HSU USER MANUAL

HSU - HUB SENSOR UNIT

Terms: TCU (Tracking Control Unit); NCU (Network Control Unit); HSU (Hub Sensor Unit); BLE (Bluetooth Low Energy); NVM (Non Volatile Memory); BT (Back Tracking); OTA (Over The Air).

1. PRODUCT DESCRIPTION

The SUNNER ecosystem is composed of three different devices: NCU, TCU and HSU.
The TCU incorporates the tracking and backtracking algorithm needed to efficiently track the sun and it also adds multiple functional alarms.
However, the weather conditions can compromise the trackers' structure well-being. Therefore, the HSU acquires weather data from different sensors: wind speed, wind direction, snow, flood, and solar irradiation; and transmits the data to the NCU.

The NCU acts as the Zigbee network coordinator that communicates the whole system. This way, the trackers can be sent to safe position depending on several weather alarms. Also, the NCU stores the HSUs, and TCUs information and it allows real-time remote control of the solar plant.
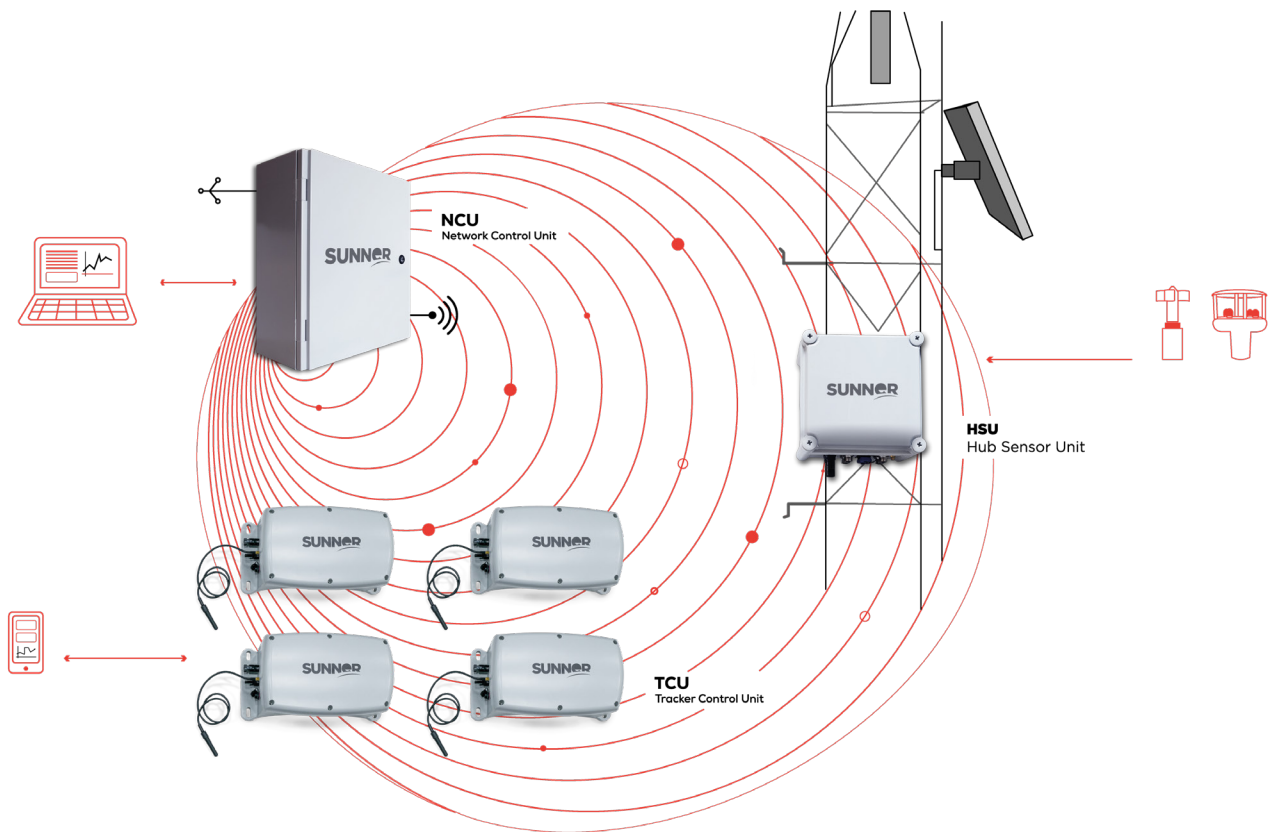
The HSU can communicate through:
•   Zigbee with the NCU
•   RS485 with the NCU or for commissioning with the PC

The communication protocol of the HSUs is Modbus and a slave ID should be assigned to each HSU.

2. COMMUNICATION

The HSU has two communication interfaces: RS485 and Zigbee. The Modbus RTU protocol has been implemented in all of them. The factory value of the Modbus slave ID is 185 and it can be configured.

- RS485

The communication parameters of the RS485 interface are: 19200 bauds, even parity, 8 data bits, 1 stop bit.

- Zigbee

The coordinator of the Zigbee network is in the NCU, and it is responsible for the creation of the Zigbee network. The Zigbee module of the HSU, which works as router, will join the Zigbee network if it has been configured with the same PAN ID as the coordinator. The PANID can be configured via Modbus using the SUNNER Config Tool or connecting directly to gateway from Digi interface.

The Zigbee network watchdog timeout can also be configured. If the node cannot reach the coordinator, it will leave the network after the configured timeout and try to rejoin. The default value is 2 minutes and if it is set to 0 the network watchdog is disabled.

3. REAL TIME DATA

The HSU acquires real time data about the weather and the HSU internal operation.

The UTC date and time is given by the NCU and it is updated by the internal HSU Real Time Clock (RTC).

