User Guide

Sensors

FlowCapt FC4

SandFlow SF4

RainFlow RF4

HailFlow HF4

WindFlow WF4

Document version: v2.20

ISAW-Toolbox version: v1.37 or higher

The ISAW sensors are robust, high performance, zero-maintenance sensors ideal for a wide range of applications.

This User Guide provides all required information and instructions to operate the sensors. For more information about the sensors, mounting kits and accessories please refer to the sensors catalogues available at www.isaw-products.com.

FC4 FlowCapt

The FlowCapt FC4 sensor is an ultra-robust instrument measuring solid particle flux intensity and wind speed.

Typical applications:

- Meteorology (blowing snow, snowdrift and wind)
- Roadside, railway and cable transport protection
- Power and communication lines
- Cold regions land management
- Applied scientific research
- Industrial surveillance

SF4 SandFlow

The SandFlow SF4 sensor is an ultra-robust instrument measuring solid particle flux intensity and wind speed.

Typical applications:

- Meteorology (blowing sand, sandstorms, lithometeors)
- Roadside, railway, airport protection
- Building and infrastructure surveillance and insurance
- Land management
- Applied scientific research

RF4 RainFlow

The extremely robust and zero-maintenance RainFlow RF4 sensor is an evolving acoustic instrument for the comprehensive measurement of the type, amount, intensity and structure of liquid and solid precipitation.

Typical applications:

- Meteorology (liquid and solid precipitation, rain and hail, hydrometeors)
- High resolution rain and hail monitoring and warning
- Roadside, railway, airport protection
- Building and infrastructure surveillance and insurance
- Land management (flood warning, soil erosion)
- Agriculture
- Maritime and offshore applications (wind turbines, buoys)
- Mining industry
- Applied scientific research

HF4 HailFlow

The extremely robust and reliable HailFlow HF4 sensor is a highly specialized acoustic instrument for the detection of hail and the characterisation of hailstone size.

Typical applications:

- Meteorology (hail, solid precipitation, lithometeors)
- High resolution hail monitoring and warning
- Roadside, railway, airport protection
- Building and infrastructure surveillance and insurance
- Agriculture
- Land management
- Maritime and offshore applications (wind turbines, buoys)
- Applied scientific research

WF4 WindFlow

The WindFlow WF4 sensor is an unbreakable, hurricane-resistant wind-speed instrument.

Typical applications:

- Wind speed monitoring of strong winds and hurricanes
- Surveillance of high wind areas
- Roadside, railway and cable transport protection
- Building and infrastructure surveillance
- Power and communication lines
- Applied scientific research

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INTRODUCTION

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Before you start

Your ISAW sensor model FlowCapt FC4, SandFlow SF4, RainFlow RF4, HailFlow HF4 or WindFlow WF4 is delivered **completely configured**, ready to be plugged into a power supply and into your reading peripheral (I/O module, data logger, automation server, controller, computer, etc.).

The default operating configuration is described in the default settings table (page 9). A configuration includes measurement settings (ex. averaging durations) and power, communication and mapping (ex. analog and/or digital outputs, voltage scales, duty-cycle, bus address) settings. You can adapt the **default configuration** at any time to almost any mode of use, following the instructions in this document. The sensors are compatible with both analog and/or digital peripherals.

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

The sensor is totally **standalone**, so that the full lifetime operation of the sensor on your installation doesn’t require any software installation or maintenance.

When receiving your sensor, we recommend that you perform a quick and simple **communication test**, to get acquainted with the sensor’s facilities. The USB dongle accessory, delivered with the sensor, and the free ISAW-Toolbox software suite allow you to realize these operations very easily. You can immediately establish a connection with a computer or laptop, access to all settings menus and see live data with a simple scope utility. You also have permanent access to the configuration and communication setups of the sensor either directly in a terminal console mode, or remotely, using other standard serial communication modes (serial commands, extended SDI-12 commands) also described in this document.

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

Power supply and maximum ratings

All ISAW sensors operate with the same generic supply rating as follows:

Supply	FC4	SF4	RF4	HF4	WF4	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%).

The sensors operate for snowdrift, sand aeolian transport, precipitation and wind speed with the following nominal measurement scales and corresponding analog output voltages.

Voltage ranges and measurement scales	FC4	SF4	RF4	HF4	WF4	Analog output sensitivity and range
Aeolian flux of particles (snowdrift, sand)	•	•				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 (default): [20 mV/(g/m^2/s)] i.e. +5V corresponds to 250 g/m^2/s
Rain			•			Sensitivity @voltage range +2.5V: [10 mV/(mm/h)] i.e. +2.5V corresponds to 250 mm/h
						Sensitivity @voltage range +5V (default): [20 mV/(mm/h)] i.e. +5V corresponds to 250 mm/h
Hail			•			Sensitivity @voltage range +2.5V or +5V: 5 hit/s
				•		Sensitivity @voltage range +2.5V or +5V: 25 hit/s
Wind speed	•	•			•	Sensitivity @voltage range +2.5V: [10 mV/(km/h)] i.e. +2.5V corresponds to 250 km/h
						Sensitivity @voltage range +5V (default): [20 mV/(km/h)] i.e. +5V corresponds to 250 km/h

The maximum drive current of the analog output is 5 mA.

Default configuration

The sensor is delivered with a standard configuration as follows:

Power supply and grounding

Wire	Signal	Sensor	Unique or user-selectable setting
White	Power +	All	Positive power supply (6 to 30) VDC
Brown	Signals GND	All	OUT1 GND, OUT2 GND
Black	Power GND	All	Power GND, SDI-12 GND

Single-ended analog and pulse outputs for FC4, SF4 and WF4

Wire	Signal	Sensor	Disabled	Particle flux				Wind speed		Raw signal (±2.5V)
				DC voltage, +0V to +2.5V	DC voltage, +0V to +5V	DC voltage, +0V to +2.5V	DC voltage, +0V to +5V	DC pulse +0V to +2.5V	DC pulse +0V t +5V	
Green	OUT1	FC4	○	○	○	○	●	○	○	
		SF4	○	○	○	○	●	○	○	
		WF4	○	○	●					
Yellow	OUT2	FC4	○	○	●	○	○	○	○	○
		SF4	○	○	●	○	○	○	○	○
		WF4	●	○	○					○

● Default setting ○ User selectable

Single-ended analog and pulse outputs for RF4 and HF4

Wire	Signal	Sensor	Disabled	Rain intensity				Hailstone count				Raw signal (±2.5V)
				DC voltage, +0V to +2.5V	DC voltage, +0V to +5V	DC pulse +0V to +2.5V	DC pulse +0V t +5V	DC voltage, +0V to +2.5V	DC voltage, +0V to +5V	DC pulse +0V to +2.5V	DC pulse +0V t +5V	
Green	OUT1	RF4	○	○	●	○	○	○	○			
		HF4						○	●	○	○	
Yellow	OUT2	RF4	○	○	○	○	○	○	●			○
		HF4	●					○	○	○	○	○

● Default setting ○ User selectable

Serial or SDI-12 communication

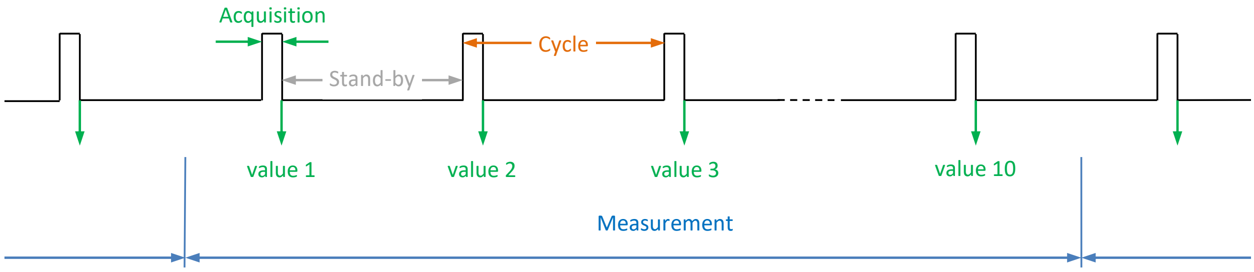
Wire	Signal	Sensor	Disabled	Wind speed	Particle flux	Wind speed & Particle flux	Rain intensity, disdrometry and hail	Hail
Blue	SDI-12 (default address: 0)	FC4	○	○	○	●		
		SF4	○	○	○	●		
		RF4	○				●	
		HF4	○					●
		WF4	○	●				
Grey Pink	RX TX	FC4	○	○	○	●		
		SF4	○	○	○	●		
		RF4	○				●	
		HF4	○					●
		WF4	○	●				

● Default setting ○ User selectable

To change one or more parameters of this configuration, use the Configuration utility (see p. 17).

Fundamentals of operation

With the default configuration, the sensor measures physical phenomena every minute during 6 seconds and delivers MIN, AVG, MAX numerical values or AVG voltages every 10 minutes:



Measurement settings	Description	Default value
Acquisition duration [A]	True observation time of the physical phenomena, also called *time integration window.*	6 seconds
Cycle duration [C]	Sum of the acquisition duration and a stand-by duration.	1 minute
Measurement duration [M]	Reading/writing data interval, called *averaging duration.*	10 minutes
Duty cycle	Ratio between acquisition duration and cycle duration, i.e. fraction of time in which the sensor is effectively active.	10%

- If you read the output data on the **analog reading connection** of the sensor (i.e. positive voltages on green and/or yellow wires), you will only get the **average value**.
- If you read the output data on a **serial mode** of communication of the sensor (SDI-12 and/or serial interface, respectively blue or grey/pink wires), you will be able to get **average, min. and max. values**.

The analog voltage outputs are persistent, so if your reading device is programmed to read a voltage value every ten minutes, you will always get a new result, whatever the synchronization between the reading device and the ISAW sensor is.

To change one or more measurement settings, use the Configuration utility (see p. 17).

QUICK START

- Initial check
- Install the ISAW-Toolbox
- Plug your sensor
- Test your sensor

Initial check

When the sensor is unpacked, it should first be checked carefully for any signs of shipping damage.

It is then recommended to proceed to a first, quick and simple communication test, connecting your sensor to a computer or laptop.

Install the ISAW-Toolbox software suite first, then plug the sensor into the USB dongle accessory, establish a communication and browse all settings. These steps are described more in detail in the next sections of this chapter.

Install the ISAW-Toolbox software suite

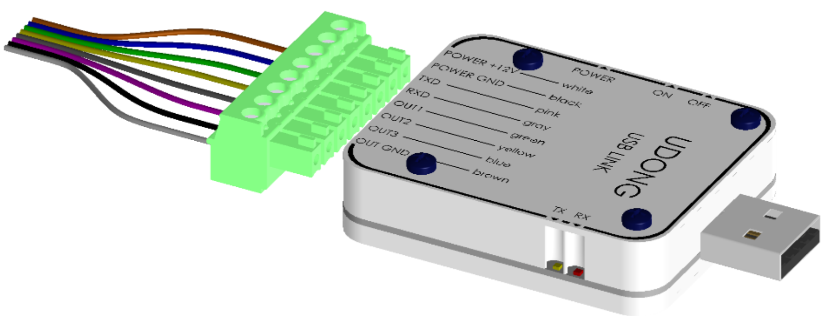
Download the ISAW-Toolbox software suite from the ISAW products website www.isaw-products.com and install the latest version of the toolbox.

Add an ISAW icon on your Desktop to ensure direct access to the ISAW-Toolbox program.

Plug your sensor

1. **Connect the sensor to the USB dongle accessory:**

Your sensor is delivered with an 8-pin connector that you can plug directly into the USB dongle accessory.



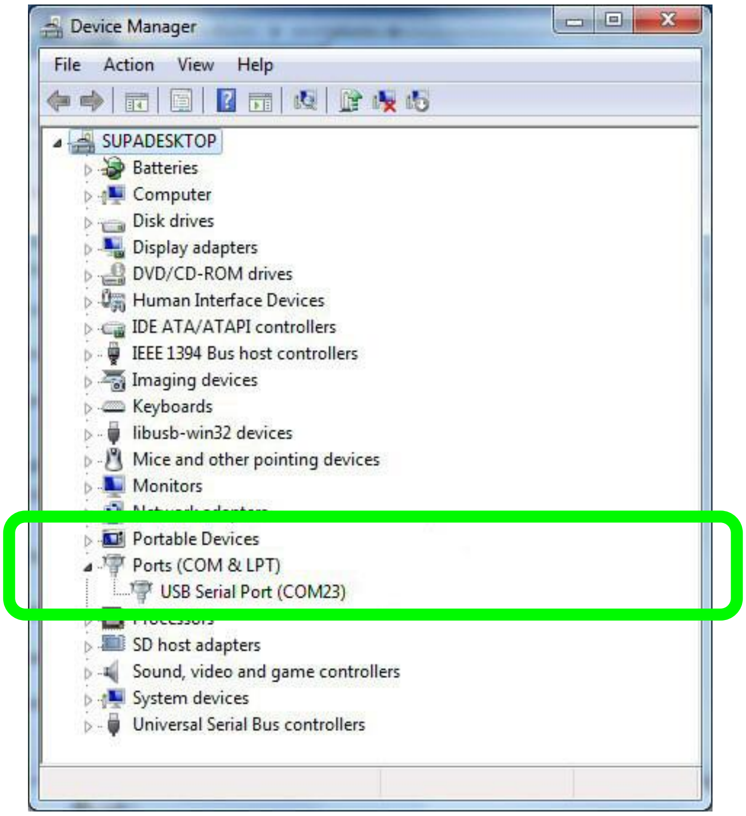
2. **Connect the USB dongle to the computer.**

Wait for the device driver to be automatically installed and completed.

(If the driver is not properly installed, you can download it from http://www.ftdichip.com/Drivers/VCP.htm and install it manually.)

3. **Get the USB dongle serial port:**

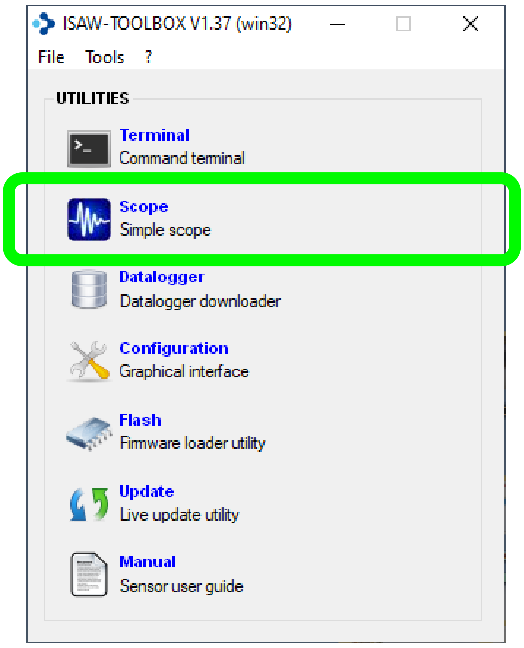
In the "Configuration panel", open the "Device manager". In the "Ports (COM & LPT)" section, you will find a new serial communication port (ex: COM23).



