Senquip User Guide

Release ORB-C1-2.1.1

Senquip

Jun 24, 2025

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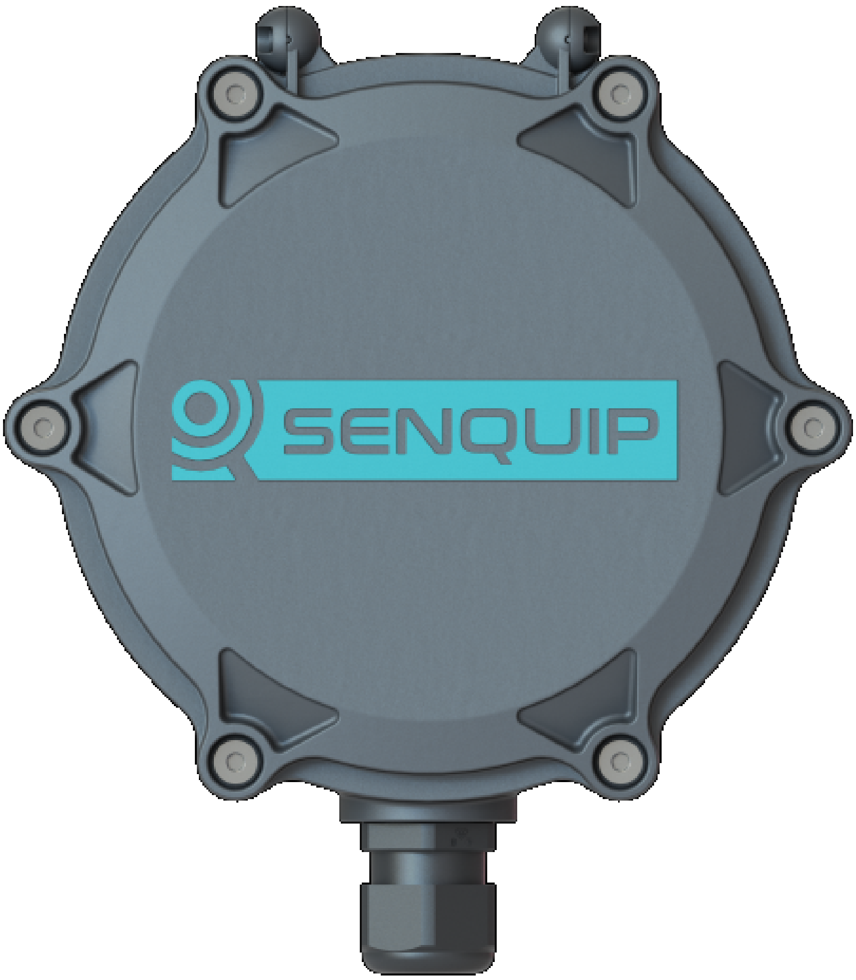
PDF Version of this User Guide.

Chapter 1

Introduction

1.1 What is the Senquip ORB



Senquip manufactures rugged, programmable telemetry devices that connect to industrial sensors and system and send the data measured to the Senquip Portal or a server of your choice.

The Senquip ORB is a telemetry device designed for use in harsh outdoor environments; up a pole, on a wall or attached to a vehicle.

Built in sensors allow measurement of supply voltage, battery voltage, time, position, speed, ambient temperature, pitch, roll and pressure. Interfaces are provided for RS232, RS485, MODBUS, CAN bus, Bluetooth, 4-20mA, pulse, frequency, and voltage. Antennas, the typical failure point in a telemetry system are all internal.

Data measured by the Senquip ORB is transmitted to the internet via Wi-Fi or 4G LTE4 and can be delivered to the Senquip Portal or to your own server or SCADA system.

Power is supplied with replaceable AA batteries, solar, or with 10V to 75V DC. If a solar panel is used, an internal LiPo battery will keep the device powered during periods without sunlight.

Senquip telemetry devices are programmable with JavaScript. Users can write their own scripts to manipulate data, create combinational alerts, execute local control, or create customised payloads for sending to 3rd party servers.

Typical markets include mining, utilities, and transport.

1.2 Who can use the Senquip ORB

The extensive array of in-built sensors, ability to interface to any industrial sensor or system, programmability, versatile power supply and rugged enclosure mean that the Senquip ORB can be used in a wide variety of applications across many industries. Typical applications are found in:

Mining, monitoring plant and equipment such as lighting plants, pumps, water tankers and more. Measure utilisation, location, fuel level, engine speed, temperature and more to ensure reliability and optimal performance.

Water Services, ensuring that drinking water is of the highest possible quality. Detection of chemical leaks in factories and in water treatment plants. Measure level, flow, temperature, pH, chemical makeup and more.

Fleet, connecting to the vehicle and load to provide more than just telematics. Interface to CAN-bus and other available sensors on a vehicle.

Smart Cities, measuring temperature, sound, asset utilisation, service delivery and other parameters to enhance the daily lives of citizens.

Environment, monitoring air-quality pollution, dust and pollen levels to provide early warnings and improve the health of local populations.

Emergency Services, monitoring of water levels and other environmental factors to provide early warning of flood, fire and other natural disasters.

Industrial Installations, interface to sensors using industry standard protocols like 4-20mA, voltage, MODBUS, and RS232.

Agriculture, soil and water monitoring to ensure fast growing, high quality crops and maximum yield.

Aquaculture, measuring water quality and temperature to ensure optimum growth and health of fish populations.

Health Services, monitoring of fridges to ensure safe storage of temperature sensitive medicines.

1.3 You can rely on the Senquip ORB

The Senquip ORB has been designed from the ground up to offer a reliable, capable, flexible and secure remote monitoring platform for industrial users.

Reliability, the Senquip ORB has been designed for use in challenging environments where reliability is paramount. Where other devices fail, the Senquip ORB will continue to deliver data, reducing overall cost of ownership and an enhanced user experience.

Capability, the Senquip ORB has more on-board monitoring, allows connection to more external sensors and has the most versatile power requirements of any telemetry unit in its class.

Flexibility, the user interface is simple to use and yet allows enough flexibility to ensure compatibility with most industrial sensors and systems. User written scripts offer infinite opportunity for customisation.

Security, all data collected is encrypted and is transmitted using secure authenticated connections.

Ownership, at Senquip, we believe that the customer owns their data. We deliver your data to your servers in a private, secure manner. We will not access, use or resell your data - it is yours.

1.4 What is included with your Senquip ORB

When you open your ORB box, the following are included:

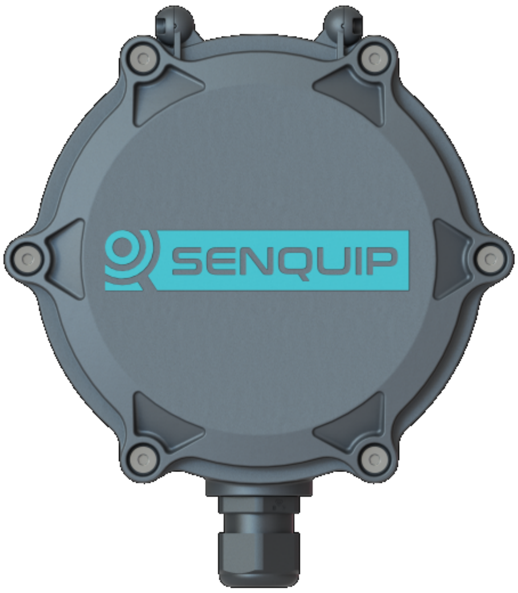


Figure 1.1. 1 x ORB

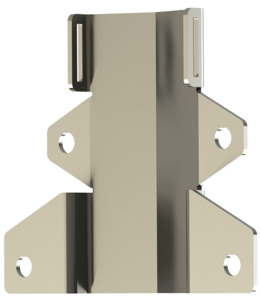


Figure 1.2. 2 x Wall and pole mounting brackets

Figure 1.3. 1 x 2-hole and 1 x 3-hole gland insert

Figure 1.4. 4 x M5x8mm mounting screws

Figure 1.5. 1 x 3mm Allen key

Figure 1.6. 1 x Getting started guide

Chapter 2

Regulatory Information

USA: Federal Communications Commission (FCC) statement

This device complies with FCC part 15 FCC Rules.

Operation is subject to the following two conditions: 1. This device may not cause harmful interference and 2. This device must accept any interference, including interference that may cause undesired operation of the device.

FCC Warning

Changes or modifications not expressly approved by the party responsible for compliance could void the user authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

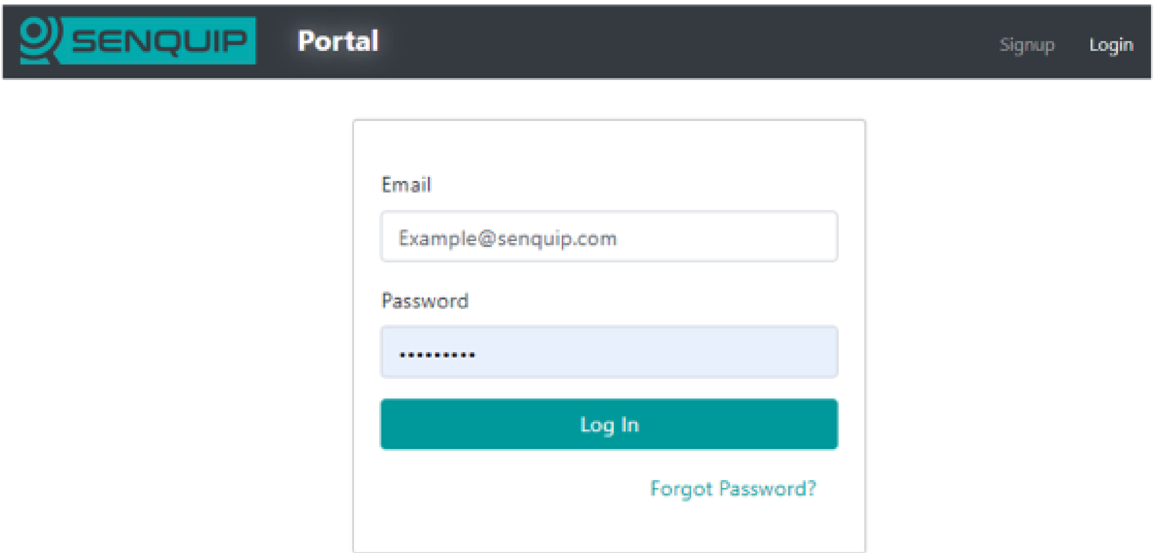
This device meets the FCC and IC requirements for RF exposure in public or uncontrolled environments.

2.1 Accessing Regulatory Information

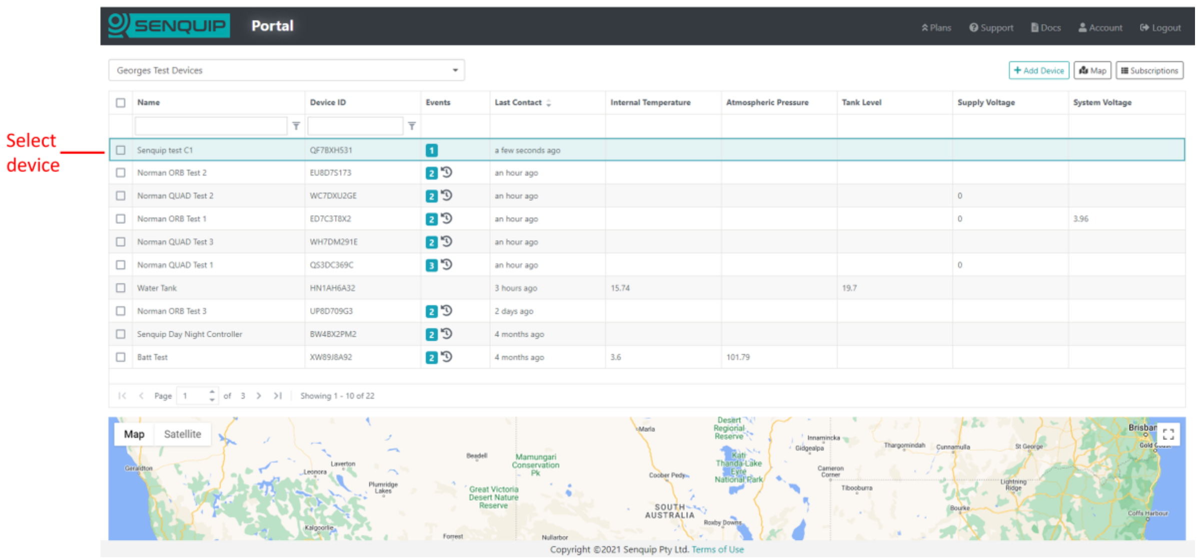
You can access the regulatory information for your device by following this link: https://portal.senquip.com/fcc.

Alternatively, you can view the device FCC ID on the Senquip Portal. To view the FCC ID:

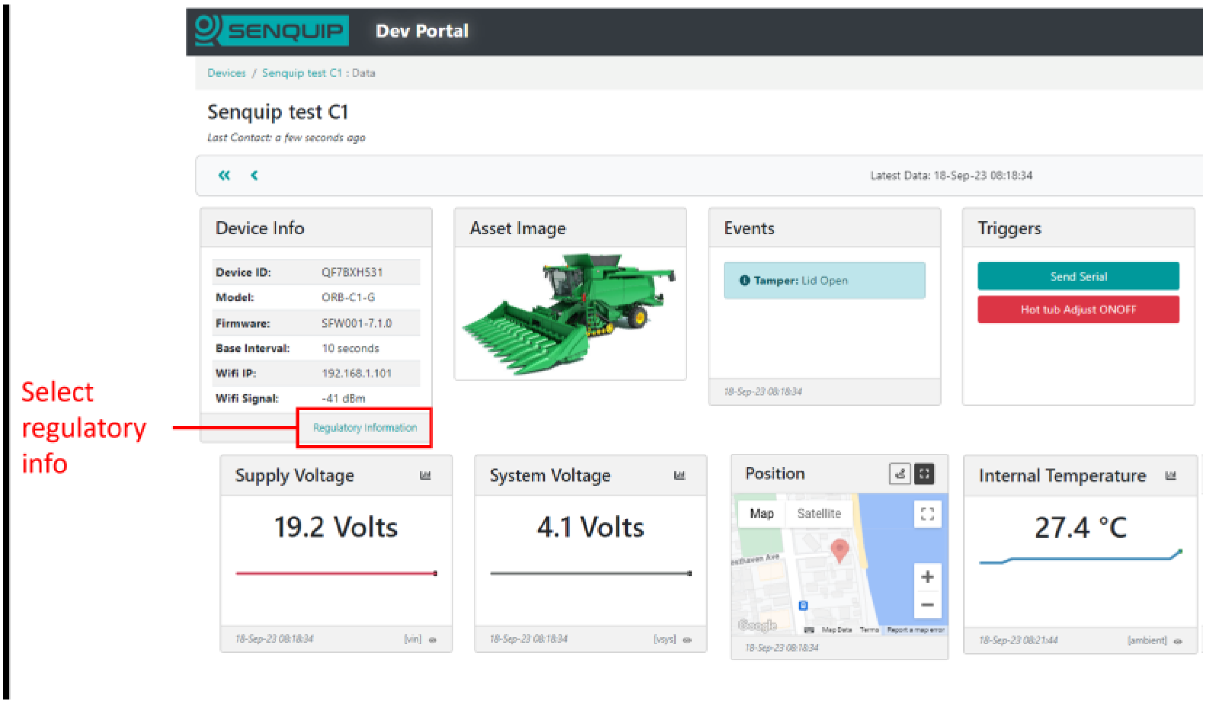
1. Launch the Senquip Portal.



2. Browse to the device page



3. On the *Device Info* widget, select *Regulatory Information*


Select regulatory info
SENQUIP
Dev Portal
Devices / Senquip test C1 : Data
Senquip test C1
Last Contact: a few seconds ago
Latest Data: 18-Sep-23 08:18:34
Device Info
Device ID: QF78XH531
Model: ORB-C1-G
Firmware: SFW001-7.1.0
Base Interval: 10 seconds
Wifi IP: 192.168.1.101
Wifi Signal: -41 dBm
Regulatory Information
Asset Image
Events
Tamper: Lid Open
18-Sep-23 08:18:34
Triggers
Send Serial
Hot tub Adjust ONOFF
Supply Voltage
19.2 Volts
18-Sep-23 08:18:34
[vin]
System Voltage
4.1 Volts
18-Sep-23 08:18:34
[vsys]
Position
Map
Satellite
18-Sep-23 08:18:34
Internal Temperature
27.4 °C
18-Sep-23 08:21:44
[ambient]

Chapter 3

Getting Started

3.1 Opening the Box

The ORB is shipped in a box with a security seal that ensures that the packaging has not been opened. If this seal is compromised, the box may have been opened, in which case, a non-authorised party could have had access to the ORB password. If the device is to be used in a critical application, please ensure that the seal is intact upon receipt and remember to change your password as soon as possible.

Figure 3.1. ORB packaging with intact security seal

3.2 Mounting

The ORB can be mounted directly on a flat surface or can be attached to a pole or wall using the appropriate mounts that are included when you purchase your ORB.

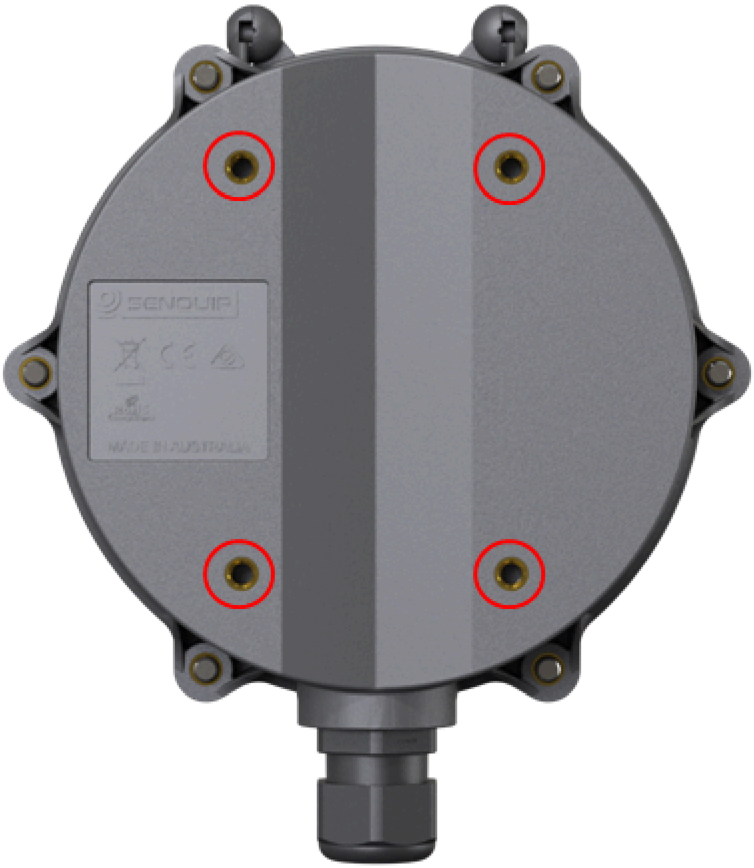


Figure 3.2. ORB mounting points circled in red

When attaching the ORB to a panel, use the four M5 bolts that are included and screw directly into the tapped holes on the rear of the ORB enclosure.

> **Warning** The depth of the tapped holes in the rear of the ORB enclosure is limited to 5mm; attempting to fasten to a depth exceeding 5mm may damage the enclosure.

Two multipurpose brackets that allow mounting to a pole or a wall are included with your ORB.

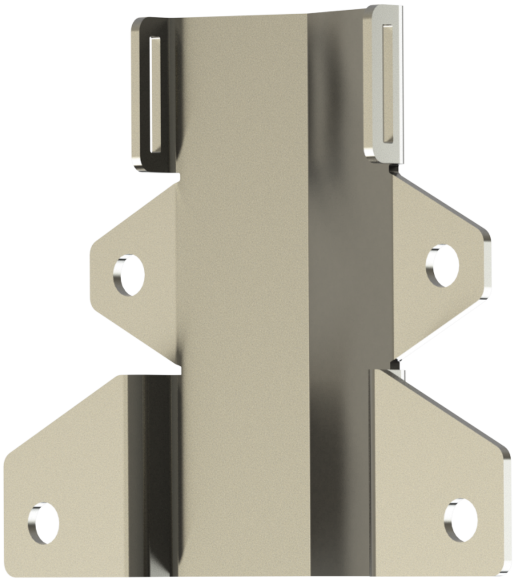


Figure 3.3. ORB mounting brackets

If attaching to a pole, use the four M5 bolts provided to attach the brackets as shown below. The pole mounting plate is designed to be used with commonly available jubilee-clips. Thread the strap end of a jubilee-clip through the slots in the top of the bracket. Repeat for the bottom bracket with a second jubilee-clip. Pass the straps around the pole and into the clamps. Tighten to secure the ORB to the pole.

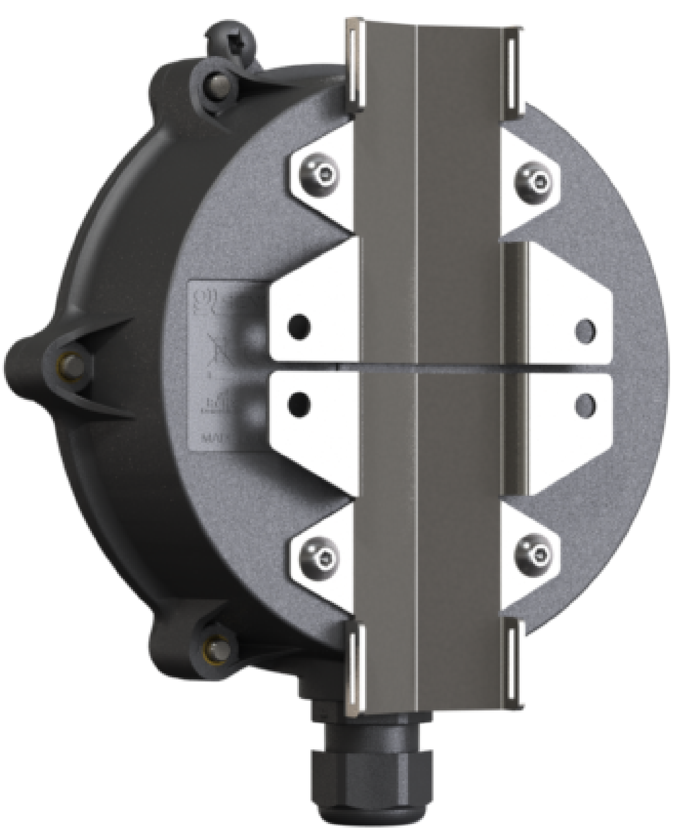


Figure 3.4. Attaching the pole mount bracket

The same mounting brackets can be used to attached the ORB to a wall. Attach the brackets to the rear of the ORB as shown below using the four supplied M5 bolts; note that the brackets are rotated 180 degrees when compared with how they are used for pole mounting.

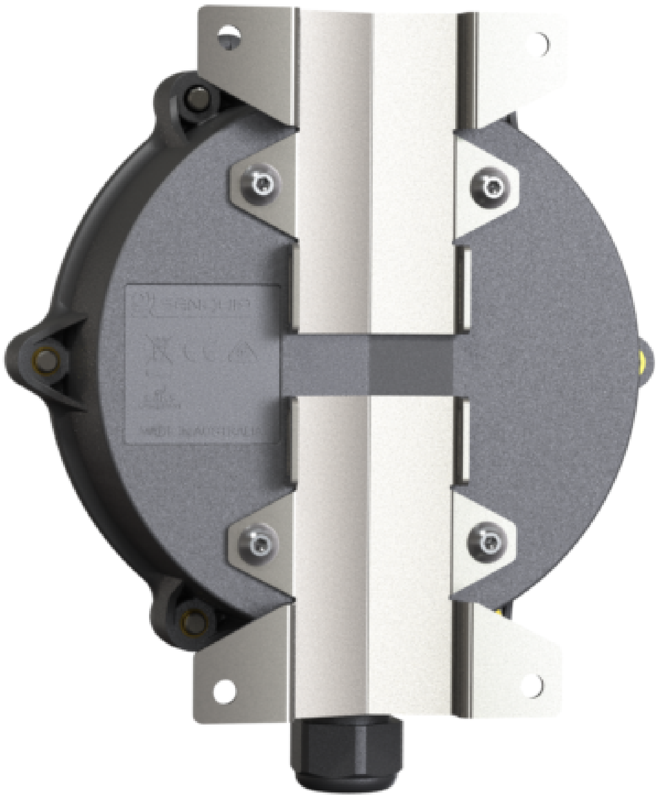


Figure 3.5. Attaching the wall mount bracket

Note Jubilee-clips and wall mounting bolts are application specific and are not provided as part of the ORB kit.

The ORB should be mounted with the cable entry gland facing the ground. Mounting the ORB with the gland in another orientation may result in water ingress via the cable entry gland. The ORB contains GPS, Wi-Fi and 4G LTE4 antennas that may not function optimally if the monitor is mounted in the incorrect orientation. In-field orientation checks can be performed using the built-in accelerometer and associated tilt measurements.

3.3 User Access

The user access panel is accessed by removing the hinged front cover. From the user access panel, batteries can be replaced, a SIM card can be inserted, wiring functions can be performed, diagnostics can be performed and the device can be reset or placed in setup mode.

Figure 3.6. User access for the ORB

To open the cover:

1. Un-fasten the 6 hex-head screws that secure the cover using the 3mm Allen key provided. The screws are captive and will not fall out when loose. Do not attempt to remove the screws from the lid.

Figure 3.7. Six cover screws

2. Open the hinged lid by lifting the bottom of the lid toward yourself and up. When the lid is opened, an internal light detector will recognise the increase in brightness and will enable the LEDs and configuration switches.

Note When closing the ORB, please ensure that the seal is correctly seated and is clean. A poorly seated or dirty seal may result in water ingress.

3.4 Anti Tamper Screw

In some installations, evidence needs to be provided where unauthorised access to the Senquip ORB has occurred. All devices include a tamper feature that can be configured to raise an alert when the lid is opened. In some instances however, a physical tamper indication is required. Senquip can provide tamper evident screws for the lid of the Senquip ORB. Once a tamper evident screw is in place, opening the device will require breaking the seal on the tamper evident screw.

Figure 3.8. Tamper evident screw

To fit a tamper evident screw, remove one of the lid screws closest to the cable gland using the 3mm Allen key provided. Replace the lid screw with the tamper evident version. The tamper screw is compatible with most available seals.

Note The tamper evident screw should be inserted last and removed first. The tamper evident screw should be inserted and removed with a 4mm Allen key.

Figure 3.9. Tamper evident screw in place on an ORB

3.5 AA Battery Install

The Senquip ORB can be operated on four AA batteries. If this is an application where there will be no power source, the batteries should be installed at this point.

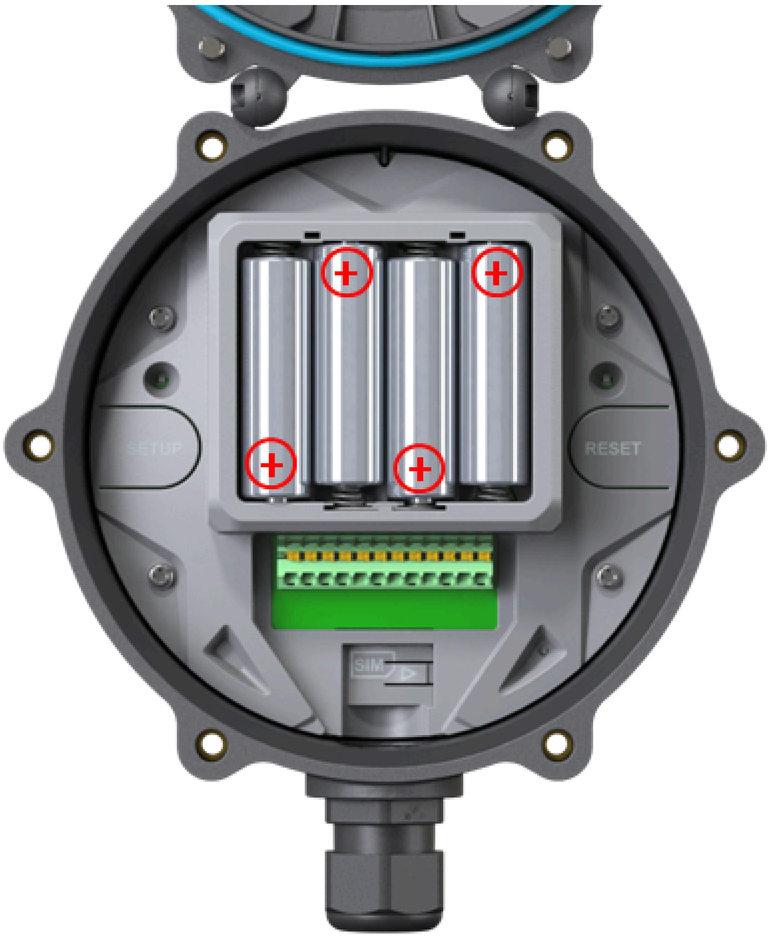


Figure 3.10. Correct battery placement

The AA batteries are to be placed in a battery holder which is exposed when the front cover is opened. Please insert the batteries, noting the correct polarity which is indicated on the base of the battery holder.

Note AA batteries are not required to provide backup power in the case of a power outage. The internal Lithium Ion Polymer battery will continue to power the device until it enters hibernate or shutdown.

3.6 SIM Card Install

The ORB uses a micro-SIM card with dimensions as shown in the figure below. Both 1.8V and 3.3V SIM Cards are supported.

If 4G LTE is the chosen communications method, then a SIM card should be installed now. In most instances, the ORB is shipped with an internal SIM card included. An internal SIM card provides for the most reliable communications in high-vibration environments.

Note If your ORB has an internal SIM card, you do not need to install an additional card.

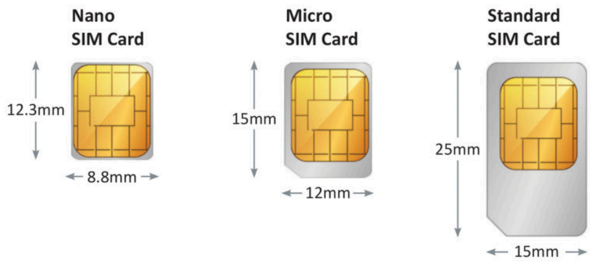


Figure 3.11. SIM Card sizes

Warning Senquip advises against the use of nano to micro SIM adapters. The adapters can get stuck in the SIM holder and cause damage, especially when removing a SIM.

Figure 3.12. SIM Card Adapter

To access the SIM card holder, the ORB lid must be opened. The SIM card holder is located at position 1 in the diagram below. The holder is a "push-push" type, meaning that the SIM card is pushed in to install and is then pushed and released to eject.

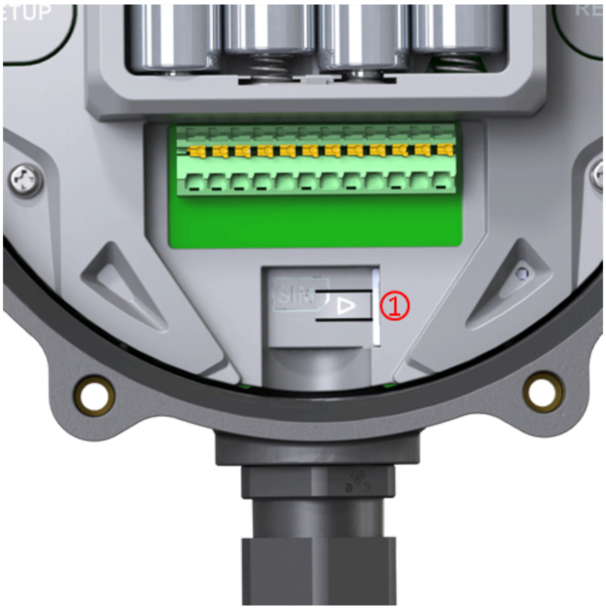


Figure 3.13. Identifying the SIM card slot

To insert a micro-SIM card into the holder, place it in the recess to the left of the SIM card slot and apply a gentle pressure to the right. The SIM card should be orientated with contacts facing up and the removed corner on the bottom right as in the diagram below.

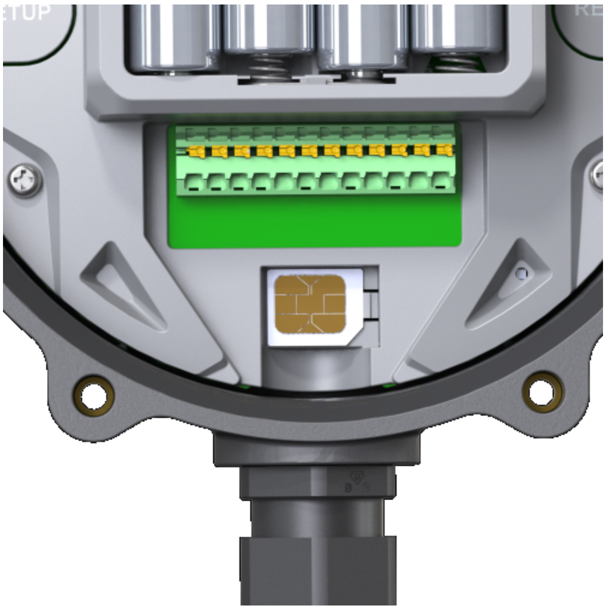


Figure 3.14. Correct insertion of a SIM card

Because the ORB is expected to be used in harsh environments, there is a plastic sprung locking mechanism moulded into the plastics. Once the SIM card is inserted, the plastic lock will lift, securing the SIM card in the holder.

Figure 3.15. Insert SIM to the right

It is recommended that the ORB be reset, by pressing the reset button, after inserting a SIM card.

To remove the SIM card, hold the locking mechanism down; press the edge of the SIM card gently and let go. The SIM card will be ejected.

3.7 Wiring guide

The ORB is fitted with a 12 way 3.5mm pitch terminal block that can be used to provide power and for connection to external sensors and systems. With the cable gland facing down, pin 1 is on the left hand side of the header and pin 12 on the right. All references to pin numbers in this document will assume this definition.

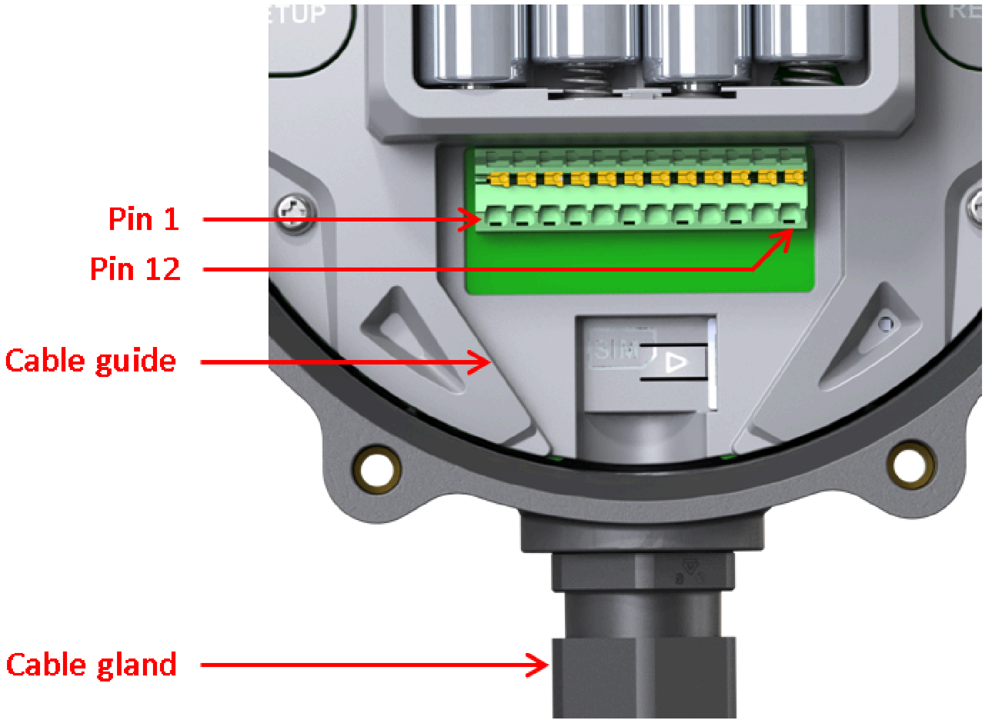


Figure 3.16. Interface pin numbers

The following pinout applies to the 12 way terminal block:

Pin number	Name	Terminal block marking	Application
1	Positive voltage in	PWR+	Positive system power; either permanent or intermittent such as from a solar panel
2	Negative voltage in (ground)	GND	Negative system power or ground
3	Source 1	SRC1	Switchable output with current measurement for powering sensors such as 4-20mA devices
4	Ground	GND	Spare ground for sensor connection
5	Source 2	SRC2	Switchable output with current measurement for powering sensors such as 4-20mA devices
6	Serial in	B / RX	RS485B in RS485 mode and receive in RS232 mode
7	Serial out	A / TX	RS485A in RS485 mode and transmit in RS232 mode
8	Input 1	IN1	Analog or digital input with edge detect capability
9	Input 2	IN2	Analog or digital input
10	Output	OUT1	Open collector output
ORB-X1			
11	Thermocouple	TC-	Thermocouple negative pin
12	Thermocouple	TC+	Thermocouple positive pin
ORB-C1			
11	CAN High	CAN H	CAN bus CAN high input

12	CAN Low	CAN L	CAN bus CAN low input

The terminal block allows for push-in connection, meaning that no tools are required. A defined contact force ensures that the contact remains stable over the long term and is high vibration environments. A finger operated release button for each terminal allows for convenient, tool-free operation.

Wire Specification:	
Wire stripping length	8 mm
Conductor cross section solid min.	0.2 mm
Conductor cross section solid max.	1.5 mm
Conductor cross section flexible min.	0.2 mm
Conductor cross section flexible max.	1.5 mm
Conductor cross section AWG min.	24
Conductor cross section AWG max.	16

Please ensure that all external power is removed from the ORB before wiring fitment begins.

Power and ground wires must be rated to at least 1A and should have a voltage rating suitable for the application. A 1A fuse in-line with the power connection is recommended. Signal wires should be chosen based on the application and may require specific features such as individual shielding, twisted pairs or impedance matching. In extremely noisy electrical environments, it is recommended that a shielded cable be used and that the shield only be connected to ground on the power supply end. Do not ground the shield on both ends.

The material from which the chosen cable is manufactured should be suitable for the environment in which it is used. Be sure to check chemical resistance, UV stability and flex durability of the cable being used.

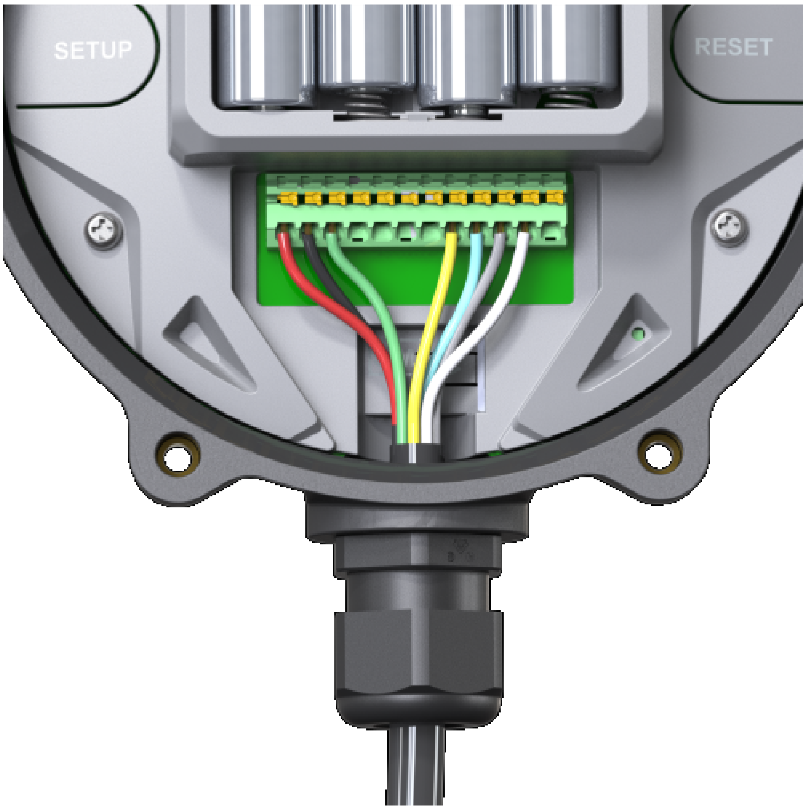


Figure 3.17. Wiring example with a sheathed cable

To ensure IP rating is retained, a sheathed cable with diameter suitable for use with the cable gland insert should be used. Three cable gland seals are supplied as specified in the table below. The gland with the single hole should be used when a single cable is required; the gland with two holes should be used where two cables are required etc. Cable seals are manufactured using NBR (Nitrile Butadiene Rubber) and are resistant to oils and biological oils, solvents and most industrial chemicals. Always check the suitability of the cable gland insert with all chemicals found in the operating environment.

Part No	No. holes	Hole diameter	Cable	
A	1	11mm	6-11mm	
B	2	5mm	3-5mm	
C	3	4mm	2-4mm	

3.8 Initial setup

Initial setup can be performed using the integrated web-server using any Wi-Fi enabled phone, tablet or computer or with the Senquip connect App with an Android or iOS device. Once the device is connected to a network, it is recommended that configuration be continued using the Senquip Portal.

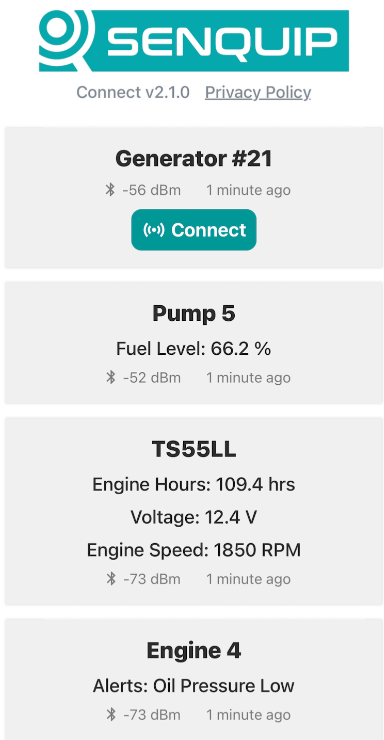


Figure 3.18. Senquip Connect App

Note For volume opportunities, devices can be pre-configured to connect immediately to a network; please contact Senquip to discuss this option.

With the cover open, two push-button switches, setup and reset, and two LEDs network (orange) and status (green) are available. The switches and LEDs are used to configure the device.

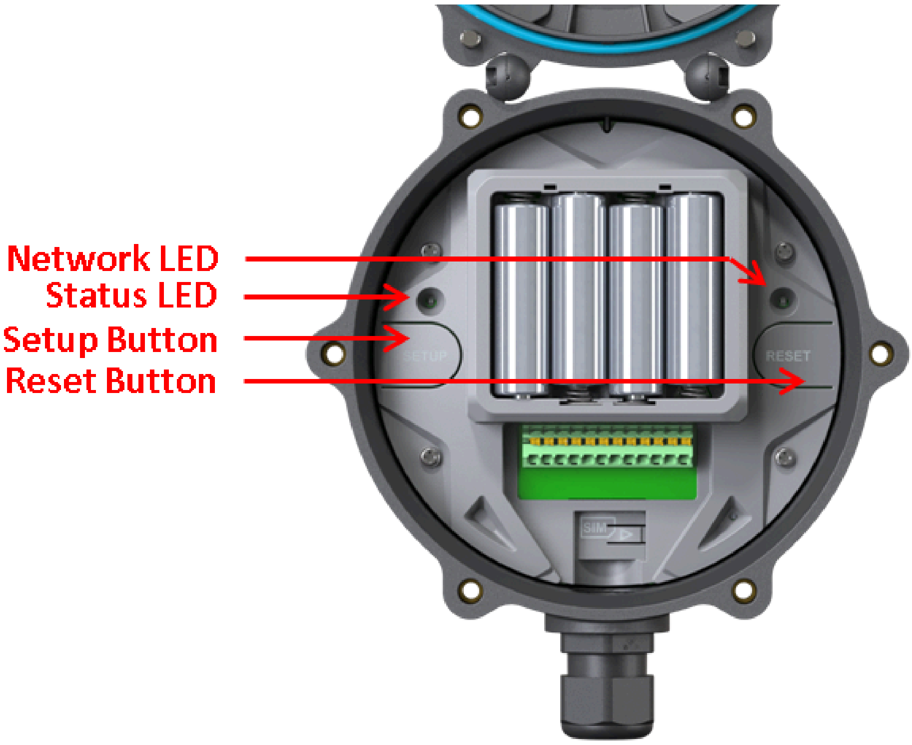


Figure 3.19. Buttons and LEDs for setup

The green status LED and orange network LED indicate the current state of the ORB. These LEDs are only active if the lid is open. When the lid is closed, the LEDs will remain off to conserve energy. A summary of LED function is given in the table below.

Note During normal operation, the LEDs will be off when the device is sleeping or hibernating and will not turn on when the lid is opened until the next measurement interval.

Status LED (Green)	Network LED (Orange)	Meaning
Off	Off	Device is sleeping or lid is closed
Flash (1Hz)	Off	Setup Mode
On	Flash (1Hz)	Searching for network
On	Pulse off (2 sec)	Attached to network (Wi-Fi or LTE), but not connected to Senquip Portal
On	On	Attached to network and connected to Senquip Portal
Fast Flash	Fast Flash	Factory reset in progress
Off	Fast Flash	Firmware update in progress
Slow Flash	Off	Pre-charge mode

Note The LEDs turn on when the lid is opened because an internal sensor detects light. If the lid is opened in dark conditions, the LEDs will not turn on.

Firmware Updates The latest firmware version and a description of changes to firmware can be found in the Senquip Device Firmware Changelist. Updating to the latest firmware can be performed from the Senquip Portal by selecting *Settings* and *Update* and then pressing the *Update Firmware* button. To update to a specific firmware version, enter the firmware number as shown in the figure below and press *Update Firmware*. During the firmware update, the orange network LED will flash fast. After a firmware update, the LEDs may freeze or remain off for a few minutes. This is normal behaviour and occurs shortly after firmware update when the ORB is encrypting the memory.

The firmware update can be seen in the command queue and has been received by the device when the status shows as success. Receipt of the firmware update by the device does not always mean that the update is correctly applied. To ensure that the update has occured, check the firmware number in the *Device Info* widget on the device Portal page. You may need to refresh the browser window.

Factory Reset To perform a factory reset, press and hold the *Setup* button. While holding the *Setup* button, press and release the *Reset* button. The green status LED and orange network LED will begin to flash fast. Continue to hold the *Setup* button down for 10 seconds. After 10 seconds, the LEDs will stop flashing at which point the *Setup* button can be released. All settings will be changed back to the factory state and the ORB will restart. Any firmware updates made to the ORB will be preserved.

> **Warning** Returning the ORB to factory defaults will remove all network settings, rendering remote updates impossible.

