Sparvio and SKH3 manual

This document instructs how to use the Sparvio sensor system with the SKH3 logger. SKH3 is the second-generation drone data logger from Sparv Embedded. The logger optimizes size, weight and power (SWaP) for drone use, but also puts high emphasis on reliability and extensibility. The inclusion of a touchscreen shows the high focus on usability – easy troubleshooting is important for the complexity of a drone-based sensor system.

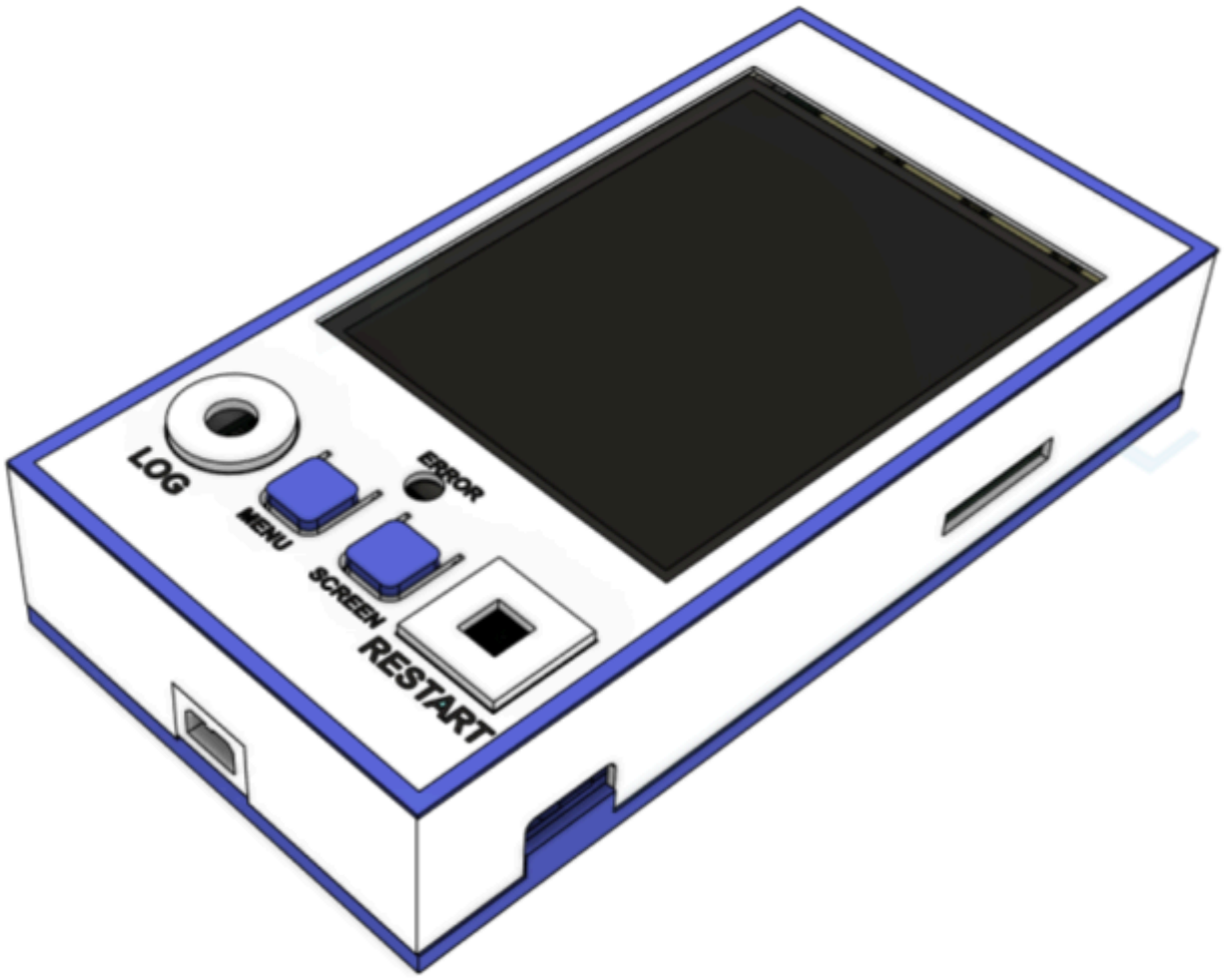


Table of contents

Installation

Install Sparvio on a UAV of your choice, either fixed-wing (airplane) or rotary-wing (quadcopter etc). All modules except SA1, RR1 and RR2 go on the drone and are connected via the included blue 6-pole SSP cables. When choosing locations for the modules, mind the requirements of each component:

SKH3 needs the buttons to be easy to press and the onboard display and LEDs should be visible.