The following measurements can be accessed:

HSU INTERNAL OPERATION	
PARAMETER	UNITS
Internal Temperature	K
Internal Battery Voltage. [1]	mV
Power Supply Voltage (PV panel or external power supply)	mV
NiMH Battery Voltage [1] (Main battery. Rechargeable, 12v 2x800mAh.)	mV
Li-Ion Battery Voltage (Secondary battery. Non rechargeable.)	mV

| WEATHER INFORMATION	
PARAMETER	UNITS
Wind Speed	m/s
Wind Direction	degrees
Snow Level (or rain/flood level)	m
Irradiance	W/m2 x100

4. WEATHER ALARMS

In case of dangerous weather conditions, different HSU alarms can be activated to send the trackers to a safe position:

- Snow alarms
- Rain/Flood alarms
- Wind alarms

4.1 SNOW ALARMS

The snow sensor compares the terrain reference level with the current measured level to activate the Snow Alarm.

Snow alarm OFF
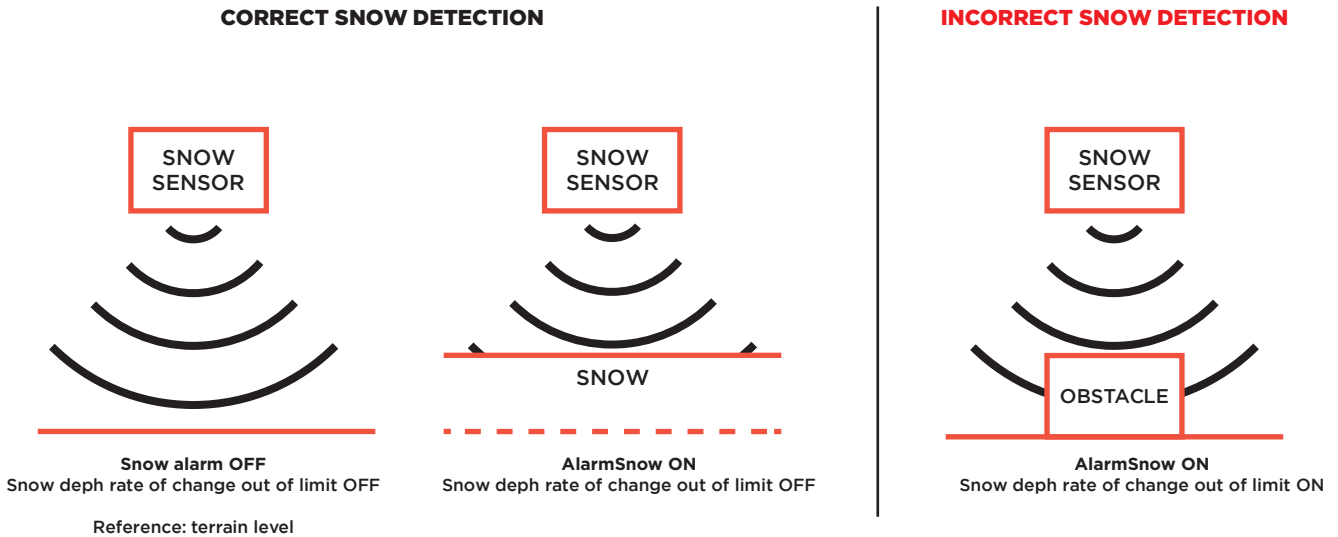Reference: terrain level

AlarmSnow ON
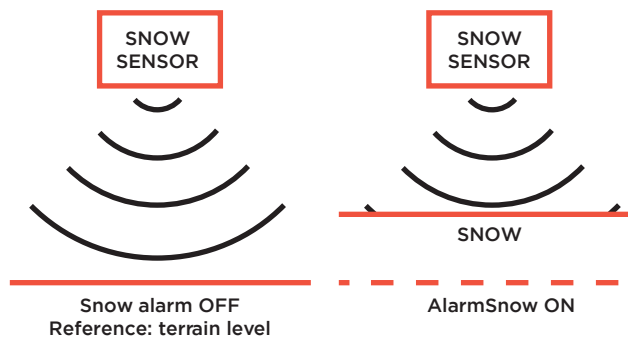
For that, it is necessary to store the height at which the snow sensor is installed. The sensor should be placed at 50 - 150 cm (highly recommended 100 cm) from the terrain level and it should be calibrated using the SUNNER Config Tool. Refer to the 'Configuration' section for further details. By default, its value is 50 cm.

Also, the Snow Alarm parameters should be configured during commissioning.

The Snow Alarm will be activated if the measured snow level is higher than the configured Threshold during a time higher than Activation Time. After that, it will be deactivated if the measured snow level is lower than configured Threshold during a time higher than Deactivation Time. This logic is illustrated in the following picture.
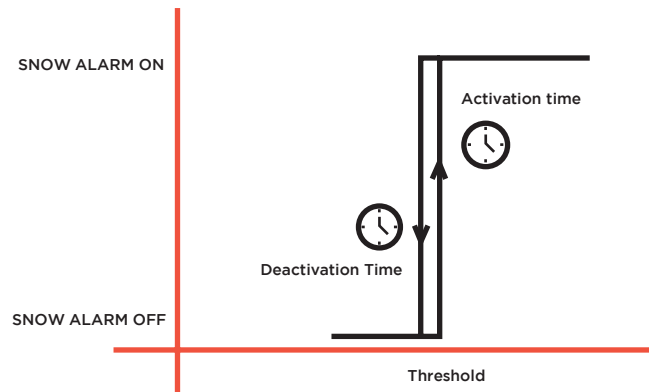
However, an obstacle (e.g., a bird or a stone) can be detected by the snow sensor and the Snow Alarm could be activated. In this case the trackers would move to safe position and stop tracking the sun. To prevent that, an additional warning 'Snow depth rate of change out of limit' is included to detect a fast change in snow level. In this way, an operator could make the necessary adjustments.