Passwords The ORB is shipped, pre-loaded, with a random password that prevent unauthorised connection to the ORB's Wi-Fi hotspot and prevent access to the ORB's built in webserver. The default passwords are printed on a label that can be found under the ORB cover.

Figure 3.20. The default passwords can be found under the lid

The label contains two sections:

- General information about the ORB such as the part number, ORB identification number, Wi-Fi SSID and the IP address of the webserver
- A removable section that contains the part number, ORB identification number, webserver password (setup password), Wi-Fi SSID and Wi-Fi password. This section should be removed and stored securely. It is recommended that the passwords be changed as soon as possible using the ORB's webserver or the Senquip portal.

Figure 3.21. Label with general information and passwords

Take note of the Wi-Fi and setup passwords as you will need them to continue with the setup. In the example above, the ORB identifier is *DE9032030*, the Wi-Fi password is *hjg3iplg* and the setup password is *QvjSF3jk*.

Setup Mode Setup Mode allows initial customer configuration via the integrated web-server. To enter setup mode, power the device and wait for the green light to go solid and then press the *Setup* button.

In setup mode, an integrated Wi-Fi Access Point (AP) is enabled through which the installer can access the ORB's built in web-server. The web-server allows for initial setup using a web based interface, similar to setting up a home router. In this mode, a user can connect to the ORB using any computer, tablet or mobile phone that has Wi-Fi and is loaded with a browser. After the ORB is connected to a network, changes can be made remotely using the Senquip Portal.

Note The Senquip ORB Wi-Fi Access Point is 2.4GHz only

If connected to external power, the ORB will remain in setup mode as long as the lid is open. If no external power is available, the ORB will enter sleep mode after 10 minutes of no activity. To re-enable setup mode, press the *Setup* button again for 2 seconds. Setup mode will be exited once the lid has been closed for more than 10 seconds.

Note A shadow over the light sensor can make the ORB exit setup mode. It is easier to configure the ORB from the Senquip Portal once a network connection has been established.

To connect to the ORB, search for available Wi-Fi networks on your Wi-Fi enabled device. The ORB will advertise itself as *ORB-xxxxx*, where xxxxx represents the last 5 digits of the ORB device identifier. The device identifier as well as password and other information can be found on a sticker under the lid of the ORB. In the example below, using an Android phone, the ORB can be seen to be advertising itself as *ORB-32030*, where *32030* are the last five digits of the ORB device identifier.

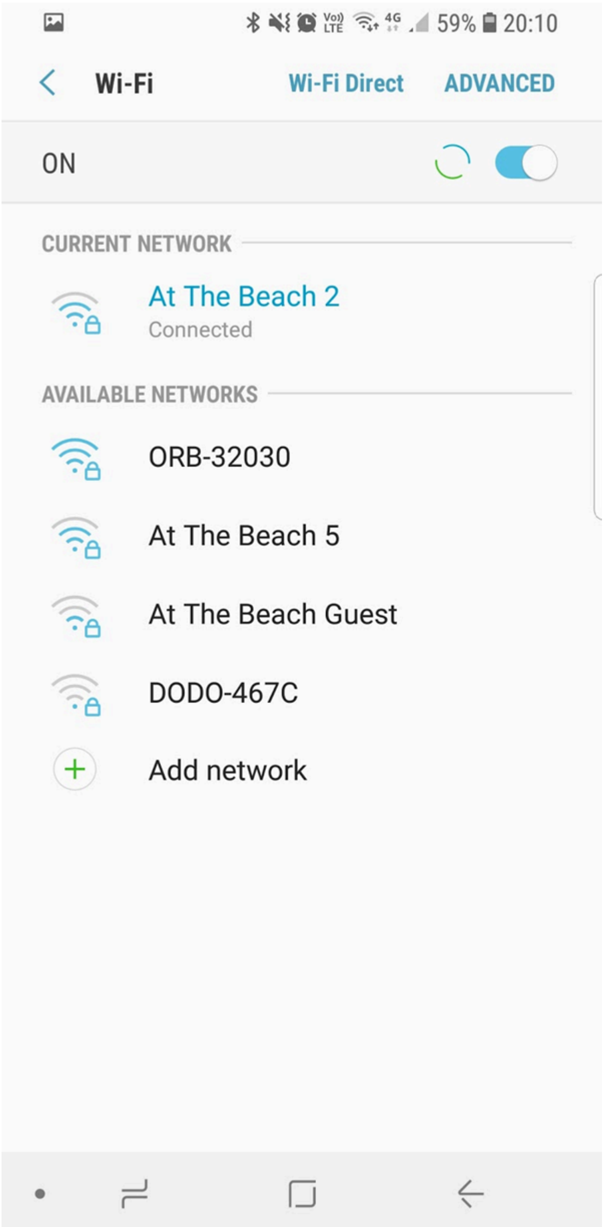


Figure 3.22. Search for Wi-Fi networks

Select the ORB's advertised Wi-Fi network name, *ORB-32030* in this example, and enter the Wi-Fi password found under the lid, *hjg3iplg* in this example. When you press connect, your Wi-Fi enabled device will connect to the ORB Wi-Fi hotspot. Being connected to the ORB Wi-Fi hotspot does not allow you to view or change any data yet. To view and change data, you need to login to the ORB webserver.

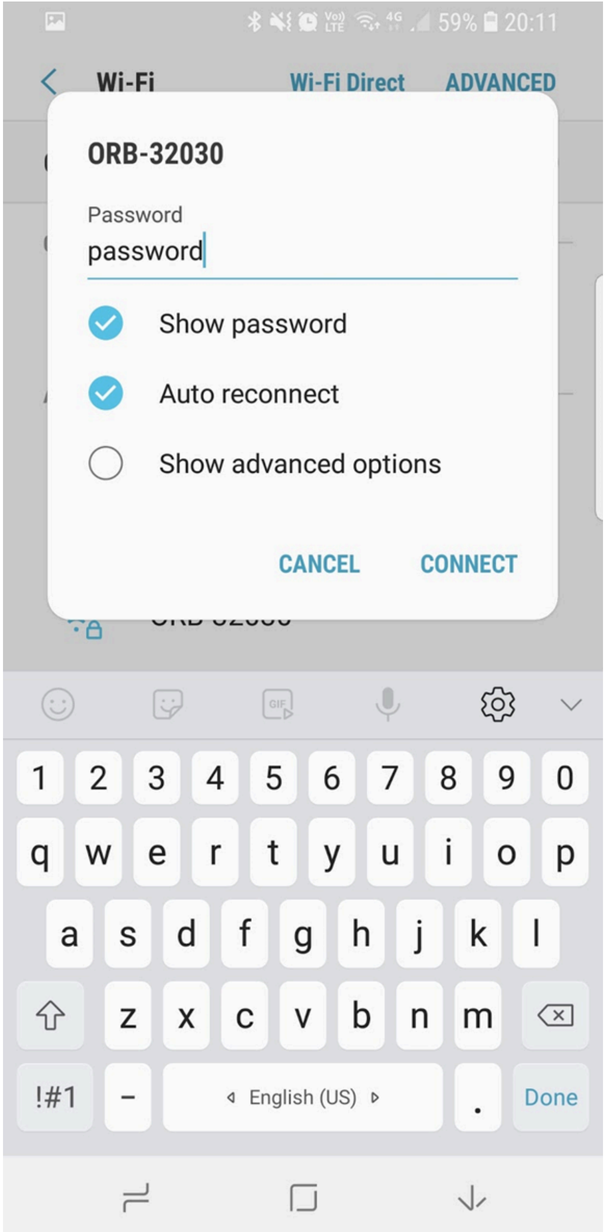


Figure 3.23. Enter the Wi-Fi password

Once you are connected to the ORB's Wi-Fi hotspot, to access the ORB's web-server, open your preferred web-browser (Senquip recommends Chrome) and in the address bar, type *192.168.4.1* and press enter. Your browser will open the ORB's web-server password entry page. For username, type in *admin*; the setup password can be found on the sticker under the lid of the ORB. In the example above, the password is *QvjSF3jk*. Remember to change this password as soon as possible using the *Admin* tab in the web-server.

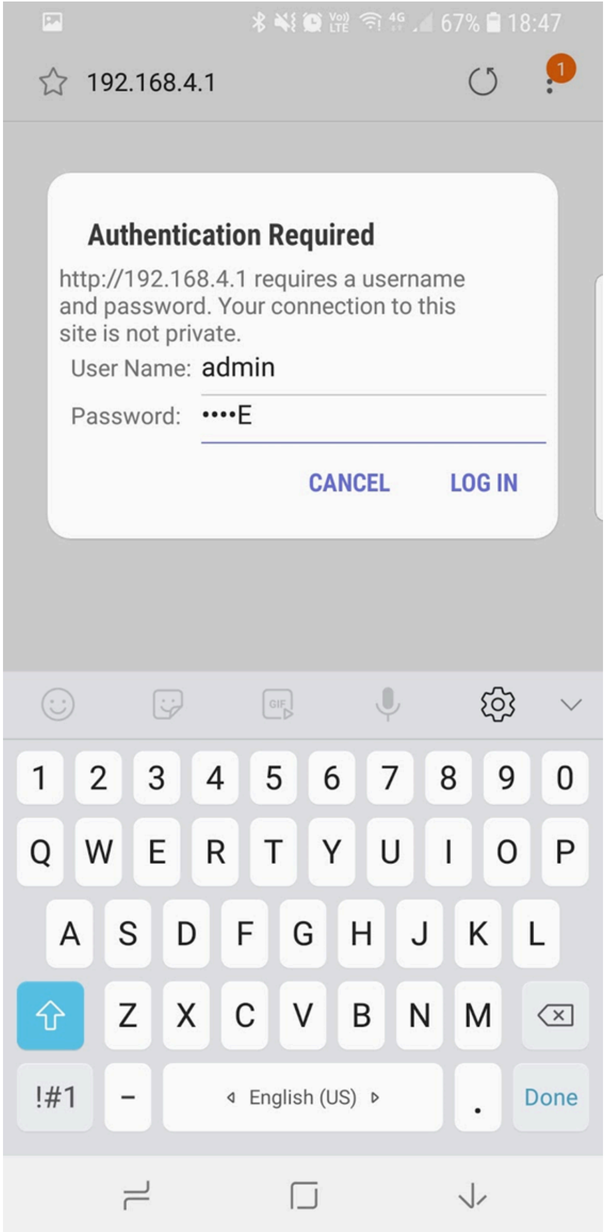


Figure 3.24. Accessing the web-server

Note Performing a factory reset will reset the passwords to their defaults as found under the lid.

If you have entered the username and password correctly, you will now have access to the ORB's web-server. From the web-server, you will be able to view current data, make configuration changes and perform software updates.

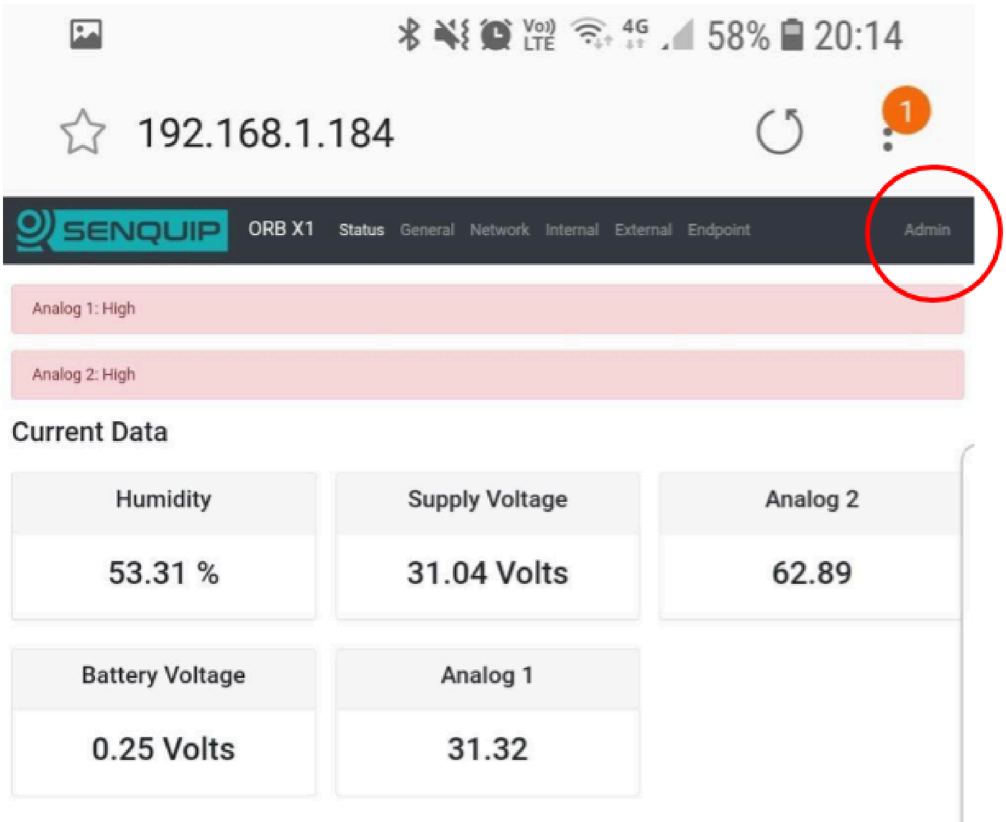


Figure 3.25. Browsing the web-server

The following pages are available on the web-server:

Page Name	Function
Status	View the current status of all enabled modules
General	Configure general, timing and power options
Network	Settings to attach the Senquip ORB to a Wi-Fi or 4G LTE network
Internal	Configure all sensors that are internal to the Senquip ORB
External	Configure sensors that are connected to the external interface
Endpoint	Configure the Senquip ORB to send data to a remote server such as the Senquip Cloud
Events	Set email and SMS notifications when alerts occur
Update	Update firmware on the Senquip ORB
API	Configure the Senquip API to communicate with third party servers
Admin	Save device settings to a file to enable easy cloning of devices

Warning Remember to change the web-server password as soon as possible using the Admin tab found on the top right, as circled in red in the above image.

Chapter 4

Power Supply

The Senquip ORB has been designed to offer maximum flexibility in terms of power supply requirements and is able to run off permanent power, solar (with internal rechargeable lithium battery) or replaceable AA batteries. Low power design techniques ensure the longest possible run-time when operating off batteries.

4.1 Permanent power

A wide input range of 10-75V operation allows for use in automotive, industrial and telecoms applications. System power is backed up with an internal lithium polymer rechargeable battery in the event of power outages. Supply voltage is monitored to a resolution of 100mV and can be reported on a periodic basis if enabled.

The supply voltage input is reverse polarity protected and is resistant to damage from static and surge.

Parameter	Specification
DC supply voltage range	10V to 75V
Hibernate voltage	9.5V

The ORB can be used with a solar panel as a source of power. When running on solar, the panel needs to be able to collect enough energy during sunlight hours to power the ORB through the night and on cloudy days. Keep in mind that solar panels will tend to get dusty and so should be over-rated to avoid regular maintenance. A typical 12V solar panel used to power the ORB along with it's specifications is shown below:

Figure 4.1. Typical ORB solar panel

Parameter	Specification
Maximum power	10W
Voltage at maximum power	17V
Current at maximum power	0.56A
Open-circuit voltage	21.6V
Short-circuit current	0.68A
Width	357mm
Height	302mm

The above solar panel was tested with an ORB measuring and reporting 2 input voltages, ambient temperature, ambient pressure and thermocouple temperature at an interval of 5 minutes. To conserve energy in what was a fixed location test, GPS location was measured every 20 base intervals or 100 minutes. The results were transmitted over 4G LTE or Wi-Fi at 5 minute intervals. The solar panel was sufficient to power the ORB.

4.2 Replaceable AA batteries

In remote applications, where only low frequency measurement is required, the ORB can be powered by four AA batteries. For best performance, 1.6V lithium cells like Energiser Lithium are recommended. Alkaline batteries have very low energy density and are not recommended. Lithium-thionyl Chloride batteries have a very low maximum discharge rate and are also not recomended. Where high quality lithium batteries are used, the ORB can run off batteries for up to 10 years in sleep mode. Battery life of 1 to 2 years should be expected in real applications where the ORB has been configured for low power operation.

Figure 4.2. High capacity batteries

The AA batteries are user replaceable and the ORB is protected against incorrect battery insertion. Correct battery orientation is clearly marked in the battery compartment.

The AA battery voltage is monitored to a resolution of 100mV and can be reported on a periodic basis if enabled.

Note AA batteries are not required to provide backup power in the case of a power outage. The internal Lithium Ion Polymer battery will continue to power the device until it enters hibernate or shutdown.

4.3 Internal rechargeable battery

An Internal 3.7V, 1800mAh rechargeable Lithium Ion Polymer (LiPo) battery is charged from system power, making the device ideal in applications where power is intermittent such as solar. The LiPo battery can be fully recharged within 4 hours of system power being connected.

If the internal LiPo has been allowed to completely discharge; when power is first applied to the ORB, the battery will go into a pre-charge mode where the battery is charged to a minimum level before the ORB starts operating. Pre-charge mode is identified by a slow flash on the green LED with the orange LED off.

An internal protection circuits prevent damage to the LiPo battery in the event of a short circuit or due to excessive discharge. A temperature monitoring circuit terminates LiPo battery charging at temperatures below 0 °C and above 45°C. It is recommended that the LiPo battery be replaced after three years of use or more regularly if the device routinely operates in extended temperatures. The LiPo battery should only be replaced by a Senquip replacement part and should only be installed by a suitably trained technician.

System voltage which is closely related to the LiPo battery voltage is monitored to a resolution of 100mV and is reported at the base interval.

State	AA Batteries	External Power	Comment
LiPo charge threshold	3.7V	4.108	The voltage below which a charge cycle is initiated
LiPo precharge voltage threshold	3.6V	3.6V	Slow flash on green LED, device not operational below this value
LiPo charging voltage	4.208V	4.208V	
LiPo charging current	150mA	300mA	
LiPo charge current termination	128mA	128mA	Charge terminates when charge current below 128mA and battery voltage is above the charge threshold
System shutdown	3.6V	3.6V	Device enters freight mode
Minimum input voltage for charging	4.1V	10V	
Maximum current from charge source	150mA	500mA	Not suitable for Lithium-thionyl Chloride batteries
Safety timer	8 hours	8 hours	Time after which charging will cease
Charge temperature range	0 to 45°C	0 to 45°C	Charging will terminate outside of this range
Operating temperature range	-20 to 80°C	-20 to 80°C	Charging will terminate outside of this range

4.4 Power consumption

The ORB has been designed to be suitable for use in applications where permanent power is not available and solar and or batteries are the only source of energy. Factors affecting power consumption include the rate at which sensor measurements are made, the number of transmissions of measured data and which internal and external sensors that are connected.

Broadly, the state of the ORB can be divided into three modes: sleep, measurement and transmission. Sleep mode is by far the lowest power state where most internal sensors are turned off and the device is waiting for the next measurement period. During a measurement period, the sensors are turned on and power consumption increases dramatically. The actual power consumed during a measurement phase depends on the power requirements of connected sensors and the duration for which they are turned on. For instance, a 4-20mA pressure sensor will, by default, draw between 4mA and 20mA of current when turned on. The sensor will clearly use less energy when measuring 4mA than when measuring 20mA. Transmission is the most energy intense operation performed by the ORB. During transmission, the Wi-Fi and or 4G LTE radios are turned on and data is transmitted. Limiting the length of radio transmissions has a significant impact on energy consumed by the ORB.

The following strategies can be used to limit power consumption, which will be particularly useful in battery powered applications:

- Limit the rate at which measurements are taken - if the parameter being measured changes slowly, then measuring it regularly will consume additional energy without a benefit.
- Turn off sensors that are not required - the ORB contains a rich set of internal sensors. If for example, the GPS is not required, turn it off.
- Choose external sensors carefully - a 4-20mA sensor may use more energy than a voltage output sensor.
- Limit the number of daily transmissions - consider only transmitting data when warning and alarm conditions are breached.
- Ensure that the ORB is placed in a position where 4G LTE, Wi-Fi, and GPS reception is optimal. Far more current is consumed when transmitting and receiving in a poor signal environment.

Measured sleep, measurement, and transmission current is given in the table below. The measurements in the table represent current flowing from the internal LiPo battery at 3.5V, with external power to the ORB removed. Except where stated, the GPS is assumed off. Actual values will depend on the power source, selected measurements, battery charge state, distance from Wi-Fi or 4G LTE source and temperature.

Note A battery life calculator is available on the Senquip Website.

Mode	Current	Time
Sleep	65uA	Up to 24 hours
Measurement (no external sensors, GPS off)	40mA	0.5s
Measurement (no external sensors, GPS cold start)	70mA	54s
Transmit (WiFi from sleep)	97mA	8s
Transmit (4G LTE from sleep)	120mA	20s

4.5 Battery life

Senquip has measured actual power consumption figures to determine the expected life when using AA cells. Remember, when setting up for low power applications, that the ORB can make regular measurements and only transmit once per day unless it enters an exception state (warning or alarm is active), in which case a transmission is made immediately and the ORB switches to the *exception interval*, allowing for faster transmission rates.

Note Battery life expectation is extremely difficult to estimate and will be affected by all kinds of parameters such as temperature, battery chemistry, quality of reception, and sensors used. The numbers below should be taken as indicative only.

WiFi Transmission

Battery	Base interval	Transmit interval	Sensors enabled	Battery life
AA 1.6V Lithium	1 per day	1 per day	All internal sensors except GPS	8.9 years

AA 1.6V Lithium	1 per hour	1 per day	All internal sensors except GPS	8.3 years
AA 1.6V Lithium	1 per hour	1 per hour	All internal sensors except GPS	2.3 years
AA 1.6V Lithium	1 per day	1 per day	All internal sensors and GPS	7.8 years
AA 1.6V Lithium	1 per hour	1 per day	All internal sensors and GPS	2.0 years
AA 1.6V Lithium	1 per hour	1 per hour	All internal sensors and GPS	1.2 years

4G LTE Transmission

Battery	Base interval	Transmit interval	Sensors enabled	Battery life
AA 1.6V Lithium	1 per day	1 per day	All internal sensors except GPS	7.1 years
AA 1.6V Lithium	1 per hour	1 per day	All internal sensors except GPS	6.5 years
AA 1.6V Lithium	1 per hour	1 per hour	All internal sensors except GPS	0.9 years
AA 1.6V Lithium	1 per day	1 per day	All internal sensors and GPS	6.3 years
AA 1.6V Lithium	1 per hour	1 per day	All internal sensors and GPS	1.9 years
AA 1.6V Lithium	1 per hour	1 per hour	All internal sensors and GPS	0.6 years

4.6 Freight Mode

When shipping an ORB, it is important that the device is placed in freight mode. In freight mode, the ORB is put into sleep mode to reduce battery drain to the minimum, and all transmitting devices are turned off. The ORB will exit freight mode when it detects that power has been re-connected.

To enter freight mode access the device webserver by pressing the setup button or directly from a browser if the ORB webserver is always on and you know the IP address. From the webserver, chose the admin link and perform the steps below:

1. Disconnect all wires including the power input. Remove AA batteries (if fitted).
2. Press the 'Enter Freight Mode' button below.
3. Wait 5 seconds, then check the Status and Network lights remain off.
4. Confirm freight mode has been entered by pressing the *Reset* button; there should be no response from the ORB.

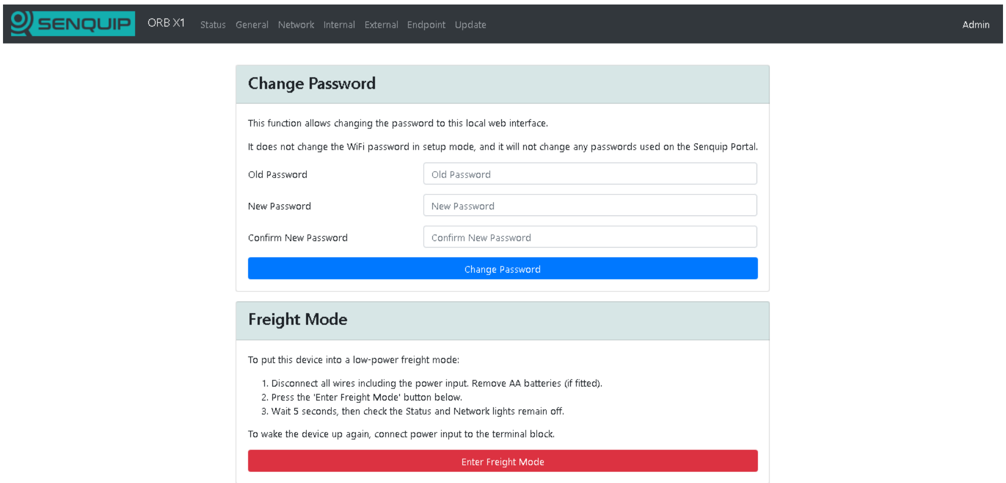


Figure 4.3. Entering freight mode

Note A shortcut is provided where pressing the *Setup* button three times, when in setup mode, will cause the Senquip ORB to enter freight mode. Confirm freight mode has been entered by pressing the *Reset* button.

Chapter 5

General Setup

5.1 Measurement and Transmit Intervals

The ORB can be configured to take periodic measurements and then to transmit those measurements at various intervals or on exception. When not measuring or transmitting, the ORB will remain in a very low power state, referred to as sleep. For example, the ORB can be configured to measure temperature at 1 minute intervals, but only to transmit the temperature once an hour or if a warning or alarm level is exceeded (an exception occurs). By allowing a more regular measurement interval and a less frequent transmit interval, the ORB is able to reduce power consumption by remaining asleep, thereby maximising battery life. In the event of an exception, a more regular transmit rate can be selected.

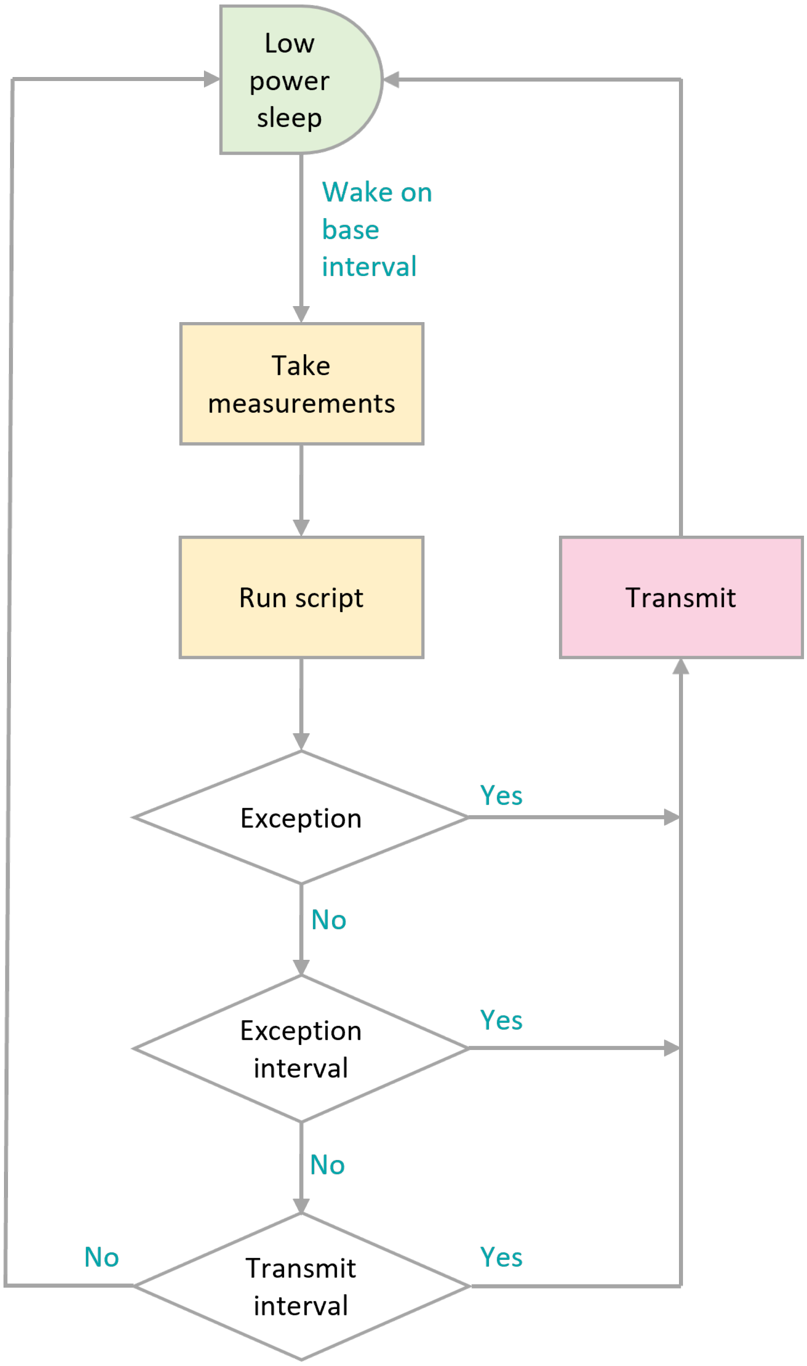


Figure 5.1. Timing flowchart

- Green: Lowest power state; aim to configure the ORB to spend maximum time in this state.
- Orange: Moderate power usage; try to reduce the number of times that the ORB wakes to measure sensors.
- Pink: Highest power consumption; only transmit data when required.

A summary of wake sources and their behaviour in sleep and hibernate is given in the table below.

Wakeup Source	Source Description	Behaviour from Sleep	Behaviour from Hibernate
Vin	The supply voltage rises above 9.5V	No effect	Device wakes, exits Hibernate Mode and runs normally.
Setup Button	The SETUP button is pressed.	Device wakes and enters Setup Mode	Device wakes and enters Setup Mode
Light	Tamper Alert is enabled and the lid is opened allowing light on the light sensor.	Device wakes and runs normally (with tamper alert event active)	Device wakes, and runs normally. It will re-enter Hibernate after the Hibernate Delay Interval if supply voltage is low.
Vibration	Wake on Vibration setting is enabled and vibration is recorded above the Vibration Threshold	Device wakes and runs normally	Device wakes, and runs normally. It will re-enter Hibernate after the Hibernate Delay Interval if supply voltage is low.
Magnet (SETUP Mode)	Magnetic Switch setting is set to Setup and a magnet is detected on the switch position.	Device wakes and enters Setup Mode	Device wakes and enters Setup Mode
Magnet (WAKE Mode)	Magnetic Switch setting is set to Wake and a magnet is detected on the switch position.	Device wakes and runs normally	Device wakes, and runs normally. It will re-enter Hibernate after the Hibernate Delay Interval if supply voltage is low.
Magnet (TRIGGER Mode)	Magnetic Switch setting is set to Trigger and a magnet is detected on the switch position.	Device wakes and runs normally. Trigger 0 is executed.	Device wakes, and runs normally. Trigger 0 is executed. It will re-enter Hibernate after the Hibernate Delay Interval if supply voltage is low.

To allow flexible measurement and transmit intervals, whilst ensuring the lowest possible power consumption, the ORB has three global and one per-peripheral measurement interval settings.

Base-Interval The base-interval is the period of time after which the ORB will wake from sleep in order to check if there are any measurements to perform or if it is time to transmit the latest measured data. In a system where measurements are required often, the base-interval can be as low as 5 seconds. In systems that are slow to respond, the base interval can be as high as 24 hours. It makes sense to set the base interval as long as possible to enable the ORB to spend as much time as possible in a low-power sleep state.

Each peripheral, whether internal to the ORB or attached to the interface, can be set to only be measured after a number of base-intervals. If a particular peripheral has the interval setting set to 1, then it will be measured at each base-interval. If the interval is set to 0, then that particular peripheral will be turned off. Each time a measurement is taken, the results will be compared with alert, warning and alarm conditions and if an alert or exception occurs, the results will immediately be transmitted.

Note if a base-interval of less than 10 seconds is specified when the ORB is communicating via Wi-Fi or 120 seconds over 4G LTE, the ORB will remain awake at all times. This setting is not suitable for battery operated installations.

Note if the enabled measurements take longer to complete than interval at which they are scheduled, the ORB will not return to sleep and measurements will be sent as fast as possible. This is most likely where the GPS and serial devices are enabled.

Transmit-Interval The transmit-interval is the time between message transmissions. It is a multiple of the base interval and is set as a number of base-intervals. All enabled measurements will be transmitted at the transmit-interval. For example, if the base-interval is 1 minute and the transmit-interval setting is sixty, then all the latest measurements will be transmitted every 60 minutes.

In cases where the ORB is configured to measure more often than to transmit, measured data can be saved and transmitted in batches. It is more efficient to batch messages and transmit less regularly than to send individual measurements. Use this option where power use needs to be minimised but all measured data needs to be retrieved.

Note if during a measurement interval, an exception occurs, the ORB will immediately transmit the measured data and will switch to the exception interval.

Note if measurement and transmission intervals coincide, measurements will be taken before transmission to ensure the latest values are transmitted.

Exception-Interval If a warning or alarm occurs, the transmit-interval can be shortened in order that measurements are transmitted more often. The exception-interval is a multiple of the base interval and sets the time between message transmissions when an exception is current (warning or alarm). For example, if the base-interval is 1 minute and the transmit-interval setting is sixty, under normal circumstances, measurements will be transmitted every 60 minutes. If the exception-interval setting is 5, then when a warning or alarm condition is current, measurements will be transmitted at 5 minute intervals instead of 60 minute intervals.

Note Only exceptions, which are warnings and alarms will trigger the exception-interval; alert conditions such as low battery will not.

If, on any base interval, a new exception or alert is detected, an immediate transmission will be made regardless of the transmit-interval.

5.2 Power Supply

An alert can be generated when the external power source is lost or the internal LiPo battery or replaceable AA cells are low or are running out of charge. If enabled, the external power loss alert will be triggered as the voltage drops below 9.5V. The AA battery alert levels are configurable. In order to conserve energy, the ORB can be configured to enter hibernate when external power is lost. In this mode, the ORB will wake on it's usual base interval, but if power is still lost, it will go back to sleep. A number of base intervals that occur before the ORB enters hibernate can be set. This allows the ORB to continue operating for a period of time after power is lost. The ORB can be set to wake from hibernate if motion is detected by the internal accelerometer or power is restored. In hibernate mode, a transmission is made periodically to allow the user to verify that the ORB is still functional. The hibernate report in period defaults to 6 hours and can be set between 5 minutes and 24 hours. In the case of the internal LiPo battery being low, this may indicate a faulty, under-rated or dirty solar panel or permanent loss of external power. A low AA battery warning indicates that the replaceable AA cells are low and should be replaced as soon as possible. If the power loss alert is enabled where solar panels are installed, an alert should be expected as clouds move over or the sun sets.

Note If *Device Always On* and *Sleep on Power Loss* are both selected then the ORB will remain awake as long as it is powered; the ORB will sleep when power is removed.

5.3 Settings

A full list of general settings is given in the table below.

Webserver Name	Webserver Item	Function	Default Value	Internal Reference
Device ID	Read only text box	Unique ID associated with the ORB during manufacture.		device.id
Device Model	Read only text box	Model number, in this case X1 followed by either W for the Wifi or G for the GSM model.		device.model
Firmware Version	Read only text box	The verion number of the firmware currently loaded in the ORB.		device.fw
Hardware Revision	Read only text box	The revision of hardware present in the ORB		
Device Name	Text entry box	A name for the ORB that is meaningful to the user.	ORB X1	device.name
Timing				
Base Interval	Text entry box	The time after which the ORB will wakeup to check which measurements need to be taken and if a transmission is scheduled.	Default: 30 sec	device.base_interval
			Min: 5 sec	
			Max: 86400 sec	
Transmit Interval	Text entry box	The number of base intervals after which a transmission is made.	Default: 1	device.transmit_interval
			Min: 1	
			Max: 999999	
Exception Interval	Text entry box	If an exception is current this interval replaces the transmit interval to allow faster updates if required.	Default: 1	device.exception_interval
			Min: 1	
			Max: 999999	
Device Always On	Tick box	If enabled the device will not sleep between Base Intervals and will remain awake. Not recommended for battery powered applications.	Enabled	device.always_on
Batch Transmit	Tick box	Tick this box if messages are to be batched and transmitted together.		
WebServer Always On	Tick box	Keeps the webserver enabled at all times to allow remote connection.		device.web_always_on
Power Input				

Power Loss Alert	Tick box	Enable if an alert is to be sent when the power input drops below a specified limit.	Disabled	device.power.alert.enable
Hibernate on Power Loss	Tick box	If this option is selected, then the ORB will enter hibernate mode when power is lost and will only transmit every 6 hours.	Disabled	device.power.sleep
Hibernate Delay Intervals	Text entry box	Enter the number of base intervals after power has been lost before the ORB enters hibernate	5	
Hibernate Period	Text entry box	How often the device will wake and transmit in hibernate mode	6 hours	
Count Hours	Tick box	Counts the number of hours that the ORB is powered. Typically used as an hour meter.	Disabled	
AA Battery				
AA Battery Low Alert	Tick box	Enable if an alert is to be sent when the AA battery level drops below a specified limit.	Disabled	device.batt.alert.enable
Threshold	Text entry box	The voltage at which an alert is raised.	Default: 4.8V	device.batt.alert.threshold
			Min: 0V	
			Max: 100V	
Lipo Battery				
Lipo Battery Low Alert	Tick box	Enable if an alert is to be sent when the Lipo battery level drops below a specified limit.	Disabled	device.lipo.alert.enable
Threshold	Text entry box	The voltage at which an alert is	Default: 3.4	device.lipo.alert.threshold

Chapter 6

Internal Sensors

6.1 Light Sensor

The Senquip ORB is equipped with an internal light sensor that is used to activate the ORB setup functions when the lid is opened and to detect tamper attempts. The light sensor is sampled on a regular basis and does not have an associated measurement interval.

An alert can be generated when the ORB detects light, meaning that the lid has been opened.

Note A tamper alert, if enabled will be triggered by a tamper attempt or an authorised entry to change settings.

A full list of light sensor settings is given in the table at the end of the chapter.

6.2 Accelerometer

The Senquip ORB has an integrated 3-axis accelerometer. The accelerometer allows for angle measurement, movement detection, harsh-usage monitoring and utilisation calculation. To provide more accurate measurement for pitch, roll and angle measurement, each time the accelerometer is measured, 10 samples will be taken at 1 msec intervals and the average will be returned as the measured value. Pitch, roll and angle will be calculated from the average acceleration.

Raw accelerometer data in the X (through the lid), Y (left to right across the ORB lid) and Z (from the hinge down to the cable gland) are available and are delivered in G's. These values can be useful, for instance where an incident is being re-created from force data.

Note Incident recreation using force data requires high speed sampling. Please contact Senquip to discuss your application.

When looking at the front cover, positive pitch is described as the top of the ORB tilting towards the observer. In the same scenario, negative pitch is described as the top of the ORB cover moving away from the observer.

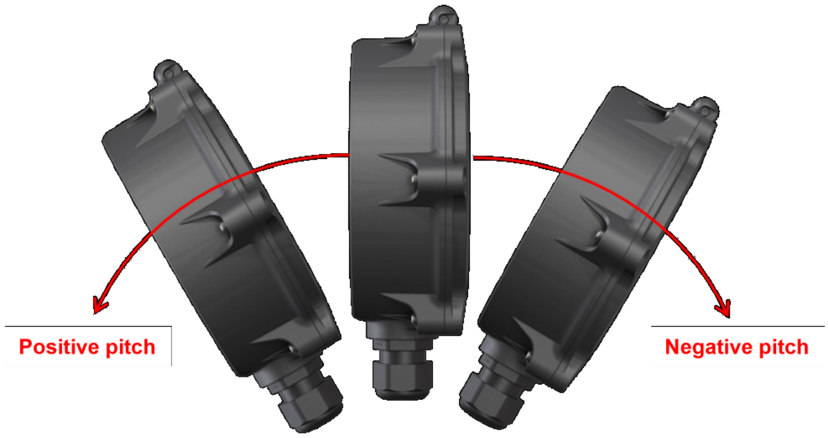


Figure 6.1. Definition of pitch

When looking at the front cover, positive roll is described as the top of the ORB tilting towards the right. In the same scenario, negative roll is described as the top of the ORB cover moving towards the left.

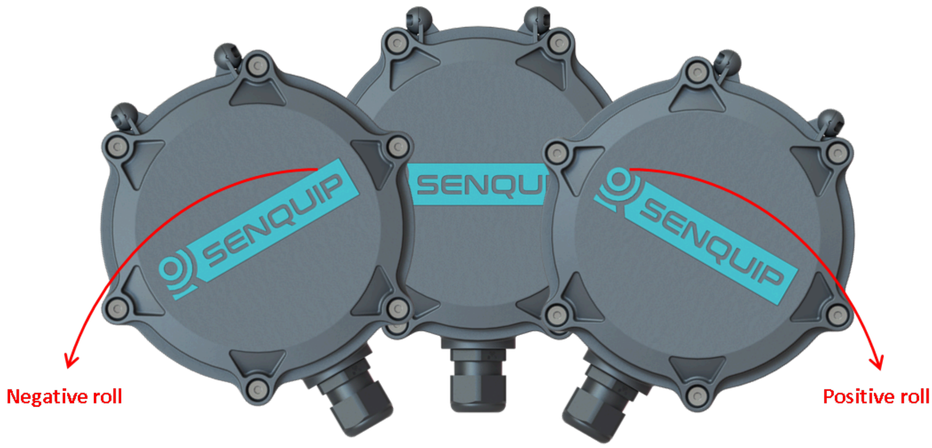


Figure 6.2. Definition of roll

Pitch and roll are useful in applications where objects to which the ORB is attached have a definite front, back, left and right; for instance a vehicle. For objects like a pole, the user may be more interested in the angle of the pole to vertical. In these applications, the tilt may be more useful than pitch or roll.

Figure 6.3. Definition of tilt

6.2.1 Specification

Parameter	Specification
G-force range	+- 16G
Resolution	1mG
Sensitivity change vs temperature	0.1% per°C
Typical zero-g level offset accuracy	+- 40mG
Tilt resolution	0.1 deg
Tilt accuracy (0-45 deg)	1.0 deg
Tilt accuracy (45-90 deg)	2.0 deg

6.2.2 Settings

Accelerometer measurements can be scheduled as a multiple of the base-interval. The fastest possible measurement rate is achieved by setting the *interval* to 1 in which case measurements will occur on every base interval. To reduce power consumption, the measurement rate can be turned down by increasing the *interval*.

Warning and *alarm* thresholds for pitch, roll and angle can be enabled. Once enabled, each time a measurement is completed, the returned value will be compared with minimum and maximum *warning* and *alarm* thresholds. If a *warning* or *alarm* level is breached, a message will immediately be transmitted. As long as the warning or alarm condition persists, messages will be transmitted at the exception-interval rather than the transmit-interval. *Hysteresis* can be specified in 1 degree increments, to prevent multiple alarms in the presence of vibration.

The accelerometer is able to detect *motion* and *shocks* due to harsh usage even during sleep. If *motion* or *shock* monitoring is enabled and either of those events occurs, a flag will be set. Event flags are checked at each base-interval and if one exists, an alert message can be scheduled to be sent at that time. The *threshold* as well as *time* for which an activity must be present can be set for both *motion* and *shock* monitoring.

Note Pitch and roll warning and alarm levels can be positive or negative. Angle warning and alarms can only be positive.

Vibration can be used as a trigger to count hours. This may be useful where the number of hours that an engine is running needs to be calculated.

A full list of accelerometer settings is given in the table at the end of the chapter.

6.3 Magnetic switch

The Senquip QUAD contains a built-in hall-effect sensor that acts as a magnetic switch. When the switch detects a magnet, the Senquip QUAD can be made to enter setup mode, wakeup, or trigger a function in a script.

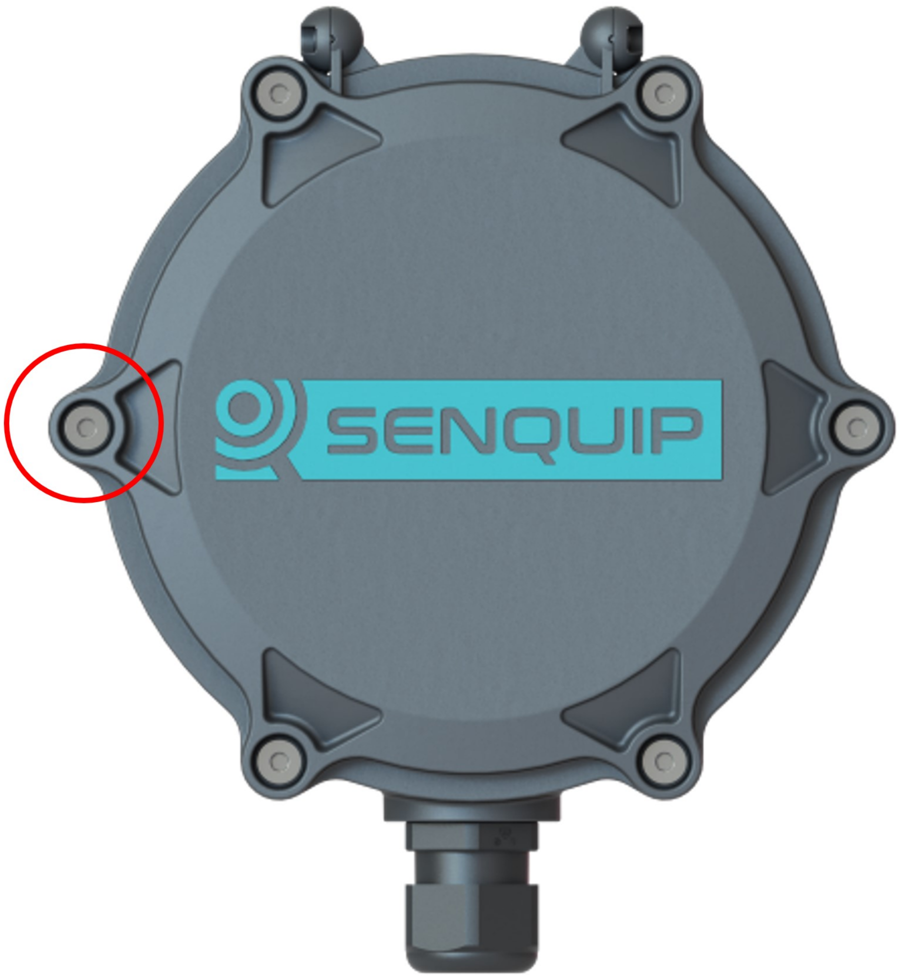


Figure 6.4. Location of magnetic switch

6.3.1 Settings

Three actions are available when the magnetic switch is activated.

- *Setup*: Put the device into setup mode. Identical to pressing the Setup button. If the device is asleep, it will wake and enter Setup Mode.
- *Wake*: Wake the device up and perform a measurement cycle. There is no action if device is already awake.
- *Trigger*: Wake the device if asleep. Trigger TP0 before first measurement cycle. TP0 should be handled in a script.

6.4 Temperature sensor

An integrated temperature sensor allows for measurement of ambient temperature. Please be aware that the temperature sensor will measure the temperature inside the ORB enclosure; this temperature can be subject to fluctuations, for example when the internal lithium ion battery is charging and so the environment within the ORB heats up. For accurate external temperature measurement or to measure a wider range of temperatures, use the thermocouple peripheral.

