Standard Operating Parameters

IIoT Gateway Satellite (Swarm)

Bruce Trevarthen
Document Author
Last Revised: 31/05/2022
Document Version: 1.1

FreeWave Technologies
5395 Pearl Parkway
Boulder, CO 80301, USA

Document Information

FreeWave Technologies, Inc
Bruce Trevarthen (“Document Author”)
5395 Pearl Parkway, Boulder, CO 80301, USA
Email: support@freewave.com

Revision History

Date	Revision Notes	Version
11-APRIL-2022	Baseline	DRAFT 2
13-APRIL-2022	Internal Review	DRAFT 3
14-APRIL-2022	First Public Release	1.0
30-MAY-2022	Minor updates and brand formatting	1.1

Terms and Conditions

Table of Contents

Introduction

This document seeks to define the standard operating parameters of the IIoT Gateway Satellite (Swarm) device, and associated sensor attachments where applicable. The intended audience of this document is anyone looking to better understand the mechanical attributes of the satellite Gateway, including Radio Frequency (RF) characteristics and considerations for non-standard installations.

FreeWave Summary

FreeWave is a Colorado based wireless electronics innovator with a proven track record of problem solving using the latest in electronics and communications capabilities.

The FreeWave ecosystem includes the ModuSense Data Portal, a framework of modular technologies for industrial-grade data gathering and analysis purposes. Data is aggregated into the ModuSense Data Portal, specifically designed for time-series based data and dynamic enough to cope with the addition of new sensors on-the-fly. From within the ModuSense Data Portal customers can view and manipulate data in real-time using the Dashboard tools, or retrieved programmatically using Webhooks, MQTT or the API.

References and Terms

FreeWave, means FreeWave Technologies, Inc, a private company based in Boulder, Colorado, USA.

GPS, means the use of tracking of GPS+Glonass, GPS+Beidou or GPS+Galileo satellite system combinations to deliver positioning and accurate time information for use within the FreeWave products.

Swarm, means Swarm Technologies, Inc. A private company operating Low Earth Orbit (LEO) satellite constellation for communications with Internet of Things devices.

Units and Measurements

- Dimensions are in millimetres (mm) unless otherwise stated.
- Weights are in kilograms (kg) unless otherwise stated.
- Distances are in metres (m) unless otherwise stated.

Device Summary

The IIoT Gateway is central to any FreeWave deployment, providing both direct-attached sensors as well as Bluetooth aggregation for dozens of near-by nodes. The Gateway comes in numerous variants, supporting different backhaul carrier options and power requirements.

Identifier	Value	Description
Product Name	IIoT Gateway Satellite (Swarm)	The human readable reference for the product, up to 40-characters in length.
Product Name Part A	IIoT Gateway	The baseline product.
Product Name Part B	Satellite	Specific designation that this is a Satellite connected device versus LTE (Cellular) as an example.
Product Name Part C	(Swarm)	The specific carrier method used in this device. For satellite providers this will reference the network name.
Model Code / SKU	CM.S2.V1	A unique part number reference to be used when ordering the device, it includes only the major hardware revision number whereas the serial number will include sub-variants
Serial Number	CM.S2B.1.1.0-N00000x	A unique 21-character code that references the product model, hardware revision and serial number.
GS1 Barcode	09421033840028	The unique barcode for the device, with a GS1 product classification of 10005661.
Harmonised Commodity Code	8517.62.0090	The Harmonised System is a standardized numerical method of classifying traded products, used by customs authorities globally.
Net Weight	2.6kg	Weight of the device when removed from packaging, fully assembled. Without any additional brackets or shield panels.
Gross Weight	3.0kg	Weight of boxed product ready to ship. Not including any sensors, and without any additional brackets or shield panels.
Box Size	330 x 400 x 105 mm	The external dimensions of the package
Box Volume	0.013860 m3	The cubic meter volume of the package ready to ship

Physical Characteristics

In order to satisfy the requirements of industrial deployments, rugged environments and harsh weather conditions, the IIoT Gateway has been built using the highest quality materials and components. Fit-for-purpose and ready-to-deploy.

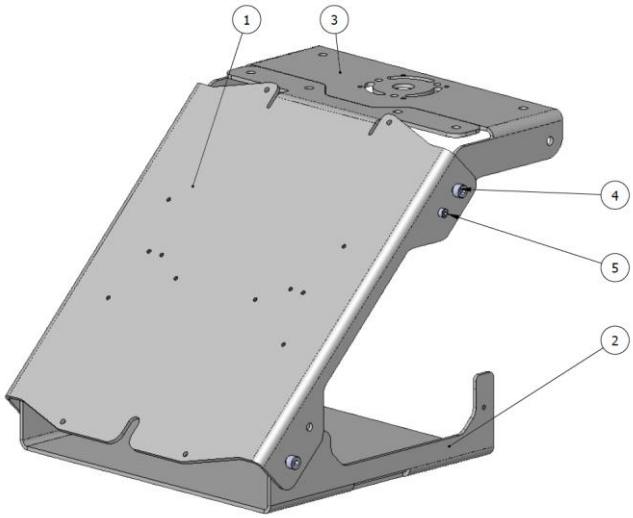
Physical Product

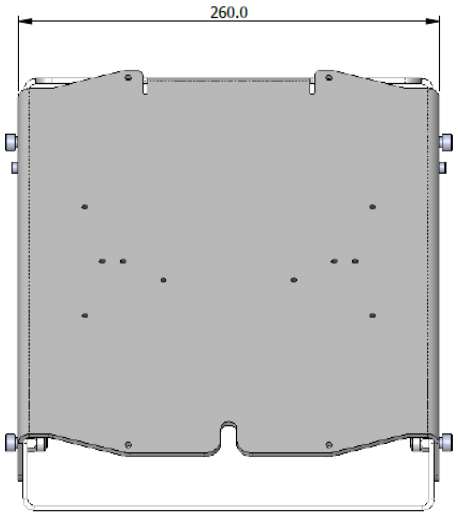
Note, actual product may vary slightly (antenna position and dust cap usage)

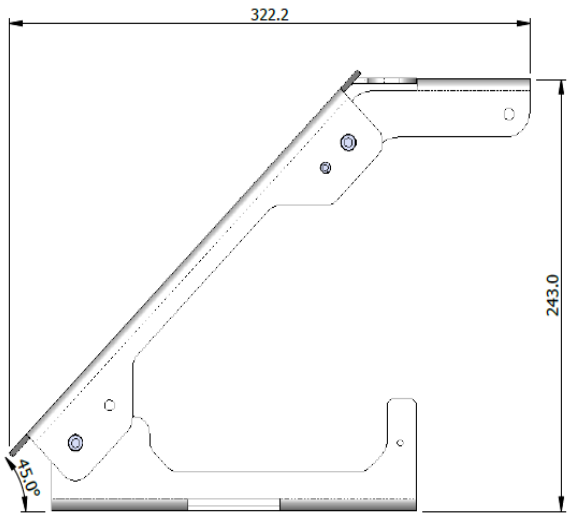
Flat Mount, No Shields

The following diagram shows the metalwork in the default configuration, ready for deployment on a flat surface horizontal to the ground and without protective shields. The optional single-sensor bracket is also shown fitted in this example.