Test your sensor

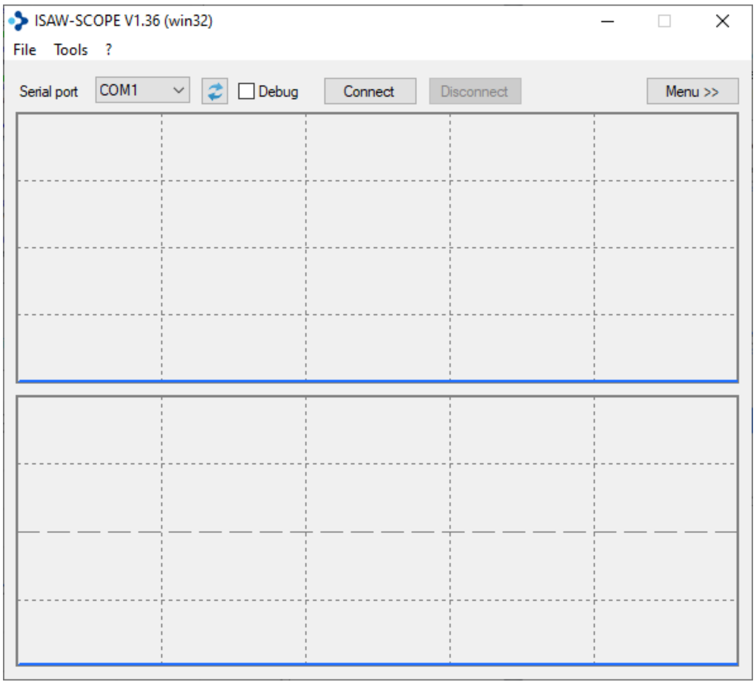
1. Open the ISAW-Toolbox software

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



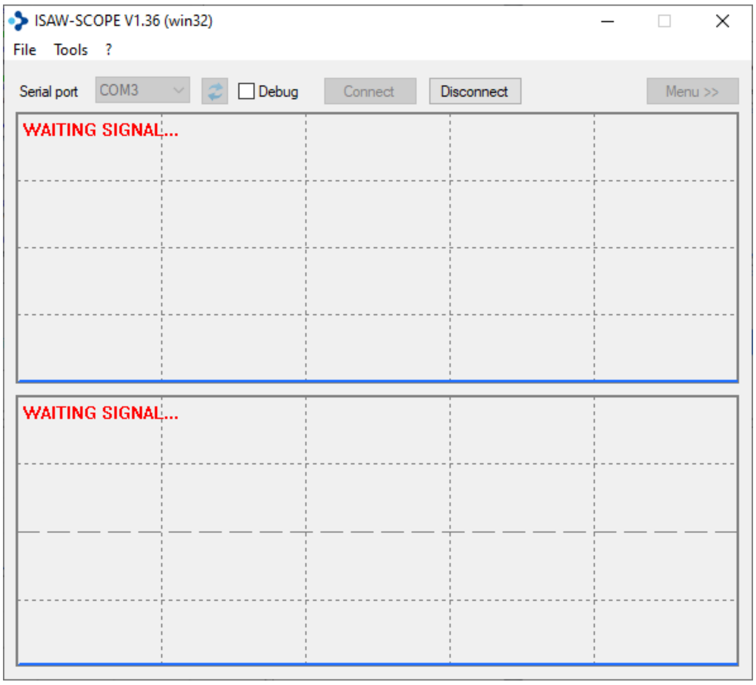
2. Start the Scope utility

Start the utility by clicking on the Scope item.



3. Connect the sensor

In the upper part of the window, select the serial port that the sensor is connected to in the list, then press the [Connect] button.



The connection procedure is completed when the [Connect] button is disabled and the [Disconnect] button is enabled.

Note: If the sensor has been 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, and then select the right port.

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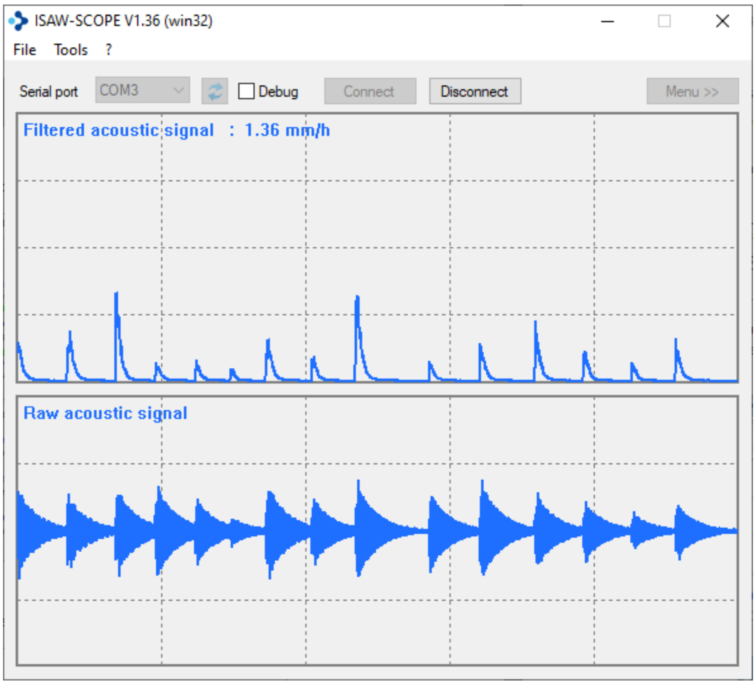
4. Check live sensor response(s)

Once your sensor is plugged in and connected, test the signal(s) by tapping or scratching gently on the sensor until a live signal appears on the scope window (see example below). If no signal appears, check the wirings and try again. If you still don't get a live signal, please contact the IAV support.



Typical RF4 live response

SENSOR CONFIGURATION

- Configuration utility
    - Summary panel
    - Outputs panel
    - SDI-12 panel
    - Serial panel
    - Datalogger panel
    - Averaging panel
    - Expert panel
    - Factory panel
- Import configuration
- Export configuration
- Change a parameter in terminal mode
- Update the sensor's firmware
- Download data from the datalogger

Configuration utility

Prerequisites:

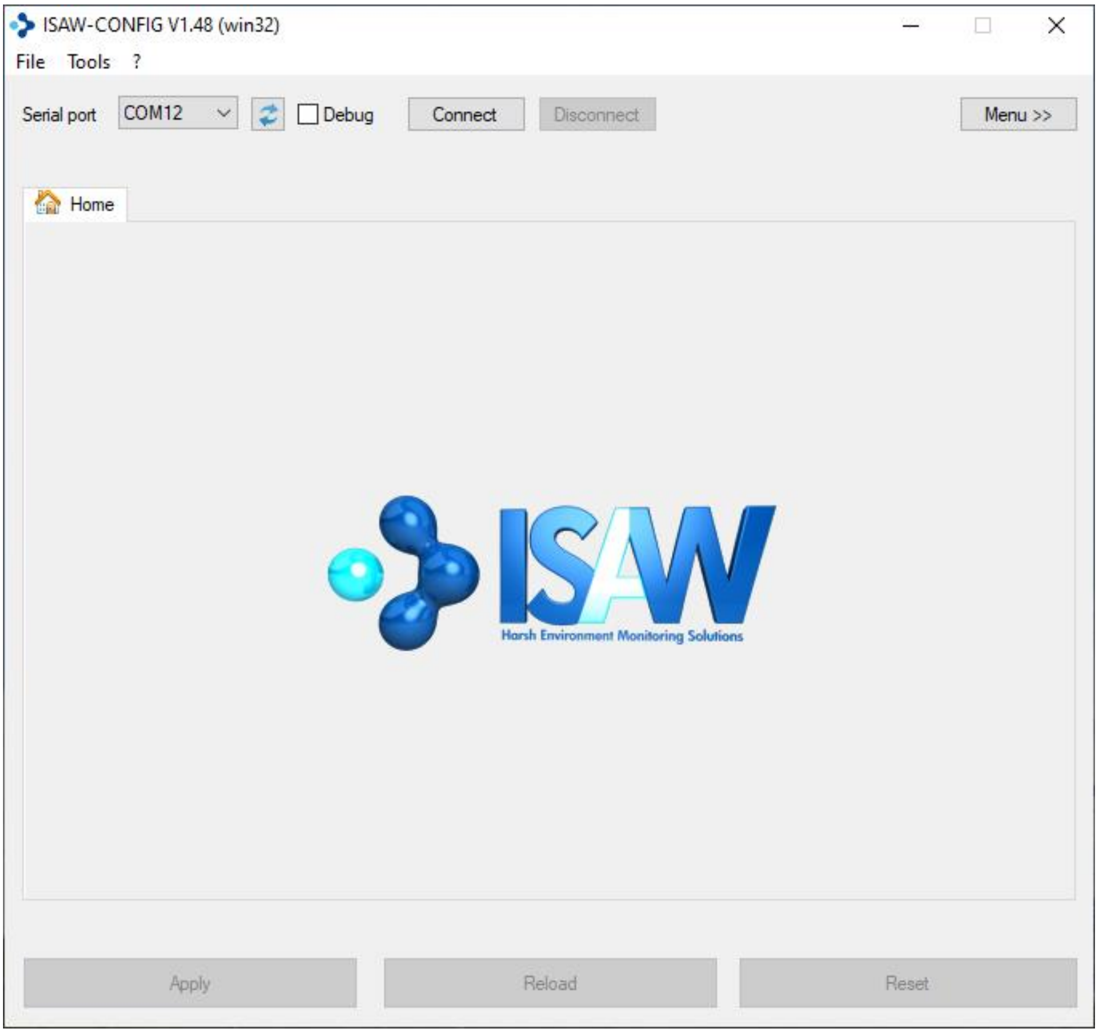
- The ISAW-Toolbox is installed (see p. 12).
- The sensor is plugged (see p. 12).

1. Open the ISAW-Toolbox

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

2. Start the Configuration utility

Start the utility by clicking on the corresponding item.

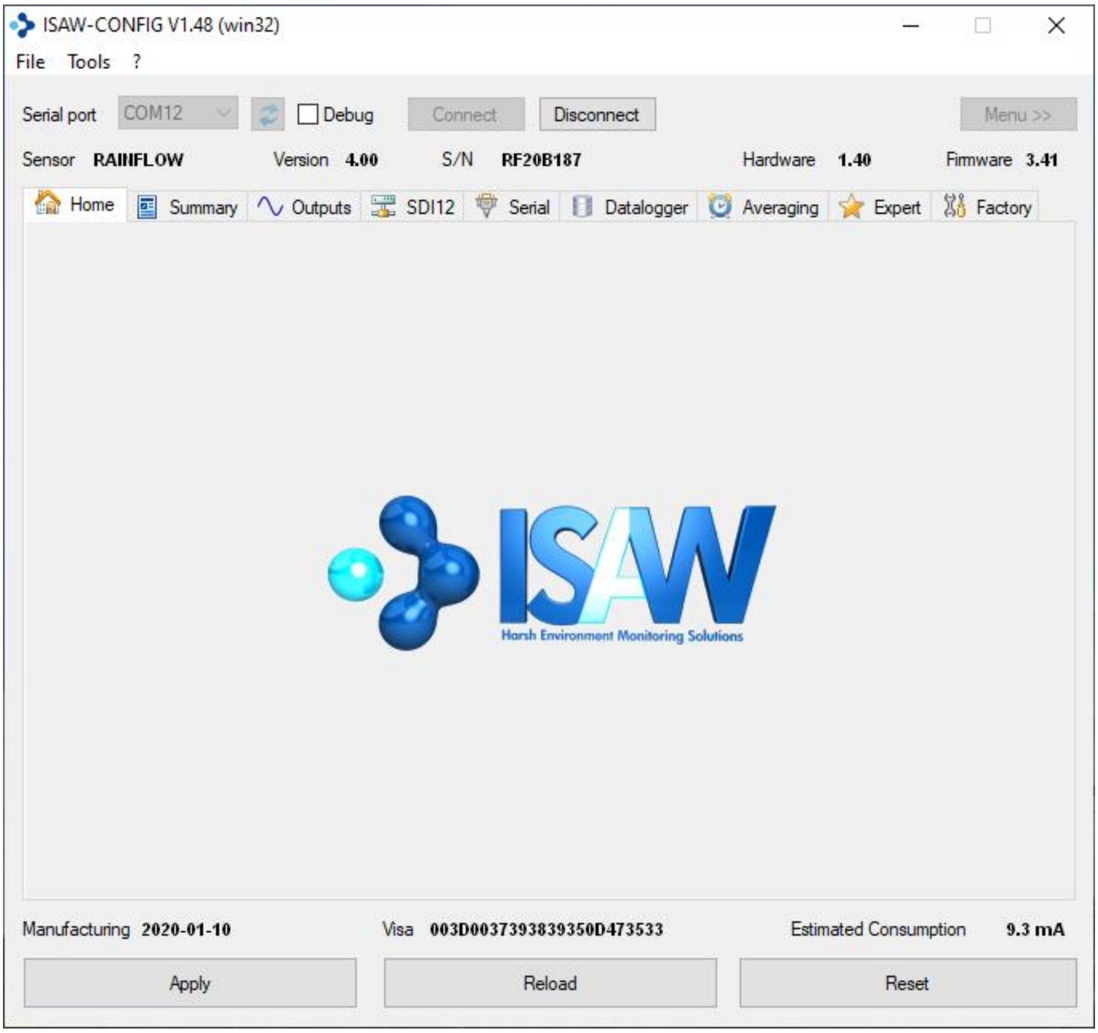


Note: Only the "Home" panel is visible as long as there is no sensor connected.

3. Connect the sensor

See p. 14.

Once the sensor is connected, the configuration tabs appears and the control buttons are enabled.



<table>
<tr><th colspan="3">Configuration panels</th></tr>
<tr><td>Home</td><td colspan="2">A single configuration application for all ISAW sensors.</td></tr>
<tr><td>Summary</td><td>Current configuration.</td><td rowspan="4">Some of the information displayed on this tab may depend on the sensor type (FlowCapt FC4, SandFlow SF4, RainFlow RF4, HailFlow HF4, or WindFlow WF4).</td></tr>
<tr><td>Outputs</td><td>Setting analog outputs, voltage ranges, and pulse settings.</td></tr>
<tr><td>Sdi12</td><td>Setting SDI-12 settings.</td></tr>
<tr><td>Serial</td><td>Serial settings.</td></tr>
<tr><td>Datalogger</td><td colspan="2">Internal data recorder.</td></tr>
<tr><td>Averaging</td><td colspan="2">Setting acquisition duration, cycle duration, duty cycle and measurement duration.</td></tr>
<tr><td>Expert</td><td colspan="2">Setting coefficients of the polynomial linearization functions, internal clock and timeout parameter.</td></tr>
<tr><td>Factory</td><td colspan="2">Reading the sensor's factory information.</td></tr>
</table>

Control buttons	
[Apply]	Sends the complete configuration displayed in all tabs to the sensor. After receiving the configuration, the sensor restarts.
[Reload]	Reloads the sensor's configuration.
[Reset]	Resets the sensor 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" command in Appendix B for more information.

