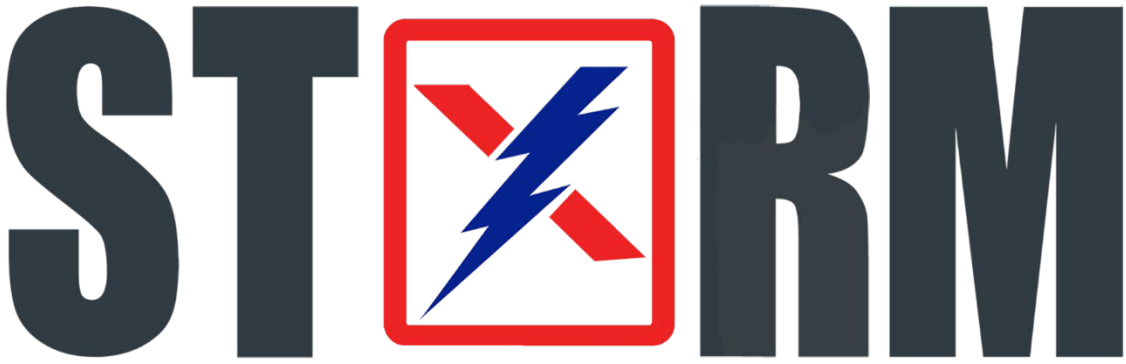

STORM V3 User Manual

Revision B

For the most current revision to this document please contact support@copasat.com

Prepared by:

COPASAT, LLC

2020 Wild Acres Rd - Building D

Largo, FL 33771

support@copasat.com

Support +1 (727) 647-6110

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Introduction

This document contains important details for the safe and effective operation of a STORM V3 terminal.

This manual may contain errors and may be revised without notice. It is the responsibility of the user to always use their best judgement and to consult with technical support for the most current information.

Configuration Overview

The STORM V3 is an upgrade kit for the commercially available StarLink and the DoD version StarShield flat high-performance antenna designed and manufactured by SpaceX. The antenna is embedded into a metallic enclosure without modification. The STORM V3 enclosure provides an environmental seal for all the components. Military standard connectors and gaskets are used for all external electrical interfaces.

There are multiple variants of a STORM V3 that incorporates the StarLink/StarShield flat high-performance antenna by SpaceX. The variants offer varying configuration options for various mission applications. Those variants are:

- STORM V3 Standard
- STORM V3 CCM
- STORM V3 IBR / Cradlepoint
- STORMSHIELD / STORMLINK (5G)

To identify which configuration you have refer to the part number on the ID label. The six-digit number indicates which configuration you have.

Variant	Six-digit unique identifier	Router Type	Antenna Type
Standard	030010	MikroTik	StarShield
	030015		StarLink
CCM	030020	N/A	StarShield
	030025		StarLink
IBR	030030	Cradlepoint 4G/LTE	StarShield
	030035		StarLink
STORMSHIELD	030600	Cradlepoint 5G	StarShield
STORMLINK	030605		StarLink

Part numbers that end in zero are StarShield antennas and part numbers that end in five are StarLink antennas.

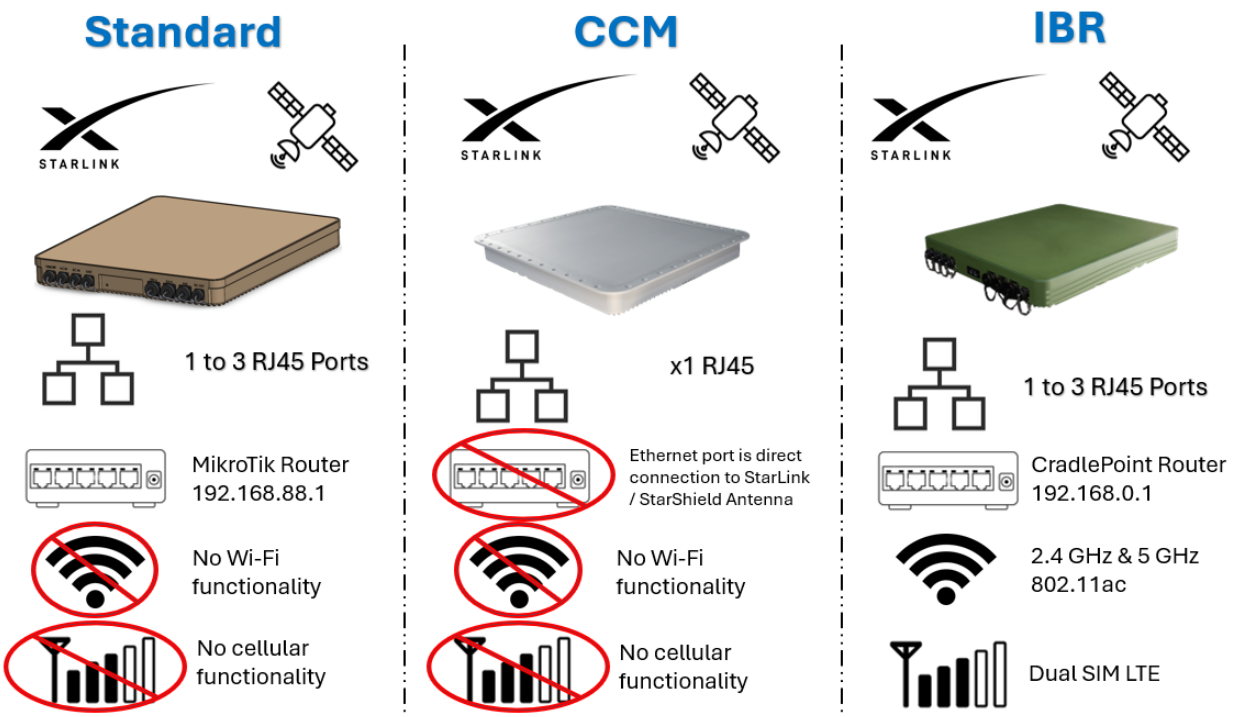


Figure 1: STORM Variant Comparison

Table 1: Variant Network Interfaces

Variant	Satellite Antenna	Cellular	SD-WAN Device	SIM Card Size	# Ethernet Ports	Wi-Fi
Standard	StarLink/StarShield Flat High Performance	-	-	-	1-3	-
CCM	StarLink/StarShield Flat High Performance	-	-	-	1	-
IBR	StarLink/StarShield Flat High Performance	LTE	Cradlepoint IBR900-600M Dual SIM LTE	Mini SIM (2FF) 25mm x 15mm x 0.71mm	1-3	Dual-band, dual-concurrent; 802.11ac Wave 2 (Wi-Fi 5)
STORMSHIELD STORMLINK	StarLink/StarShield Flat High Performance	5G / LTE	Cradlepoint R1900	Mini SIM (2FF) 25mm x 15mm x 0.71mm	1-3	Dual-band, dual-concurrent; 802.11ax (Wi-Fi 6)

Table 2: Variant Physical Properties

Variant	Weight (lbs.)	Length (in)	Width (in)	Height (in)
Standard	29.2 Terminal Only	23.46	20.38	2.7
Standard's Transit Case Loaded	68*	31.75	24.6	12.18
CCM	32.2 Terminal Only	24.88	22.38	3.27
CCM's Transit Case Loaded	76*	30.9	30.56	12.84
IBR	32.1 Terminal Only	23.46	20.38	2.7
IBR's Transit Case Loaded	72*	31.75	24.6	12.18
STORMSHIELD / STORMLINK	31 Terminal Only	23.46	20.38	2.7
STORMSHIELD / STORMLINK Transit Case Loaded	72*	31.75	24.6	12.18

* May vary based on cabling or accessories packed.

Table 3: Variant Accessory / Mounting Compatibility Matrix

Variant	Magnet Mount Compatible	Vacuum Mount Compatible	Flush mount Chassis	Tripod Compatible
Standard	Yes	Yes	-	Yes
CCM	No	No	Yes	-
IBR	Yes	Yes	-	Yes
STORMSHIELD STORMLINK	Yes	Yes	-	Yes

STORM V3 Standard

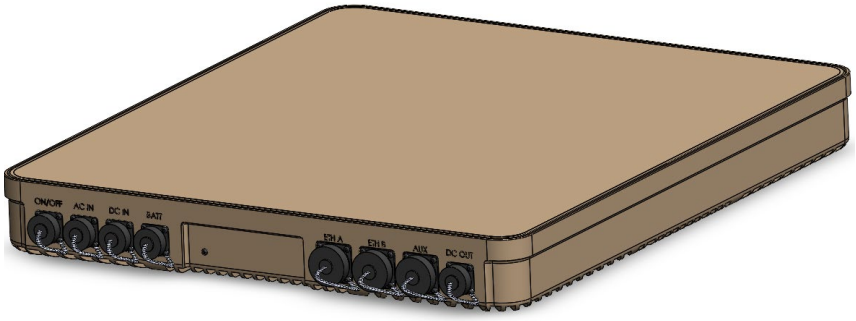


Figure 2: STORM V3 Standard (Tan)

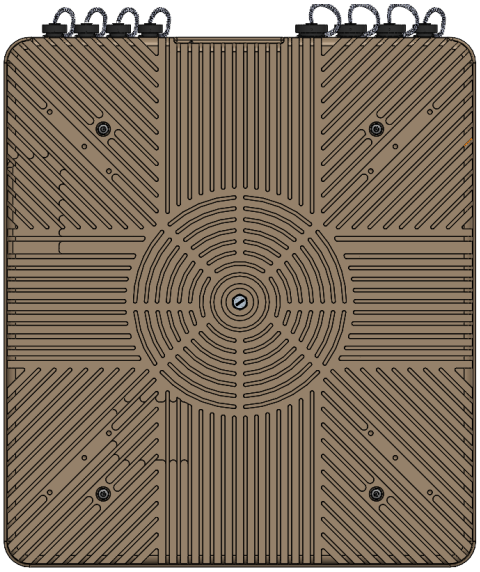


Figure 3: STORM V3 Standard (Bottom View)

Base Part Number: CS-G1-030010 / CS-G1-030015

A ruggedized StarLink or StarShield antenna with integrated power supplies for mobile applications. This unit has no secondary transmitter besides the primary satellite antenna.

- Power Source: 12-36 VDC and/or 110-240 VAC
- Network: RJ45 (up to 3)
- Weight 29.2 lbs.
- Dimensions: 23.46in (L) x 20.38in (W) x 2.63 in (H)

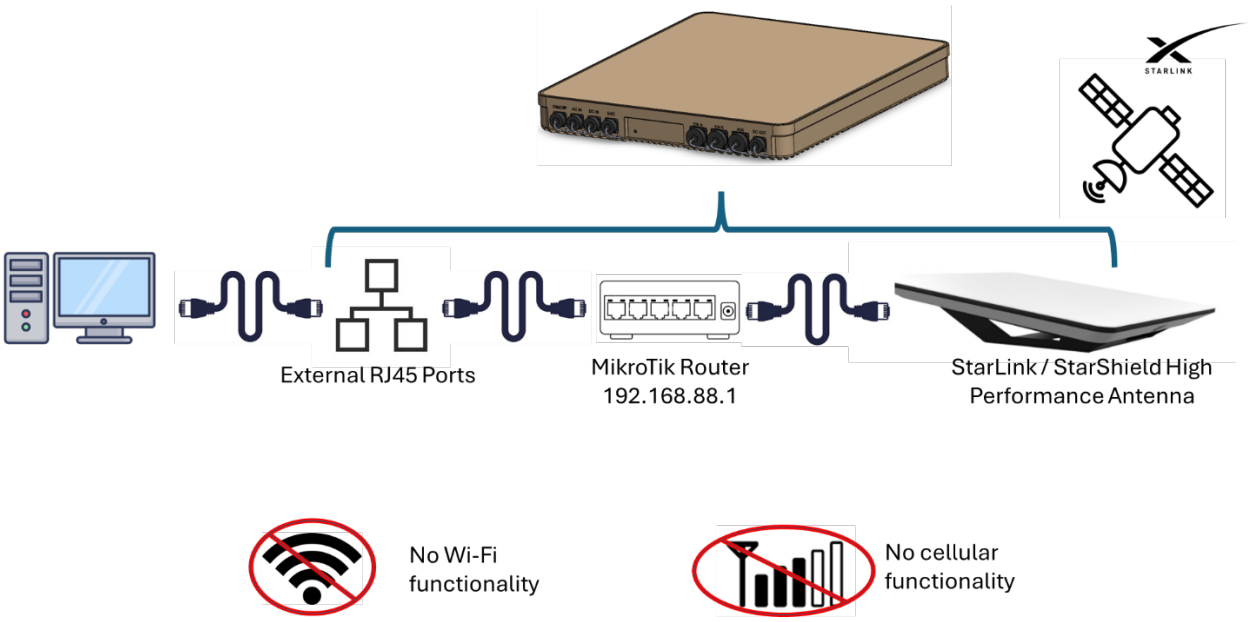


Figure 4: STORM V3 Standard Network Architecture Overview

STORM V3 CCM

Figure 5: STORM V3 CCM (Gray)