The GPS needs to face upwards, away from electric parts like motors, with a clear view of the sky.

The telemetry antenna should point straight up or straight down. Be mindful of the propellers and avoid nearby metal parts that can shield the radio signal.

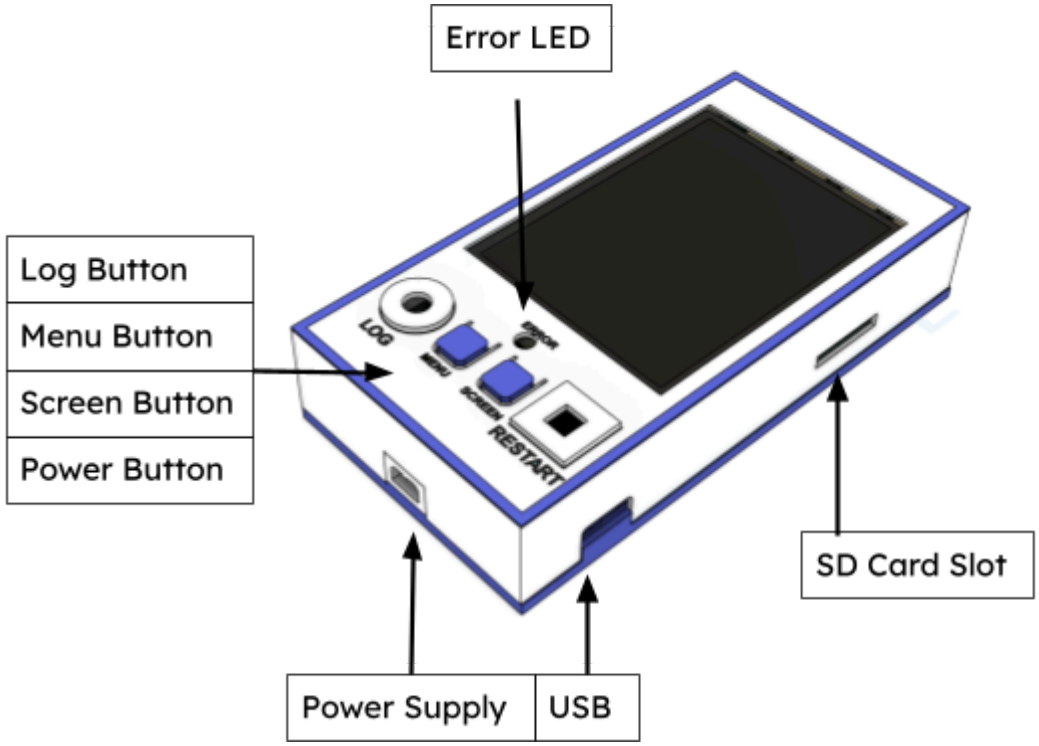
Sensors should generally be placed in the oncoming air flow from the drone's movement through the air. Temperature and humidity sensors are affected by heat conducted and radiated from the drone body so these sensors should be placed away from heat sources.

All modules may require future firmware upgrades, in which case the connector or the lead for each module needs to be accessible.