4. Optional: check the current configuration:

Click on the **Summary** tab to display all current parameter values.

5. Change parameters:

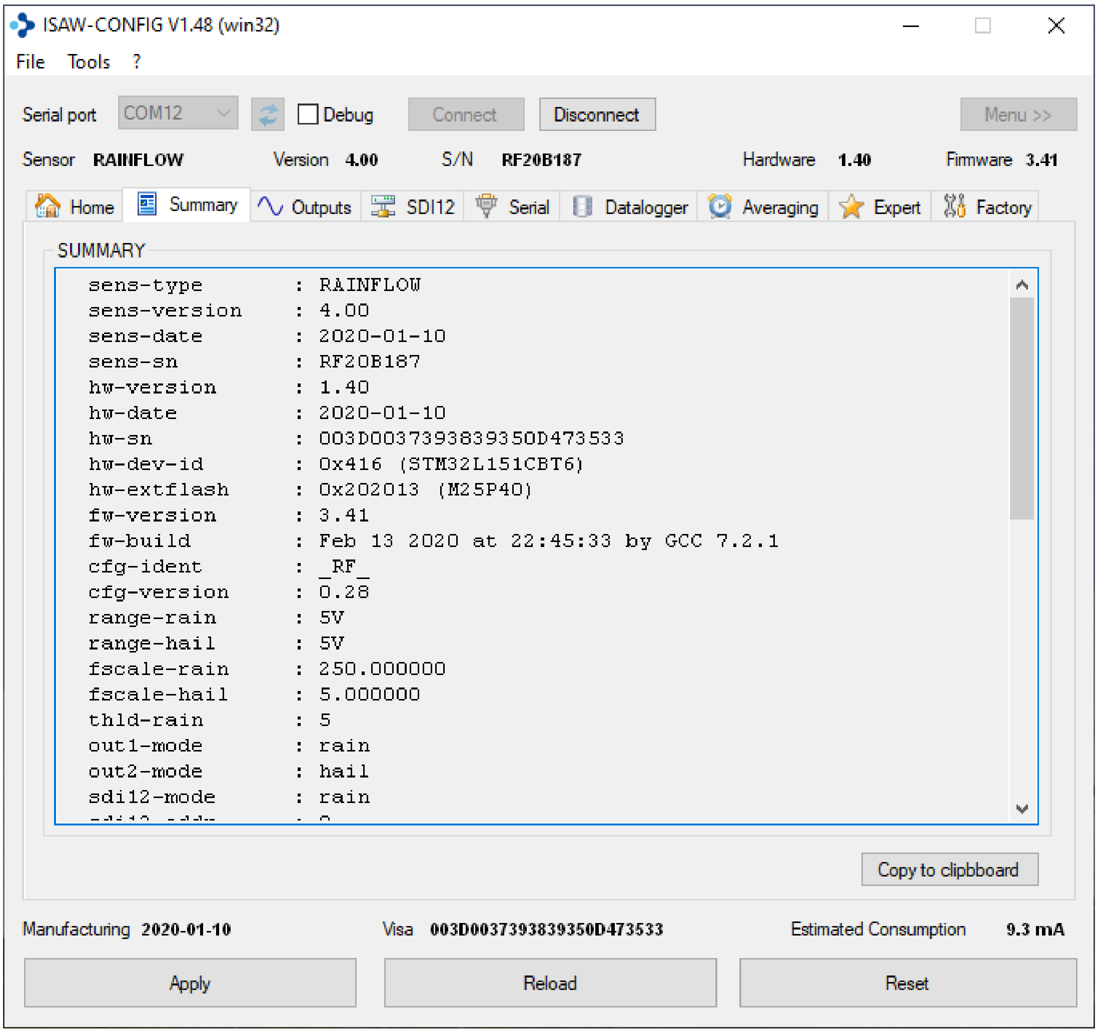
Use the other tabs (click on the tab selection buttons) to make the required parameter changes then click on the [Apply] button to send your changes to the sensor.

Adjusting averaging calculations or power consumption settings for particular applications		
[A] Acquisition duration parameter, in seconds	The true measurement (= observation) duration, i.e. the time integration window used by the sensor to periodically acquire wind speed, snowdrift, sand aeolian transport or rain, before returning to stand-by (ex: 10 seconds every minute).	
[S] Stand-by duration parameter, in seconds	Stand-by mode, i.e. the time between two measurement acquisitions.	
[C] Cycle duration parameter, in seconds	[C] = [A] + [S], i.e. a cycle of measurement (acquisition duration + stand-by duration).	
[M] Measurement duration parameter, in seconds	Also called *writing interval* or *averaging interval* i.e. the time intervals at which output values or voltages are calculated and updated (this parameter is not used in pulse mode).	
[D] Duty cycle parameter, in percentage	The cyclic ratio between the measurement duration and the stand-by duration; thus the rate of power consumption compared to power consumption when under continuous power (the lower the value of [D], the lower the total power consumption).	
Relationships between parameters [A], [S], [C], [M] and [D]	[C] = [A] + [S] [D] = 100 × [A] / [C] [S] = [A] × (100 / [D] − 1) Note: [M] is independent from [A], [S], [C] and [D] (i.e. the writing interval can be chosen at any duration superior to [C])	
Parameter settings recommendations (and default factory settings values). Notes: - Set [A], [D] and [M] to fix [S] and [C]. - Max. admissible value of [C] is 65535 s.	[A]	Set [A] according to the resolution you need based on the natural phenomenon; values can be set from 1 to 255 s. Typical values for wind, snow, sand, precipitation are between 5 and 30 s; the default factory value is 6 s.
	[D]	Set [D] to adjust the power consumption (especially in case of limited power consumption); values can be set from 0% (e.g., stand-by) to 100% (e.g., continuous powering). Typical values are between 5 and 100%; the default factory value for battery operated situations is 10%.
	[M]	Set [M] to your final end-user information or surveillance need, e.g., according to your reading, logging or alert threshold update period. Typical values are between 300 s (5 min) and 3600 s (60 min); the default factory value is 1800 s (30 min).
Output refresh interval	Analog mode	Output voltages are updated at every writing interval [M] and remain permanently available for reading (persistent voltages).
	Pulse mode	At each cycle the measured values are added to the previous sums. A pulse is generated when a sum exceeds the pulse-generation threshold. Pulses are delivered independently of [M].
	SDI-12 mode	Cumulative or reset string result is sent on request (see more in Appendix E).
	Serial mode	String result is sent through TX output at every writing interval (see more in Appendix B).
	Datalogger mode	Measurements are written into the internal memory at every writing interval [M].
Default factory setting summary	[M] = 600 s (writing interval of 10 min.) [A] = 6 s (true measurement duration) [D] = 10% (total consumption of 2.1 mA) Thus [S] = 54 s and [C] = 60 s. *"The sensor measures physical phenomena every minute during 6 seconds and delivers MIN, AVG, MAX numerical values or AVG voltages every 10 minutes".*	

Summary panel

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

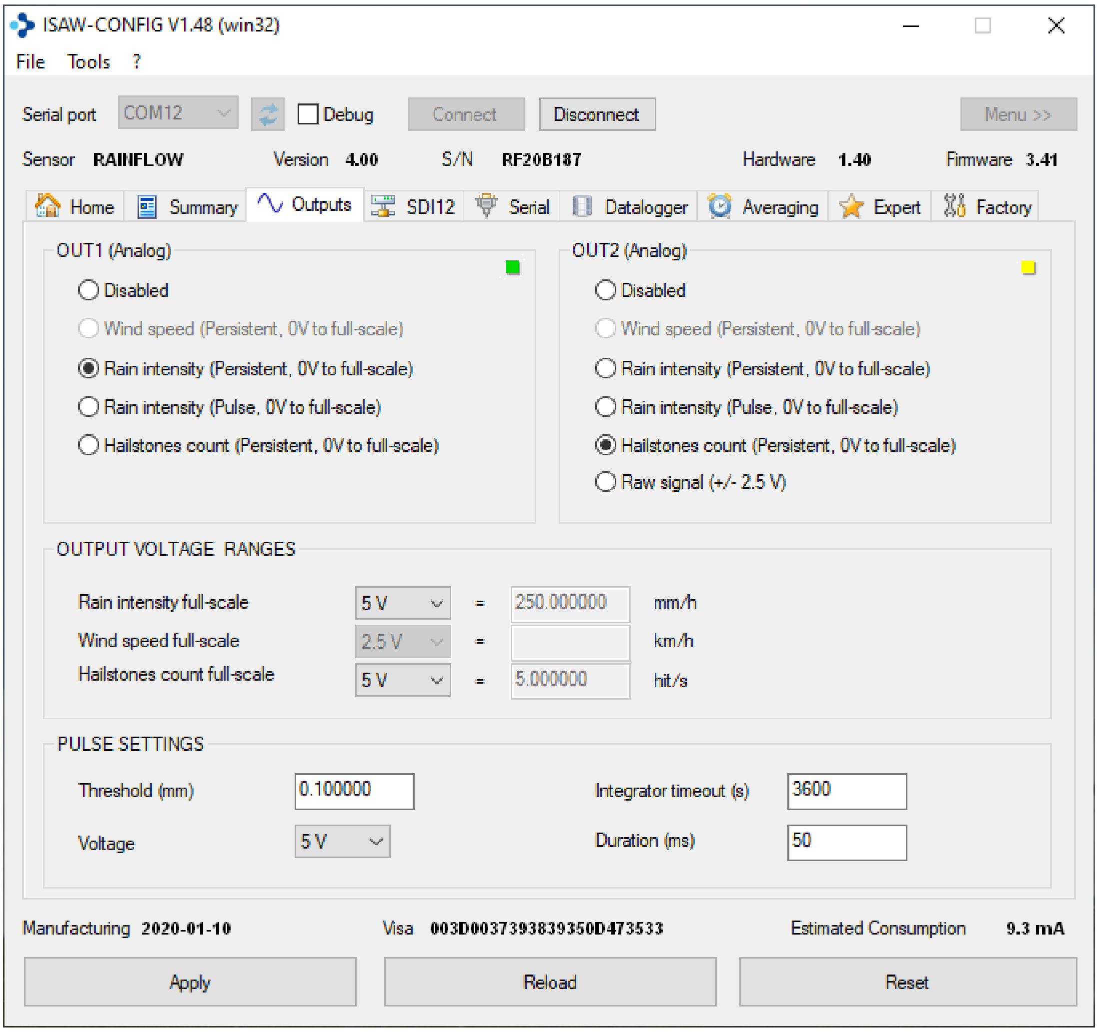
See Appendix A for more details on parameters.



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 reasons.

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 sensor 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 sensor), 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 sensor to be adapted to almost any reading device.

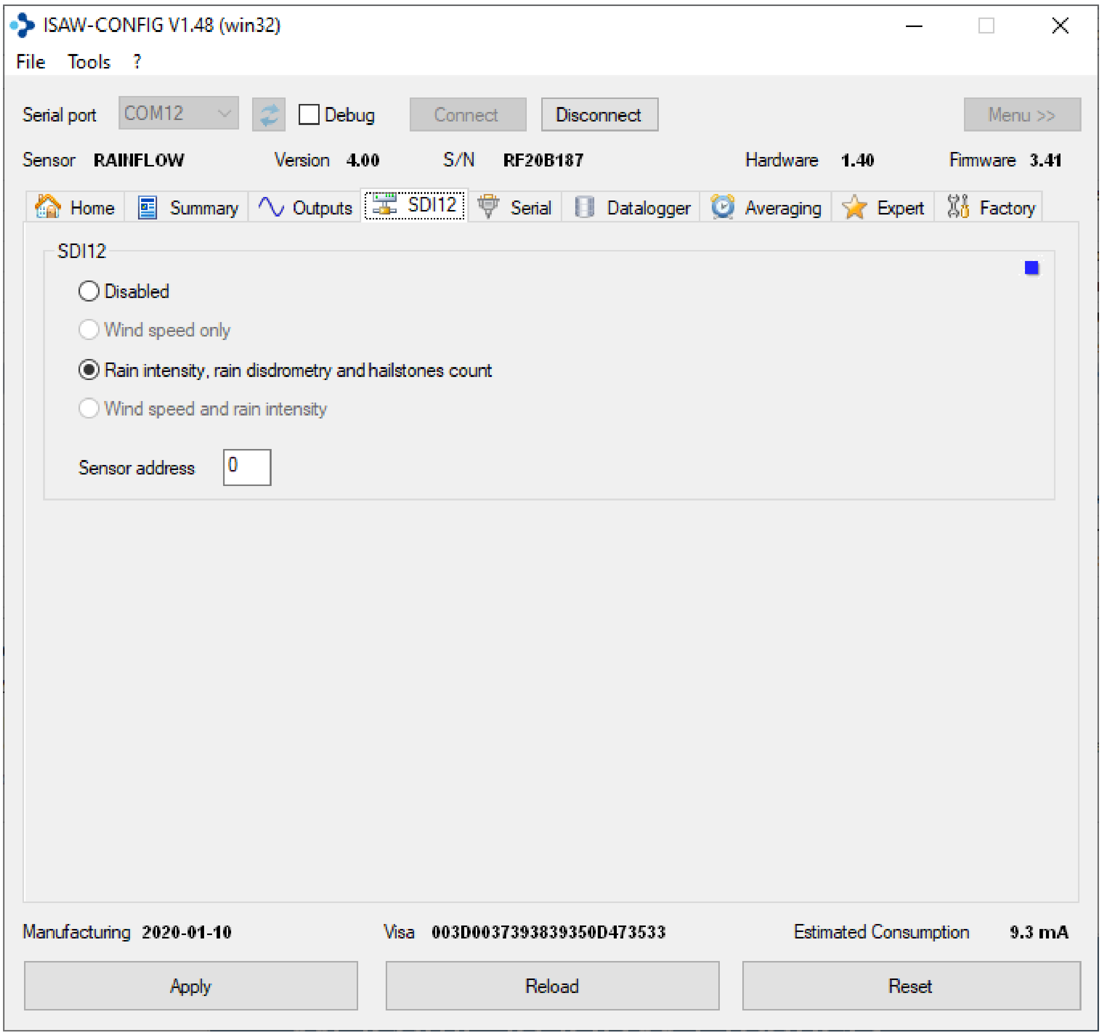
To understand the output mapping, the only thing to consider is that the sensors have two generic analog outputs, called OUT1 and OUT2. OUT1 is always carried by the green wire, OUT2 is always carried by the yellow wire. You decide which signal is attributed to OUT1 and OUT2 by selecting one of the options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

Note: You can check the average power consumption corresponding to your selected settings at any time at the bottom right of the panel.

