User Guide

Operating instructions for ISAW sensors

Models

FlowCapt FC4

SandFlow SF4

RainFlow RF4

WindFlow WF4

CE

Document version: v1.0

The ISAW sensors are robust, high performance sensors for snow, sand, rain and wind. Their construction with no mobile parts makes them ideal for a wide range of meteorological, industrial and scientific applications even in the harshest environments. This User Guide provides all required information and instructions to operate the sensors. For more information about the available furniture's, spare parts and accessories, please refer to the ISAW sensors main catalogue that lists all the available ISAW equipment.

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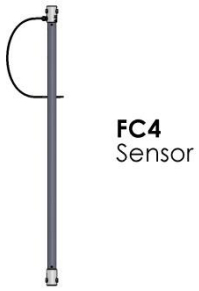
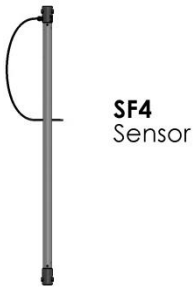
FC4	FlowCapt
 FC4 Sensor	Snowdrift fluxes and wind-speed monitoring sensor ■ Snowdrift/blowing snow monitoring ■ Mass fluxes and wind speed measurements ■ Meteorological and scientific applications ■ Industrial surveillance applications

SF4	SandFlow
 SF4 Sensor	Sand aeolian transport and wind-speed monitoring sensor ■ Sand/dust aeolian transport monitoring ■ Mass fluxes and wind speed measurements ■ Meteorological and scientific applications ■ Industrial surveillance applications

RF4	RainFlow
 RF4 Sensor	Rain and hail monitoring sensor ■ Rain/hail precipitation monitoring ■ Rain intensities, high-resolution disdrometry and low-precision wind speed measurements ■ Meteorological and scientific applications ■ Industrial surveillance applications

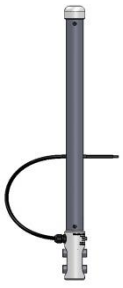
WF4	WindFlow
 WF4 Sensor	Wind-speed monitoring sensor ■ Wind speed monitoring ■ Meteorological and scientific applications ■ Maritime applications ■ Industrial surveillance applications

Table of contents

INTRODUCTION

Before you start

Your ISAW sensor model FlowCapt FC4, SandFlow SF4, RainFlow RF4 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 12). 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, etc.) 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 LINK 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	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 a duty-cycle of 100%).

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

Voltage ranges and measurement scales	FC4	SF4	RF4	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: [20 mV/(g/m^2/s)] i.e. +5V corresponds to 250 g/m^2/s
Rain (or hail)			•		Sensitivity @voltage range +2.5V: [50 mV/(mm/h)] i.e. +2.5V corresponds to 50 mm/h
					Sensitivity @voltage range +5V: [100 mV/(mm/h)] i.e. +5V corresponds to 50 mm/h
Wind speed	•	•		•	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

QUICK START

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.

It is recommended to install the ISAW-Toolbox software suite first, then plug the sensor into the USB LINK accessory delivered with the sensor, establish a communication and browse all settings. These steps are described more in detail in the next sections of this chapter.

To manually check any sensor model, just tap on it with a finger or a light tool to see live response in the scope mode utility.

Install the ISAW-Toolbox software suite

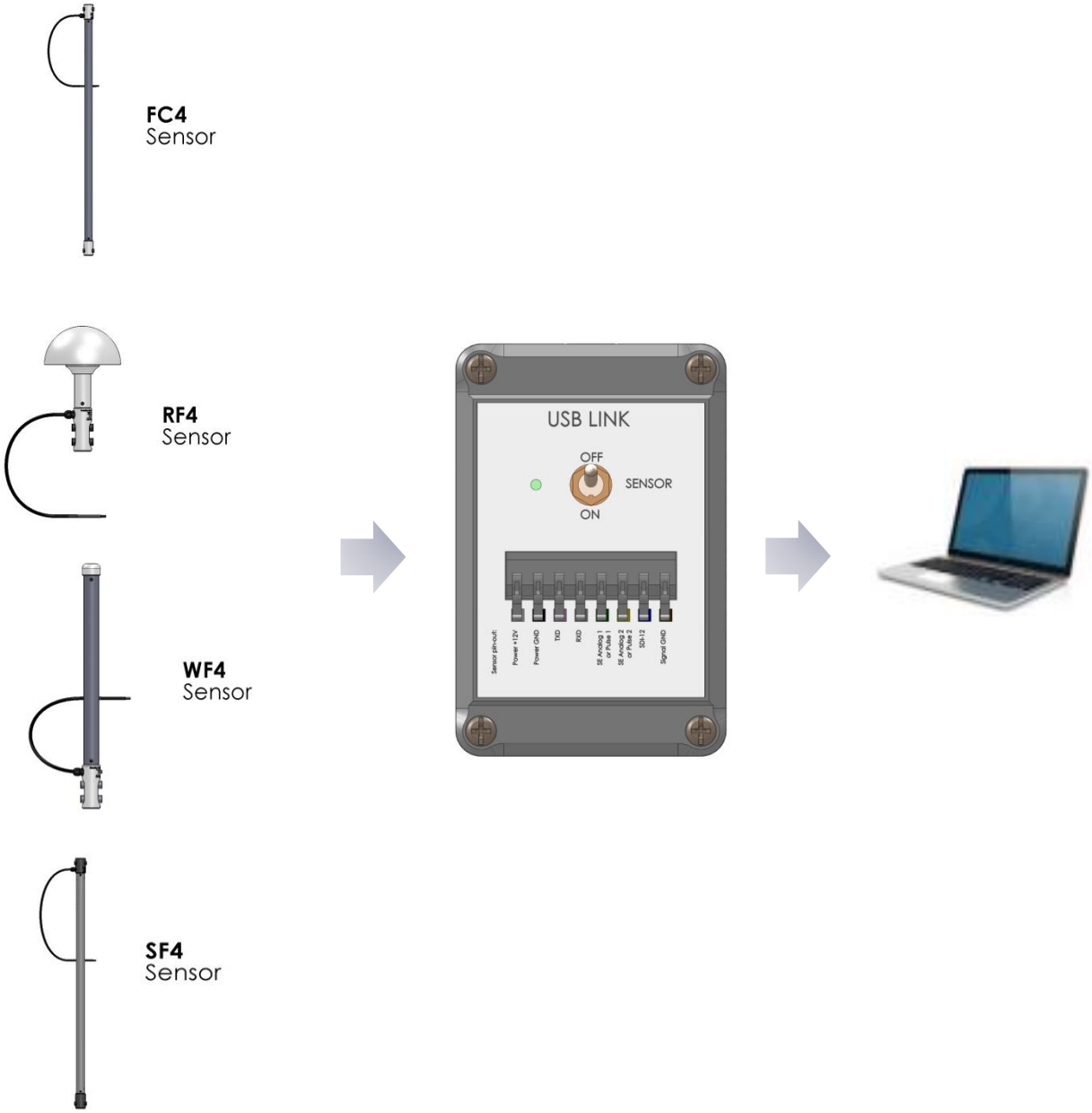
Download the ISAW-Toolbox software suite from the "Download" section of the ISAW products website www.isaw-products.com on a computer running at least Windows 7. Download and install the latest version of the toolbox.