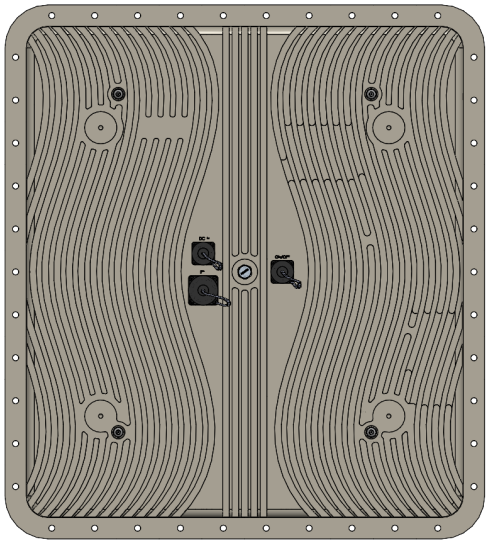


Figure 6: STORM V3 CCM (Bottom View)

Base Part Number: CS-G1-030020 / CS-G1-030025

A flush mount option designed for marine applications. All connectors are located on the bottom.

- The standard color is Gray.
- Power Source: 12-36 VDC Only
- Network: RJ45 (x1)
- Weight 32.2 lbs.
- Dimensions: 24.88 in (L) x 22.38 in (W) x 3.27 in (H)

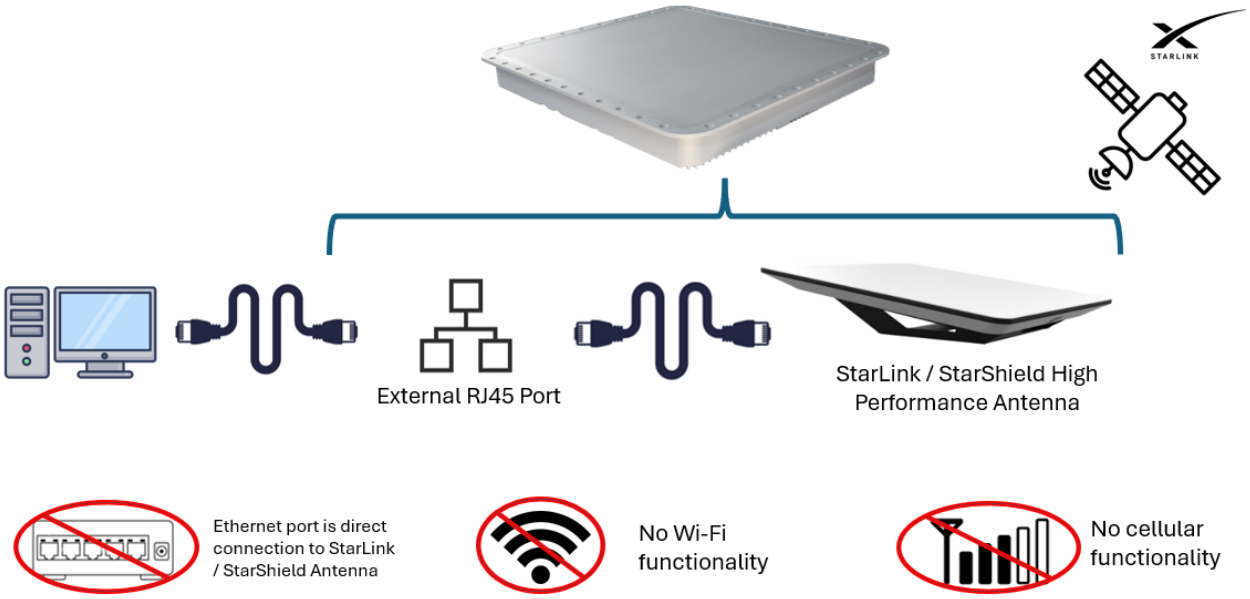


Figure 7: STORM V3 CCM Network Architecture Overview

STORM V3 IBR

Figure 8: STORM V3 IBR (Green)

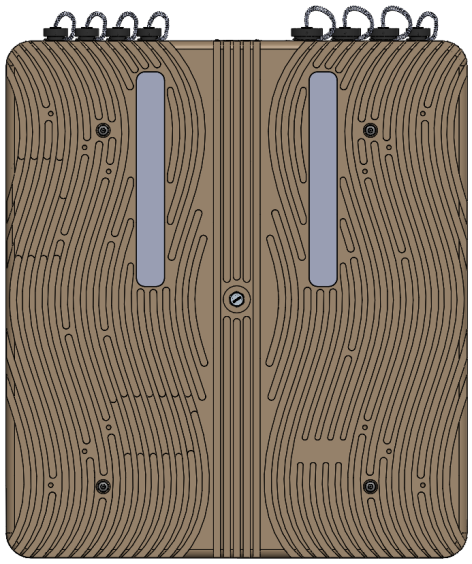


Figure 9: STORM V3 IBR (Bottom View)

Base Part Number: CS-G1-030030 / CS-G1-030035

All the features of the Standard with a Cradlepoint IBR900 for cellular connectivity plus integrated Wi-Fi.

Cellular and Wi-Fi antennas are mounted on the bottom of the terminal (in the two long rectangular slots as shown in Figure 2).

- Power Source: 12-36 VDC and/or 110-240 VAC
- Network: RJ45 (up to 3); Wi-Fi
- Weight 32.1 lbs.
- Dimensions: 23.46in (L) x 20.38in (W) x 2.63 in (H)

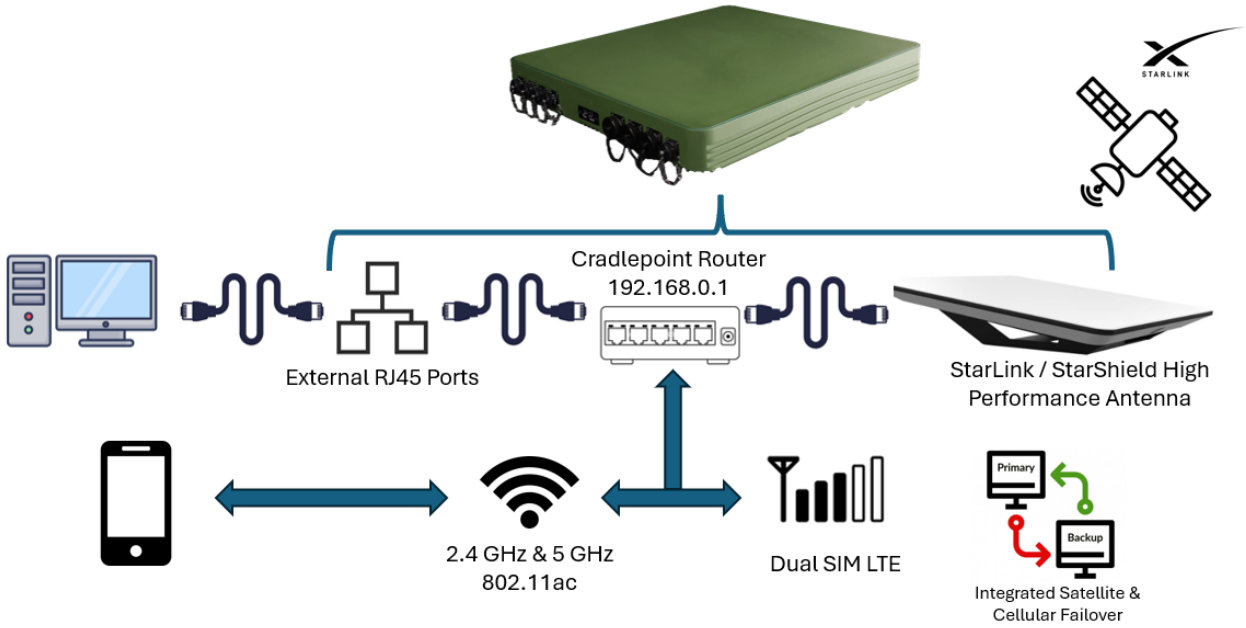


Figure 10: STORM V3 IBR Network Architecture Overview

STORM V3 IBR

Figure 11: STORMSHIELD / STORMLINK

Figure 12: STORMSHIELD / STORMLINK (Bottom View)

Base Part Number: CS-G1-030600 / CS-G1-030605

All the features of the Standard with a Cradlepoint R1900 for cellular connectivity plus integrated Wi-Fi.

Cellular and Wi-Fi antennas are mounted on the bottom of the terminal

- Power Source: 12-36 VDC and/or 110-240 VAC
- Network: RJ45 (up to 3); Wi-Fi
- Weight 32.1 lbs.
- Dimensions: 23.46in (L) x 20.38in (W) x 2.7 in (H)

Figure 13: STORMSHIELD / STORMLINK (5G) Network Architecture Overview

Universal hardware features

A pressure relief valve ensures that adverse temperature or rapid depressurization environments do not compromise the environmental gasket between the antenna and the enclosure. The pressure relief valve has a rating of IP68.

The chassis is aluminum. If the paint is damaged the chassis will not adversely corrode and does not require paint repair except for aesthetic preferences.

STORM V3 Color Options

Color	Color Code	Chip Number per FED-STD-595	Color Description per FED-STD-595	Color Type
Gray	GY	36231	International Gray	Camouflage / Lusterless (Flat)
Tan	DT	33446	TAN 686A	Camouflage / Lusterless (Flat)
Green	OG	34094	Green 383	Camouflage / Lusterless (Flat)
White	WH	37925	-	Camouflage / Lusterless (Flat)
Black	BK	37038	Black International	Camouflage / Lusterless (Flat)

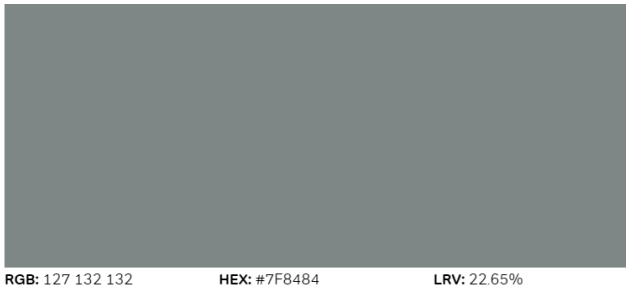


Figure 14: Gray 36231

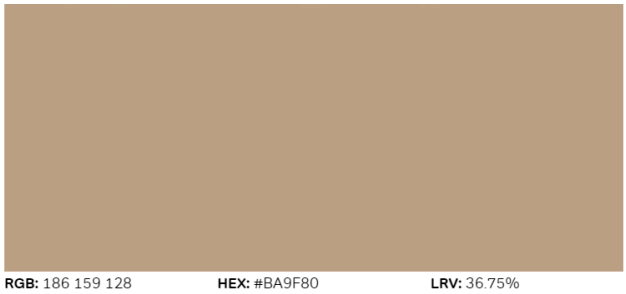


Figure 15: Tan 33446

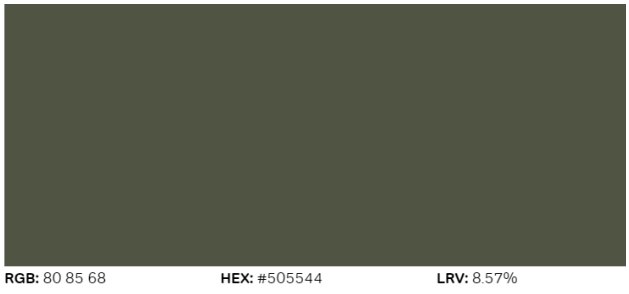


Figure 16: Green 34094

Figure 17: White 37925

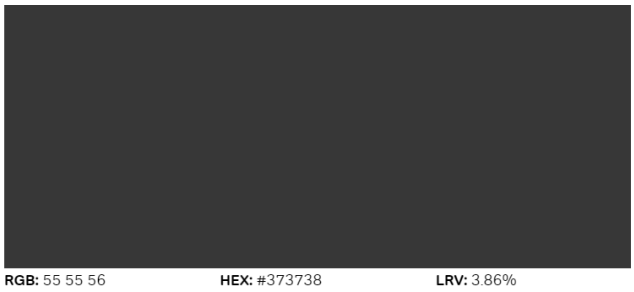


Figure 18: Black 37038

Safety

Hardware Design Safety

Physical Separation Safety

The terminal is sealed, and field service is not permissible. The antenna is secured to a metallic enclosure with tamper resistant bolts. The specialized tool to remove the tamper resistant bolt is not provided with the antenna to prevent unauthorized and unsafe repairs to the terminal. There is no access to the power supply boards.