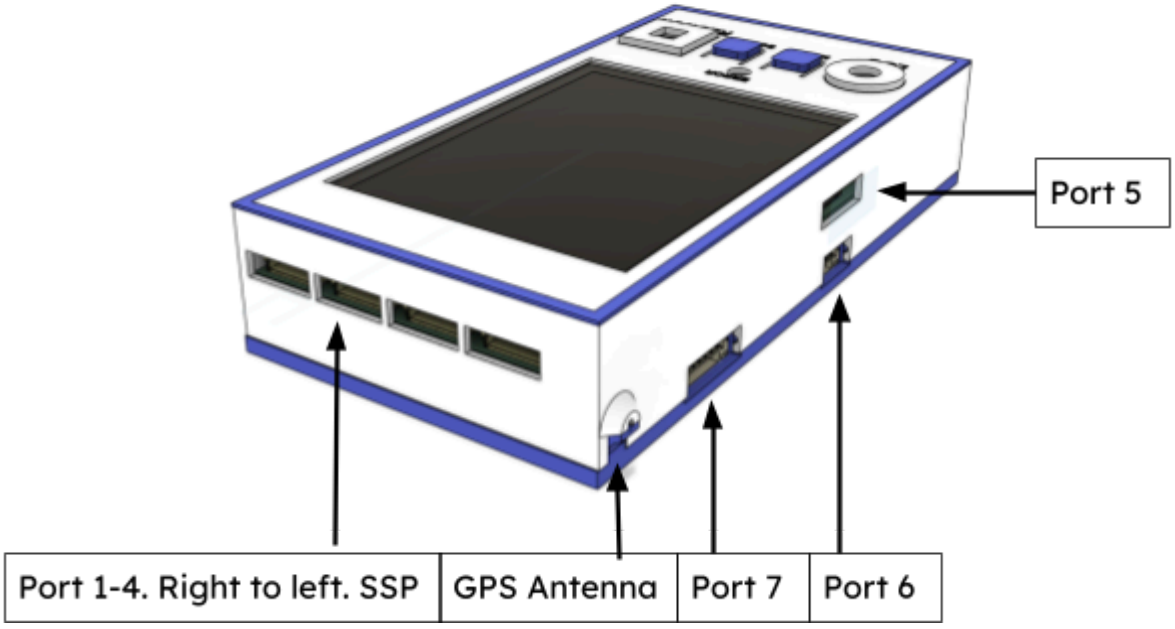
Secure the modules with velcro (included), double-adhesive tape, cable ties or similar. As an alternative, some modules have two screw holes.

If a pole is mounted on the drone, SKH3 can be mounted on the pole with the included mounting mechanism. Otherwise SKH3 can be mounted like any of the modules.

Overview



View 1 of SKH3



View 2 of SKH3

How to start and stop (external Power Config)

Connect a power supply to start the system. Any voltage in range 5 - 17 V works, but the voltage needs to also be compatible with any connected sensors.

Disconnect the battery to turn off. SKH3 has an internal backup battery that ensures logging is shut down in an orderly fashion. This backup battery is automatically charged when a Power Supply or USB is connected.

In this configuration the connected sensors only receive power from SKH3 when the Power Supply is connected. It does not power sensors from USB or the internal battery.

How to start and stop (internal power config)

Press the power button to turn SKH3 on and off.

How to operate

The *Error LED* shines red if there are any errors. Details can be found on the Start Screen.

The round *Log Button* starts and stops logging. It shines blue when logging is active.

The *Menu Button* is used together with the touch screen to navigate the interface. The button goes back from the current screen towards the Main Menu.

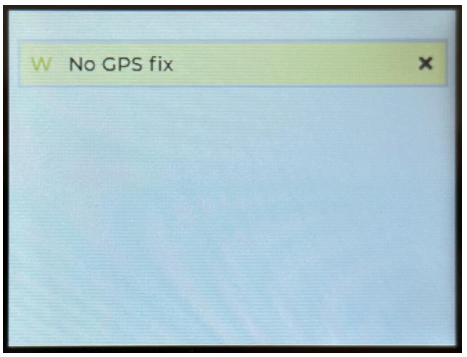
The *Screen Button* is used to turn on and off the display.

The square *Power Button* is not normally used when SKH3 is configured to run from external power. The button can be held for 10 seconds to force SKH3 off in case of errors.

The *SD Card Slot* is used to log measurements onto an SD card.

Port 7 is used to connect a TriSonica using SKS31.

Start screen



The start screen lists notifications that might be of interest. Press the *Menu Button* to leave this screen and go to the Main Menu. The Start Screen can also be reached by pressing the *Errors* option in the Main Menu.