CORRECT SNOW DETECTION		INCORRECT SNOW DETECTION

SNOW SENSOR	SNOW SENSOR	SNOW SENSOR
	SNOW	OBSTACLE
Snow alarm OFF Snow deph rate of change out of limit OFF	**AlarmSnow ON** Snow deph rate of change out of limit OFF	**AlarmSnow ON** Snow deph rate of change out of limit ON
Reference: terrain level		

For that, the user must define the following parameters:

- Change Threshold: maximum change in mm in snow height between 2 samples to activate the 'Snow depth rate of change out of limit' alarm. Value: 0 ... 200 mm. Default value: 80 mm.
- Sample Period: time between snow sensor samples in minutes. Value: 1 ... 50 min. Default value: 2 min.

The following table sums up the configurable parameters related to the Snow alarm:

ALARM	DESCRIPTION	CONFIGURATION PARAMETERS
Snow alarm	A potentially dangerous snow level is detected.	• Threshold Value: [float] meters Default value: 0'01 m • Activation Time Value: 0...50 min Default value: 10 min • Deactivation time Value: 0...50 min Default value: 10 min
Snow depth rate of change out of limit	An increment/decrement higher than the configured Threshold between 2 consecutive samples is detected.	• Change Threshold Value: 0...200 mm Default value: 80 mm • Sample Period Value: 1...50 minutes Default value: 2 minutes

Default values of each HSU firmware version should be verified by the user.

4.2 RAIN/FLOOD ALARM

The logics behind the Rain/Flood Alarm are the same as for the Snow Alarm: the sensor compares the terrain reference level with the measured level to activate an alarm.

Therefore, these two alarms share:

- The same logics: explained in the previous section.
- The same configuration registers.
- The same physical connection: the snow sensor and flood sensor are the same sensor. Refer to the 'HSU Installation Manual' for further information.

Just in case the user wants to relate the sensor information to flood instead of snow, the 'Flood Sensor Available' option can be selected during the commissioning (instead of 'Snow Sensor Available'). In this way, the Rain/Flood Alarm is activated (instead of the Snow Alarm). Refer to the 'Configuration' section for further information.

ALARM	DESCRIPTION	CONFIGURATION PARAMETERS
Rain/Flood alarm	A potentially dangerous flood level is detected.	• Threshold Value: [float] meters Default value: 0'01 m • Activation Time Value: 0...50 min Default value: 10 min • Deactivation time Value: 0...50 min Default value: 10 min
Snow depth rate of change out of limit	An increment/decrement higher than the configured Threshold between 2 consecutive samples is detected.	• Change Threshold Value: 0...200 mm Default value: 80 mm • Sample Period Value: 1...50 minutes Default value: 2 minutes

Default values of each HSU firmware version should be verified by the user.

4.3 WIND ALARM

The security of the trackers is highly dependent on wind condition. To ensure a safe operation, the HSU generates different types of wind alarms:

• WIND ALARM

Three alarms are available for different wind strategies: Wind alarm 1, Wind alarm 2, and Wind alarm 3 (avg).
The Wind Alarms will be activated if the wind speed is higher than the Activation Speed threshold during a time higher than Activation Time. After that, it will be deactivated if the wind speed is lower than the Deactivation Speed threshold during a time higher than the Deactivation Time.
Instantaneous wind speed values are used to activate/deactivate Wind Alarm 1 and Wind Alarm 2.
The average wind speed value is used to activate/deactivate Wind Alarm 3.

• SAFE WIND ALARM

Another three registers are available for different wind strategies: Safe Wind Alarm 1, Safe Wind Alarm 2, and Safe Wind Alarm 3 (avg).
The Safe Wind Alarms logic is based on the previous one, but it will only be deactivated after the Wind Alarm X is deactivated for a time higher than the Safe Position Timeout.
The Wind Alarm and Safe Wind Alarm logics are described in the following graph:
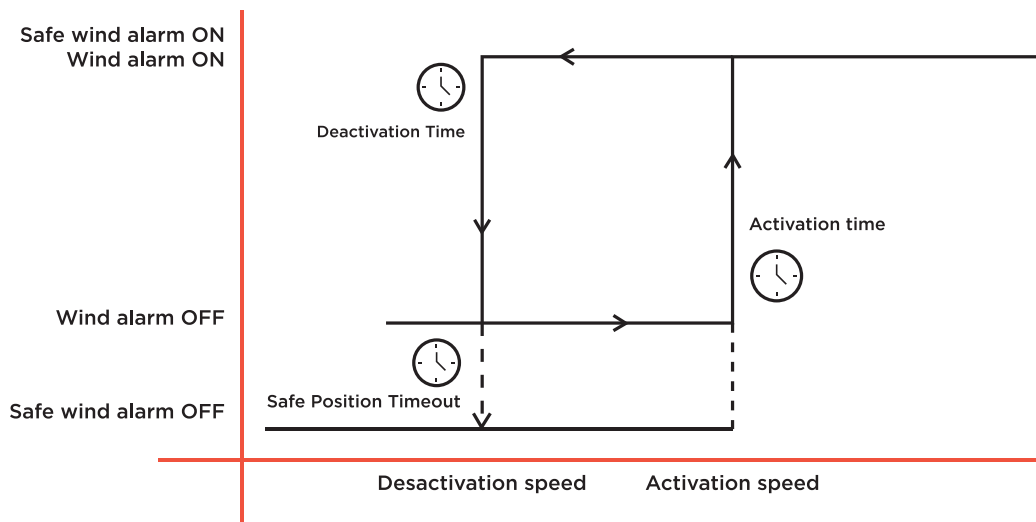
Note that the time specified in the Activation Time X and Deactivation Time X parameters are unique for each Wind Alarm X. But the Safe Position Timeout parameter applies a temporary filter to all the three Safe Wind Alarms.