6.4.1 Specification

Parameter	Specification
Measurement range	-40 - 85°C
Resolution	0.01 deg°C
Absolute accuracy (25°C)	+-0.5 deg°C
Absolute accuracy (0 - 65°C)	+-1 deg°C

6.4.2 Settings

Measurements can be scheduled as a multiple of the base-interval. The fastest possible measurement rate is achieved by setting the *interval* to 1 in which case measurements will occur on every base interval. To reduce power consumption, the measurement rate can be turned down by increasing the *interval*.

Warning and *alarm* thresholds for ambient temperature can be enabled. Once enabled, each time a measurement is completed, the returned value will be compared with minimum and maximum *warning* and *alarm* thresholds. If a *warning* or *alarm* level is breached, a message will immediately be transmitted. As long as the warning or alarm condition persists, messages will be transmitted at the exception-interval rather than the transmit-interval. *Hysteresis* can be specified in 1°C increments, to prevent multiple alarms in the presence of fluctuating temperature.

A full list of temperature sensor settings is given in the table at the end of the chapter.

6.5 GPS

Models of the ORB that have 4G LTE connectivity also have an integrated Global Positioning System (GPS). The GPS receiver, with integrated antenna and LNA allows for position and speed based reporting. The internal GPS will receive GPS, GLONASS, BeiDou and Galileo satellites to ensure high accuracy measurement and fast time to first fix. Data available from the GPS includes:

- Latitude, longitude and height
- Speed (km/h) and bearing

- Date and time
- Number satellites being tracked

In order to utilise the GPS, the ORB needs to be mounted such that the internal antenna has visibility of the sky. Plastic and fibreglass roof sheeting will have a minimal effect on GPS performance whereas reinforced concrete and metal roofs will render the GPS inoperable. In applications where GPS is required but the ORB cannot be mounted in a position where the sky is visible, a GPS re-radiating antenna can be used. Please make sure that the chosen re-radiating antenna is of high quality and legal for use in your region. An advantage of good GPS signal quality is that the ORB will consume less power as acquisition time will be less.

6.5.1 Specification

Parameter	Specification
Time to first fix from power up	Typically 60 seconds
Position update rate	Maximum 1Hz
Horizontal position accuracy	Typically +-5m (<2.5m CEP-50)
Vertical position accuracy	Typically +-20m
Horizontal speed accuracy	1km/h

6.5.2 Settings

Measurements can be scheduled as a multiple of the base-interval. The fastest possible measurement rate is achieved by setting the *interval* to 1 in which case measurements will occur on every base interval. To reduce power consumption, the measurement rate can be turned down by increasing the *interval*. The GPS is a high power peripheral and so use should be limited when running on battery power.

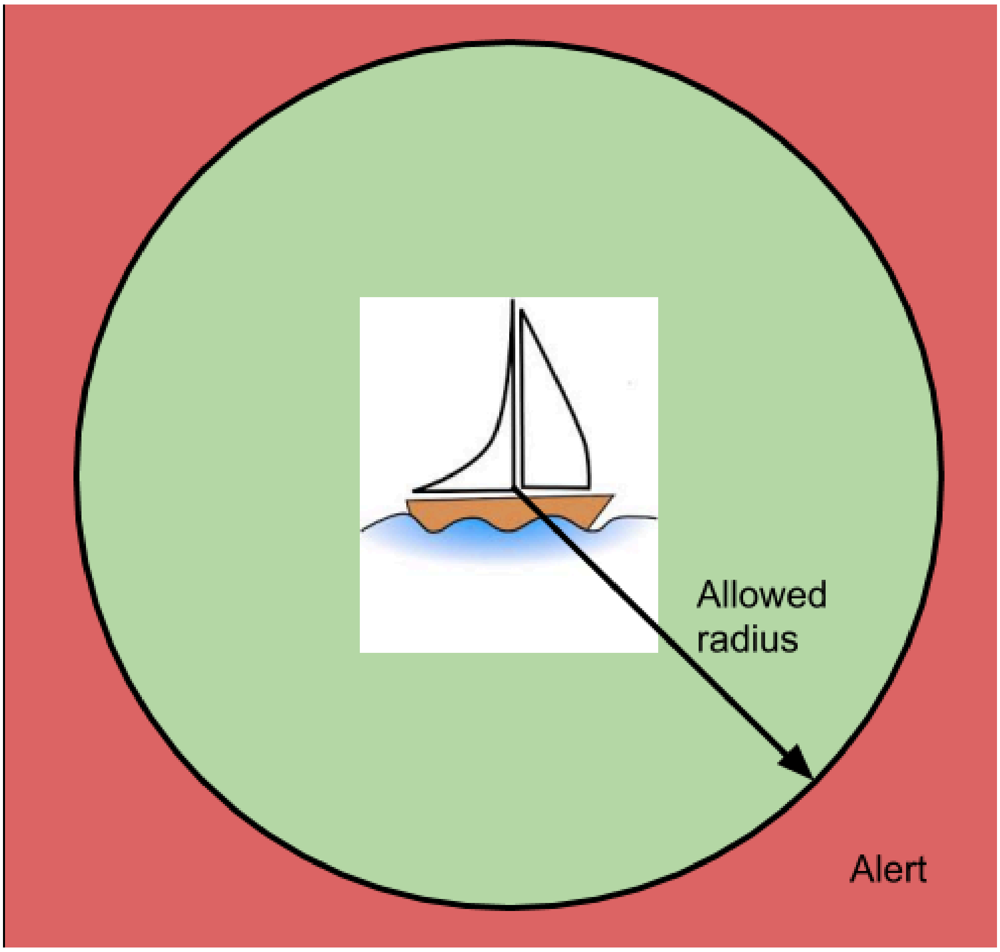


Figure 6.5. GPS alert parameters

The GPS can create an *alert* based on position and speed. A known position (*expected latitude* and *expected longitude*) can be specified and if the ORB moves a particular *radius* from that point, an alert can be raised. *Hysteresis* can be specified in 1 meter increments to prevent multiple alerts, for instance as a boat swings on a mooring near the edge of the allowed radius. Likewise, a maximum *speed* can be specified and if the ORB exceeds that speed, an alert will also be raised. Speed *hysteresis* can be specified in 1km/h increments, to prevent multiple alerts as the speed fluctuates at the alert point. The time that GPS speed exceeds 2km/h can counted and be used to calculate machine utilisation.

Note In the example above, the ORB could also report bilge water level, solar battery voltage and a host of other parameters associated with the yacht.

A full list of GPS settings is given in the table at the end of the chapter.

6.6 Bluetooth Interface

The ORB has a Bluetooth peripheral that can transmit and receive Bluetooth Low Energy (BLE) advertising packets. BLE beacons typically use the advertising packets to communicate measured data such as temperatures, voltages, movement, and battery voltage. BLE tags are a special type of beacon that typically only contain identification information and are used to locate items. BLE beacons send advertising messages at different rates. Some report every second and some may be every minute or more. Battery operated BLE devices tend to send at lower rates to save power. Some BLE device are smart and will slow their send rate if they are not being used. A tire pressure monitoring device may stop sending if the tire is not rotating. Typical protocols used in advertising packets include Eddystone and iBeacon. The ORB supports both.

The BLE beacons from ELA shown below enable identification, and measurement of temperature, humidity, voltage, switch position, and more.

Figure 6.6. Example BLE beacons from ELA

The ORB will report the beacon address, data, and the strength of the received signal.

- The address (or identifier) is unique and allows individual tags to be recognised.
- The data may contain battery voltage, temperature, humidity, or any other data being conveyed by the beacon.
- The receive signal strength (RSSI) gives an indication of how strong the signal from the beacon is.

For details on using the ORB as a BLE beacon to transmit custom advertising packets, please refer to the Senquip Scripting Guide.

Note The BLE module and Wi-Fi module share a common radio. BLE operation will work best when the ORB is operated using a cellular network rather than Wi-Fi.

6.6.1 Specification

Parameter	Specification
Bluetooth version	4.2

6.6.2 Settings

Measurements can be scheduled as a multiple of the base-interval. The fastest possible measurement rate is achieved by setting the *interval* to 1 in which case the Bluetooth peripheral will be sampled on every base interval. To reduce power consumption, the measurement rate can be turned down by increasing the *interval*.

When active, the Bluetooth peripheral will scan for all advertising packets. In a typical environment, phones, computers, and other devices are all advertising. The ORB Bluetooth peripheral could easily report a dozen Bluetooth devices even when the one you are searching for is off. The ORB can filter for only the required Bluetooth devices by filling in the *Address Capture List*. Required addresses should be entered in hexadecimal and should be separated by commas. When the ORB wakes for the next measurement interval, the Bluetooth peripheral will be sampled until all the messages listed have been found or the *Capture Time* has been reached. If multiple messages with the same identifier are required in a single measurement interval, place a * followed by the number of messages of that identifier to be returned after the identifier in the list. For example: 98588A10375E*4, 98588a103777, 98588a103888*10 will return 98588A10375E four times, 98588a103777 once and 98588a103888 ten times. Leave the *ID Capture List* blank to receive all messages.

The *Capture Time* setting can be used to set a timeout after which the Bluetooth peripheral will stop listening, allowing the ORB to transmit received messages and return to sleep. *Capture-time* can be used as a mechanism to allow the ORB to sample the environment for devices for a defined time-period.

A full list of Bluetooth settings is given in the table at the end of this chapter.

6.7 Internal Sensor Settings

A full list of settings for internal sensors is given in the table below.

Name	Item	Function	Range	Unit	Internal Reference
Light Sensor					
Name	text	A name for the light sensor that is meaningful to the user.	25 chars		tamper.name
Tamper Alert	boolean	This parameter determines if an alert is generated when the light sensor detects light or not.			tamper.enable
Ambient Temperature					
Name	text	A name for the input that is meaningful to the user.	25 chars		ambient.name
Interval	integer	The number of base intervals after which the temperature is sampled. A value of 1 means that the input is collected every base interval. Set to 0 to disable.	0 to 10000		ambient.interval
Hysteresis	decimal	The amount by which the measured value has to drop below the threshold to re-enable the alert after an event.	0 to 100	°C	ambient.hysteresis
Warning	text	Warning thresholds. Refer to user guide.	-40 to 100	°C	ambient.warning
Alarm	text	Alarm thresholds. Refer to user guide.	-40 to 100	°C	ambient.alarm
Accelerometer					
Name	text	A name for the input that is meaningful to the user.	25 chars		accel.name

Interval	integer	The number of base intervals after which the accelerometer is sampled. A value of 1 means that the input is collected every base interval. Set to 0 to disable.	0 to 10000		accel.interval
Output XYZ Vectors	boolean	Send X,Y,Z gravity vectors in data output.			accel.outputxyz
Hysteresis	decimal	The amount by which the pitch, roll or angle has to exceed a threshold before triggering alarms or warnings.	0 to 20	Degrees	accel.hysteresis
Pitch Warning	text	Warning thresholds. Refer to user guide.	-90 to 90	Degrees	accel.pitch.warning
Pitch Alarm	text	Alarm thresholds. Refer to user guide.	-90 to 90	Degrees	accel.pitch.alarm
Roll Warning	text	Warning thresholds. Refer to user guide.	-90 to 90	Degrees	accel.roll.warning
Roll Alarm	text	Alarm thresholds. Refer to user guide.	-90 to 90	Degrees	accel.roll.alarm
Angle Warning	text	Warning thresholds. Refer to user guide.	0 to 90	Degrees	accel.angle.warning
Angle Alarm	text	Alarm thresholds. Refer to user guide.	0 to 90	Degrees	accel.angle.alarm
Motion Warning	text	Warning thresholds. Refer to user guide.	0 to 5000	milli-g	accel.motion.warning
Motion Alarm	text	Alarm thresholds. Refer to user guide.	0 to 5000	milli-g	accel.motion.alarm
Wake from Hibernate	boolean	The high warning motion threshold is used to wake the device when hibernating.			accel.motion.wake_from_hiber
Motion Wake Threshold	decimal	The motion threshold above which the device will wake from hibernation.	1 to 2000	milli-g	accel.motion.wake_threshold
Count Motion Hours	boolean	Counts the number of hours the device exceeds the Motion Wake Threshold. Typically used as an machinery work vs idle hour meter.			accel.motion.count_hours
GPS					
Name	text	A name for the GPS signal that is meaningful to the user.	25 chars		gps.name
Interval	integer	The number of base intervals after which the gps is sampled. A value of 1 means that the input is collected every base interval. Set to 0 to disable.	0 to 10000		gps.interval
Max Time	integer	Maximum time the device will wait for a valid GPS fix.	0 to 3600	Seconds	gps.maxtime
Position					
Position Alert	boolean	Sets whether a change in position generates an alert.			gps.position.alert.enable
Radius	integer	An alert will be raised if the device moves further than this value from the expected position.	1 to 10000	Meters	gps.position.alert.radius

Hysteresis	integer	Once the alert is active or inactive, the radius must change by this value to change the alert state.	1 to 10000	Meters	gps.position.alert.hysteresis
Expected Latitude	decimal	Latitude at which the device is expected to be.	-90 to 90	Degrees	gps.position.alert.lat
Expected Longitude	decimal	Longitude at which the device is expected to be.	-180 to 180	Degrees	gps.position.alert.lon
Speed					
Count Movement Hours	boolean	Counts the number of hours the device is moving according to the GPS speed.			gps.speed.count_hours
Speed Alert	boolean	Sets whether a change in speed generates an alert.			gps.speed.alert.enable
Threshold	integer	An alert will be raised if the device's speed goes above this threshold.	1 to 1000	km/h	gps.speed.alert.threshold
Hysteresis	integer	Once the alert is active or inactive, the speed must change by this value to change the alert state.	1 to 1000	km/h	gps.speed.alert.hysteresis
Bluetooth					
Name	text	A name that is meaningful to the user.	25 chars		ble.name
Interval	integer	The number of base intervals after which the Bluetooth module is turned on. Set to 0 to disable.	0 to 10000		ble.interval
Scan Time	integer	The device will capture matching messages for this length of time.		Seconds	ble.capture_time
Address Capture List	text	List of adresses to be captured in HEX format, separated by a comma. Leave blank to capture all.	200 chars		ble.id_list
Send Raw Data	boolean	If ticked, all captured messages will be added to the data message.			

External Sensors

7.1 Current Source 1 and 2

Two 12V switched current sources, which can source a maximum of 200mA each are supplied on pins 3 and 5. The 12V supply is internally generated and is battery backed and so can still be used when running of solar or battery power. Current supplied by each of the switched current sources is measured to a resolution of 0.1mA and so is able to be used to supply and measure the output of 4-20mA and other current-output sensors. Internal resettable fuses protect the outputs against over-current events.

The switched current sources are expected to be used to power external sensors such as hall-effect sensors, 4-20mA sensors and serial devices. It can be configured to turn on prior to measurement to allow sensors time to boot or for measurements to stabilise. After measurements are complete, the output can be switched off to preserve power; this is especially important when running off solar or batteries. The current sources can be used to power a sensor that is measured using one of the inputs, since the inputs are measured just before the current sources are turned off.

Note When a current source is used to power a sensor that is read by an input, the intervals specified for the current source and input must be the same.

Many 4-20mA sensors are powered by the current flowing through the loop to which they are connected and are called loop powered devices. Loop powered sensors can be connected using switched source 1 as the current source (pin 3) and GND (pin 2 or 4) or alternatively using switched source 2 as the current source (pin 5 as shown below) and GND.

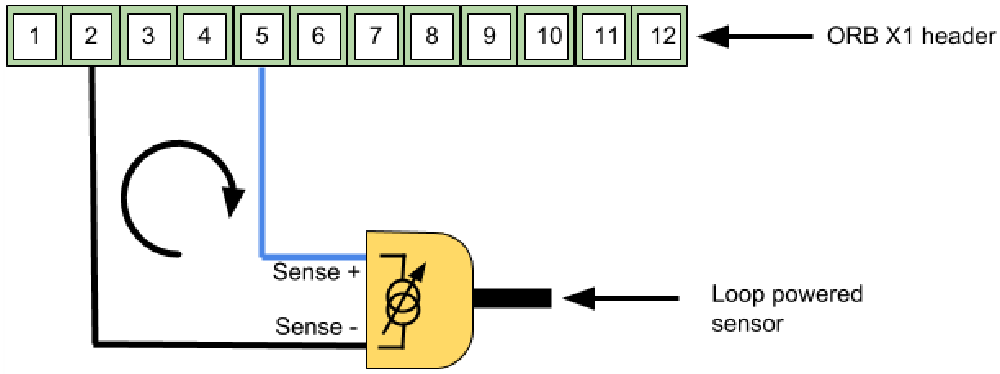


Figure 7.1. Connecting a single loop powered device

Some sensors and systems that use current as an output require an external power supply. In an implementation where system power is available, the sensor can be connected as shown below.

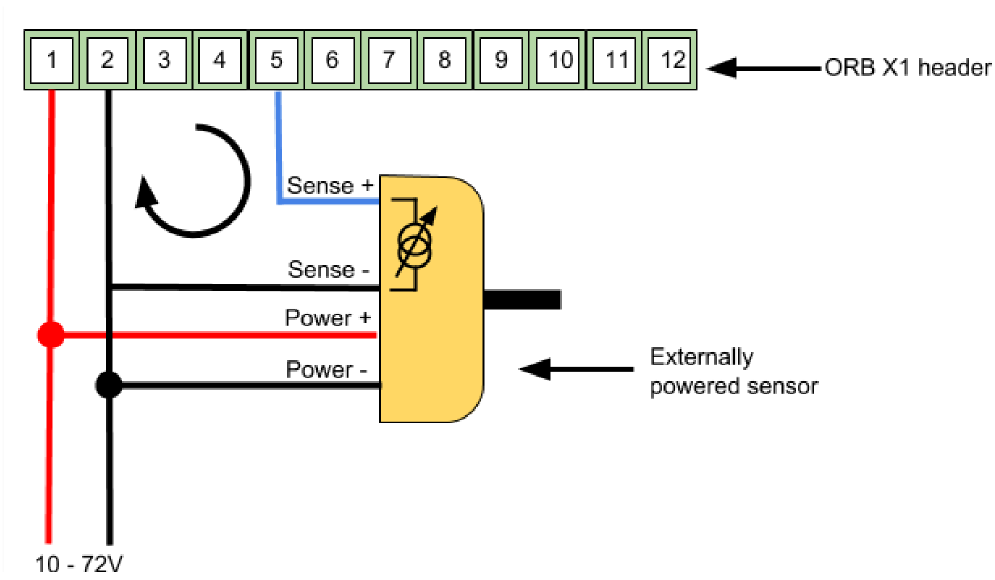


Figure 7.2. Connection of a single externally powered 4-20mA device

In solar or battery operated systems where permanent power is not available, externally powered current-output sensors can utilise the ORB switched power source as shown below. Switched source 1 and 2 should be configured to switch on for the minimum amount of time before a measurement is made in order to minimise power consumption.

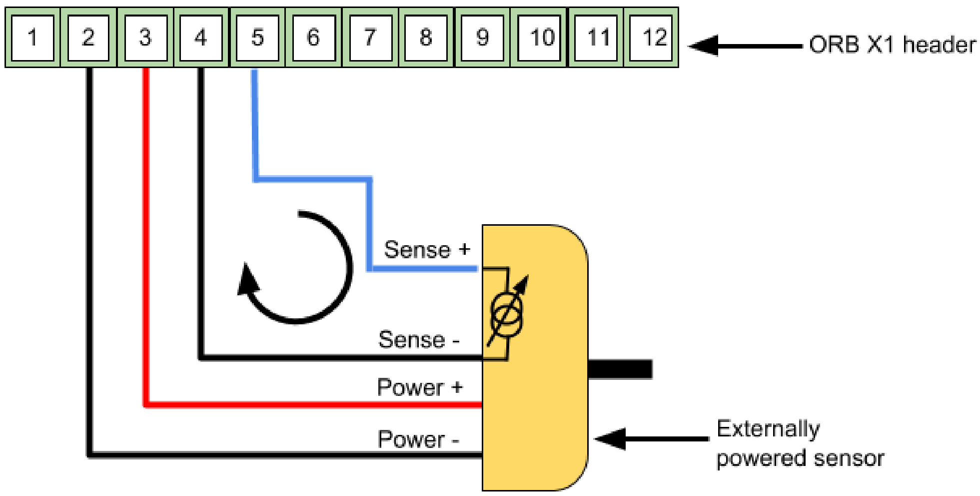


Figure 7.3. Connection of a single externally powered 4-20mA device using switched power

Two loop powered 4-20mA sensors can be connected to the ORB by utilising both of the switched current sources.

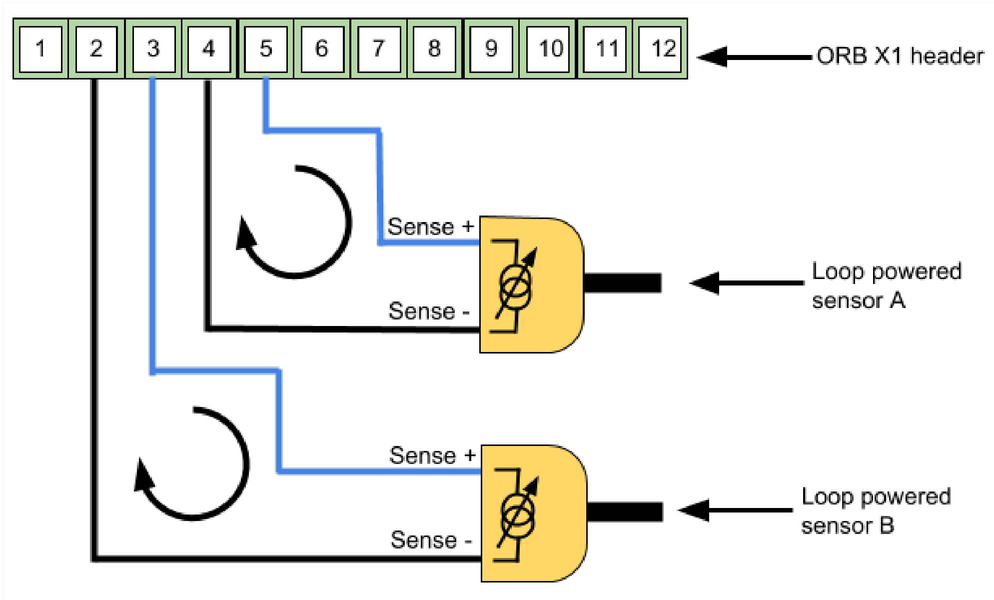


Figure 7.4. Connection of two loop powered 4-20mA devices

Both inputs will report the voltage that is connected to them and so can be used as general purpose analog or digital inputs.

Note When a voltage is connected to the current source pins, current may flow backwards into the ORB and the resulting current measurement may be negative.

Warning Connecting a power source greater than 12V to pins 3 or 5 may result in permanent damage to the functions of those pins or to the ORB.

7.1.1 Specification

Parameter	Specification
Maximum source current	100mA per pin
Maximum measurable current	40mA
Current measurement accuracy	+-0.1mA
Current measurement precision	20uA (11 bits over 40mA)
Maximum voltage on pins	12V
Voltage measurement accuracy	+-300mV

7.1.2 Settings

Measurements can be scheduled as a multiple of the base-interval. At the *interval*, the current sources will turn on and a measurement will be made. The fastest possible measurement rate is achieved by setting the interval to 1 in which case measurements will occur on every base interval. To reduce power consumption, the measurement rate can be turned down by increasing the measurement-interval.

If a connected device needs some time to stabilise before measurements can be taken, the current sources can be set to turn on a short time before a measurement is to be made using the *start time* option. Keep the *start time* value to a minimum to reduce overall power consumption when running on batteries or solar.

Note If more than one external device is being powered by the switched power, please ensure that the stabilisation time is set to the maximum for all devices powered.

If the current sources are being used to power an external sensor device that needs to be constantly powered, the *always on* option can be used to prevent the current source from being turned off.

The ORB measures current, in mA, sourced by the two outputs. If however the attached sensor is calibrated in a unit other than mA, then that *calibration* can be applied to the measurement. If for instance, a 4-20mA level sensor is attached to output 1 and 4mA represents 0m of water and 20mA represents 100m of water, then the *calibration* values are set as follows:

current1.calibration.low_x = 4	4mA is the low value at which the sensor is specified
current1.calibration.low_y = 0	0m is the value represented by 4mA
current1.calibration.high_x = 20	20mA is the high value at which the sensor is specified
current1.calibration.high_y = 100	100m is the value represented by 20mA
current1.calibration.unit = m	m is the unit as measured by the sensor

The mA values measured by the ORB will be converted into the user specified units before being transmitted or being compared with the warning and alarm values. If the user wants to leave the units in mA, then use the defaults as specified in the table below.

The input measurement range and accuracy can be optimised specifically for 4-20mA devices. Select the *optimise* option to optimise accuracy for 4-20mA sensors.

Warning and *alarm* thresholds can be enabled. Once enabled, each time a measurement is completed, the returned value will be compared with minimum and maximum *warning* and *alarm* thresholds. If a *warning* or *alarm* level is breached, a message will immediately be transmitted. As long as the *warning* or *alarm* condition persists, messages will be transmitted at the exception-interval rather than the transmit-interval. *Hysteresis* can be specified in increments of the specified unit, to prevent multiple alarms in the presence of electrical noise.

A full list of current source settings is given in the table at the end of this chapter.

7.2 Serial Interface

The serial port can be used to capture data that is sent from an external system or to interface to a MODBUS sensor.

The serial port occupies pins 6 and 7 on the interface header. The pins have functions that depend on the chosen interface as shown in the table below. When RS485 mode is chosen, an optional 120Ω termination resistor can be selected.

Interface type	Pin 6 function	Pin 7 function
RS232	Receive (Rx)	Transmit (Tx)
RS485	RS485-B	RS485-A

Note RS485-B is sometimes referred to as D+ or TX+/RX+ and RS485-A as D- or TX-/RX-.

The RS485 receiver supports up to 256 nodes per bus, and features full failsafe operation for floating, shorted or terminated inputs. Interface pins are protected against electrostatic discharge up to 26kV, whether the ORB is powered or unpowered.

7.2.1 Specification

Parameter	Specification
RS232 transmitter output low voltage (typical)	-5.5V

RS232 transmitter output high voltage (typical)	+5.9V
RS232 Input threshold voltage	+1.5V
RS485 differential output voltage (minimum with load resistance 120Ω)	+2V
RS485 differential input signal threshold	+-220mV
Maximum nodes in RS485 mode	256
RS485 termination resistor	120Ω

7.2.2 Settings

Measurements can be scheduled as a multiple of the base-interval. The fastest possible measurement rate is achieved by setting the *interval* to 1 in which case measurements will occur on every base interval. To reduce power consumption, the measurement rate can be turned down by increasing the *interval*.

In *serial capture* mode the measurement interval can be used to reduce the number of readings being provided by a connected sensor or system that may be permanently powered. If for instance, a connected system is sending a message every second but it is only required to be read and transmitted every minute, the measurement interval can be set to 1 minute in which case the ORB will wake on the minute interval, receive a message and return to sleep thereby missing the other 59 messages sent by the attached system. Since serial packets cannot be interrogated by the ORB without a customised script, it makes sense to set the measurement interval to the same as the transmit interval in most cases.

The serial port on the ORB can be configured as an RS232 or RS485 hardware interface using the *type* option.

If RS485 mode is selected, an optional 120Ω termination resistor can be selected by selecting the *Termination resistor* option. The purpose of the termination resistor is to match the impedance of a transmission line to the hardware impedance of the interface to which it is connected. Termination is generally not required in lower speed networks (9600 baud or less) and networks shorter than 500m in length. No more than 2 termination resistors should be used, one at each end of the RS485 transmission line.

A *baud rate* of 4800, 9600, 19200, 38400, 56800 or 115200 needs to be selected using the *baud rate* option. Other settings, including the number of bits, odd or even parity and 1 or 2 stop bits are added in the *settings* field. The most common setup is 8 bits, no parity and 1 stop bit or "8N1".

The serial interface can be configured in serial capture mode or MODBUS mode using the *mode* option. Capture mode is typically used where an external sensor sends serial data and a portion of that serial data is to be captured. MODBUS mode is used to connect to external sensors that are compatible with the MODBUS standard.

In *serial capture mode* The ORB listens for periodic data and when received, transmits this data at the next send interval. The maximum length of a message that can be captured is 512 characters. Once 512 characters have been received, the ORB will terminate the capture and will transmit it on the next transmit interval.

In capture mode, the *max-time* setting can be used to set a timeout after which the serial port will return to sleep. *Max-time* can be used as a way to end serial measurement in the event that no serial data is received, or as a mechanism to allow the ORB to sample the serial port for a defined time-period.

Note If the serial port needs to be kept on all the time, set the *max-time* to longer than the measurement interval. The contents of the serial buffer is retained as long as the ORB does not return to sleep.

The operation of the *max chars* option is similar to the *max time* setting except that the serial port stops sampling after a certain number of characters has been received. In most cases where the *max-chars* setting is used to terminate serial capture, the *max-time* setting is also used to end the serial measurement in the event that data does not arrive.

In *Serial capture mode*, in systems where many messages are sent and only a few are of interest, a *start* *string* of up to 10 characters can be enabled. For instance, in a typical GPS serial NMEA feed, the following are a subset of available messages:

- DTM - Datum being used.
- GGA - Fix information
- GLL - Lat/Lon data
- GSA - Overall Satellite data
- GSV - Detailed Satellite data
- RMC - Recommended minimum data for GPS
- RTE - Route message
- VTG - Vector track an Speed over the Ground

If in the application, the user is only interested in receiving the GGA message, then a *start string* can be set to GGA. In that way, any messages starting with DTM, GLL, GSA or other unwanted messages will be discarded.

Note If a start string is enabled, the ORB will stay awake until the string is received or until the *max-time* is reached.

In firmware revisions less than 2, serial *start strings* are specified as text, with special characters such as carriage return and line feed being specified by their respective escape sequences. A list of allowable escape sequences is given below:

- \f Form-feed
- \n Newline (Line Feed)
- \r Carriage Return
- \t Horizontal Tab
- \v Vertical Tab
- \\ Backslash

Note Because escape sequences start with a backslash (\), if a capture string contains a backslash, it needs to be escaped and so is represented as a double backslash (\\).

In firmware release 2 and above, serial *start strings* are specified as text, with special characters such as carriage return and line feed being specified by their respective ASCII codes in hexadecimal. A list of example hexadecimal sequences is given below:

- \x0C Form-feed
- \x0A Newline (Line Feed)
- \x0D Carriage Return
- \x09 Horizontal Tab
- \x0B Vertical Tab
- \x08 Backslash

The change to the method used to represent special characters has been made to allow for all ASCII characters to be used, and to allow for hexadecimal data to be captured.

Note In firmware revisions 2 and lower, special characters are specified as escape characters. In revisions 2 and above, special characters are represented by their ASCII representations in hexadecimal.

In some serial protocols, the start of a packet is specified by a preceding period of inactivity on the serial bus. The *Idle Time Before Start* parameter can be used to specify an idle time, which is exceeded will trigger the serial port to start capturing serial data.

Note If the serial port is capturing data and a subsequent idle time occurs, the capture process will restart and captured data will be discarded.

A serial capture *stop string* of up to 10 characters can also be provided. Again using the NMEA example, all NMEA messages end with a carriage return and line feed and so the serial capture *stop strings* in each case will be the same and will be "\r\n" or \x0D\x0A in revision 2 and above firmware. In most instances, the serial *stop strings* will be the same for all messages.

Note If a *start string* is specified without a *stop string*, or the *stop string* is never encountered, the serial port will capture characters until the *max-time* or *max-chars* is reached, the next measurement interval occurs or 256 characters are received.

An optional serial *request string* can be sent, on each measurement interval, to an external device. The purpose of the *request sting* is to request data from an external sensor or system. The *request string* can be a maximum of 10 characters and can be entered as text. Special characters like carriage return and line feed can be inserted using escape sequences or their ASCII representations as described earlier in the chapter.

The ORB implements the *MODBUS* communications protocol standard as a master, which enables communication with many slave devices connected to the network. The ORB can be configured to periodically request specific data from slave *MODBUS* devices on the network and transmit that data at specified intervals.

Up to twenty MODBUS data requests can be configured on the ORB; these data requests can either be from twenty individual slave devices or multiple requests from the same device. For each of the twenty data reads, the *slave address*, *function* and *register address* need to be specified. The *slave address* will be specified by the manufacturer of the device that is attached to the ORB; in some cases, slave devices allow their addresses to be configured. The *function* specifies the type of data to be read from the slave device. The ORB supports the following types of data reads:

- Disabled - the particular MODBUS channel is not used
- Read Coil - a 1 bit data value
- Read Discrete - a 1 bit data value
- Read Holding - a single 16 bit holding register
- Read Input - a 16 bit input register
- Read Holding (32 bits, Little Endian register order) - a 32 bit holding register
- Read Holding (32 bits, Big Endian register order) - a 32 bit holding register
- Read Input (32 bits, Little Endian register order) - a 32 bit input register
- Read Input (32 bits, Little Endian register order) - a 32 bit input register

Endianness is the order or sequence of bytes of digital data in computer storage and will be specified by the sensor that is being connected to the ORB.

A single MODBUS device may have multiple data values that can be read. The *register address* specifies which data the slave device needs to deliver.

In *MODBUS mode*, calibration can be applied so that the registers read by the ORB can be scaled to be in the units of what is being measured. For instance, a register that returns 0 to 255 may represent 0% humidity to 100% humidity. The ORB can be calibrated to take a number and to convert it to humidity in % and return that as the measured value.

In any system, the sensor and possibly the measured value will be subject to errors that may accumulate to reduce accuracy. In a system that uses the ORB to measure fluid volume in a 100 litre tank using a MODBUS sensor, the sensor may have offset errors such that with zero liquid in the tank, the ORB is showing a small volume. The ORB and sensor may also not be perfectly linear in that they may not measure 1 litre in exactly the same way when the tank is empty versus when it is full. The tank itself may also not be perfectly manufactured and may, for instance have walls that are not perfectly straight. All of these errors could add together such that the final system is less accurate than expected. To achieve a more accurate system, a calibration can be performed. In this example, the tank could be calibrated by adding a small amount of liquid, say 10 litres (low Y) and noting the value reported by the ORB (low X). Now fill the tank by adding another 99 litres (high y) and note the value being reported by the ORB (high X). By filling the high and low X and Y values into the calibration constants associated with *analog mode*, offset and non-linearity errors can be eradicated, resulting in a much more accurate system.

In *MODBUS mode*, *warning* and *alarm* thresholds for can be set for each MODBUS channel. Once enabled, each time a measurement is completed, the returned value will be compared with minimum and maximum *warning* and *alarm* thresholds. If a *warning* or *alarm* level is breached, a message will immediately be transmitted. As long as the *warning* or *alarm* condition persists, messages will be transmitted at the exception-interval rather than the transmit-interval.

Note If calibration has been applied, then the warning and enable thresholds are in the calibrated units.

A full list of serial interface settings is given in the table at the end of the chapter.

7.3 Inputs

Pins 8 and 9 on the 12 way header are multi-purpose inputs. The inputs can be configured to measure analog voltages, where the value on the pin is measured; digital states that represent ON or OFF; frequency; duty cycle and count pulses. In analog and digital mode, pin 8 represents input 1 and pin 9 represents input 2.

Pin	Channel
8	Input 1
9	Input 2

The voltage present on the inputs should not exceed 72V. The inputs are protected against over-voltage events to 100V and against static discharge.

The equivalent input impedance of pins 8 and 9 is the same and is shown below. As far as DC circuits are concerned, any input connected to pin 8 or 9 will experience a 310kΩ resistance to ground. For analog measurements, a low-pass filter reduces high frequency noise, improving measurement accuracy.

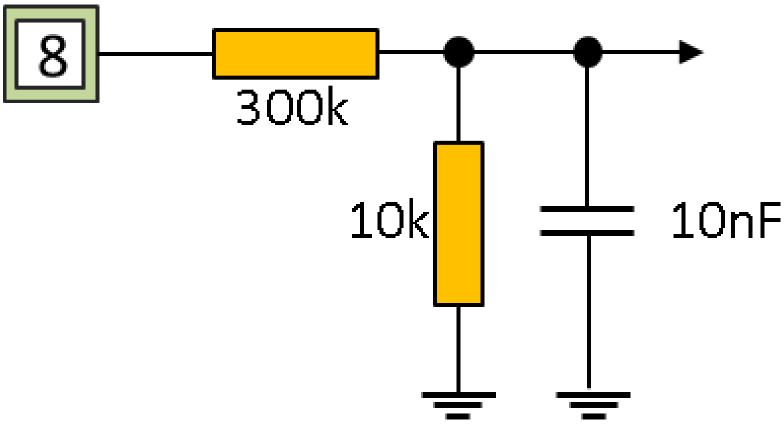


Figure 7.5. Equivalent circuit for inputs

Note The low pass filter is not applied when the input module is used to measure frequency and duty cycle.

7.3.1 Specification

Parameter for Analog and Digital measurements	Specification
Maximum input voltage	72V
Analog measurement accuracy	+-50mV
Input resistance (Input1)	182kΩ
Input resistance (Input2)	310kΩ
Input filter cutoff frequency	53Hz

Parameter for Frequency and Duty Cycle Measurement	Specification
Maximum input voltage	72V
Input resistance (Input1)	182kΩ
Minimum amplitude	3V (measured down to 1.7V but not guaranteed)
Minimum measureable frequency	1Hz (square wave, 3V minimum amplitude)
Maximum measureable frequency	10kHz (square wave, 3V minimum amplitude)
Frequency measurement resolution	1Hz
Frequency measurement accuracy	+-1Hz to 100Hz, +-10Hz to 10kHz
Maximum measurable duty cycle	100%
Minimum measureable duty cycle	1%
Duty cycle measurement resolution	1%
Duty cycle accuracy	+-1%

Minimum pulse duration for duty cycle measurement	10msec (1% of 1Hz)

Parameter for Pulse Counting	Specification
Maximum input voltage	72V
Input resistance (Input1)	182kΩ
Minimum amplitude	3V (tested down to 1.7V but not guaranteed)
Minimum frequency	0.01Hz (not tested lower)
Maximum measureable frequency	5kHz (square wave, 3V amplitude)
Minimum pulse duration for pulse counting	+100usec (tested to 20usec but not guaranteed)

7.3.2 Settings

Measurements can be scheduled as a multiple of the base-interval. The fastest possible measurement rate is achieved by setting the *interval* to 1 in which case measurements will occur on every base interval. To reduce power consumption, the measurement rate can be turned down by increasing the *interval*.

The mode selects the function of the input pin. Input 1 can be operated in *Digital*, *Analog*, *Frequency* and *Duty Cycle* modes; input 2 only has *Digital* and *Analog* modes.

Analog mode

Select *analog mode* if the input is a voltage that needs to be measured. Analog measurement should be used when interfacing with voltage-output sensors or when measuring a voltage, for instance when reporting on solar capacity. The maximum voltage that can be measured is 72V and the resolution is 50mV.

For maximum accuracy, and to allow for scaling of sensors, calibration can be applied in analog mode.

Digital mode

Select *digital mode* if the input typically has two levels and can be considered as ON or OFF. Digital mode is typically used when interfacing to a switch or a system that has two discrete voltages representing ON and OFF. An example of a signal with 2 discrete on and off voltage levels would be an ignition signal on a vehicle. In digital mode, the *threshold* at which an input is considered ON or OFF can be set between 0 and 72V in 100mV increments. For example, if the ORB is being used to detect an ignition signal in a 12V vehicle, the *threshold* could be set to 6 volts. In a system where the output is either 0 or 5 volts, the *threshold* could be set at 2.5 volts. Hysteresis can be applied to prevent false changes in state if the input voltage crosses the *threshold* slowly or in the presence of noisy inputs. In the example below, adding *hysteresis* prevents the output falsely showing as on as the noisy signal crosses the threshold. In digital mode, the hours that the input is above the threshold can be counted and used as an hour meter.

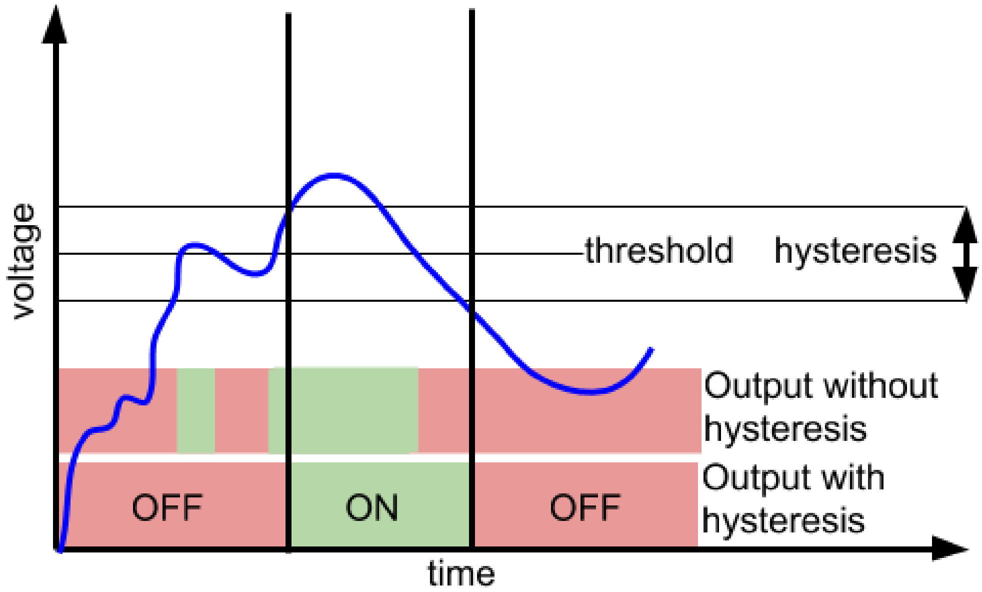


Figure 7.6. Hysteresis

Since the inputs on the ORB have a 310kΩ resistance to ground, if an external switch is placed between supply and the input, no additional circuitry is required. When the external switch is open, the 310k resistance will pull the input low. When the external switch is closed, the input will be driven high. Where there is no permanent power source, switches can be powered using one of the current loops. Connection to an external switch that is connected to system power is shown below.

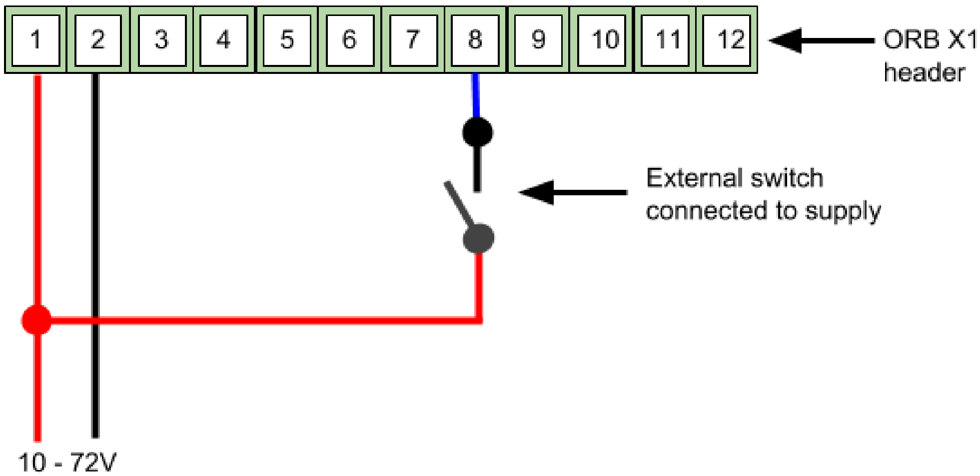


Figure 7.7. External switch connection when switch to positive

If an external switch is to be connected to ground, an external pullup resistor of less than 10kΩ is required between the pin to which the switch is connected and system power. Power to the pullup can also be provided using the internally generated switched power on either of the current source pins. When the switch is open , the external pullup drives the pin high. When the switch is closed, the pin is grounded. Connection to an external switch that is connected to ground is shown below.

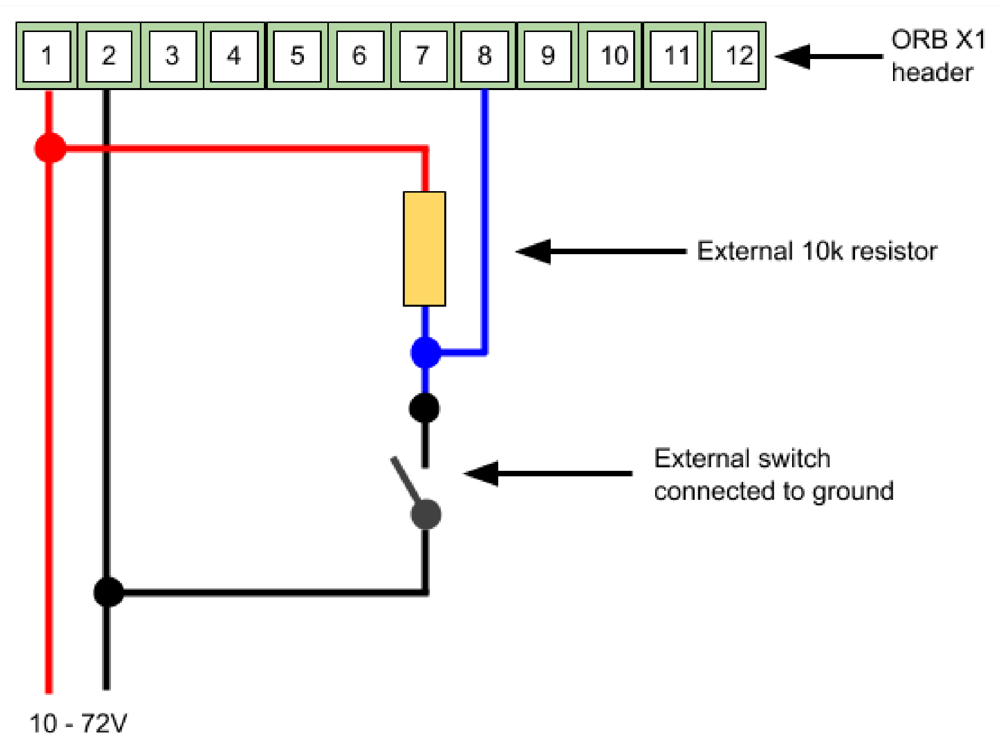


Figure 7.8. External switch connection when switch to ground

Note Connecting an external pullup resistor will increase current consumption when running of batteries and using the switched power output.

In digital mode, an *alert* can be generated when the input changes state. This may be useful, for instance where monitoring an alarm system to see if it is activated or not. Each time the system is activated or de-activated, an *alert* can be generated and transmitted

Input 1 has additional functionality that allows switch change of state detection whilst the ORB is in sleep state. This allows the ORB to remain in a very low power sleep state, to wake on switch level change and transmit the change of state. This functionality is not available on input 2.

Frequency mode

Input 1 has an additional mode that allows for the measurement of frequency. In *frequency mode*, on each measurement interval, the frequency of a signal on the pin is measured. Primary applications are speed, rpm and flow rate measurement.