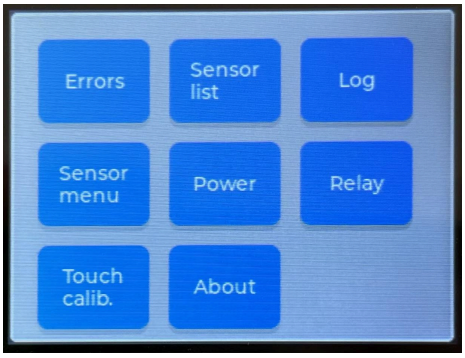
The severity of the notification is indicated with a letter. Types of notifications:

E	Error	Severe problems that likely will result in data loss. When any error is active, the error LED will shine red. Logging will be done as far as possible also during error conditions.
W	Warning	Less severe. For example, some data may be missing, such as time, position or sensor readings.
I	Information	Events that are not erroneous. Example: The GPS has been disabled by the user.

Each notification can be dismissed with the ‘x’ button. Tapping on a notification brings up more details.

Notifications can be “active” or “past”. Notifications that refer to a past event are still shown, as the user can’t oversee the display all the time. For example, a temporary loss of GPS fix will be detected here.

Main menu



The Main Menu gives access to more specific dialogs. The exact options depend on the hardware configuration and settings:

- Errors: The same as Start Screen
- Sensor list: Shows a list of all connected sensors
- Log: Information about the SD card and logging to it
- Sensor menu: Some sensors have their own screens where you can see their measurements. Those screens are reached from this menu.
- Power: Information about power current and voltages
- About: Information about the hardware and firmware versions

Advanced features:

- Touch calib.: Calibrate the touchscreen (normally not needed)
- Profile: Configure the logger for how many sensors to expect and which menu items to show.

Logging

Logging starts automatically when the logger is powered on.

Pressing the *Log Button* will toggle logging. The logging LED is off if logging is disabled. It will blink if logging is enabled but it is unable to log, if for example there is no SD card inserted. The logging LED will be on if logging is ongoing.

Each logging start will create a new log file. Stopping and restarting logging can serve to mark a significant event, such as flight start.

It usually takes half a minute to acquire a GPS fix, at which point the current UTC time and the position can start being logged.

A built-in real-time clock provides the time before a GPS fix gives a more accurate time. In rare cases, the real-time clock may not know the time. Even in such cases, logging may still be started and a subsequent GPS fix will retroactively correct the recorded timestamps.

All sensor values are logged at their respective sampling rate. For example, SKS1 values are logged at 1 Hz while SKS2 is logged at 10 Hz. Refer to each data sheet for the respective sampling rate. Some sensors have a configurable sampling rate.

SKH3 records logs in a custom, binary file format with file suffix “.dat”. These contain more details and events than is typically needed, but can be useful for troubleshooting.

Retrieving logs

Before removing the SD card, ensure that the card is not being used by either disabling logging or by powering off SKH3. Then push the SD card to make it eject, and move it to a PC and run skh3_log_to_csv.

Converting logs: skh3_log_to_csv

Given some original directory and some target directory this program will find all binary logs in the source directory and move them to the target directory while also generating CSV files in the target directory. Since the original binary logs are stored next to the CSV files they can be used later to generate CSV files with different settings. As long as there is some GPS time data in the original log the CSV will have UTC timestamps. So you don’t need to have a GPS fix when starting to measure.

Every measurement from all connected sensors is logged.

The directory structure of the SD card looks like this `/sparv/ssp_log/LOG_0.DAT`. It works to set the source directory to any of those three directories.

The program will suggest an appropriate directory as a target. If the SD card is inserted

before starting the program it will automatically suggest the SD card as the source directory.

Checklist for correct logging

- ☐ The Log screen shows that logging is ongoing and counts up the number of logged lines.
- ☐ The green logging LED is on and is not blinking
- ☐ Sparvio sensors are blinking green at their sampling frequency

Telemetry

If a telemetry hardware module is connected, SKH3 will transmit data in real-time to RR1 or RR2 connected to a computer. The data can be viewed as real-time graphs using Grafana.

The limited bandwidth of the telemetry link means that some data may not be transmitted. Additionally, radio interference or a weak signal (for example from loss of line-of-sight) can lead to telemetry data loss. The complete data is only guaranteed to be recorded to the onboard log.