A summary table is presented below:

WIND ALARM		
NAME	**CONFIGURABLE PARAMETERS**	**WIND SPEED VALUE**
Wind Alarm 1	Each Wind Alarm X can be configured by four parameters:	Instantaneous wind speed
Wind Alarm 2	• Activ	Instantaneous wind speed
Wind Alarm 3 (avg)	• ation time X Value: 0...65535 s Default value: 30 s • Activation speed X Value: 0...70 m/s Default value: 12,5 m/s • Deactivation time X Value: 0...65535 s Default value: 300 s • Deactivation speed X Value: 0...70 m/s Default value: 9,72 m/s	Average wind speed

SAFE WIND ALARM		
NAME	**CONFIGURABLE PARAMETERS**	**WIND SPEED VALUE**
Safe Wind Alarm 1	Same thresholds as the Wind Alarm X, but with an additional timeout only for deactivation:	Instantaneous wind speed
Safe Wind Alarm 2	• Safe Position Timeout	Instantaneous wind speed
Safe Wind Alarm 3 (avg)	Value: 0...50 min Default value: 1 min	Average wind speed

Default values of each HSU firmware version should be verified by the user.

These parameters are customizable. Please, refer to the 'Configuration' section for further information.
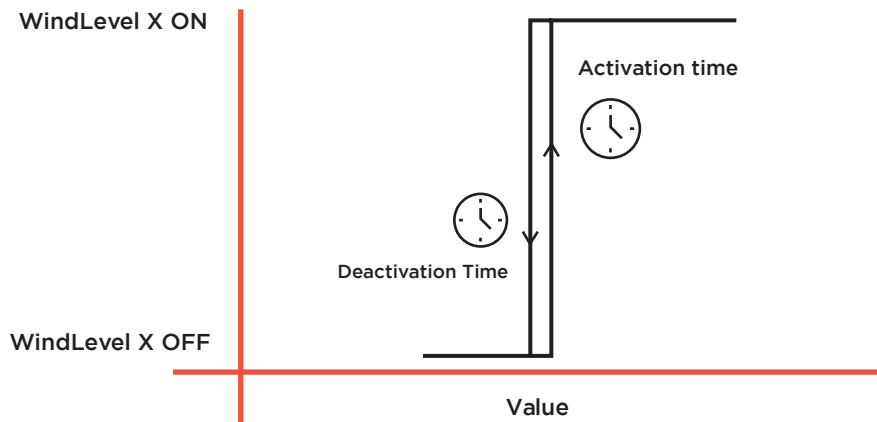
5. WIND LEVEL

To optimize the tracking algorithm in the presence of high wind speed, 10 wind levels can be configured in the HSU.

This information can be used to limit the tilt angle of the trackers to protect the mechanical structure under certain wind conditions while maintaining sun tracking.

The wind levels are defined by the configurable parameters: (being X the number of the wind level)

PARAMETER	DESCRIPTION	VALUE
Value	Wind Speed Threshold for wind level X activation.	[float] m/s
Activation time	Period of time for wind level X activation.	0...3000 s
Deactivation time	Period of time for wind level X deactivation	0...3000 s

A wind level X will be activated if the wind speed is higher than the defined 'Value' during a time higher than the 'Activation Time'. After that, it will be deactivated if the wind speed is lower than the defined 'Value' during a time higher than 'Deactivation Time'.

The default values are:

WIND LEVEL	DEFAULT VALUE	DEFAULT ACTIVATION TIME	DEFAULT DEACTIVATION TIME
1	27.78 m/s	10 s	300 s
2	27.78 m/s	10 s	300 s
3	27.78 m/s	10 s	300 s
4	27.78 m/s	10 s	300 s
5	27.78 m/s	5 s	300 s
6	27.78 m/s	5 s	300 s
7	27.78 m/s	5 s	300 s
8	27.78 m/s	5 s	300 s
9	27.78 m/s	5 s	300 s
10	27.78 m/s	5 s	300 s

Default values of each HSU firmware version should be verified by the user.

Each wind level is independent. In case of several wind levels active, the wind level transmitted to the NCU, and therefore to the TCUs, will be the most restrictive one.

WARNING:
Wind levels 8, 9 and 10 are not used in the SUNNER NCU and SUNNER TCU provided by IED.
Therefore, these levels should not be used when working with the complete SUNNER ecosystem (NCU, TCU and HSU).
The threshold Value of the wind levels 8, 9 and 10 should be such that they cannot be activated in any weather condition.
However, if the wind levels 8, 9 and 10 are active, the SUNNER TCU will activate the wind level 7.
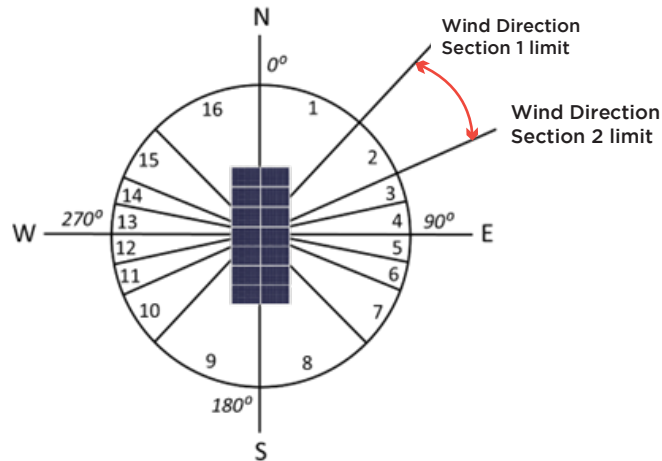
6. WIND DIRECTION

6.1 Wind direction sections

The wind direction information can be provided using sections, as shown in the image below.