1. Main solar panel mounting plate. Shown here without the solar panel. The Gateway electronics mount to the rear.
2. Standard base plate. Shown here attached to the bottom of the solar panel mounting plate for flat surface deployment.
3. Optional single sensor bracket. Designed to hold a wide range of sensors for self-contained assembly deployments.
4. M6x20 Stainless Steel Hex Cap Screw. (4 in total on this assembly as shown).
   Primary fitment bolt for the optional single sensor bracket.
5. M4x10 Stainless Steel Hex Cap Screw. (2 in total on this assembly as shown).
   Locking pin for the optional single sensor bracket to provide leverage strength.



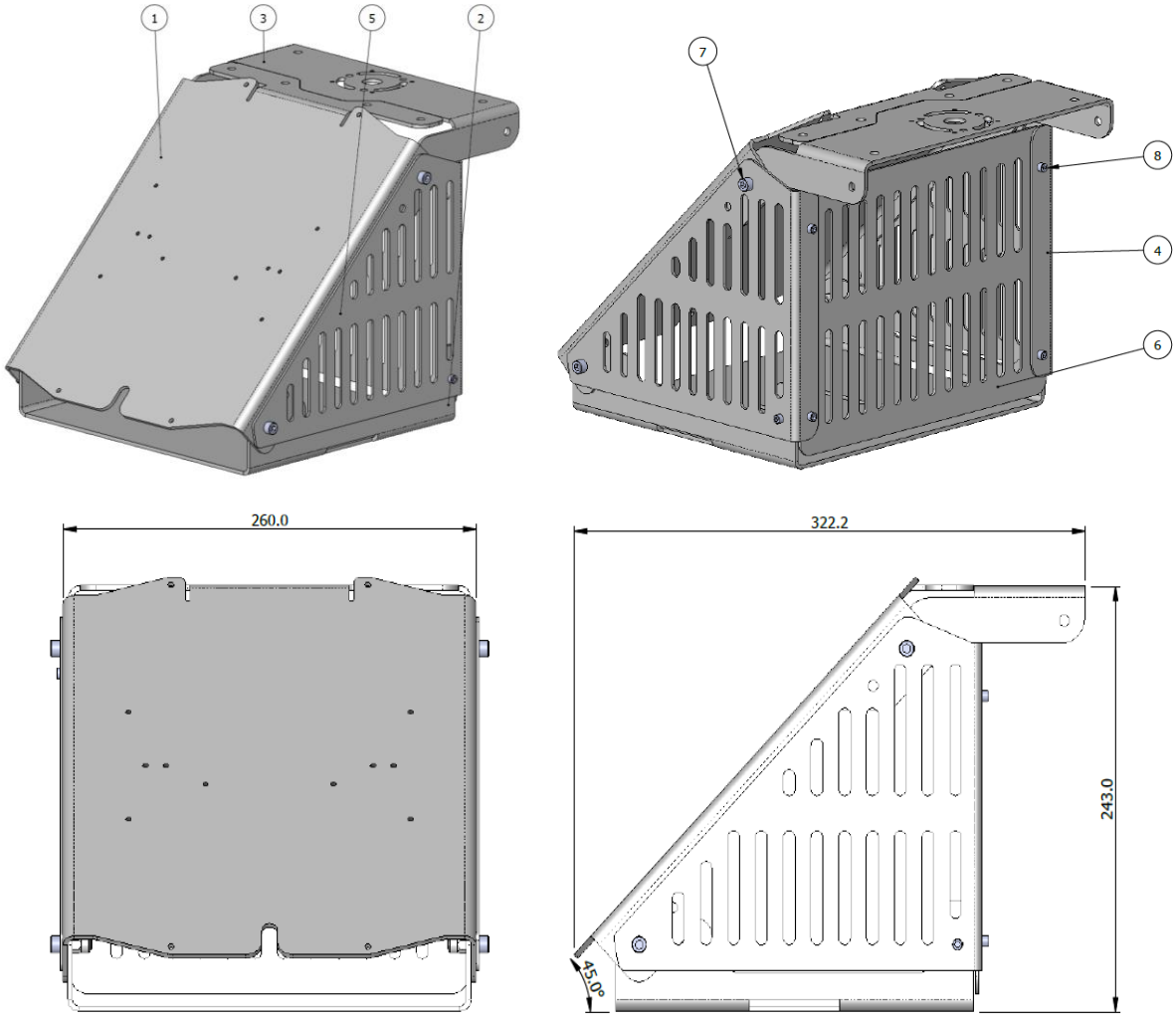




Flat Mount, with Shields

The following diagram shows the metalwork in the default configuration, ready for deployment on a flat surface horizontal to the ground but with the optional protective shields fitted. The optional single-sensor bracket is also shown fitted in this example. (Shield Kit SKU: P.PCK.STD)

1. Main solar panel mounting plate. Shown here without the solar panel. The Gateway electronics mount to the rear.
2. Standard base plate. Shown here attached to the bottom of the solar panel mounting plate for flat surface deployment.
3. Optional single sensor bracket. Designed to hold a wide range of sensors for self-contained assembly deployments.
4. RH Side Shield Support. A mirror of the LH side (not interchangeable).
5. LH Side Shield Support. A mirror of the RH side (not interchangeable).
6. Shield back plate.
7. M6x20 Stainless Steel Hex Cap Screw (4 in total on this assembly as shown).
8. M4x10 Stainless Steel Hex Cap Screw (6 in total on this assembly as shown).