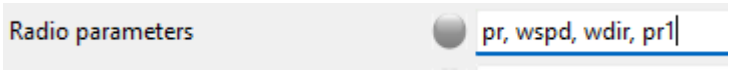
radioParams

There is a setting that selects which measurements are sent over the telemetry link. If you use Sparvio App you can set `radioParams` to a list of variables, separated by comma. Each of those will be sent over the link whenever new values are measured for them.

You can find which variables you want to include by using skh3_log_to_csv to create a file with a description of the variables. This way you can see the exact variables used in your system and the values they will take. In the following example you would add “pr1” to the list if you want to send “Absolute pressure from barometer #1”.

```
# pr; Pressure; [Pa]; Absolute pressure
# pr1; Barometer #1 pressure; [Pa]; Absolute pressure from barometer #1
# pr2; Barometer #2 pressure; [Pa]; Absolute pressure from barometer #2
```

You may have to replace some variables in order to fit your new variables. Here is an example list from Sparvio App that includes pr1.



Sensor light signals

The LED on each sensor blinks every time a measurement is taken. The modes are:

- Solid yellow: The sensor is warming up. Measurements are not valid yet.
- Solid red: Error (for example wrong supply voltage or broken sensor)
- Solid blue: Special non-measuring mode such as calibration or command mode
- Blinking green: The sensor is measuring and has contact with the hub.
- Blinking yellow: The sensor is measuring but can’t report the values to the hub.
- Blinking red: Measurements can’t be taken. If this happens, contact Sparv Embedded.
- Purple: The bootloader is active

Configuration

SKH3 and sensor modules contain a lot of variables for accessing settings and sensor values. These variables can be set using Sparvio App.

Wind mount rotation

These variables describe the rotation of the wind sensor. For example windMntYaw can be set to 90 degrees if the wind sensor is mounted such that it faces to the right compared to the forward direction of a drone.

- windMntYaw
- windMntPitch
- windMntRoll

Magnetic declination

The magDec can be set to correct the magnetic north to true north when using the TriSonica compass for global wind calculations.

Note

- The drone’s yaw measurement is used instead of TriSonica if available, so the TriSonica compass is rarely used.
- The TriSonica compass needs calibration for proper measurements.

DJI Drone

There are some limitations when using a DJI drone. The limitations are due to the “PSDK” software provided by DJI that is the only way for SKH3 to communicate with the drone.

When starting:

- If SKH3 is started before the drone is connected then SKH3 will give up after 1 minute or so (this does not seem intentional but rather an issue with their software).
- The drone can be started before SKH3 is connected without issue.

After both devices have started:

- Any duration (tested 10 min) of lost connection between SKH3 and E-Port Dev Kit or between E-port Dev Kit and the drone can be handled.
- Restarting SKH3 works.
- Restarting the drone without restarting SKH3 does not work.

CSV data

The skh3_log_to_csv program creates CSV (“comma-separated values”) files with certain column names.
Each column is a combination of the component name (the sensor) and a variable name.

Example: AerisCH4_7F7D751E.ch4
AerisCH4_7F7D751E = name of the component (by default, the sensor type and serial number)
ch4 = name of the variable (here, methane concentration)

The meaning of the variables can be exported from skh3_log_to_csv.

Component: Aeris

An Aeris sensor can also be connected directly to the logger. In that case the measurements will have the SKH3’s name as the component name.

Variable	Unit	Description
pcbTemp	℃	Temperature inside the Aeris core (where the measurement is taking place)
humVPpm	ppm	The ratio of water vapor to the total volume
aerisT5	℃	Temperature in the Aeris pressure sensor
aerisTGas	℃	Temperature used for Aeris spectroscopy calculation

Component: Mavlink

Reports data recorded by the autopilot. The measurements are probably not from any single sensor but fused from multiple sensors and filtered by software.

Variable	Unit	Description
roll	°	Sideways tilt. 0 = horizontal 90 = the right side is facing straight towards the ground
pitch	°	Angle of attack 0 = horizontal -90 = facing straight down
heading	°	Geometric orientation 0 = Trisonica faces true north 90 = Trisonica faces true east
alt	m MSL	Altitude.

dir	°	Course -- traveling towards this direction with 'spd' speed. This can differ from heading. 0 = moving towards true north, 90 = towards true east.
spd	m/s	Speed over ground.
velX	m/s	Speed over ground, true north component.
velY	m/s	Speed over ground, true east component.
velZ	m/s	Vertical speed, up is positive.

