 minutes. To get more frequent refresh of the displayed data, you can change the "Averaging" parameters "Acquisition (A)", "Cycle (C)" and "Measure (M)" of the instrument. To do so, connect the instrument to a PC using the UDONG accessory and refer to the "Averaging panel" section of the User Guide. Example for quick test: set A=1s, C=2s and M=4s. In this case, do not forget to re-set the "Averaging" configuration of your instrument according to your needs after this test.

D.8. Update the Modbus adapter firmware

IAV Technologies constantly improves its products and provides upgrades of the ISAW firmware for all instruments. This section describes the procedure for upgrading the ISAW firmware.

This chapter describes the procedure for upgrading the Modbus adapter's firmware.

D.8.1. Hardware setup

You will need

■   a USB-to-RS485 Serial Converter Cable,

■   the USB link accessory, which will be used as a 12V power supply,

■   optional: an FTDI TTL-232 cable (if you want to know the Modbus adapter version before V1.19).

USB-to-RS485 Serial Converter Cable   *FTDI TTL-232 Cable (optional)*

1.   **To communicate between the Modbus adapter and the PC**, use any RS485/422 adapter (e.g. FTDI USB-RS485-WE-1800-BT) connected to the "MODBUS" connector of the MODBUS ADAPTER.

2.   **Optional:** Connect the Modbus adapter to the PC using the FTDI 232 cable with the black wire (ground) facing the GND mark ▶.

3.   **To power the Modbus adapter**, use the white and black wires of the UDONG accessory connected to the "POWER" connector.
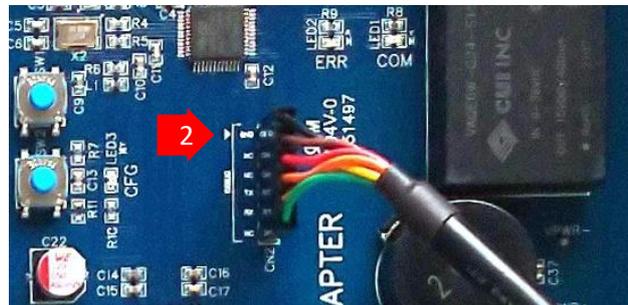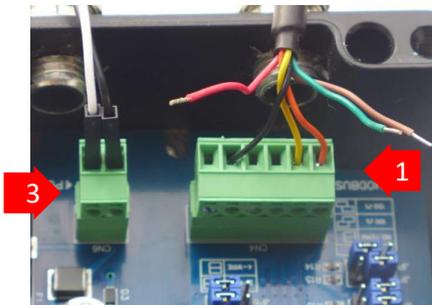
Hardware setup with USB hub and Modbus adapter

D.8.2. Update procedure

Prerequisites:

◼ The hardware setup is complete.

◼ The ISAW-Toolbox is installed (see § 1.3).

◼ The last versions of the firmwares are installed (use the Update utility to check).

To display the current Modbus adapter configuration (optional), open your favorite serial terminal (e.g., Putty[6], TeraTerm, HyperTerminal) on the right serial port (here COM6) at 115200 bauds, 8 bits, 1 stop, no parity.

Tip: To identify the serial port the FTDI 232 cable is connected to, open the Control Panel > Device Manager > Ports interface. Unplug then plug the FTDI USB end and check the activated USB serial port.

---

[6] Lightweight and non-intrusive "putty.exe" freeware available at http://www.putty.org.
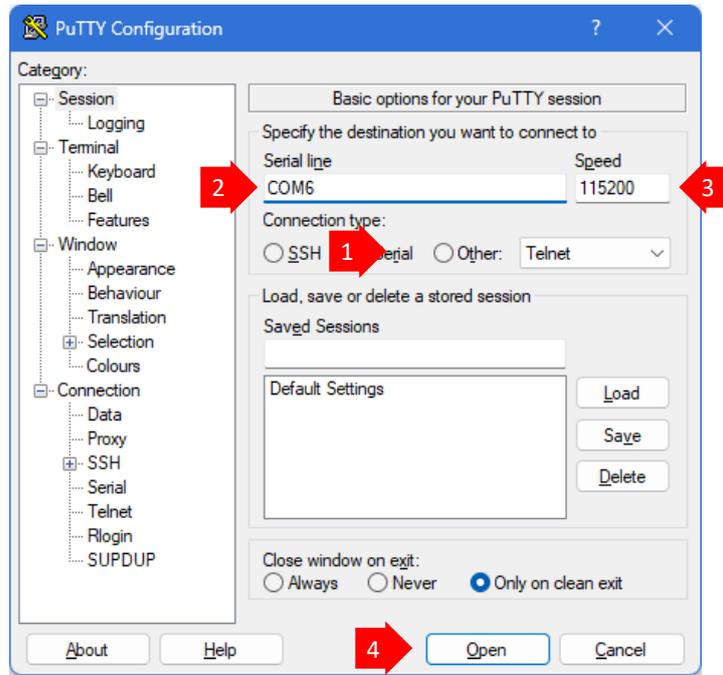
Press the REBOOT button on the Modbus adapter.