SDI-12 panel

When choosing an SDI-12 interface for your sensor (see more details in the next paragraph), its positive voltage is always physically carried by the blue wire in all ISAW sensors, you can select in the SDI-12 panel the data frame content you need and set the sensor address of your choice. For more instructions about the use of the SDI-12 interface, please refer to Appendix E.



SDI-12 stands for "serial data interface at 1200 baud" [Source: www.sdi-12.org]. It is recommended for applications of the ISAW sensors 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 sensor (as well as other SDI sensors) 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 sensors. The SDI-12 bus is capable of having ten or more sensors connected to it. Some SDI-12 users connect more than ten sensors to a single data recorder. Multi-parameter means that a single sensor may return more than one measurement.

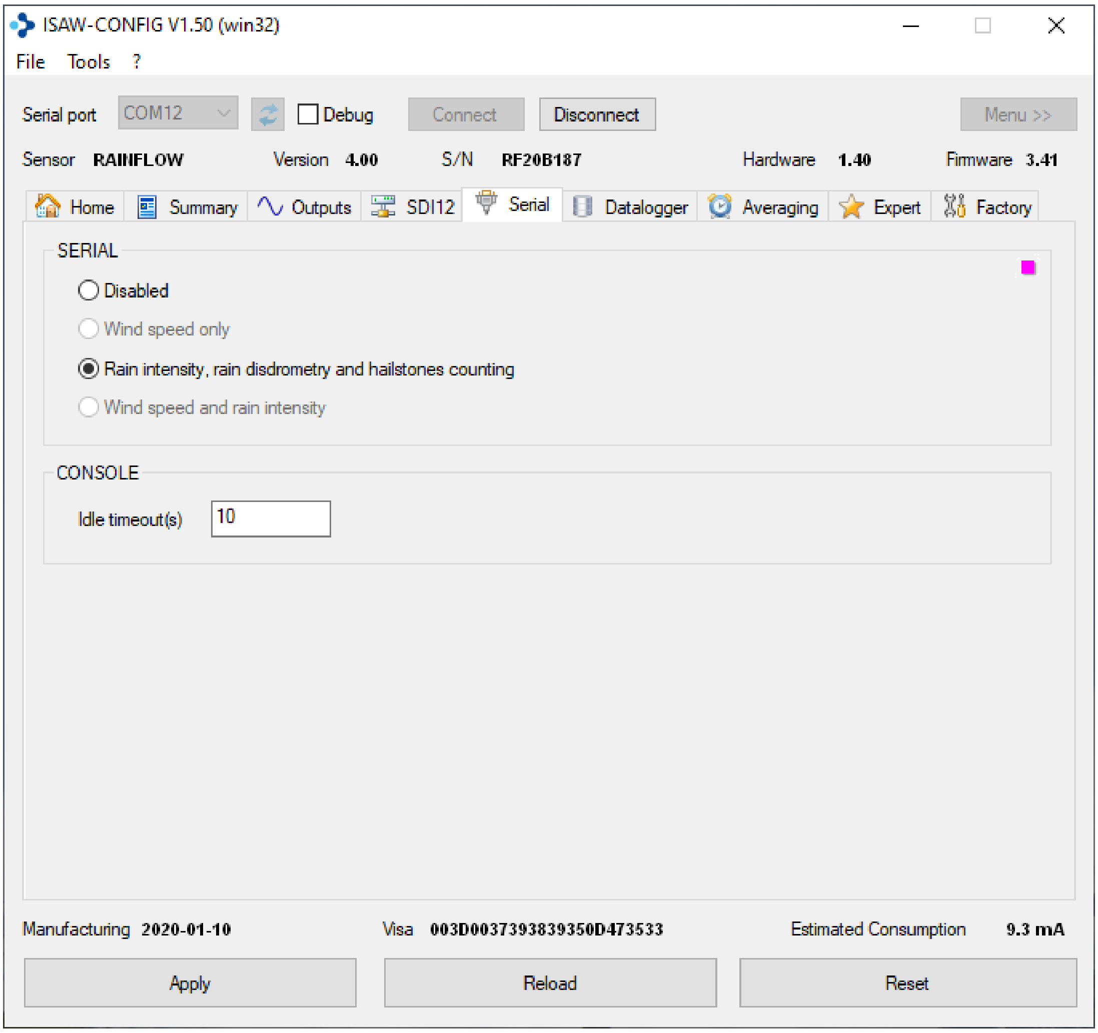
This serial-digital interface is thus a logical choice for interfacing your ISAW sensor with a distant data recorder.

This has advantages for sensors and data recorders:

- Unique and complex self-calibration algorithms are executed in the microprocessor-based ISAW sensor.
- The sensors can be interchanged without reprogramming the data recorder with calibration or other information.
- Power is supplied to sensors 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 sensors.
- SDI-12 sensors 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 sensors.

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 sensors. You can select the data frame content you need in the Serial panel and set the idle timeout of your console.



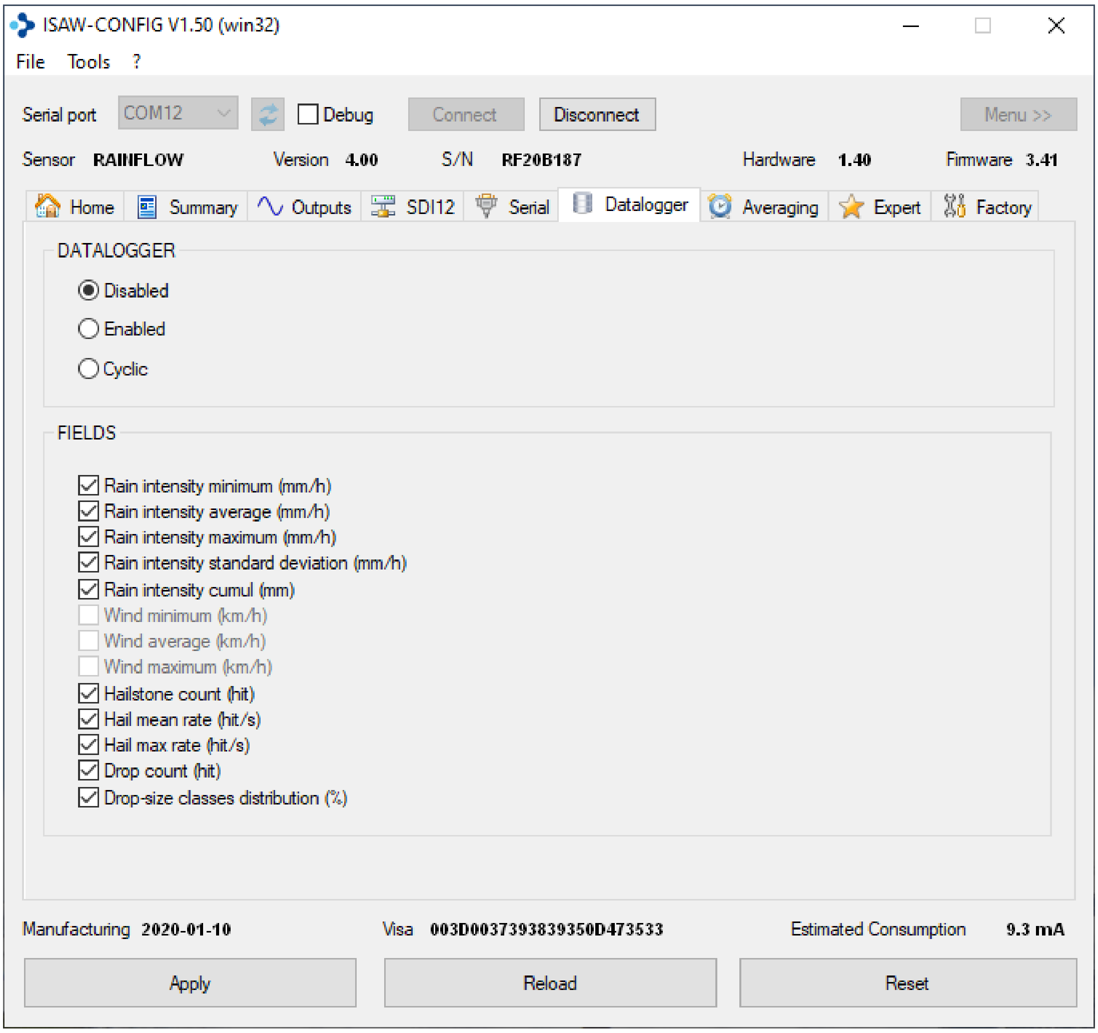
For more instructions on the use of the serial communication, please refer to Appendix D.

Datalogger panel

The internal datalogger can be configured as follows:

- Disabled: No data are 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 page).



You can individually select the fields you want to record.

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

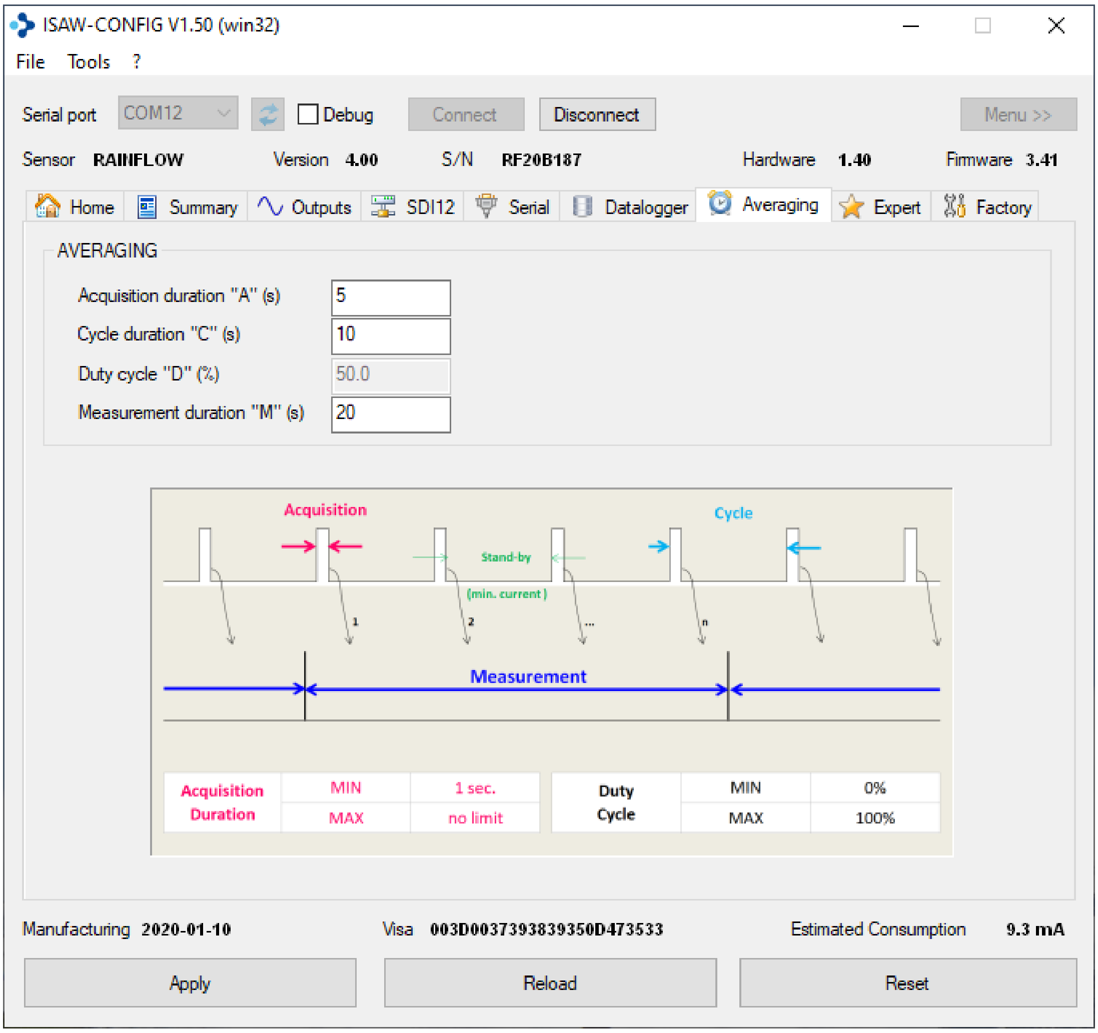
The datalogger capacity indicates the estimated number of measurements and the duration of the measurement session based on the measurement duration.

WARNING: The datalogger must be erased after changing the configuration fields (see p. 35).

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 sensor is effectively active),
- Measurement duration or also called the *averaging duration* (the reading or writing data interval you want).



For example, with the above default settings, the sensor will behave as follows:

- Measure the physical phenomena for a duration of 6 seconds every 60 seconds; thus, a stand-by duration of 54 seconds every minute, or in other words, a duty cycle of 10%.
- Provide the measurement result (i.e., the output data, digital or analog), every 10 minutes.

This way, your sensor, with an average total power consumption of 2.1 mA, every 10 minutes, will internally produce a data result that is the average, the min. and the max. values of 10 measurements of 6 seconds duration each (one measurement every minute) and deliver this result to your reading peripheral according to the output settings that have been enabled in the output panel.