Component: SKH3

These variables are measured by SKH3. An Aeris sensor can also be connected directly to SKH3. In that case the measurements will have the SKH3's name as the component name but they will have the same meaning as in the Aeris section.

Variable	Unit	Description
alt	m MSL	Altitude recorded by the SKH3 GPS
lat	°	Latitude, recorded by the SKH3 GPS
lon	°	Longitude, recorded by the SKH3 GPS
dir	°	Course -- traveling towards this direction with 'spd' speed. This can differ from heading. 0 = moving towards true north, 90 = towards true east.
pr	Pascal	Ambient barometric air pressure
pr1, pr2	Pascal	Air pressure from the two individual barometers
spd	m/s	Speed over ground, from SKH3 GPS
velX	m/s	Speed over ground, true north component, from SKH3 GPS
velY	m/s	Speed over ground, true east component, from SKH3 GPS
velZ	m/s	Vertical speed, up is positive, from SKH3 GPS

Component: SKH3, measured by TriSonica or WindMaster

These variables are measured by the wind sensors TriSonica or WindMaster but reported by SKH3. They measure wind relative to the sensor but SKH3 uses positioning data to calculate the wind relative to the ground (true north). SKH3 uses positioning data from the drone for the calculations.

Variable	Unit	Description
wspd	m/s	Horizontal wind speed relative to Trisonica.
wdir	°	Horizontal wind direction relative to Trisonica. 0° is the wind coming from the north and 90° is coming from the east.
windU	m/s	Zonal component i.e. the component of the wind towards east (m/s). Relative to Trisonica, not the ground.
windV	m/s	Meridional component i.e. the component of the wind towards north (m/s). Relative to Trisonica, not the ground.
windW	m/s	Vertical component i.e. the upwards component of the wind (m/s). Relative to Trisonica, not the ground.
roll	°	Sideways tilt. 0 = horizontal 90 = the right side is facing straight towards the ground
pitch	°	Angle of attack 0 = horizontal -90 = facing straight down
heading	°	Magnetic orientation 0 = Trisonica faces magnetic north 90 = Trisonica faces magnetic east The drone gives a better measure, when available.
gWindU	m/s	Zonal component i.e. the component of the wind towards east (m/s). Relative to the ground, not the sensor.
gWindV	m/s	Meridional component i.e. the component of the wind towards north (m/s). Relative to the ground, not the sensor.
gWindW	m/s	Vertical component i.e. the upwards component of the wind (m/s). Relative to the ground, not the sensor.
sonicTemp	℃	Sonic temperature.
extRh	%RH	Relative humidity.
extPr	Pascal	Ambient air pressure.

Component: SKS1, SKS21, SKS22

Variable	Unit	Description

rh	%RH	Relative humidity.
temp	℃	Ambient temperature.
tmp117Temp	℃	On SKS21, temperature reported by the TMP117 sensor.
h4T1	℃	On SKS21, temperature reported by the H4 sensor.

Component: SKH3, measured by a DJI drone

These variables are measured by a DJI drone but reported by SKH3.

Variable	Unit	Description
extLat	°	Latitude
extLon	°	Longitude
extAlt	m MSL	Altitude
extVelX	m/s	Speed over ground, true north component
extVelY	m/s	Speed over ground, true east component
extVelZ	m/s	Vertical speed, up is positive
extHeading	°	True orientation 0 = true north 90 = true east
extPitch	°	Angle of attack 0 = horizontal -90 = facing straight down
extRoll	°	Sideways tilt. 0 = horizontal 90 = the right side is facing straight towards the ground
extHeadingSpeed	°/s	Angular velocity of heading
extPitchSpeed	°/s	Angular velocity of pitch
extRollSpeed	°/s	Angular velocity of roll

Troubleshooting

Check the SKH3 display for error messages. Tapping an error message brings up a screen explaining the issue closer.
To give effective support, Sparv needs

- a description of the problem
- the serial number of the SKH3
- the list of connected sensors
- a binary log file (with file suffix .bin)
- the system log, available on the SD card as file /sparv/txt_log/current.txt

Firmware upgrade

The SKH3 firmware can be upgraded by a special Windows program. Sparv Embedded makes the latest program link available when needed.