The current configuration of the Modbus adapter is displayed, starting with the firmware version:

Open the ISAW Toolbox **Flash** Utility.
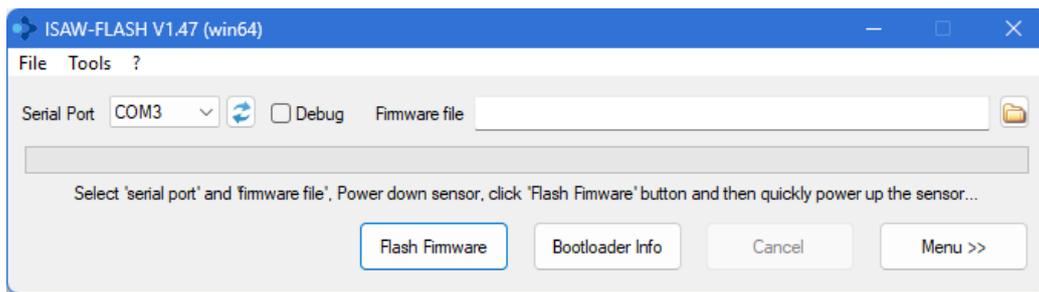
Serial Port: Select the FTDI 485 serial port.

Tip: To identify the serial port the FTDI 485 cable is connected to, open the Control Panel > Device Manager > Ports interface. Unplug then plug the FTDI USB end and check the activated USB serial port.

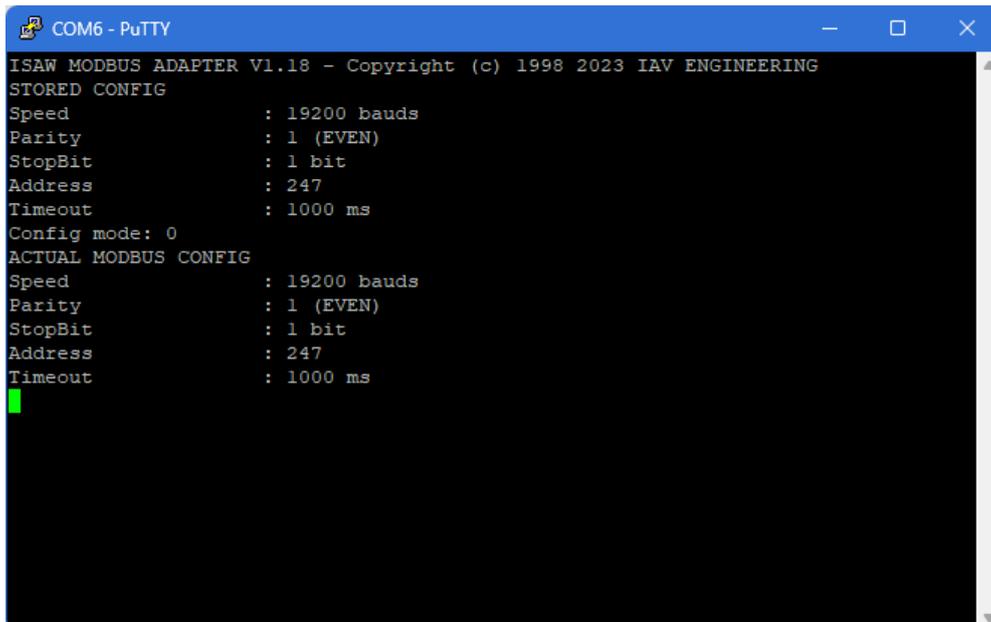Select the firmware file: Select the last version of the Modbus firmware in the "ISAW-Toolbox\Modbus" directory:

ISAW-Modbus-Adapter-x.xx.bin (where x.xx is the version number)

Shut down the Modbus adapter power supply: set the USB link power switch to OFF.

Press the [Flash Firmware] button. At this stage, ISAW-Flash will automatically search for a powered device during ten seconds.

Power-on the Modbus adapter: Switch the USB link power back to ON. As soon as ISAW-Flash has found the powered Modbus adapter, the firmware upload starts automatically.
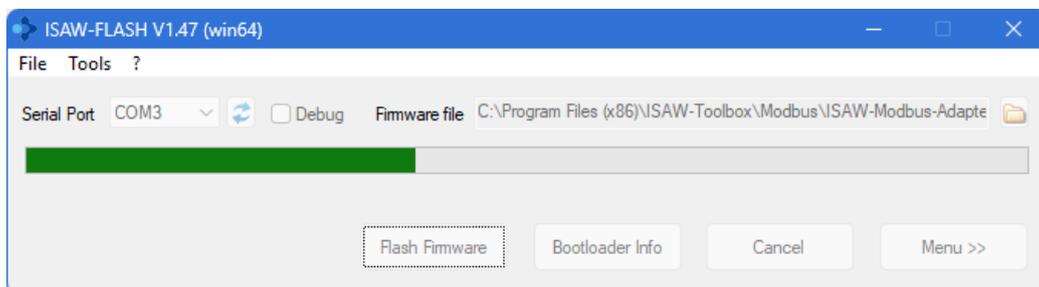
Wait during the firmware upload. This may take a few minutes.

WARNING: Do not disconnect the power supply during the firmware upload.

When the firmware upload is successfully completed, a confirmation message is displayed.

The Modbus adapter is now ready to use.

Optional: Use your serial terminal to check if the firmware version is properly updated (see first step).

Appendix E: More about aeolian solid particles physics and principle of detection

E.1. Linearization function

The next table and figures show the linearization formula with the factory default values (Note: for custom applications, the value of the coefficients can be modified in the Expert mode panel of the instrument's configuration utility).