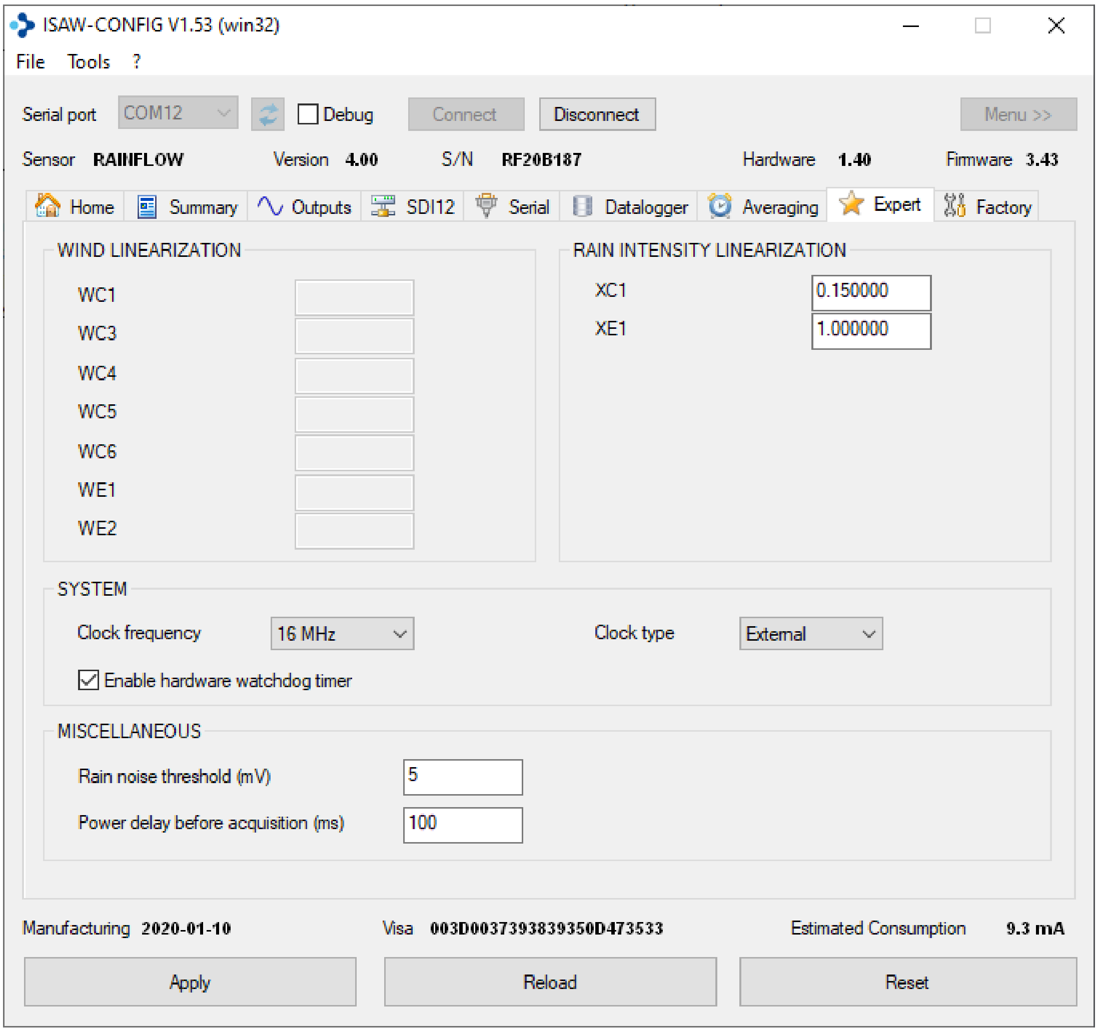
For advanced functions like hail detection (RF4, HF4) or disdrometry (RF4), it is recommended to set a duty-cycle of more than 50% (typically A = 5 s, C = 10 s and M = 600 s), so that a short duration event could not remain undetected or too much underestimated because of a too-long stand-by mode of the sensor.

Note: If you read the output data on the **analog reading connection** of the sensor (i.e. positive voltages or pulses on green and/or yellow wires), you will only get the average value. If you read the output data on a **serial mode of communication** of the sensor (serial and/or SDI-12 panels, respectively blue and grey/pink wires), you will be able to get average, min. and max. values.

Another important characteristic of the ISAW sensor is that the analog voltage outputs are persistent, so, for instance in the example cited above, if your reading device is programmed to read a voltage value every ten minutes, you will always get a new result whatever the synchronization between the reading and the ISAW sensor.

Expert panel

The Expert panel setting, reserved for scientific users, or customized use of the sensors, allows you to set advanced linearization parameters, i.e. changing the internal calculation mode of the sensor.



For example, you can turn the sensor into pass-through mode, change the internal noise threshold (see "Hail noise threshold" in Appendix C) or implement different coefficients to the internal calculation functions of the sensor.

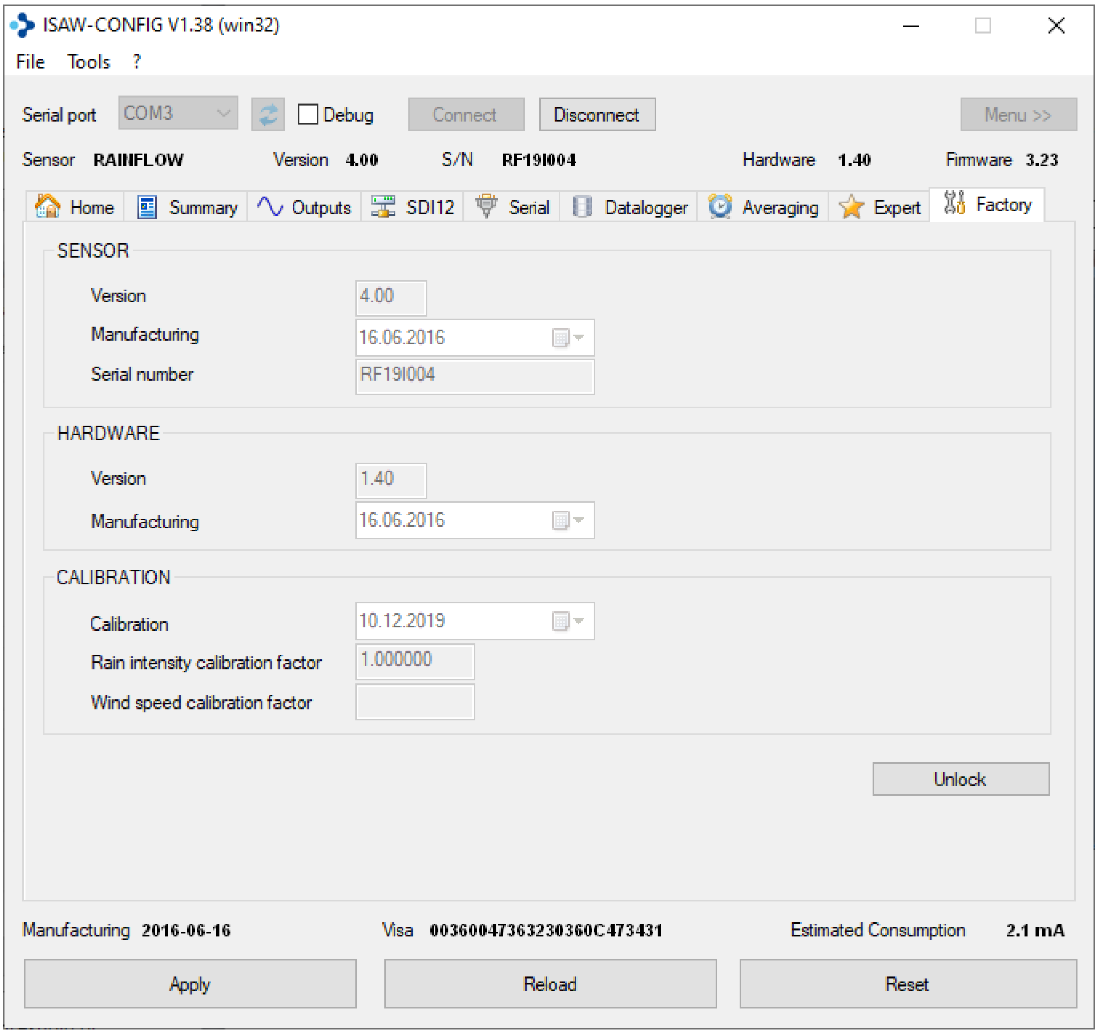
The [Reset] button allows you to always return to the default factory settings.

WARNING: Changing these parameters is not recommended.

Factory panel

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

Note: Only the manufacturer or the integrator can modify these parameters.



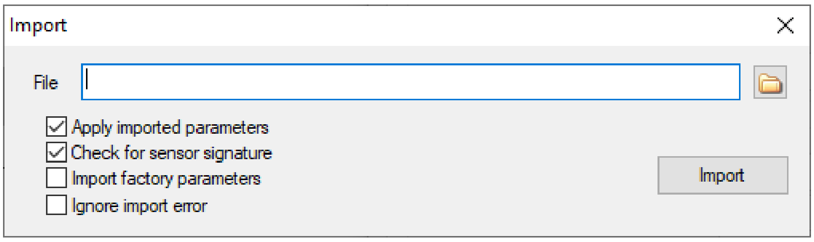
In case of failure of your sensor or when contacting support, it is recommended to keep a copy of this information at hand to facilitate the identification of your sensor.

Import configuration

This function allows you to reload in the Configuration utility a previously exported configuration of a sensor (*.isawcfg file).

1. Open the Import window:

In the Configuration utility, select the "File > Import Configuration" menu. The Import window is displayed.



2. Select the file to import:

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.

3. 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 sensor when the import is completed.
Check for sensor signature	Check if the imported file has been exported from the same sensor (check the sensor'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.

4. Start the import

Start the import 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 sensor.

Export configuration

The export function operates in the same way, it allows saving the current sensor configuration in a file.

1. **Open the Export window:**

In the Configuration utility, select the "File > Export Configuration" menu. The Export window is displayed.

2. **Enter the name of the export file**

The default file name is the sensor's serial number with an .isawcfg extension.

3. **Start the export**

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

Change a parameter in terminal mode

You can also configure your sensor using serial communication in terminal mode.

1. Open the ISAW-Toolbox

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

2. Start the Terminal utility

Start the Terminal utility by clicking on the corresponding item.

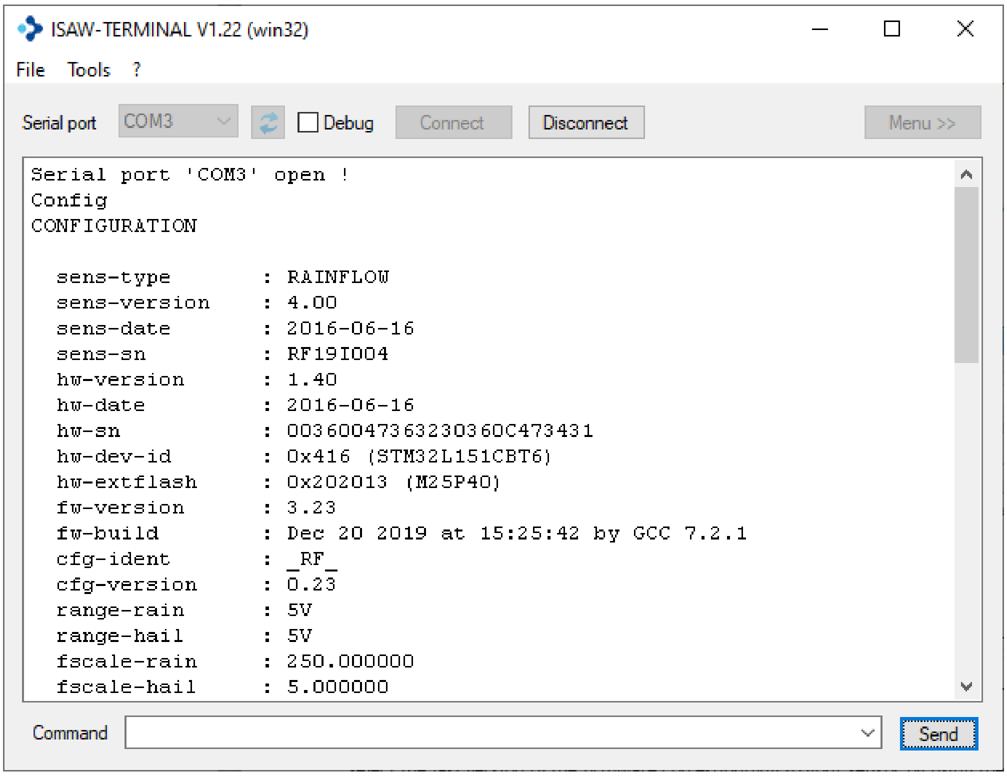
3. Connect the sensor

See p. 14.

4. Optional: 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[1].



5. 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

---

1 All parameters are detailed in Appendix A.

Update the sensor's firmware

IAV Technologies constantly improves its products and provides upgrades of the ISAW firmware for the FlowCapt FC4, SandFlow SF4, RainFlow RF4, HailFlow HF4 and WindFlow WF4 sensors.

This chapter describes the procedure for quickly upgrading the ISAW firmware.

Prerequisites:

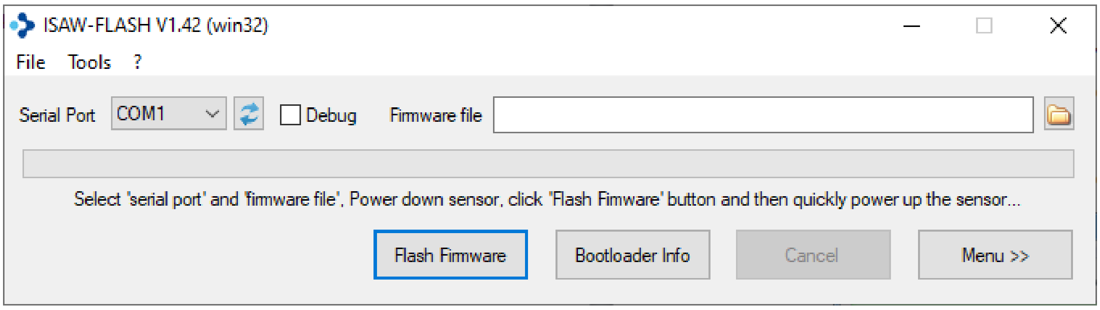
- The ISAW-Toolbox is installed (see p. 12).
- The last versions of the sensors firmwares are installed (use the Update facility to check).
- The sensor is plugged in (see p. 12).

1. Open the ISAW-Toolbox

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

2. Start the Flash utility

Start the Flash utility by clicking on the corresponding item.



3. Select the USB dongle serial port:

Click on the dropdown list to select the right serial port.

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

4. Select the firmware file:

Select the last version of the firmware corresponding to your sensor by using the button:

Sensor	Firmware file
FlowCapt FC4	ISAW-FlowCapt-x.xx.bin
SandFlow SF4	ISAW-SandFlow-x.xx.bin
RainFlow RF4	ISAW-RainFlow-x.xx.bin
HailFlow HF4	ISAW-HailFlow-x.xx.bin
WindFlow WF4	ISAW-WindFlow-x.xx.bin

where x.xx is the version number.

WARNING: Be sure you select the right firmware for your sensor!

5. Shut down the sensor power supply:

Set the USB dongle's power switch to OFF.

6. Press the [Flash Firmware] button.

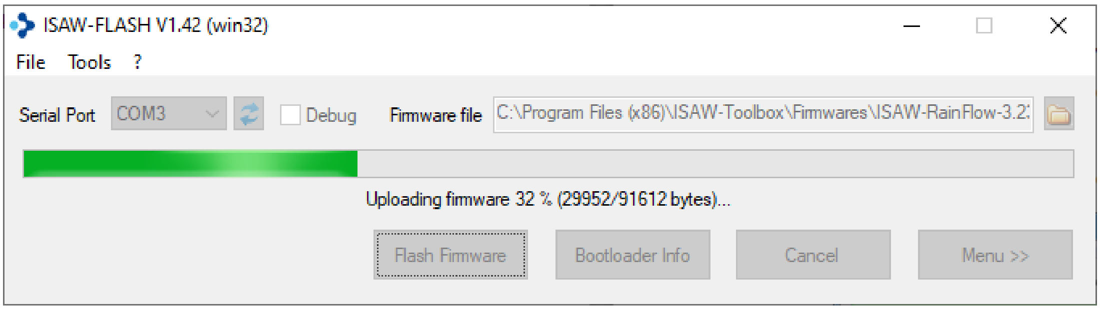
7. Power-on the sensor:

Switch the USB dongle's power back to "ON".