In the diagram below, the ORB is configured to measure engine speed using an output from the P (pulse) terminal on an alternator.

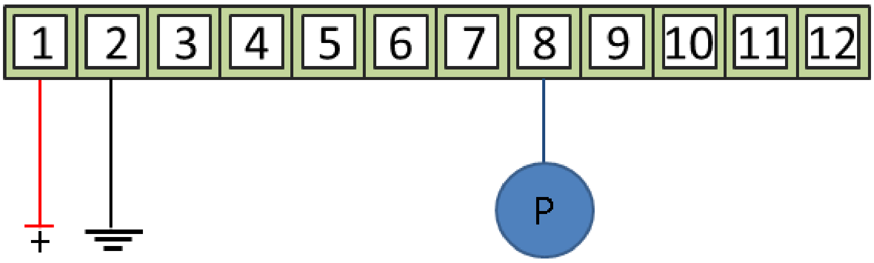


Figure 7.9. RPM measurement

Duty-Cycle mode

Input 1 has an additional mode that allows for the measurement of duty-cycle. In *duty-cycle mode*, on each measurement interval, the duty-cycle of a signal on the pin is measured. Sensors regularly use duty cycle to communicate percentage of full-scale; for instance, 0% duty cycle may represent 0% humidity and 100% duty-cycle may represent 100% humidity. In some sensors, 0% and 100% duty cycle represent error conditions.

Calibration

In *analog mode*, *frequency mode* and *duty-cycle mode*, calibration can be applied so that the measurement returned by the ORB is in the units of what is being measured. For instance, in *analog mode*, a voltage of 0 to 5V may represent 0% humidity to 100% humidity. The ORB can be calibrated to take a voltage measurement and to convert the measurement to humidity in % and return that as the measured value.

In any system, the measurement instrument (the ORB), the sensor and possibly the measured value will be subject to errors that may accumulate to reduce accuracy. In a system that uses the ORB to measure fluid volume in a 100 litre tank using a 4-20mA sensor, the ORB and sensor may have offset errors such that with zero liquid in the tank, the ORB is showing a small volume. The ORB and sensor may also not be perfectly linear in that they may not measure 1 litre in exactly the same way when the tank is empty versus when it is full. The tank itself may also not be perfectly manufactured and may, for instance have walls that are not perfectly straight. All of these errors could add together such that the final system is less accurate than expected. To achieve a more accurate system, a calibration can be performed. In this example, the tank could be calibrated by adding a small amount of liquid, say 10 litres (low Y) and noting the value reported by the ORB (low X). Now fill the tank by adding another 99 litres (high y) and note the value being reported by the ORB (high X). By filling the high and low X and Y values into the calibration constants associated with *analog mode*, offset and non-linearity errors can be eradicated, resulting in a much more accurate system.

Warnings and Alarms In *analog mode*, *frequency mode* and *duty-cycle mode*, *warning* and *alarm* thresholds for can be set. Once enabled, each time a measurement is completed, the returned value will be compared with minimum and maximum *warning* and *alarm* thresholds. If a *warning* or *alarm* level is breached, a message will immediately be transmitted. As long as the *warning* or *alarm* condition persists, messages will be transmitted at the exception-interval rather than the transmit-interval.

Note If calibration has been applied, then the warning and enable thresholds are in the calibrated units.

Pulse counting

In all modes, the number of pulses that have occurred since the ORB was last reset can be measured and reported. To enable the counting of pulses, enable the *pulse* option. If for instance, a flow-sensor is being used to deliver fuel to a vehicle, the instantaneous frequency would represent flow rate (possiblyin litres per minute) and the number of pulses would represent the total amount of fuel delivered (possibly in litres). When *pulse* counting is enabled, the ORB remains awake, continuously monitoring the input in order to capture all the pulses that occur.

Note In firmware releases from SFW002-3.0.0, the pulse count is stored to non-volatile memory and so will be retained during a device reset.

The count can be set to *reset* after a number of pulses have been counted. This may be useful, for instance if a sensor is measuring water in litres, and only kilolitre indications are required. In this case, a *pulse warning* level can be set at 1000 pulses at which time a transmission will be made and at the same time, the counter will be *reset*. One transmission will be made for each 1000 litres of water measured.

Note Because *pulse* counting keeps the input active, there will be an increase in power consumption.

In the diagram below, a flow sensor with integrated reed-switch is connected to input 1 to allow the number of pulses occurring to be measured.

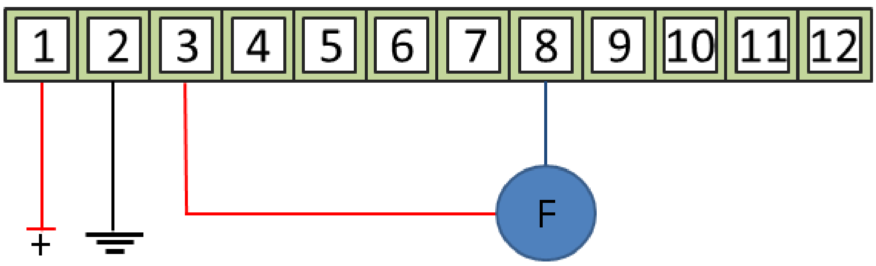


Figure 7.10. Flow sensor connection

A full list of settings for the inputs is given in the table at the end of this chapter.

7.4 CAN Bus Interface

The ORB-C1 has a CAN bus interface that can be used to read data from all kinds of vehicles and sensors that use CAN as their communications medium. Hundreds of sensors can be connected to a single CAN network.

In many cases, the protocol that is being used on the CAN bus is known, and so large volumes of understandable data can be extracted from all kinds of vehicles. Common CAN protocols include:

- J1939, the dominating CAN-based protocol for trucks and busses.
- ISO 11783, a J1939 flavor for agricultural tractors.
- ISO 11992, an interface between trucks and trailers.
- NMEA 2000, a protocol based on J1939 for marine use.
- CANopen, provides a standard for industrial machinery commonly used in industrial automation.

The ORB is compatible with the latest CAN Flexible-Data-rate (FD) specification.

Pins 11 and 12 on the ORB header provide the interface to a CAN network with pin 11 being CAN High (dominant high) and pin 12 being CAN Low (dominant low).

In CAN networks, 120Ω terminating resistors are found at each end of the network. In most systems, the terminating resistors will already be in place and will not be needed. In cases where a sensor network is being formed between an ORB and external sensor, a 120Ω resistor should be placed between the pins 11 and 12 on the ORB.

Warning In CAN bus systems, the ground supplied to the ORB must be the same ground as used by the CAN network. High differential voltages between the CAN lines and ground can damage the CAN interface.

7.4.1 Specification

Parameter	Specification
CAN High driver voltage (typical)	2.9V
CAN Low driver voltage (typical)	0.9V
Common mode voltage for reception (maximum)	+-25V
Absolute maximum voltage on CAN High and CAN Low	+-60V
Termination resistor	120Ω

7.4.2 Settings

Measurements can be scheduled as a multiple of the base-interval. The fastest possible measurement rate is achieved by setting the *interval* to 1 in which case the CAN network will be sampled on every base interval. To reduce power consumption, the measurement rate can be turned down by increasing the *interval*.

The CAN bus peripheral on Senquip devices supports can bit rates of 125, 250, 500 and 1000 bits per second as specified in the *Nominal Baud Rate* field.

To ensure minimum intrusion on CAN systems, the CAN peripheral can be set to listen only. In this mode the Senquip device will only receive messages that are acknowledged on the bus by a listening node. Where required, the Senquip device can be made to acknowledge messages by selecting the *TX Enable* option.

A typical automotive CAN network will contain hundreds of messages, all with their own identifiers. The CAN peripheral can filter only the required messages by filling in the *ID Capture List*. Required identifiers should be entered in hexadecimal and should be separated by commas, for example "18FF20F2, 18FF36F0, 18FF1BF2". When the Senquip device wakes for the next measurement interval, the CAN network will be sampled until all the messages listed have been found or the *Capture Time* has been reached. If multiple messages with the same identifier are required in a single measurement interval, place a * followed by the number of messages of that identifier to be returned. For example, populating the *ID Capture List* with "18FF20F2*4, 18FF36F0, 18FF1BF2*10, 18FF1F12*" will return four 18FF20F2 messages, one 18FF36F0 message, ten 18FF1BF2 messages, and one 18FF1F12 message. Leave the *ID Capture List* blank to receive one of every message that arrives. Place a * in the *ID Capture List* to receive all messages in the order that they arrive. Keep in mind that receiving every message on the bus could overwhelm the Senquip device in systems with lots of high repetition rate messages.

The *Capture Time* setting can be used to set a timeout after which the CAN bus peripheral will stop listening, allowing the Senquip device to transmit received messages and return to sleep. *Capture-time* can also be used as a mechanism to allow the CAN peripheral to sample the CAN bus for a defined time-period.

CAN messages can be sent to connected device from within a script. The messages can be sent once, or can be set to repeat at a given time interval. If the device enters sleep or hibernate, repeating messages will be stopped. If the Senquip device is reset, the sending of repeating CAN messages is unaffected. The messages will continue to be sent until a change is applied. For example, if new script is loaded, forcing a reset, the CAN messages will continue to be sent until the new script applies a change. In the case of a malfunction that lasts for more than 30 second, repeating CAN messages will be stopped.

A full list of CAN bus settings is given in the table at the end of this chapter.

7.5 Output

An open-collector output that can be made to switch to ground is provided on pin 10 of the header. The output is capable of sinking 450mA to ground and has an internal resettable fuse in place to prevent over-current events. The output is capable of switching coils and is therefore able to drive external relays and low power solenoids. The open circuit voltage applied to the output should not exceed system voltage or 72V.

As an alternate function, where additional inputs are required, the output can be configured as an analog or digital input.

Note There is a limit to the amount of energy that the protection circuit can absorb. For instance, shorting the output to power at 72V when the output is on will likely destroy the output.

The output is typically used to indicate warning and alarm conditions currently active and can be set to active in the event of a measurement returning an exception. When configured to do so, the buzzer or indicator lamp shown in the diagram below will turn on when a warning or alarm condition exists as pin 10 is switched to ground.

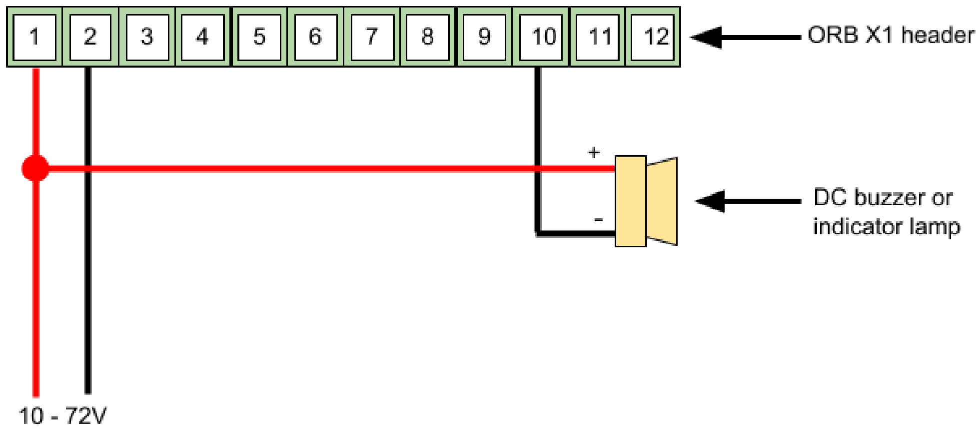


Figure 7.11. Using the output to drive a buzzer with permanent power

In solar or battery operated systems where permanent power is not available, externally powered current output sensors can utilise the ORB switched power source on pin 3 as shown below.

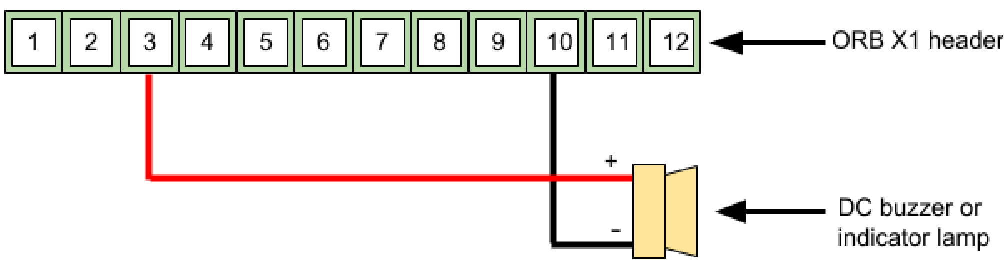


Figure 7.12. Using the output and internal power to drive a buzzer

7.5.1 Specification

Parameter	Specification
Maximum open circuit voltage	72V
Maximum hold current	450mA min
Minimum fuse current	550mA max
Digital input threshold	6V
Hysteresis	1V

7.5.2 Settings

The output can be scheduled to be configured at a multiple of the base-interval. In the event that the *Interval* is set to a number higher than 1, the output state will only checked and configured on the next output interval. This can be used to create a pulsed output that may be useful in driving alert indicators or in allowing attached devices to time to cool down.

The *Mode* setting can be used to configure the output with alternate functions as an analog or digital input. In input mode, the same settings as are associated with Input 2 apply except that the digital threshold and hysteresis are fixed.

The output can be configured to activate when any of the peripherals report an exception (*warning*, *alarm* or *alert*) as a result of a measurement and can be set to remain on only as long as the warning or alarm is active or to *hold* on for a time after the *warning* or *alarm* has gone away.

Note The output state will be configured at each output interval. The hold-time is how long the output is kept enabled after the exceptions are cleared.

A full list of settings for the output is given in the table at the end of this chapter.

7.6 External Sensor Settings

A full list of settings for external sensors is given in the table below.

Name	Item	Function	Range	Unit	Internal Reference
Input 1					
Name	text	A name for the input that is meaningful to the user.	25 chars		input1.name
Interval	integer	The number of base intervals after which the input is sampled. A value of 1 means that the input is collected every base interval. Set to 0 to disable.	0 to 10000		input1.interval
Mode	preset	Specifies the function of the IN1 terminal. The calibration, warnings and alarms are applied to this mode.			input1.mode
Digital 1					
Digital Threshold	decimal	A threshold against which the input is compared to determine if the input state is ON or OFF.	0 to 30	Volts	input1.digital.threshold
Digital Hysteresis	decimal	Once the input is in a certain state, hysteresis is the amount by which the input has to change before moving to the other state.	0 to 20	Volts	input1.digital.hysteresis

Count Hours	boolean	Counts the number of hours the digtial input is ON (above threshold).			input1.digital.count_hours
Digital Change Alert	boolean	Sets whether a change in digital state generates an alert.			input1.digital.alert.enable
Analog 1 Calibration	text	Calibration parameters for Analog 1. Refer to user guide.	30 chars		input1.cal
Unit	text	The unit of measure associated with the calibration. Examples: Litres/min, RPM, Volts			input1.unit
Warning	text	Warning thresholds. Refer to user guide.			input1.warning
Alarm	text	Alarm thresholds. Refer to user guide.			input1.alarm
Alarm/Warning Hysteresis	decimal	Once the input is in a certain state, hysteresis is the amount by which the input has to change before moving to the other state.			input1.hysteresis
Pulse Input					
Pulse Counting	boolean	Enables counting of pulses in addition to frequency measurement.			input1.pulse.enable
Reset Value	integer	The value at which the number of pulses counted on the input is reset to zero.	1 to 2000000000	Counts	input1.pulse.reset_value
Pulse Scaling	decimal	Multiplier to convert the pulse count to a useful unit.			input1.pulse.scaling
Pulse Unit	text	The unit of measure associated with the scaled pulse count. Eg: Litres			input1.pulse.unit
Pulse Warning	text	Warning thresholds. Refer to user guide.			input1.pulse.warning
Pulse Alarm	text	Alarm thresholds. Refer to user guide.			input1.pulse.alarm
Input 2					
Name	text	A name for the input that is meaningful to the user.	25 chars		input2.name
Interval	integer	The number of base intervals after which the input is sampled. A value of 1 means that the input is collected every base interval. Set to 0 to disable.	0 to 10000		input2.interval
Mode	preset	Specifies the function of the IN2 terminal. The calibration, warnings and alarms are applied to this mode.			input2.mode
Digital 2					
Digital Threshold	decimal	A threshold against which the input is compared to determine if the input state is ON or OFF.	0 to 30	Volts	input2.digital.threshold
Digital Hysteresis	decimal	Once the input is in a certain state, hysteresis is the amount by which the input has to change before moving to the other state.	0 to 20	Volts	input2.digital.hysteresis
Count Hours	boolean	Counts the number of hours the digtial input is ON (above threshold).			input2.digital.count_hours

Digital Change Alert	boolean	Sets whether a change in digital state generates an alert.			input2.digital.alert.enable
Analog 2 Calibration	text	Calibration parameters for Analog 2. Refer to user guide.	30 chars		input2.cal
Unit	text	The unit of measure associated with the calibration. Examples: Litres/min, RPM, Volts			input2.unit
Warning	text	Warning thresholds. Refer to user guide.			input2.warning
Alarm	text	Alarm thresholds. Refer to user guide.			input2.alarm
Alarm/Warning Hysteresis	decimal	Once the input is in a certain state, hysteresis is the amount by which the input has to change before moving to the other state.			input2.hysteresis
Output 1					
Name	text	A name for the input that is meaningful to the user.	25 chars		output1.name
Interval	integer	Does not affect output mode. The number of base intervals at which the input is sampled. Set to 0 to disable. Set to 1 for every base interval.	0 to 10000		output1.interval
Mode	preset	Specifies the function of the OUT1 terminal.			output1.mode
Warnings	boolean	Determines if the output is turned on when a warning is active.			output1.warnings
Alarms	boolean	Determines if the output is turned on when an alarm is active.			output1.alarms
Alerts	boolean	Determines if the output is turned on when an alert is active.			output1.alerts
Hold Time	integer	Sets the time in seconds for which the output is held on after it is triggered. If set to zero, the output remains on while any exceptions are active.		Seconds	output1.hold_time
Digital Change Alert	boolean	If enabled, a change in digital state will generate an alert.			output1.digital.alert.enable
Analog 3 Calibration	text	Calibration parameters for Analog 3. Refer to user guide.	30 chars		output1.cal
Unit	text	The unit of measure associated with the calibration. Examples: Litres/min, RPM, Volts			output1.unit
Warning	text	Warning thresholds. Refer to user guide.			output1.warning
Alarm	text	Alarm thresholds. Refer to user guide.			output1.alarm
Alarm/Warning Hysteresis	decimal	Once the input is in a certain state, hysteresis is the amount by which the input has to change before moving to the other state.			output1.hysteresis
Thermocouple 1					

Name	text	A name for the input that is meaningful to the user.	25 chars		tc1.name
Interval	integer	The number of base intervals after which the thermocouple is measured and events are checked. A value of 1 means that the input is collected every base interval. Set to 0 to disable.	0 to 10000		tc1.interval
Hysteresis	decimal	The amount by which the measured value has to drop below the threshold to re-enable the event.	-1000 to 1000	°C	tc1.hysteresis
Type	text	Determines the type of thermocouple connected. Valid values are: K, J, T, N, S, E, B and R	1 chars		tc1.type
Warning	text	Warning thresholds. Refer to user guide.	-1000 to 1000	°C	tc1.warning
Alarm	text	Alarm thresholds. Refer to user guide.	-1000 to 1000	°C	tc1.alarm
CAN 1					
Name	text	A name that is meaningful to the user.	25 chars		can1.name
Interval	integer	The number of base intervals after which the CAN module is turned on. Set to 0 to disable.	0 to 10000		can1.interval
Nominal Baud Rate	integer	Baud rate for CAN communication. Supported values are: 125, 250, 500, 1000		kbit/s	can1.nominal_baud
Capture Time	integer	The device will capture matching messages for this length of time.		Seconds	can1.capture_time
TX Enable	boolean	Allows the device to transmit and acknowledge messages on the CAN bus.			can1.tx_enable
ID Capture List	text	List of IDs to be captured in HEX format, separated by a comma eg: 18FEE60A. Leave blank to capture all.	200 chars		can1.id_list
Send Raw Data	boolean	If ticked, all captured messages will be added to the data message.			
Current Loop 1					
Name	text	A name for the input that is meaningful to the user.	25 chars		current1.name
Interval	integer	The number of base intervals after which the input is sampled. A value of 1 means that the input is collected every base interval. Set to 0 to disable.	0 to 10000		current1.interval
Mode	preset	Specifies the function of the SRC1 terminal.			current1.mode
Always On	boolean	Determines if Switched Power is to be enabled permanently.			current1.always_on
Start Time	decimal	Time in seconds that the output is turned on before measurements are taken. Allows an external device to stabilise.	0 to 3600	Seconds	current1.start_time

Digital Change Alert	boolean	Sets whether a change in digital state generates an alert. (Digital Mode Only)			current1.digital.alert.enable
Current 1 Calibration	text	Calibration parameters for Current 1. Refer to user guide.	30 chars		current1.cal
Unit	text	The unit of measure associated with the calibration. Examples: Percent, Pascals, Meters			current1.unit
Warning	text	Warning thresholds. Refer to user guide.			current1.warning
Alarm	text	Alarm thresholds. Refer to user guide.			current1.alarm
Alarm/Warning Hysteresis	decimal	The amount by which the calibrated current value has to drop below the threshold to re-enable the event.			current1.hysteresis
Current Loop 2					
Name	text	A name for the input that is meaningful to the user.	25 chars		current2.name
Interval	integer	The number of base intervals after which the input is sampled. A value of 1 means that the input is collected every base interval. Set to 0 to disable.	0 to 10000		current2.interval
Mode	preset	Specifies the function of the SRC2 terminal.			current2.mode
Always On	boolean	Determines if Switched Power is to be enabled permanently.			current2.always_on
Start Time	decimal	Time in seconds that the output is turned on before measurements are taken. Allows an external device to stabilise.	0 to 3600	Seconds	current2.start_time
Digital Change Alert	boolean	Sets whether a change in digital state generates an alert. (Digital Mode Only)			current2.digital.alert.enable
Current 2 Calibration	text	Calibration parameters for Current 2. Refer to user guide.	30 chars		current2.cal
Unit	text	The unit of measure associated with the calibration. Examples: Percent, Pascals, Meters			current2.unit
Warning	text	Warning thresholds. Refer to user guide.			current2.warning
Alarm	text	Alarm thresholds. Refer to user guide.			current2.alarm
Alarm/Warning Hysteresis	decimal	The amount by which the calibrated current value has to drop below the threshold to re-enable the event.			current2.hysteresis
Serial 1					
Name	text	A name for the input that is meaningful to the user.	25 chars		serial1.name
Interval	integer	The number of base intervals after which the serial port is turned on. Set to 0 to disable.	0 to 10000		serial1.interval
Type	preset	The electrical interface type.			serial1.type
Termination Resistor	boolean	This parameter enables the integrated termination resistor.			serial1.termination

Mode	preset	Describes how the serial port is to be handled. CAPTURE: serial data is captured between start and end characters. MODBUS: serial data is treated according to MODBUS RTU standard			serial1.mode
Baud Rate	integer	Baud rate for serial communication. Common values are: 4800, 9600, 19200, 38400, 57600, 115200			serial1.baud
Settings	text	A string describing the number of bytes: 7,8,9. Parity type: N(none), E(even), O(odd). Number of stop bits: 1 or 2. Typically: 8N1			serial1.settings
Capture					
Start String	text	The serial port starts reading data when it detects these characters. Example: $GPGGA, serial data will be ignored until $GPGGA is received after which data will be captured. If nothing is specified, the serial port will capture all data until the timeout period is reached.	32 chars		serial1.capture.start
Idle Time Before Start	integer	For a valid start condition, there must be this amount of idle time before receiving serial data. Additionally, the captured data will restarted if the serial port is idle for this time. Set to 0 to disable.	0 to 60000	Milliseconds	serial1.capture.start_idle_time
End String	text	Once capturing, if these characters are received, the serial port will stop capturing and will return to sleep. For binary data or escape sequences refer to the User Guide.	32 chars		serial1.capture.end
Request String	text	This string will be sent when the serial port is first turned on. Use this function to request data from a remote module.	32 chars		serial1.capture.request
Max Time	integer	The device will wait this length of time for a valid capture.		Seconds	serial1.capture.maxtime
Max Chars	integer	Maximum number of characters to be captured before the serial port goes back to sleep.			serial1.capture.maxchars
Alert on Capture	boolean	If checked an alert will be raised on any successful serial capture.			serial1.capture.alert
MODBUS RTU					
Slave Timeout	decimal	How long to wait for a response from each slave device.	0 to 10	Seconds	serial1.modbus.timeout
MODBUS 1					
Modbus 1 Name	text	A meaningful name for Modbus Channel 1.	25 chars		mod1.name
Modbus 1 Settings	text	Settings for Modbus Channel 1. Refer to user guide.	18 chars		mod1.settings
Modbus 1 Calibration	text	Calibration paramters for Modbus Channel 1. Refer to user guide.	30 chars		mod1.cal

Modbus 1 Unit	text	The unit of measure associated with the calibration. Examples: Percent, L/hr, Meters			mod1.unit
Warning	text	Warning thresholds. Refer to user guide.			mod1.warning
Alarm	text	Alarm thresholds. Refer to user guide.			mod1.alarm
MODBUS 2					
Modbus 2 Name	text	A meaningful name for Modbus Channel 2.	25 chars		mod2.name
Modbus 2 Settings	text	Settings for Modbus Channel 2. Refer to user guide.	18 chars		mod2.settings
Modbus 2 Calibration	text	Calibration paramters for Modbus Channel 2. Refer to user guide.	30 chars		mod2.cal
Modbus 2 Unit	text	The unit of measure associated with the calibration. Examples: Percent, L/hr, Meters			mod2.unit
Warning	text	Warning thresholds. Refer to user guide.			mod2.warning
Alarm	text	Alarm thresholds. Refer to user guide.			mod2.alarm
MODBUS 3					
Modbus 3 Name	text	A meaningful name for Modbus Channel 3.	25 chars		mod3.name
Modbus 3 Settings	text	Settings for Modbus Channel 3. Refer to user guide.	18 chars		mod3.settings
Modbus 3 Calibration	text	Calibration paramters for Modbus Channel 3. Refer to user guide.	30 chars		mod3.cal
Modbus 3 Unit	text	The unit of measure associated with the calibration. Examples: Percent, L/hr, Meters			mod3.unit
Warning	text	Warning thresholds. Refer to user guide.			mod3.warning
Alarm	text	Alarm thresholds. Refer to user guide.			mod3.alarm
MODBUS 4					
Modbus 4 Name	text	A meaningful name for Modbus Channel 4.	25 chars		mod4.name
Modbus 4 Settings	text	Settings for Modbus Channel 4. Refer to user guide.	18 chars		mod4.settings
Modbus 4 Calibration	text	Calibration paramters for Modbus Channel 4. Refer to user guide.	30 chars		mod4.cal
Modbus 4 Unit	text	The unit of measure associated with the calibration. Examples: Percent, L/hr, Meters			mod4.unit
Warning	text	Warning thresholds. Refer to user guide.			mod4.warning
Alarm	text	Alarm thresholds. Refer to user guide.			mod4.alarm
MODBUS 5					
Modbus 5 Name	text	A meaningful name for Modbus Channel 5.	25 chars		mod5.name
Modbus 5 Settings	text	Settings for Modbus Channel 5. Refer to user guide.	18 chars		mod5.settings
Modbus 5 Calibration	text	Calibration paramters for Modbus Channel 5. Refer to user guide.	30 chars		mod5.cal

Modbus 5 Unit	text	The unit of measure associated with the calibration. Examples: Percent, L/hr, Meters			mod5.unit
Warning	text	Warning thresholds. Refer to user guide.			mod5.warning
Alarm	text	Alarm thresholds. Refer to user guide.			mod5.alarm
MODBUS 6					
Modbus 6 Settings	text	Settings for Modbus Channel 6. Refer to user guide.	18 chars		mod6.settings
Modbus 6 Calibration	text	Calibration paramters for Modbus Channel 6. Refer to user guide.	30 chars		mod6.cal
MODBUS 7					
Modbus 7 Settings	text	Settings for Modbus Channel 7. Refer to user guide.	18 chars		mod7.settings
Modbus 7 Calibration	text	Calibration paramters for Modbus Channel 7. Refer to user guide.	30 chars		mod7.cal
MODBUS 8					
Modbus 8 Settings	text	Settings for Modbus Channel 8. Refer to user guide.	18 chars		mod8.settings
Modbus 8 Calibration	text	Calibration paramters for Modbus Channel 8. Refer to user guide.	30 chars		mod8.cal
MODBUS 9					
Modbus 9 Settings	text	Settings for Modbus Channel 9. Refer to user guide.	18 chars		mod9.settings
Modbus 9 Calibration	text	Calibration paramters for Modbus Channel 9. Refer to user guide.	30 chars		mod9.cal
MODBUS 10					
Modbus 10 Settings	text	Settings for Modbus Channel 10. Refer to user guide.	18 chars		mod10.settings
Modbus 10 Calibration	text	Calibration paramters for Modbus Channel 10. Refer to user guide.	30 chars		mod10.cal

Network Connection

The ORB can communicate with the Senquip Portal or a remote server via Wi-Fi or 4G LTE. Where both Wi-Fi and 4G LTE networks are selected, the ORB will first attempt to connect via Wi-Fi and if that is unsuccessful, the ORB will then attempt to connect via 4G LTE. In the event that neither Wi-Fi or 4G LTE networks can be found, the ORB can be set to log data to internal memory and then upload it when a network becomes available (see *Endpoint* settings).

8.1 Wi-Fi Specification

Wi-Fi on the ORB is used to transmit data, to allow settings to be remotely updated, to allow in-field software updates and also to enable setup via an integrated web-server that can be accessed in setup mode via a mobile phone or other Wi-Fi device.

The ORB Wi-Fi implementation supports Wi-Fi 802.11 b/g/n. The Wi-Fi antenna is integrated into the ORB. In typical applications, the range achievable with Wi-Fi is 500m.

8.2 4G LTE Specification

4G LTE on the ORB is used to transmit data, to allow settings to be remotely updated and to allow in-field software updates.

The ORB 4G LTE implementation is designed for global use and supports Cat-M1 and CAT-1 in the following bands:

Device	LTE Category	Bands
ORB-xx-G	CAT-M1 EGPRS	B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B26/B28/B39 850/900/1800/1900MHz
ORB-xx-H	CAT-1 GSM / EDGE	B1/B3/B7/B8/B20/B28 B3/B8

The 4G LTE antenna is integrated into the ORB.

8.3 Connecting to a Wi-Fi or LTE Network with the Senquip Connect App

The Senquip Connect App is a mobile application that allows users to connect to nearby Senquip devices using Bluetooth to configure networks and for data viewing. The app is available for both Android and iOS devices running recent firmware. See the Senquip Device Firmware Changelist for more information on compatible firmware versions.

Network configuration via Bluetooth is available when the Senquip device is in setup mode. To enter setup mode, press the setup button on the device. The green light will start to flash. Open the Senquip Connect App and scan for available devices. Devices in setup mode will allow connection for the purpose of network configuration. Press connect and enter the device setup password.

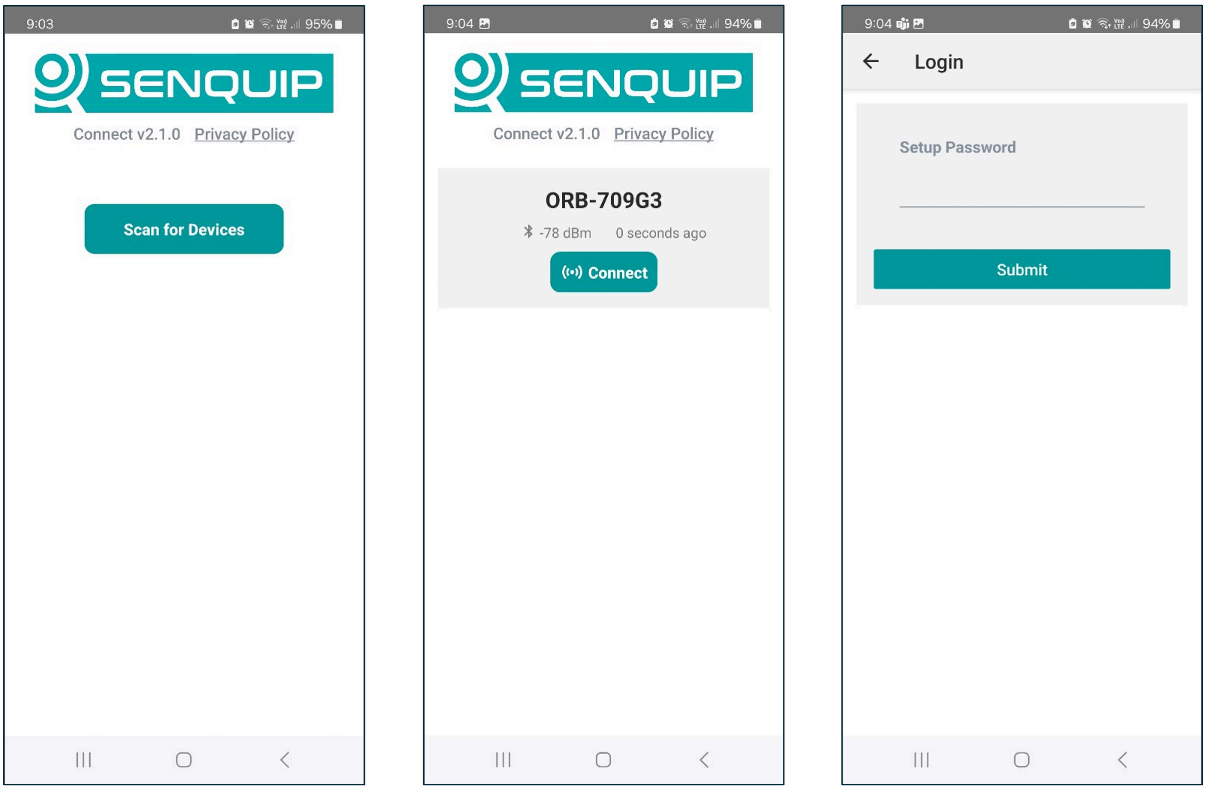


Figure 8.1. Scanning for Devices

Once connected to a device, select *Configure WiFi* or *Configure Cellular / LTE*.

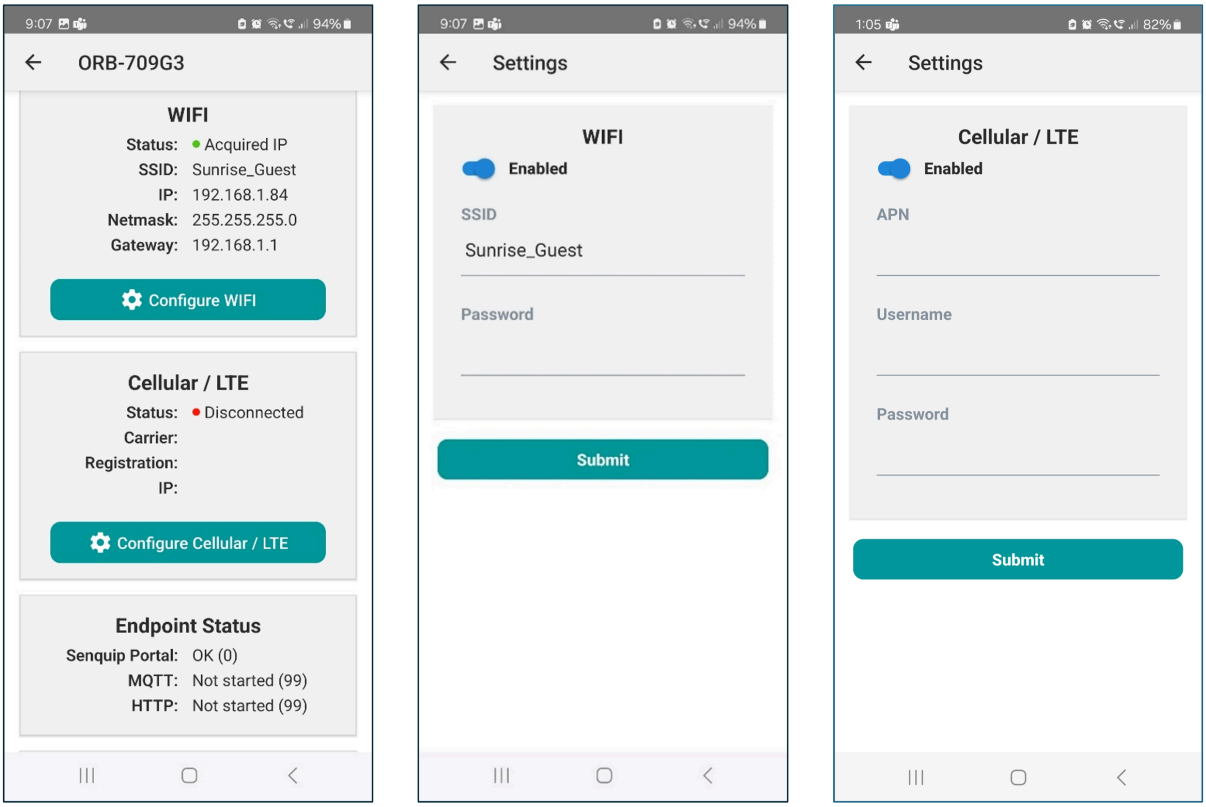


Figure 8.2. Configuring the Network

For Wi-Fi networks, the chosen SSID and password need to be entered. Further advanced Wi-Fi settings are available when using the embedded webserver or Senquip Portal for configuration.

For LTE networks, Auto APN can be enabled in which case the device will attempt to find a suitable APN for the network. Alternatively the APN for the network should be entered. In rare cases, a username and password are required for the SIM.

Press *Submit* to send the settings to the device. The device will save the settings and will reboot back into setup mode. To exit setup mode, press reset on the device. Continue device configuration using the Senquip Portal.

8.4 Connecting to a Wi-Fi Network with the Embedded Webserver

Once in setup mode, use the Network page to connect the ORB to a Wi-Fi network.

On the Network page, press the Scan for Wi-Fi Networks button. After a few seconds, a list of SSIDs for visible Wi-Fi networks will be shown. Select the Wi-Fi network to which you would like to connect by selecting the SSID from the list. The SSID will automatically be copied to the Wi-Fi SSID field and you will be prompted for the network password. After entering the password, press Save Settings. You will be prompted to restart the device; settings will only be applied after a restart. To continue with setup, press *CANCEL* or to restart and apply your settings, press *OK*.

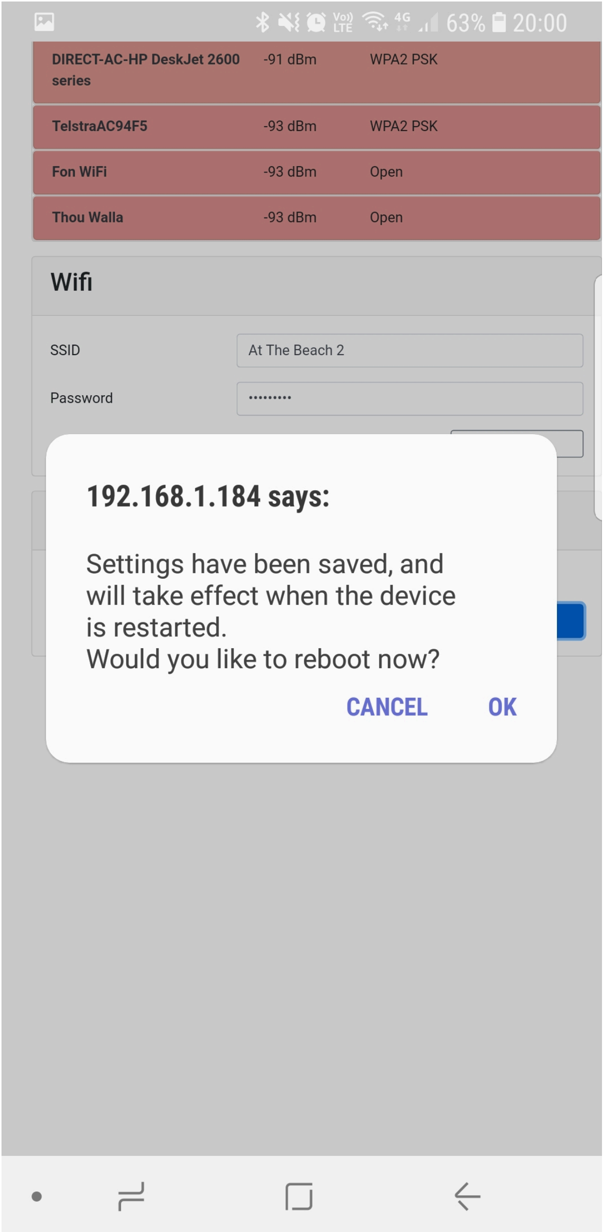


Figure 8.3. Save changes and reboot

After a reboot, the ORB will attempt to connect to the specified Wi-Fi network. You can check if the ORB has successfully connected to the chosen network by placing the ORB in setup mode and returning to the Network page. At the top of the page, the current network status will be shown. Note the IP address that your Wi-Fi modem has allocated to the ORB; you can use this address to access the ORB directly on your WiFI network.

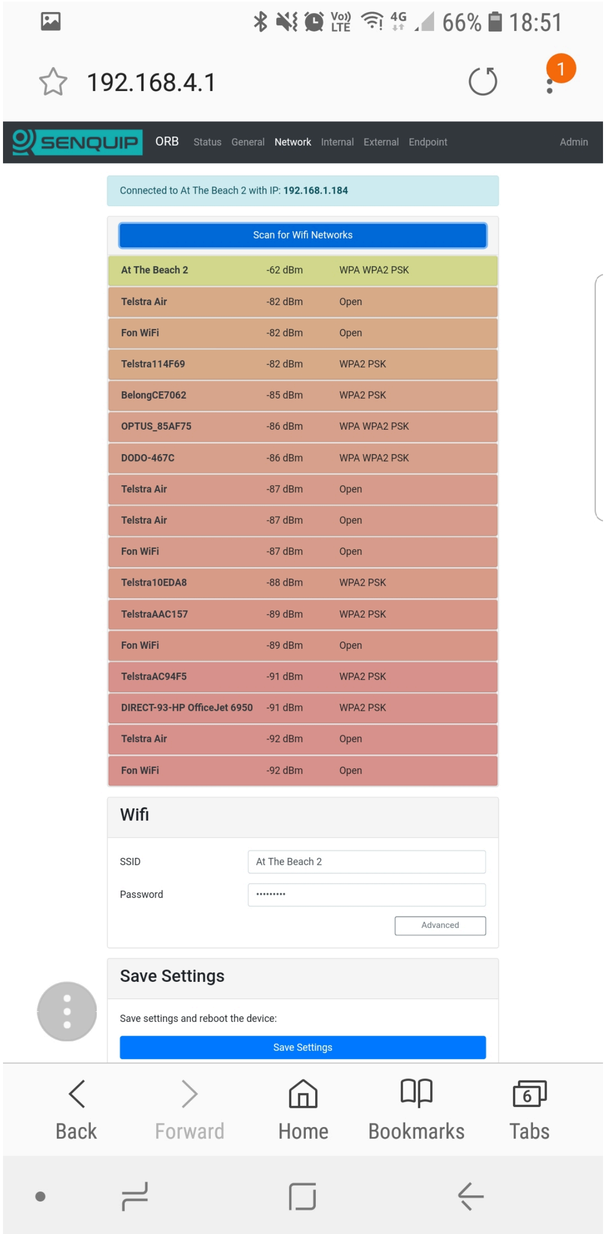


Figure 8.4. Note the IP address on your network

Further Wi-Fi settings are available by selecting the Advanced option. Once selected, a static IP address, netmask, gateway and DNS server can be specified.

The integrated web-server is normally only active in setup mode; it can however be made to be always on by setting the web setting to ON. This may be an advantage in systems where permanent power is available and the user wants to be able to make remote changes directly on the ORB without having to access the Senquip Portal. Keeping the web-server active will require that the ORB remain awake at all times but does mean that the user can make instant changes to settings and see the latest measured data.

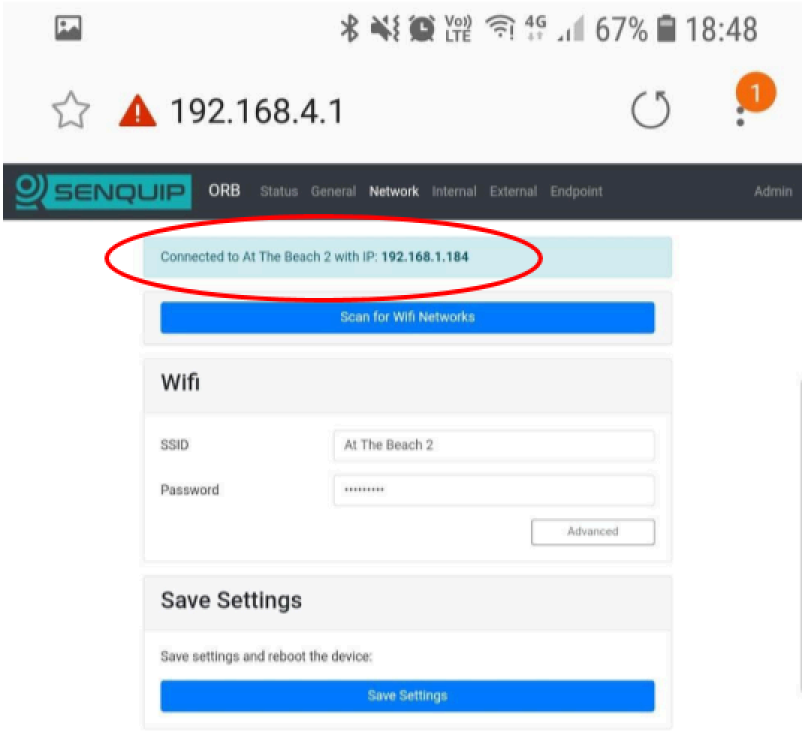


Figure 8.5. Access via local IP

When connected to a Wi-Fi network, the ORB may need to be able to make outgoing connections to remote services. To allow the ORB to make connections, some ports need to be enabled for outgoing connections on your Wi-Fi network.

Function	Port Number	Description
NTP Time	123	To be able to correctly timestamp measured data and for certain encryption functions the ORB needs to know time accurately. Time is accessed by connecting to an NTP server on this port.
MQTT to Senquip Portal	8883	Secure communications with the Senquip Portal are established on this port.
OTA update	80, 443	Over the Air (OTA) is a method by which the ORB software can be remotely updated. To enable remote software upgrades of the ORB software, outgoing connections need to be enabled on this port.

Note If custom endpoints are enabled, additional ports may need to be opened.

The following Wi-Fi authentication modes are supported:

- WPA
- WPA2
- WPA3

8.4.1 Wi-Fi Settings

A full list of Wi-Fi settings is given in the table at the end of the chapter.

8.5 Connecting to an LTE Network with the Embedded Webserver

Once in setup mode, use the Network page to connect the Senquip ORB to a mobile network.

In most cases only an APN will be required to establish a 4G LTE connection. Some service providers will require a username and password and some SIM cards will require a pin. If these are not needed, leave them blank.