FLUX Channel Input Voltage [U mV]	Flux [g/m2/s]	WIND channel Input Voltage [U mV]	Wind [km/h]
0	0	0	0
100	0.40	100	69.65
200	1.60	200	98.75
300	3.60	300	121.04
400	6.40	400	139.82
500	10.00	500	156.37
600	14.40	600	171.32
700	19.60	700	185.07
800	25.60	800	197.87
900	32.40	900	209.88
1000	40.00	1000	221.25
1100	48.40	1100	232.06
1200	57.60	1200	242.39
1300	67.60	1300	252.29
1400	78.40	1400	261.82
1500	90.00	1500	271.02
1600	102.40	1600	279.91
1700	115.60	1700	288.53
1800	129.60	1800	296.90
1900	144.40	1900	305.04
2000	160.00	2000	312.97
2100	176.40	2100	320.70
2200	193.60	2200	328.25
2300	211.60	2300	335.64
2400	230.40	2400	342.86
2500	250.00	2500	349.93
2600	270.40	2600	356.86
2700	291.60	2700	363.66
2800	313.60	2800	370.34
2900	336.40	2900	376.90
3000	360.00	3000	383.34
3100	384.40	3100	389.68
3200	409.60	3200	395.92
3300	435.60	3300	402.06

PARTICLE FLUX MODEL

$$F = XC1 * U^{XE1}$$
$$U = k * Vin$$

F	flux intensity	[g/m2/s]
U	calibrated voltage	[mV]
Vin	input voltage	[mV]
k	calibration coefficient (calib$_f$lux)
XC1	model coefficent = 4e-05	
XE1	model exponent = 2	

Values typically found in nature

k=1.2
k=1.0
k=0.8

Calibrated

Full Scale - Maximum Voltage = 3300 mV

Considering the realty of the aeolian sand transport dynamic ranges which are widely discussed in the literature, this linearization function must always be interpreted only as a simplified and practically-oriented model.

E.2. Calibration method of the instrument

The electronic and the mechanical response instrument is factory-calibrated individually and this for a lifetime duration so without requiring periodic recalibration.
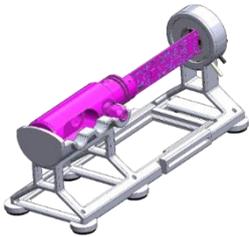
This is performed trough a controlled vibroacoustic coupler and some artificial particles flux excitation of each instrument. The method produces the needed reference acoustics and vibration signals and the needed momentum impacts excitations so that the whole sensitivity of the instrument can be set to the desired nominal reference sensitivity, with a precision and an accuracy of ±5 %.

Milled Particles size distribution

Calibration example
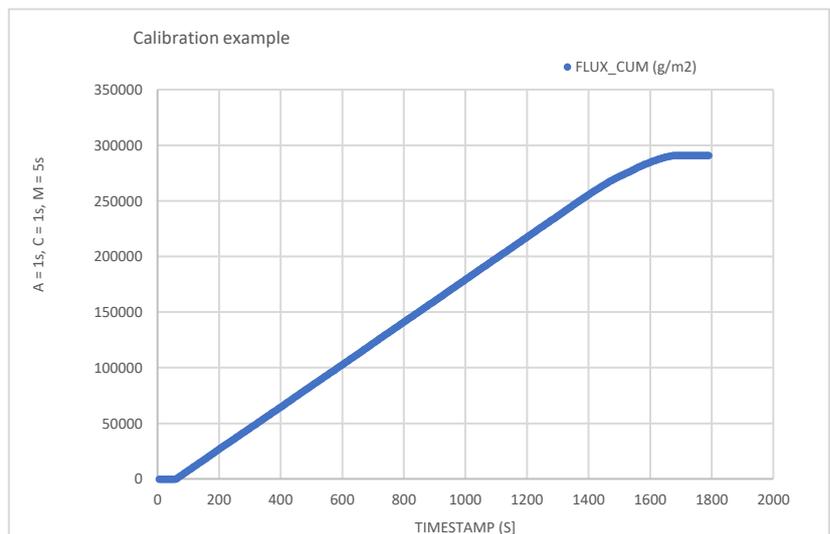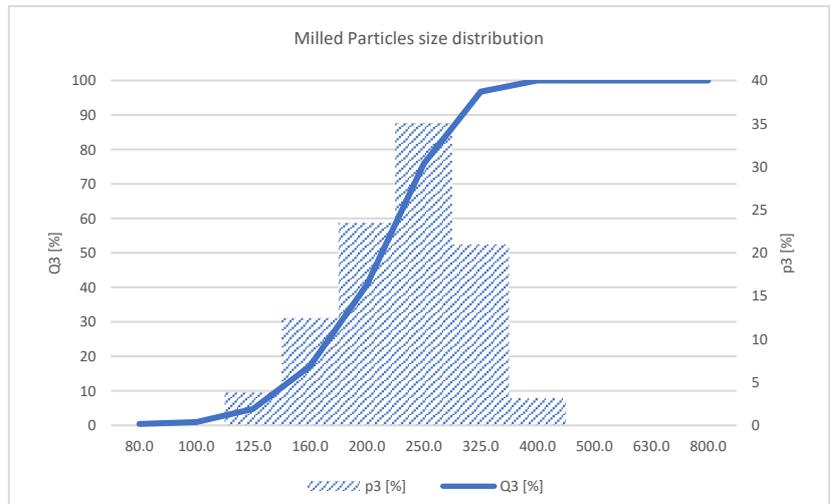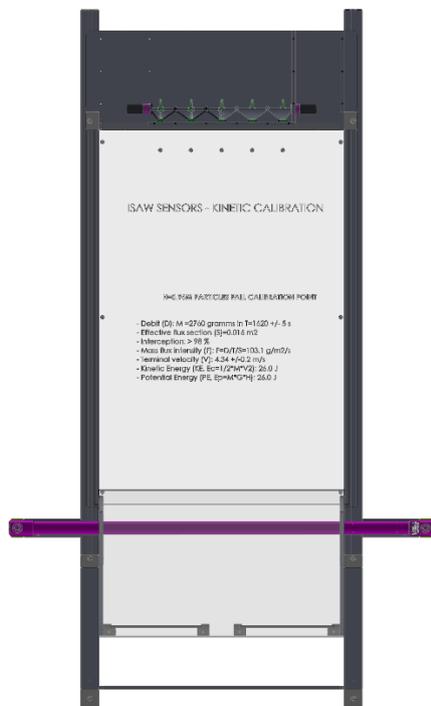
FLUX SENSITIVITY EXPLAINED THROUGH THE EXAMPLE OF A GRAVITARY CONTROLED FLUX