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

Plug your sensor

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

   Your sensor has eight wires, plug each sensor wire of the main cable into the USB LINK accessory, according to the colour labels on the 8-pin terminal. You can plug and unplug all cables in any order (as long as you respect the colour correspondences).



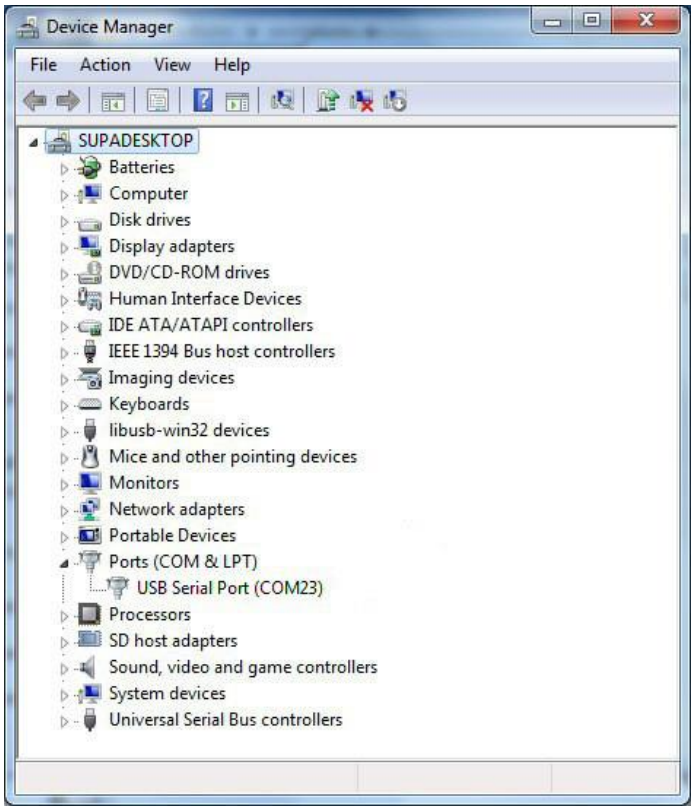
2. **Connect USB LINK to the computer.**

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 LINK serial port:

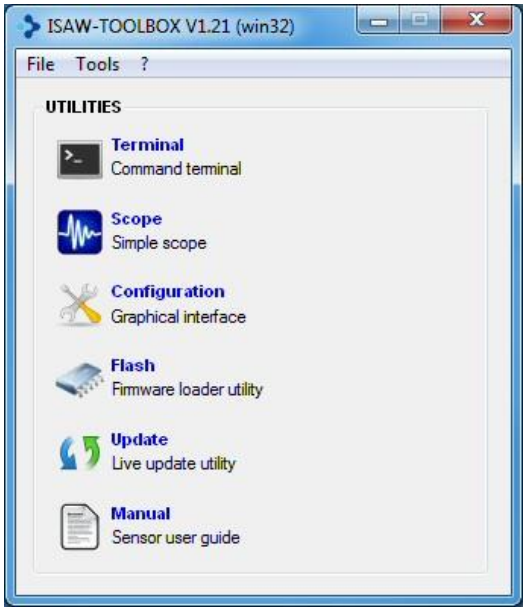
In the “Configuration panel”, open the “Device manager”. In the “Ports (COM & LPT)” section, you will find a new serial communication port (ex: COM23).



Test your sensor with the scope utility

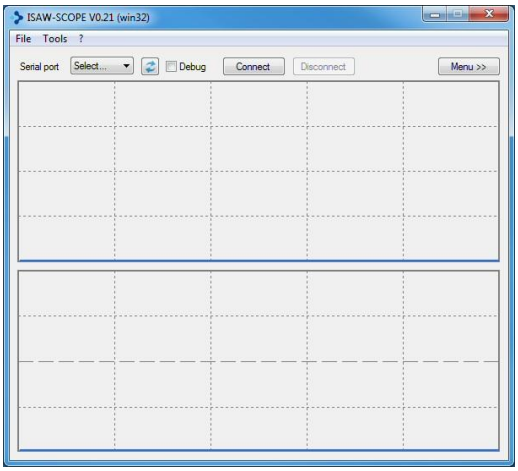
1. Open the ISAW-Toolbox software

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.

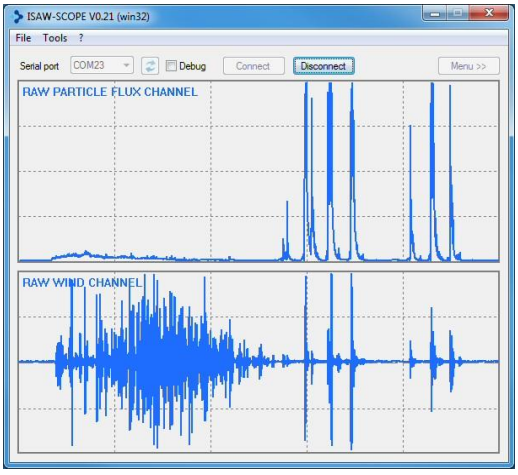
The connection procedure is completed when the [Connect] button is disabled and the [Disconnect] button is enabled.

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.

---

4. Check live sensor response(s) [1]

Once your sensor is plugged in and connected, test the signal(s) by tapping 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.



[1] One output signal for sensor WindFlow WF4, two output signals for sensors FlowCapt FC4, SandFlow SF4 and RainFlow RF4.