The directions are divided in 16 different sections. The initial and final degree of each section is configurable using the configurable parameter 'Wind Direction Section X Limit'. The section X ranges from the angle saved in 'Wind Direction Section X Limit' to the angle saved in 'Wind Direction Section X+1 Limit'. In case of section 1, it ranges from 0 degrees to the angle saved in 'Wind Direction Section 1 Limit'.

The Wind Direction State Active parameter will report the current wind direction section. For example, if the wind direction sections are defined as they are shown in the upper drawing and the wind direction is 87 degrees, the Wind Direction State Active would be '4'.

By default, the values are:

PARAMETER	DEFAULT VALUE
Wind Direction Section 1 limit	10
Wind Direction Section 2 limit	16
Wind Direction Section 3 limit	30
Wind Direction Section 4 limit	151
Wind Direction Section 5 limit	165
Wind Direction Section 6 limit	171
Wind Direction Section 7 limit	190
Wind Direction Section 8 limit	196
Wind Direction Section 9 limit	210
Wind Direction Section 10 limit	331
Wind Direction Section 11 limit	345
Wind Direction Section 12 limit	351
Wind Direction Section 13 limit	360
Wind Direction Section 14 limit	360
Wind Direction Section 15 limit	360
Wind Direction Section 16 limit	360

Default values of each HSU firmware version should be verified by the user.

6.2 Wind vane offset

The physical misalignment of the wind vane can be corrected using the Vane Offset parameter. This value is added to the sensor output to compensate a misaligned installation to North. By default, its value is 0 degrees.

Please, go to 'Configuration' section for further information.

7. SENSOR ALARMS

In case a communication failure with any sensor is detected, different alarms may appear:

*   Communication error with anemometer
*   Communication error with snow sensor
*   Communication error with pyranometer

8. DATALOGGER

The HSU stores the weather information from the last 7 days in the internal NVM.
The user can access the following weather information about every minute (from 00:00 to 23:59) of the selected day:

*   Prevailing wind direction (0 ... 360 degrees)
*   Average wind speed (0 ... 42 m/s)
*   Maximum wind speed (0 ... 42 m/s)
*   Maximum snow level (0 ... 1000 cm)
*   Average irradiance (0 ... 13760 W/m2 x10)

9. CONFIGURATION: SUNNER CONFIG TOOL

For easy configuration of the HSU, the 'SUNNER Config Tool' application is provided by IED.

The SUNNER Config Tool can be used for two purposes:
*   Configuration of the HSUs and TCUs.
*   Maintenance of the HSUs and TCUs.
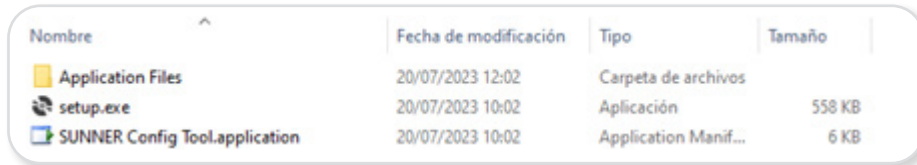
The information and configuration options for the HSU are:
*   **Status information:** real-time HSU information, time, weather information and alarms.
*   **Sensors:** sensors connection configuration.
*   **Alarms:** wind alarms and wind level configuration.
*   **Wind direction:** wind direction sections and vane offset configuration.
*   **Snow sensor:** configuration and calibration.
*   **Commissioning:** network configuration and time updating options.
*   **Datalogger:** download the weather information from the last 7 days.

9.1 Wind vane offset

The SUNNER Config Tool used to configure the HSU is provided by IED.

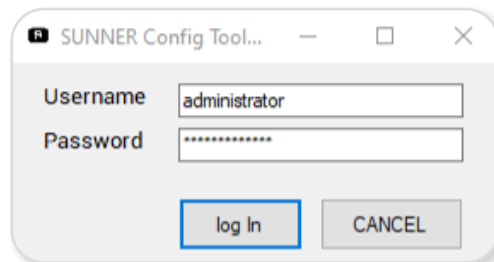The execute the **"setup.exe"**.

The **'SUNNER Config Tool.application'** will open automatically.

9.2 Login

Open the SUNNER Config Tool using the credentials provided by IED.

Two account types can be provided:

- User account: can read the HSU information.
- Administrator account: can read the HSU information and modify the configurable parameters.

After log-in, select the connection options:

- Choose de device: HSU.
- Choose the sample period: The recommended value is 1 second. However, if the network is saturated, it is possible to increase the value.

- Choose the connection. Two available options:
  - **RTU:** Choose this option if your PC is connected via RS485 cable to the HSU.
  Select the COM Port, set the baud rate to 19200 and write the Slave ID.
  - **TCP:** Choose this option if your PC is connected to the ethernet network of SUNNER ecosystem.
  Select the IP direction of the gateway to which the HSU is connected, set the port to 502 and write the Slave ID.
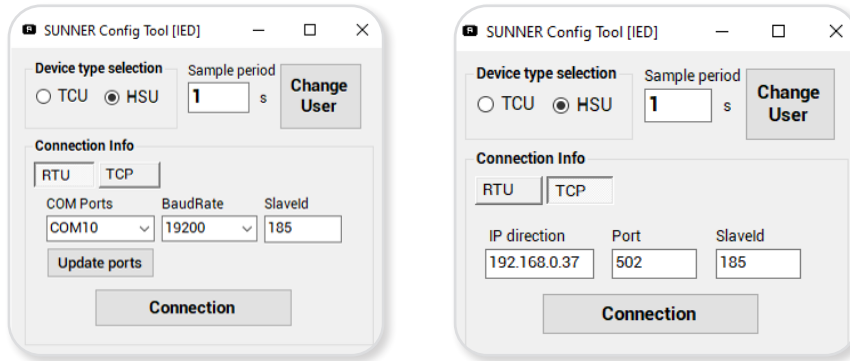