TEST BENCH	THEORY	
	EC	**EP**
	1/2*M*V2	M*G*H
	0.5*KG*M2*S-2	KG*(M*S-2)*M
	J=KG*M2*S-2	J=KG*M2*S-2
	TERMINAL VELOCITY IN VACCUM = (2*G*H)^0.5 [M*S-1]	
	Note (1): Examining the physical units we see that KE (Ec or Ep) in KG*M2*S-2 while FLUX in KG*M-2*S-1 i.e. KE/FLUX prop. to M4*S-1)	

INDIVIDUAL PARTICLE (CALIBRATED TEST PARTICLES, PLASTIC MATERIAL)

PART. DENSITY	1.2	[GR*CM-3]
PART. DENSITY	1200	[KG*M-3]
PART. SIZE	5.00E-04	[M]
PART. SHAPE	QUASI CUBIC	[1]
PART. VOL.	1.25E-10	[M3]
PART. MASS	1.50E-07	[KG]
PART. MASS	1.50E-04	[GR]

FALLING TRAY OF PARTICLES & FALLING APERTURE

EFFECTIVE FALLING HEIGHT	0.960	[M]
EFFECTIVE WIDTH	0.060	[M]
EFFECTIVE LENGHT	0.345	[M]
HEIGHT	0.224	[M]
EFFECTIVE HEIGHT	0.215	[M]
TOT. EFF. VOL.	4.45E-03	[M3]
NUMBER OF PART.	1.84E+07	[1]
TOT. EFF. MASS	2.760	[KG]
APERTURE: NUMBER OF HOLES	5	[1]
DIA.OF HOLES	3.60E-03	[M]
TOT. EFF. HOLES APERTURE	5.09E-05	[M2]
EST. INTERCEPTION RATE	9.80E-01	[%]
MEASURED FALLING DURATION	1.62E+03	[S]
HITS/SEC FOR THE FALLING DURATION	1.12E+02	[HITS*S-1]

PHYSICS OF THE FALL

EST. TERM. VEL. (THEOR. VACCUM)	4.34	[M*S-1]
EST. KE (J) TOT as M*G*H	2.60E+01	[J=KG*M2*S-2]
EST. KE (J) TOT as 1/2*M*V2	2.60E+01	[J=KG*M2*S-2]
EST. KE/T FOR THE FALLING DURATION	0.0161	[POWER, W=J*S-1]

READING ON CALIBRATED SENSOR

mV RMS	1605.20	[10E-3V]
LINEARIZATION COEFFICIENT XC1	4.00E-05	[1]
LINEARIZATION COEFFICIENT XE1	2	[1]
FLUX_AVG READING=XC1*mV^XE1	103.1	[G*M-2*S-1]
FLUX_AVG READING	0.103	[KG*M-2*S-1]
FLUX_CUM READING	1.66E+05	[G*M-2]
FLUX_CUM READING	166.45	[KG*M-2]

Note (2) : Interpretation of the FLUX_CUM reading : why so much than 166.45 kg/m2 ? : A mass of 2760 grams of particles in a tray felt from a 0.960m height on the horizontal sensor, it took 1620 seconds to empty the tray, and the effective interception section of the sensor is approx. 32mm*983mm= 0.031 m2 -> this indeed corresponds to the ratio between the 2.760 kg of particles in the tray and the 166.45 kg FLUX_CUM reading : 2.760/166.45=0.0166m2 ; the ratio between 0.031 m2 and 0.0166 m2 is because of the cylindricity of the sensor i.e. the particles hitting the edges transmit less energy than those in the axis of the tube (in other words, the effective *apparent* interception section of the sensor is closer to 0.0166 m2).

SENSITIVITY OF THE SENSOR

MILLIVOLTS PER MILLIJOULE/SEC	99.7	10E-3V*10E-3J*S-1
VOLTS PER JOULE/SEC	99.7	V*J*S-1
VOLTS PER WATT OF FLUX	99.7	V/W

"The global FLUX sensitivity of the sensor is 99.7 millivolts per milliwatt of particles flux"

Appendix F: Use cases review for the SandFlow SF4

There exist a rich set of real-world examples, showing SF4 used in desert climatic stations, industrial perimeter monitoring, wind-turbine or solar farms exposed to abrasion, railway or road transport surveillance systems, metro and urban transport protection zones, and many other infrastructures.