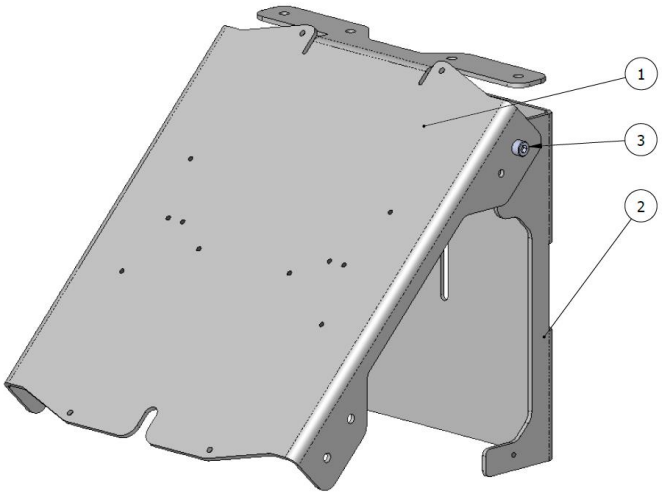


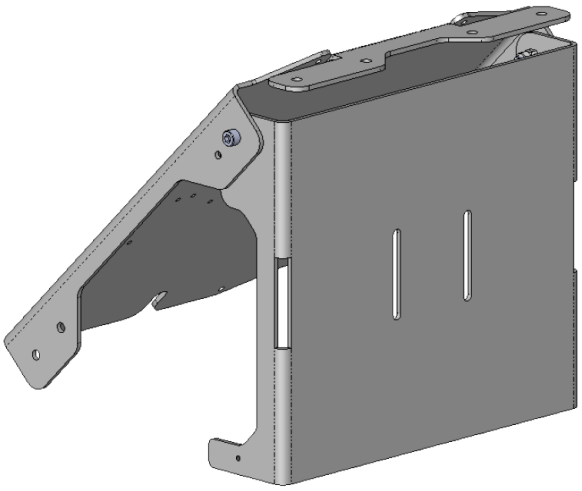
Pole Mount, No Shields

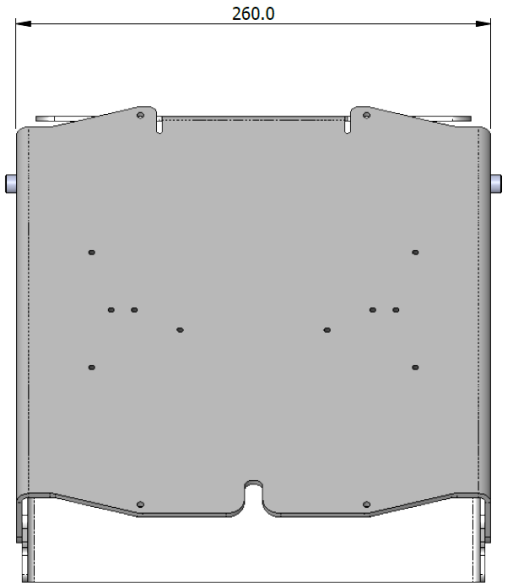
The following diagram shows the metalwork in the pole-mount configuration, ready for deployment on a pole or flat post perpendicular to the ground and without protective shields.

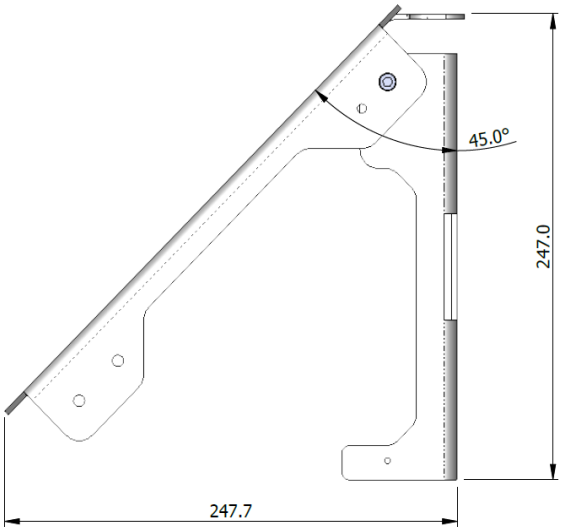
Note, the optional single-sensor bracket cannot be fitted in this deployment configuration.

1. Main solar panel mounting plate. Shown here without the solar panel. The Gateway electronics mount to the rear.
2. Standard base plate. Shown here attached to the top of the solar panel mounting plate for pole-mount deployment.
3. M6x20 Stainless Steel Hex Cap Screw. (2 in total on this assembly as shown).









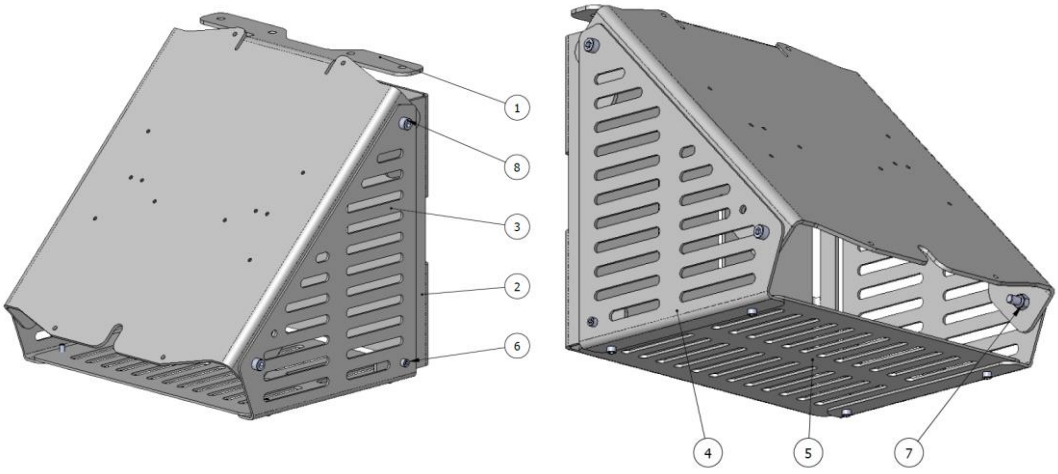
Pole Mount, with Shields

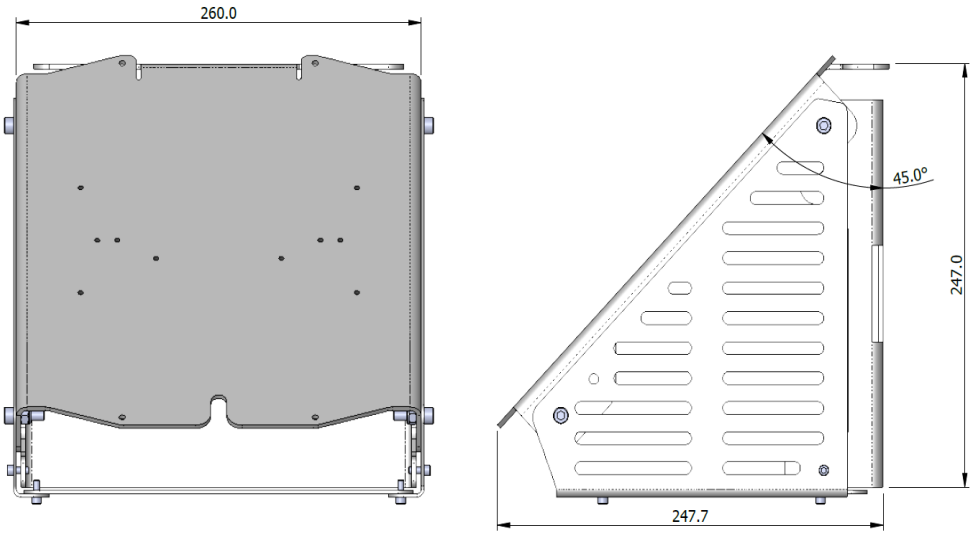
The following diagram shows the metalwork in the pole-mount configuration, ready for deployment on a pole or flat post perpendicular to the ground but with optional protective shields fitted.

(Shield Kit SKU: P.PCK.STD)

Note, the optional single-sensor bracket cannot be fitted in this deployment configuration.

1. Main solar panel mounting plate. Shown here without the solar panel. The Gateway electronics mount to the rear.
2. Standard base plate. Shown here attached to the top of the solar panel mounting plate for pole-mount deployment.
3. RH Side Shield Support. A mirror of the LH side (not interchangeable).
4. LH Side Shield Support. A mirror of the RH side (not interchangeable).
5. Shield back plate.
6. M4x10 Stainless Steel Hex Cap Screw (6 in total on this assembly as shown).
7. M6 Stainless Steel Nyloc Nut (2 in total on this assembly as shown).
8. M6x20 Stainless Steel Hex Cap Screw (4 in total on this assembly as shown).