Full method

The most reliable way to upgrade the firmware is to put the SKH3 in boot mode and then run the upgrade PC program.

1. Connect SKH3 via USB to a PC
2. If the receiver is turned on, power it off
3. Press and hold the menu button
4. Power on the receiver. If done correctly, the receiver will not make any sound and the LEDs will not turn on.
5. Release the menu button
6. Run the firmware upgrade PC program
7. The program will run in a new terminal window. After about 30 seconds, the program will succeed with the text “Firmware upgrade done”
8. Close the terminal window.
9. Restart SKH3.

Simplified method

To save time you can try skipping putting the receiver in bootloader mode and just run the upgrade program. It may be necessary to run the program twice this way. If this doesn’t work you will have to perform the “Full method” sequence above.

1. Run the firmware upgrade PC program – see link below
2. The program will run in a new terminal window. After about 30 seconds, the program will succeed with the text “Firmware upgrade done”
3. Close the terminal window.

Battery Level

The SKH3 displays both the remaining battery percentage and an estimate of how much operating time is left. This information appears on the Power screen from the general menu and helps you plan enough time to complete your recordings.

When the battery reaches 0 percent, the device enters deep sleep and wakes periodically to check if a charged battery has been installed. This feature protects your battery from deep discharge.

Viewing Battery Status

- Open the general menu.
- Select Power.
- Read the displayed battery percentage and estimated runtime.

Configuring Your Battery Profile

To get accurate battery readings, specify your battery type and capacity:

- Open the general menu.
- Select Profile.
- In Battery type, choose one of the following:

Battery type	Description
No Battery	Disable battery monitoring
Lipo2S	2-cell lithium-polymer battery
Lipo3S	3-cell lithium-polymer battery
Lipo4S	4-cell lithium-polymer battery

- In Capacity, enter your battery's rated milliamp hours (mAh), for example 450 or 900.

Accurate settings ensure the runtime estimate matches your actual battery performance.

Disabling Battery Monitoring

If you don't need battery tracking—such as when powering SKH3 from an unmanned aerial vehicle (UAV), set Battery type to No Battery.

Important Notes

- Selecting a battery type lower than your actual battery may cause the device to

enter deep sleep prematurely. If this happens, connect to USB only, update your profile with the correct capacity, then reinsert the battery.

- When both USB and a battery are connected, SKH3 draws power from the battery first. It can still enter deep sleep if the battery depletes. To run without any battery restrictions, power the device exclusively via USB or set the battery type to "No Battery".

Appendix: Technical details

Powering SKH3 (external power config)

SKH3 is turned on by connecting an external 5-17V power supply and turned off by disconnecting the power supply. The power button is normally not used.

Power is handled as per the first case that's applicable at every point in time:

1. When external power is connected, SKH3 and sensors are powered from external power. The internal backup battery will be charged up.
   No power is drawn from USB or from the backup battery.
2. When USB is connected, SKH3 is powered from USB. Sensors are unpowered. The internal backup battery will be charged up.
3. SKH3 is powered from its backup battery. Sensors are unpowered. SKH3 will do a controlled shut down unless another power source reappears shortly.

Since sensors are not powered from USB, the requirement for USB current delivery capability is modest, but a 500 mA USB power source is still advisable to handle SKH3 current peaks.

Powering SKH3 (internal power config)

Here SKH3 is equipped with a large internal battery and only supports USB as the external power source. SKH3 is turned on and off with its power button. The internal battery is not intended to be disconnected; doing so will make SKH3 lose the current time.

Power is handled as per the first case that's applicable at every point in time:

1. When USB is connected, SKH3 and sensors are powered from USB. The battery will be charged up.
2. Without USB, SKH3 and sensors are powered from the internal battery.

SKH3 will draw up to 500 mA from USB, but not more. If the sum of SKH3, the sensors and the battery charging would exceed 500 mA, battery charging will be limited.