9.3 Status information

The following window will arise. In the upper part, the username and the access level will be shown. To change user, please select 'Back to connection' and then 'Change User'.
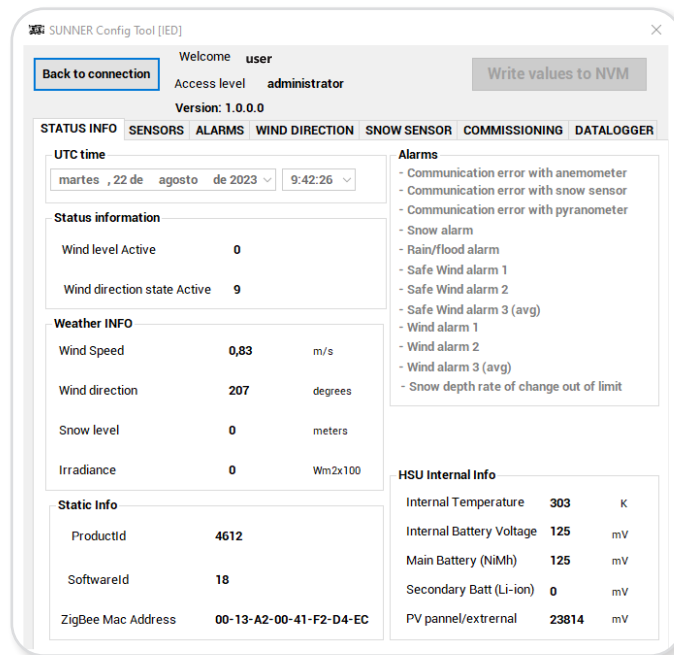
Here the main UTC time in the HSU, real-time weather information, internal information and weather alarms are shown. These values cannot be modified.
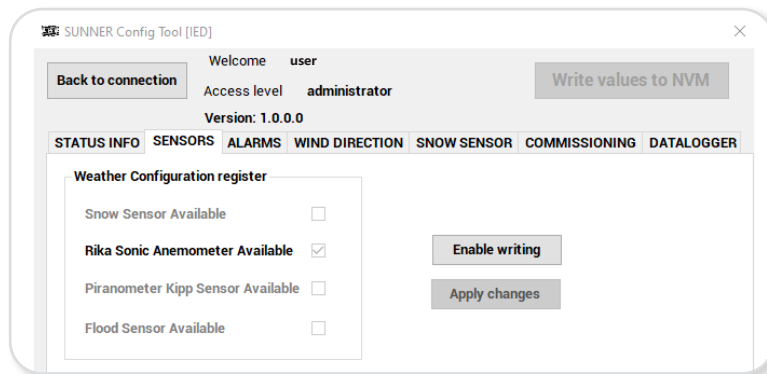
If any alarm is active, a warning sign will arise, and the active alarms will be highlighted in bold type.
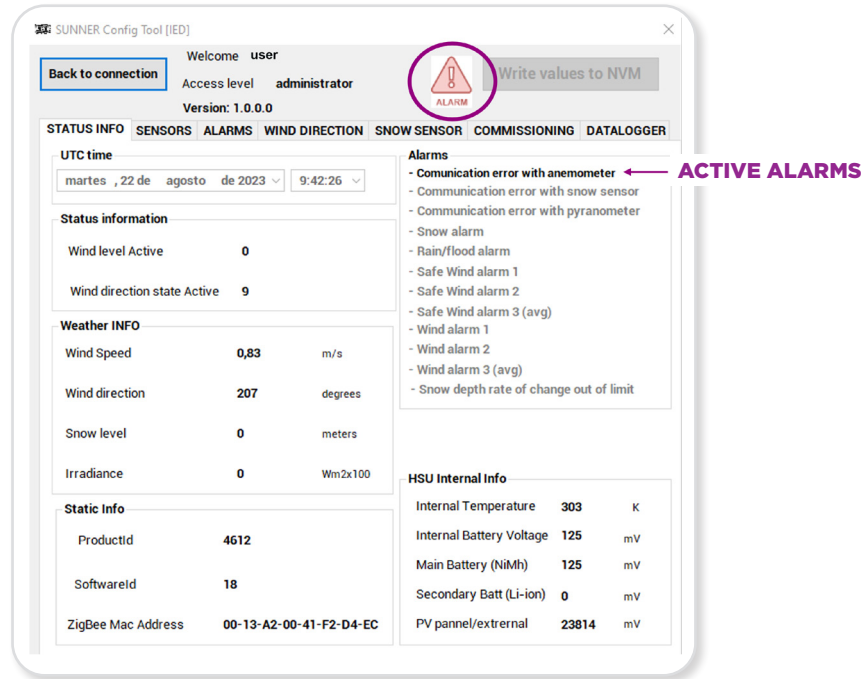
9.4 Sensors

In the upper part, select 'Sensors'.

Here, the sensors connection is shown/configured.

To modify the configuration, click on "Enable writing" and select the sensors that are physically connected to the HSU.

The relationship between the HSU alarms, physically connected sensors, and weather configuration registers is:

SENSOR CONNECTED	WEATHER CONFIGURATION REGISTER	ALARMS AND WARNINGS
Anemometer & Wind vane	(Default, if 'Rika Sonic Anemometer Available' is not selected.)	Wind Alarm 1 Wind Alarm 2 Wind Alarm 3 (avg) Safe Wind Alarm 1 Safe Wind Alarm 2 Safe Wind Alarm 3 (avg) Wind level Active Wind direction state Active Communication error with anemometer
Ultrasonic Anemometer	Rika Sonic Anemometer Available	
Snow sensor [1]	Flood Sensor Available	Rain/Flood Alarm Snow depth of change out of limit Communication error with snow sensor
	Snow sensor Available	Snow Alarm Snow depth of change out of limit Communication error with snow sensor
	Pyranometer Kipp Sensor Available	(Only irradiance information) Communication error with pyranometer

[1] The 'Rain/Flood Sensor Active' and 'Snow Sensor Active' cannot be simultaneously active, as they are the same sensor. Please, refer to 'Snow alarm' and 'Rain/Flood alarm' sections for further information.