SENSOR CONFIGURATION

- Default configuration
- Configuration utility
- Summary panel
- Outputs panel
- SDI-12 panel
- Serial panel
- Expert panel
- Factory panel
- Import configuration
- Export configuration
- Change a parameter in terminal mode
- Update the sensor’s firmware

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 and SDI-12 GND
Black	Power GND	All	Negative power supply (Power GND), 0 VDC

Single-ended analog and pulse outputs

Wire	Signal	Sensor	Disabled	Wind speed		Particle flux				Rain intensity				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	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	○	○	●	○	●	○	○					
		RF4	○	○	●					○	●	○	○	
		WF4	○	○	●									
Yellow	OUT2	FC4	○	○	○	○	●	○	○					○
		SF4	○	○	○	○	●	○	○					○
		RF4	○	○	○					○	●	○	○	○
		WF4	○	○	●									○

● Default setting ○ User selectable

Serial or SDI-12 communication

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

● Default setting ○ User selectable

To change one or more parameters of this configuration, use the configuration utility.

Configuration utility

Prerequisites:

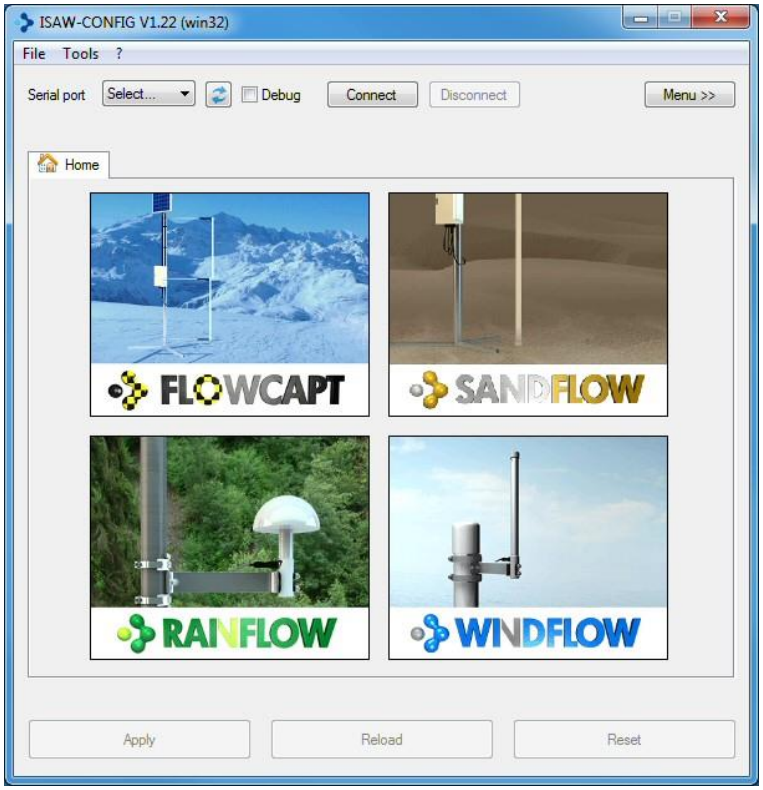
- The ISAW-Toolbox is installed (see p. 7).
- The sensor is plugged (see p. 8).

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.

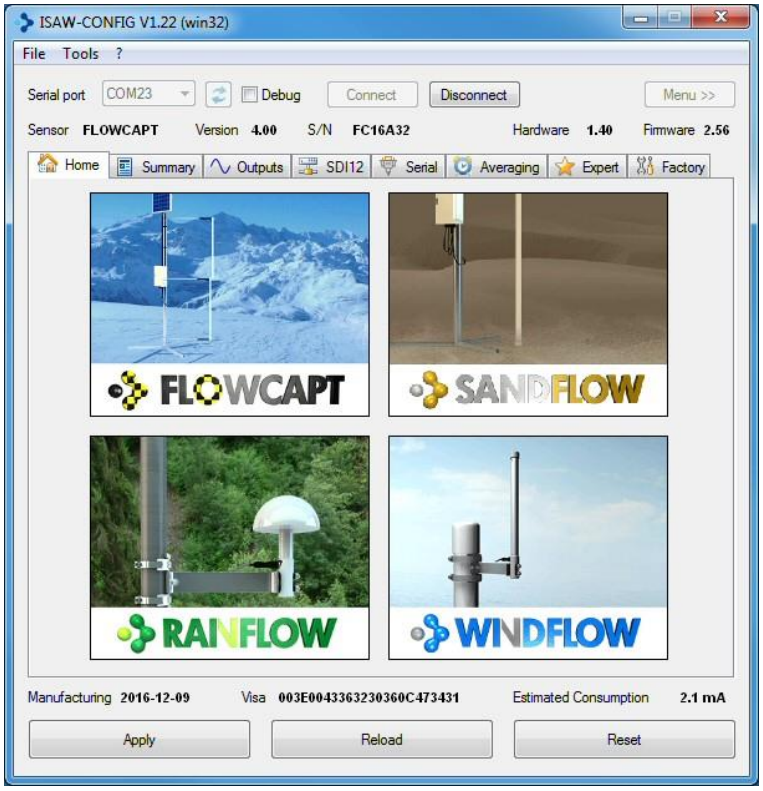


Note: Only the "Summary" panel is visible as long as there is no sensor connected.

3. Connect the sensor

See p. 9.

Once the sensor is connected, the configuration panels appear and the control buttons are enabled.



Configuration panels		
Home	A single configuration application for all ISAW sensors.	
Summary	Current configuration.	*Some of the information displayed on this tab may depend on the sensor type (FlowCapt FC4, SandFlow SF4, RainFlow RF4, or WindFlow WF4).*
Outputs	Setting analog outputs, voltage ranges, and pulse settings.	
Sdi12	Setting SDI-12 settings.	
Serial	Serial settings.	
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 sensor's factory information.	

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 the ISAW Firmware User Manual for more information.