At this stage, ISAW-Flash will automatically search for a powered sensor during ten seconds.

8. Wait during the firmware upload.

As soon as ISAW-Flash has found the powered sensor, the firmware upload starts automatically.



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

When the firmware upload is successfully completed, ISAW-Flash will display a confirmation message.

9. The sensor is now ready to use.

The sensor'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 Appendix A).

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

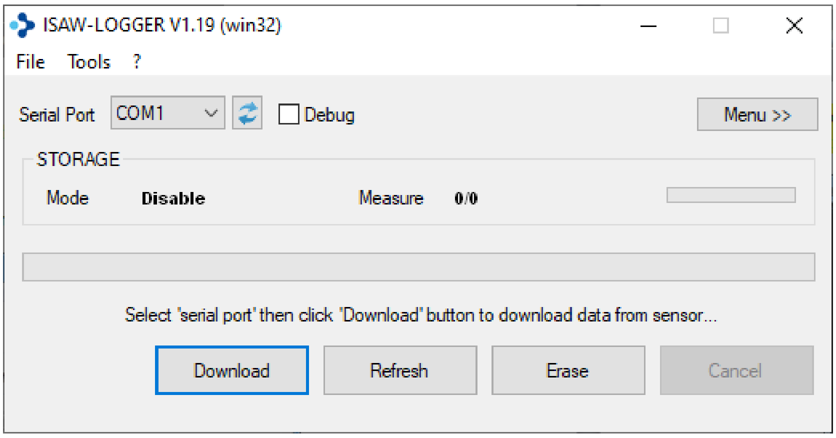
Download data from the datalogger

1. Open the ISAW-Toolbox

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

2. Start the Datalogger utility

Start the Datalogger utility by clicking on the corresponding item.



3. Select the USB dongle serial port:

Click on the dropdown list to select the right serial port.

The STORAGE section shows the datalogger's current status:

Mode: Disabled, Enabled or Cyclic

Measure: Number of recorded measurements / Total number of recordable measurements

The gauge shows the datalogger's memory status.

Use the [Refresh] button to update the STORAGE information.

4. Start the download:

Click on the [Download] button, enter the name of the destination .CSV file, then click on the [Save] button to complete the download.

5. Optional: clear the datalogger's memory

To delete all logged data from the datalogger, use the [Erase] button.

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

Appendix A: Operating parameters

The screen below lists all the firmware’s parameters. You can get this list in terminal mode by using the "get" or "set" command without argument. All parameters are described on the next pages.

COM12 - PuTTY

```
  get <parameter>

PARAMETERS

  sens-type        ro   :  Sensor type
  sens-version     rw*  :  Sensor version
  sens-date        rw*  :  Sensor manufacturing date
  sens-sn          rw*  :  Sensor serial number
  hw-version       rw*  :  Hardware version
  hw-date          rw*  :  Hardware manufacturing date
  hw-sn            ro   :  Hardware serial number
  hw-dev-id        ro   :  Hardware device identifier
  hw-extflash      ro   :  Hardware flash identifier
  fw-version       ro   :  Firmware version
  fw-build         ro   :  Firmware build info
  cfg-ident        ro   :  Config identifier
  cfg-version      ro   :  Config version
  range-rain       rw   :  Rain range (2V5|5V)
  range-hail       rw   :  Hail range (2V5|5V)
  fscale-rain      ro   :  Rain fullscale (mm/h)
  fscale-hail      ro   :  Hailstones count fullscale (hit/s)
  thld-rain        rw   :  Rain noise threshold (mV)
  out1-mode        rw   :  OUT1 mode (off|rain|pulse|hail)
  out2-mode        rw   :  OUT2 mode (off|rain|pulse|hail|raw)
  sdi12-mode       rw   :  SDI12 mode (off|rain)
  sdi12-addr       rw   :  SDI12 address
  serial-mode      rw   :  SERIAL mode (off|rain)
  logger-mode      rw   :  Data logger mode (off|on|cyclic)
  logger-cfg       rw   :  Data logger field config
  logger-usage     ro   :  Logger record count usage
  logger-capa      ro   :  Logger record count capacity
  avg-a            rw   :  Acquisition duration (s)
  avg-c            rw   :  Cycle duration (s)
  avg-m            rw   :  Measurement duration (s)
  pulse-thld       rw   :  Pulse threshold (mm)
  pulse-to         rw   :  Pulse integrator timeout (s)
  pulse-ms         rw   :  Pulse duration (ms)
  pulse-lvl        rw   :  Pulse level (2V5|5V)
  lin-xcl          rw   :  Rain coeff XCl
  lin-xel          rw   :  Rain exponent XEl
  calib-date       rw*  :  Calibration date
  calib-rain       rw*  :  Rain calibration factor
  cons-idle        rw   :  Console idle timeout (s)
  sys-clk          rw   :  System clock type (internal|external)
  sys-speed        rw   :  System clock speed (4MHz|8MHz|16MHz|32MHz)
  sys-uptime       ro   :  Sensor uptime (s)
  sys-status       ro   :  System status
  sys-watchdog     rw   :  Watchdog status (off|on)
  sys-reboot       ro   :  System reboot mode
  misc-pwrdly      rw   :  Power delay before acquisition (ms)
  misc-dbg         ro   :  Debug status field
  misc-admin       ro   :  Administrator status
  misc-scopemode   ro   :  Non persistent scope mode
```

ro: read-only – rw: read/write – rw*: read/admin-write

Parameter	Description	Type	Access[2]	Values / Format	Examples
sens-type	Sensor's type	string	ro	FLOWCAPT FLOWCAPT sensor SANDFLOW SANDFLOW sensor RAINFLOW RAINFLOW sensor HAILFLOW HAILFLOW sensor WINDFLOW WINDFLOW sensor	FLOWCAPT
sens-version	Model version of the sensor	version	rw*	<major>.<minor> where major and minor cannot exceed 255	4.0
sens-date	Date of manufacturing/assembly of the full sensor	date	rw*	YYYY-MM-DD YYYY: Year, MM: Month, DD: Day	2015-12-22
sens-sn	Sensor's serial number (matches sensor's body engraving)	string	rw*	FCxxxxxxx FLOWCAPT serial number SFxxxxxxx SANDFLOW serial number RFxxxxxxx RAINFLOW serial number HFxxxxxxx HAILFLOW serial number WFxxxxxx WINDFLOW serial number	FC15A04
hw-version	Version of electronic hardware	version	rw*	<major>.<minor> where major and minor cannot exceed 255	1.4
hw-date	Date of electronic hardware manufacturing/assembly	date	rw*	YYYY-MM-DD YYYY: Year, MM: Month, DD: Day	2015-12-22
hw-sn	Electronic hardware's serial number	string	ro	xxxxxxxxxxxxxxxxxxxxxxxx	002E0040363230360C473431
fw-version	Version of current firmware	version	ro	<major>.<minor> where major and minor cannot exceed 99	2.90
hw-extflash	Internal Flash memory identifier	string	ro	0xxxxxxx(<model>) (0x000000 if no Flash memory is soldered to the sensor's electronic board)	0x202013 (M25P40)
fw-build	Compilation information of current firmware	string	ro	Not specified	Dec 21 2015 at 21:08:34 by GCC 4.8.3
cfg-ident	Eeprom configuration map identifier	string	ro	_FC_ FLOWCAPT eeprom identifier _SF_ SANDFLOW eeprom identifier _RF_ RAINFLOW eeprom identifier _HF_ HAILFLOW eeprom identifier _WF_ WINDFLOW eeprom identifier	_FC_
cfg-version	Eeprom configuration map version	version	ro	<major>.<minor> where major and minor cannot exceed 255	0.21
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 (default)

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

Parameter	Description	Type	Access[2]	Values / Format	Examples
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 (default)
range-rain	OUT1 and/or OUT2 range for full-scale rain intensity	string	rw	2V5 2.5 volts for 250 mm/h full-scale 5V 5 volts for 250 mm/h full-scale	5V (default)
range-hail	OUT1 and/or OUT2 range for full-scale hail intensity	string	rw	2V5 2.5 volts for 5 hit/s (RF4) or 25 hit/s (HF4) full-scale 5V 5 volts for 5 hit/s (RF4) or 25 hit/s (HF4) full-scale	5V (default)
fscale-wind	OUT1 and/or OUT2 full scale wind, km/h	string	ro	250	
fscale-flux	OUT1 and/or OUT2 full scale particle flux, g/m^2/s	string	ro	250	
fscale-rain	OUT1 and/or OUT2 full-scale rain intensity, mm/h	string	ro	250	
fscale-hail	OUT1 and/or OUT2 full-scale hail intensity, hit/s	string	ro	5 or 25	
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) rain Rain intensity (Persistent, 0 to full-scale) hail Hail intensity (Persistent, 0 to full-scale) pulse Particle flux (Pulse, 0 or full-scale)	FC4, SF4: flux (default) RF4: rain (default) HF4: hail (default) WF4: wind (default)
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) rain Rain intensity (Persistent, o to full-scale) hail Hail intensity (Persistent, 0 to full-scale) pulse Particle flux (Pulse, 0 or full-scale) raw Raw analog AC signal	FC4, SF4: flux (default) RF4, HF4, WF4: Disabled (default)
sdi12-mode	SDI-12 mode (blue wire)	string	rw	off Disabled wind Wind speed only flux Particle flux only rain Rain intensity, disdrometry, hail hail Hailstone count and hailstone disdrometry all Wind speed and particle flux or rain or hail	FC4, SF4: all (default) RF4: rain (default) HF4: hail (default) WF4: wind (default)
sdi12-addr	SDI-12 address	string	rw	ASCII character (standard SDI-12 characters are 0 to 9)	0 (default)

Parameter	Description	Type	Access[2]	Values / Format	Examples
serial-mode	Serial mode (pink wire)	string	rw	off Disabled wind Wind speed only flux Particle flux only rain Rain intensity, disdrometry, hail hail Hailstone count and hailstone disdrometry all Wind speed and particle flux	FC4, SF4: all (default) RF4: rain (default) HF4: hail (default) WF4: wind (default)
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.	off (default)
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/rain/hail Bit 14: reserved Bit 6: avg flux/ rain/hail Bit 13: reserved Bit 5: max. flux/ rain/hail Bit 12: drop/hailstone classes Bit 4: std flux/ rain/hail Bit 11: drop/hailstone count Bit 3: cum. flux/rain Bit 10: max rate (RF) Bit 2: min. wind Bit 9: mean rate (RF) Bit 1: avg wind Bit 8: hailstone count (RF) Bit 0: max. wind	FC4, SF4: 0x00FF (default) RF4: 0x1F1F (default) HF4: 0x181F (default) WF4: 0x00E0 (default)
logger-usage	Datalogger record count usage	integer	ro	Number of recorded measurements.	0 (default)
logger-capa	Datalogger record count capacity	integer	ro	Maximum number of recordable measurements. Depends on the number of fields selected in logger-cfg.	0 (default)
avg-a	Acquisition duration (s)	integer	rw	Must be > 0 (see Averaging duration rules below)	6 (default)
avg-c	Cycle duration (s)	integer	rw	Must be >= avg-a and avg-m/avg-c is integer (see Averaging duration rules below)	FC4, SF4, RF4, WF4: 60 (default) HF4: 6(default)
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 (default)
pulse-thld	OUT1/OUT2 flux pulse threshold (FC4/SF4: g/m^2; RF4: mm; HF4: hit)	float	rw	RF4: Must be > 500.0 FC4/SF4/HF4: No limit	FC4, SF4: 10000.0 (default) RF4: 0.1 (default) HF4: 10 (default)
pulse-to	OUT1/OUT2 flux pulse reset timeout (s)	integer	rw	Must be > avg-m	3600 (default)
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 (default)

Parameter	Description	Type	Access[2]	Values / Format	Examples
lin-wc1	Wind linearization coefficient WC1	float	rw	Default factory setting	
lin-wc3	Wind linearization coefficient WC3	float	rw	Default factory setting	
lin-wc4	Wind linearization coefficient WC4	float	rw	Default factory setting	
lin-wc5	Wind linearization coefficient WC5	float	rw	Default factory setting	
lin-wc6	Wind linearization coefficient WC6	float	rw	Default factory setting	
lin-we1	Wind linearization exponent WE1	float	rw	Default factory setting	
lin-we2	Wind linearization exponent WE2	float	rw	Default factory setting	
lin-xc1	Particle flux and precipitation intensity linearization coefficient XC1	float	rw	Default factory setting	
lin-xe1	Particle flux and precipitation intensity linearization exponent XE1	float	rw	Default factory setting	
calib-date	Date of sensor calibration	date	rw*	YYYY-MM-DD YYYY: Year, MM: Month, DD: Day	2017-02-23
calib-wind	Wind calibration factor	float	rw*	Must be > 0	1.0 (default)
calib-flux	Particle flux calibration factor	float	rw*	Must be > 0	1.0 (default)
calib-rain	Rain intensity calibration factor	float	rw*	Must be > 0	1.0 (default)
calib-hail	Hailstone count calibration factor	float	rw*	Must be > 0	1.0 (default)
cons-idle[3]	Timeout of console to return in idle mode	integer	rw	Seconds	10 (default)
sys-clk	System clock (It's not recommended to change this parameter)	string	rw	internal Use internal clock external Use external clock	external (default)
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 (default)
sys-uptime	Time elapsed since power on	integer	ro	Seconds	3426
sys-status	System status	string	ro	OK No error ADC-OVERRUN ADC Error	OK
sys-watchdog[4]	Hardware watchdog timer status	string	rw	on Watchdog is enabled off Watchdog is disabled	on (default)

[3] 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).

[4] 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.

Parameter	Description	Type	Access[2]	Values / Format	Examples
sys-reboot	Last system reboot type	string	ro	user Sensor has been rebooted manually by the user (power or software) watchdog Sensor 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 (default)
misc-debug	Debug bit-field status	Integer	ro	See "debug" command (Appendix B).	0x0000 (default)
misc-admin[5]	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 (default)

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` <= `avg-c` <= `avg-m`
`avg-m` / `avg-c` is an integer

The rules are checked each time a parameter is changed. 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.

5 You can change the admin status using the “admin” command. Admin status is automatically reset to default ("no") after reboot.