For CAT-1 devices, an additional *Connection Mode* setting is available. This setting allows the selection of 4G or 2G, 3G, 4G mobile technology. 4G offers higher bandwidth and is recommended unless there are initial connection issues.

A *Roaming* option is available for SIM cards that offer connection to networks other that SIM card home network.

RSSI	Signal Strength	Meaning
0	-113dBm or less	Signal strength poor
1	-111dBm	Signal strength poor
2…30	-109… -53dBm	Medium signal strength
31	-51dBm or greater	Signal strength excellent

8.5.1 4G LTE Settings

A full list of 4G LTE settings is given in the table at the end of the chapter.

8.6 Network Settings

A full list of network settings is given in the table below.

Name	Item	Function	Internal Reference
Wi-Fi			
Wifi	boolean	Connect to existing Wifi connection specified below.	wifi.sta.enable
SSID	text	Wifi SSID to connect to.	wifi.sta.ssid
Password	password	Wifi password to use for connection.	wifi.sta.pass
Static IP Address	text	Leave blank if assigned by DHCP.	wifi.sta.ip
Static Netmask	text	Leave blank if assigned by DHCP.	wifi.sta.netmask
Static Gateway	text	Leave blank if assigned by DHCP.	wifi.sta.gw
DNS Server	text	Leave blank if assigned by DHCP.	wifi.sta.nameserver
GSM			
GSM	boolean	Enable the GSM connection.	gsm.enable
APN	text	Access Point Name of mobile operator	gsm.apn
Username	text	Username for data connection. Leave blank if not specified	gsm.user
Password	text	Password for data connection. Leave blank if not specified	gsm.pass
Connection Mode	preset	Select mobile technology (CAT-1 devices only)	gsm.scan_mode
Roaming	boolean	Enable network roaming	gsm.roaming

Endpoint Setup

When connected via Wi-Fi or 4G LTE, data measured by a Senquip ORB can be sent to the Senquip Portal or a remote server or SCADA system, using UDP, HTTP, HTTPS, MQTT and MQTTS. The endpoint settings allow for configuration of the end server detail and the protocol used to communicate with that server.

9.1 Data Security

Devices that connect to company networks and the internet need to be properly secured to mitigate risks and protect organisations from malicious cyber-attacks. Senquip takes the challenge of cyber-security seriously and utilises public-key-infrastructure as a part of their security solution to create a unique, trusted and protected identity for every Senquip device.

Public Key Infrastructure certificates are an important part of developing a complete security solution. By authenticating devices, encrypting confidential data, and maintaining data and system integrity, certificates establish online trust and reliable security.

Authentication: Certificates for devices validate identities to make sure only authorized users, messages, or other types of servers have access to the device.

Encryption: All data stored on the device is encrypted at rest using AES-256. All communication with the Senquip Portal is secured and encrypted using client certificates and Transport Layer Security (TLS).

Integrity: Certificates make sure that any messages or data transferred to and from Senquip devices are not altered.

Each Senquip device is pre-loaded with a unique client certificate, allowing for immediate, out-of-the box, secure communication with the Senquip Portal. Users can then load additional certificates to allow secure communications with other servers, using the encrypted link from the Senquip Portal.

Note For volume applications, Senquip can supply the ORB pre-loaded with additional certificates.

9.2 Data Format

Data that is transmitted by the ORB to a remote server is formatted in JSON format. JSON (JavaScript Object Notation) is a lightweight data-interchange format. It is easy for humans to read and write and it is easy for machines to parse and generate. It is based on a subset of the JavaScript Programming Language, Standard ECMA-262 3rd Edition - December 1999. JSON is a text format that is completely language independent but uses conventions that are familiar to programmers of the C-family of languages, including C, C++, C#, Java, JavaScript, Perl, Python, and many others. These properties make JSON an ideal data-interchange language.

JSON is built on two structures:

- A collection of name/value pairs. In various languages, this is realized as an object, record, struct, dictionary, hash table, keyed list, or associative array.
- An ordered list of values. In most languages, this is realized as an array, vector, list, or sequence.

An example data JSON packet as sent by the ORB is shown below:


```
{
 "deviceid": "4299A5340",
 "humidity": 70.51,
 "vlipo": 4.13,
 "vbat": 2.17,
 "vin": 20.09,
 "analog1": 4.08,
 "digital2": 0,
 "roll": 37.57,
 "pitch": -89.28,
 "angle": 37.57,
 "pressure": 100.4,
 "ambient": 30.4,
 "alarms": {
  "pitch": [
   "Low"
  ],
  "tc1": [
   "Out of Range"
  ]
 },
 "ts": 1544665316.3,
 "tsformat": "13/12/2018 01:41:56"
}
```


Figure 9.1. Example JSON data packet

Users of the Senquip Portal do not need to understand the data format; data can be viewed on the Senquip Portal numerically or graphically or can be downloaded in spreadsheet format.

For users who are sending data to third party servers that require data in a format other that JSON, arbitrary data formats can be scripted on the Senquip device. Application notes are provided that detail the scripting of custom data packet formats for connection to common third party platforms. Further information on scripting for Senquip devices can be found in the Senquip Scripting Guide.

9.3 Data Buffer

Where neither Wi-Fi or 4G LTE networks can be found, the Senquip ORB can store up to 1 MByte of messages for devices running SFW001 firmware and 2MByte for devices running SFW002 firmware, to internal memory for later transmission when a network becomes available. When the internal memory is full, the device stop logging. Once network connectivity is established, the most recently stored data will be transmitted first.

9.4 UDP

Data can be sent via raw UDP to a fixed IP address and port. This method is only suitable for a local network Wi-Fi connection as the data is not encrypted and there is no authentication. Raw UDP also provides no acknowledgment that data was received.

9.5 HTTP

An HTTP session is a sequence of network request-response transactions. The ORB initiates a request by establishing a HTTP connection on a particular port on a client server (typically port 80, occasionally port 8080).

9.6 HTTPS

HTTPS is the secure version of HTTP and is sometimes referred to HTTP over TLS. The 'S' at the end of HTTPS stands for 'Secure'. It means all communications between your browser and the website are encrypted. Wherever possible, HTTPS should be used as an alternative to HTTP.

HTTPS requires that the certificate-authority (CA) certificate of the destination be loaded onto the ORB.

Note for volume applications, the ORB can be pre-configured with CA certificates to allow secure communications with a customer server.

9.7 MQTT

MQTT is a secure machine-to-machine (M2M) Internet of Things connectivity protocol specifically designed for low data-rate applications and is perfect for implementation on the ORB. MQTT is the protocol used when the ORB communicates with the Senquip Portal and is also supported by many open source IoT platforms such as Thingsboard.

Senquip devices implement MQTT Version 3.1.1 client functionality, and work with all popular MQTT server implementations such as AWS IoT, Microsoft Azure, HiveMQ and Mosquitto.

Note The ORB can maintain concurrent MQTT connections to the Senquip portal and a customer server or SCADA system.

Consideration must be given to data security on open networks. In applications where data security is critical, the use of MQTTS with encryption and authentication should be considered.

9.8 MQTT over TLS

MQTT over TLS (MQTTS) adds enhanced security as all data is encrypted and secured with SSL certificates. Most business grade IoT platforms such as AWS (Amazon Web Services) offer MQTTS.

MQTTS is recommended by Senquip as the preferred protocol for use with the ORB as it offers a low power, reliable, secure connection. The ORB is pre-loaded with certificates allowing secure communication with the Senquip Portal.

Note For volume applications, the ORB can be pre-configured with additional certificates to allow secure communications with a customer server or SCADA system.

9.9 Settings

UDP, *TCP* and *HTTP* connections require an IP address of the host server and a port on which the host server is listening. Secure protocols like *MQTTS* and *HTTPS* require certificates to be loaded on the ORB. The ORB is pre-loaded with certificates that allow connection to the Senquip Portal that is hosted on Amazon Web Services. Certificates for customer servers can be uploaded using the Senquip Portal.

All messages are time-stamped using the UNIX time standard. Unix time (also known as POSIX time or UNIX Epoch time) is a system for describing a point in time, defined as the number of seconds that have elapsed since 00:00:00, Thursday, 1 January 1970. Every day is treated as if it contains exactly 86400 seconds, so leap seconds are not applied. UNIX time is used to timestamp messages as it is used widely in Unix-like and many other operating systems and file formats.

The ORB automatically updates time by accessing a Network Time Protocol (NTP) server. By default the device will get the time via NTP from pool.ntp.org, on whatever network connection is available (Wi-Fi or 4G LTE). It does this if the time is not valid, for instance, after a reset, and then every 12 hours thereafter. Between updates, time is kept with a high precision real-time clock that is powered by the internal LiPo battery.

Although UNIX time is easy for computer systems to use, it is not easily human readable. If a human readable time-stamp is required, set the *timestamp* setting to ON, in which case, the ORB will insert an additional time and date field, formatted in human readable format, as below:

DD/MM/YYYY, hh:mm:ss for example: 27/06/2018, 17:30:15

Time is UTC (coordinated universal time); no offsets are applied for local time-zones on the ORB. The Senquip Portal will apply local time offsets as specified by the settings on your computer.

The Senquip Portal can be used to update settings on the ORB remotely. Each time the ORB makes contact with the Senquip Portal (for example to transmit measurements), the ORB will check for any settings changes. If there are changes to settings, these will be downloaded and applied. Pending configuration changes are listed on the settings pages on the Senquip Portal.

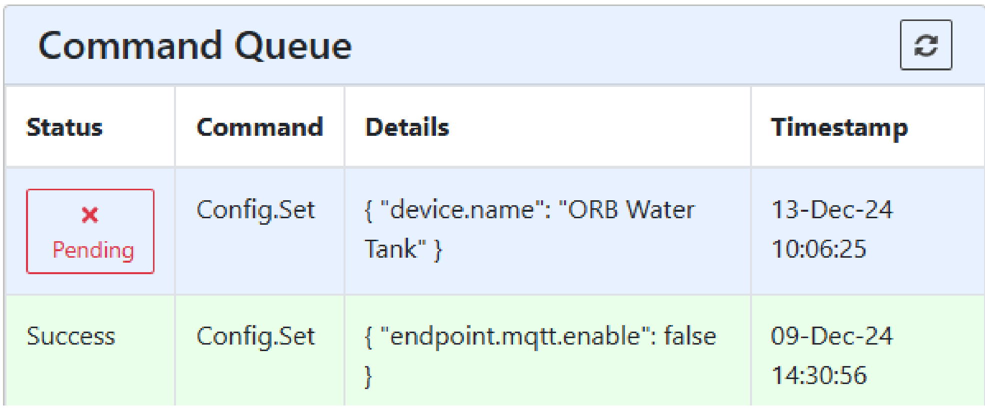


Figure 9.2. Pending change where the device name has been changed.

If the ORB is configured to send data to a 3rd party server, the ORB will by default contact the Senquip Portal to check for settings updates once a day. Set the *Configuration via Senquip Portal* to OFF to prevent the ORB from contacting the Senquip Portal to check for settings. This setting may be used where power consumption is critical such as when AA batteries are being used an a very long battery life is required.

Warning Disabling *Configuration via Senquip Portal* will mean that no settings or firmware updates will be able to be performed remotely using the Senquip Portal.

A full list of endpoint settings is given in the table below.

Name	Item	Function	Internal Reference
Data Endpoints			
Configuration via Senquip Portal	boolean	Enables connection to Senquip Portal for remote configuration.	endpoint.config_to_portal
Send Data to Senquip Portal	boolean	Enables data from the device to be sent to the Senquip Portal.	endpoint.data_to_portal
Offline Buffer	boolean	Save data if device is offline, and send when network is available.	endpoint.buffer_enable
Add Formatted Time	boolean	This option adds a human readable time/date format to the data output.	endpoint.addtimedate
Report Network Info	boolean	Add network details and signal strength to data output.	endpoint.network_report
UDP			
UDP	boolean	Enables sending data over UDP to specified address below.	endpoint.udp.enable
UDP Address	text	Address and port to send data to.	endpoint.udp.address
HTTP			
HTTP POST	boolean	Enables sending data via a HTTP POST request to address below.	endpoint.http.enable
HTTP Address	text	Destination address and port for HTTP POST request.	endpoint.http.address
MQTT			
MQTT	boolean	Enables sending data to a MQTT broker.	endpoint.mqtt.enable
Broker Address	text	MQTT Broker Address and Port.	endpoint.mqtt.server
Client ID	text	Client ID to send to the broker. Defaults to device.id if left blank.	endpoint.mqtt.client_id
Username	text	Username for MQTT authentication with username/password. (Optional)	endpoint.mqtt.user
Password	text	Password for MQTT authentication with username/password. (Optional)	endpoint.mqtt.pass

Chapter 10

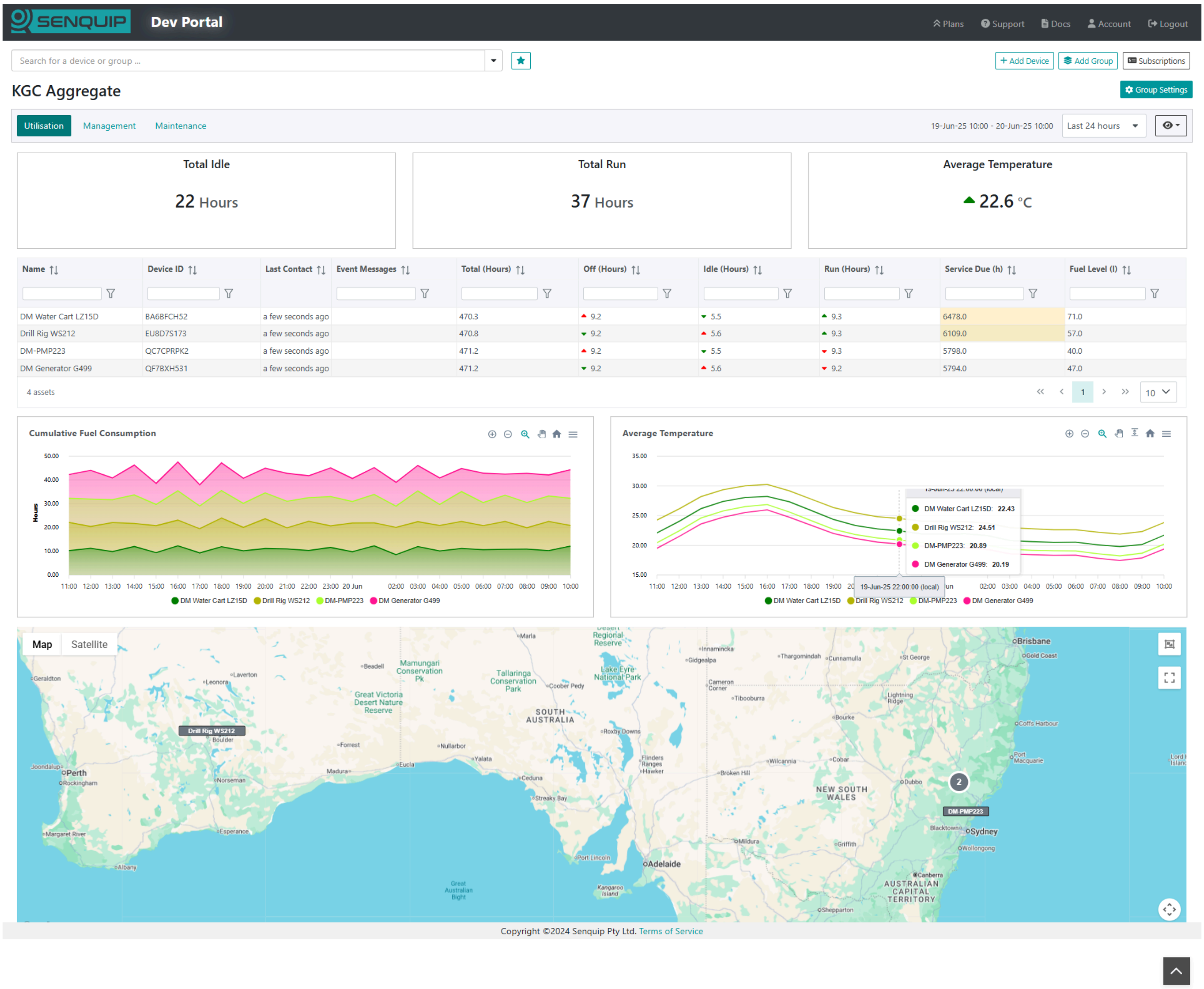
Senquip Portal

The Senquip Portal is a secure, cloud-based platform hosted on Amazon Web Services (AWS), designed to provide powerful management and visualisation tools for your Senquip devices.

The Portal enables users to:

- View dashboards that display data across groups of devices
- Access detailed device pages showing real-time and historical sensor data
- Perform device management including configuration and firmware updates
- Handle user management with role-based access control
- Maintain long-term data storage for historical analysis and compliance
- Manage events with configurable warnings and alarms
- Manage device subscriptions

The Senquip Portal provides a streamlined and scalable interface used to monitor, manage, and respond to field data from anywhere in the world.



Name	Device ID	Last Contact	Event Messages	Total (Hours)	Off (Hours)	Idle (Hours)	Run (Hours)	Service Due (h)	Fuel Level (l)
DM Water Cart LZ15D	BA6BFCH52	a few seconds ago		470.3	9.2	5.5	9.3	6478.0	71.0
Drill Rig WS212	EU8D7S173	a few seconds ago		470.8	9.2	5.6	9.3	6109.0	57.0
DM-PMP223	QC7CPRPK2	a few seconds ago		471.2	9.2	5.5	9.3	5798.0	40.0
DM Generator G499	QF7BXH531	a few seconds ago		471.2	9.2	5.6	9.2	5794.0	47.0

Figure 10.1. Senquip Vision Dashboard

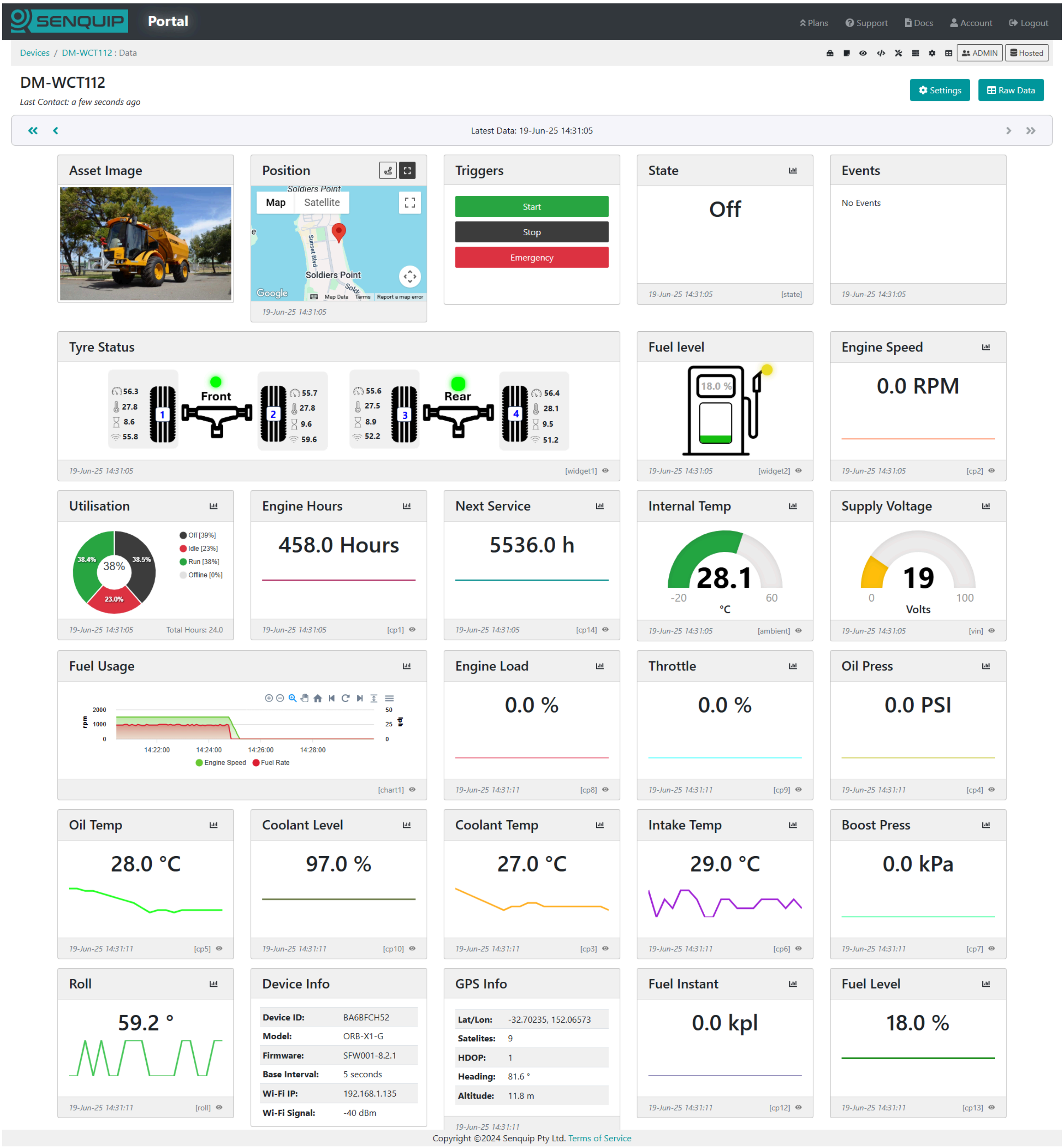


Figure 10.2. Senquip Device Data Page

10.1 Create a Senquip Portal Account

If you do not have an account on the Senquip Portal, you will need to create one. There are no charges for creating an account on the Senquip Portal and a credit card is not required.

1. Go to <https://portal.senquip.com>`_ and select the *Signup* button.

Figure 10.3. Create a Senquip Portal account

2. Complete the required fields and then press *Signup*.

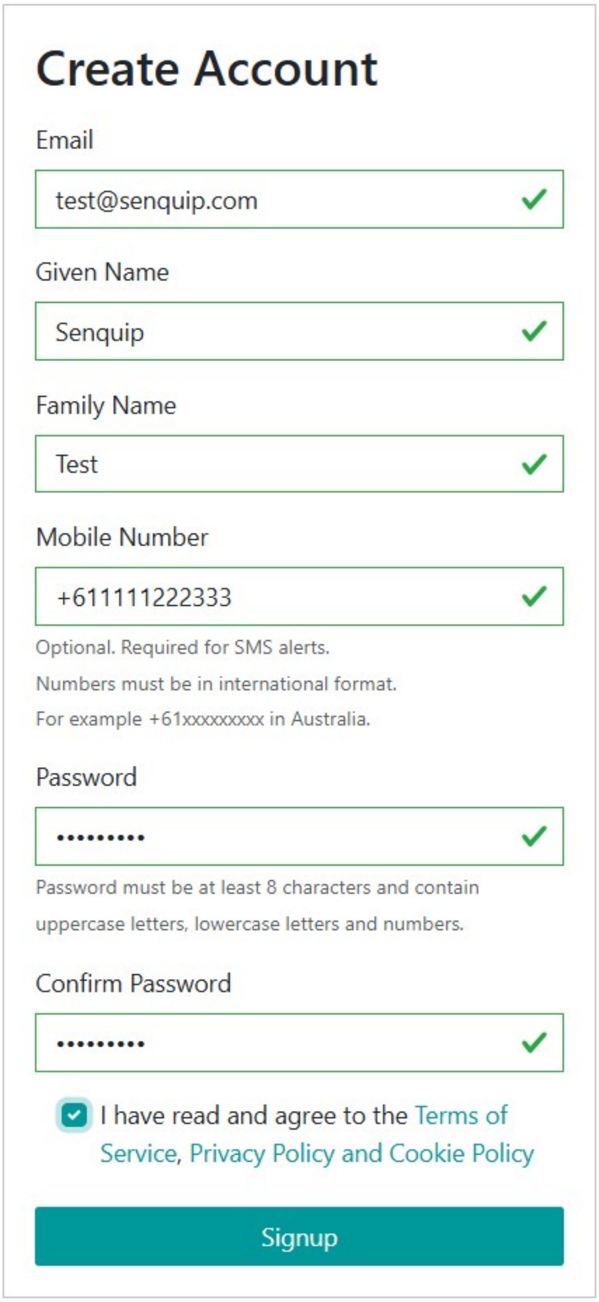


Figure 10.4. Complete the required fields

3. A verification email will be sent to the email address provided. Click on the link in the email to verify your account. The email address must be verified as important system updates, alerts, warnings, and alarm messages will be sent to the email address.

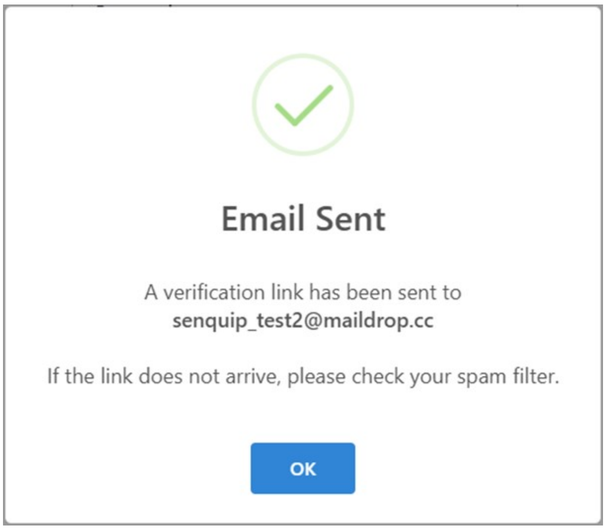


Figure 10.5. Your email must be verified

Note The email may end up in your spam folder or may be blocked by your company firewall.

4. To activate your account, login to the Senquip Portal once.

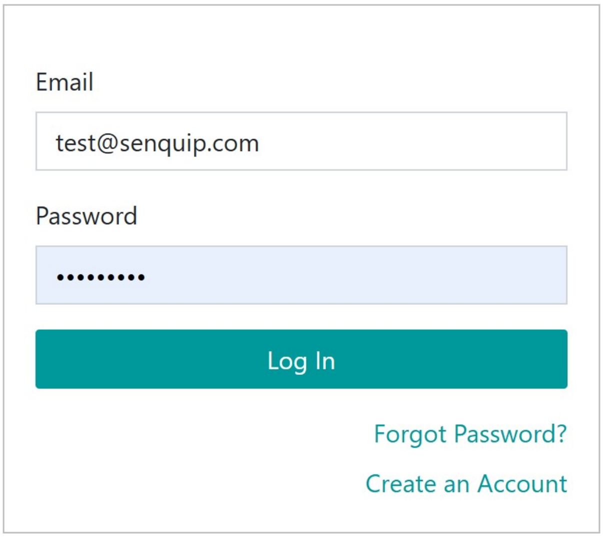


Figure 10.6. You must login to activate your account

10.2 Creating a Group

Storing devices in groups facilitates:

- Dashboards that display device data in a way that is meaningful for the application
- User management across a group of devices
- Simultaneous configuration of multiple devices

To create a group:

1. Select the *Add Group* button

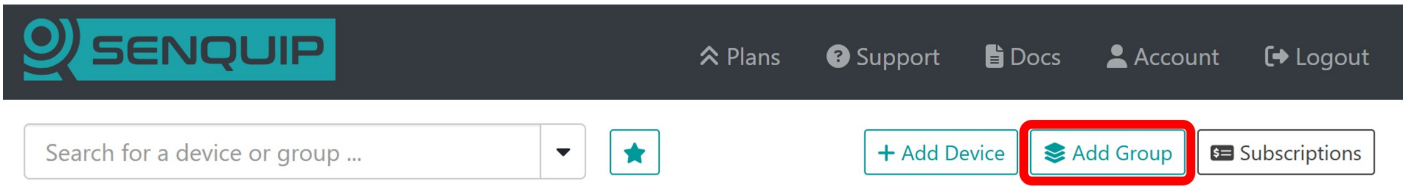


Figure 10.7. Create a new Group

2. Select a name for your group that will be meaningful to the indented user group and press *Create*. The group name can be changed later in the Group Settings.

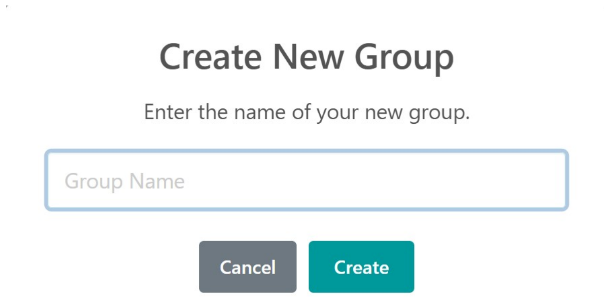


Figure 10.8. Select a meaningful name

10.3 Add Devices to a Group

You can add devices to a group by either:

1. By pressing the *Add Device* button and entering the device ID. If you are adding a new device to your account, you will be required to enter the setup password.

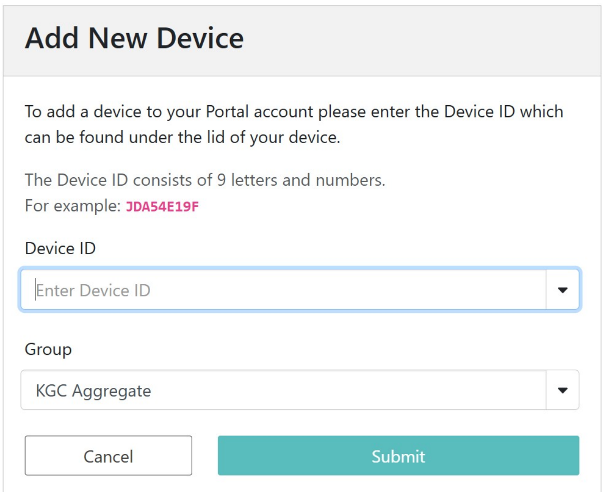


Figure 10.9. Adding a single device to a group

2. Copying or moving devices from another Group for which you have administrator permissions.
3. Requesting that another user give you access to a device or a group of devices.

Note Your account will need to be active for another user to add devices

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Note If you have no groups, and devices are added, they will be placed in the default *Ungrouped* Group.

10.4 Finding Devices and Groups

Use the search bar at the top of the page to find devices and groups. Search by group name, device ID, or device name. The *Favourites* button can be used to identify the last few devices and groups accessed, and to mark devices and groups as favourites.

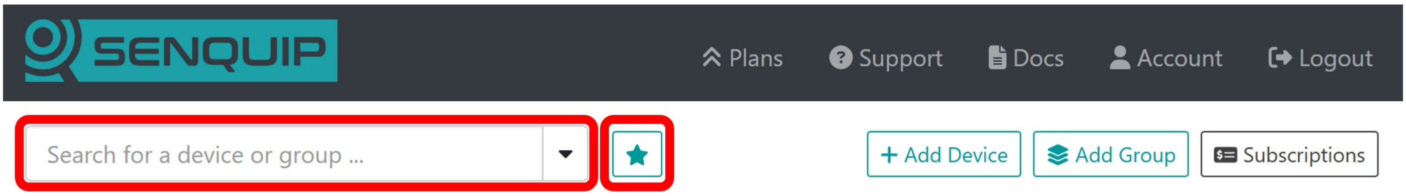

Figure 10.10. Search by group, name , or device id

10.5 Group Management

Group functionality simplifies the management of large numbers of devices.

- Groups are collections of devices.
- Devices can belong to multiple groups.
- Private Groups only have one user.
- A group becomes a Public Group when a second user is added to the group.

Groups enable the following functionality:

- Management of user permissions for multiple devices at the same time
- Changing the configuration of multiple devices with a single action
- The standardisation of device data pages across a group
- The creation of dashboards to simplify decision making

Groups are managed by selecting the *Group Settings* button from where group settings, devices, and users can be managed.

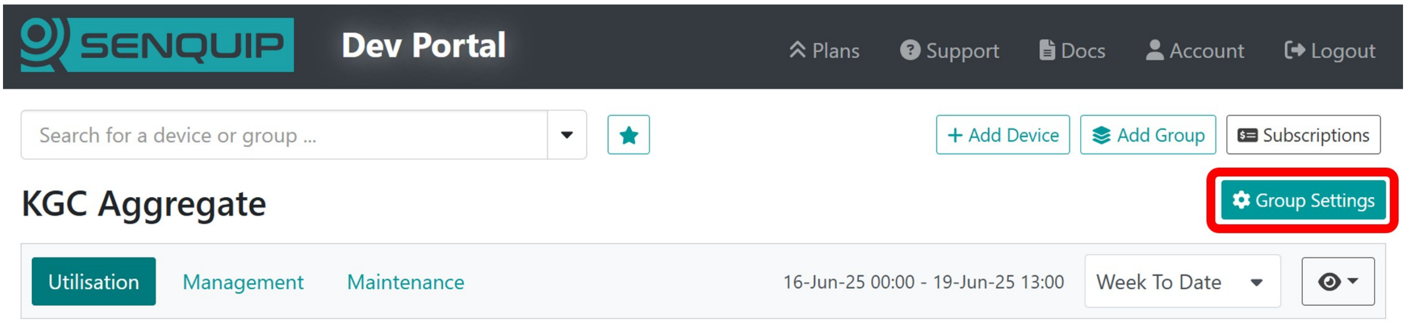

Figure 10.11. Change Group settings

10.5.1 Device Management

The *Group Devices* option allows devices to be added to the group, copied or moved to another group, or deleted from the group.

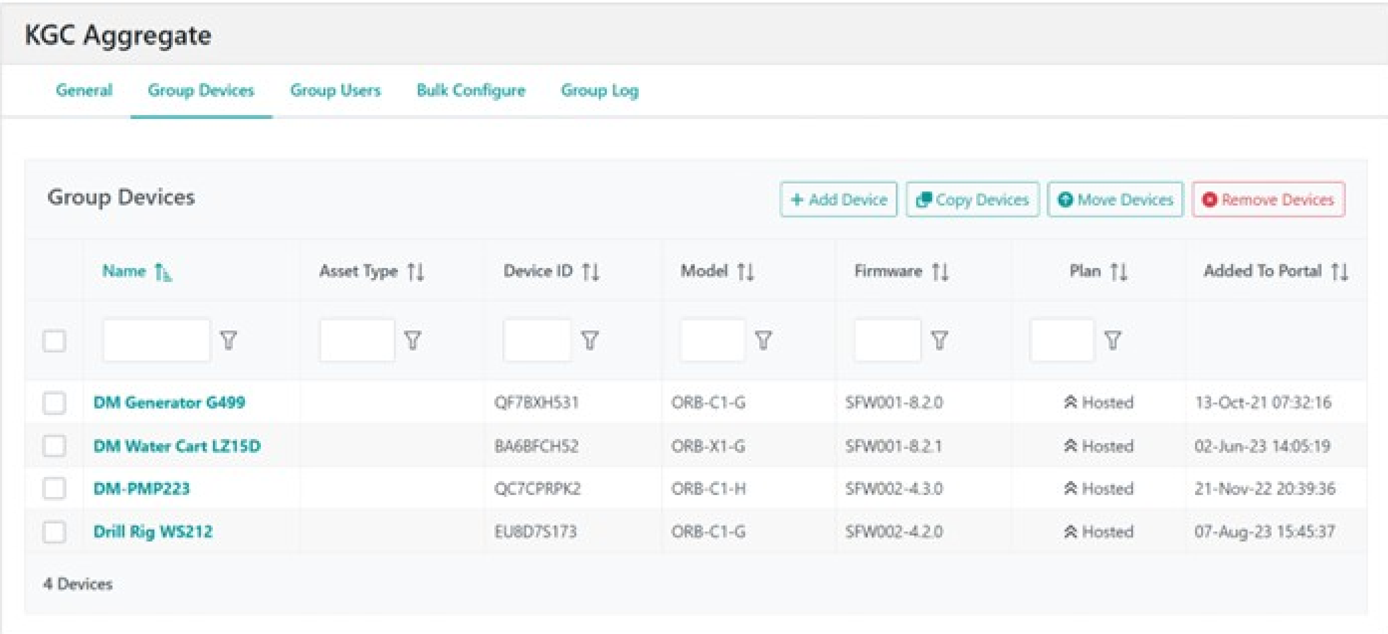

Figure 10.12. Manage devices in a Group

10.5.2 User Management

The *Group Users* option allows users to be added or removed from a group. Where users are added, they must be allocated appropriate permissions for the group.

Allowed Permission	Admin	User	Operator	View
View data	Yes	Yes	Yes	Yes
Trigger device actions	Yes	Yes	Yes	
View users	Yes	Yes		
Change device settings	Yes	Yes		
View or edit script*	Yes	Yes		
View server log	Yes			
View device passwords	Yes			

Add or remove group users	Yes			
Add or remove group devices	Yes			
Import and export settings	Yes			

Note If you have created a private group and want to share that group, you will need to have administrator permissions for all devices in that group.

Note Users should be added with the minimum permission level required to perform their function.

Warning Anyone who has the device ID and setup password can add the device to their account with Admin permissions.

In the example below, Senquip Test0 is the owner of the group and has *Administrator* access to all devices in the group. Senquip Test1 has been added to the group with permission level *User*.

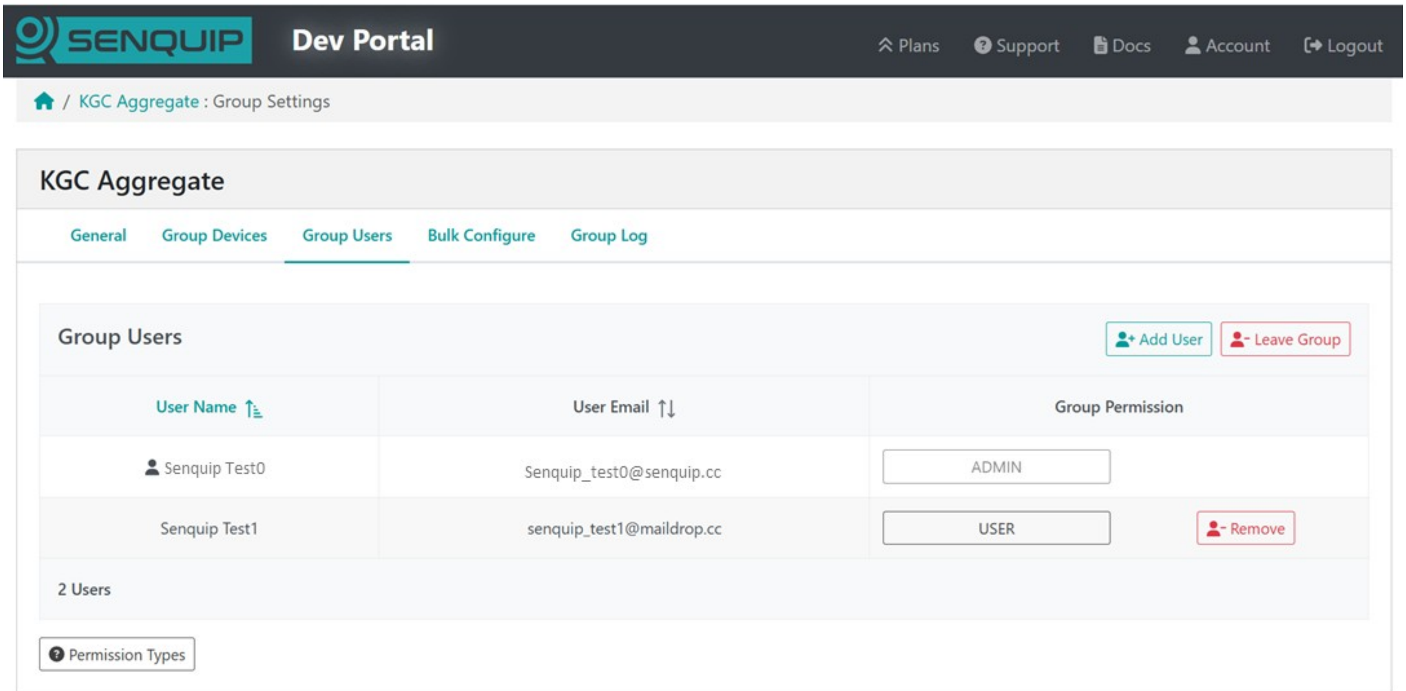

Figure 10.13. Grant appropriate permisions to group users

10.5.3 Device Configuration Management

Bulk configuration of devices allows for settings to be changed across many devices at the same time. Bulk device configuration will be released in 2025.

10.6 Senquip Vision Dashboards

Senquip Vision is a powerful, customisable dashboard that enables businesses to monitor and analyse key operational metrics across a group of devices. Designed for management, maintenance and operational users, it provides a clear and intuitive interface for tracking real-time data, historical trends, and device status, all in one place.

The following are key elements of a Senquip Vision Dashboard:

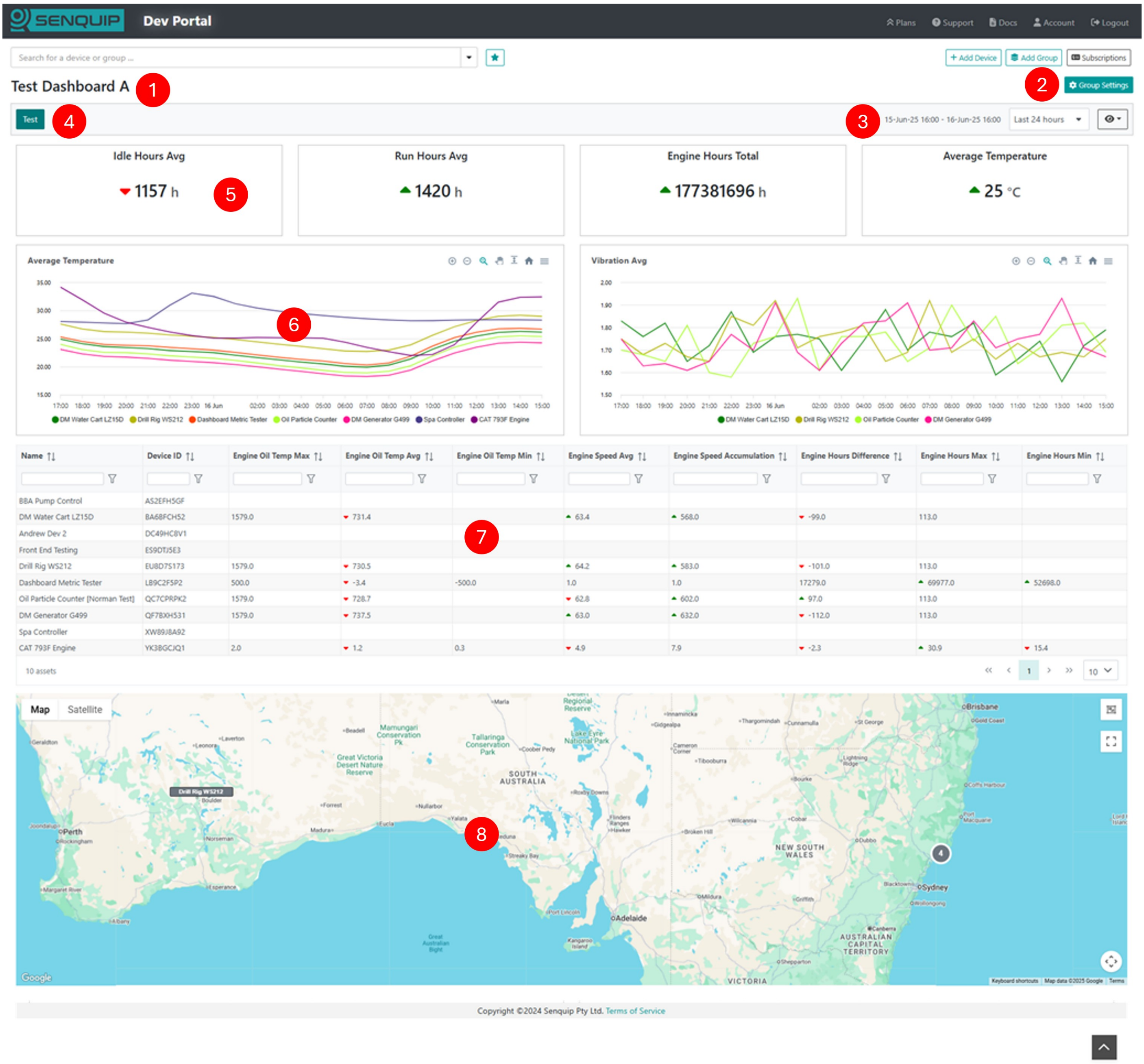

Figure 10.14. Fully cusomisable Senquip Vision dashboard

Key	Element	Description
1	Dashboard Name	A name that is meaningful to the target user group.
2	Group Settings	Manage the group and perform bulk user management and device configuration.
3	Period	The time range over which data in the dashboard is calculated and shown.
4	View	Multiple views can be created to accommodate users with different roles (e.g. management and maintenance views)
5	Headline Number	Displays key metrics aggregated across all devices in a group.
6	Summary Chart	Visualises data trends over the selected time period.

7	Summary Table	Shows metrics for all devices in the group, calculated over the selected time period.
8	Map	Displays current device locations, with colour indicating device status.

10.6.1 Views

When a new Group is created, a default display with table and map will be generated. Users can then create different views for management, operational, maintenance and other functions. Headline numbers, a customised table, charts, and a map can be added to a view.

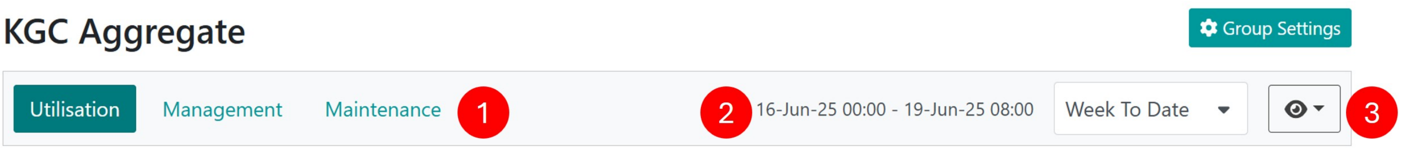

Figure 10.15. Create a different view for each user function

Key	Element	Description
1	Views	Select between the various views that have been created for the dashboard
2	Period	Select the period of time over which data should be calculated and displayed
3	Edit View	Views can be edited by pressing the view settings icon on the right of the view toolbar to expose add, edit, and delete options.

10.6.2 Period

A period of interest can be selected that aligns with the function of the view. For example, when considering rainfall data, month to date may be the most meaningful period. When considering productivity, the last 7 days may be more useful. When a period is selected, calculations on data (metrics) are performed over that time, and data is displayed for that period. Available periods are shown in the table below. Additional periods and previous periods can be selected using the *Custom Range* option.

Period	Description
Last 24 hours	Rolling window of 24 hours
Last 7 days	Rolling window of 7 days
Last 30 days	Rolling window of 30 days
Week to date	Fixed 7-day period, staring at 00:00 on Monday
Month to date	Fixed period staring on the 1st of the month at 00:00
Custom Range	Select your own range

10.6.3 Metrics

Metrics refer to data measured by a device, or values derived from that data by applying operations such as average, total, difference, and others. Metrics are shown in the summary table, on charts, and are the basis for headline numbers. Available metrics include latest data, minimum, maximum, total, difference, accumulation, and time weighed average. Metrics are selected for a measurement when columns are added to the summary table.