Environmental Seal

The terminal is environmentally sealed. The terminal utilizes a combination of gaskets and sealants to ensure the internal cavity is environmentally sealed. A vacuum leak test is performed to verify the gasket is working as designed on each terminal produced.

The design relies on Amphenol PT Series connectors which are compliant to MIL-DTL-26482. The connectors are rated for environmental applications, both industrial and military. The datasheet indicates, “Complete moisture sealing is achieved by combining four seals: shell, peripheral, interfacial, and wire. Wire seal is accomplished by multiple ripple design, exceeding the wire sealing requirements of MIL-DTL-26482”.

DC Power Safety

The internal DC system is completely isolated from the chassis and personnel. The output voltages are below 60 Vdc, which is the same as a class 2 power supply; therefore, it is safe.

It is not recommended to electrically bond the negative DC terminal to the chassis but if it is only tied at one-point, multiple connections to ground in the external equipment may cause “ground loop” currents.

The DC power supply has over current protection via individual fuses for its input and all DC outputs. In addition, the DC input is internally reverse polarity protected.

AC Power Safety

The metal chassis is connected to an external grounded conductor, i.e., the “safety ground” via the supplied AC IN cabling. Shore/Grid power source shall provide earth ground.

The AC power supply has over current protection via an internal fuse. In addition, the AC input is surge protected from over voltage surges.

Safety Controls and Precautions

All personnel involved in the operation, maintenance, and management of the satellite terminal are responsible for adhering to the safety guidelines. Additionally, designated safety officers or supervisors must ensure that safety protocols are always followed.

General Safety Guidelines:

- Prioritize safety over operational tasks.
- Wear appropriate personal protective equipment (PPE) when required.
- Report any safety hazards or concerns immediately to the designated authority.

Electrical Safety:

- Ensure proper grounding and insulation of all electrical components.
- Follow lockout/tagout procedures during maintenance activities.
- Do not overload electrical circuits or use damaged electrical equipment.

WARNING: ELECTRICAL SHOCK HAZARD. Greater than 100 and less than 250 volts alternating current is used in the operation of this equipment. Do not contact electrical connectors when installing or operating this equipment. Personnel are not authorized to conduct maintenance or troubleshoot beyond visual inspection of equipment or specific technical manual procedures. Power to the equipment must be disconnected before working on the equipment.

Connecting or disconnecting power cables while the power is ON can cause electric shock or arcing, especially in wet environments. Ensure that the power is OFF when connecting or disconnecting cables. Failure to comply could result in death or serious injury to personnel.

AC Operation: The metal Chassis needs to be grounded, i.e., connected to an external “safety ground” (sometimes called earth ground). The metal chassis serves as a protective safety barrier, serving as an electrical enclosure.

RF Radiation Safety:

General precautions:

- Minimize exposure to radio frequency (RF) radiation by following established safety protocols.

- Limit the duration of exposure to RF radiation by rotating personnel when necessary.
- Use RF shielding where appropriate to reduce exposure levels.

Additional radiation safety information can be found here:

https://fcc.report/IBFS/SES-LIC-20210803-01361/12144479.pdf

This radiation hazard analysis demonstrates that SpaceX terminals will not result in exposure levels exceeding the applicable MPE limits.

Mitigations should always be implemented for the following warnings:

WARNING: Hazards of Electromagnetic Radiation to Personnel (HERP). To avoid potential excessive RF Radiation exposure, personnel should maintain a safe separation distance of 2 meters from the terminal when powered on. Ensure the terminal is not powered on before accessing it.

WARNING: Hazards of Electromagnetic Radiation to Fuel (HERF). HERF may occur where metal surfaces in a combustible vapor environment (such as fuel nozzles near a fuel tank fill aperture) may become energized by electromagnetic energy, creating a spark that ignites the vapor. Maintain a 3-meter safe separation distance from any fuel sources or refueling operations.

Wind Loading

The STORM V3 terminal is designed for on the move communications and has been trialed on both vehicles and maritime vessels. Users shall independently assess mounting for their specific application. OEM does not certify a specific wind loading value as it is installation specific.

The following values shall be considered when assessing wind loading:

- The largest individual surface area of a STORM V3 is 3.32 sq ft
- Side is 0.43 sq ft.

Structural Safety:

- Regularly inspect the structural integrity of the terminal and address any signs of damage or deterioration promptly.
- Ensure that the terminal is installed on stable ground and adequately anchored to prevent tipping or collapse.

Fire Safety:

- Install and maintain fire detection and suppression systems in accordance with local regulations.
- Keep flammable materials away from the terminal and implement safe storage practices.

Training Requirements:

- Provide comprehensive safety training to all personnel involved in satellite terminal operations.

- Conduct regular safety drills and refresher training sessions to reinforce safety protocols.

Environmental Protection:

- Adhere to environmental regulations and best practices to minimize the impact of terminal operations on the surrounding environment.
- Implement measures to prevent pollution and properly dispose of waste materials.

Security Measures:

- Implement security measures to prevent unauthorized access to the terminal's equipment and facilities.
- Restrict access to sensitive areas and equipment, and regularly review security protocols.

Compliance and Regulations:

1. Ensure compliance with all relevant safety standards, regulations, and industry guidelines.
2. Regularly review and update safety procedures to incorporate any changes in regulations or best practices.

Quick Setup Guide – Standard

1. Connect Power Source
   a. Ensure adequate source power is provided for maximum load (Refer to Electrical Interfaces for electrical requirements).

2. After connecting at least one power source, press the ON/OFF button. The button should remain recessed in the ON state, it will illuminate.

3. StarLink/StarShield boot up timeline:
   a. 5 minutes for the antenna to orient and connect to the StarLink network
   b. 15 minutes for the connection to stabilize and achieve maximum available data rates

4. Connect to the network via any available ethernet port.

Configuration Guide – Standard

StarLink / StarShield Configuration

1. Log into STARLINK account
2. Identify the terminal you want to work with. In this example we will use STORMV3 COTM
3. Click on Manage next to STORMV3 COTM

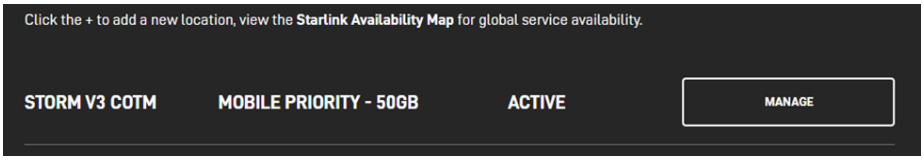


Figure 19: StarLink Account Antenna Selection

4. Under the DEVICES select CONFIGURE to access the Snow Melt Mode and Location Request Mode window.

Figure 20: StarLink Account Configure Selection

5. Select required settings and click save.

Figure 21: Snow Melt, Location Request Mode, & Defer Software Settings

Configuration MikroTik Router

GUI IP Address: 192.168.88.1

Default password: P@55w0rd!

Default username: admin

To simplify setup contact support@copasat.com to receive a pre-configured configuration file.

1. Power on the Terminal
2. Connect a computer with an ethernet cable to the terminal.
3. On a connected computer and navigate to the Command (CMD) Prompt App. This can be done by typing "CMD" into the Search bar on the lower left of the screen.
4. Execute the following command "ping 192.168.88.1"in to CMD App. A series of confirming replies (about one a second) will verify the computer is able to communicate with the MikroTik router.
5. If a series of replies says, "Request time out." that indicates the computer is not communicating with the router and the router should be reset, refer to the troubleshooting section.
6. Once confirmation of connection is established, on the computer open a web browser to IP address "192.168.88.1". This will take you to MikroTik's GUI. See figure below.

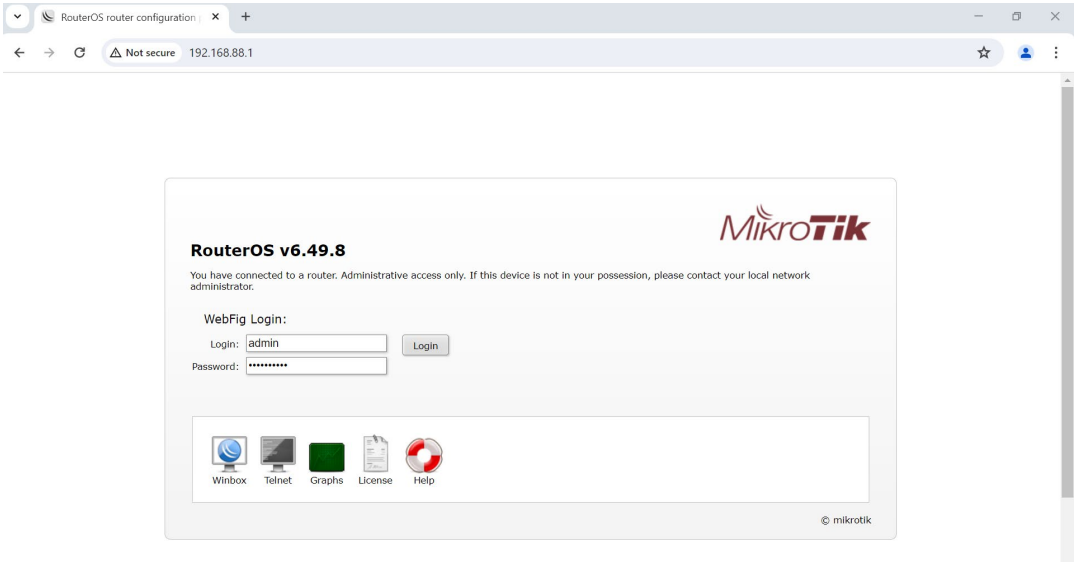


Figure 22: MikroTik GUI Portal

7. Each MikroTik Router has the default password: P@55w0rd! and a default username of admin.
8. Once the credentials are accepted it may take you to a screen listing general features. If so, close that screen. See figure below.

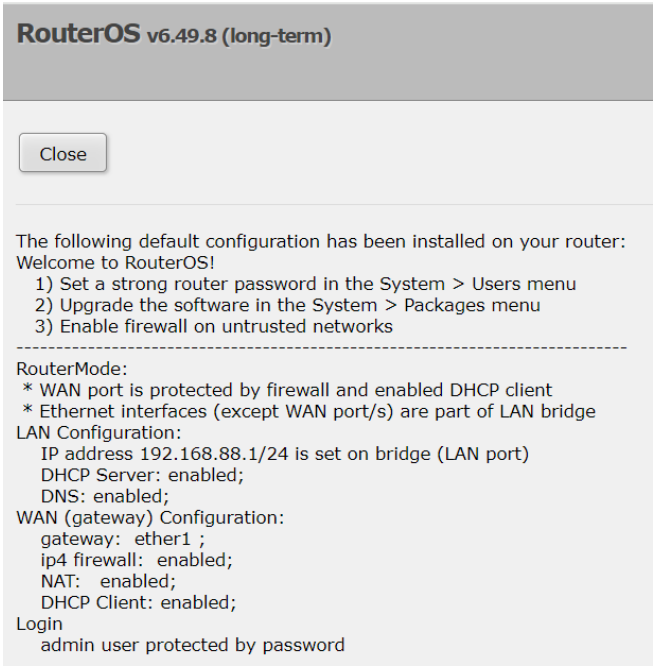


Figure 23: Default Router OS Pop Up

9. Once that screen is closed you will be in the desired location. This screen will have "RouterOS…" on the top left of the screen.