4. Optional: check the current configuration:

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

5. Change parameters:

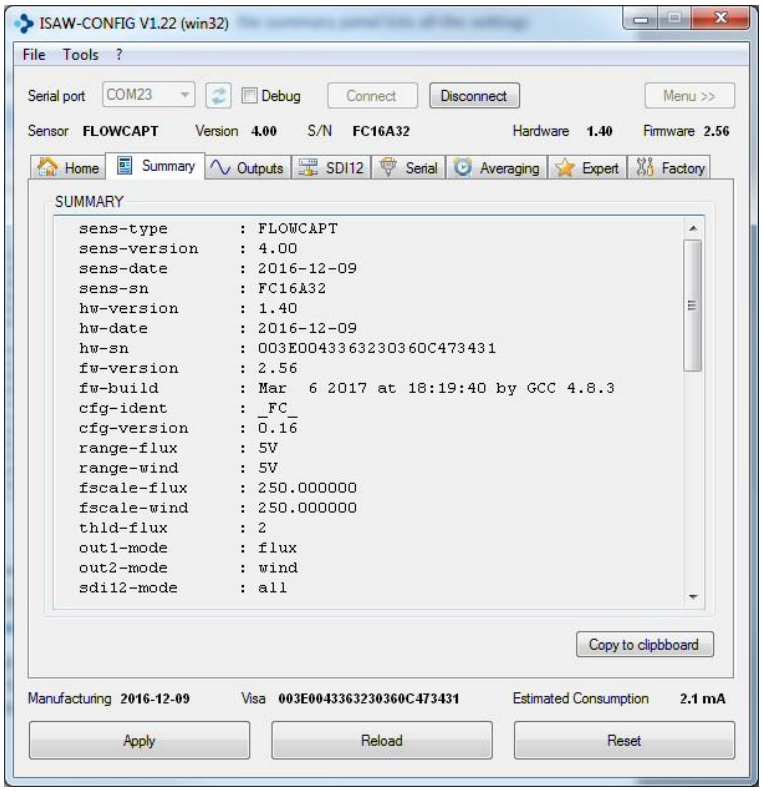
Use the other tabs (click on the tab selection buttons) to make the required parameters changes then click on the [Apply] button to send your changes to the sensor.

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 interval 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, rain 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 C).
	Serial mode	String result is sent through TX output at every writing interval (see more in Appendix B).
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.

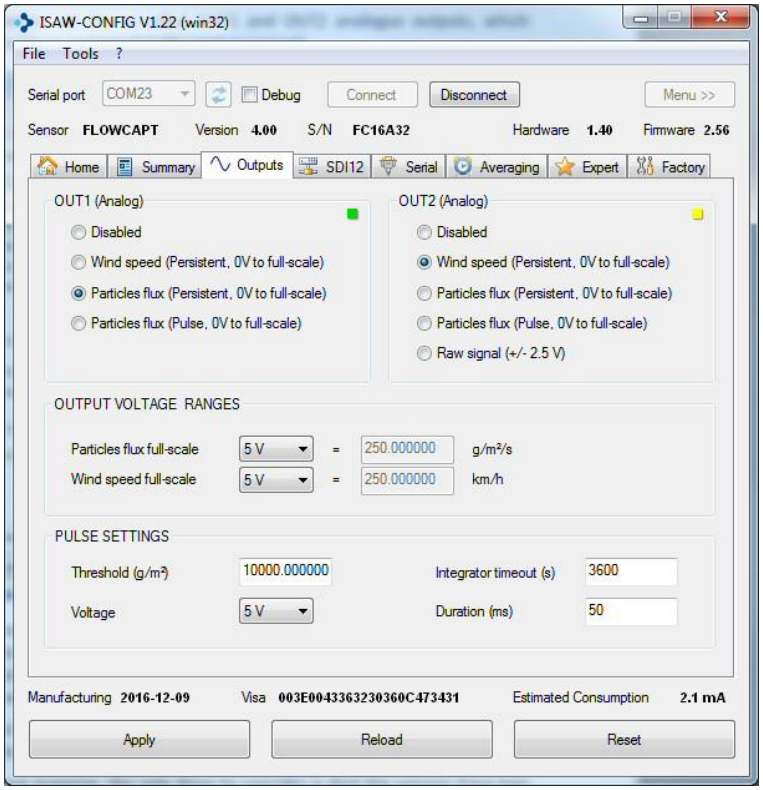
See Appendix A for more details on parameters.



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.

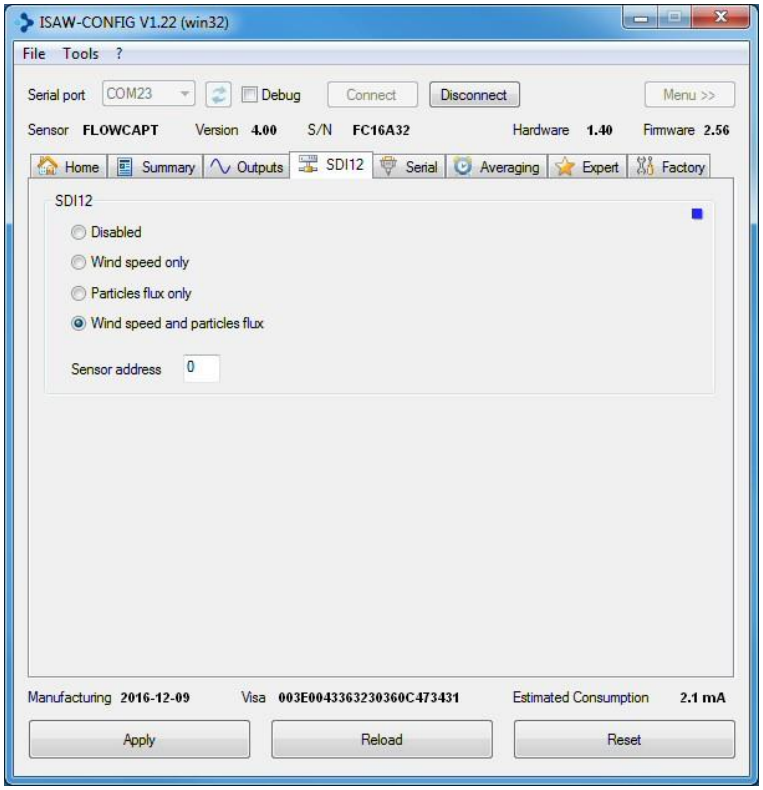
To understand the output mapping, the only thing to consider is that the sensors have two generic analog outputs, called OUT1 and OUT2. OUT1 is always carried by the green wire, OUT2 is always carried by the yellow wire. You decide which signal is attributed to OUT1 and OUT2 by selecting one of the options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



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.