Click on 'Apply changes' and then the 'Write to NVM " to make the changes permanent, so that when the HSU is restarted the changes will remain.
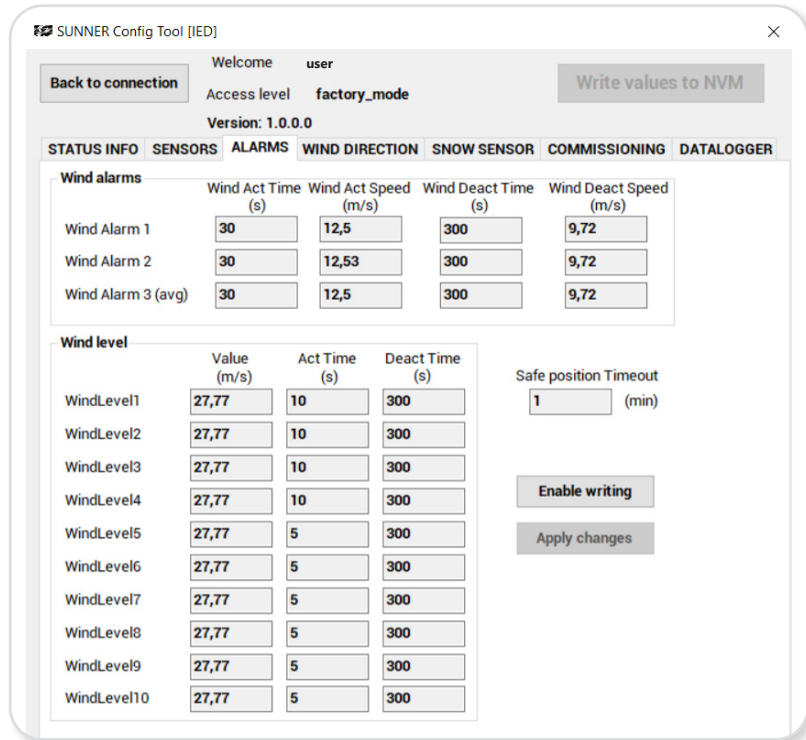
NOTE: Otherwise, the changes will remain until the HSU is shut down and when the HSU is restarted the values will be those previously saved in the NVM.

9.5 Alarms

In the upper part, select 'Alarms'.

Here the wind alarms and wind level configuration are shown/configured.

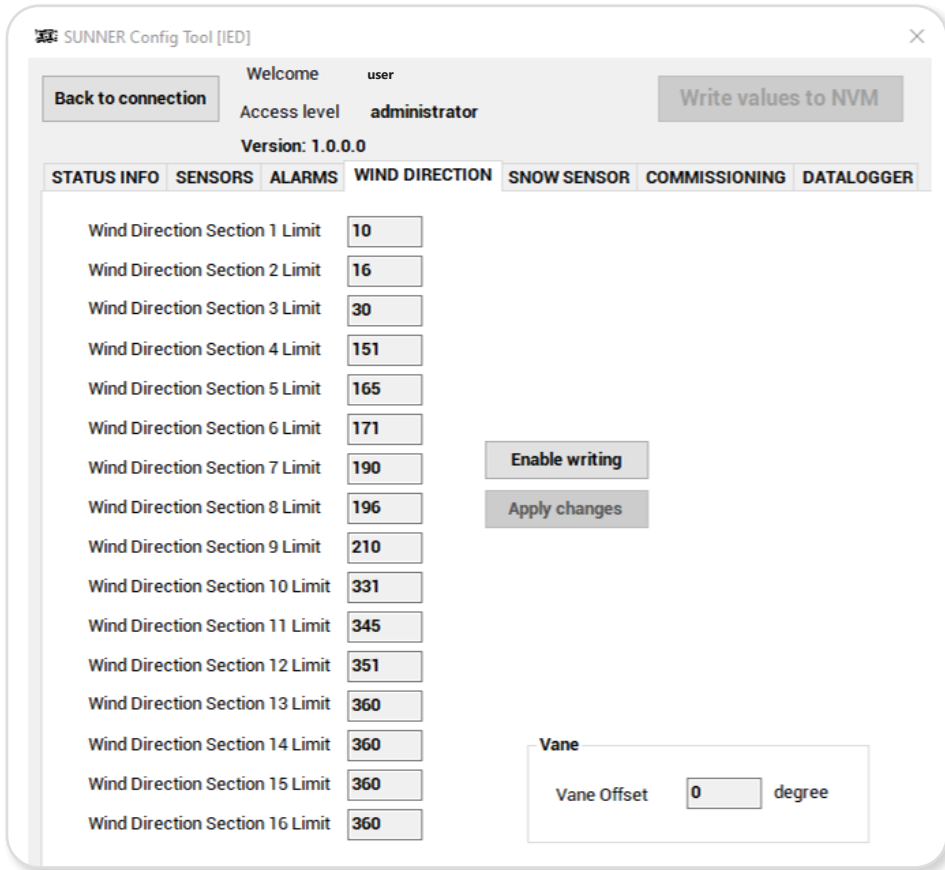Select 'Enable writing' to configure the parameters.

Select 'Apply changes' and, to make the changes permanent, click the 'Write to NVM ″ button, so that when the HSU is restarted the changes will remain.