Changing The Password

In this screen, if required, you will be able to change the password. Navigate to the Quick Set tab, scroll down to the right, and click Password. See figure below.

Figure 24: Changing the Router Password

Enter the original "P@55w0rd!" password in the top field. Create the new password by typing the new password into the New Password and Confirm Password fields. Click Password to confirm the password change. See figure below.

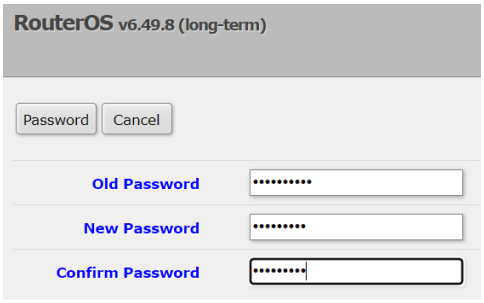
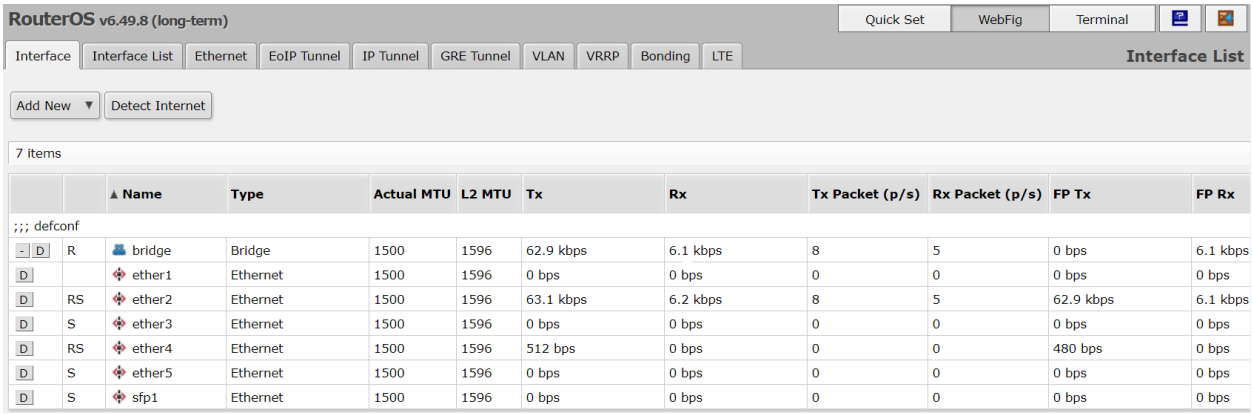


Figure 25: Resetting the Router Password

Viewing Port(s)

Click on the WebFig tab to go to the Interface page to see the active port.



		Name	Type	Actual MTU	L2 MTU	Tx	Rx	Tx Packet (p/s)	Rx Packet (p/s)	FP Tx	FP Rx
;;; defconf											
D	R	bridge	Bridge	1500	1596	62.9 kbps	6.1 kbps	8	5	0 bps	6.1 kbps
D		ether1	Ethernet	1500	1596	0 bps	0 bps	0	0	0 bps	0 bps
D	RS	ether2	Ethernet	1500	1596	63.1 kbps	6.2 kbps	8	5	62.9 kbps	6.1 kbps
D	S	ether3	Ethernet	1500	1596	0 bps	0 bps	0	0	0 bps	0 bps
D	RS	ether4	Ethernet	1500	1596	512 bps	0 bps	0	0	480 bps	0 bps
D	S	ether5	Ethernet	1500	1596	0 bps	0 bps	0	0	0 bps	0 bps
D	S	sfp1	Ethernet	1500	1596	0 bps	0 bps	0	0	0 bps	0 bps

Figure 26: Router Port View

Troubleshooting

Issue: No connection to the GUI or forgotten password

Resolution: Reset the MikroTik Router

Note: After resetting the MikroTik Router ensure any closed ports and any port labels will need to be reconfigured.

MikroTik Factory Reset

1. Power off the terminal.
2. Remove the button cap screw on the front panel of the terminal. Use a small diameter tool (paperclip, screwdriver, etc.) to press and hold the reset button that is internal to the terminal through the hole where you removed the screw.

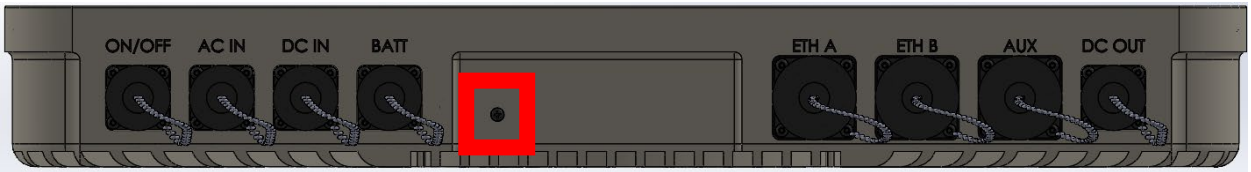


Figure 27: Router Reset Button Access

3. Power the terminal on and wait 5-8 seconds. Then, release the reset button. Holding the reset button in longer will put the router into a different state and will not reset to factory settings.
4. Wait 90 seconds and log back onto the MikroTik website. If the MikroTik is unable to communicate with the website repeat the factory reset process again.
5. Once communication with the MikroTik and MikroTik website is restored repeat all procedural steps of this document from the beginning or restore from a backup file.
6. Reinstall the screw. The screw has an O-ring to prevent moisture intrusion. If lost, please contact CopaSAT for a replacement.

Quick Setup Guide – CCM

1. Connect Power Source
   a. Ensure adequate source power is provided for maximum load (Refer to Electrical Interfaces for electrical requirements).

2. After connecting a power source, press the ON/OFF button. The button should remain recessed in the ON state, it will illuminate.

3. StarLink/StarShield boot up timeline:
   c. 5 minutes for the antenna to orient and connect to the StarLink network
   d. 15 minutes for the connection to stabilize and achieve maximum available data rates

4. Connect to the network via the ethernet port.

Configuration Guide – CCM

The CCM configuration does not include any network components outside of the StarLink / StarShield antenna.

StarLink / StarShield Configuration

1. Log into STARLINK account
2. Identify the terminal you want to work with. In this example we will use STORMV3 COTM
3. Click on Manage next to STORMV3 COTM

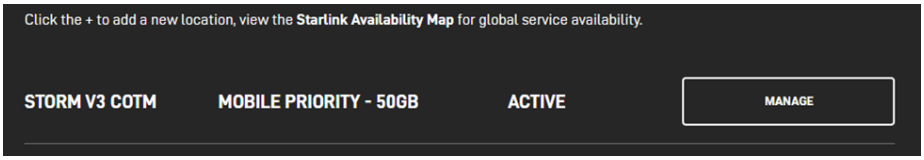


Figure 28: StarLink Account Antenna Selection

4. Under the DEVICES select CONFIGURE to access the Snow Melt Mode and Location Request Mode window.

Figure 29: StarLink Account Configure Selection

5. Select required settings and click save.

Figure 30: Snow Melt, Location Request Mode, & Defer Software Settings

IBR / Cradlepoint Operational Guide

Quick Setup Guide – IBR / Cradlepoint

1. Connect Power Source
   a. Ensure adequate source power is provided for maximum load (Refer to Electrical Interfaces for electrical requirements).

2. After connecting at least one power source, press the ON/OFF button. The button should remain recessed in the ON state, it will illuminate.

3. StarLink/StarShield and Cradlepoint boot up timeline:
   a. 3 minutes for the Cradlepoint to boot up and broadcast the SSID(s)
   b. 5 minutes for the antenna to orient and connect to the StarLink network
   c. 15 minutes for the connection to stabilize and achieve maximum available data rates

4. Default Wi-Fi settings:
   a. SSID: STORM V3 (2.4 GHz) Password: P@55w0rd!
   b. SSID: STORM V3 (5 GHz) Password: P@55w0rd!

5. Default Cradlepoint settings:
   a. Default IP Address: 192.168.0.1
   b. Default Username: admin
   c. Default Password: Cradlepoint Serial Number

   The default Cradlepoint password is the Cradlepoint serial number which is located on the terminal's identification label.

   CradlePoint will automatically reboot after removing the SIM Card door.

Configuration Guide – IBR / Cradlepoint

StarLink / StarShield Configuration

1. Log into STARLINK account
2. Identify the terminal you want to work with. In this example we will use STORMV3 COTM
3. Click on Manage next to STORMV3 COTM

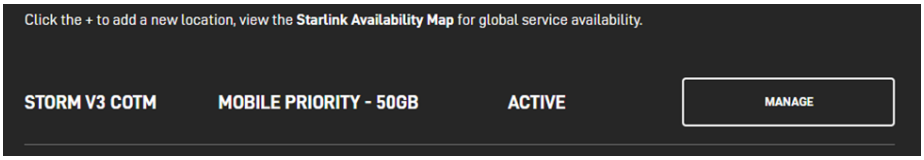


Figure 31: StarLink Account Antenna Selection

4. Under the DEVICES select CONFIGURE to access the Snow Melt Mode and Location Request Mode window.

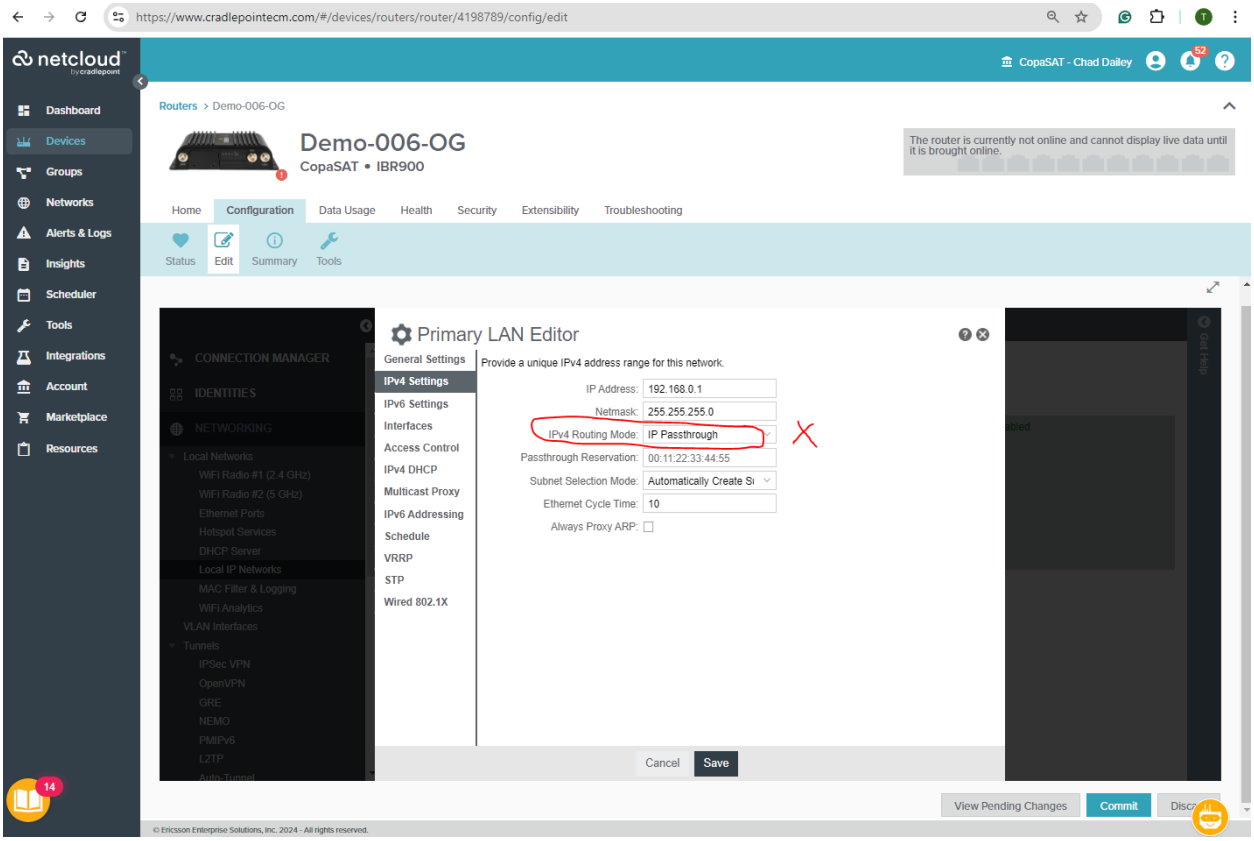
Figure 32: StarLink Account Configure Selection