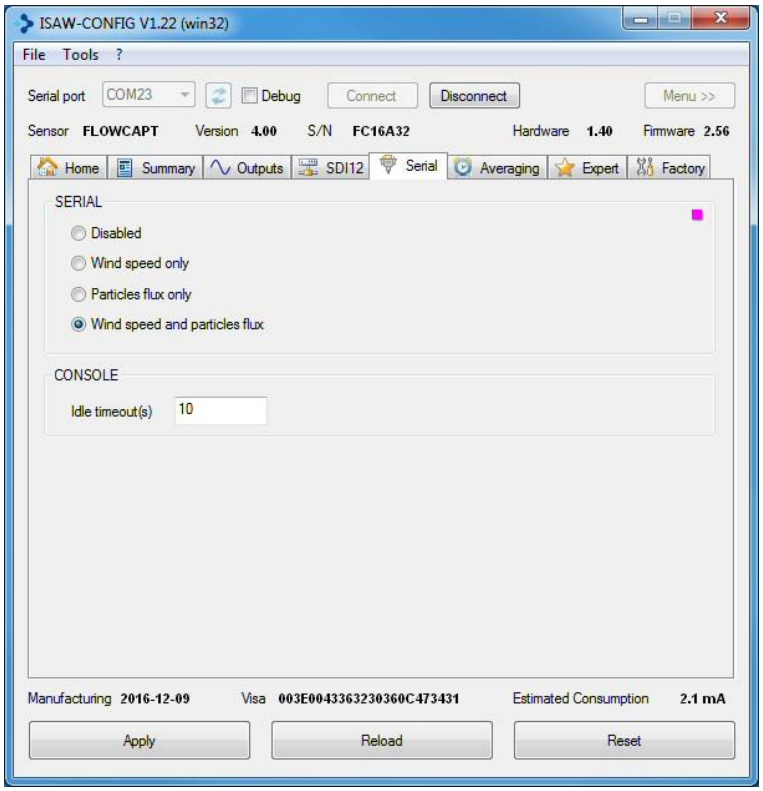
This serial-digital interface is thus a logical choice for interfacing your ISAW sensor with a distant data recorder.

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.

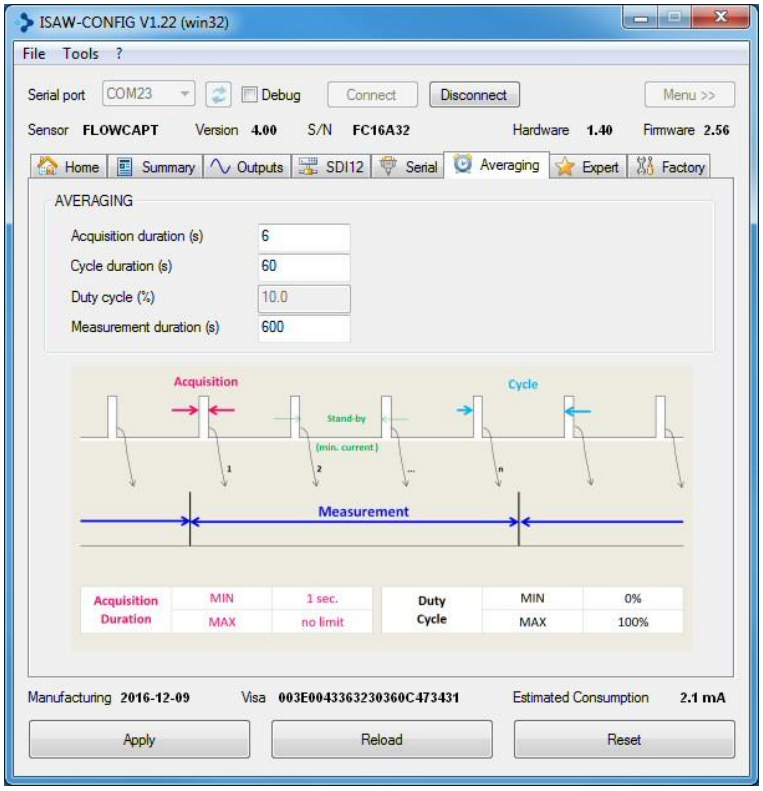


For more instructions on the use of the serial communication, please refer to Appendix B.

Averaging panel

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

- acquisition duration (true time of observation of the physical phenomena, also called *time integration window*),
- cycle duration (the sum of the acquisition duration and a stand-by duration),
- duty cycle (resulting from 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.

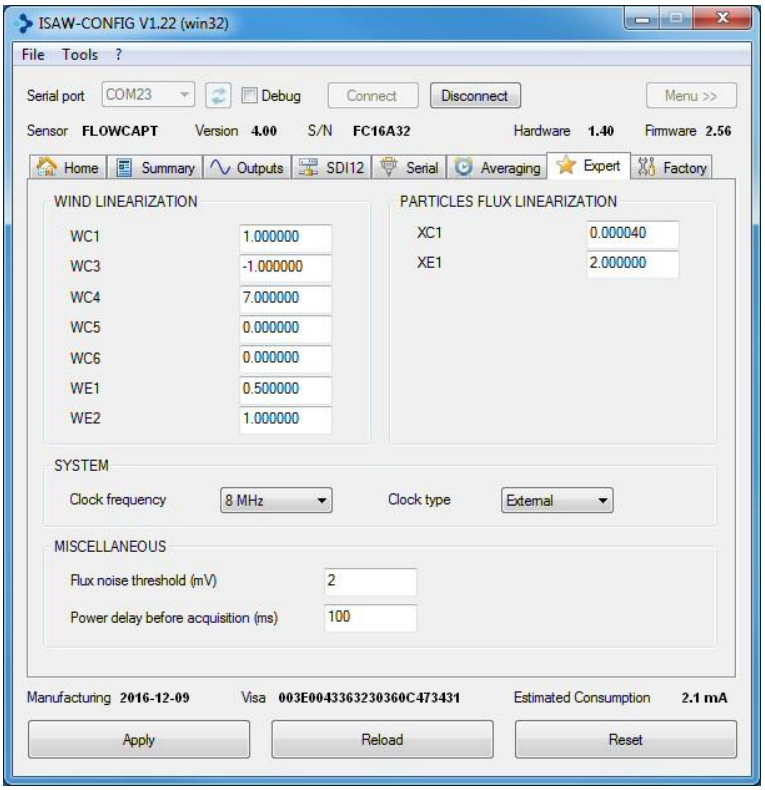
This way, your sensor, with an average total power consumption of 2.1 mA, every 10 minutes, will internally produce a data result that is the average, the min. and the max. values of 10 measurements of 6 seconds duration each (one measurement every minute) and deliver this result to your reading peripheral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

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 or implement different coefficients to the internal calculation functions of the sensor.