F.1.   General introduction

The SandFlow SF4 is a fourth-generation acoustic sensor designed to measure wind-driven sand transport in desert, semi-arid, and coastal regions. It operates continuously, capturing the characteristic signature of saltation and reptation as they occur at the surface, or possibly some turbulent suspension at higher elevation if it contents sufficiently coarse grain size. Thanks to its high robustness, low power consumption, and ability to operate autonomously in extremely harsh conditions, the SF4 has become an essential instrument for both operational monitoring and scientific observation of sand drift processes.

Over the years, the SF4 has evolved from an instrument primarily used in research contexts to a practical and reliable tool supporting infrastructure operators, engineers, and planners. Its sensitivity to real transport events, combined with its very high interoperability (GSM, SCADA, BMS, IoT, etc.), has made it particularly valuable wherever sand poses a risk to human activities or large-scale installations.

The following sections present a consolidated and realistic set of use cases reflecting the genuine value brought by direct, real-time measurement of aeolian transport.

F.2.   Sand transport and the contribution of the SF4

Sand transport in desert regions is typically intermittent, often occurring in rapid bursts and varying in intensity depending on wind patterns, grain size, surface moisture, and local topography. Understanding these dynamics or triggering protective measures require instruments capable of detecting the precise moment when grains begin to move, observing the evolution of flux during a storm, and quantifying the cumulative impact of events that may last only a few minutes yet produce significant operational consequences.

The SandFlow SF4 is designed precisely for this purpose. By analyzing acoustic vibrations generated by colliding grains, it reveals both the intensity and variability of transport with a temporal resolution that could hardly be achieved with traditional traps or periodic sampling. The resulting measurements serve not only as direct indicators of hazard levels but also as essential inputs for transport models, sediment-risk mapping, the design of mitigation structures and the management of protective actions according to the actual ongoing sand transport.

F.3.   Railways affected by blowing sand

Railway infrastructure represents one of the most vulnerable systems in desert regions. Sand accumulation can bury tracks, compromise ballast integrity, and obstruct turnouts and signaling equipment. Even short storm events may endanger train circulation or necessitate emergency clearance operations. For operators, the ability to anticipate when and where sand is moving is far more valuable than simply observing the aftermath.

The SF4 provides this anticipatory information. By detecting the earliest phases of saltation, it allows maintenance teams to mobilize before accumulation becomes critical. Over time, a network of sensors can reveal the spatial structure of recurrent problem zones, supporting decisions about barrier placement, maintenance scheduling, and traffic-management strategies.

Because the sensor integrates easily into any automated system and/or data service, alerts can be automated and correlated with local meteorological conditions, improving both safety and operational continuity.

F.4. Solar power plants in desert environments

Large photovoltaic and concentrated solar power installations are highly sensitive to airborne sand. Even moderate saltation can lead to rapid soiling of panels or mirrors, increasing cleaning costs and reducing energy output. More intense storms may abrade protective coatings, disturb tracking mechanisms, or generate local dune formation within the plant footprint.

In this context, the SandFlow SF4 data can soon become crucial for operational decision-support tool. Continuous measurements allow operators to distinguish between low-impact events and truly abrasive storms that justify immediate protective action, such as stowing trackers or halting vulnerable equipment. Flux data accumulated over weeks and months helps to identify the areas within a solar farm that receive the greatest sand load, guiding the placement of fences, vegetation, or deflectors.

F.5. Wind turbine farms exposed to sand abrasion

Wind turbines operating in arid regions face severe leading-edge erosion. High-velocity sand grains accelerate blade wear, degrade aerodynamic efficiency, and increase maintenance demands. Sand may also infiltrate cooling filters or accumulate around turbine bases, affecting local access and equipment operation.

With the SF4, wind-farm operators acquire a direct measurement of abrasive flux. Instead of relying solely on wind speed or general sandstorm forecasts, they can monitor the real exposure of turbines and trigger protective modes when flux exceeds predefined thresholds. This helps reduce erosion rates and extend blade lifespan.

Furthermore, long-term datasets support the calibration of blade degradation models and help identify zones within a wind farm that are systematically exposed to higher sand loads. In this sense, the SF4 contributes both to day-to-day operations and to strategic farm design.

F.6. Critical electrical and industrial infrastructure

Electrical substations, high-voltage transmission lines, data centers, and industrial platforms are often affected by sand deposition and contamination. Particles accumulating on insulators may increase the risk of flashover, while air-handling units can be overwhelmed by sand ingestion. In some cases, local dune formation threatens to obstruct access routes and service areas.

Here again, the SF4 provides a means of anticipating problematic conditions rather than discovering them after the fact. Interconnected to any external data service system, the SandFlow SF4 data can automatically trigger actions such as washing routines, adjust air-intake configurations, or alert field operators. By mapping flux intensity around critical installations, engineers can identify where protective walls or deflection structures will offer the greatest benefit. As sand-related incidents become more frequent with the expansion of infrastructure into arid regions, such proactive monitoring can be increasingly valuable.

F.7. Airports and aerodrome installations

Airports located in desert environments must contend with sand accumulation on runways, rapid visibility loss during storms, and the risk of damaging sensitive navigation equipment. Sand ingestion poses a serious danger to aircraft engines, especially during takeoff and landing.