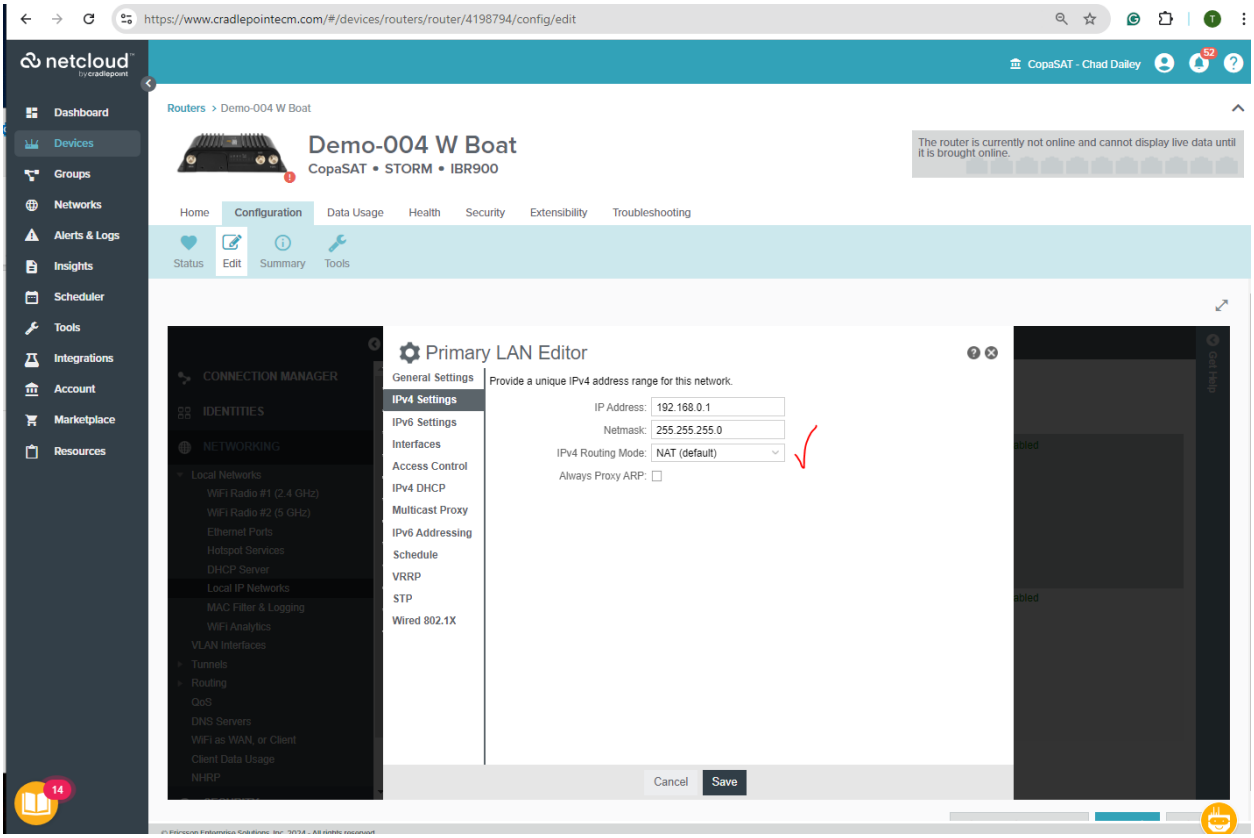
5. Select required settings and click save.

Figure 33: Snow Melt, Location Request Mode, & Defer Software Settings

Cradlepoint Configuration

Warning: Do NOT put the Cradlepoint in Bypass or Bridge mode. There is no physical access to reset the Cradlepoint. Unit will need to be returned to the factory for repair.





Default Cradlepoint settings:

- Default IP Address: 192.168.0.1
- Default Username: admin
- Default Password: Cradlepoint Serial Number

The default Cradlepoint password is the Cradlepoint serial number which is located on the terminal's identification label.

CradlePoint will automatically reboot after removing the SIM Card door.

To access the NetCloud portal navigate to a Web Browser and type into the browser's search bar the CradlePoint IP address "192.168.0.1"

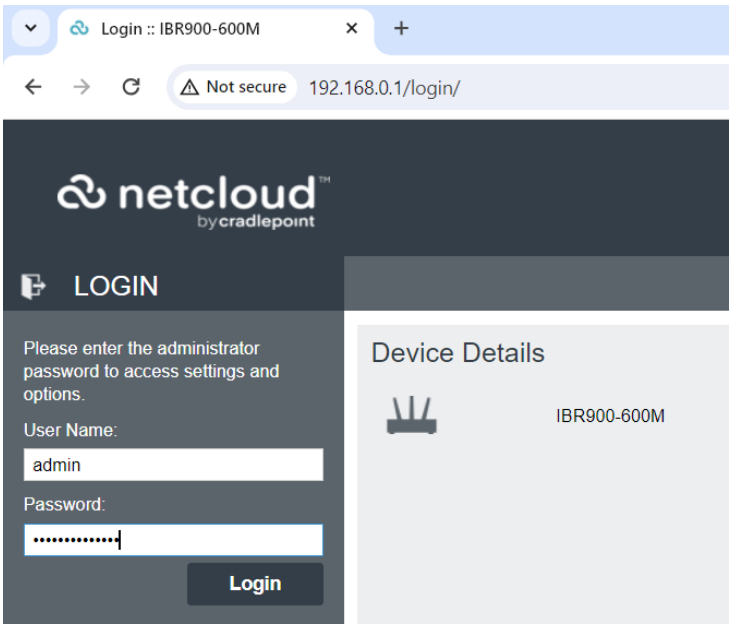


Figure 34: Cradlepoint Login

Configuring Wi-Fi

There are two WiFi channels that can either be Enabled or Disabled. WiFi Radio #1 operates at 2.4 GHz and WiFi Radio #2 operates at 5 GHz.

In the netcloud/cradlepoint website use the toolbar on the left side of the screen and navigate to *Networking > Local Networks > WiFi Radio #1 or WiFi Radio #2*. Under "WiFi Name (SSID)" check the box next to the IBR name and click "Edit".

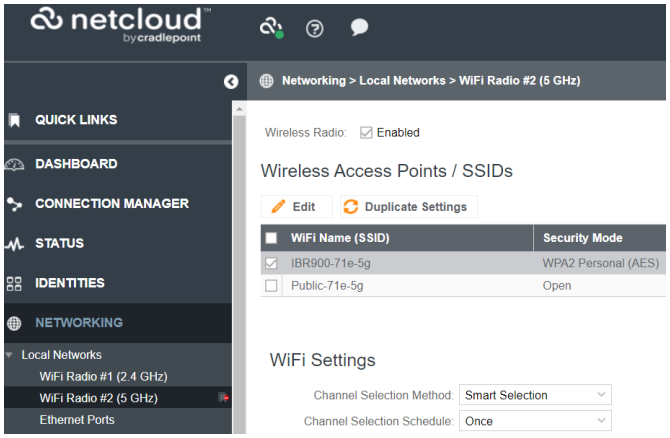
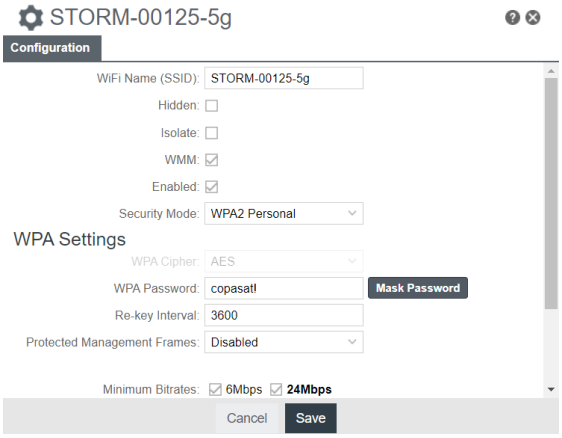


Figure 35: netcloud - navigating to WiFi Radio

- In the "Configuration" tab in the field for "WiFi Name (SSID)" enter your preferred name for the SSID.
- Change the "WPA Password" to your preferred password.
- Optional to select "Unmask Password" to verify the password was input correctly.
- Click "Save".
- Click "Ok" to confirm the settings were successfully saved.



Antenna Routing Policy

On the left sidebar click “Networking”, then click “Routing”, and then click “Static and Policy Routing”. As screen will appear with a top section titled “Route Policies” and a bottom section titled “Route Tables”. On that bottom section, click the checkbox for “Main”. Then, click “Edit”.

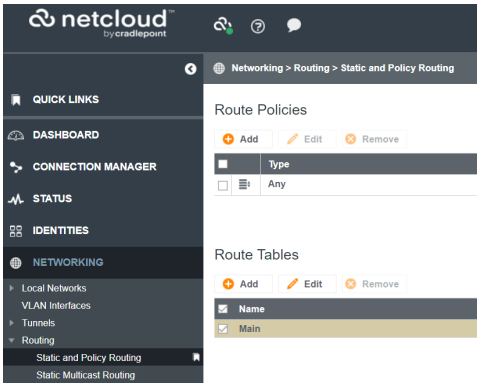


Figure 36: Creating a new routing policy

This will open a window with a header titled “Route Table Editor”. Select “Add”.

Figure 37: Route Table Editor

This will open a window with a header titled “Static Route Editor”. Enter “192.168.100.1” in the “Destination IP/Network Address”. On the “Device” drop down menu select “Ethernet Wan Profile”. Click “Save”. Click “Save” one more time and a screen will appear stating “Settings were successfully saved”. Click “Ok”.

On the PC, navigate to the Command (CMD) Prompt App. This can be done by typing “CMD” into the Search bar on the lower left of the screen.

Type “ping 192.168.100.1” into CMD App. A series of confirming replies (about one a second) will verify the computer is able to communicate with the StarLink/StarShield. If a series of replies says “Timed Out” that indicates the router is not communicating with the router.

On a mobile device (like a smart phone) confirm a connection to a Wi-Fi signal connection to the Terminal and then and navigate to the StarLink App. Confirm with the app that the StarLink / StarShield is online. Use the StarLink App to confirm the Terminal is communicating with the satellite by observing the upper right wherein a proper pairing will say “Online” and a non-pairing will state “Disconnected”.

Environmental Limits

The StarLink / StarShield flat high-performance antenna is designed and manufactured by SpaceX. The antenna is not modified by CopaSAT and is used as is within the STORM V3 assembly. As such the operating temperature limits are limited to the antenna's operating range.

Snow Melt Capability	Up to 75mm / hour (3in / hour)
Operating Temperature	-30°C to 50°C (-22°F to 122°F)
Environmental Rating:	Designed to IP67 (formal verification pending)
Wind Rating	Installation specific

Mechanical Interfaces

STORM V3 Standard Mechanical Interfaces

Mechanical Interface Control Drawing: CS-11-030010 Mechanical ICD.pdf

Standard Mounting Provisions

There are three square patterns of ¼-20 UNC-2B threads (0.250-inch thread depth) which may be used to mount the terminal.

- Thread anti-seize (Loctite LB 8150 or equivalent) is recommended for accessory mounts
- Thread locker (Loctite 242 or 262 with Primer 7471) is recommended for permanent installations
- Max torque: 55 in-lbs.