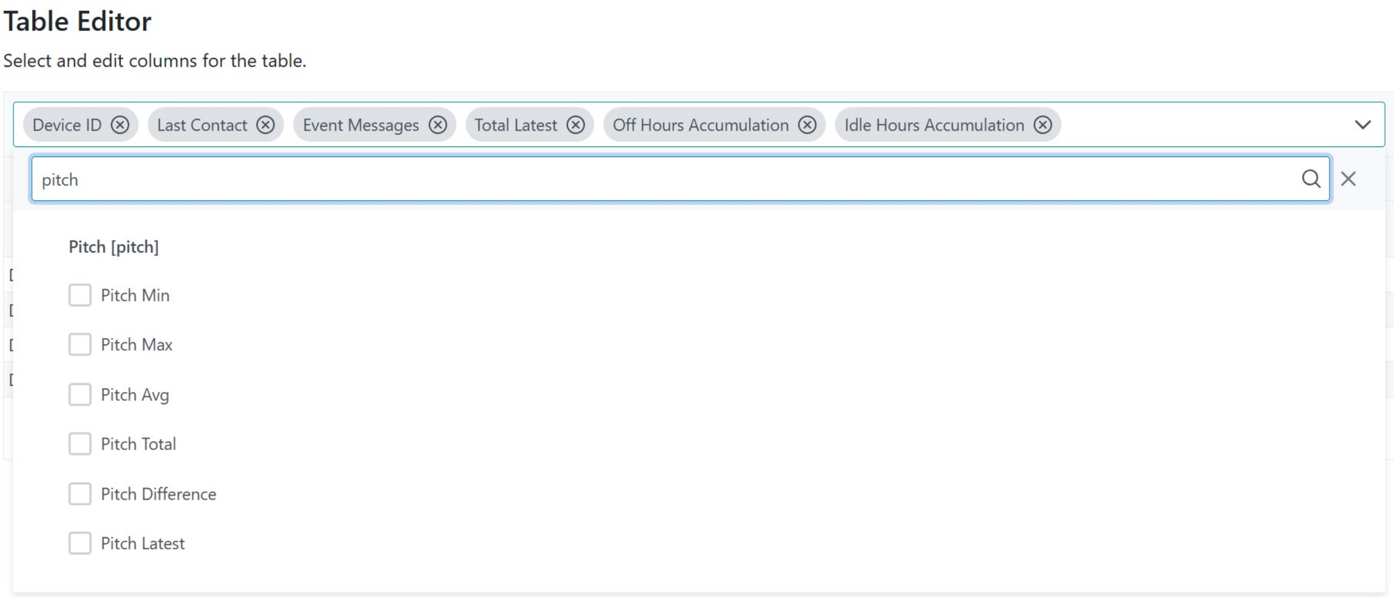

Figure 10.16. Min, max, average, total, difference, and latest metrics are available

Metrics are calculated at the end of each hour for the data collected in that hour and are then collated for the selected period.

Maximum and Minimum

The highest and lowest value measured over the selected period.

Example applications:

- lowest temperature in the last 24 hours
- Lowest tank level so far this month
- Highest engine temperature this week
- Highest engine RPM over the past 24 hours

Note If no samples are available in the period, this value is undefined.

Note If only one sample is available in the period, the minimum and maximum are the same.

Note Maximum and minimum up till the end of the last complete hour.

Latest Data

The latest value measured by the device.

Example applications:

- Current engine hours
- Current tank level
- Current temperature
- Current machine state

Note If there is no current data, then the last available data will be displayed.

Time Weighted Average

The time weighted average considers how long each value was applicable when calculating the average. If for instance, only a few samples are taken in a day, the Time Weighted Average will assume that the previous sample was valid until a new one arrives. This ensures that values occurring for longer durations contribute proportionally more to the average.

In the example below, a dam level is monitored. Actual level samples arrive sporadically. In the absence of a sample, the previous sample is assumed to still be valid. The time weighted average will be the area under the chart divided by the period. Notice that the first sample is 2-Jan-2025 0:00:00 which represents midnight on the 1st Jan. Likewise, the last point is the 1-Feb-2025 0:00:00 which represents midnight on the 31st Jan.

Figure 10.17. Time weighted average works well where there are missing samples

Example applications:

- Average dam level over a month
- Average flow over a month

Note If there is no previous data at the start of the period, the last sample from the previous period will be used.

Note If there is no previous sample, then the first sample will be assumed to have been the value at the beginning of the period.

Total Over a Period

Calculates the total of all the measured samples over a period. In the figure below, daily rainfall is totalised for the month. Notice that the first sample is 2-Jan-2025 0:00:00 which represents midnight on the 1st Jan. Likewise, the last point is the 1-Feb-2025 0:00:00 which represents midnight on the 31st Jan.

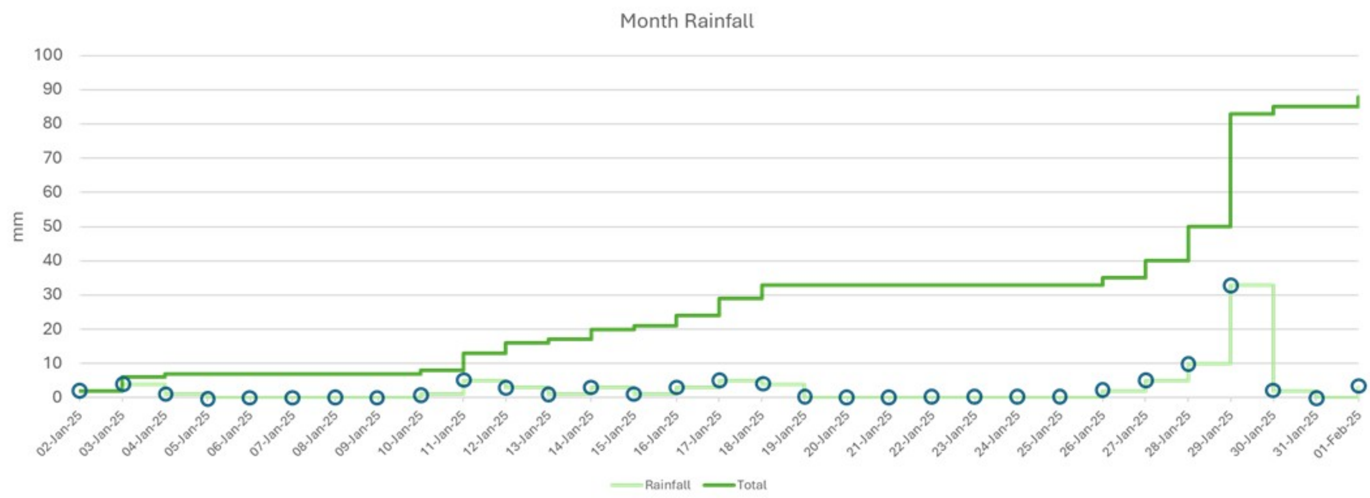

Figure 10.18. Total, sums all data values

Example applications:

- Total rainfall over a period
- Number of times that the pressure has dropped below a threshold.
- How many times a gate has been opened.

Creating a metric to process totals based on historic data simplifies device configuration by offloading totalisation over a period function from the device to the Senquip Portal.

Note If no samples are available in the period, this value is zero.

Note The sum over a period is calculated up to the end of the last complete hour.

Difference Over a Period

The difference between the most recent data and the same data at the end of the previous period. Example of use:

- Change in dam level over the past month
- Change in engine hours over the past week
- Change in idle hours over the last 7 days

Note If no samples are available in the period, this value is undefined.

Note If no samples are available in the previous period, this value is undefined.

Note The difference over a period is calculated up to the end of the last complete hour.

Accumulation Over a Period

Calculates the total increase in a parameter over the selected period, regardless as to whether the source parameter is reset. For instance, if an engine hour meter is replaced or reset, and returns to zero, the accumulation will not be reset and will continue to climb. In the figure below, engine hours are being read from an hour meter. As the hour meter rises, so does the accumulation. When the hour meter is reset, the accumulation does not change and continues to climb. Accumulation is a good measure of a total where the source data may reset.

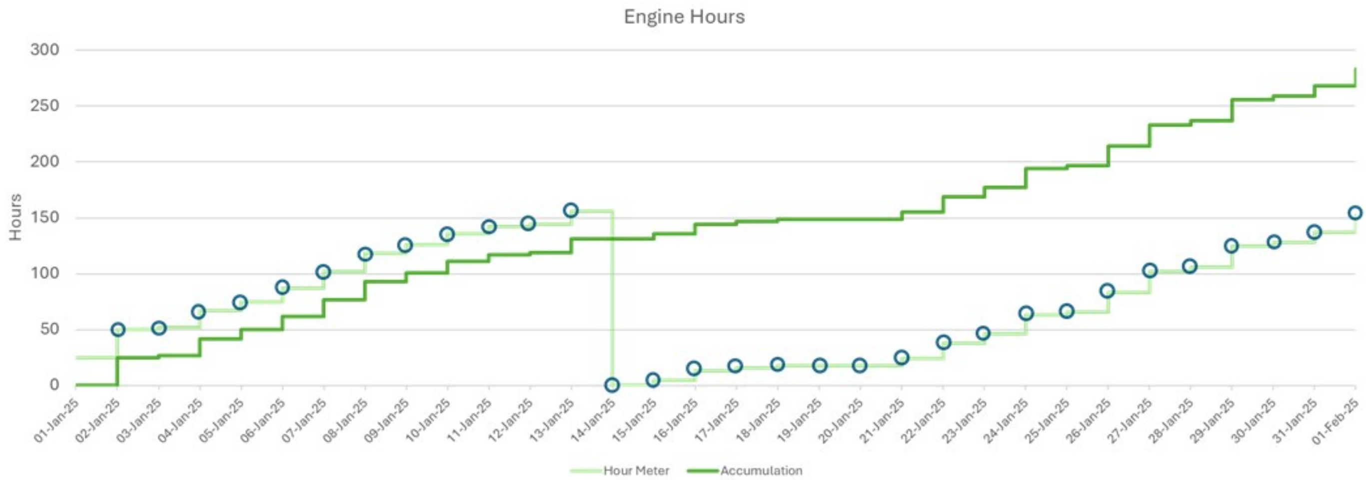

Figure 10.19. Accumulation calculates increase even is the source parameter is zeroed

Example:

- Engine run time where the engine hour meter may be replaced
- Engine idle time where the counter resets to zero when the engine is powered off
- Total distance travelled based on a trip distance meter
- Total flow where the flow meter may get zeroed

Note If no samples are available in the period, the value will remain the same as end of the previous period.

Note If no samples are available in the previous period, the start value will be assumed to be zero.

Note The accumulation over a period is calculated up to the end of the last complete hour.

10.6.4 Summary Table

The summary table widget is the primary element on a view. It shows metrics over the period for all devices in a view. In the example below, we see that fuel is low on some machines, indicated by the cells being marked red. On 2 machines, the fuel is very low, and alert messages are active. Idle hours when compared with the previous period are down on three machines as marked by the green down arrows. Run hours on 3 machines are up, a good outcome.

Click a device in the table to inspect the device data page.

Name	Device ID	Last Contact	Event Messages	Total (Hours)	Off (Hours)	Idle (Hours)	Run (Hours)	Service Due (h)	Fuel Level (l)
DM-WCT112	BA6BFCH52	a few seconds ago		398.5	9.2	5.6	9.2	9159.0	69.0
DM-RIG878	EU8D7S173	a few seconds ago	Fuel low	410.5	9.2	5.6	9.2	507.0	10.0
DM-PMP223	QC7CPRPK2	a few seconds ago	Fuel low	515.9	9.3	5.5	9.2	3042.0	2.0
DM-GEN501	QF7BXH531	a few seconds ago		410.4	9.2	5.5	9.2	572.0	77.0

4 assets

Figure 10.20. Device summary table showing alarms on the fuel level

Columns are added, removed, and edited using the table editor. In the example below, metrics have been filtered by temp, and the minimum, and average temperature have been chosen to be added to the summary table.

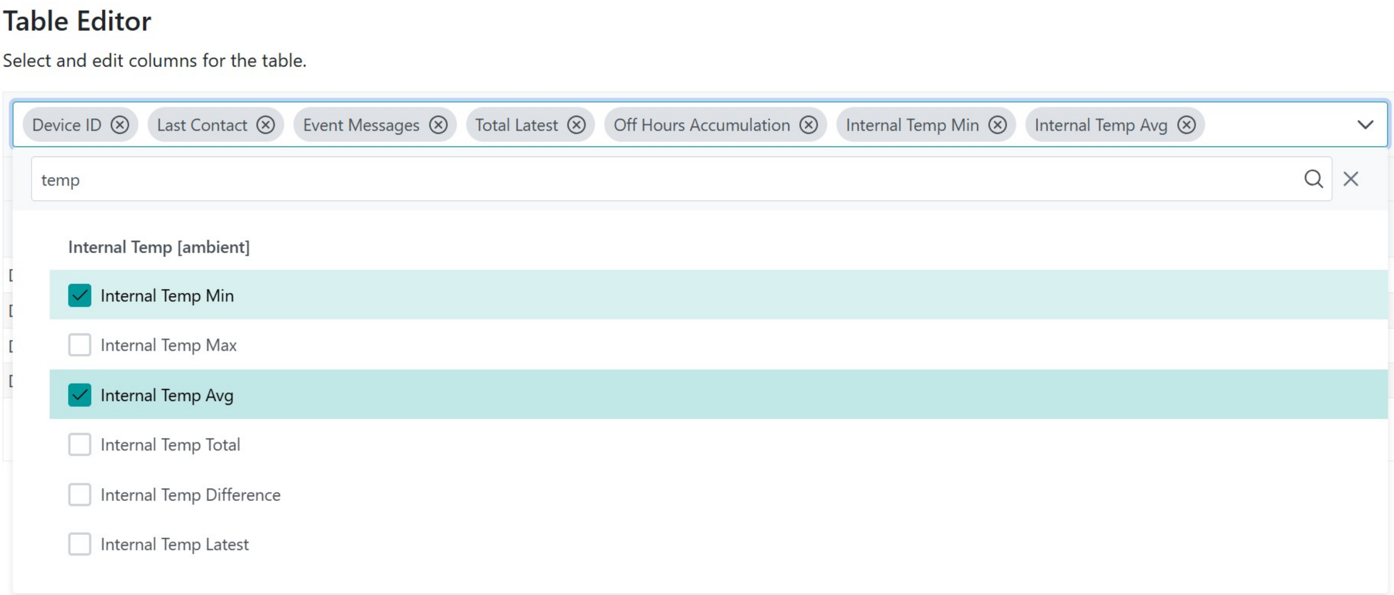

Figure 10.21. Adding metrics to a Device Summary Table

The features of table columns can be changed by pressing the edit button at the top of each column in the table editor. Warning and alarm levels can be applied, which when selected will change the cell colour to orange or red. Red and green indicator arrows can be enabled in each cell to show whether a value has increased or decreased when compared to the previous period.

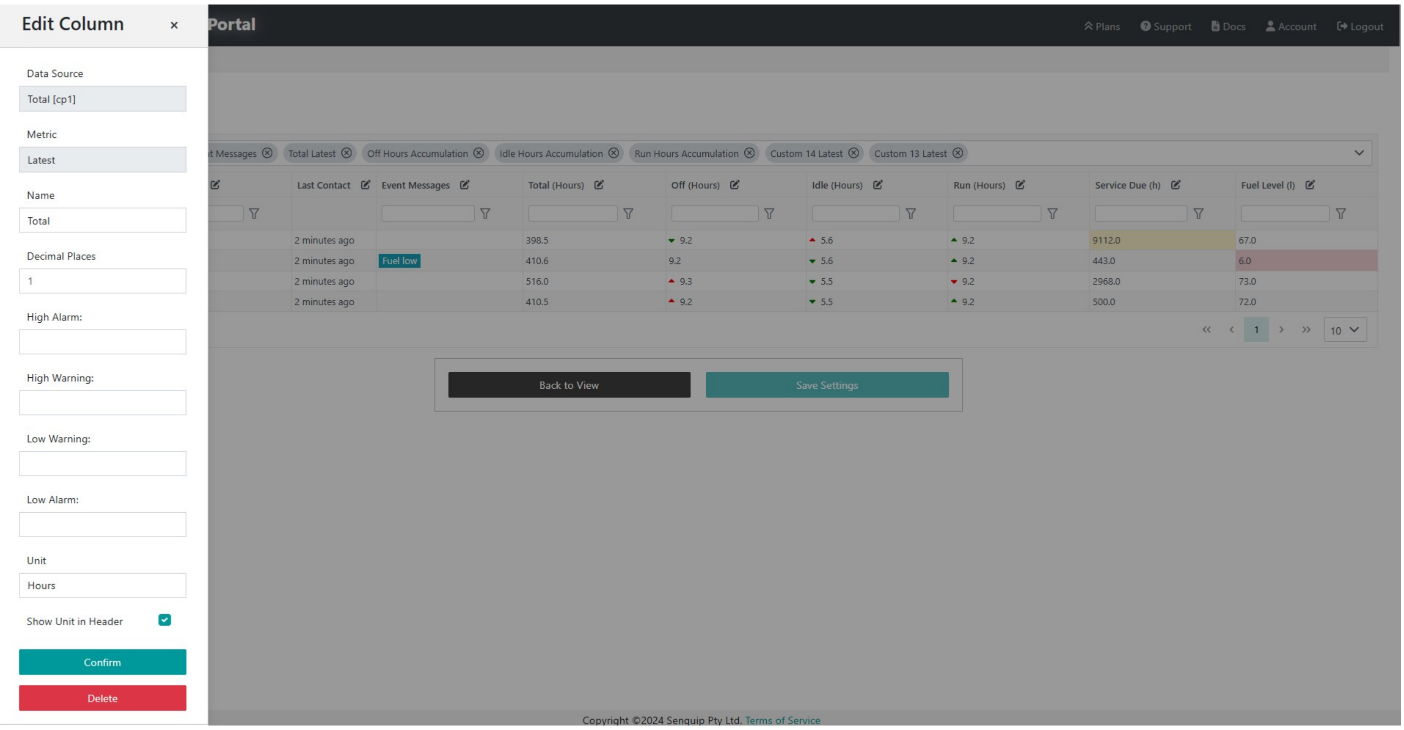

Figure 10.22. Press the edit button on each column to edit functionality

In this example summary table, a warning has been placed when engine hours increase above 6000, and an alarm has been placed on low fuel. Indicator arrows are indicating that idle are down on 3 machines, and run hours are up in most cases.

Name	Device ID	Last Contact	Event Messages	Total (Hours)	Off (Hours)	Idle (Hours)	Run (Hours)	Service Due (h)	Fuel Level (l)
DM-WCT112	BA6BFCH52	a few seconds ago		398.5	▾ 9.2	▴ 5.6	▴ 9.2	9159.0	69.0
DM-RIG878	EU8D7S173	a few seconds ago	Fuel low	410.5	9.2	▾ 5.6	▴ 9.2	507.0	10.0
DM-PMP223	QC7CPRPK2	a few seconds ago	Fuel low	515.9	▴ 9.3	▾ 5.5	▾ 9.2	3042.0	2.0
DM-GEN501	QF7BXH531	a few seconds ago		410.4	▴ 9.2	▾ 5.5	▴ 9.2	572.0	77.0

4 assets

Figure 10.23. Example Device Summary Table showing warnings and alarms

Filters

Filters are used to single out devices from all the devices in the group. Permanent filters can be applied in the table editor, or temporary filters can be applied in the live view. For example, a group may be created that contains all the off-highway assets at a quarry. Different views can then be created to show lighting towers, pumps, and crushers by adding a filters on asset type in the table associated with each view.

> **Warning** Remember to save your settings before returning to the view.

10.6.5 Headline Numbers

Headline numbers show data based on all devices in the current view. In the example below, total idle hours and total run hours across the 4 devices in the table are shown as headline numbers. We can immediately see that idle hours are up over the last 7 days when compared to the previous period, the good news is that run hours are also up. Increased idle hours are bad and are marked with a red up arrow. Increased run hours are good and are marked with a green up arrow. Hover on the arrow to see the value for the previous period.

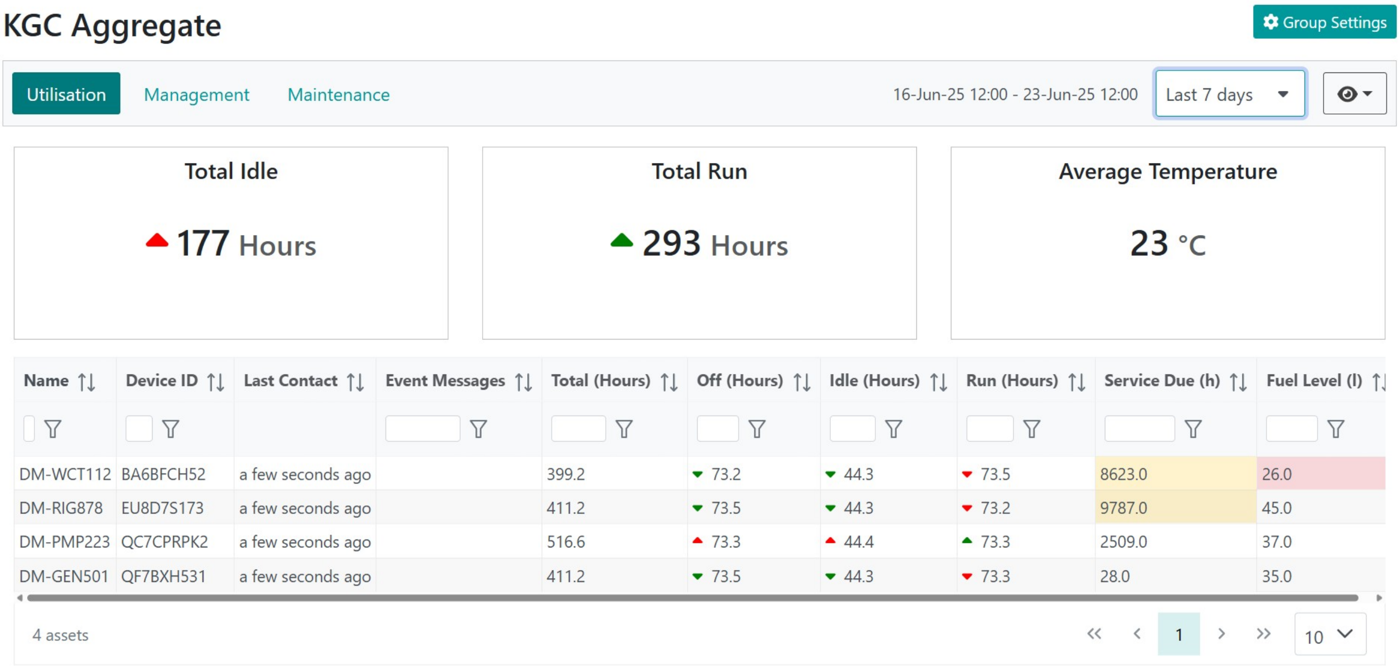

Figure 10.24. Headline numbers show metrics across all devices in the view

Headline numbers are added using the *Edit View* button. Headline numbers perform operations on all devices in the view. Available operators are:

- Total: Sum a metric across all devices in the view
- Average: Calculate the average across a metric, for all devices in the view

When creating a headline the following steps must be taken:

1. Select the data source from all available metrics. In the example below, the data source chosen is Internal Temperature Average.
2. Choose the operator from either total or average. In the example below, average is chosen and so the headline number will show the average of all the internal temperatures across all devices in the view.
3. Chose a meaningful title, a unit, the number of decimal places to show
4. Select a trend arrow, if required, being careful to chose whether up and down are good or bad

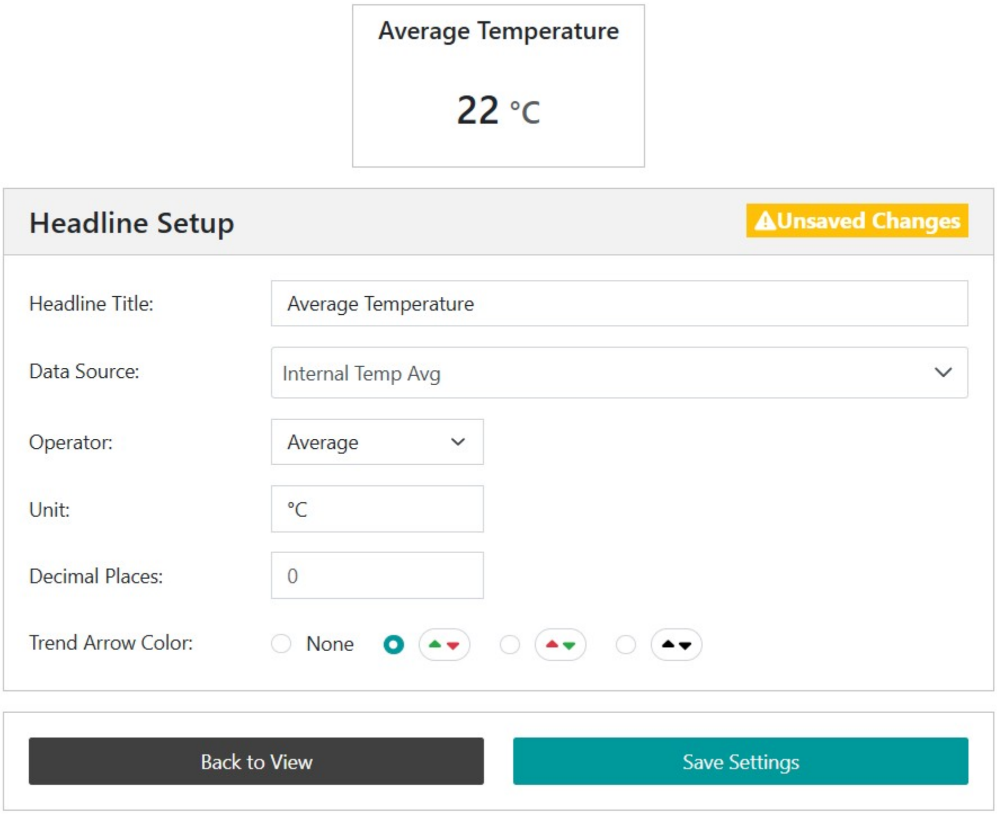

Figure 10.25. Headline numbers total and average a source metric across all devices in the view

Warning Remember to save your settings before returning to the view.

10.6.6 Charts

Charts can be added to show trend data across the period of interest. Charts show metrics as calculated at the end of each hour. In the example below, a stacked line chart is used to show total fuel used across all machines by the hour. It can been seen that the water cart used 12.09 litres of fuel for the hour ending at 07h00.

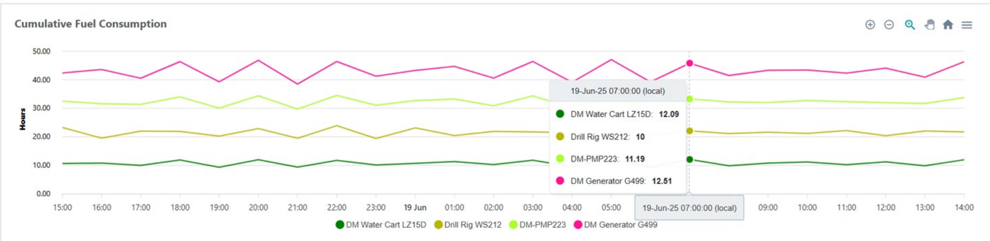

Figure 10.26. Charts show trend data across multiple devices

Charts are added using the *Edit View* button. When creating a chart, the following steps must be taken:

1. Select the data source from all available metrics. In the example below, the data source chosen is the average of Custom 11. In this case, Custom 11 is a custom parameter that has been generated in a script on a device and measures instantaneous fuel consumption.
2. Choose the chart type as either line or area, and select whether it is stacked.

3. Chose a meaningful chart name and configure the y-axis.

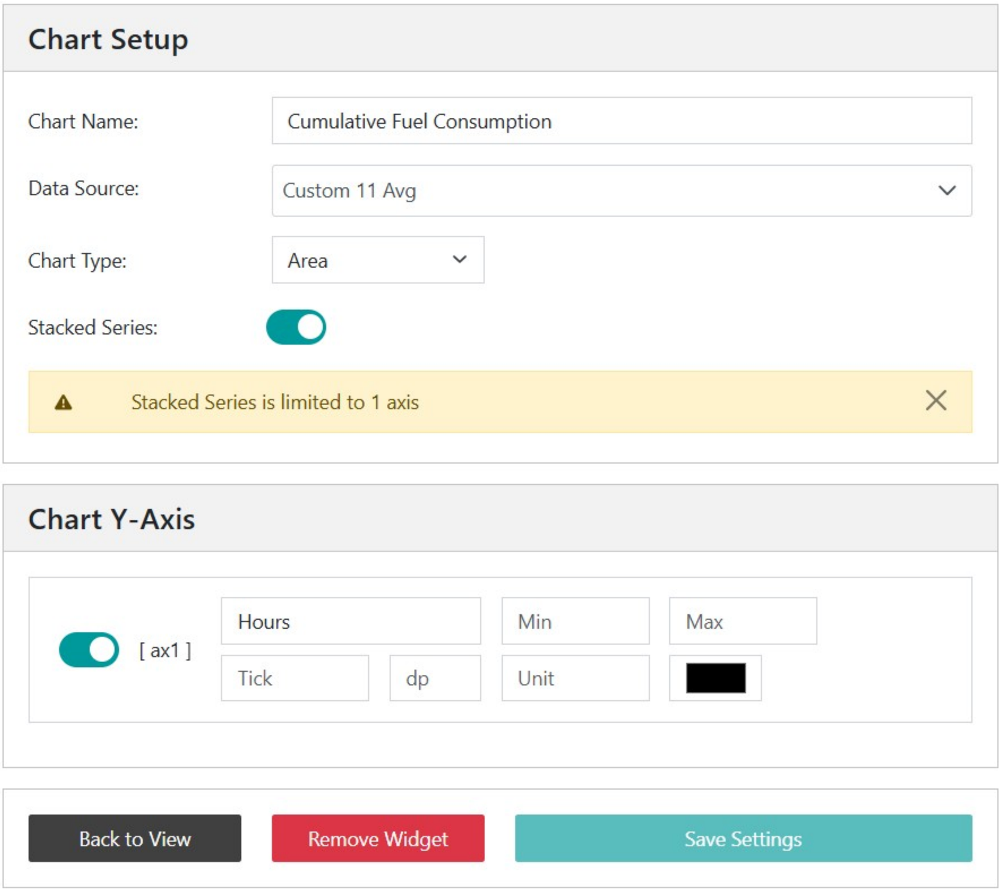

Figure 10.27. A stacked chart shows cumulative contribution of multiple data series over time

Warning Remember to save your settings before returning to the view.

10.6.7 Map

A map will be added to the view by default; it can be removed using the options activated by pressing the *Edit View* button.

Figure 10.28. Clusters of device seperate as the zoom level increases

Where the are many devices in the same area, they will cluster and be shown as the total number of devices in that area. As the zoom level is increased, the devices will separate.

The colour of the labels on the map indicates if there are any current alerts associated with the device.

- Grey: No alerts
- Blue: Alerts
- Orange: Warnings
- Red: Alarms

Click a device on the map to inspect the device data page.

10.6.8 Customising Layout

Senquip Vision allows you to customise the size and position of dashboard widgets for optimal viewing on desktop, tablet, and mobile screens.

To adjust widget layout:

1. Press the *Edit View* button and select *Edit Widgets*.
2. Choose a display mode: Desktop, Tablet, or Mobile.
3. Reposition widgets by dragging them using the arrow handle at the bottom-left corner.
4. Resize widgets by dragging the bottom-right corner of the widget.
5. When finished, select *Exit Edit* to return to the dashboard view.

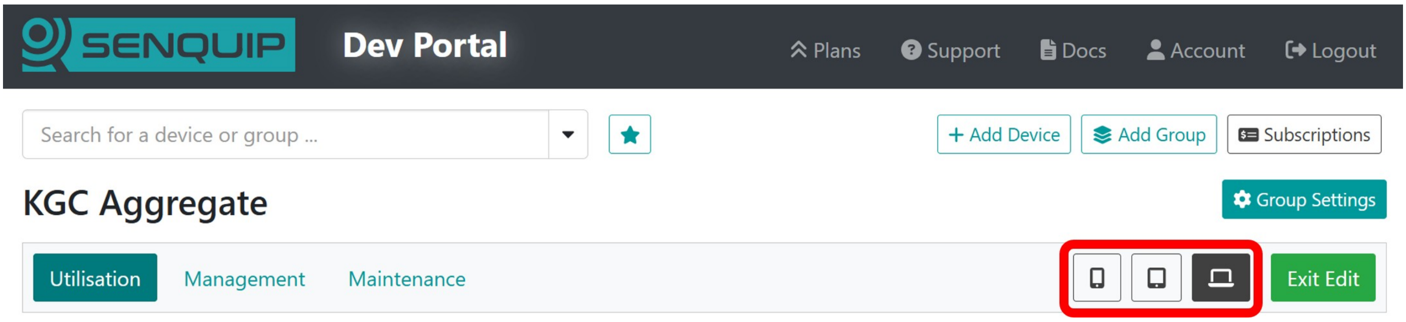

Figure 10.29. Optimise the layout for different screen sizes

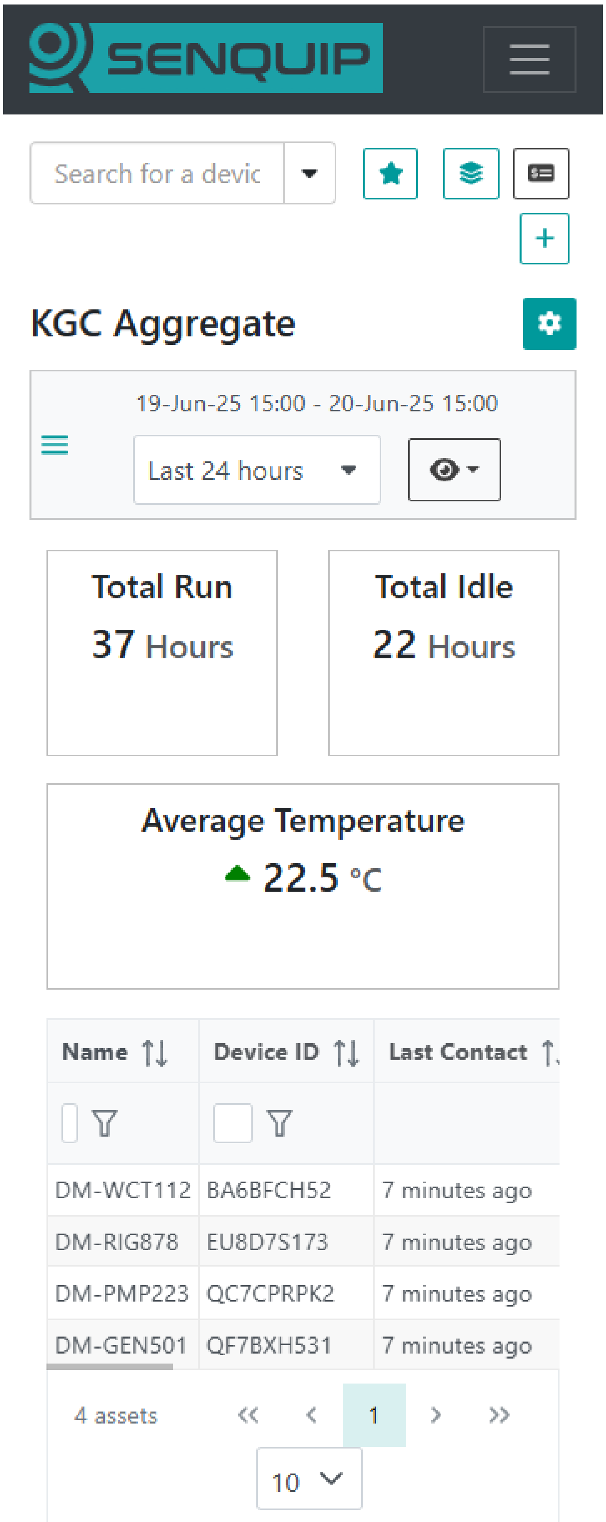

Figure 10.30. Dashboard view optimised for mobile screens

10.6.9 Device Data Page

The Device Data Page offers a centralised and intuitive view of all real-time and historical measurements reported by a Senquip device. Data is shown in real time and can be visualised as numbers, gauges, charts, or infographics.

The following are key elements of the Device Data Page:

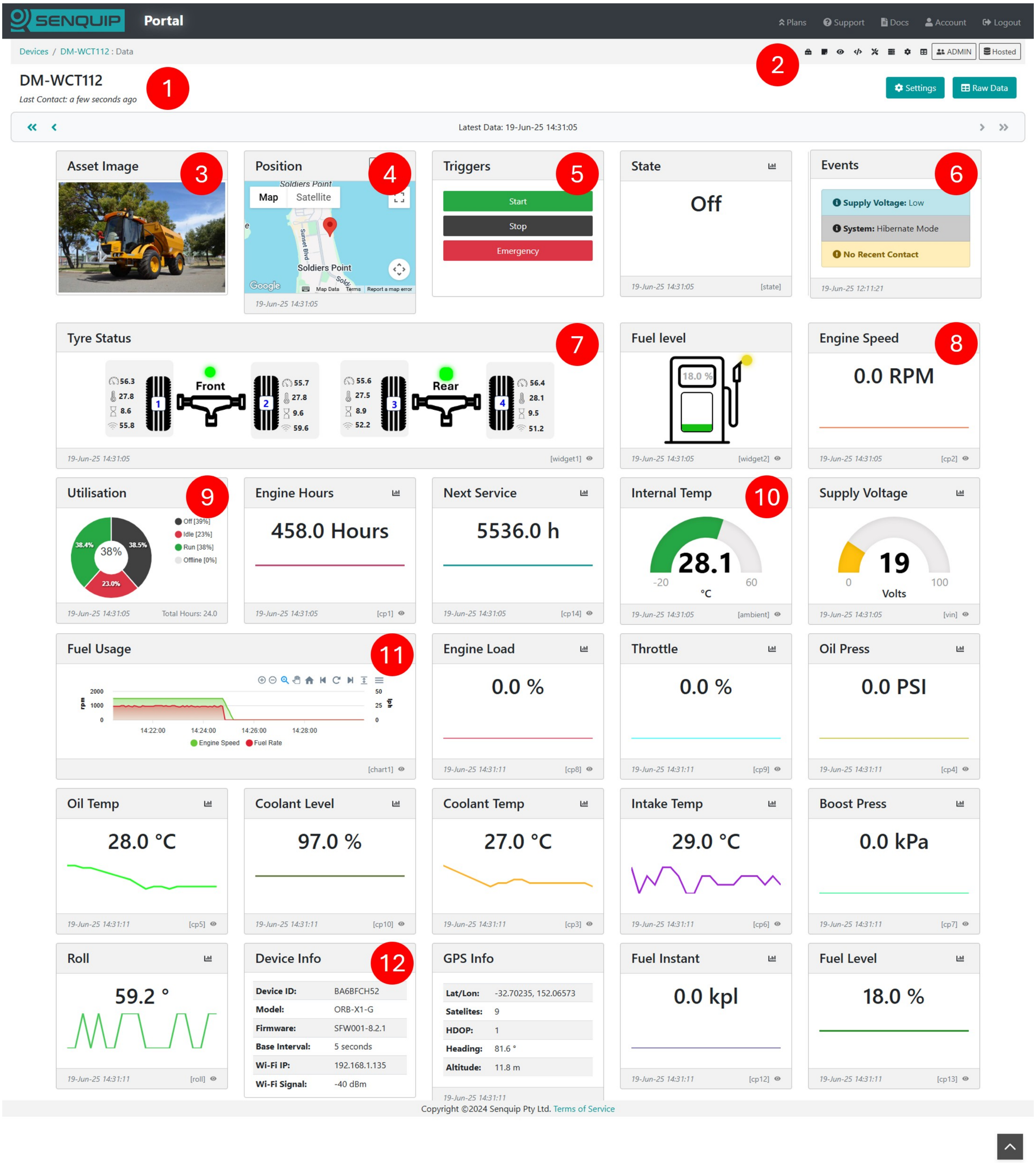

Figure 10.31. Device Data Pages provide a detailed view of measured data

Key	Element	Description
1	Device Name	The name associated with the Senquip device

2	Toolbar Icons	Provide quick access to device settings, scripting, raw data, and more
3	Asset Image	Optional application image
4	Map	Shows the current device location and historic track
5	Trigger Buttons	Allow for remove control by activating functions locally on a remote device
6	Events	Shows all active alerts, warnings, and alarms for a device
7	Infographic	User generated graphical widget that allows information to be shown in a meaningful way
8	Number	Widget displaying numerical data as a number
9	Utilisation	Pie chart showing asset utilisation
10	Gauge	Numerical data shown as a gauge
11	Chart	User generated chart showing trend data
12	Device Info	Shows information about the device
13	Raw Data	(Not shown) The raw JSON data for a device

The Device Data Page is also the central hub for managing device setup. From the toolbar icons on the page, you can select the following:

- Asset Notes: Add notes and images associated with the device application and install.
- Display Settings: Choose which measurements are displayed, and the order in which they are displayed. Create custom Graphical Widgets and Charts.
- Scripting: Link to the device scripting page to customise device operation, create custom parameters, add trigger buttons, and configure states.
- Diagnostics: View device diagnostics information, SIM information, signal strength and more.
- Server Log: Show a log of all user activity including when settings were changed, and when users were added.
- Settings: Change device settings, perform firmware upgrades, and configure events.
- Raw Data: Download historical data and export to CSV if required.

Note Available options will vary depending on user permissions.

10.6.10 Device Data Page Configuration

As measurements are enabled on the Senquip device, associated widgets will automatically appear on the Device Data Page. The widgets can be turned on and off, and the order of display can be changed.

Page Layout

Select the *Display Settings* icon to choose which measurements are displayed, and the order in which they are presented.

Figure 10.32. Turn widgets on and off and configure the display order

Add Asset Image and Logo

Select the Asset Notes icon to upload an image of the asset being monitored, a brand logo, the install location, and to make notes about the install.

Change Widget Display Format

Press the eye icon at the bottom right of the widget to switch between various display formats. Available formats are:

- Hidden - Hide the data if it is not relevant to the application
- Trendline - The default graph that facilitates recognition of change. Allows the user to view longer term trends between date ranges.
- Gauge - Useful when representing measurements that must exist within a range. Can be scaled so that the pointer is vertical under normal conditions. Warning and alarm levels can be set.
- Digital - A simple ON or OFF display that shows the status of a measurement. The threshold at which the display switches from ON to OFF can be set.

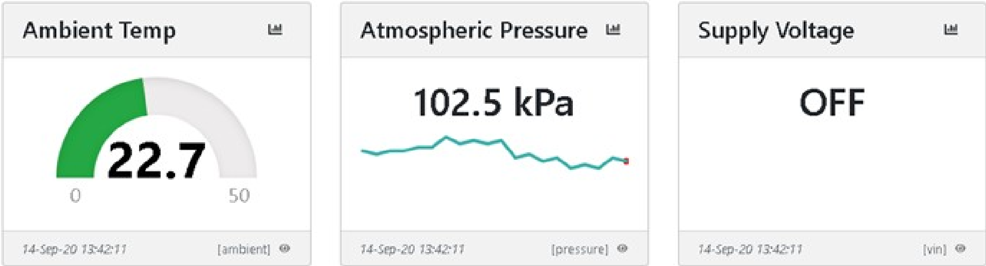

Figure 10.33. Switch between numberic, gauge, and digital display modes

Click on the icon at the top right of each widget to show numerical data on a chart over a selected period. Click on a point on the chart to show values at that point.

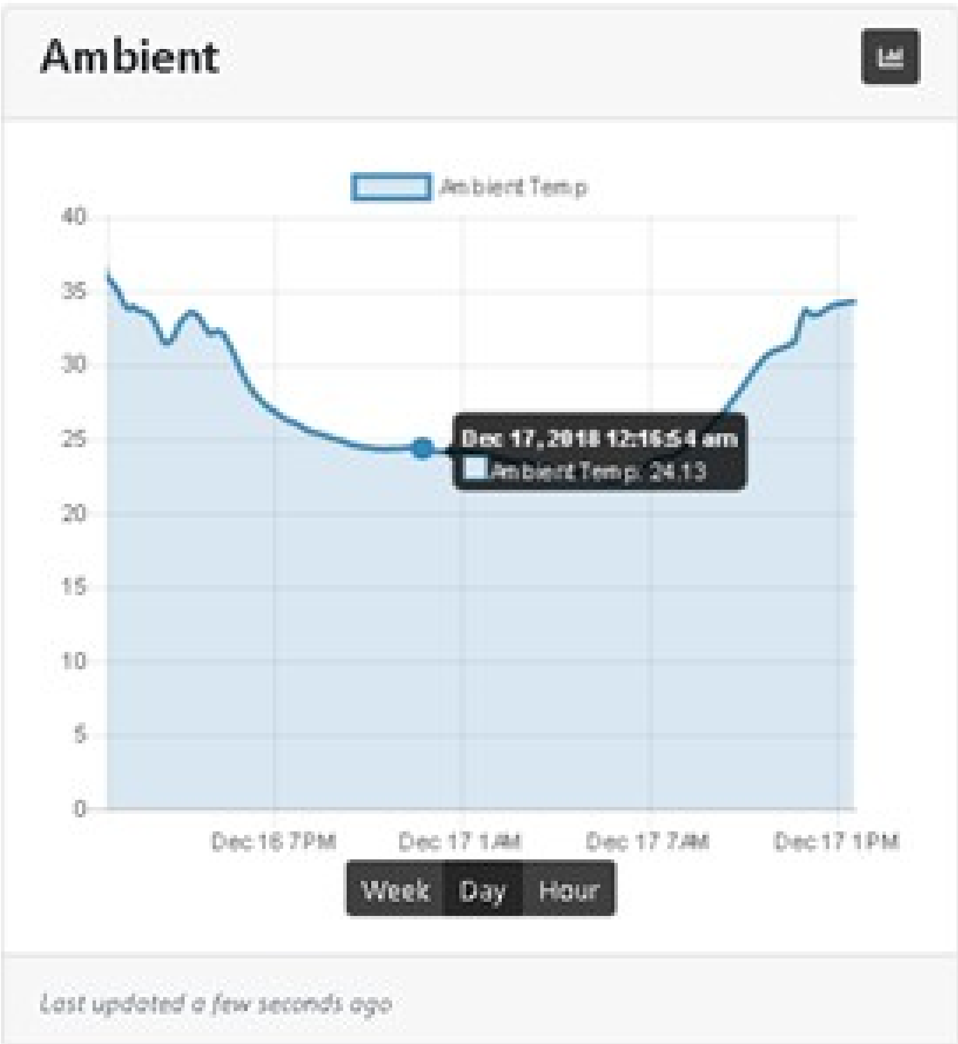

Figure 10.34. Numeric data can be shown as a line chart

10.6.11 Historical Data

To view or download historical data, press the *Raw Data* button on the top right of the dashboard. A table showing all the data associated with the selected device will be shown. To download the data, press the *Export to CSV* button. The data will be saved to your downloads folder. The downloaded file can be opened and manipulated with any spreadsheet tool.