NOTE: Otherwise, the changes will remain until the HSU is shut down and when the HSU is restarted the values will be those previously saved in the NVM.

9.6 Wind direction

On the upper part, select 'Wind direction'.

Here the wind direction sections can be configured. Also, the Vane Offset can be configured. This value is added to the sensor output to compensate a misaligned installation to North.

Select 'Enable writing' to configure the parameters.

Select 'Apply changes' and, to make the changes permanent, click the 'Write to NVM ″ button, so that when the HSU is restarted the changes will remain.

NOTE: Otherwise, the changes will remain until the HSU is shut down and when the HSU is restarted the values will be those previously saved in the NVM.

9.7 Snow sensor

On the upper part, select 'Snow Sensor'.

Here the snow sensor configuration is shown/configured and the snow sensor calibration is done. Note that the snow sensor configuration applies to both the Snow Alarm and Rain/Flood Alarm.

Select 'Enable writing'.

The configuration options are:
• The Threshold, Activation Time and Deactivation Time for the Snow Alarm or Rain/Flood Alarm.
• The Sample Period and the Change Threshold for the 'Snow depth rate of change out of limit' alarm.
• Use the 'Calibrate snow sensor' button to automatically save the height at which the snow sensor is installed. This should be a value between 20 and 100 cm. By default, its value is 50 cm.

For further information, please refer to 'Snow alarm' and 'Rain/Flood alarm' sections.

Select 'Apply changes' and, to make the changes permanent, click the 'Write to NVM ″ button, so that when the HSU is restarted the changes will remain.

NOTE: Otherwise, the changes will remain until the HSU is shut down and when the HSU is restarted the values will be those previously saved in the NVM.

9.8 Comissioning

On the upper part, select 'Commissioning'.

Here the network configuration and time updating options are shown/configured.
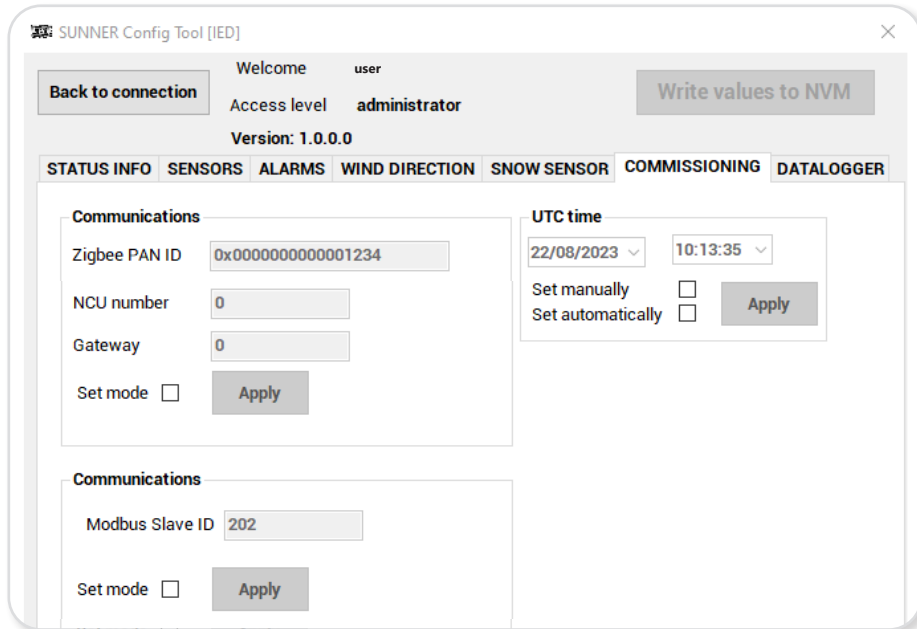
Enable 'Set mode' of the communication blocks to modify the parameters. Then select 'Apply' to save the new values.

The UTC time of the HSU is automatically updated by the internal RTC. However, it is possible to externally update it:
* Manually: Enable 'Set manually', write the date and time, and select 'Apply'.
* Automatically: Enable 'Set automatically' and select 'Apply'. The HSU will acquire the date and time of the PC.
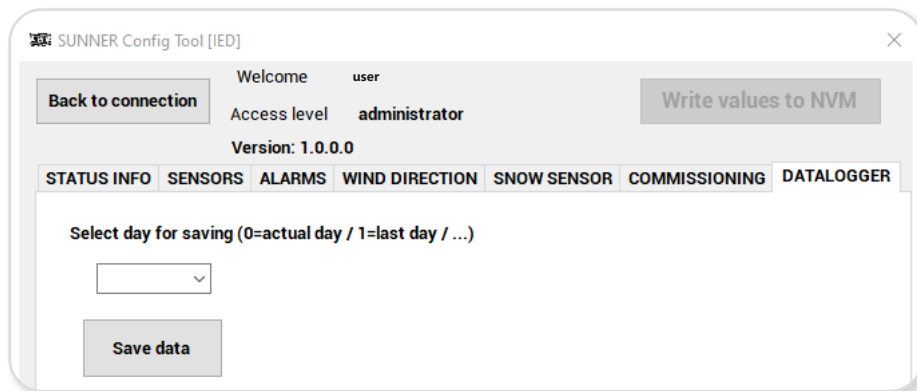
NOTE: It is not necessary to select 'Write values to NVM' to change the values permanently. This will happen automatically.

9.9 Download datalogger

On the upper part, select 'Datalogger'.

Here the weather information for the last 7 days can be downloaded.

First, select the day and then 'Save data'.

The value of the following parameters of each minute (from 00:00 to 23:59) of the selected day will be downloaded:
- Prevailing wind direction
- Average value of wind speed
- Maximum wind speed value
- Maximum snow level value

The download process may take some minutes.

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All dimensions and sizes are approximate.
Specifications and prices are subject to change without notice.