Dimensions are in inches:

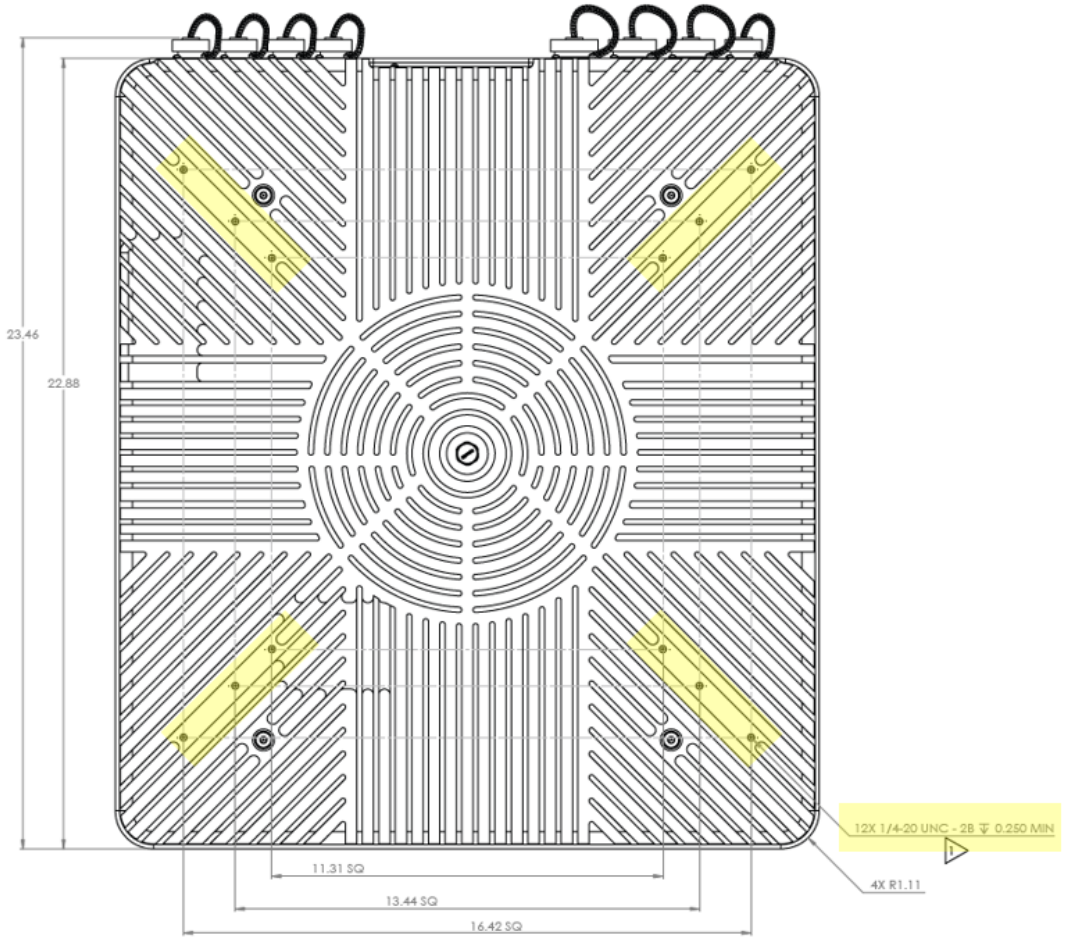


Figure 38: Standard MICD

STORM V3 CCM Mechanical Interfaces

Mechanical Interface Control Drawing: CS-11-030020 Mechanical ICD.pdf

CCM Mounting Provisions

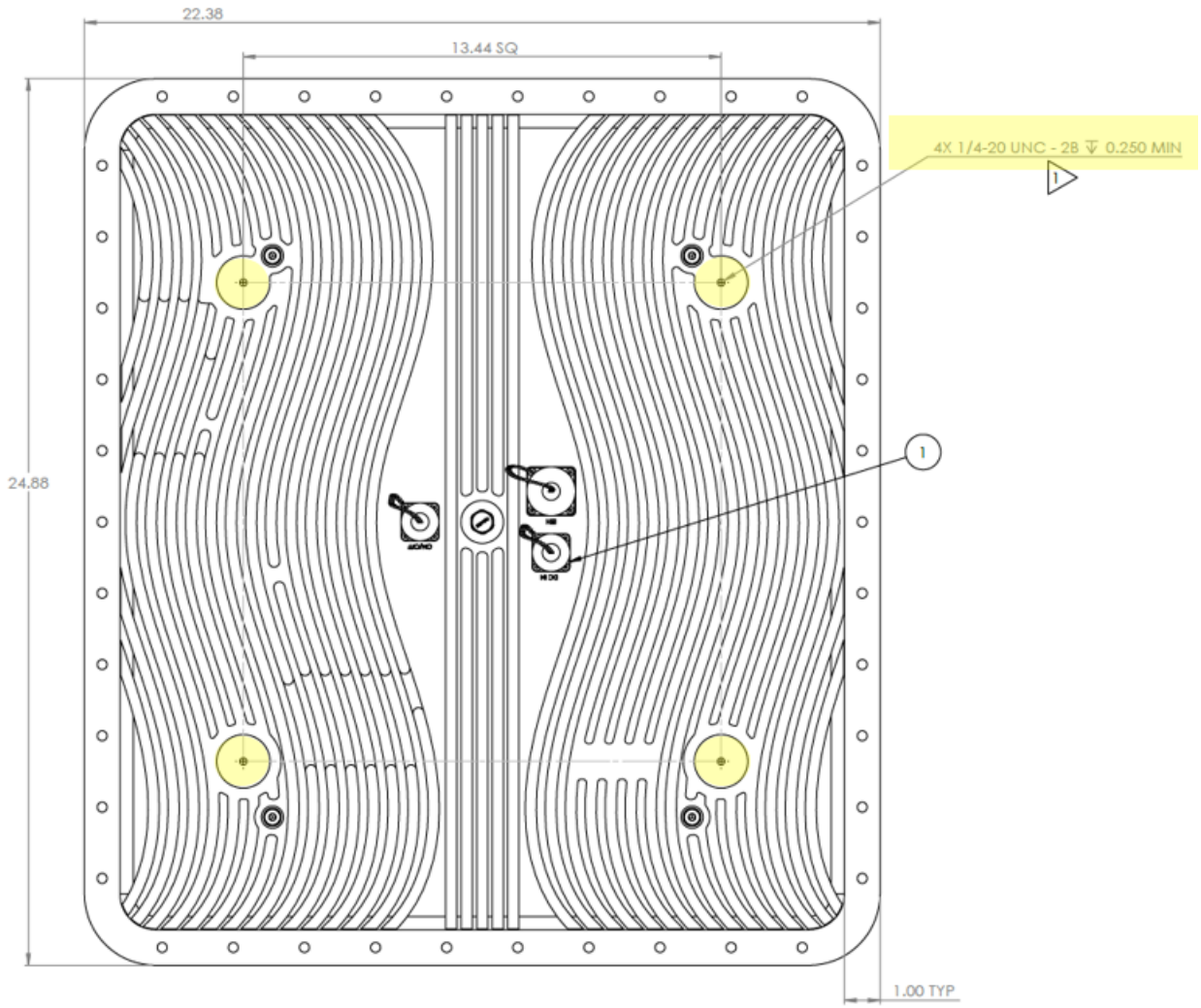
There is a single square pattern of ¼-20 UNC-2B threads (0.250 inch thread depth) which may be used to mount the terminal.

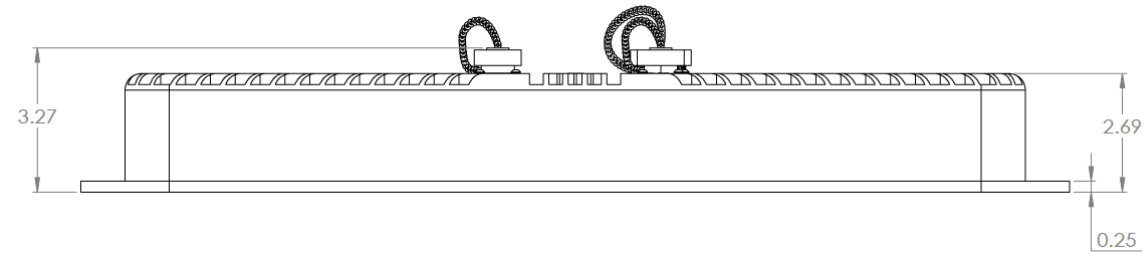
- Thread anti-seize (Loctite LB 8150 or equivalent) is recommended for accessory mounts
- Thread locker (Loctite 242 or 262 with Primer 7471) is recommended for permanent installations
- Max torque: 55 in-lbs.

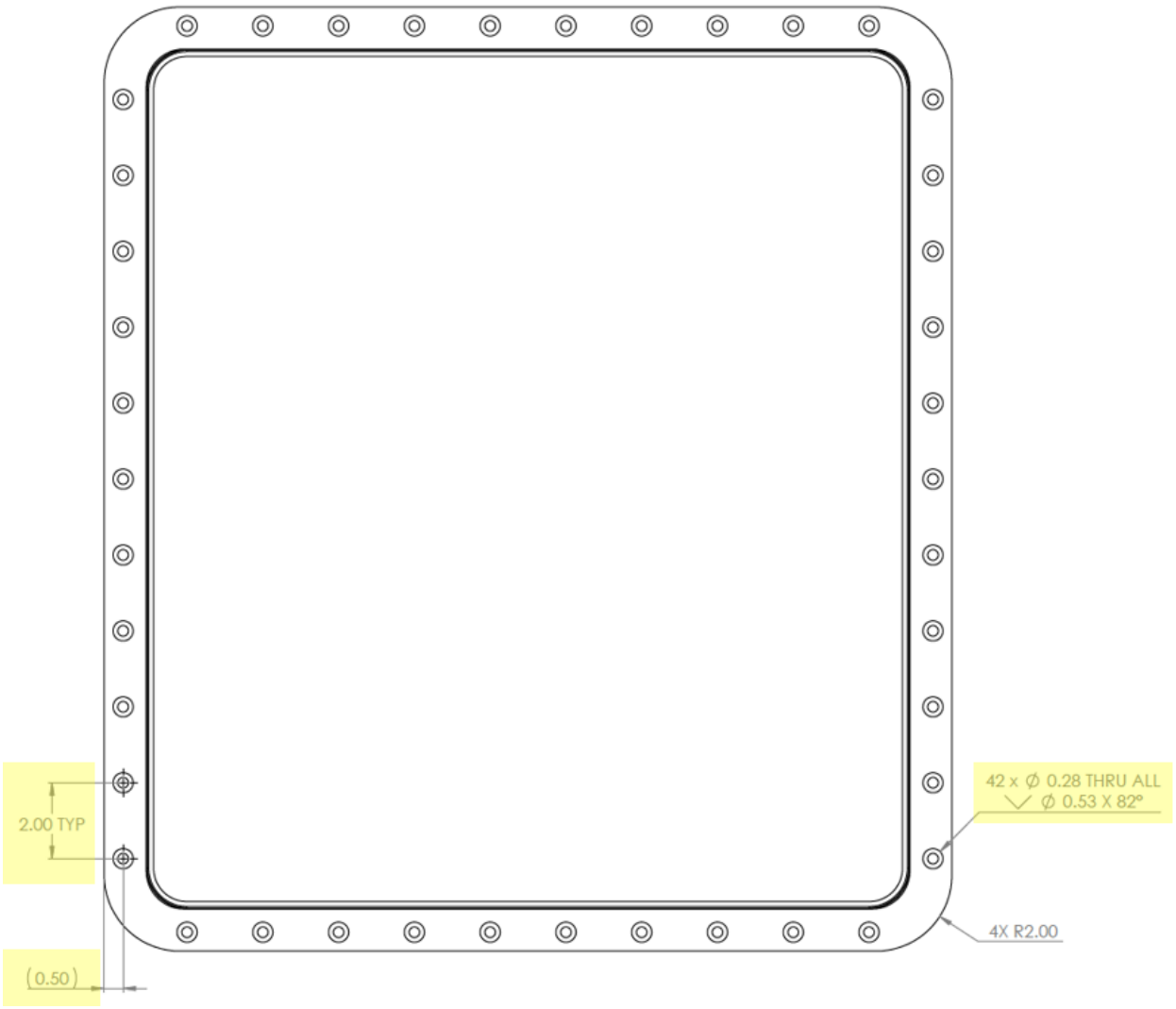
There flange has 42 countersink (82 degrees) clearance holes for a ¼ inch bolt interface.

- Fastener length, material, and torque are installation specific.