Technical Specifications

MODEL	CM.S2.V1.1.x
Product Name	IIoT Gateway Satellite (Swarm)
Satellite Communications	SWARM TILE01 with 2-way
	137-138MHz Downlink / 148-150MHz Uplink
Processors & Memory	Arm® Cortex®-M4
	NOR Memory IC 32Mb, SPI - Quad I/O
Onboard Sensors	GPS, Power, Charge Voltage, RSSI
GPS Module	Sierra Wireless XM1210, TCXO. GPS+Glonass, GPS+BeiDou, GPS+Galileo. Signal used for both position information and accurate time sync for data records.
Charge Circuit & Battery	Tracking onboard battery voltage, along with the status output of onboard solar charging circuit in order to give a clear indication of how well the internal battery is charging
External RS485 Sensor Inputs	Fault-protected Half duplex RS422, RS485 Transceiver
	12VDC Supply, 2kV Isolation, 470µF Max Capacitive Load
	Dual Channel. Max Current (per port): 80mA
Bluetooth Host	U-BLOX NINA B3, v5.0 (Bluetooth low energy) nRF52840
Power Supply	Built-in 6000mAH Li-polymer Battery
	Charging Voltage: 4.2V, Rated Voltage: 3.7V, UVLO at 3.4V
Solar Panel	Epoxy encapsulated Monocrystalline, 9~12W Nominal output
DC Input & Charging	18~30VDC, 2A Max Current, MPPT Charger (19.4Vmp), Optional 12v DC Battery Input
CONNECTORS	
Antenna - Satellite	Female SMA, Swarm Antenna

Antenna - GPS	Female SMA, GPS/GNSS Whip Antenna
Antenna - Bluetooth	Female SMA, Bluetooth Whip Antenna
RS485 Sensor Input	2 x IP68 Circular Connector Sockets, 4-Position (vcc, gnd, data+, data-)
DC Input	IP68 Circular Connector Socket, paired with solar panel cable
PHYSICAL DESCRIPTION	
Assembly Flat (L x W x H)	330x260x70mm (without antenna), 545x260x70mm (with antenna)
Assembly at 45° (L x W x H)	330x250x255mm (without antenna), 465x250x255mm (with antenna)
Net Weight	2.6kg (full assembly + antenna) excluding packaging
ENVIRONMENTAL	
Operating Temperature	-20°C to 60°C
Storage Temperature	-40°C to 85°C

Radio Frequency (RF) Modules

The IIoT Gateway contains multiple radio components that are used to perform specific functions that contribute to the overall functionality of the device. These radio components are described in detail in the following pages.

Bluetooth

The IIoT Gateway contains a Bluetooth transceiver module, with the following technical characteristics.

- Frequency: 2.45GHz
- Bluetooth low energy output power EIRP: 10dBm
- RX sensitivity (conducted at 25°C): -94dBm
- RX sensitivity in long range mode (conducted at 25°C): -100dBm
- Maximum output power: +8dBm (restricted to +4dBm in firmware)
- Radio modes: Bluetooth Low Energy (BLE) and IEEE 802.15.4 (LR-WPAN)
- Antenna: 2.4GHz 3dBi Dipole Antenna with Vertical Polarisation, 108mm length, SMA (Female)

The module is used for multiple functions, as follows:

Bluetooth Beacon

When the Gateway is in normal operation mode, it will beacon a specific set of values every one (1) second. These values include the Gateway name, battery level and other relevant metadata specific to its version. This information is read by the FreeWave Mobile App during a scan event, allowing the App to display real-time information for nearby devices. This helps the user identify which devices might need attention (for example battery level) without actively connecting to each device.

Bluetooth Client

In-between each of the beacon advertisements, the Gateway will listen for incoming peering requests. The FreeWave Mobile App contains a set of unique keys that allows it to connect to the Gateway for administrative purposes. In this peering mode the Gateway can be updated (firmware and configuration updates). The user can also use this mode to trigger an instantaneous read of the sensor ports to validate connection and installation integrity.

Bluetooth Host

The primary function of the Bluetooth module is to serve as a host, to scan the nearby area for relevant Bluetooth beacon signals. When compatible devices are found, their beacon packet is read and saved to memory on the Gateway, to be included in the next transmission of sensor readings up to the ModuSense Data Portal.

By default, the Gateway takes readings on a sample frequency of 15 minutes and will run a Bluetooth scan for ten (10) seconds. Near-by devices that meet the filtration criteria will be identified and their beacon packets retrieved and stored for later transmission.

The default runtime parameters can be configured directly using the ModuSense Mobile App or over-the-air using the ModuSense Data Portal to send a special packet down to the Gateway (see 'Two-way Communications').

GPS

There are two GPS modules within the Gateway, one on the main-board and one within the Swarm modem.

The main board GPS has the following technical characteristics.

- Frequency Bands: GPS L1, GLONASS L1, QZSS L1, SBAS L1, GALILEO E1
- RX sensitivity: -161dBm
- Antenna: 1575MHz and 1602MHz 2dBi Antenna with Linear Polarisation, 100mm length, SMA (Female)

Main-board GPS:

The main-board GPS module takes care of both location information and accurate time. The location is used to place the Gateway on a map, such as the map view within the ModuSense Data Portal. The time information is used to tag telemetry readings with accurate time. This is critical to the operation of the Gateway since the messages are often placed in memory or on a queue for transmission at a later stage.

If the Gateway cannot establish a GPS fix, it will not have accurate time information and therefore cannot tag records.

Swarm Modem GPS:

The GPS module within the Swarm Modem is used to support the transmission process. The Swarm modem will re-acquire a GPS fix every three (3) hours. The GPS fix is used by the Swarm modem to keep the internal clock synchronised with the satellites to ensure data integrity during transmissions. Without a GPS fix, the Swarm modem will not transmit.

Swarm

The Swarm Modem used within the IIoT Gateway (version CM.S2.V1) is an embedded module developed by FreeWave using the certified Swarm Tile component supplied by Swarm Technologies. The modem includes additional power filtering and noise reduction circuitry to improve performance and reliability.

The Swarm module has the following technical characteristics.

- Frequency Band - Downlink: 137-138 MHz (space to Gateway)
- Frequency Band - Uplink: 148-150 MHz (Gateway to space)
    - Specifically 148.0039 – 150.0461 MHz
- Antenna: ¼ Wave Whip, 2dBi with Linear Polarisation, 200mm length, SMA (Female)

RF Environment Considerations

The IIoT Gateway Satellite (Swarm) has been designed, tuned and tested to function as a ready-to-deploy solution with all radio functions tested to perform appropriately. This includes the angle of the solar panel, the metal work used in the assembly and how it interoperates with the antenna.

Ground Plane

The Swarm antenna is a ¼ wave antenna and all 1/4 wave antennas work best if they are installed in the center of a metal ground plane with at least ¼ wavelength radius. If you remove the Swarm antenna from the Gateway you will need to take care to re-validate the RF performance and part of that will be to ensure you have a suitable ground plane.