Timestamping

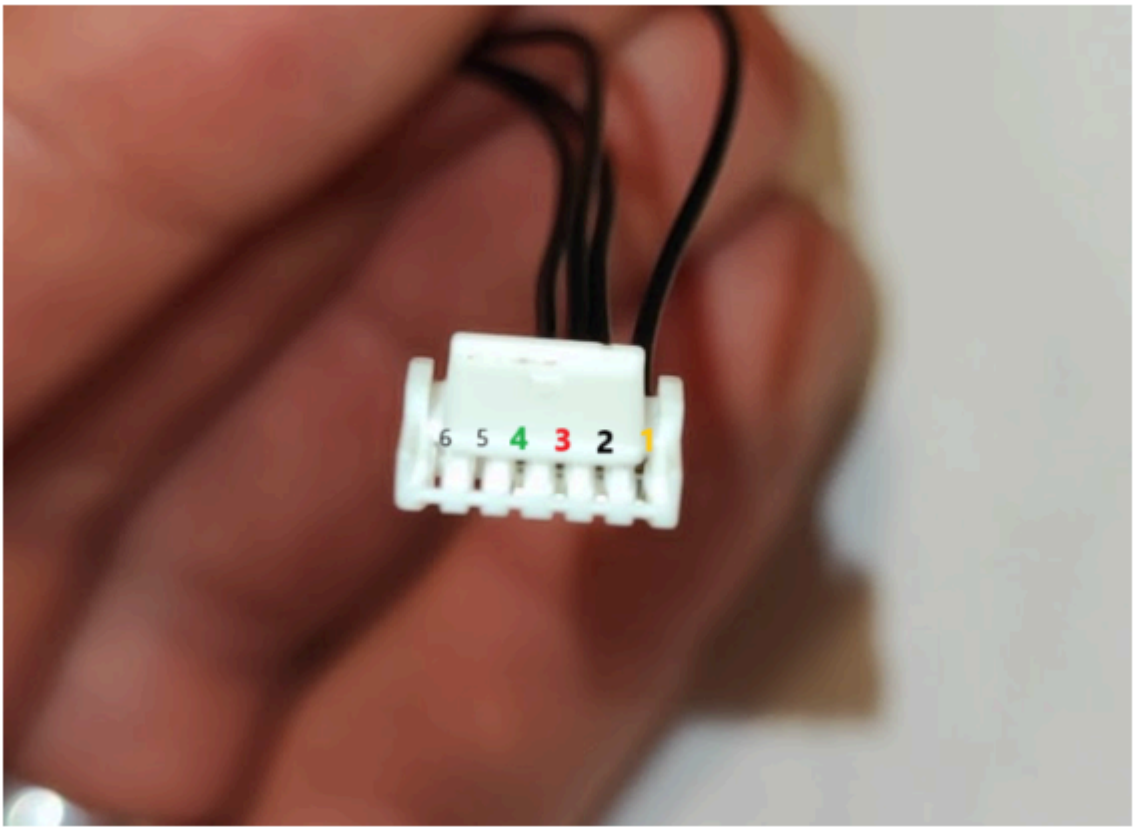
SKH3 incorporates advanced techniques to ensure both immediate and accurate timestamping, with an accuracy approaching the logging resolution of 1 millisecond. On startup, a real-time clock provides the initial timestamping. When a GPS fix is acquired, the internal clock is adjusted to the atomic clocks of the GPS network for improved accuracy. If GPS fix is lost, timekeeping is carried on by the internal clock, with some degree of drift over time.

SKH3 keeps doing recurring synchronizations between the GPS network and its internal clock. These points of timing synchronization are included in the log file. In this way, a computer can further analyze and correct for any drift in-between the synchronization

points. The effect is a robust system where data between any number of loggers will stay synchronized.

SKH3 wind sensor connector pinout

This connector is only available on the SKE2 extension.



	 Trisonica pinout	
1	Yellow	9-36 V.
2	Black	Ground and the serial connection return.
3	Red	RS-232 TxD (Serial Data Out of the TSM).
4	Green	RS-232 RxD (Serial Data into the TSM).
5	-	NC
6	-	NC

Issues with the SSP connector

The female SSP connector has 6 pins. These have a small chance of becoming bent during insertion. Please check the connector before connecting your device. And disconnect the connector to check if you are having connection issues. To avoid this issue insert the connector as straight as possible.