Dimensions are in inches:







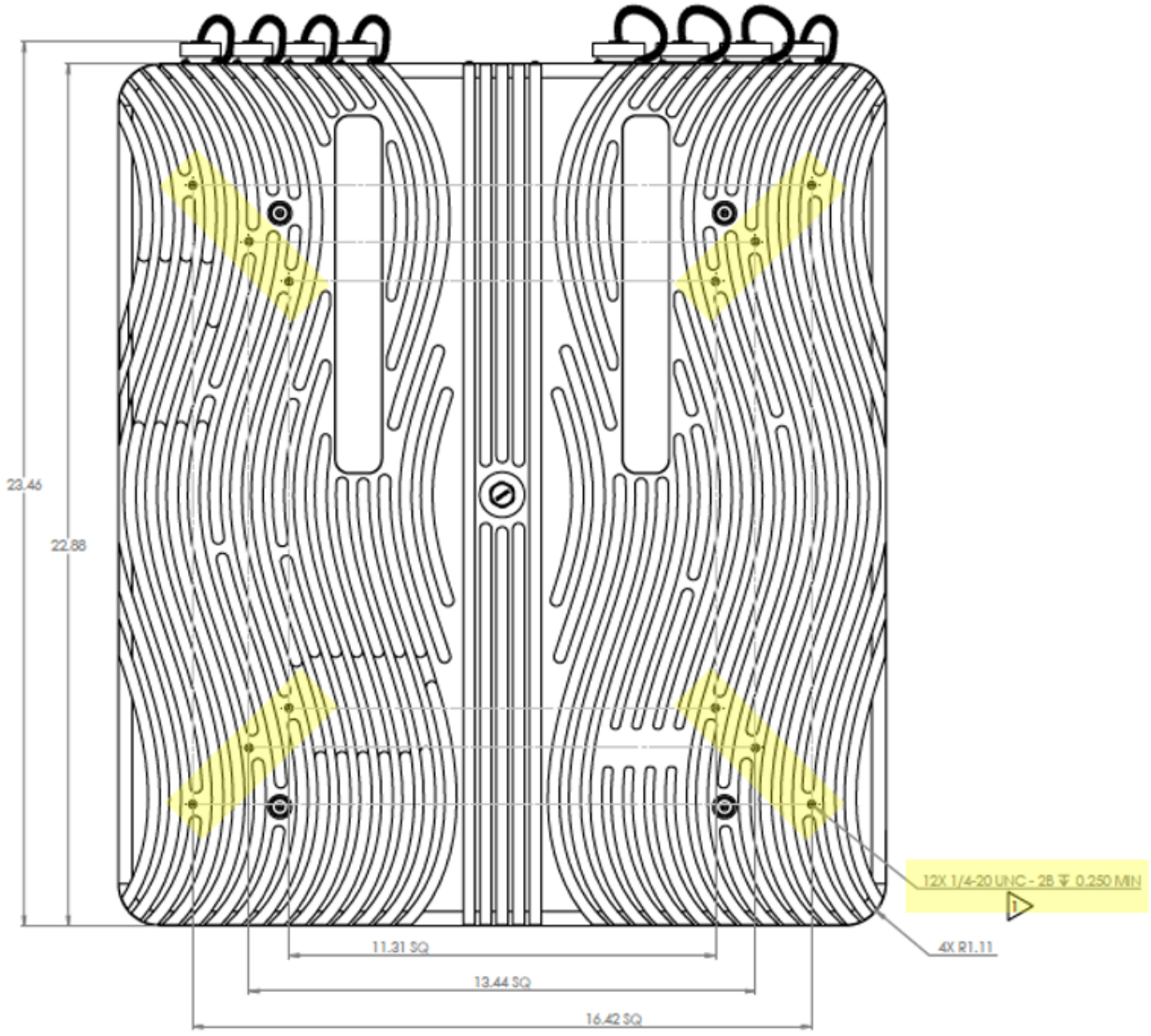
STORM V3 IBR Mechanical Interfaces

Mechanical Interface Control Drawing: CS-11-030030 Mechanical ICD.pdf

IBR Mounting Provisions

There are three square patterns of ¼-20 UNC-2B threads (0.250-inch thread depth) which may be used to mount the terminal.

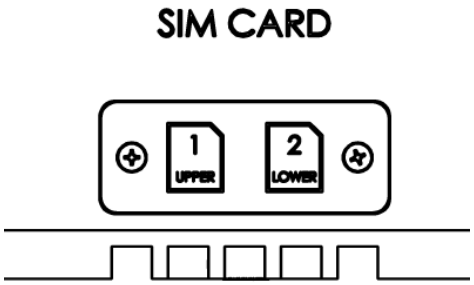
- Thread anti-seize (Loctite LB 8150 or equivalent) is recommended for accessory mounts
- Thread locker (Loctite 242 or 262 with Primer 7471) is recommended for permanent installations
- Max torque: 55 in-lbs.

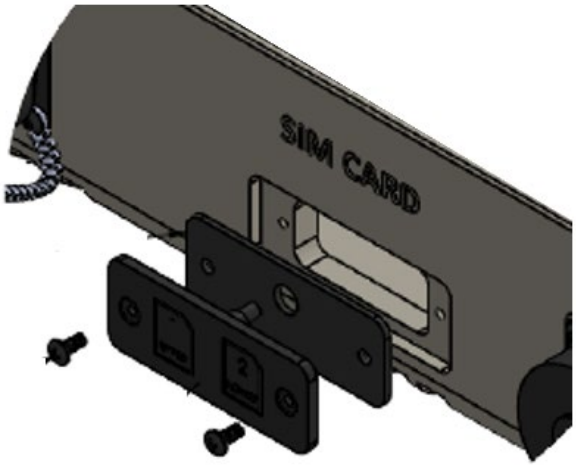


SIM Card Door

The SIM card door is attached with two Philips head fasteners.

- Apply thread locker primer Loctite SF 7471
- Apply thread locker Loctite 222 MS
- Torque to 6 in-lbs.
- Replacement Fastener:
    - Source/Vendor: McMaster-Carr
    - Item Number: 91249A105
    - Fastener Description:
        - Black Oxide Finish
        - 18-8 Stainless Steel
        - Pan Head Phillips Screw
        - 4-40 Thread, ¼” Length





Electrical Interfaces

Voltage Requirements & Current Limits

Table 4: Voltage Requirements

Connector	Voltage	Current (Amps)
AC IN	110 – 240 VAC (50/60 Hz)	4.7A Max
DC IN	12 – 36 VDC	40A Max
BATT	24 VDC nominal (12 - 36 VDC range)	-

Notes:

- Supplied voltage needs to be within range under load.
- Not all units are configured with all available power options.

Power Requirements

Table 5: Power Requirements

	Power Requirements (Watts)					
	Standard		CCM		IBR	
Description	Nominal	Max	Nominal	Max	Nominal	Max
Antenna Acquisition	-	230	-	230	-	230
Antenna Steady State	130	-	130	-	130	-
Snow Melt	-	65	-	65	-	65
Cradlepoint (IBR900) Wi-Fi Tx/Rx	-	-	-	-	9	14
Cradlepoint (IBR900) LTE Tx/Rx	-	-	-	-	6	9
Power Switch LED	1	1	1	1	1	1
12V Out (external device)	12	24	-	-	12	24
Ethernet Switch	-	-	-	-	3	4
Router	18	24	-	-	-	-
High Voltage DC/DC Converter Efficiency (20% Loss)	26	59	39	59	26	59
Low Voltage DC/DC Converter Efficiency (8% Loss)	2.4	3.9	0.0	0.0	2.5	4.1
Total Power Requirement	**189**	**406**	**170**	**355**	**189**	**409**

Power Requirement Notes:

a. Multiple power sources may be connected simultaneously. If multiple power sources are connected the highest priority source will be utilized (Priority ranking: AC > DC > Battery).

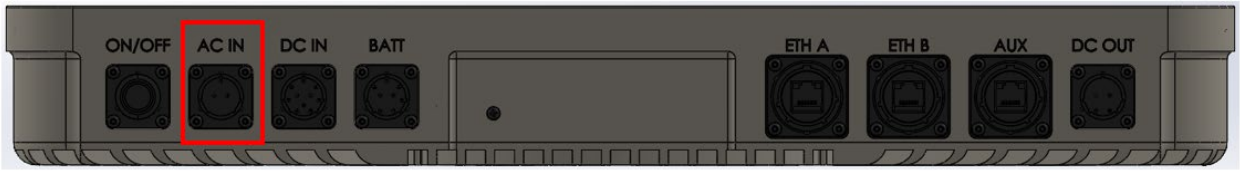
b. If a DC IN power source is utilized the wire gauge and length is dependent on the system voltage used.
c. BATT power source was designed for a pair of BB-2590 or equivalent batteries.
d. System will momentarily turn off when switching either from BATT or to BATT from another power source.

Connector Mechanical Interface Summary

Table 6: Connector Interfaces

DESCRIPTION	MANUFACTURER PN	MATING CONNECTOR PN	VENDOR
AC IN	PT02E-12-3P(025)	PT06E-12-3S(470)	AMPHENOL
DC IN	PT02E-12-10P(025)	PT06E-12-10S(470)	AMPHENOL
BATT	PT02E-12-8P(025)	PT06E-12-8S(470)	AMPHENOL
DC OUT	PT02E-12-4S (025)	PT06E-12-4P (470)	AMPHENOL

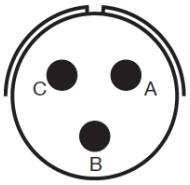
AC Input



Panel mount harness assembly:

- CopaSAT Part Number: CS-61-010220
- Reference designation: W1, AC Input
- Amphenol connector: PT02E-12-3P (025)

Pin Out



A – Line 1

B – Neutral or Line 2

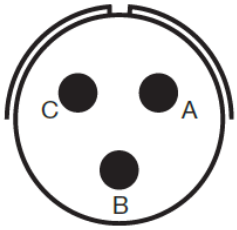
C – Ground

System is agnostic to A and B being swapped.

External cable

- CopaSAT Part Number: CS-44-010160
- Reference designation: W20, AC Power
- Amphenol connector: PT06E-12-3S (470)
- 16 GA wire is standard, custom length may require a different wire gauge

Pin Out



A – Line 1

B – Neutral or Line 2

C – Ground

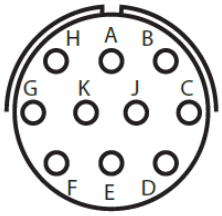
System is agnostic to A and B being swapped.

DC Power

DC Panel mount connector

- CopaSAT Part Number: CS-61-010230
- Reference designation: W2, DC Input
- Amphenol connector: PT02E-12-10P (025)

Pin Out



A through E are POSITIVE (+)

F through K are NEGATIVE (-)

DC External cable

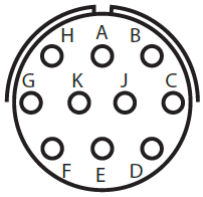
Standard

- CopaSAT Part Number: CS-44-010150
- Reference designation: W30, DC Power
- Amphenol connector: PT06E-12-10S (470)
- 12 GA wire is standard for the bulk of the cable length, custom length may require a different wire gauge
- 30-amp fuse

Right Angle

- CopaSAT Part Number: CS-44-010150-RA
- Reference designation: W31, DC Power

Pin Out



A through E are POSITIVE (+)

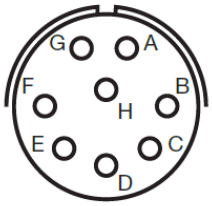
F through K are NEGATIVE (-)

BATT (Battery)

Battery panel mount connector

- CopaSAT Part Number: CS-61-010240
- Reference designation: W3, Battery (Internal)
- Amphenol connector: PT02E-12-8P (025)

Pin Out

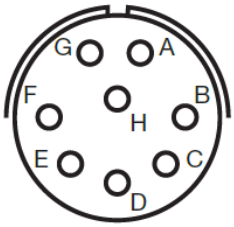


A	POSITIVE (+)	DISCHARGE
B	POSITIVE (+)	DISCHARGE
G	NEGATIVE (-)	DISCHARGE
F	NEGATIVE (-)	DISCHARGE
C	POSITIVE (+)	CHARGE
E	NEGATIVE (-)	CHARGE
D	No Connect	
H	No Connect	

Battery external cable (Discharge)

- CopaSAT Part Number: CS-44-010170
- Reference designation: W40, External Battery Discharge
- Amphenol connector: PT06E-12-8S (470)