The SandFlow SF4 offers airport operators a precise and immediate view of sand-movement conditions. By detecting the onset of transport, it helps determine actions such as when runway sweeping should be activated, when operations must be reduced, or when protective protocols must be applied to navigational aids. Beyond operational decision-making, long-term sand-flux records can highlight specific areas of the airfield that consistently accumulate material, supporting targeted mitigation measures.

F.8. Roads and highways in desert regions

Roads and highways are frequent victims of sudden sand encroachment. A single gust-front can deposit enough material to create hazardous driving conditions or block lanes entirely. Visibility is often reduced abruptly, creating dangerous situations for drivers.

Deploying the SF4 along vulnerable road sections provides a continuous monitoring capability that can feed into intelligent transport systems. Traffic managers can for example issue warnings, adjust speed limits, or initiate clearance operations based on real-time information rather than visual inspection alone. Over time, sand-transport maps derived from the SandFlow SF4 data can reveal recurrent "hot zones" where additional infrastructure — such as fences, berms, or realignment — may be necessary.

F.9. Consolidated benefits

Across all these contexts, the SandFlow SF4 offers a coherent set of advantages.

Operationally, it reduces the uncertainty surrounding sandstorm behavior, enabling faster and more targeted interventions.

From an engineering perspective, the sensor supports the design of more resilient infrastructures by providing a detailed understanding of sand-flux patterns.

Economically, these capabilities translate into reduced maintenance costs, fewer service interruptions, and longer equipment lifetimes.

F.10.Use boundaries and good practices

While the SF4 excels in detecting the transport of medium-to-coarse grains characteristic of saltation, it is less sensitive to very fine dust, which behaves aerodynamically in a different manner. For complex environments or large plants, a single sensor can soon be insufficient to well manage many areas or equipment's; a multi-point network is often required to capture the desired spatial variability. In a general manner, an optimal deployment requires careful placement in unobstructed areas, and sometimes, a learning of the local flux's ranges by follow-up experience of a few weeks or a few months for the determination and fine-tuning of adequate thresholds.

F.11. Conclusion

The SandFlow SF4 has established itself as a versatile and reliable tool for monitoring sand transport and mitigating its effects on infrastructure. Whether protecting transportation systems, energy facilities, industrial complexes, or airports, it provides a direct measurement of an environmental process that is otherwise difficult to quantify - the actual ongoing sand transport.

Across all experiences, the SF4 demonstrates:

- **High robustness** for harsh desert environments
- **Continuous real-time measurement** at 1-second resolution
- **High accuracy for medium and coarse sand**, that dominate the masses of depositions
- **Effective early-warning capabilities** for all situations
- **Compatibility with modeling frameworks** requiring dynamic sand flux inputs

Its strength lies in its continuity and very high temporal resolution of measurement, its compatibility and interoperability with all modern monitoring architectures, and its proven capacity to support both operational decision-making and long-term planning.

The SandFlow SF4 sensor emerges as a **mature, field-proven instrument** for monitoring aeolian sand transport. Its acoustic impact technology, robustness, and real-time data capabilities make it invaluable wherever sand poses operational or safety risks. It is a cornerstone of modern sand-drift monitoring and mitigation systems.

Limitations

- Low sensitivity to fine grains (<250 μm) because of the dependence on grain momentum—weak collisions may be missed. SandFlow SF4 is not optimal for dust storms dominated by very fine particles, or situations with only very low-energy dust or sediment transport.

- High spatial variability of sand transport can cause differences that have to be taken into account for the correct interpretation of the data.

Optimal use cases

- Industrial HVAC/air-intake protection
- Wind-turbine erosion and solar farms soiling monitoring
- Road Railway and Airfield hazard monitoring
- Automated sand mitigation systems
- Desert and coastal dune fields, geomorphological process studies

Appendix G: DECLARATIONS

- EU DECLARATION OF CONFORMITY
- TREACABILITY AND CALIBRATION DECLARATION
- WMO APPLICABILITY

DECLARATION DE CONFORMITE UE
EU DECLARATION OF CONFORMITY

Nous | *We*	**IAV Technologies SARL**	
	Chemin des Couleuvres 4A	
	CH-1295 TANNAY	
ID:	CHE-197.530.466	

déclarons que les produits | *declare that the products*

Désignation *Name*	Fabriqués depuis *Manufactured since*	Numéro de série S/N* *Serial number S/N**
FlowCapt FC4	Jan. 2016	FC*YYB*xxx
SandFlow SF4	Jan. 2016	SF*YYB*xxx
RainFlow RF4	Jan. 2016	RF*YYB*xxx
HailFlow RF4	Jan. 2020	HF*YYB*xxx
WindFlow WF4	Jan. 2016	WF*YYB*xxx
USB Link Accessory (UDONG)	Jan. 2016	U*YY*xxx
Modbus Adapter (MOBUS)	Jan. 2020	MB*B*xxx
4-20 mA Adapter (AD420)	Mar. 2024	A*YY*xxx
Extension Cable (EXT10)	Nov.2019	E*YY*xxx

> ***** YY = Année de fabrication (2 chiffres) – *Year of manufacturing (2 digits)*
> B = Numéro de batch (de A à Z) – *Batch number (from A to Z)*
> xxx = Numéro de production dans le batch – *Production number in the batch*

auxquels se réfèrent cette déclaration, sont conformes aux prescriptions de la directive et des normes qualité suivantes | *to which this declaration relates, are in conformity with the requirements of the following directive and quality standards:*