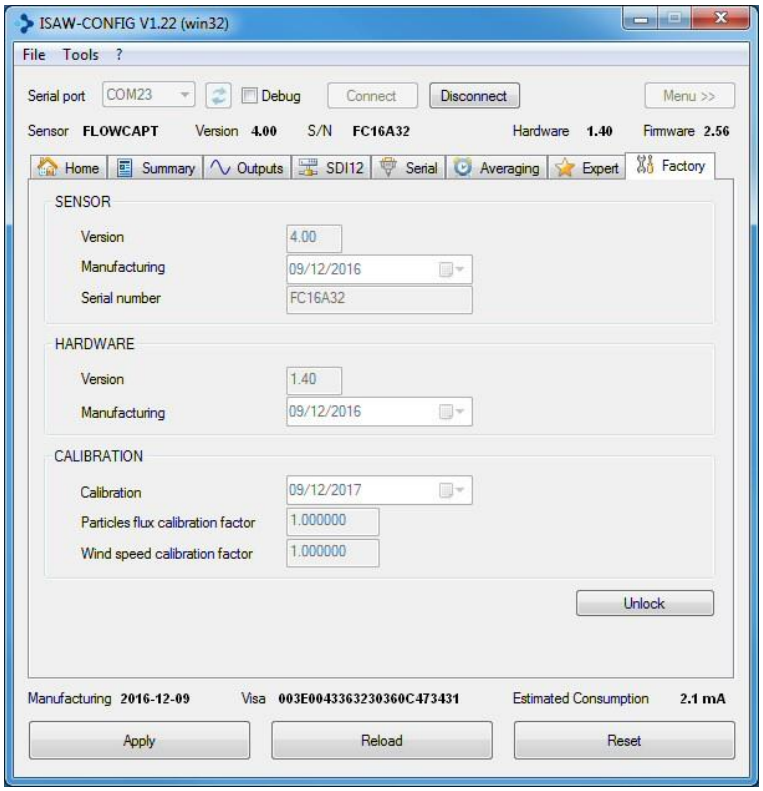
The [Reset] button allows you to always return to the default factory settings.

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 ISAW-Config a previously exported configuration of a sensor (*.isawcfg file).

1. Open the Import window:

In ISAW-Config, 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 ISAW-Config, 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

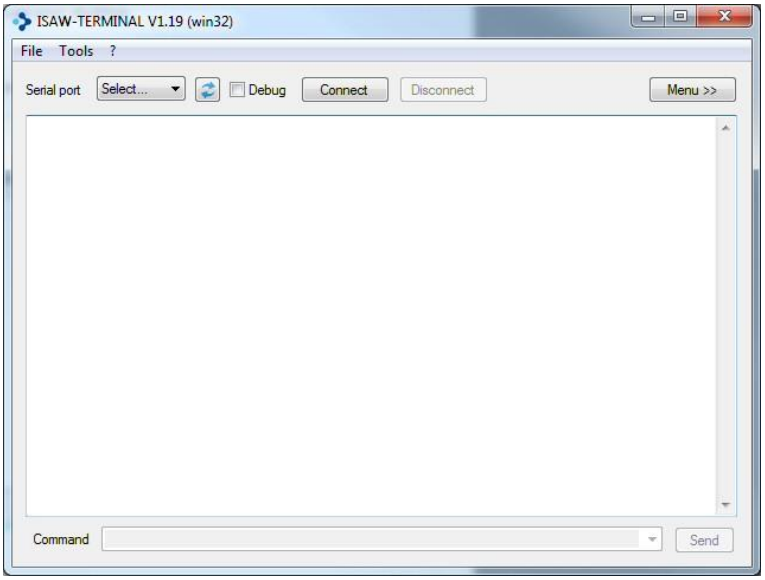
You can also configure your sensor using serial communication in terminal mode.

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. 9.

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.

5. Change the required parameter[2]:

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

[2] 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 and WindFlow WF4 sensors.

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

Prerequisites:

- The ISAW-Toolbox is installed (see p. 7).
- The sensor is plugged in (see p. 8).
- You have downloaded from the "Download" section of the ISAW products website[3] the last version of the ISAW firmware to be installed:

Sensor	Firmware file
FLOWCAPT FC4	ISAW-FlowCapt-x.xx.bin
SANDFLOW SF4	ISAW-SandFlow-x.xx.bin
RAINFLOW RF4	ISAW-RainFlow-x.xx.bin
WINDFLOW WF4	ISAW-WindFlow-x.xx.bin

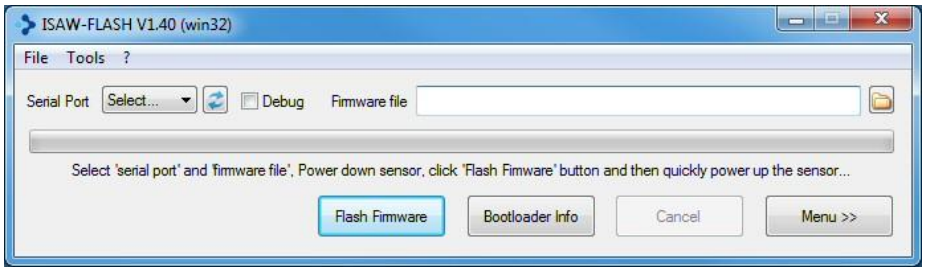
where x.xx is the version number.

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 LINK serial port:

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

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.

[3] See : www.iav.ch > ISAW Products > Downloads

4. Select the firmware file.

You can drag and drop the file on the entry field, or select it by using the  button.

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

5. Shut down the sensor power supply:

Set the USB LINK accessory power switch to OFF.

6. Press the [Flash Firmware] button.

7. Power-on the sensor:

Switch the USB LINK accessory 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.