Appendix B: RF4 Disdrometry - Drop size classes

The disdrometry function (DSD) provides a statistic value result, defined as a distribution expressing the percentage of drops situated in as many drop-size classes, according to the following classification table.

The sensor's classification table for drop-size includes 27 classes of equal intervals. The upper marker of the smallest class is a diameter of 0.75 mm and the lower marker of the biggest class is a diameter of 7 mm. The upper and lower markers typically correspond to the thresholds of respectively the detection and saturation of the sensor, with a certain margin of operation (drops with a diameter under 0.75 mm and over 7 mm can still be detected).

Class #	Class Label	Drop Diameter D (mm)
1	0.75	D < 0.75
2	1.00	0.75 ≤ D < 1.00
3	1.25	1.00 ≤ D < 1.25
4	1.50	1.25 ≤ D < 1.50
5	1.75	1.50 ≤ D < 1.75
6	0.75	1.75 ≤ D < 2.00
7	1.00	2.00 ≤ D < 2.25
8	1.25	2.25 ≤ D < 2.50
9	1.50	2.50 ≤ D < 2.75
10	1.75	2.75 ≤ D < 3.00
11	0.75	3.00 ≤ D < 3.25
12	1.00	3.25 ≤ D < 3.50
13	1.25	3.50 ≤ D < 3.75
14	1.50	3.75 ≤ D < 4.00
15	1.75	4.00 ≤ D < 4.25
16	0.75	4.25 ≤ D < 4.50
17	1.00	4.50 ≤ D < 4.75
18	1.25	4.75 ≤ D < 5.00
19	1.50	5.00 ≤ D < 5.25
20	1.75	5.25 ≤ D < 5.50
21	0.75	5.50 ≤ D < 5.75
22	1.00	5.75 ≤ D < 6.00
23	1.25	6.00 ≤ D < 6.25
24	1.50	6.25 ≤ D < 6.50
25	6.75	6.50 ≤ D < 6.75
26	7.00	6.75 ≤ D < 7.00
27	99	D ≥ 7.00

The class 99 indicates a possible saturation of the instrument which means possible drops (respect. hailstones) with a diameter greater than 7 mm.

Appendix C: HF4 Disdrometry

- Hailstone size classes
- Setting the hail noise threshold to remove false positives

Hailstone size classes

The HF4 sensor is set to distinguish between **15 classes of hailstone diameter**, ranging from 0.5 to 8 cm (see table below), with a capability of counting up to 25 solid impacts per second. This function, that is comparable to the so-called disdrometry (DSD) function for rain, provides a statistic value result, defined as a distribution expressing the percentage of hailstones situated in as many drop-size classes, according to a classification table (see opposite).

The sensor's classification table for hailstone-size includes 15 classes of equal intervals. The lower marker of the smallest class is a diameter of 0.5 cm and the upper marker of the biggest class is a diameter of 7.5 cm. The upper and lower markers typically correspond of the thresholds of respectively the detection and saturation of the sensor, with a margin of operation (hailstones with a diameter of less than 0.5 cm and more than 80 mm may still be detected).

Class #	Class Label	Hailstone Diameter D (mm)*
1	10.0	5.0 ≤ D < 10.0
2	15.0	10.0 ≤ D < 15.0
3	20.0	15.0 ≤ D < 20.0
4	25.0	20.0 ≤ D < 25.0
5	30.0	25.0 ≤ D < 30.0
6	35.0	30.0 ≤ D < 35.0
7	40.0	35.0 ≤ D < 40.0
8	45.0	40.0 ≤ D < 45.0
9	50.0	45.0 ≤ D < 50.0
10	55.0	50.0 ≤ D < 55.0
11	60.0	55.0 ≤ D < 60.0
12	65.0	60.0 ≤ D < 65.0
13	70.0	65.0 ≤ D < 70.0
14	75.0	70.0 ≤ D < 75.0
15	99	D ≥ 75.0

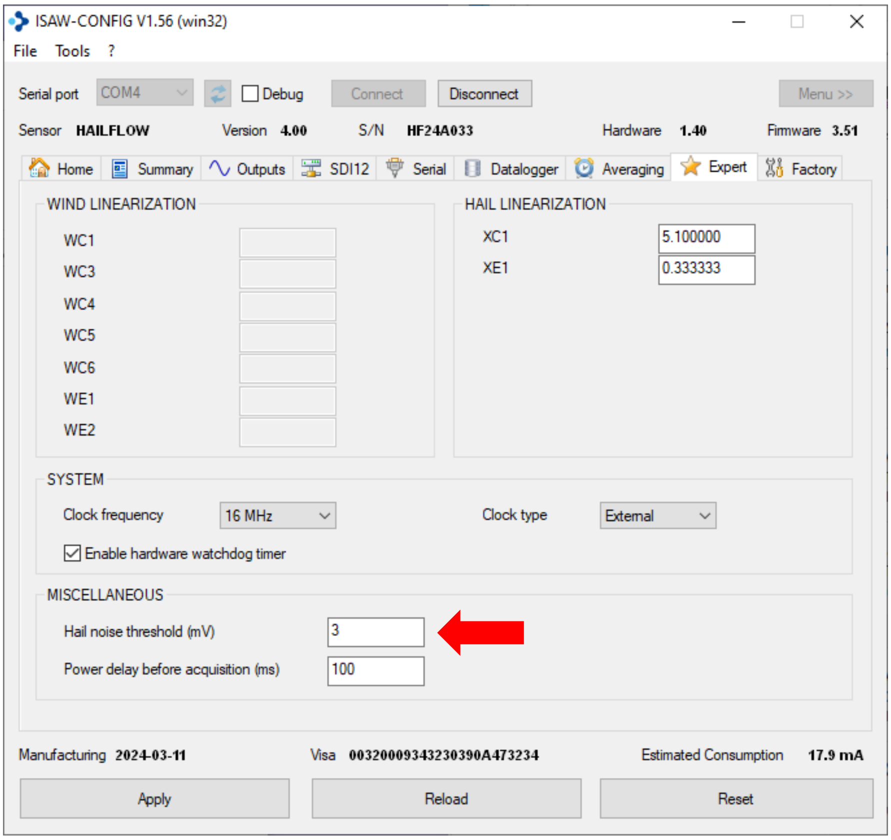
The class 99 indicates a possible saturation of the instrument which means possible hailstones with a diameter greater than 7.5 cm.

For the HailFlow HF4, the lower detection threshold has been set to a nominal fixed size limit of 5 mm hailstone diameter, because unless there are very special conditions, smaller hailstones cannot be distinguished from the electronic self-noise of the sensor.

Setting the hail noise threshold to remove false positives

In some use cases, the sensor may detect **false positives** in the smallest size classes, i.e. the data contains hits when no hail has occurred.

The factory default value of the detection threshold of the sensor (Hail noise threshold = 3 mV) must then be increased to a higher voltage value, in order to eliminate these "false detections". This is done on the “Expert panel” of the Configuration utility:

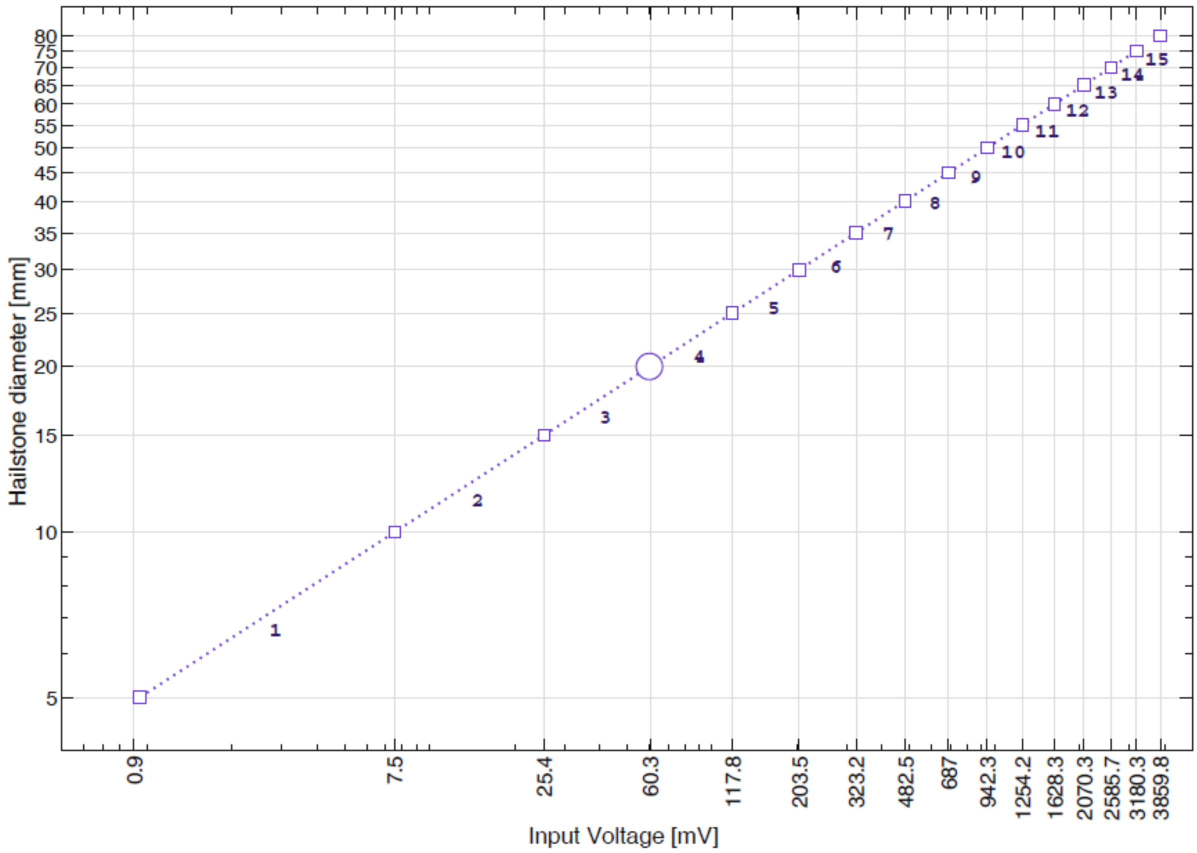


In most cases where false detections occur, they are parasitic shocks between the sensor and the structure to which it is attached, such as the knocking of a cable in the presence of wind, or grains carried by the wind, or, for example, a bird resting on the sensor.

In a general manner, the higher the possible parasitic events, the higher the detection threshold shall be set. The higher the detection threshold is set, the better the rejection of the false hail events, but with the consequence of ignoring the lowest classes of hailstone diameter.

Note: This is NOT a change of scale (which would affect the sensitivity and calibration of the sensor) but simply a low-limit threshold, i.e. a “set to zero” of all the impact voltages that are below the threshold, to “ignore” the concerned events.

The following graph shows the relationship between this voltage setting (X-axis), the corresponding theoretical diameter of the hailstone (Y-axis), and the corresponding class numbers from 1 to 15.



For example, as per the above chart, setting the **Hail noise threshold** to **7.5 mV** would automatically remove all the parasitic events that could be mistaken for an occurrence of class 1 hailstones.

A recommended field approach would be to first put the sensor in the field with the factory default setting of 3 mV, to get the maximum extension to the low limit of the scale, and then, after having analyzed the data, and if necessary, increase the threshold value in order to eliminate what has been observed as "noise".

If the sensor is already installed on a **distant location**, it may be easier to modify the threshold remotely by using the **SDI-12 extended command `aXS…!` on the parameter `thld-hail`** (see Appendix E, page 58):

- To read the value of the `thld-hail` parameter (here: 3), use the "Get" command `aXG…!`:
  `> 1XGthld-hail!`
  `< OK3`

- To change the value of the `thld-hail` parameter to 7.5, use the "Set" command `aXS…!`:
  `> 1XSthld-hail=7.5!`
  `< OK`

- Do not forget to **reboot the sensor** after changing the sensor configuration:
  `> 1XR!`
  `< OK`

Appendix D: Serial communication

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

- Connect in terminal or console mode
- Console commands
- Error messages
- Serial measurement frame

Connect in terminal or console mode

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

Prerequisite: The sensor is plugged (see p. 12).

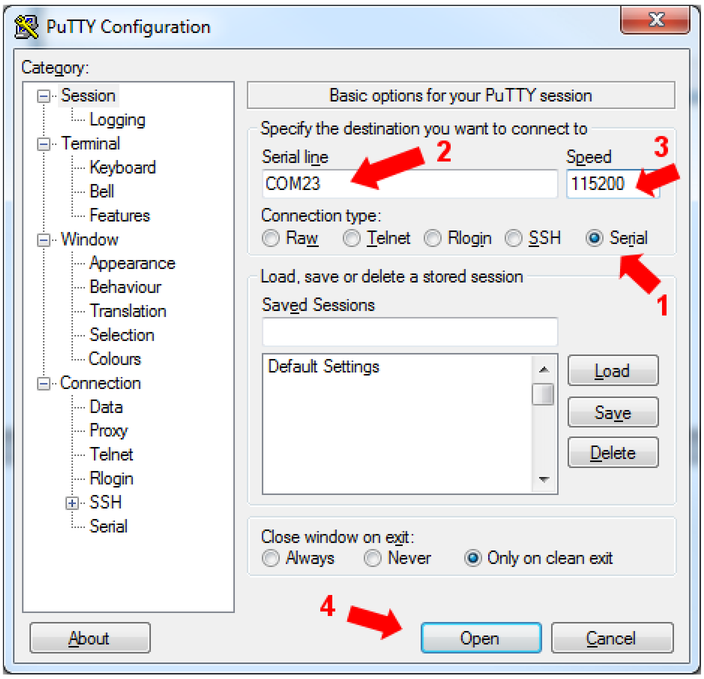
WARNING: Do not connect the sensor directly to a non-TTL serial port like standard RS232 (DB9 connector). You must use a 3.3V serial adapter; otherwise, you may cause permanent damage to the sensor!