2004/108/EU « Compatibilité électromagnétique », selon les standards suivants |*« Electromagnetic compatibility », using the following standards:*

EN 61326-1:2013 Matériels électriques de mesure, de commande et de laboratoire | *Electrical equipment for measurement, control and laboratory use.*

EN 55022:2010 Appareils de traitement de l'information - Caractéristiques des perturbations radioélectriques - Limites et méthodes de mesure |*Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.*

2011/65/EU « Limitation de l'utilisation de certaines substances dangereuses dans les équipements électriques et électroniques », selon les standards suivants |*« Restriction of the use of certain hazardous substances in electrical and electronic equipment », using the following standards:*

EN 50581:2012 Documentation technique pour l'évaluation des produits électriques et électroniques par rapport à la restriction des substances dangereuses | *Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.*

2006/42/CE « Machines », avec les qualités de composants électroniques et mécaniques suivantes | *« Machinery », with the following additional electrical/electronic and mechanical qualities:*

Parties électriques/électroniques : | *Electrical/electronic parts:*
- Production certifiée ISO9001 et ISO13485 (EN46001) |*ISO9001 and ISO13485 (EN46001) certified production*
- Assemblage conforme à RoHS |*RoHS compliant assembly*
- Contrôle final par échantillonnage AQL 0.65 pour les défauts majeurs et 1.00 pour les défauts mineurs |*Final control per sampling AQL 0.65 for major defects and 1.00 for minor defects*
- Référentiel qualité par défaut IPC-A-610, produits de classe II |*Default quality referential IPC-A-610, class II products.*

Parties mécaniques métal/plastiques | *Metal/plastic parts:*

o   Production certifiée IQNet et SQS | *IQNet and SQS certified production*
o   Acier certifié INOX 1.4301 2B / 316L 1.4404 1.4401 2B, soudures selon la norme ISO5817 Qualité D | *Certified stainless steel INOX 1.4301 2B / 316L 1.4404 1.4401 2B, welded process ISO5817 Quality D*
o   Conformité plastique PET-C |*PET-C plastic conformity*: FDA 21 CFR 177.1630 2011/65/EU (RoHS2); 2015/863/EU (RoHS3); 1907/2006/EU (REACH)

Nous déclarons également que la personne autorisée à constituer le dossier technique est le chargé de projet de la société, basé au siège social de la société IAV Technologies SARL |*We also declare that the person authorized to produce the technical documentation is the project manager located at the IAV Technologies SARL Company.*

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Mis à jour à Tannay, le 1ᵉʳ avril 2024
Updated in Tannay on the 1ˢᵗ of April 2024

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Signatures autorisées et timbre :
Authorized signatures and stamp:

Dr. Eric VAN LANCKER
Directeur / *Director*
Associé-gérant

Dr. Vincent CHRITIN
Fondateur / *Founder*
Associé-gérant

ISAW PRODUCT
TRACEABILITY AND CALIBRATION DECLARATION

We,

IAV Technologies SARL
Chemin des Couleuvres 4A
CH-1295 TANNAY

ID: CHE-197.530.466

hereby certify that all ISAW instruments:

HailFlow HF4,
RainFlow RF4,
FlowCapt FC4,
SandFlow SF4
and WindFlow WF4

are delivered **factory calibrated** and accompanied by their individual calibration certificate.

The factory calibration is valid **for the entire lifetime of the instrument**. It consists of a calibration coefficient written in the internal memory of the instrument in a non-volatile and non-modifiable way. This calibration value is accessible anytime in the sensor parameters list.

This calibration is stored and remains valid even after a firmware update.

Should you wish to **check the instrument calibration**, IAV Technologies SARL has the exclusive right to perform this check. This operation requires the instrument to be returned to the factory, where it will be recalibrated and issued a new calibration value and a new individual calibration certificate.

Tannay, **May 16th, 2023,**

Vincent Chritin

(Authorized signature)

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WMO Applicability

The SandFlow SF4 blowing-sand and aeolian-transport sensor operates in a measurement domain for which the World Meteorological Organization (WMO) does not define any dedicated technical standards or instrument-specific requirements (the World Meteorological Organization does *not* define any official standard, recommendation, or regulatory requirement for sand drift measurement, aeolian sediment flux, blowing sand monitoring, dust or sand storm flux instrumentation, optical / acoustic / mechanical sand particle sensors). Unlike precipitation, snow, hail, humidity, wind, etc., sand monitoring is thus outside the scope of the current WMO instrument standards. Even though WMO does not regulate sand instrumentation, some general meteorological instrument guidelines still *indirectly* apply. These are not specific to sand, but apply to *any* instrument used in meteorological networks.

Nevertheless,

■　Its design, calibration and operational characteristics conform to the general principles established by WMO-No. 8 – Guide to Meteorological Instruments and Methods of Observation, particularly regarding instrument siting, exposure, and co-located wind measurements, which are essential for interpreting sand-transport processes.

■　The SF4 also meets the traceability, documentation and long-term reliability requirements of WMO-No. 49 Technical Regulations, supported by its lifetime factory calibration stored in non-volatile memory.