The antenna can be mounted away from the Gateway, on its own pole or extension (to gain height and move the antenna away from other metalwork). However, you will need to reproduce the ground plane at the new location. One of the easiest ways to do that is with ground plane radials; see the link and image below.

https://m0ukd.com/calculators/quarter-wave-ground-plane-antenna-calculator/

Example Ground Plane Radial

Harsh Conditions

Although the Gateway is designed to withstand most outdoor conditions, there are situations where it may be prudent to increase the level of protection for specific connectors. The RF cables and antenna connections in particular are susceptible to any increased resistance/impedance which can be caused by water pooling and/or being blown into gaps by high winds.

To protect the connections on the electronics enclosure you can use coax-seal tape or simply add the protective shields to the assembly to reduce wind exposure.

To protect the antenna connections from these same high-wind and rain conditions we recommend using coax-seal tape around the base of each antenna connection.

Visit the FreeWave Support Site for details and demonstration videos, at https://support.freewave.com/ .

Battery Charging

The Gateway is equipped with an onboard Lithium-Polymer (Li-Po) battery pack, this battery is charged via the solar panel included and an MPPT charger built into the Gateway.

In cold climates under 0°C / 32°F, lithium batteries have decreased performance and will discharge quicker than normal. In such conditions, lithium batteries will not charge even if the solar panel receives sunlight. This is due to a restriction imposed by the battery manufacturer. In cold climates, charging a battery in cold weather can lead to lithium metal plating forming on the anode of the Gateway leading to a potential battery short and eventually battery failure. To prevent this, the battery is equipped with a temperature monitor that will prevent it from being charged below 0°C / 32°F.

In snowy conditions the solar panel may become obscured by snow and the Gateway will not charge. The snow covering the panel must either be removed manually or wait for ambient temperatures to rise to melt the snow.

There is research being conducted on special coatings for the solar panel to reduce/eliminate snow build up. You can view more here:

https://news.umich.edu/spray-on-coating-could-make-solar-panels-snow-resistant/

While the standard Gateway is battery powered with solar charging, there are options available for either external battery support or mains power support for colder climates.

If the Gateway is configured for external battery support, then that is its permanent state. It cannot be used as a standard Gateway with a Lithium battery.

Should you wish to discuss external battery support or mains power adapters, please contact the FreeWave Support team.

Key Functions

In this section, the following key functions relevant to the IIoT Gateway Satellite (Swarm) are explained in detail.

- Automatic Power On
- Manual Power On
- Automatic Power Off
- Manual Power Off
- Storage Mode
- Sensor Reading Routine
    - Port 1
    - Port 2
    - Onboard
    - Bluetooth
- Transmission Routine
    - Queuing
    - Sending
    - Receiving

Automatic Power On

If the Gateway is deployed but not powered on (either intentionally or by mistake) it will still eventually power on in certain conditions. The power management module is constantly monitoring both the battery voltage and the solar panel input voltage. If the solar panel is exposed to sunlight (or a bright enough artificial light source) it will wake from storage mode (if it were in that mode) and start monitoring the voltage coming from the solar panel. The power management module will analyse the overall charge performance across a 15 minute period. If the unit is deemed to be in a satisfactory charging condition, it will power on automatically.

Manual Power On

When a Gateway is powered off (but not in storage mode) it will blink the power LED red every five (5) seconds. In this state you can manually power on the Gateway by momentarily pressing the power button. When you press the power button it will cause the status LED to light-up green, followed by the power light. The Gateway will then enter boot mode, and if this is the first boot since storage mode, it will complete a first-boot routine that involves queuing a full configuration download to be transmitted (see 'Boot Record')

Automatic Power Off

Technically referred to as UVLO, the automatic power off function is actually an Under Voltage Lock Out (UVLO) trigger. The power management module reviews the status of the battery every 60 seconds and if the battery voltage falls below the configured voltage floor of 3.4v, it will trigger a power down routine that will put the Gateway into the equivalent of storage mode. The only way a Gateway can exit from this mode is if the battery voltage recovers, through charging of the battery via the built-in solar charger (see 'Automatic Power On').

Manual Power Off

Whilst a Gateway is running, the power light will be blinking green every five (5) seconds. In this mode you can momentarily press the power button, causing the Gateway to power down into stand-by mode. In this mode the unit is still fully powered but the main program is disabled, no sensor readings will be taken and no transmissions are possible. If left in this mode while the solar panel is exposed to sunlight (or a bright enough artificial light source) the Gateway will eventually power back on automatically (see 'Automatic Power On', above).

Storage Mode

If you plan to put the Gateway in storage for an extended period of time, or for shipping purposes, the storage mode is recommended to avoid unnecessarily draining the battery. To enter this mode you must first cover the solar panel with either the original packaging or a suitably dark cover to avoid triggering the 'Automatic Power On' process. Once the solar panel is covered, press and hold the power button for up to six (6) seconds. During this time all three LED lights will light-up red and then go out one by one, this is a warning sequence, you can abort the process at any time by releasing the power button before the red LEDs go out. Keep pressing the power button until all LED lights have gone out, then release. If any of the LEDs continue to blink in any way, the process has failed. This could be due to the solar panel being exposed to enough light, or the power button was not held down long enough.

Sensor Reading Routine

During normal operation, the Gateway will take sensor readings on a cycle that starts on each hour (default is 15 minutes, being 4 times per hour). The records retrieved during this sensor reading routine are stored locally in onboard memory with a UTC date and time stamp. Once the transmission cycle is triggered (default is hourly) these records are bundled together and queued for transmission. The data collected every 15 minutes in the sensor reading routine is specific to the ports used and Bluetooth devices within range.

Port 1

When facing the keypad, the RS485 port on the left of the enclosure is port 1. The device plugged into this port must match the configuration. Port configurations include device selection and sample frequency. These settings can be configured directly using the FreeWave Mobile App or over-the-air using the ModuSense Data Portal to send a special packet down to the Gateway (see 'Two-way Communications').

Port 2

When facing the keypad, the RS485 port on the right of the enclosure is port 2. The device plugged into this port must match the configuration. Port configurations include device selection and sample frequency. These settings can be configured directly using the FreeWave Mobile App or over-the-air using the ModuSense Data Portal to send a special packet down to the Gateway (see 'Two-way Communications').

Onboard

During the normal sensor read routine, the onboard telemetry is also sampled and included in the record. For the Gateway this includes the following:

- Battery level, mV
- Charge input, mV

Additional on-board telemetry is included in the initial boot record, see 'Boot Record' below.

Bluetooth

For a default period of ten (10) seconds, the Gateway will scan, every 15 minutes by default, for data packets from nearby devices. This scanning takes place twice, the first time using standard Bluetooth BLE beacon channels and the second using Coded PHY channels for extended range devices.

Data retrieved during the scan is stored for later transmission. If the device is known to FreeWave and the Gateway has a decoder for the data packet, it will be decoded and stored in a more efficient format to reduce overall transmission data volumes.