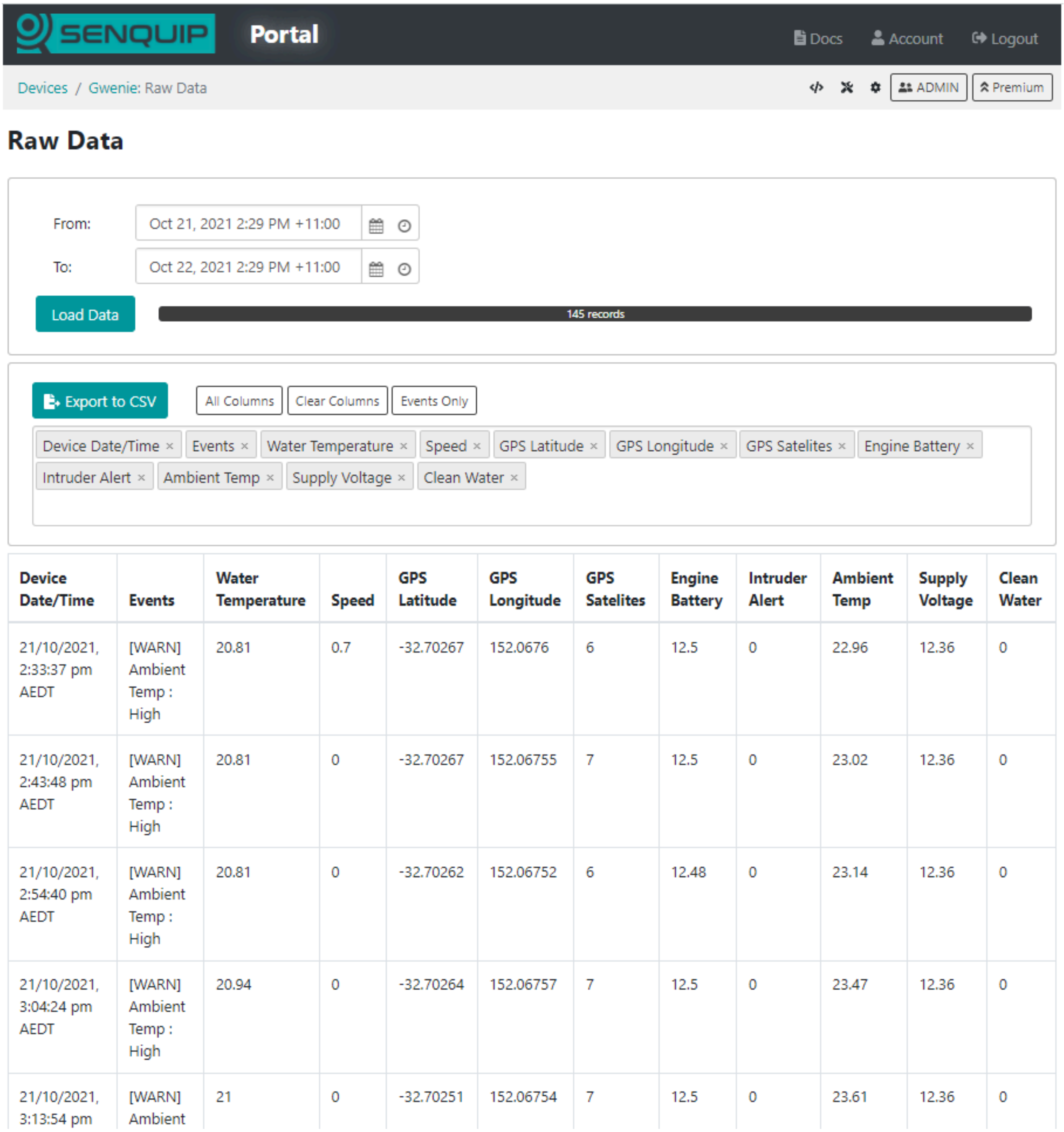

Figure 10.35. Data associated with the selected device shown in a table

Note The timestamp in the *timestamp* column is in Unix Time; if you would like a GMT date and time field, enable the timestamp setting in endpoint settings.

10.6.12 Device User Administration

Use the *User* button to manage the users of each Senquip device. When a device is added to an account using the device ID and password, the user that added the device automatically becomes an admin for that device. Admin users can manage other user rights and have full permissions for the device. The different user types are detailed in the table below:

Allowed Permission	Admin	User	Operator	View
View data	Yes	Yes	Yes	Yes
Trigger device actions	Yes	Yes	Yes	
View users	Yes	Yes		
Change device settings	Yes	Yes		
Add/remove users	Yes			

Warning Anyone who has the device ID and setup password can add the device to their account with Admin permissions.

10.6.13 Configuration via Senquip Portal

Settings associated with a Senquip device can be updated remotely via the Senquip Portal. To change the settings for a selected device, press the *Settings* button on the top right of the dashboard. The selected device settings will be shown and can be changed by clicking in the relevant fields. Once a setting has been changed, press the *Save Settings* button at the bottom of the page.

Senquip devices check for settings changes each time they make a connection to the Senquip Portal. If a device is set to transmit data once an hour, then the settings will be changed up to an hour after the changes have been made on the portal. If quicker changes are required, the device will need to be visited and the changes made via the integrated webserver in setup mode.

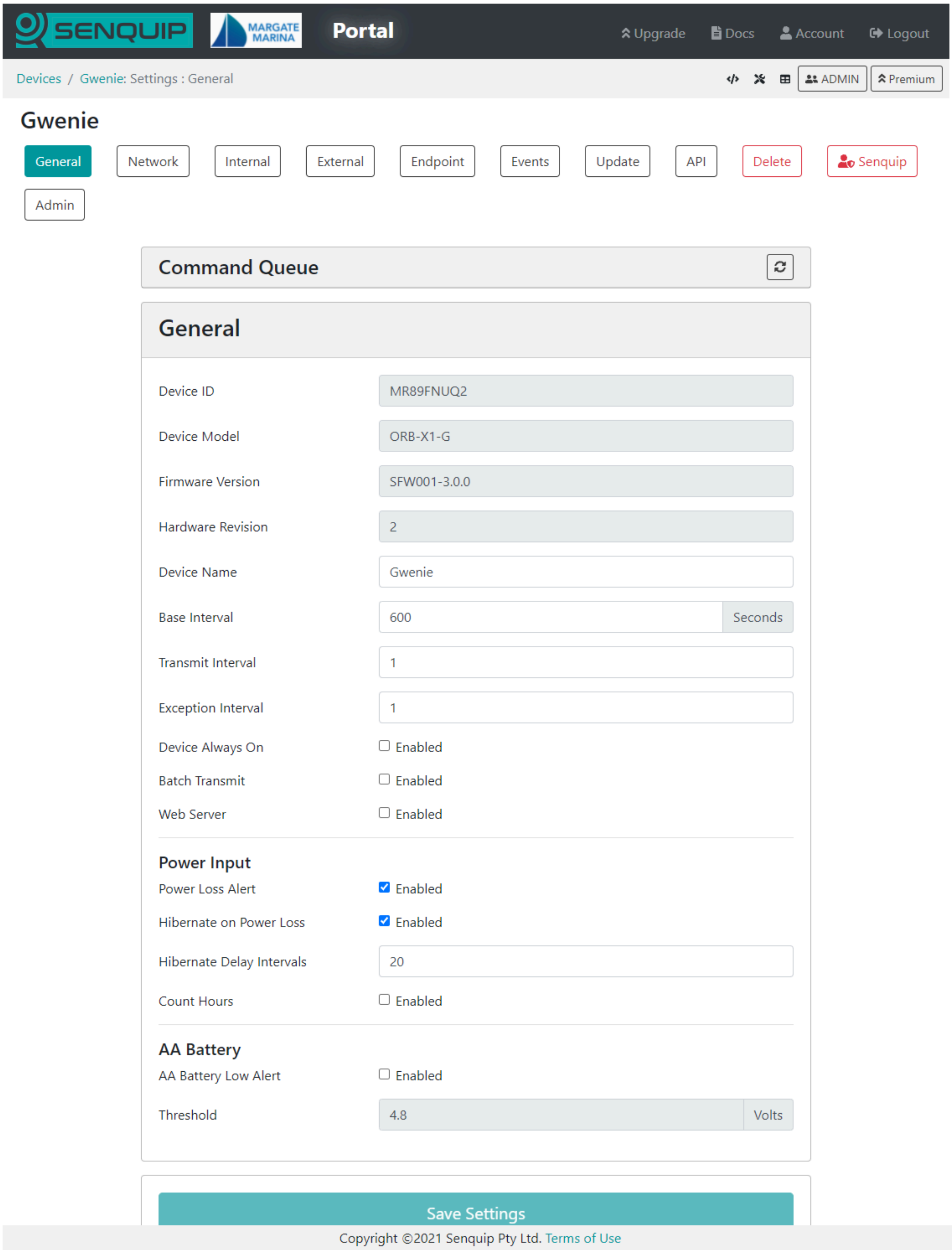

Figure 10.36. Remote update of device settings via the Senquip Portal

Note In applications where power is available, a quicker transmit interval will mean that settings changes can be made more quickly.

10.6.14 Remote Firmware Updates

Senquip will routinely make firmware updates to enable new features, enhance security and fix bugs.

Device firmware can be updated via the Senquip Portal. To update the firmware, press the *Update* button on the settings page. You will be directed to a page asking for the firmware number. This number can be found in the Device Firmware Changelist on the Senquip website or through your preferred distributor.

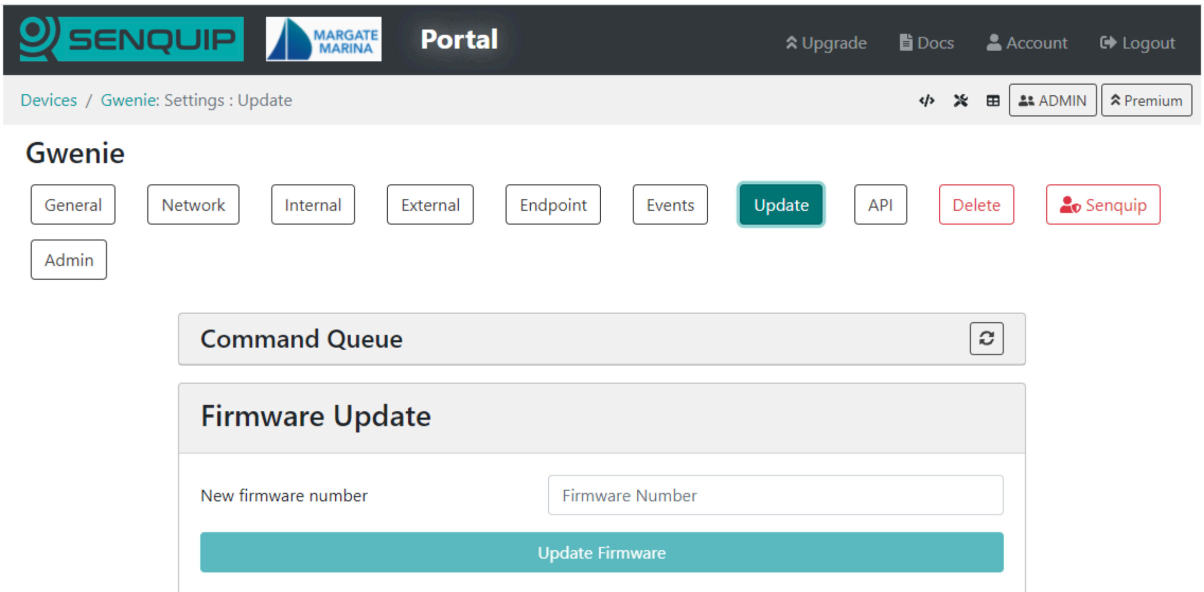

Figure 10.37. Remote firmware updates via the Senquip Portal

A Firmware Update typically takes about 5 minutes on Wi-Fi and 20 minutes on 4G LTE. During the update the green light will be off and the orange light will flash fast. Once the device has received the firmware update and is processing it, the lights may appear to freeze. This is normal behaviour. Please allow plenty of time for the device to finish the update and return to normal operation.

Note There is always a risk that something may go wrong during a firmware update; it is not recommended that firmware be updated unless it is suggested by Senquip or a specific new feature is required.

10.6.15 Event Reporting

The Senquip Portal allows forwarding of alert, warning, and alarm events generated on a device to email or SMS endpoints. A Hosted plan is required for this feature. Use the *Events* page on the Senquip Portal to configure event reporting. Events can be configured to be sent once as they occur, or with a daily reminder.

Warning Make sure to add *no-reply@senquip.com* to your safe senders list on you email client to prevent email events from going into spam or junk folders.

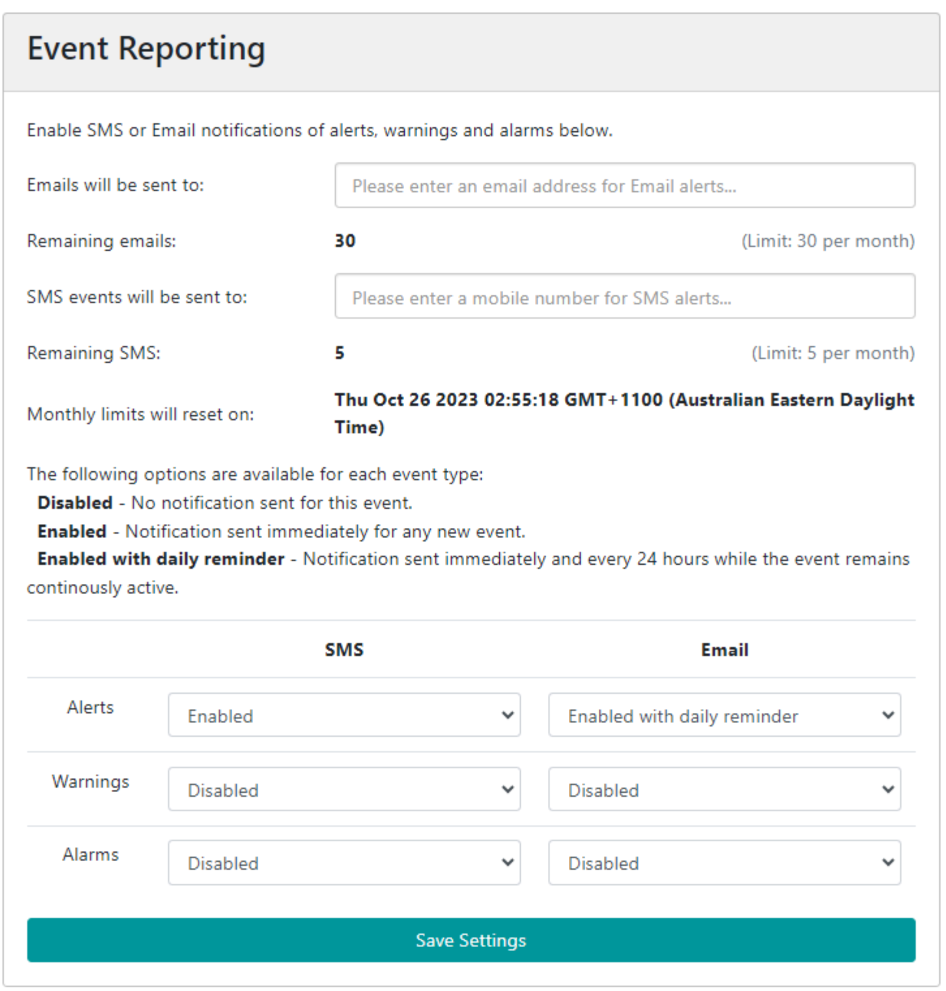

Figure 10.38. Configure event forwarding

If an event is current, and the event escalates, for example a warning turns into an alarm, the more severe event will be forwarded. If an event is current and it de-escalates, for an example, an alarm turns into a warning, the event will not be forwarded. If a type of event is current, and a new type of event occurs, the new event will be forwarded. For instance, if a high current warning is active and has been forwarded to email or SMS, and a high temperature warning becomes active, the high temperature warning will also be forwarded.

10.6.16 Creating Custom Widgets

Users can create custom widgets that display data graphically in a way that is meaningful to the user. In the example below, the pressure and temperature of each tire on an axle is shown. In the example, the pressure on tyre 2 has dropped and so the pressure field has turned yellow as a warning to the user.

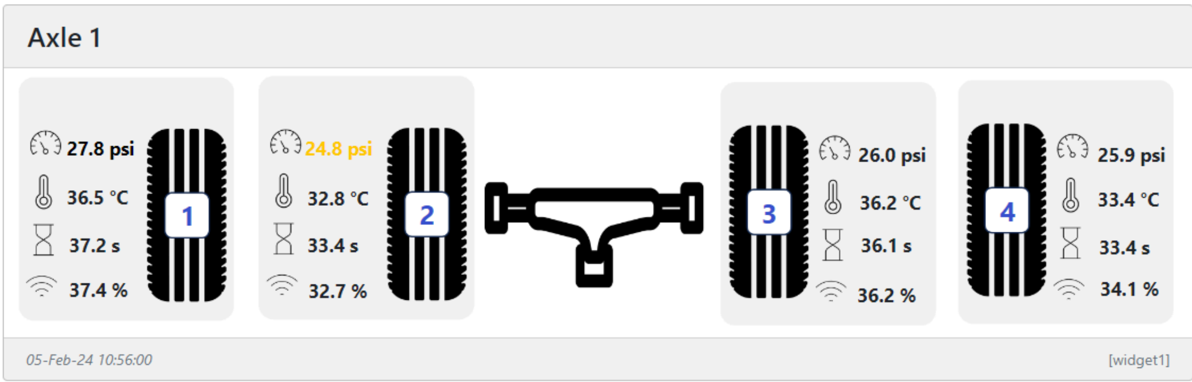

Figure 10.39. A graphical widget showing tyre status

To create a widget, select the *Display Settings* icon on the device data page and chose *Add Custom Widget* at the bottom left of the page. A new custom widget will be generated and you will be taken to the *Widget Editor* page to customise your widget. At the top of the *Widget Editor* page is your widget. It will default to a blank background with an example of how to display temperature shown. The text can be moved to a new location by clicking on it and dragging it.

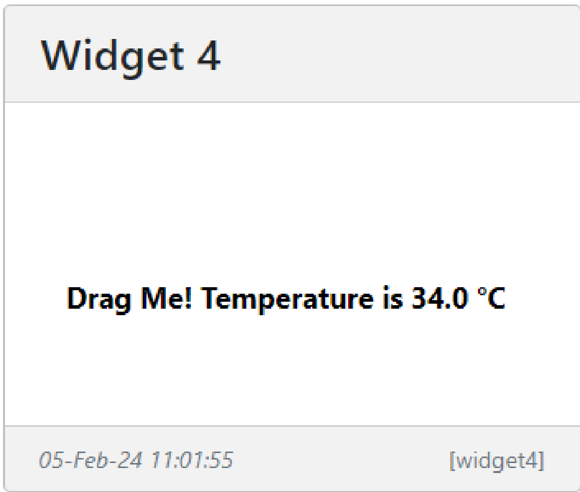

Figure 10.40. Default blank widget showing temperature

As an example, we will generate a widget that shows the level of water in a water cart. In the *Widget Setup* window, we get to name our widget with something meaningful to the user. We will name our widget “Water Cart” We can also set the width of the widget in units of a standard Senquip Portal widget. We will leave the width as 1 unit wide. A background colour can be selected and a background image loaded. We will use the *Choose File* option to load a background image of a water cart. We can choose to show the units associated with values displayed on our widget, or to leave the units off and make the units part of the background image of the text that is displayed along with the value. We will turn off showing units. Selecting *Dynamic Colour Change* automatically changes the colour of values and associated text when a warning or alarm is associated with that value. We will leave this on.

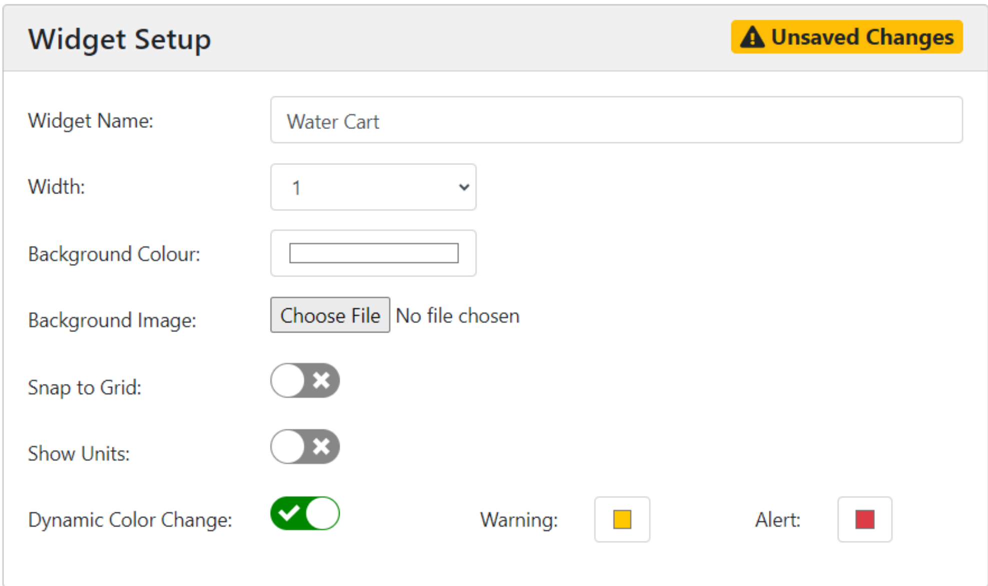

Figure 10.41. Settings for our water cart example

Note Remember to save your changes.

The *Widget Text* window allows us to insert text and values on the image in the widget. When you created your widget, an example text entry was created “Drag Me! Temperature is ${data.ambient}”. In this example, the text “Drag Me! Temperature is” will be displayed along with the value of the ambient temperature. The most recent value of ambient temperature is inserted in the text string by using a dollar and curly bracket, followed by the data element, in this example ambient temperature, and a closing bracket “${data.ambient}”. In our example, we will create a script that has a custom variable *cp20* called *Water Level*, and will use this in our example, inserting the unit kl in text as follows “${data.cp20} kl”.

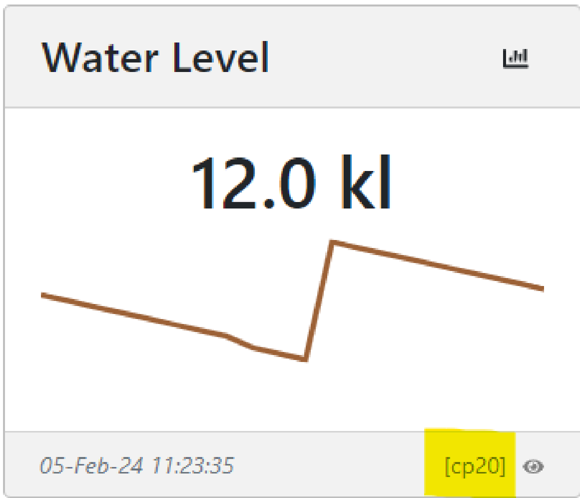

Figure 10.42. Water Level as shown on the device page.

We will choose *Bold*, *20px* font size, and will make the default colour green.

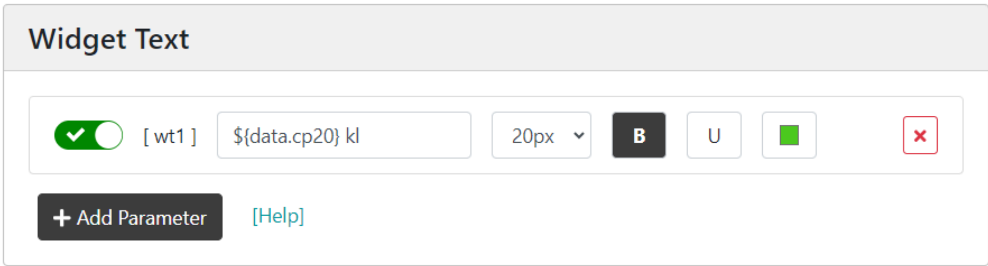

Figure 10.43. Water cart widget text settings.

Note Because we have chosen *Dynamic Colour Change*, the colour of the text will change if there is a warning or alarm current on *cp20*.

Our widget now looks like the image below.

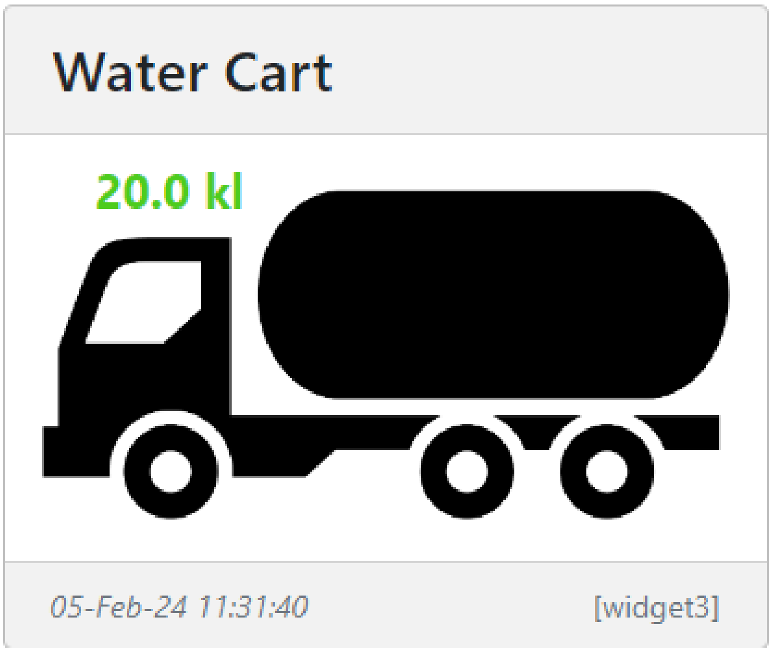

Figure 10.44. Water cart widget with water level shown in green.

We will now use the *Widget Elements* window to add a dynamic level indicator to the tank on the water truck. We will associate the level indicator with the *water level*, *cp20*, and will set the *width*, *height*, and *radius* to match that of the tank on the water truck image. Since the water level parameter created in the script has a range of 0 to 20, we will set the *minimum* and *maximum* levels of the indicator to 0 and 20.

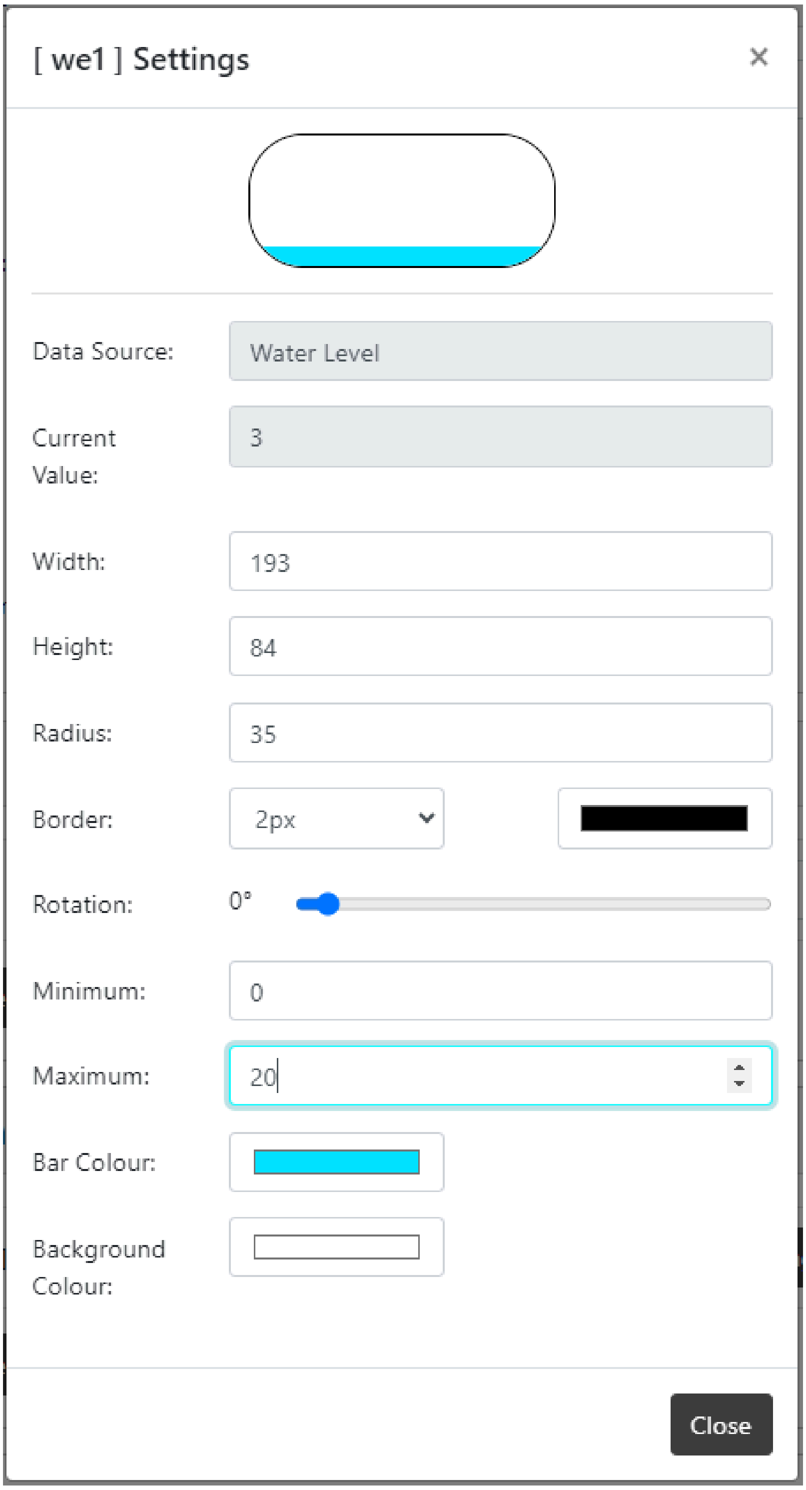

Figure 10.45. Settings for water cart level element

We could also add a status indicator light to the image by adding a *status indicator* element. Status indicators can be associated with data values and can be set to change colour as the data value drops below a threshold.

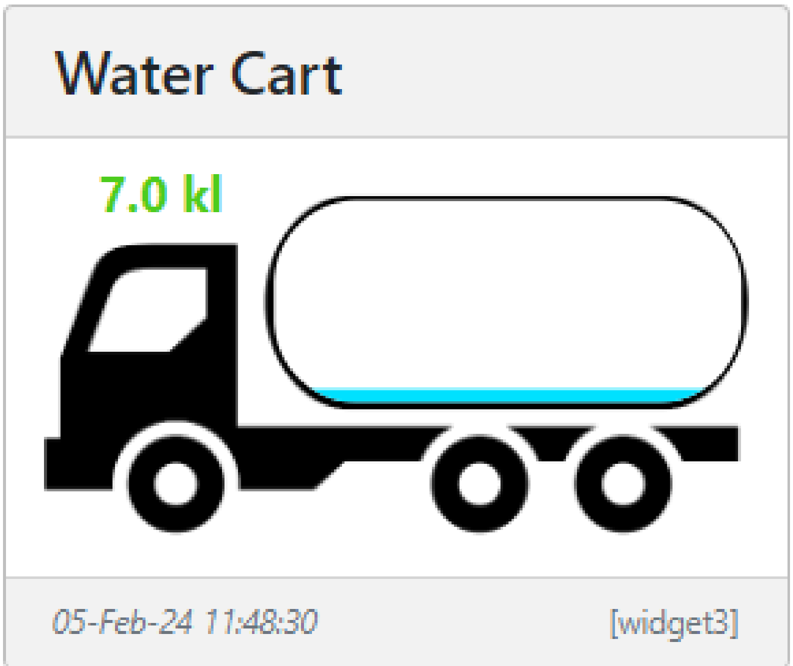

Figure 10.46. Completed water cart widget

Once saved, the water cart widget will appear on the device page alongside all the other enabled widgets.

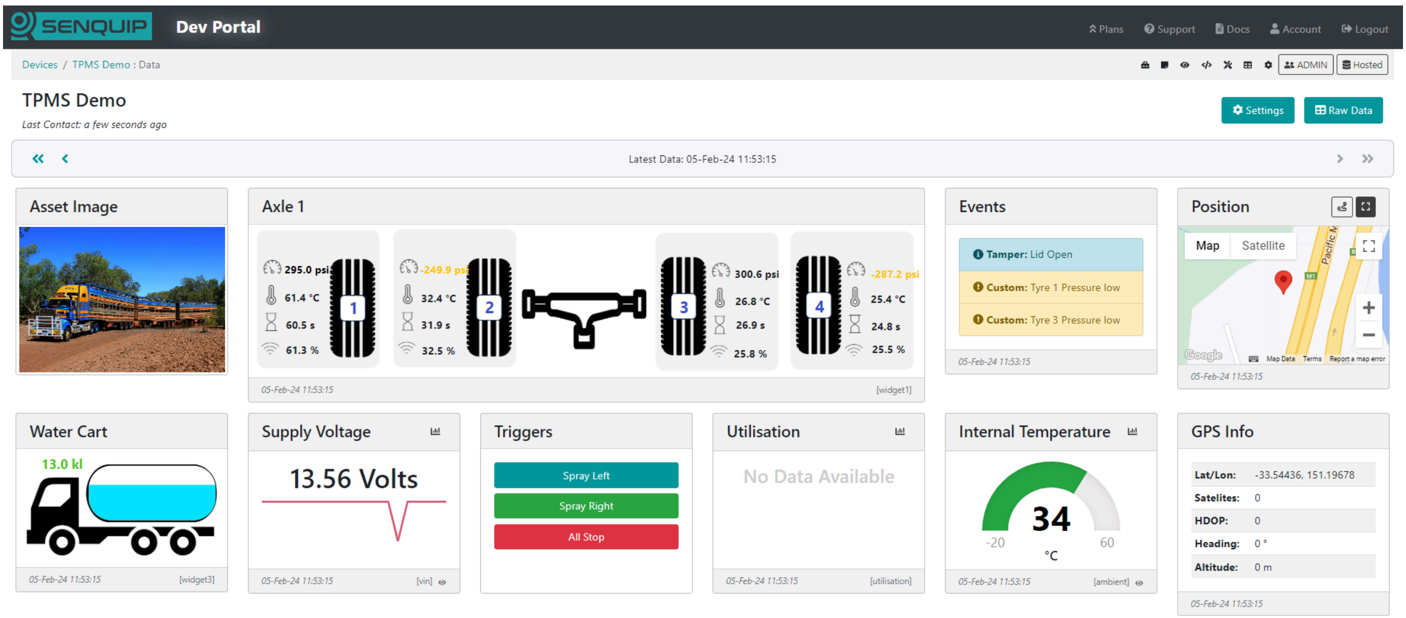

Figure 10.47. Water cart widget shown on the Senquip Portal

To edit the widget, go to the *Display Settings* page and select the widget by clicking on the widget name.

Sizing of widget images

The width of a custom widget can be chosen as 1 to 4 standard widgets in width. The height of the widget is determined by the size of the image uploaded. In the water cart example above, the image was scaled to result in a widget that is the same height as most of the other standard widgets on the device page. This makes for a neat and consistent looking display. To create a widget the same height as most widgets on the Senquip Portal, use the following ratios for the background image.

Note The image does not have to be these exact sizes as the width will auto scale. The ratio does however need to be correct.

Widget width	Image width	Image height	Ratio
1	320	178	1.8
2	670	178	3.8
3	1020	178	5.7
4	1370	178	7.7

10.6.17 Creating Custom Charts

Users can create custom line, area, and bar charts with multiple axis, and multiple series. In the example below, the number of particles of a particular size in oil is shown on a stacked area chart, with the total of the stack indicating the total number of particles.

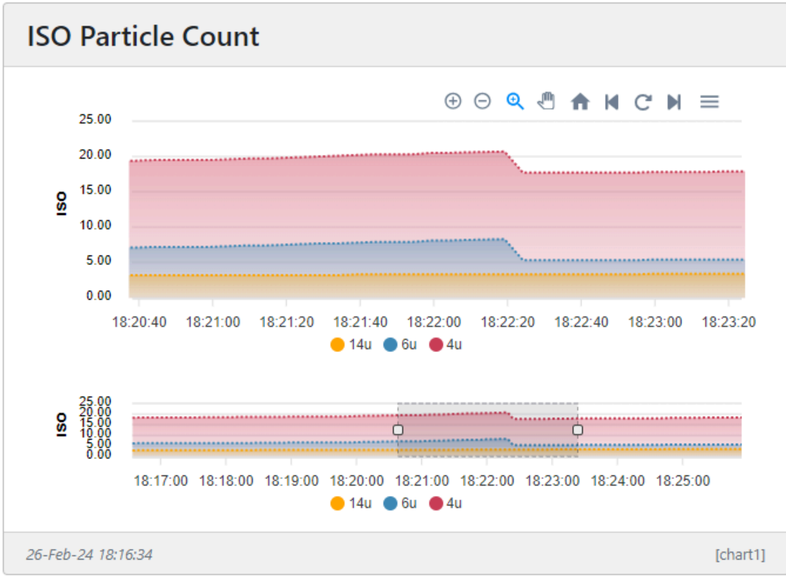

Figure 10.48. Brushed area chart showing particles in oil

Note To speed up render time, all charts are downsampled to show 1000 points across the chart. The algorithm used to downsample the chart data has been selected to retain as many of the features of the original data as possible. It is however possible that details may be missed in a highly compressed timeline.

To create a custom chart, select the *Display Settings* icon on the device data page and chose *Add Custom Chart* at the bottom left of the page. A new custom chart will be generated and you will be taken to the *Chart Editor* page to customise your chart. At the top of the *Chart Editor* page is your custom chart. It will default to a simple chart with no series.

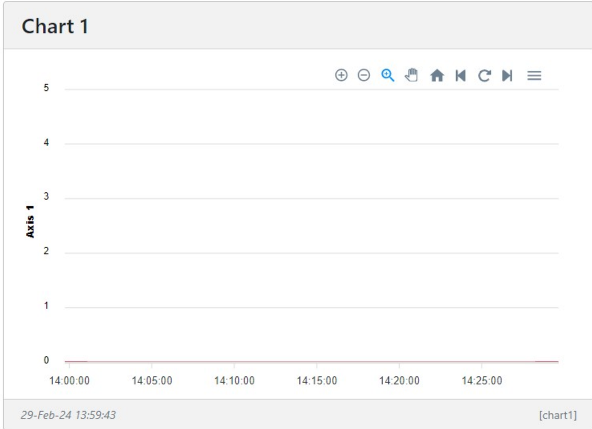

Figure 10.49. Default custom chart

We start by giving the chart a name, in this example, we will generate a chart showing temperature and pressure in a compressor and so we will call the chart "Compressor 2D". We will choose a *Line* chart, and will give the chart a size of 2 widgets wide by 2 widgets high. We have chosen a time range of *10 minutes*. If we had selected *Brushed Chart*, a magnifying window below the chart would appear that can be dragged left and right to scroll through chart data. The earlier oil particle chart is an example of a brushed chart. If we had selected a *Stacked Series*, the values of the various series would be summed. The example of the oil particle chart is a stacked chart.

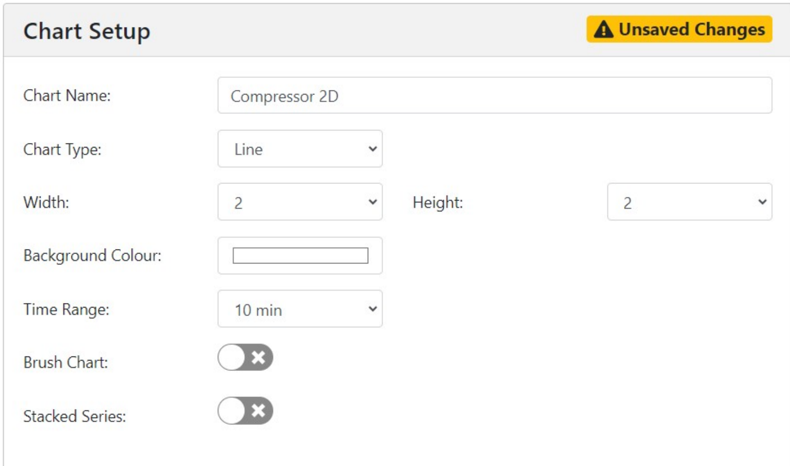

Figure 10.50. Custom chart settings

We will now add the axis to the chart. We add 1 axis for temperature and 1 axis for pressure. We have added custom minimum and maximum values for the axis but if we had left them blank, axis values would have been assigned based on the available data. The tick interval has been left blank and will be calculated automatically. One decimal place has been selected for the axis labels, and a colour has been assigned to each axis. Custom axis settings are disabled if the *Brush Chart* option is selected. Only a single axis can be added if *Stacked Series* is selected.

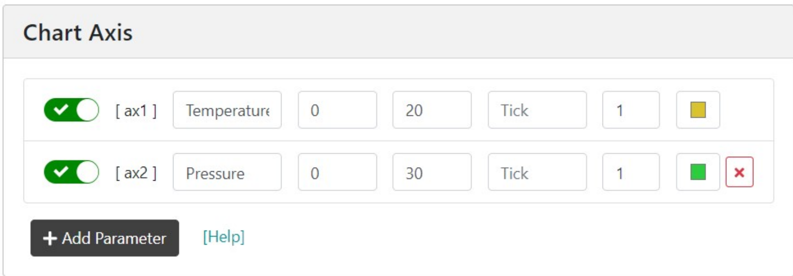

Figure 10.51. Custom chart axis

We will now create a series and will assign an axis to each series. We first select the axis associated with the series. We then select a measurement. In our example, we will add compressor temperature and internal device temperature to the *Temperature* axis and pressure to the *Pressure* axis. We have selected the line type as *Solid*, have selected a line width of 2, and have chosen a colour for each series.

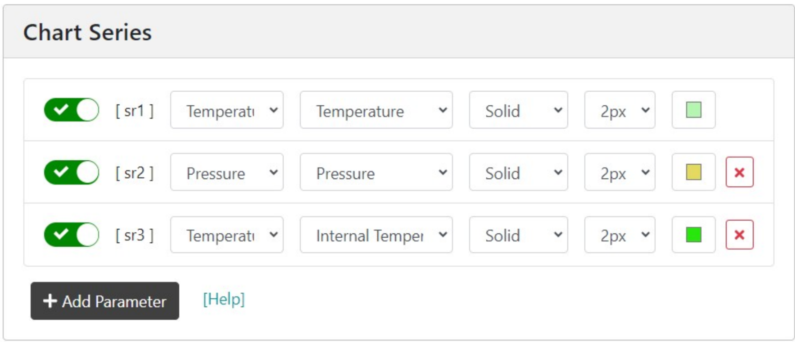

Figure 10.52. Adding series to a custom chart

Note Remember to save your settings.

We have now generated our first chart.

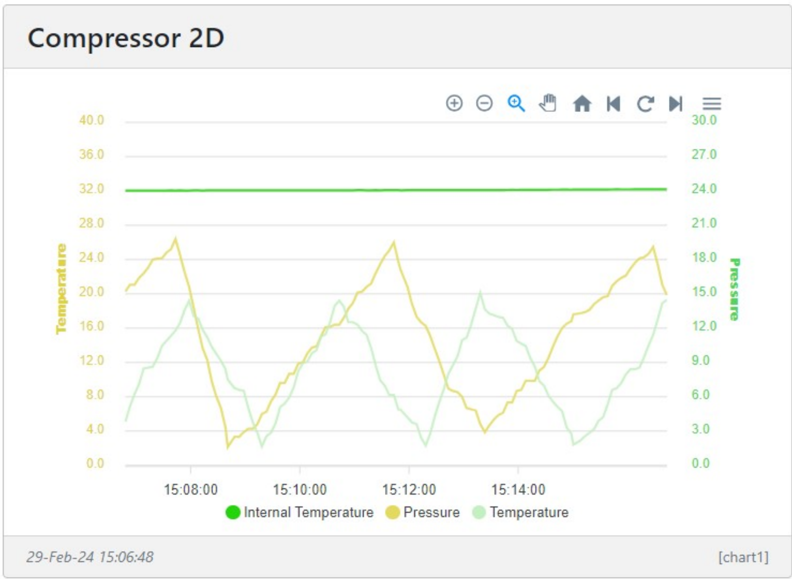

Figure 10.53. Example chart showing generator temperature and pressure

The charts offer controls for zooming, panning, loading previous and new data, and enhancing a zoomed area. The enhance option is provided so that the user can zoom into an area and then select the option to load more data from the server to enhance the chart where the downsizing algorithm may have smoothed detailed features.

The process for creating a bar chart is similar except that the data to be displayed must be sent from the Senquip device as an array of numbers. The array must be turned into a JSON string object before being dispatched. Each element of the array represents the height of the associated bar.

For instance, the following vibration chart was created by reading 128 frequency bins from a vibration sensor and sending them as a stringified array. The required code is summaried below. Also in the example below, a goal value within which the vibration profile must remain is dispatched to the Senquip Portal. The goal data is static (does not change often), therefore it does not need to be dispatched on every cycle. To set a series as a goal, use the *Mark as Goal* option in the chart series menu.

```
...
let profile = readVibrationProfile();
SQ.dispatch(12,JSON.stringify(profile));
...
let goal =
[10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,

10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,20,30,50,70,90,110,120,120,120,120,

120,120,120,120,120,120,120,120,120,120,120,120,110,90,70,50,30,20,10,10,10,10,10,

10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,
 10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10];
if (cycle === 50) {SQ.dispatch(13,JSON.stringify(goal));}
...
```

Example - Reading a Vibration Profile and then Dispatching it to the Senquip Portal.

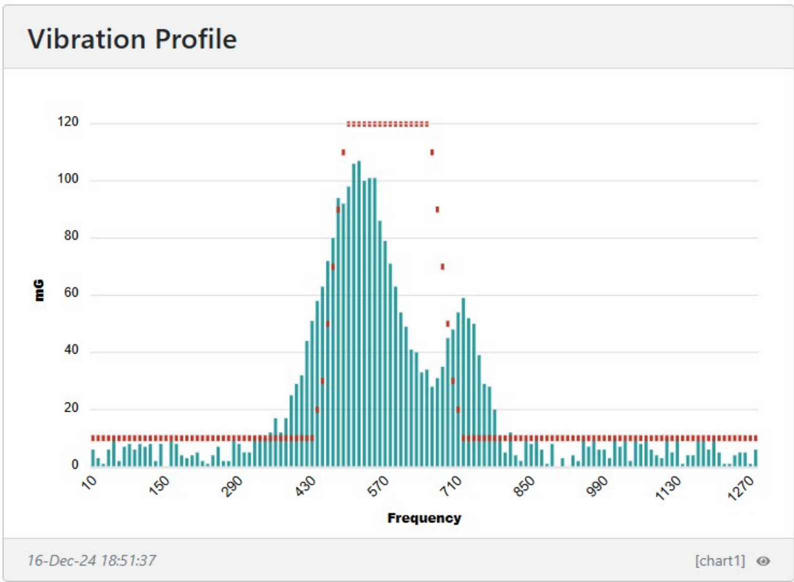

Figure 10.54. Example bar chart showing a vibration profile and goal

In the following example, each of the 5 series is dispatched as a stringified array with a single element.