■　When integrated into environmental or meteorological networks, the SF4's outputs can be encoded in accordance with WMO-No. 306 (BUFR) present-weather descriptors for blowing sand or sandstorm phenomena, ensuring compatibility with international data-exchange frameworks.
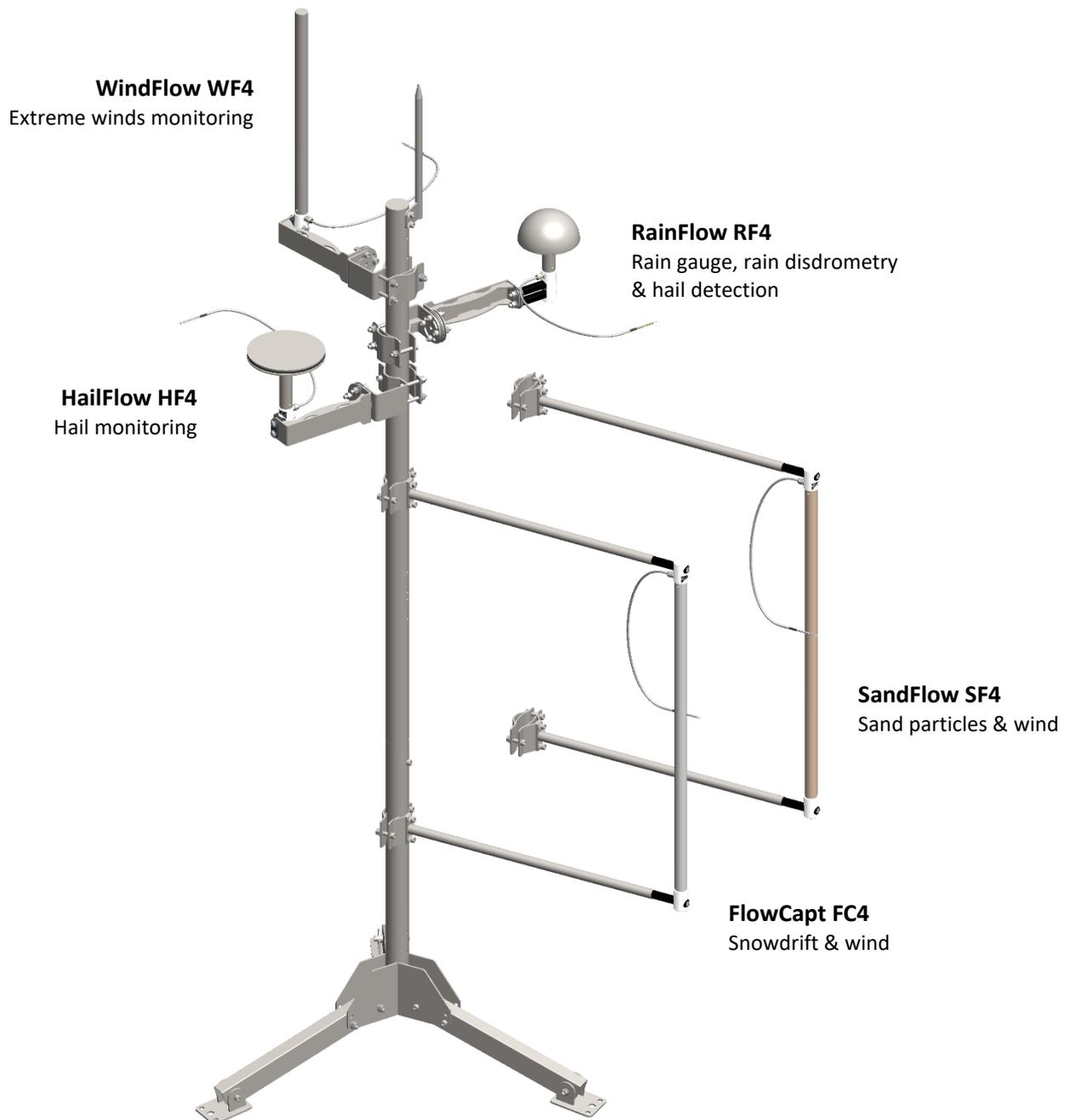
WMO Standard or Document	Applicability	Relevance to SandFlow SF4
WMO-No. 8	Indirect only	No sand-specific chapter. Only siting and general instrument guidelines apply.
WMO-No. 49	Generic applicability	Calibration, reliability, metadata for instruments in networks.
WMO-No. 306 (BUFR)	Limited	Sand storms can be encoded, but sand flux cannot.
WMO Dust/Aerosol Guidelines	Not instrument standards	Provide context but no performance or calibration rules.
WMO SPICE / Solid Precipitation Standards	Not applicable	These apply to snow/ice, not sand.

WMO Relevance to SandFlow SF4

As such, although no WMO standard governs the measurement of sand flux itself, the SandFlow SF4 fully satisfies the broader WMO guidelines applicable to robust, field-grade environmental monitoring instruments.

Appendix H: ISAW INSTRUMENTS OVERVIEW

A total of five instruments is available as ISAW ultra-specialized sensors for the monitoring of solid and liquid precipitation, as well as aeolian blowing particles.

WindFlow WF4
Extreme winds monitoring

RainFlow RF4
Rain gauge, rain disdrometry
& hail detection

HailFlow HF4
Hail monitoring

SandFlow SF4
Sand particles & wind

FlowCapt FC4
Snowdrift & wind

Made in Switzerland