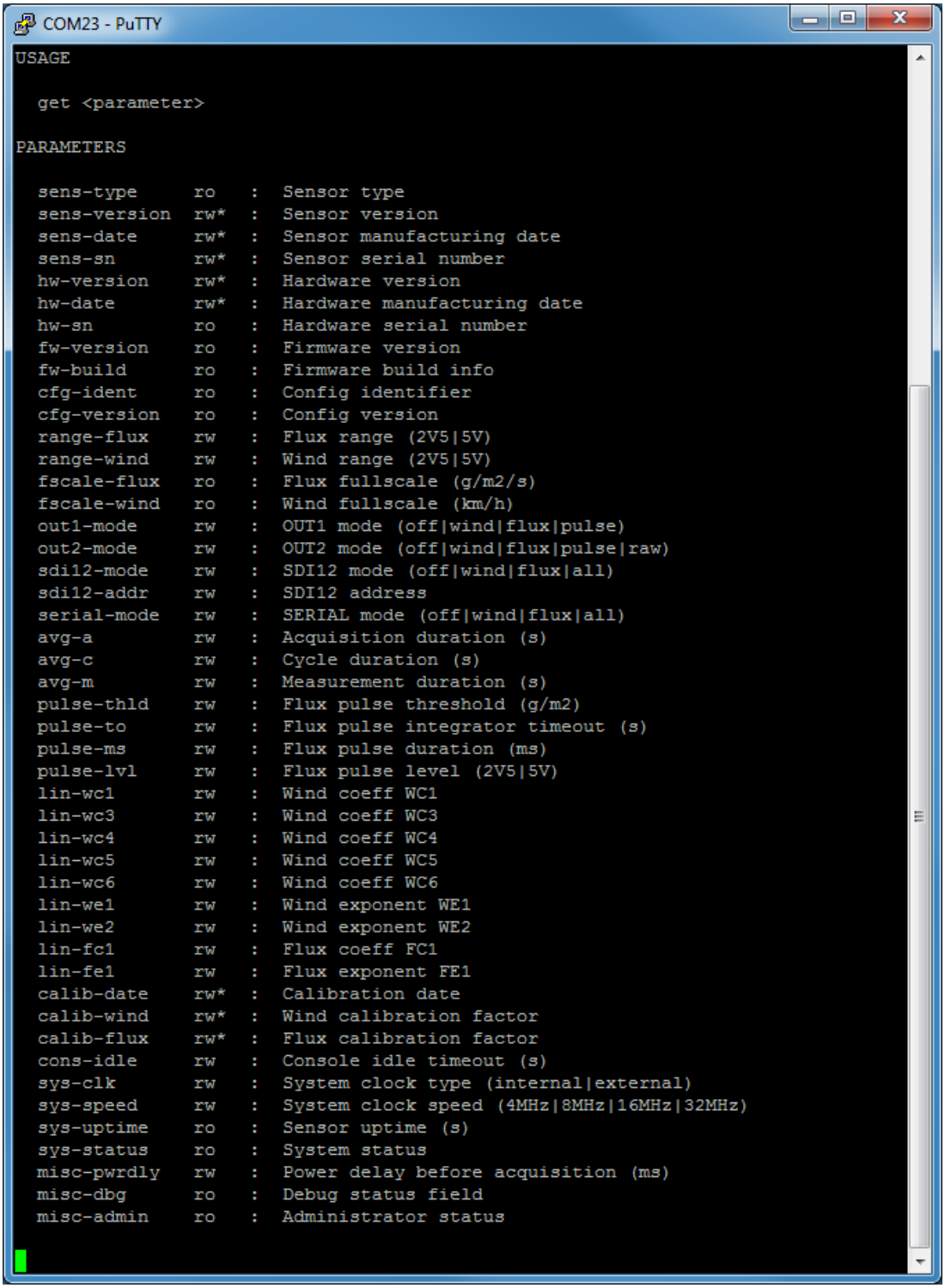
9. The sensor is now ready to use.

You can close the ISAW-Flash utility and check the configuration of the sensor. You may have to set all the parameters (see section "SENSOR CONFIGURATION").

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

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.



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

All parameters are described in the following table.

Parameters

Parameter	Description	Type	Access[4]	Values / Format	Example
sens-type	Sensor's type	string	ro	FLOWCAPT FLOWCAPT sensor SANDFLOW SANDFLOW sensor RAINFLOW RAINFLOW 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 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	xxxxxxxxxxxxxxxxxxxxxxx	002E0040363230360C473431
fw-version	Version of current firmware	version	ro	<major>.<minor> where major and minor cannot exceed 99	2.2
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 _WF_ WINDFLOW eeprom identifier	_FC_
cfg-version	Eeprom configuration map version	version	ro	<major>.<minor> where major and minor cannot exceed 255	0.9
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)

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

Parameter	Description	Type	Access[4]	Values / Format	Example
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)
fscale-flux	OUT1 and/or OUT2 full scale particle flux, g/m^2/s	string	ro	250	
fscale-wind	OUT1 and/or OUT2 full scale particle wind, km/h	string	ro	250	
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 (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) pulse Particle flux (Pulse, 0 or full-scale) raw Raw analog AC signal	wind (default)
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 (default)
sdi12-addr	SDI-12 address	string	rw	ASCII character (standard SDI-12 characters are 0 to 9)	0 (default)
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 (default)
avg-a	Acquisition duration (s)	integer	rw	Must be > 0 See p. 33.	6 (default)
avg-c	Cycle duration (s)	integer	rw	Must be > avg-a and avg-m/avg-c is integer See p. 33.	60 (default)
avg-m	Measurement duration (s)	integer	rw	Must be > avg-c and avg-c must be modulo avg-m See p. 33.	600 (default)
pulse-thld	OUT1/OUT2 flux pulse threshold (g×m-2)	float	rw	Must be > 500.0	10000.0 (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)
lin-wc1	Wind linearization coefficient WC1	float	rw	See p. 33.	1.0 (default)
lin-wc3	Wind linearization coefficient WC3	float	rw	See p. 33.	0 (default)

Parameter	Description	Type	Access[4]	Values / Format	Example
lin-wc4	Wind linearization coefficient WC4	float	rw	See p. 33.	4.1689 (default)
lin-wc5	Wind linearization coefficient WC5	float	rw	See p. 33.	0.1681 (default)
lin-wc6	Wind linearization coefficient WC6	float	rw	See p. 33.	0 (default)
lin-we1	Wind linearization exponent WE1	float	rw	See p. 33.	0.3616 (default)
lin-we2	Wind linearization exponent WE2	float	rw	See p. 33.	0.8552 (default)
lin-fc1	Particle flux linearization coefficient FC1	float	rw	See p. 33.	0.00004 (default)
lin-fe1	Particle flux linearization exponent FE1	float	rw	See p. 33.	2.0
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)
cons-idle[5]	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	8MHz (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
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[6]	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)

[5] 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).

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

Linearization functions

- **Wind:**

Wind speed is computed with these formulas:

```
WindInter = WC1 * ( WindInput + WC3 )
WindSpeed = WC4 * WindInter^WE1 + WC5 * WindInter^WE2 + WC6
```

WindInput: Wind input signal after filtering stages (mV)
WindSpeed: Resulting wind speed (km/h)

- **Flux:**

Flux in computed with this formula:

```
Flux = FC1 * FluxInput^FE1
```

FluxInput: Flux input signal after filtering stages (mV)
Flux: Resulting particle flux ($g/m^2/s$)

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.