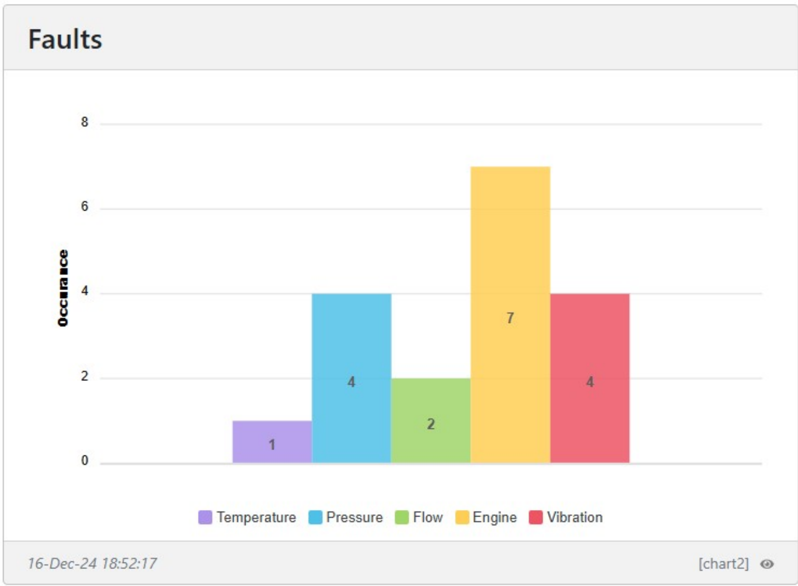

Figure 10.55. Example bar chart showing fault data

10.7 Management and Hosting on the Senquip Portal

The Senquip Portal offers hosting of data, a data visualisation dashboard, firmware upgrades, and device management including remote configuration and scripting. Every Senquip device purchased comes with a *managed* plan for the life of the product (10 years). *Managed* plans allow remote configuration and scripting on the Senquip Portal. Users have the option of purchasing a *hosted* plan to enable data hosting and data visualisation on the Senquip Portal. Hosted plans are available on a monthly, yearly, or lifetime basis (10 years), and can be purchased directly off the Senquip Portal or through distributors.

10.7.1 Basic

Managed plans are most suitable for users who are hosting their data on their own server and have their own dashboards. Features of the management plan include:

- Configure devices from the Senquip Portal
- Connection to a private server
- View current data
- 5 Minute updates to the Senquip Portal
- 1 Day of data storage
- Device Scripting
- Access for 3 users
- Firmware updates

10.7.2 Hosted

Hosted plans are for users who will use the Senquip Portal to store and visualise their data. Features of the hosted plan include:

- Configure devices from the Senquip Portal
- Connection to a private server
- View current and historical data
- 5 second data update limit
- 2 years of data storage
- Device scripting
- Senquip Portal access for 50 users
- Firmware updates
- Export raw data
- Trigger remote actions
- Create custom data widgets
- Create custom charts
- Device to device messaging
- 300 email alerts per month
- 100 SMS alerts per month
- Senquip Cloud API access
- AEMP API access

Note Every device includes 90 days of hosted access from the date of activation.

For the most up to date feature list and to purchase a hosted plan, please visit the Senquip Portal or contact your preferred distributor.

Chapter 11

Mechanical Specification

11.1 Mechanical drawings

Critical dimensions for the ORB, mounting plate and mounting hardware are given below. Full three dimensional models are available on request.

Note All dimensions are in mm.

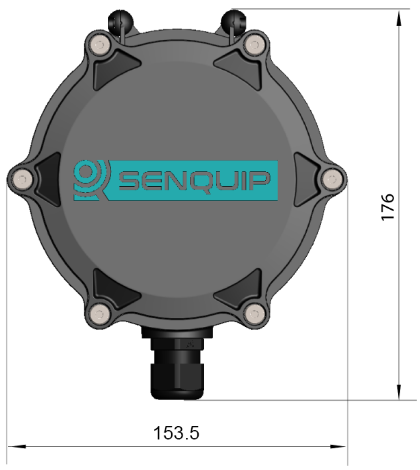

Figure 11.1. Dimensioned front view

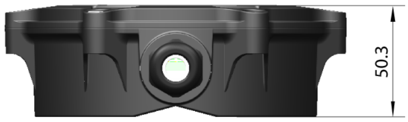

Figure 11.2. Dimensioned top view

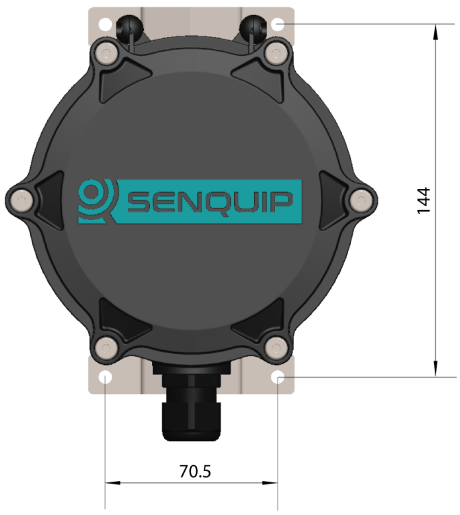

Figure 11.3. Dimensioned front view including mounting brackets

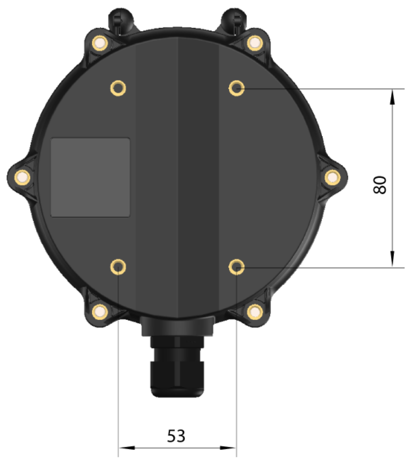

Figure 11.4. Dimensioned rear view

11.2 Mechanical Fittings

The following screws and seals are used on the ORB. Spare parts, if required are available from Senquip.

Location	Size	Length	Max depth	Fastening method
Screws				
Lid attachment	M5	To avoid hinge damage, only captive screws provided by Senquip are to be used.		3mm Allen key
Mounting	M5	8mm	9.5mm	3mm Allen key
PCB mounting	M3	10mm	10mm	T10 Torx key
Gland nut	AF24			
Seals				
O-ring	ID121 x 3mm	To maintaing the IP rating of the enclosure, only use o-rings that have been provided by Senquip.		
Gland	M20 x 1.5	To maintaing the IP rating of the enclosure, only use glands that have been provided by Senquip.		

11.3 Environmental

The ORB is designed for use in harsh outdoor environments and is suitable for use in industrial, mining, fleet and agricultural applications.

The enclosure is rated to IP67, meaning that it is dust tight, with no ingress of dust permitted and watertight against the effects of immersion of up to 1m for 30 minutes. The cable gland, when fitted with suitable wiring is rated at IP68.

The chart below describes IP ratings and how to interpret them.

Figure 11.5. IP number description

The ORB can be operated in temperatures between -40°C and 85°C however the internal Lithium-Ion-Polymer battery charging will be throttled at temperatures colder than -10°C and higher than 40°C.

An internal gore vent allows for pressure equalisation between the interior of the enclosure and the environment meaning that the ORB can be shipped in non-pressurised environments such as some aircraft.

11.4 Material Specification

The enclosure and all fittings have been chosen to be resistant to salt spray and common industrial chemicals such as petro-carbons. UV stabilised materials have been chosen to allow mounting in direct sunlight.

Component	Material
Enclosure and front cover	Glass filled nylon
Enclosure front cover seal	Nitrile Butadiene Rubber (NBR)
Captive cover screws	Stainless-steel (304)
Cable Gland	Polyamide
Gland insert	Nitrile Butadiene Rubber (NBR)
Optional Mounting plate	Stainless-steel (316)

Chapter 12

Maintenance

The ORB-X1 has been designed to require a minimum of maintenance. The only serviceable item is the internal LiPo backup battery.

12.1 Replacing the LiPo Battery

> CAUTION
> RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE.
> DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS.

It is expected that the LiPo battery will have an in service life of 5 years. Factors that will reduce the life are:

- Exposure to temperatures above 55°C or below -10°C.
- Unusually high number of charge / discharge cycles.
- Being left in a discharged state for an extended period of time.

Replacement of the LiPo battery should only be performed by suitability trained service personnel. Only LiPo batteries supplied by Senquip should be used. Senquip LiPo batteries contain temperature sensing and protection circuitry to ensure safe operation of the ORB.

Note Use of 3rd party batteries may cause damage to the unit and will void the warranty.

The LiPo battery is located under the battery holder plastics inside the ORB. To replace the LiPo battery, the following steps need to be completed:

- Un-fasten the 6 hex-head screws securing the cover using a 4mm hex bit. The screws are captive and will not fall out when loose. Do not attempt to remove the screws from the lid.
- Open the hinged lid by lifting the bottom of the lid toward yourself and up. When the lid is opened, an internal light detector will recognise the increase in brightness and will enable the LEDs and configuration switches.

Figure 12.1. LEDs and configuration switches.

- Remove the 4 AA batteries and if permanently powered, make sure that power to the ORB is switched off.
- Disconnect all wiring from the header.
- Remove the SIM card.

Figure 12.2. Remove the SIM card before opening.

Warning Failure to remove the SIM card before trying to remove the battery cover could cause mechanical damage to the SIM card holder.

- Remove the battery cover by removing the 4 Torx-head screws using aTorx T10 driver. Note that by removing the battery cover, sensitive electronics may be exposed. The AA battery terminals extend through the battery cover; care should be taken not to damage the terminals when removing the cover.

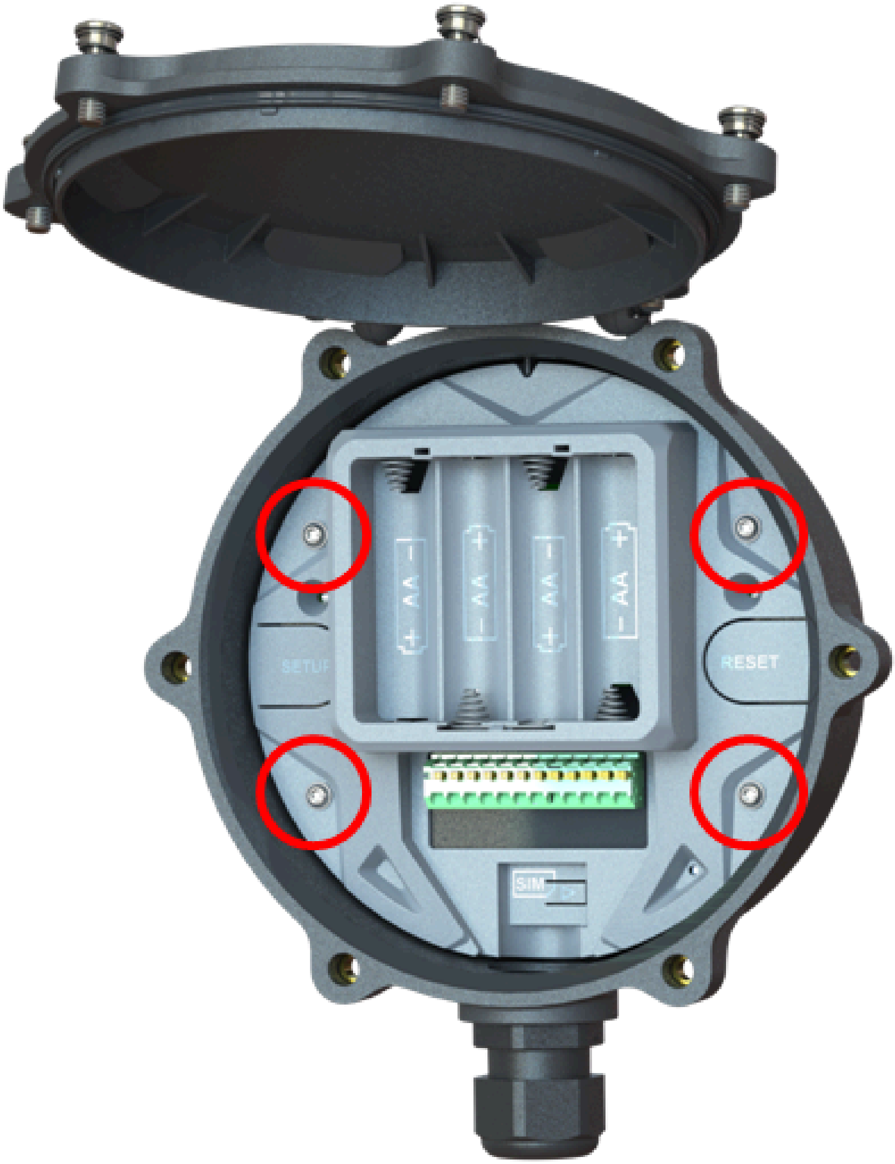

Figure 12.3. Removing the battery cover.

Warning Make sure that you do not expose the circuit board or components to static electricity.

- The LiPo battery is plugged into a polarised 3 pin JST connector. Gently remove the battery plug by pulling on the 3 wires, ensuring that the direction of pull is in-line with the connector.

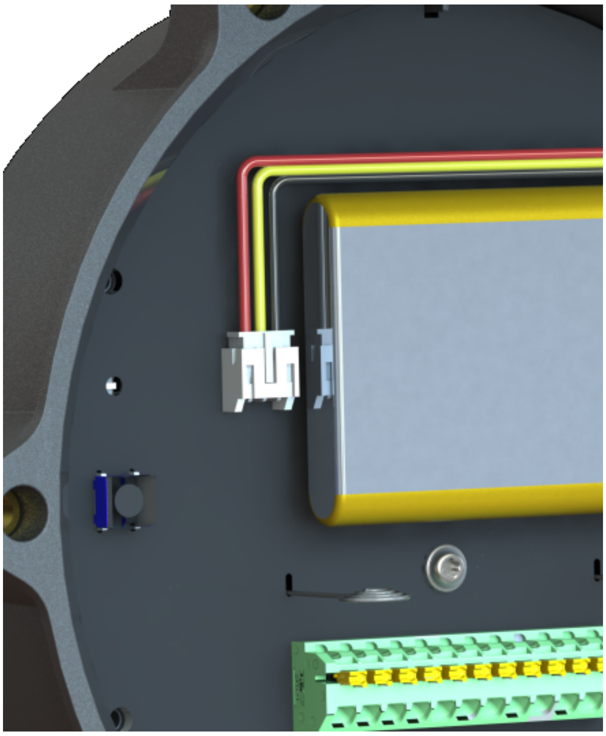

Figure 12.4. Orientation of Lipo Battery.

- Note carefully the polarisation of the 3-way battery plug and be sure to insert the replacement battery with the same polarity.

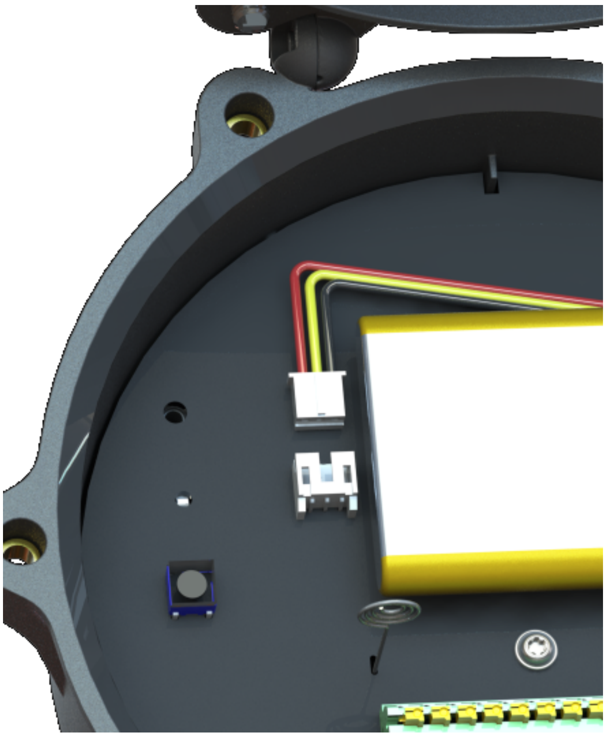

Figure 12.5. Battery plug removed.

- The LiPo battery is secured to the PCB with removable 3M double sided tape. To remove the battery, pull gently, ensuring that you do not damage the battery.
- Remove the old tape; new batteries supplied by Senquip will ship with replacement double sided tape.

Figure 12.6. Remove the old tape.

Note Used LiPo batteries can be dangerous and are harmful to the environment and should only be disposed of using an authorised disposal service.

- Reverse the above procedure to re-assemble the ORB.
- Press the Reset button to restart the ORB.

Chapter 13

Frequently Asked Questions

13.1 Introduction

This document is a collection of responses to questions that are commonly asked by new users of the Senquip telemetry devices. If you cannot find an answer to your question below, please contact us at support@senquip.com. Table of Contents

13.2 Senquip Portal

13.2.1 I created an account but did not get a confirmation email.

Almost certainly our confirmation email has been blocked by your company server or is in your junk or spam folder. We do see that approximately 2% of accounts are created with incorrect email addresses and so it is possible that you have eneterd an incorrect email address. If the problem persists, contact support@senquip.com and we will manually confirm your account.

13.2.2 Do I need a hosted subscription to remotely configure my device?

No. The purchase of a Senquip device entitles the owner to make configuration changes, perform firmware updates and view data using the Senquip Portal for the life of the device.

13.2.3 Do I need a hosted subscription to perform firmware updates?

No. The purchase of a Senquip device entitles the owner to perform firmware updates using the Senquip Portal for the life of the device.

13.2.4 Can I view data on the Senquip Portal for free?

Yes, you can view data on the Senquip Portal on a free basic plan. Updates to the Senquip Portal may be limited to 5 minute intervals and the data will not be stored for more than a day.

13.2.5 I cannot see historical raw data on the Senquip Portal.

If your device is on a free basic plan, Senquip will not store more than 1 day of historical data. Continuous backups of data storage becomes expensive so is feature of hosted plans where data will be saved for 2 years. Updating a device plan to hosted can be done on the Senquip Portal by using the subscriptions facility.

13.2.6 What payment mthods are available for Hosted Portal plans?

Payment methods vary by region and include Credit Card, Direct Debit, Google Pay, Apple Pay, and others.

13.2.7 Do I have to use the Senquip Portal to view my data?

Senquip devices can send measured data to any endpoint via UDP, HTTP, and MQTT. Data transfers can be secured through the upload of customer certificates to the device.

13.2.8 Can I completely disconnect from the Senquip Portal?

Yes. To stop sending data to the Senquip Portal, unselect the Send Data to Senquip Portal option in the endpoint settings. To stop configuration settings from the Senquip Portal unselect Configuration via Senquip Portal. Further settings updates will have to be done using the Senquip webserver.

13.2.9 Does Senquip have access to my data?

No. Unless you give a Senquip employee access to a device by giving them view, operator, user, or admin status, Senquip employees will not be able to view your data. Sometimes, you may give a Senquip employee access to your device so that they can assist you in setup. As an administrator, you can remove this access at any time.

13.2.10 Can I secure proprietary scripts?

Yes. You can use the lock feature on the Senquip Portal to lock scripts so that only you can access the content of the script.

13.2.11 I am getting a network error when I try to login to the Senquip Portal

The Senquip Portal requires accurate time to correctly secure your connection. If the time on your PC is out by more than a few minutes, you will get a network error. Correct the time on your PC and retry.

13.2.12 I have added a measurement in the settings, but the widget is not showing in the portal.

Browsers typically cache most of the elements in a webpage. Refresh your Chrome or Edge browser by: * Hold down Ctrl and click the Reload button. * Or Hold down Ctrl and press F5. Check that the widget has not been turned off in the portal display settings. To turn on (or off) a widget, press the eye icon on the device page and select which widgets you would like to show, and the order in which you want to show them. Remember to refresh your browser.

13.2.13 There are measurements missing in the data stored on the Senquip Portal.

When a Senquip device tries to connect to a network but cannot, it will retry several times and then discard the measured data and return to sleep. If you would like data to be stored when there is no coverage, select the Offline Buffer option in endpoint settings. If the transmit interval is different to the base interval, the measurement that coincides with the Transmit Interval is the one that will be sent. If you would like the measurements taken on every base interval to be stored, select the Batch Transmit option under general settings.

13.2.14 I have logged into the Senquip Portal but there is no data showing.

Measurements will only show on a device page in the Senquip portal once a device has published measurements to the portal at least once. When you receive a new device, it will be in freight mode, and it will not have published data to the Senquip Portal. Power the device to exit freight mode, configure the network settings and the device will start to publish data at the specified Base Interval.

13.2.15 I have changed a setting on the Senquip Portal, but the Senquip device has not changed behaviour.

When a setting is changed on the Senquip Portal, it is added to a queue that is stored until the device next makes contact. To see if a setting has been applied by a device, press the command queue button at the top of each settings page. Settings changes shown in green have been applied. For remote configuration using the Senquip Portal to be possible, the Configuration via Senquip Portal option must be selected in the endpoint settings.

13.2.16 I have many Senquip devices and I am struggling to identify them.

Once you have many devices installed, it can be difficult to identify which Senquip device is performing which function. It is highly recommended that each device is named using the Device Name setting when first installed and that devices are added to logical groups on the Senquip Portal. If a device has not been named and it needs to be identified, turn the GPS on to determine its location.

The columns on the device summary page can be customised to show key data for a group of assets. You may, for instance want to show fuel level, utilisation and alerts on the summary page.

13.2.17 How can I increase the number of users on a device?

Devices with hosted plans can have up to 50 users attached to each device. Take out a hosted plan by selecting the subscriptions button on the device summary page, or by contacting your distributor. For more detail on hosted plans, see: Hosted Plans.

13.2.18 How can I find the IMEI number for a Senquip device?

The IMEI number is available on the device diagnostics page for all mobile enabled devices.

13.2.19 How can I find the IMSI and ICCID number for the SIM in a Senquip device?

The IMSI and ICCID are related to the SIM in the Senquip device and will be available on the diagnostics page if a SIM is inserted and the SIM responds to the ICCID and IMSI request commands.

13.2.20 Is my data secure?

Yes. To ensure the highest levels of security, Senquip devices use a NIST validated, ultra-secure hardware crypto element for key and certificate storage and cryptographic processing. The crypto-element is pre-loaded with certificates for Amazon Web Services (AWS), allowing for immediate, out-of-the box, secure communication with the Senquip Portal. Users can load additional certificates to allow secure communications with other endpoints.

Data stored on Senquip device is encrypted using AES256 encryption.

13.2.21 Can I use symbols and characters as units on the Senquip Portal?

Yes. To use symbols like the degrees symbol (o) as in oC, create the text in an editor such as Microsoft Word or Notepad and copy it into the field in the Senquip Portal. Alternatively, use the alt code for the symbol you need, for instance, ALT 0167 for the °symbol.

13.2.22 I can't add a user to a device.

To add a user to a device, you must have administrator priveledges for that device. For a user to be added to the Senquip Portal, they must have activated an account on the portal. To add a user, from the device page, press the Users icon in the top right. Enter the email address with which the user has signed up to the Senquip Portal. Select the user permissions as Admin, User and Read. If the email address entered is not associated with an activated account on the Senquip Portal, an error will occur, and the user will not be added.

13.2.23 How do I change the payment details for my subscriptions?

You may want to change your payment method when, for instance, your credit card has expired and you need to add an updated version. To change payment details, login to the Senquip Portal and select the *Account* option at the top right to navigate to your account page. Select the *Billing Detail* option and then press the *Edit Billing Detail or View Invoices* banner. This will take you to the secure payment portal from where you can add payment methods by pressing *Add payment method* and delete payment methods by pressing the cross next to each payment method.

13.2.24 Where can I find copies of invoices for subscription payments?

Login to the Senquip Portal and select the *Account* option at the top right to navigate to your account page. Select the *Billing Detail* option and then press the *Edit Billing Detail or View Invoices* banner. This will take you to the secure payment portal where invoice history can be seen at the bottom of the page. Click on an invoice to open the details of that invoice and to download a copy.

13.2.25 Will I get a warning from Senquip before my hosted plan expires

Yes, you will get an email reminder 30 days and 5 days before your hosted plan expires. Please make sure to add Senquip to your trusted email address list to avoid the remiders going into your junk or spam folders.

13.2.26 How much data can I download?

Each *Raw Data* download is limited to 50MB. For more data, it is recommended to use the API.

13.2.27 Sorting of my *All* group is only sorting the first 10 entires.

The sort functionality is limited to the first page when the *All* category is chosen. This is to prevent delays when a users has hundreds of devices in theit *All* group. Create your own groups to execute the sort function correctly.

13.3 Network

13.3.1 I have inserted a SIM card, but the device is not connecting to the network.

Senquip devices that use 4G networks need to be configured with an Access Point Name (APN). The APN is unique to each mobile service provider and should be known by the provider of the SIM. Sometimes a username and password are also needed for a SIM. To configure SIM settings, use the device network settings page.

Later versions of firmware for Senquip devices include a feature called Auto-APN. With Auto-APN, the Senquip device reads data off the SIM and searches a database to try and find a suitable APN. If successful, the Senquip device will connect directly to the network.

Senquip produces devices for 4G LTE CAT-M1 and 2G, 3G, 4G CAT-1 networks. CAT-M1 is a newer protocol supported by most networks and deliveres extended range from a given 4G tower. Make sure that the 4G network that you are using supports CAT-M1, sometimes referred to CAT-M.

13.3.2 What is Auto-APN?

Later versions of firmware for Senquip devices include a feature called Auto-APN. With Auto-APN, the Senquip device reads data off the SIM and searches a database to try and find a suitable APN. If successful, the Senquip device will connect directly to the network.

13.3.3 My APN is not on the list of Auto-APN options.

If you have a SIM card for which Auto-APN does not work, please contact support@senquip.com to have your service provider details added.

13.3.4 Why does Senquip prefer to operate on the 4G LTE CAT-M1 network?

Senquip supports 2G, 3G, 4G, and 5G LTE networks. We prefer to use the 4G and 5G LTE CAT-M1 service where available.

3G networks are being turned-off in many counties including Australia and New Zealand from 2020. 4G and 5G networks are capable of very high-speed data transfer that is not required for IoT devices. The designers of the networks realized this and introduced IoT specific services NB-IoT and CAT-M1. These services use lower power and achieve extended ranges, meaning longer battery life and better coverage in buildings and remote areas. Senquip prefers 4G and 5G CAT-M1 over NB-IoT as the prior has data rates that allow for in-field updates and the technology allows roaming between towers in mobile applications.

13.3.5 I cannot see my Senquip device on my local Wi-Fi network.

If you know a Senquip device IP address on your local Wi-Fi network, then you can login to the device webserver provided it is active. The webserver will only be active in setup mode unless the *Web Server* option has been selected in general settings.

The webserver will be inactive if the Senquip device is sleeping, to prevent the device sleeping, select the *Device Always On* option in general settings.

The webserver will be disabled if 4G communication options have been chosen as it is a significant security risk to leave the webserver active when operating on an open network.

13.3.6 I am not sure if my Wi-Fi network is reliable enough.

Wi-Fi networks can be affected by the number of transceivers, the geometry of the site and the way in which a Senquip device is mounted. To receive information of the quality of the connection made by a Senquip device, enable the Report Network Info option in endpoint settings. You will be able to map network coverage using this feature.

13.3.7 What SIM card should I use?

Senquip devices use a Micro SIM. The SIM can be either 1.8V or 3.3V. The SIM needs to be for an operator that supports either a CAT-1 (-H devices) or CAT-M1 (-G devices) network. Nano SIMs with adapters should not be used as the SIM card can become loose in the carrier, damaging the SIM holder.

For volume applications, Senquip can provide devices with SIM cards that are soldered to the PCB during manufacture. Soldered SIMs are more reliable in high vibration environments.

13.3.8 Why does Senquip not allow the webserver to be on when operating on an LTE network?

When a Senquip device is operating on a public LTE network, it will receive an IP address that is open to the internet. If the webserver is enabled, the device may be exposed to malicious attacks by automated *bots* that will try to break the password and gain access to the Senquip device. By turning off the webserver, the risk of attack is eliminated.

13.3.9 I have been using the hotspot on my phone to test Senquip devices and it is not working anymore.

The Wi-Fi Hotspot feature available on most smartphones is typically limited to between 3 and 5 active device connections. Once this limit is reached, the smartphone will not allow further devices to connect. We note that one some newer smartphones, this limit has been increased to 10. We also note various work arounds to increase this limit.

13.4 GPS / GNSS

13.4.1 Is the Senquip GPS compatible with other GNSS networks?

Yes, the Senquip GPS will receive data from GPS, GLONASS, Bei Dou, Galileo, and QZSS satellites. Senquip uses the term GPS instead of the more correct GNSS because it is more commonly understood.

13.4.2 I have enabled GPS but I am not seeing any GPS data.

To provide GPS data such as position, and speed of satellites, Senquip devices needs to connect to satellite constellations. Ensure that the device is mounted in a location where the device has a clear view of the sky, not through metal. Ensure that the device is mounted with the cable gland down.

In poor reception areas, the device may require additional time to acquire satellite data. Try increasing the GPS Max Time to 240 or even 360 seconds in poor reception areas.

13.4.3 Can I attach a GPS or 4G antenna to my Senquip Senquip device?

No. The Senquip Senquip device has all required antennas internal to the device. This has been done specifically as Senquip Senquip devices are expected to be used in harsh conditions where antennas would be damaged. If you need an external antenna, please use a Senquip QUAD.

13.4.4 How accurate is the GPS on my Senquip device?

With a clear view of the sky, the position accuracy of the GPS is better than 2.5m 50% of the time, and better than 5m 95% of the time.

GPS position accuracy depends on many factors such as the mounting position, orientation, visibility of the sky, weather conditions and time of day. The best position accuracy will always be obtained when the Senquip device is mounted vertically in a position where it has a clear view of the sky. To enhance GPS position accuracy, the Senquip devices track GPS, GLONASS, Bei Dou, Galileo and QZSS satellites.

13.5 Measurements

13.5.1 My Modbus readings are failing regularly on RS485.

RS485 networks require 120 Ohm termination resistors at each end of the main run of the network. Turn on the *Termination Resistor* in *Serial* settings.

13.5.2 My CAN bus data is sometimes corrupted.

CAB Bus networks require 120 Ohm termination resistors at each end of the main run of the network. Ensure that 120 Ohm resistors are in place on your network.

13.5.3 I sent a CAN message and it is spamming the bus.

The CAN protocol will automatically resend CAN messages if they are not acknowledged by a device on the network. Ensure that there is a second CAN device on the network.

13.5.4 I'm powering a Modbus device from a current source on a Senquip device but it takes a while to boot.

Newer firmware versions on SFW002 and greater will delay Modbus reads until the *Start Time* on the Source or IO pin has elapsed. This allows time for externally powered Modbus and other sensor to boot or stabilise measurements.

13.5.5 Modbus float values are only to 2 decimal places.

By default, the Modbus periperal sends float values with 2 decimal places of precision. To increase this, use the calibration option. For instance, 1.23456V will be dispatched as 1.23V without calibration and 1234.56mV with calibration (0-1 in gives 0-1000 out). If, in the example, you have to have the result shown in Volts, use a script to dispatch the scaled version with the required number of decimal places.

13.6 Power

13.6.1 Do I need to add AA batteries as a backup in a solar installation?

No. Senquip devices have an internal LiPo battery which, in most solar applications, will be sufficient to power the device during the night and in low sunlight conditions. In low power configurations, the internal LiPo battery can power a Senquip device for months. Use the battery calculator on the Senquip website to estimate how long the internal battery will power your solar setup.

Senquip devices report the internal LiPo battery voltage. It is recommended that the LiPo battery be monitored for a while after a solar install to ensure it is being sufficiently charged by the solar panel.

AA batteries are only required in applications where there is no permanent or solar power available. They can be added as an additional backup when using permanent or solar power.

13.6.2 I am running on solar and am losing data at night and on cloudy days.

It is likely that your solar panel is not supplying enough energy to power your application and charge the Senquip device internal LiPo battery. Monitor the LiPo battery voltage on the Senquip Portal. A charged battery will reach approximately 4.2V. A low battery is below 3.5V.

The simplest way to extend battery life is to increase the Base Interval in general settings.

13.6.3 How can I extend battery life on my Senquip device?

A Senquip Senquip device should be able to last for many years running on AA batteries. To estimate the life of your device, see the battery calculator on the Senquip website. For low power installations such as solar and battery installs, to save energy, consider the following:

- Increase your Base Interval. In applications where measured data is not changing quickly, you may be able to increase the base interval. A longer base interval means that the Senquip device spends more time sleeping between measurement intervals and so saves energy.
- Increase your Transmit Interval. In some applications you may not need every measurement that is taken to be reported but are more interested in receiving an alert when a warning or alarm condition occurs. In these cases, increase the transmit interval so that data is not transmitted on every measurement interval. Once a day measurement may be enough.
- Turn off peripherals that are not needed. If you are not using the serial port, GPS or other peripheral, make sure that they are turned off.
- Reduce the interval of peripherals. A Senquip device mounted on a pole is unlikely to move. One GPS update a day may be sufficient. The GPS, serial and current sources are the most power-hungry peripherals, use them sparingly.
- Consider using voltage sensors instead of current sensors. Sensors like liquid level sensors are often available in current or voltage versions. A 4-20mA sensor will draw 20mA at full scale whereas a voltage version may only draw 1mA. Where using the serial and current sensors, reduce the wait times before measurement and before returning to sleep.
- Make sure that the device is not always on, and that the webserver is off.

- Under endpoint settings, do not send human readable time and network info. The smaller the set of data you send, the lower the power of your device. Send to a single endpoint if possible.
- Senquip is constantly working on code improvements to reduce the power of devices. Make sure that your device is running the most recent firmware version.

13.6.4 I wired my Senquip device incorrectly; have I damaged it?

Senquip devices have protection against the most common wiring faults like reversing the voltage. There are some inputs such as the serial, current sense and thermocouple inputs that can be damaged if connected to supply voltages.

13.6.5 Do I need a fuse in-line with the power supply of my Senquip device?

It is always a good idea to include a fuse in the supply to any electronic device. A 1A fuse would be a suitable size for use with the Senquip device.

13.6.6 I have opened my Senquip device, and the lights are not on.

Your device is most likely sleeping; this is good as it conserves power. The lights will come on when the device next wakes for a measurement cycle. If you want to access the device immediately, press the setup button to access the device webserver or press reset to initiate a re-start that will trigger a measurement cycle. If you want to be able to access your device to make settings changes at any time, select the *Always On* option in the general settings.

13.6.7 The device that I am setting up via the webserver keeps switching off.

The device webserver is activated by pressing the setup button and then connecting to the device Wi-Fi. The device will exit the webserver when settings are saved and it executes a reset, when the lid is closed or when no activity is detected for a few minutes. To ensure that the webserver does not close-down when you are configuring a device, make sure that you do not cover the device light sensor and that you are not inactive for extended periods of time.

13.6.8 Can I use AA NiCd batteries in my Senquip Senquip device?

NiCd batteries are generally rated at 1.2V. Although the Senquip device will operate from 1.2V batteries, they will not last very long. It is recommended to use high quality Alkaline or Lithium batteries. For longest life, use 1.6V or 3.6V lithium batteries.

13.6.9 Can I use 3.6V lithium batteries in my Senquip Senquip device?

Yes. 3.6V Lithium Thionyl Chloride batteries are generally the longest lasting when used with a Senquip Senquip device. The improvement in life is however small when compared with lower cost Lithium Energizer and other brand batteries that are widely available.

13.6.10 How long will the internal LiPo battery in the Senquip device last?

The lithium battery is expected to last 5 years without significant degradation. The life of the battery may be reduced if it is exposed to temperatures above 55°C or below -10°C, if it experienced an unusually high number of charge/discharge cycles or if it is left in a discharged state for an extended time. Spare LiPo batteries can be sourced from Senquip and can be replaced by a qualified technician.

13.6.11 I have received my Senquip device, pressed the setup button and nothing happens.

When Senquip devices are shipped, they are placed in freight-mode to preserve the internal battery and to prevent the device from transmitting when being transported. To exit shipping mode, apply power or insert batteries.

13.6.12 How long can I run my Senquip device off AA batteries?

To achieve maximum life, use high quality Lithium batteries such as Ultimate Lithium from Energiser. Battery life will depend entirely on your application, the rate of measurement, transmissions and the types of sensors attached. As a guide, if your Senquip device was to be left sleeping, it could achieve up to 10 years of life. In a typical battery powered application, where the Senquip device is communicating over GSM, with once per hour updates, the Senquip device can be expected to last 2 years on a set of batteries. The Senquip device can be configured to monitor its batteries and report low battery conditions.

Use the battery calculator available on the Senquip Portal to estimate the battery life of your system.

13.6.13 Why is my AA battery voltage reading lower than I expect?

If you have inserted four 1.5V AA batteries into your Senquip Senquip device, you would expect the battery voltage shown on the portal to be 6V. It may sometimes instead show 5.5V. There is internal resistance in your battery so that when current is drawn from it, the measured voltage drops. If, for instance, the Senquip Senquip device was drawing energy from the AA batteries to charge the internal battery when a measurement was made, the measured battery voltage would be slightly lower than 6V. There is also a small amount of protection circuitry between the battery and the measurement circuit and again, we would expect a small drop across this circuitry.

13.6.14 I haven not used my device for a while, and it is taking a long time to make a first connection.

If you leave a device unpowered for an extended time and you have set the Senquip device in a high-power mode by for instance setting a fast update rate, the internal LiPo battery will have run flat. When the Senquip device first receives power, it evaluates the internal LiPo battery and if it is found to be extremely flat, the Senquip device will pre-condition the LiPo before resuming normal operation. If you open the lid during pre-conditioning, you will see the green light pulsing slowly during pre-conditioning.

13.6.15 How do I make a Senquip device safe for shipping?

Put the device in freight mode. In freight mode, the battery drain is reduced to almost zero and all transmitters are turned off. Enable freight mode via the webserver, on the Senquip Portal in the Admin page, or from setup mode by pressing the setup button 3 times.

The device will exit freight mode when power is applied or batteries are inserted.

13.6.16 Will my ORB enter hibernate mode if AA batteries are installed

Yes, hibernate mode, if enabled, is triggered when the supply voltage drops below 9.5V whether the device is powered with AA batteries or not. Hibernate can be disabled in the *General* settings.

13.7 Setup

13.7.1 If I perform a factory reset, will I lose my settings?

Yes. A factory reset will remove all your settings including your network settings. After performing a factory reset, you will need to connect to the device via the internal webserver to re-establish an internet connection.

13.7.2 I performed a factory reset and I cannot remember a setting.

Go to the settings page for the device and open the command queue at the top of the page. You will be able to see a log of previous settings applied to the device.

13.7.3 If I perform a firmware update, will I lose my settings?

No. Performing a firmware update preserves your settings. If the firmware update introduces new settings, these will be set to the default value. Note that updates to major firmware revisions may reset some variables such as non-volatile variables used in scripts and hour meters.

13.7.4 Can I save my settings to a file?

Yes. You can export your settings, scripts and Senquip Portal settings to a file using the export settings option in the admin settings. Before exporting your settings, you will need to use the Request Device Settings option to get the latest settings from the Senquip device.

13.7.5 Can I save settings to another device?

Yes. Use the Import Settings option in the admin settings to import settings from another device.

13.7.6 I have lost my password, what can I do?

If you have lost the original device password, please contact support@senquip.com who will assist you in recovery.

If your device is connected to your Senquip Portal account, you can continue to view device data and make configuration changes. If you have changed your password, and have forgotten your new password, a factory reset will restore the original device password.

13.7.7 How long does a firmware update take?

The time taken to perform a software update depends on the network type chosen and the signal strength of the connection. A typical update over Wi-Fi will take 5 minutes and an LTE update will take 15 minutes. The orange light will flash during the update process. If the upload is interrupted, it will need to be restarted. A failed firmware upgrade will not harm the Senquip device.

13.7.8 If a firmware update fails, will my Senquip device be harmed?

No. If a firmware update fails, your Senquip device will not be harmed. The Firmware update will need to be restarted.

13.7.9 My device is not accepting a firmware update.

In some instances with short base intervals and lots of data being transmitted, the Senquip device may not have the capacity to process a firmware update. In this instance, reduce the base interval to 60 seconds and then apply the firmware update. Once complete and with the device reporting the new firmware version, change the base interval back to the required rate.

13.7.10 How can I force a Senquip device to accept a change made on the Portal if it is sleeping?

Since the device will not contact the Senquip Portal during sleep, no changes can be made until the next transmit interval. To force a device to make immediate contact, press the reset button. After reset, contact is made with the Senquip Portal, and any outstanding settings will load. This is most useful when you have set a long sleep period and want to test a quick change before deployment.

13.7.11 I have enabled the webserver in *General* settings but I loose contact with it every few minutes.

The webserver will be terminated when the device enters sleep mode between measurement cycles. To keep the webserver on, select *Device Always On* in the *General* settings.

13.7.12 Android phone will not stay connected to device webserver.

Phones always attempt to connect to the best available Wi-Fi network. Since the Senquip device hotspot does not have internet access, it is not considered a good network and the phone switches to an alternate network. This behaviour can be disabled on Android phones by accessing Wi-Fi settings >> Intelligent Wi-Fi and turning off the option to *Switch to Better Wi-Fi Networks*.

13.8 Operation

13.8.1 Is the time on my Senquip device accurate?

Yes. At boot, the Senquip devices connects to an available network and queries time from an NTP server such as Google NTP. If an NTP server is not available, the device will try to retrieve time from the LTE network and failing that, from the device GPS.

13.8.2 How often is time synchronised on a Senquip device?

Senquip devices renew their time sync every 6 hours. Time between refresh is maintained by a crystal derived source in the device.

13.8.3 Why does the first measurement after a reset take longer?

After a reset, a Senquip device needs to load the operating system into memory, configure itself and load user settings. This can take a few seconds.

13.8.4 My device does not go to sleep between measurement cycles.

The minimum time between cycles that warrants the device going to sleep depends on the network settings and peripherals enabled. For instance, if you have GPS enabled and a base interval of 1 minute, the device will not go to sleep because it would likely take longer to re-acquire sattelites than the 1 minute sleep time. These are the minimum base interavals that will allow the device to go to sleep:

Parameter	Specification
Operating on Wi-Fi	10 seconds
Operating on LTE	120 seconds
GPS enabled	180 seconds (or the *Max Time* specified in *GPS* settings)

13.8.5 When my device wakes from hibernate, will if perform measurements before returning to sleep?

Yes, waking from hibernate is considered a normal measurement cycle and all enabled measurements will be performed. If, in a script, a timer is enabled for a future time, the device will not wait for that timer to trigger before returning to hibernate.

13.9 Scripting

13.9.1 Does my script run in the Senquip Portal?

No. Your script will run on the Senquip device in field. This means that your script will continue to execute even if your device loses contact with the network.

13.9.2 How do I get access to scripting?

Administrators of devices have access to device scripting.

13.9.3 I cannot see the scripting icon on the device page.

To request access to scripting you need to be an administrator for the device.

13.9.4 How can I tell if there is an error in my script?

Limited error detection is available real-time in the scripting page. For feedback on why a script that looks ok in the editor has failed, turn on Send Errors in the scripting window. Errors will show up as script events in the events widget on the device page.

13.9.5 My script looks ok in the editor but is failing to run.

The most common source of problems with scripts is the use of JSON keys that do not exist. If, for instance, GPS speed is used in a script, but the GPS loses satellite lock, the GPS speed key will no longer be available. When the script tries to use GPS speed, the script fails. Use a function like if ((typeof obj.analog1 === "number") to check that a variable exists and is of the correct type before using it.

13.9.6 If my script fails, with my Senquip device fail?

Maybe. In general, if a script fails to end correctly, the script will terminate, and the device will continue to run. Scripting is an advanced feature, and an incorrectly written script can cause a Senquip device to fail or even brick a device. Read the scripting guide carefully before committing a script.

13.9.7 My script looks ok, but I get a calling non-callable error.

Your script may be trying to use a function that is not available in the version of firmware that you are using. Update to the latest firmware version before using scripting.

13.9.8 Can I perform bitwise operation in a script.

Yes, see the application note on bitwise operation.

13.9.9 I'm not seeing the latest script that is loaded in my device.

Empty the cache on your browser. You may need to enable developer tools and do a hard reload of your cache (In Google Chrome, enable developer tools, right lich on the refresh icon).

13.9.10 Does a device factory reset erase my script?

Yes, all settings are reset to defaults including wiping of your script.

13.9.11 Can you dispatch custom variables from within a timer function?

Yes, this functionality has been added to newer firware versions of SFW002 and higher.

Glossary

jubilee-clips
A Jubilee-clip, also known as a hose clamp, is used in conjunction with the supplied brackets when pole mounting the ORB-X1.

certificate-authority
A certificate authority (CA) is a trusted entity that issues digital certificates, which are data files used to cryptographically link an entity with a public key. Certificate authorities are a critical part of the internet's public key infrastructure (PKI) because they issue the Secure Sockets Layer (SSL) certificates that web browsers use to authenticate content sent from web servers.

ASCII
American standard code for information interchange. Developed by American National Standards Institute (ANSI), it is the most common code used by computers to translate text (letters, numbers, and symbols) into a form that can be sent to, and understood by, other computers and devices such as modems and printers.

LTE-M1
LTE Cat M1 is a low-power wide-area (LPWA) air interface that lets you connect IoT and M2M devices with medium data rate requirements (375 kb/s upload and download speeds in half duplex mode). It enables longer battery lifecycles and greater in-building range, as compared to standard cellular technologies such as 2G, 3G, or LTE Cat 1

3G & 4G
3G was the first "high speed" cellular network, and is a name that refers to a number of technologies that meet IMT-2000 standards. 4G is the generation of cellular standards that followed 3G, and is what most people use today for mobile cellular data. You can use 3G and 4G for IoT devices, but the application needs a constant power source or must be able to be recharged regularly.

MODBUS
Modbus RTU is an open, serial (RS-232 or RS-485) protocol derived from the Master/Slave architecture. It is a widely accepted protocol due to its ease of use and reliability. Modbus RTU is widely used within Building Management Systems (BMS) and Industrial Automation Systems (IAS). This wide acceptance is due in large part to MODBUS RTU's ease of use.

JSON
JavaScript Object Notation (JSON) is a standard text-based format for representing structured data based on JavaScript object syntax. It is commonly used for transmitting data in web applications (e.g., sending some data from the server to the client, so it can be displayed on a web page, or vice versa).

NIST
The National Institute of Standards and Technology (NIST) is a physical sciences laboratory, and a non-regulatory agency of the United States Department of Commerce. Its mission is to promote innovation and industrial competitiveness. NIST's activities are organized into laboratory programs that include nanoscale science and technology, engineering, information technology, neutron research, material measurement, and physical measurement.

LiPo
A lithium polymer battery, or more correctly lithium-ion polymer battery (abbreviated as LiPo), is a rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid electrolyte.

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