---

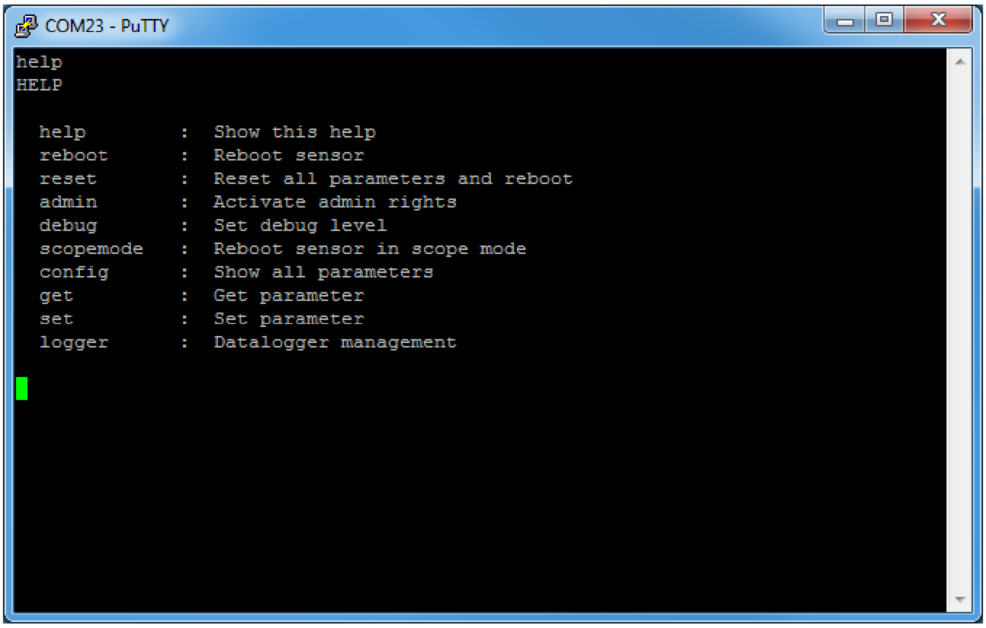
1. Connect your Terminal software

Open your favourite 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:



2. Execute ISAW command

Once connected, you can enter any command.

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 sensor configuration you need to reboot the sensor by using the "reboot" command.
`reset confirm`	Recovers the default factory configuration and reboots the sensor. All parameters are reinitialized, except the following ones (internal factory parameters): sens-type hw-version fw-build cfg-ident calib-flux sens-version hw-date cfg-version sys-uptime sens-date hw-sn calib-date sys-status sens-sn fw-version calib-wind misc-dbg
`config`	Displays the sensor 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.
`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 are listed in Appendix A. **Note:** Remember you need to reboot the sensor after changing the sensor configuration. Example: `set sdi12-addr 7` `OK`
`logger <command>`	Control the datalogger: `<command>` can be: `download` Dowload the data. `clear` Delete all logged data.

Command	Result / Description
logger <field> <on|off>	Activates/deactivates the logging of a value: <field> can be: For FlowCapt or SandFlow: `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) For RainFlow: `rain_min` Minimum rain intensity (mm/h) `rain_avg` Average rain intensity (mm/h) `rain_max` Maximum rain intensity (mm/h) `rain_std` Rain intensity standard deviation (mm/h) `rain_cum` Cumulative rain (mm) `drop_hit` Number of drops (hit) `drop_size` Percentage of drops within the class (%) `hail_hit` Number of hailstones (hit) `hail_mean` Mean rate (hit/s) `hail_max` Max rate (hit/s) For HailFlow: `hail_min` Minimu hailstone count (hit/s) `hail_avg` Average hailstone count (hit/s) `hail_max` Maximum hailstone count (hit/s) `hail_std` Standard hailstone count deviation (hit/s) `hail_cum` Cumulative hailstone count (hit) `hailstone_hit` Number of hailstones (hit) `hailstone_size` Percentage of hailstones within the class (%) For WindFlow: `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 (see p. 35). Example: `logger win_min off`

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.

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 (FC4/SF4)**

  `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/m^2/s”
  `<min>` is the minimum of the flux measurement [g/m^2/s]
  `<avg>` is the average of the flux measurement [g/m^2/s]
  `<max>` is the maximum of the flux measurement [g/m^2/s]
  `<std>` is the standard deviation of the flux measurement [g/m^2/s]
  `<unit>` is the unit of the following value in the frame: “g/m^2”
  `<sum>` is the cumulative flux [g/m^2]

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

- **WIND (FC4/SF4/WF4)**

  `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`

- **RAIN (RF4)**

  `RAIN;<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: “mm/h”
  `<min>` is the minimum of the rain measurement [mm/h]
  `<avg>` is the average of the rain measurement [mm/h]
  `<max>` is the maximum of the rain measurement [mm/h]
  `<std>` is the standard deviation of the rain measurement [mm/h]
  `<unit>` is the unit of the following value in the frame: “mm”
  `<sum>` is the cumulative rain [mm]

  Example: `RAIN;499;mm/h;32.11;34.27;38.93;6.42;mm;64.74`

- **DROP (RF4)**

`DROP;<counter>;<unit>;<hit_count>;<unit>;<unit>;<class>;<distrib>;<class>;<distrib>;<class>;<distrib>;…;<class>;<distrib>`

`<counter>`	is a frame counter incremented at each result
`<unit>`	is the unit of the following values in the frame: “hit”
`<hit_count>`	is the number of drops [hit]
`<unit>;<unit>`	are the units of the following pairs of values in the frame: “mm;%”
`<class>`	is the fixed drop size class in millimetres [mm] (see table in Appendix B)
`<distrib>`	is the percentage of drops within the class [%]

Example: `DROP;1;hit;0;mm;%;0.75;0;1.00;0;1.25;0;1.50;0;1.75;0;2.00;0;2.25;0;2.50;0;2.75;0;3.00;0;3.25;0;3.50;0;3.75;0;4.00;0;4.25;0;4.50;0;4.75;0;5.00;0;5.25;0;5.50;0;5.75;0;6.00;0;6.25;0;6.50;0;6.75;0;7.00;0;99.00;0`

- **HAIL (RF4)**

`HAIL;<counter>;<unit>;<hit_count>;<unit>;<mean_rate>;<max_rate>`

`<counter>`	is a frame counter incremented at each result
`<unit>`	is the unit the of following value in the frame: “hit”
`<hit_count>`	is the number of hailstones [hit]
`<unit>`	is the unit the of following values in the frame:” hit/s”
`<mean_rate>`	is the mean rate during measurement [hit/s]
`<max_rate>`	is the max rate [hit/s]

Example: `HAIL;685;hit;2865;hit/s;89.32;103.5`

- **HAIL (HF4)**

`HAIL;<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: “hit/s”
`<min>`	is the minimum of the hailstone count measurement [hit/s]
`<avg>`	is the average of the hailstone count measurement [hit/s]
`<max>`	is the maximum of the hailstone count measurement [hit/s]
`<std>`	is the standard deviation of the hailstone count measurement [hit/s]
`<unit>`	is the unit of the following value in the frame: “hit”
`<sum>`	is the cumulative hailstone count [hit]

Example: `HAIL;9388;hit/s;11.00;11.00;11.00;0.00;hit;20283.00`

- **HAILSTONE (HF4)**

`HAILSTONE;<counter>;<unit>;<hit_count>;<unit>;<unit>;<class>;<distrib>;<class>;<distrib>;<class>;<distrib>;…;<class>;<distrib>`

`<counter>`	is a frame counter incremented at each result
`<unit>`	is the unit of the following values in the frame: “hit”
`<hit_count>`	is the number of hailstones [hit]
`<unit>;<unit>`	are the units of the following pairs of values in the frame: “mm;%”
`<class>`	is the fixed hailstone size class in millimetres [mm] (see table in Appendix C)
`<distrib>`	is the percentage of hailstones within the class [%]

Example: `HAILSTONE;9322;hit;7;mm;%;10;0;15;0;20;0;25;0;30;0;35;14;40;14;45;29;50;29;55;14;60;0;65;0;70;0;75;0;99;0`

Appendix E: SDI-12 – Serial Data 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 standard commands
- SDI-12 extended commands

SDI-12 standard commands

Name	Command	Description/Response		
Acknowledge Active	a!			
Sensor Identification	aI!	13IAV-TECWINDFLO342 13IAV-TECFLOWCAP342 13IAV-TECRAINFLO342 13IAV-TECHAILFLO342 13IAV-TECSANDFLO342		
Change Address	aAb!	***No need to reboot sensor***		
Address query	?!			
Start Measurement	aM!	***Always reset measure***		
		sdi12-mode=wind	a0003	
		sdi12-mode=flux(1)	a0005	
		sdi12-mode=rain(2)	a0008	
		sdi12-mode=hail(3)	a0005	
		sdi12-mode=all	a0008	
Start Measurement and request CRC	aMC!	***Always reset measure***		
		sdi12-mode=wind	a0003	
		sdi12-mode=flux(1)	a0005	
		sdi12-mode=rain(2)	a0008	
		sdi12-mode=hail(3)	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(1)	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=rain(2)	aD0!	Min. rain intensity (mm/h)
			aD1!	Avg rain intensity (mm/h)
			aD2!	Max. rain intensity (mm/h)
			aD3!	Std rain intensity (mm/h)
			aD4!	Cumulative rain (mm)
			aD5!	Hail hit count (hit)
			aD6!	Hail mean rate (hit/s)
			aD7!	Hail max rate (hit/s)
		sdi12-mode=hail(3)	aD0!	Min. hailstone count (hit/s)
			aD1!	Avg hailstone count (hit/s)
			aD2!	Max. hailstone count (hit/s)
			aD3!	Std hailstone count (hit/s)
			aD4!	Cumulative hailstone count (hit)
		sdi12-mode=all(1)	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)

Name	Command	Description/Response		
Additional Measurements	aM1! … aM9!	***No additional measurement*** a0000		
Additional Measurements and request CRC	aMC1! … aMC9!	***No additional measurement*** a0000		
Start Verification	aV!	No verification a0000		
Start Concurrent Measurement	aC!	*Always reset measure*		
		sdi12-mode=wind	a0003	
		sdi12-mode=flux(1)	a0005	
		sdi12-mode=rain(2)	a0008	
		sdi12-mode=hail(3)	a0005	
		sdi12-mode=all	a0008	
Start Concurrent Measurement and request CRC	aCC!	*Always reset measure*		
		sdi12-mode=wind	a0003	
		sdi12-mode=flux(1)	a0005	
		sdi12-mode=rain(2)	a0008	
		sdi12-mode=hail(3)	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		
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(1)	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=rain(2)	aR0!	Min. rain intensity (mm/h)
			aR1!	Avg rain intensity (mm/h)
			aR2!	Max. rain intensity (mm/h)
			aR3!	Std rain intensity (mm/h)
			aR4!	Cumulative rain (mm)
			aR5!	Hail hit count (hit)
			aR6!	Hail mean rate (hit/s)
			aR7!	Hail max rate (hit/s)

Name	Command	Description/Response		
Continuous Measurements	aR0! … aR9! aRC0! … aRC9!	sdi12-mode=hail(3)	aR0!	Min. hailstone count (hit/s)
			aR1!	Avg hailstone count (hit/s)
			aR2!	Max. hailstone count (hit/s)
			aR3!	Std hailstone count (hit/s)
			aR4!	Cumulative hailstone count (hit)
		sdi12-mode=all(1)	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)

(1) FlowCapt and SandFlow only
(2) RainFlow only
(3) HailFlow only

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.

SDI-12 extended commands

ISAW firmware can handle an extended SDI-12 command that allows sensor 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    : Sensor address
c    : Extended command identifier
ooo… : Optional argument
!    : Command terminator
```

For each SDI-12 extended command, the sensor 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	: Sensor address
vvvv…	: Value
mmmm…	: Error message (see p. 51)
<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 sensor 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 sensor 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 sensor after changing sensor configuration.

Name	Description	Command	Response
reboot (aXR!)	After changing the sensor configuration, you need to reboot the sensor by using this command.	aXR! a : Sensor address ! : Command terminator	aOK<CR><LF> aER=mmmm…<CR><LF> a : Sensor address mmmm… : Error message (see p. 51) <CR><LF> : Response terminator
reset (aXZ…!)	Use this command if you want to recover the default factory configuration and reboot the sensor. All parameters are reinitialized, except internal factory parameters.	aXZccccccc! a : Sensor address ccccccc : Reset confirmation "confirm" ! : Command terminator	aOK<CR><LF> aER=mmmm…<CR><LF> a : Sensor address mmmm… : Error message (see p. 51) <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 : Sensor address wwwwwwww : Admin password ! : Command terminator	aOK<CR><LF> aER=mmmm…<CR><LF> a : Sensor address mmmm… : Error message (see p. 51) <CR><LF> : Response terminator
get (aXG…!)	The get command allows getting a parameter value from configuration.	aXGpppppp…! a : Sensor address pppppp… : Parameter name (see Appendix A) ! : Command terminator	aOK=vvvv…<CR><LF> aER=mmmm…<CR><LF> a : Sensor address vvvv… : Parameter value (see Appendix A) <CR><LF> : Response terminator
set (aXS…!)	This command allows changing parameter values of the configuration.	aXSpppp…=vvvv…! a : Sensor address pppppp… : Parameter name (see Appendix A) vvvv… : Parameter value (see Appendix A) ! : Command terminator	aOK<CR><LF> aER=mmmm…<CR><LF> a : Sensor address mmmm… : Error message (see p. 51) <CR><LF> : Response terminator
disdrometer (aXD!)	This command allows getting disdrometer results (RF4 and HF4 sensors only, see note on next page).	aXD! a : Sensor address ! : Command terminator	aOK=vvvv…<CR><LF> aER=mmmm…<CR><LF> a : Sensor address vvvv… : Disdrometry value mmmm… : Error message (see p. 51) <CR><LF> : Response terminator

Note: Due to the limited size of an SDI12 frame, for the disdrometry functions of respectively the RF4 sensor (drop size classes, see Appendix B), and the HF4 sensor (hailstone size classes, see Appendix C), the class sizes do not appear in the response of the `aXD!` command (unlike for the serial command). Only the total number of drops (resp. hailstones) followed by the distribution of the 27 (resp. 15) counters is mentioned as follows:

`aOK=<hit_count>;<distrib>;<distrib>;<distrib>;….`

`<hit_count>`	is the number of drops (resp. hailstones) [hit]
`<distrib>`	is the percentage of drops (resp. hailstones) within the class [%]

SDI-12 Synchronous vs Asynchronous mode

Reminder about the sensor configuration:

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

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

The sensor 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 sensor resets all measurements: cumulative values and counters are reset to zero.

Datalogger – SDI-12 Interrogation:

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

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

Asynchronous mode: "aM!/aDx!"

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

Command:

aM! // Stores sensor 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 sensor parameter [M] is not taken into account.

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

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

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

If the data logger 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 logger 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 logger should be programmed to send a "retrieve" command every [M] interval to acquire all sensor 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 logger retrieves data more frequently than every [M] seconds, for example every 60 seconds, the sensor will respond with 10 successive identical values (OVERSAMPLING).
- If the data logger 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 logger 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 sensor intensity exceeds a certain threshold, the command frequency is increased.

Campbell logger program example

1. Read wind and snowdrift values for a FlowCapt FC4 with SDI-12 address 4 connected to a Campbell CR800 / CR1000 port C1:

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

'***   reading sensor
SDI12Recorder (FC(),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 sensor (power cycling, measurement interval, storage interval).

2. Measure the analog voltage output on your logger’s ports SE1 (flux) and SE2 (wind):

```
VoltSe(FC_Flux,1,mV5000,1,False,0,_50Hz,0.05,0)
VoltSe(FC_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.