Appendix B: 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 communication example

Connect in terminal or console mode

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

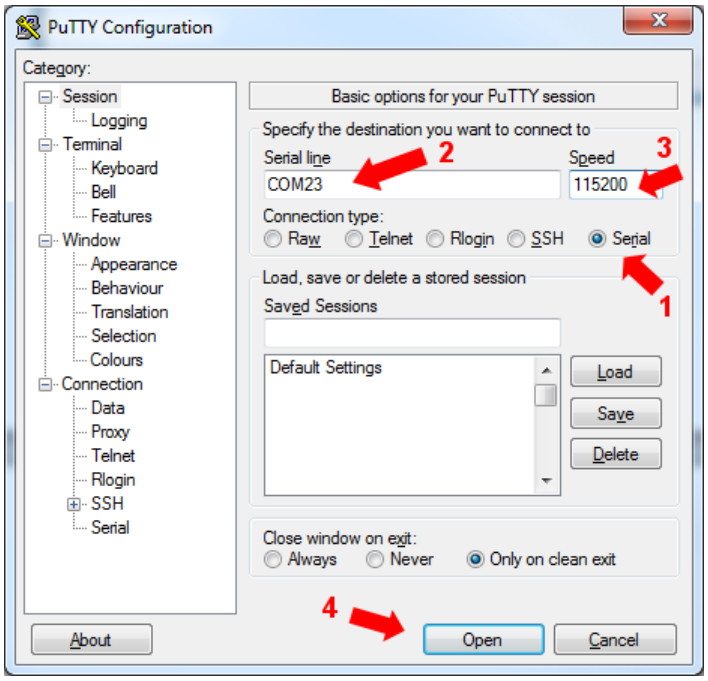
Prerequisite: The sensor is plugged (see p. 8).

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!

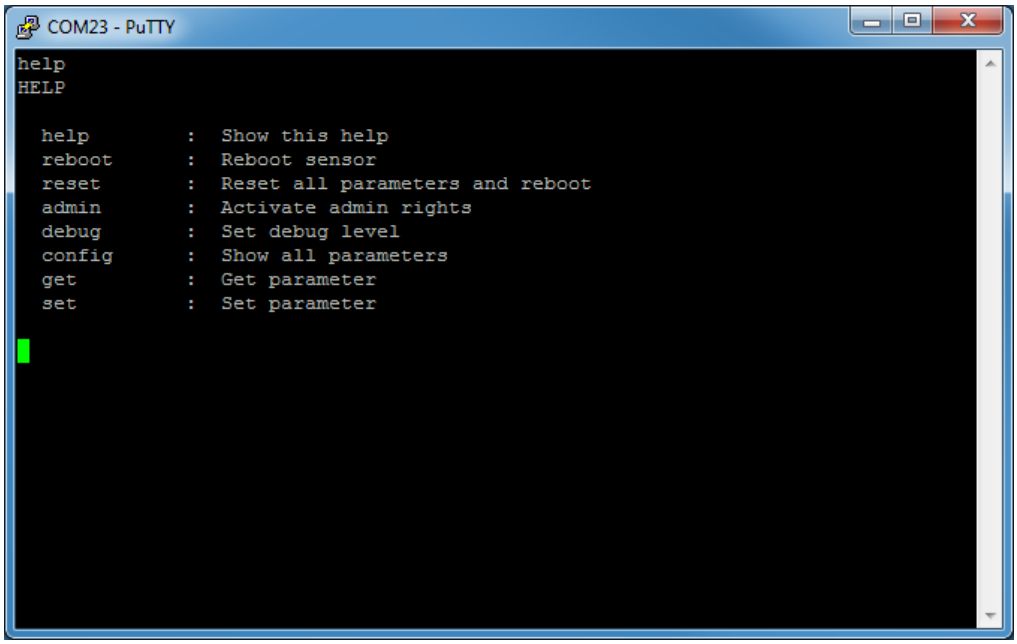
1. Connect your Terminal software

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
`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, sens-version, sens-date, sens-sn, hw-version, hw-date, hw-sn, fw-version, fw-build cfg-ident, cfg-version, calib-date, calib-wind, calib-flux, sys-uptime, sys-status, 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`
`help`	Displays the list of all available commands.

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 communication example

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

Format:

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

Example:

```
FLUX;987;g/m2/s;247.24;262.41;288.12;4.80;g/m2;98652.94
WIND;987;km/h;57.63;68.74;89.32
```

Note: values are always preceded by the corresponding unit.

Appendix C: 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
- Campbell logger program example

SDI-12 standard commands

Name	Command	Description/Response		
Acknowledge Active	a!			
Sensor Identification	aI!	13IAV-ENGRWINDFL201 13IAV-ENGRFLOWCA201 13IAV-ENGRRAINFL201 13IAV-ENGRSANDFL201		
Change Address	aAb!	***No need to reboot sensor***		
Address query	?!			
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!	Wind min (km/h)
			aD1!	Wind avg (km/h)
			aD2!	Wind max (km/h)
		sdi12-mode=flux	aD0!	Particle flux min (g/m^2/s)
			aD1!	Particle flux avg (g/m^2/s)
			aD2!	Particle flux max (g/m^2/s)
			aD3!	Particle flux std (g/m^2/s)
			aD4!	Particle flux sum (g/m^2)
		sdi12-mode=all	aD0!	Particle flux min (g/m^2/s)
			aD1!	Particle flux avg (g/m^2/s)
			aD2!	Particle flux max (g/m^2/s)
			aD3!	Particle flux std (g/m^2/s)
			aD4!	Particle flux sum (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! … aMC9!	***No additional measurement*** a0000		

Name	Command	Description/Response		
Start Verification	aV!	No verification a0000		
Start Concurrent Measurement	aC!	*Always reset measure*		
		sdi12-mode=wind	a00003	
		sdi12-mode=flux	a00005	
		sdi12-mode=all	a00008	
Start Concurrent Measurement and request CRC	aCC!	*Always reset measure*		
		sdi12-mode=wind	a00003	
		sdi12-mode=flux	a00005	
		sdi12-mode=all	a00008	
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!	Wind min (km/h)
			aR1!	Wind avg (km/h)
			aR2!	Wind max (km/h)
		sdi12-mode=flux	aR0!	Particle flux min (g/m²/s)
			aR1!	Particle flux avg (g/m^2/s)
			aR2!	Particle flux max (g/m^2/s)
			aR3!	Particle flux std (g/m^2/s)
			aR4!	Particle flux sum (g/m^2)
		sdi12-mode=all	aR0!	Particle flux min (g/m^2/s)
			aR1!	Particle flux avg (g/m^2/s)
			aR2!	Particle flux max (g/m^2/s)
			aR3!	Particle flux std (g/m^2/s)
			aR4!	Particle flux sum (g/m^2)
			aR5!	Wind min (km/h)
			aR6!	Wind avg (km/h)
			aR7!	Wind max (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.

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. 37)
`<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. 37) <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.	aXZcccccccc! a : Sensor address ccccccc : Reset confirmation "confirm" ! : Command terminator	aOK<CR><LF> aER=mmmm…<CR><LF> a : Sensor address mmmm… : Error message (see p. 37) <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. 37) <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. 37) <CR><LF> : Response terminator

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