Transmission Routine

The satellite data plan on the Swarm network is limited to 750 x 192-byte messages per calendar month, so the sample interval needs to be configured in a way that will stay within the bounds of the data plan. This works out to be approx. 24 x 192-byte messages per day. Additional data plans can be added to accommodate more data, costs associated will be billed automatically.

When the sample interval is triggered, the readings from the various sensors and the onboard telemetry are combined into a single sub-message and stored in the main onboard memory. For a 15-minute sample interval, this happens four times per hour.

The 15-minute sub-messages are not queued for transmission on the Swarm network at the same time. This process occurs separately and within a separate time interval. By default, this is set to 1 hour. This means that once per hour the Gateway will package up the four sets of readings (based on 15-minute intervals) into one compressed package. This package will be split into 192-byte messages (roughly, the boundary is not always exact due to data item sizes).

This message (or messages) are transferred to the Swarm modem for transmission when possible (queued on the Swarm modem until the next satellite pass. Use this online tool for pass checking: https://kube.tools.swarm.space/pass-checker/

Queuing

Every time the Gateway enters the transmission routine it will retrieve queued sensor readings from the on-board memory in a Last-In-First-Out (LIFO) queue. This ensures the most recent data is transmitted first so there is no delay for the most recent readings.

Note: The Swarm modem sends the data over the satellite network as FIFO (First-In, First-Out).

While they are not operating in the same way, there is no impact on the display of data on the dashboards and the ordering is only evident when viewing the contents of the messages.

Transmission (earth to space)

The Swarm modem is always powered in stand-by mode (configurable using the FreeWave Mobile App) so that it will always be ready when a satellite passes overhead. The passing satellite will send out a special wake signal so that the Gateway knows to power up the full modem transmitter and get to work.

Two-way Communications

Receiving data from the ModuSense Data Portal over the Swarm network is limited to two (2) messages per day or 60 per month. These messages can take up to 24 hours to arrive on the Gateway. This is used to update runtime configurations such as sample frequency, port definitions or Bluetooth scan parameters.

Boot Record

On first boot, the Gateway will send a full configuration dump which contains useful information to validate the configuration and provide a baseline for future reference. The boot record is made up of four distinct parts:

1. Diagnostic Boot Info
2. Diagnostic Boot Info Swarm
3. Diagnostic Config Info
4. Diagnostic Config Read Only Info

Diagnostic Boot Info

time	2022-03-10T06:22:54Z	The boot record time stamp
i-softdevice-version	256	
s-bluetooth-mac	ea99999e999d	MAC address of the Bluetooth network adaptor
s-firmware-version	1.1.6	
uuid	unique id	Gateway UUID, 36 character universally unique

Diagnostic Boot Info Swarm

i-swarm-window0	-1	64 bits 'on' (0:00 to 4pm)*
i-swarm-window1	4294967295	32 bits 'on' (4pm to 0:00)*
s-configuration	AI=2086	Application ID
	DI=0x0008b2	Device ID
	DN=TILE	Name
s-firmware-version	2021-03-23-18:25:40,v1.0.0	firmware date and version
uuid	unique id	Gateway UUID, 36 character universally unique

** Time windows are based on 4 bits per hour (15 minute segments)*

Diagnostic Config Info

i-bluetooth-max-scan-count	16	Maximum number of Bluetooth devices to scan, others will be ignored.
i-max-sends-per-cycle	10	Messages queued to tile per cycle, needed when total data is more than 192 bytes. 10 per cycle means up to 10 messages within the transmit cycle, 1 hour. if read cycles were high (5 minutes) then the transmit cycle of 1 hour will need a lot more max-sends-per-cycle
i-port1-period	900	Default, 15-minute cycle
i-port1-period-config	66821	This variable contains configuration parameters and is only used by camera currently, this is 'config' for the RS485 device. This value can be used by any RS485 'profile' that requires dynamic configuration.
i-port1-profile	1	ID of sensor profile (1 = SD.CF1)
i-port2-period	900	Default, 15-minute cycle

i-port2-period-config	66821	This variable contains configuration parameters and is only used by camera right now, this is 'config' for the RS485 device. This value can be used by any RS485 'profile' that needs dynamic config.
i-port2-profile	3	ID of sensor profile (3 = SD.PM2512)
i-sample-interval-hour	1	This variable specifies the interval between successive samples. If set to 6, this means that every 6 hours from the first reading a sample will be taken. This resets at the start of every day (UTC) if the time does not evenly divide into 24 hours.
i-sample-interval-minute	15	This variable specifies the interval between successive samples within an hour. If set to 60, a reading will occur once an hour at XX:00:00. If set to 15, a reading will occur every 15 minutes at XX:00:00, XX:15:00, XX:30:00 and XX:45:00 on every hour that specified by the variable 'sample_interval_hour'.
i-sample-offset-hour	0	This variable specifies the first hour that a sample will take place past 00:00:00 UTC. By default this is 0, so a reading will occur at 00:00:00.
i-transmit-interval-minute	60	How many minutes between placing messages on the Swarm modem for transmission. This resets hourly, so 60 means only once per hour. A value of 10 would be 6 times per hour.
i-transmit-schedule-hour	16777215	24 bit number, one bit per hour of the day.
uuid	unique id	Gateway UUID, 36 character universally unique

Diagnostic Config Read Only Info

i-bluetooth-advertising-rate	1000	(1 second, default) Interleaved with the Coded PHY channel so if this is set to 1 second, it will be 1 second per channel. E.g. if this was set to 4000 (4 seconds) then it would happen every 8 seconds
i-bluetooth-scan-length	10000	10 second scan, default
i-bluetooth-transmit-power	4	(+4dBm) this must be 4,0,-4,-8,-16,-20
i-config-version	13	This tells new firmware if a migration needs to be run to bring the configuration record (in memory) up to the new version, i.e. adding new fields or enforced values.
i-gps-fix-retry-limit	90	Maximum failures to get a fix before we stop trying for this cycle (highest setting value is 255).
i-modem-type	1	Socket Usage - 0:None, 1:Swarm, 2:R410
i-sensor-type	5	Personality - 4:SensorNode, 5:CM Gateway
i-uvlo-cutoff	3400	voltage at which the unit will automatically enter storage mode. See storage mode above.
uuid	unique id	Gateway UUID, 36 character universally unique

Supported Sensors

The following table lists sensor devices that have been fully integrated and certified for use with the IIoT Gateway.

RS485 MODBUS

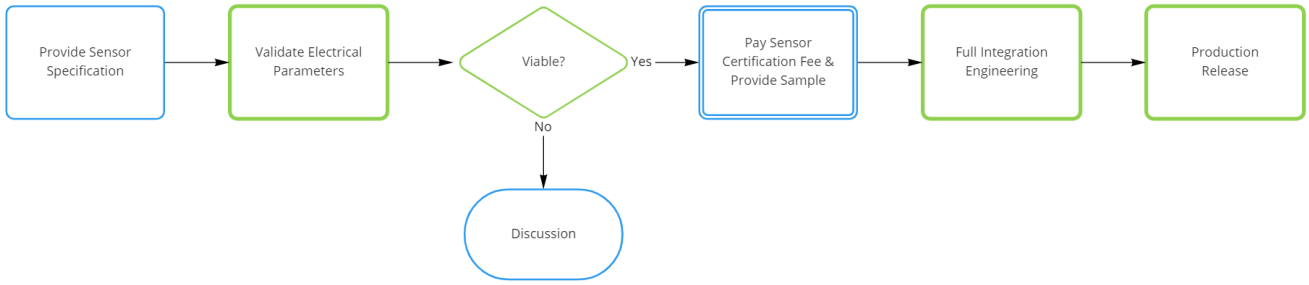
MODEL/SKU	DESCRIPTION
SD.CF1	Wind Speed & Direction Sensor (Ultrasonic)
SD.FS1	Wind Speed Anemometer
SD.PM2512	Air Quality Sensor, Particulate Matter PM2.5/10, Temperature & Humidity
SD.SM1	Soil Moisture Sensor, Temperature and Moisture %
SD.WLX	Radar Distance Sensor, 24GHz
SD.WS601	Rain Gauge Tipping Bucket, Stainless Steel, 0.1mm resolution, 2% accuracy
SD.WSQ	Weather Station Sensor, Temperature & Humidity & Barometric Pressure
SD.HPT604.3M	Water Level Sensor, Hydrostatic Pressure, 3 Meter Sensor Cable
SD.HPT613D.3M	Water Level Sensor, Hydrostatic Pressure, High Accuracy, 3 Meter Sensor Cable
SD.SHT20	Temperature & Humidity Probe
SD.SWW.TURB	Water Turbidity Sensor
SD.EXTO9.6	Geotech Civil Extensometer, 9 meter with 6 plates
SD.EXTO18.6	Geotech Civil Extensometer, 18 meter with 6 plates
SD.W816	Weather Station. Temperature, Humidity, Barometric Pressure, Wind Speed & Direction, Rainfall.
SD.RS100.485	Optical Rain Gauge, 0.1mm resolution, 15% accuracy

Bluetooth

MODEL/SKU	DESCRIPTION
SD.BLUTILT	Bluetooth Tilt Sensor, High Accuracy, 0.001 arcdeg resolution
SD.THS	Bluetooth Brood Monitor, Temperature & Humidity
SD.ENV.01	Bluetooth Environmental Monitoring Sensor, Temperature & Humidity & Lux & VoC
S.HS.BTS.V5	Bluetooth HiveScale Platform

Custom Sensor Support

The IIoT Gateway can be configured to support almost any RS485 MODBUS or Bluetooth sensor. The process of adding a device to the supported sensor list is as follows:



Days of Autonomy

An important feature of the IIoT Gateway is the ability to operate autonomously, without any intervention. This ensures the Gateway will continue to function for a known period of time regardless of environmental conditions.

The measurement of 'days of autonomy' for a IIoT Gateway is based on several variables, therefore the actual number of days you can expect for your Gateway will depend on the specific characteristics of your deployment.

1. Location relative to sunlight exposure

   The solar panel is most effective when it is angled to be perpendicular to the sun, by default the assembly is expected to be locked into a 45° position to accommodate the majority of deployment locations. The perfect angle, however, will depend on where you are on earth and what time of year it is, so therefore it is not practical to keep changing the angle.

2. Likelihood of solar panel obstruction (leaves, snow, dirt, pollen)

   If the Gateway is deployed near trees, ensure these do not block the sun during the day and also try to avoid a situation where leaves will land on the panel, particularly in light rain as they will stick.

   In situations where the panel becomes covered in snow, dirt or pollen, it may need to be manually cleaned if the next rainfall does not do the job for you.

3. Frequency of sensor readings

   By default the Gateway will take readings every fifteen minutes, unless the power draw from the attached sensors is considered high, in which case the frequency will be set to one hour for that specific port – for example the SD.PM2512 Air Quality Sensor.

   If you configure the frequency of sensor readings to be more often, the Gateway will consume more battery power, in particular at night when there is no recharge activity.

4. Power draw of the sensors attached

   Some sensors draw a considerably large amount of power and should only be used in a low-frequency reading cycle, or with external battery support.

5. Ambient temperature

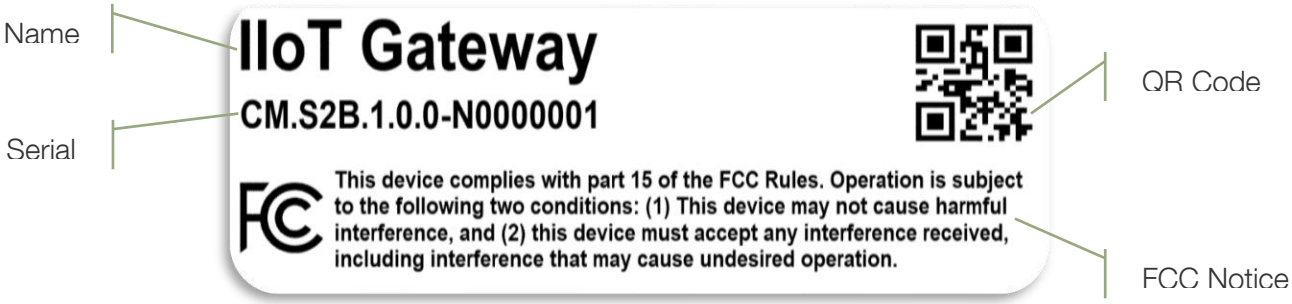
   The on-board Lithium-Polymer battery is equipped with a temperature monitor that will prevent it from being charged below 0°C / 32°F. Whilst it will continue to supply power below 0°C / 32°F it will have a significantly degraded performance and the days of autonomy will be reduced.

In normal operation with default sensor settings and in typical environmental conditions (sunny and above 0°C / 32°F) the days of autonomy can be expected to be seven (7). For situations where you require a longer runtime or the conditions are sub-optimal, please get in touch to discuss larger battery options and external battery support (allowing for different battery chemistry options).

Labels and Packaging

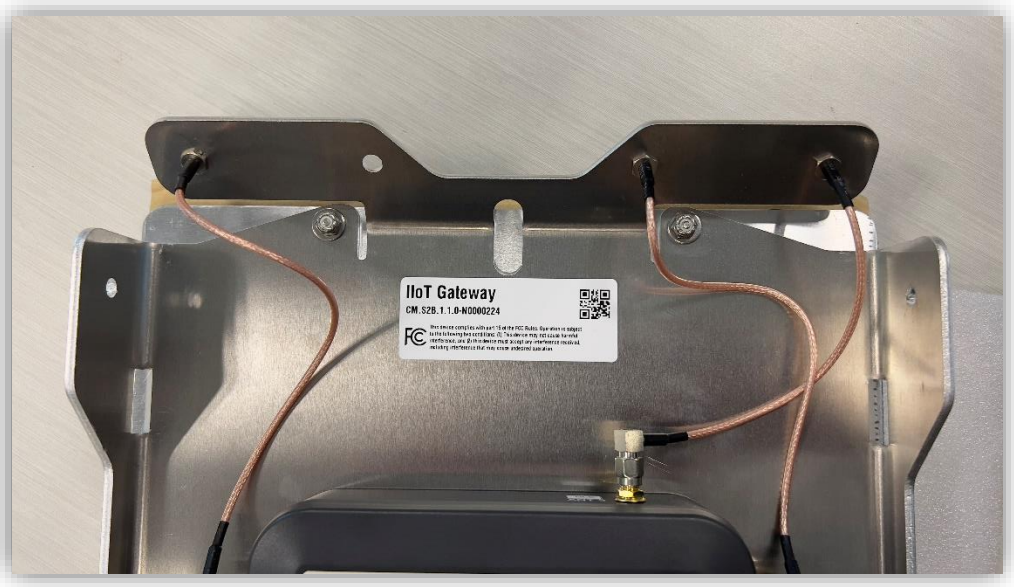
Product Label

Situated on the Gateway device itself, above the electronics enclosure, you will find the product label, as follows:



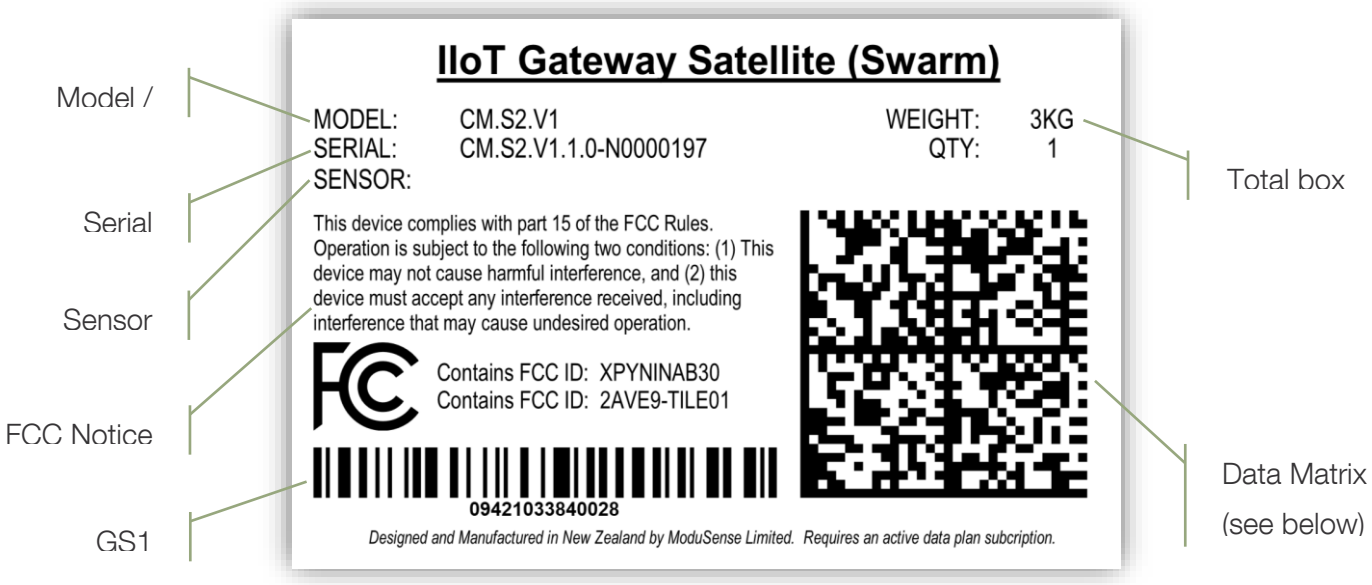
The **Serial Number** is unique to the device and contains hardware variation, version and build information.

The **QR Code** contains the full Serial Number.



Location of product label on rear of solar assembly, above the electronics enclosure.

Product Box Label

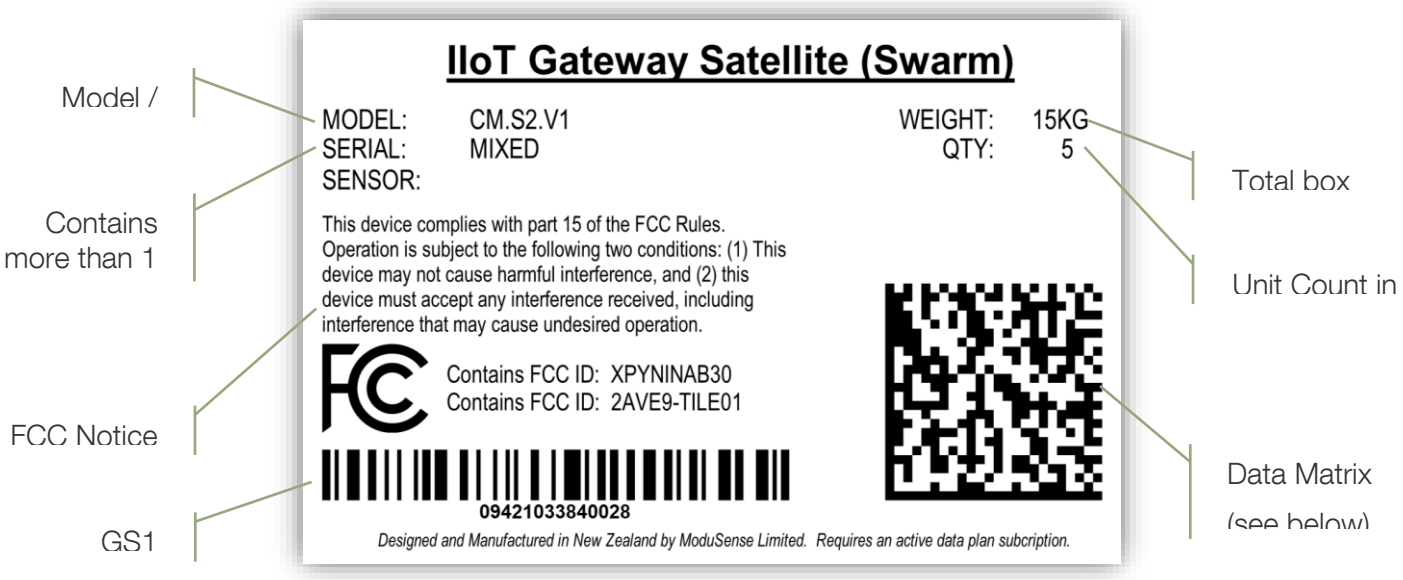


If the box contains a sensor, such as the Water Level Sensor with three (3) meter cable, this will show the part number of the sensor itself so you can identify what is in the box, for example: 'SD.HPT604.3M'. When no sensor is included, this will be blank or read N/A.

Single Product Box Data Matrix:

)>[RS]06[GS]1PCM.S2.V1[GS]SCM.S2.V1.1.0-N0000197[GS]4LNZ[GS]Q1[GS]10DN/T[GS]1TN/T[RS][EOT]

Intermediate Box Label ('Outer')



Because the 'outer' box contains multiple single product boxes, this label will not list the individual serial numbers or included sensors.

Multiple Product Box Data Matrix:

[)>RS06GS1PCM.S2.V1GSSMIXEDGS4LNZGSQ5GS10DN/TGS1TN/TRSEOT