Pin Out

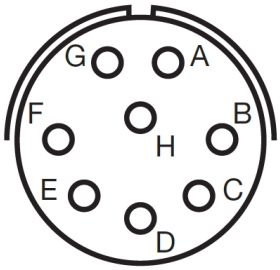


A	POSITIVE (+)
B	POSITIVE (+)
C	No Connect
D	No Connect
E	No Connect
F	NEGATIVE (-)
G	NEGATIVE (-)
H	No Connect

Battery external cable (Charge)

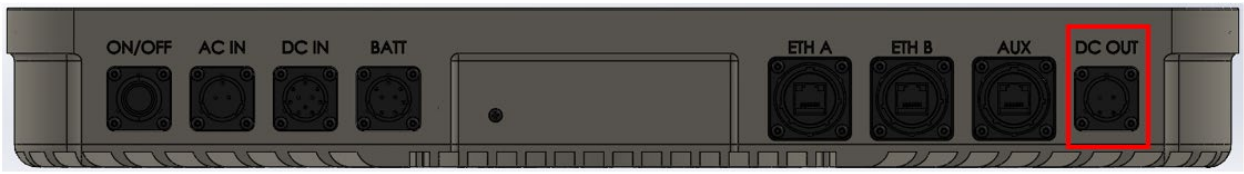
- CopaSAT Part Number: CS-44-010180
- Reference designation: W41, External Battery Charger Single Battery
- Amphenol connector: PT06E-12-8S (470)

Pin Out



A	No Connect	
B	No Connect	
G	No Connect	
F	No Connect	
C	POSITIVE (+)	CHARGE
E	NEGATIVE (-)	CHARGE
D	No Connect	
H	No Connect	

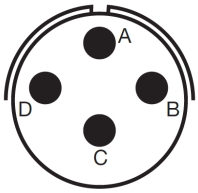
DC Out



DC Out panel mount connector

- CopaSAT Part Number: CS-61-010250
- Reference designation: W4, DC Out (Internal)
- Amphenol connector: PT02E-12-4S (025)
- Max Power: 20 Watts
- Nominal voltage: 12VDC
    - Configuration change planned to alter this to a 24 VDC supply

Pin Out

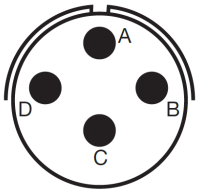


A	POSITIVE (+)
B	POSITIVE (+)
C	NEGATIVE (-)
D	NEGATIVE (-)

DC Out External cable

- CopaSAT Part Number: CS-44-010190
- Reference designation: W50, DC Out
- Amphenol connector: PT06E-12-4P (470)
- 18 GA wire is standard, custom length may require different wire gauge

Pin Out



A	POSITIVE (+)
B	POSITIVE (+)
C	NEGATIVE (-)
D	NEGATIVE (-)

Installation Considerations

The STORM V3 is a very compact and mobile satellite terminal. This is not intended to be a complete guide but is intended to give the user points to consider in order to optimize performance of the terminal.

Your STORM V3 achieves the fastest data rates and has the fewest network issues when it has a clear view of the sky so it can stay connected with satellites as they move overhead. Objects that obstruct the connection between your terminal and the satellite, such as a tree branch, pole, or roof, may cause service interruptions.

- The antenna has a 140-degree field of view.
- An angle (~8 degrees) will prevent water or snow from accumulating on the service which may degrade performance.
- Optimal performance is generally achieved by orienting the terminal North.
- Cabling considerations
    - Minimizing the cable length from the power source will limit voltage loss
- Power considerations
    - Operating on the highest voltage available within the unit's input range will reduce strain on the power supply and provide additional operating margin.
- Thermal considerations
    - The terminal has no active cooling and therefore benefits from minimizing additional heat loading which may occur from the ground, other devices, the sun, etc.
    - An air gap under the terminal is recommended, particularly for non-mobile applications, the larger the separation from the terminal to other objects is ideal.
    - In extreme environments considerations may need to be taken to maintain the terminal's thermal profile within its design parameters. This may necessitate a trade of increased obstructions to limit solar loading.

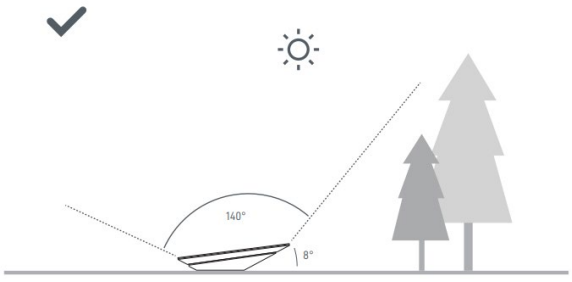


Figure 39: Installation Viewing Angles

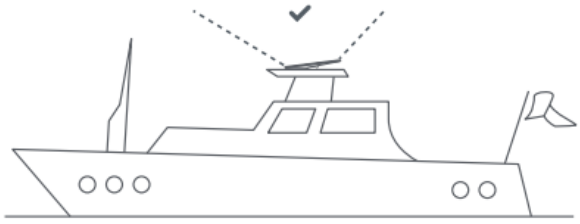


Figure 40: Installation Reference Maritime

Antenna Software Updates

https://starlink-enterprise-guide.readme.io/docs/software-updates

- Software updates are released approximately every two weeks but can be more or less frequent.
- Updates are not scheduled on specific days and are designed to rollout without disrupting service.
- Software updates are downloaded in the background and applied when the terminal reboots.
- Software updates do not count against service priority data limits. Starlink will "zero-count" the data used for updates and telemetry.

Software Update Reboots

- The StarLink will automatically reboot to apply software updates periodically at 3:00 AM local time +/- 30 minutes.
- Local time is based on the current physical location of the StarLink hardware.

Other Information

Static IP

- StarLink does not provide static IP addresses currently.
- The StarLink network is dynamic and from time-to-time IP addresses will change for resilience, as network capacity increases, or when new countries are added to the network.
- If your network is using an IPsec VPN, please configure a "dynamic peer" for the device connected to StarLink.
- Additional information at: https://starlink-enterprise-guide.readme.io/docs/ip-addresses

Service Plans

CopaSAT does not sell or manage service plans at this time. There are numerous service plans offered by SpaceX/StarLink. Generally, different options exist for stationary, mobile, maritime, antenna type (StarLink or StarShield) and network priority. CopaSAT is available to guide you to a subscription provider to support your terminal.

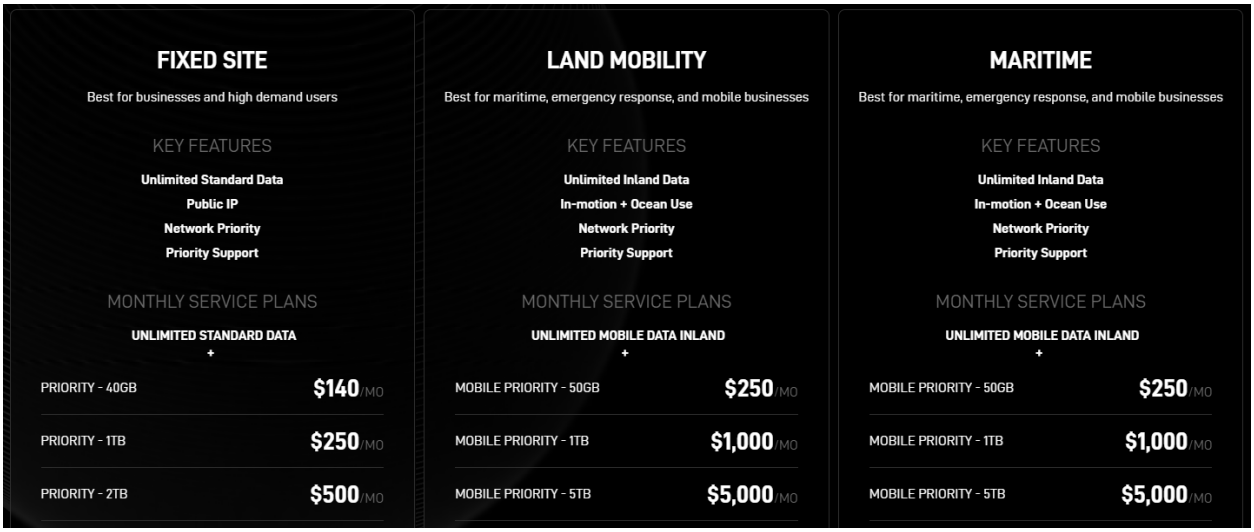


Figure 41: StarLink Service Plan Offerings August 2024

Cleaning

The terminal is best cleaned with warm water and a soft sponge or towel. Mild detergents may be used if required. Brushes with bristles should be avoided to avoid scratching the paint.

The connector caps should always be on when the connection is not used, including during cleaning operations.

Troubleshooting Connectivity

Hardware or Subscription?

The StarLink /StarShield antenna requires an active subscription to provide data services.

This next step will require a physical ethernet connection to the device. Ensure that all alternative network connections are disabled or are physically not connected (ex// Wi-Fi, other LAN devices), this is to ensure that you are able to troubleshoot the unit and not receive false indications of network access.

To assess if there is a hardware issue versus a subscription issue, with the terminal powered on and after sufficient time has elapsed from the initial boot up (approximately 5 minutes) attempt to reach www.StarLink.com. If you can reach www.StarLink.com but are unable to reach any other sites your unit does not have an active subscription. If you are unable to reach www.StarLink.com troubleshoot the hardware first.

Obstructions

It can take up to one week for StarLink to create its obstruction map. As the obstruction map becomes more accurate, StarLink will choose to communicate with satellites in unobstructed parts of the sky when it can.

For best performance, we recommend setting up StarLink with a completely clear view of sky. Obstructions may cause outages when all available satellites are obstructed.

Hardware Troubleshooting

Does the light on the On/Off switch illuminate?

If the light does not illuminate on the power button when depressed:

- No power, insufficient power, or an incompatible power form
- Faulty On/Off switch
- Inspect fuse in DC power cable

For Standard and IBR variants with a DC OUT port. Is there 12-13 VDC between pins A and D?

- If yes, this confirms the 12VDC power bus is functioning. This same power circuit supplies voltage to the MikroTik or the Cradlepoint depending on the variant.

With a Standard (MikroTik) variant are you able to access or ping the router via 192.168.88.1?

- If yes, this confirms:
    - The MikroTik router is powered on.
    - The 12VDC power bus is functioning.
- If no, possible causes:
    - The MikroTik router does not have power.
    - Network connection (ethernet cable(s)) is faulty.

With an IBR (Cradlepoint) variant are you able to access or ping the Cradlepoint via 192.168.0.1?

- If yes, this confirms:
    - The CradlePoint router is powered on
    - The 12VDC power bus is functioning
- If no, possible causes:
    - The CradlePoint router does not have power
    - Network connection (ethernet cable(s)) is faulty

With an IBR (Cradlepoint) variant is it broadcasting a SSID name over Wi-Fi?

- If yes, this confirms:
    - The CradlePoint router is powered on
    - The 12VDC power bus is functioning
- If no, possible causes:
    - The CradlePoint router does not have power
    - The Cradlepoint Wi-Fi network settings have been disabled

A helpful datapoint to troubleshoot the terminal is the current draw. With either AC or DC power sources measuring the current draw will give insight into what may or may not be functioning within the unit.

	Power Requirements (Watts)					
	Standard		CCM		IBR	
Description	Nominal	Max	Nominal	Max	Nominal	Max
Antenna Acquisition	-	230	-	230	-	230
Antenna Steady State	130	-	130	-	130	-
Snow Melt	-	65	-	65	-	65
Cradlepoint (IBR900) Wi-Fi Tx/Rx	-	-	-	-	9	14
Cradlepoint (IBR900) LTE Tx/Rx	-	-	-	-	6	9
Power Switch LED	1	1	1	1	1	1
12V Out (external device)	12	24	-	-	12	24
Ethernet Switch	-	-	-	-	3	4
Router	18	24	-	-	-	-
High Voltage DC/DC Converter Efficiency (20% Loss)	26	59	39	59	26	59
Low Voltage DC/DC Converter Efficiency (8% Loss)	2.4	3.9	0.0	0.0	2.5	4.1
Total Power Requirement	**189**	**406**	**170**	**355**	**189**	**409**

Items to assess based on power readings:

1. If constant (> 5 minutes) high power draw (>200 watts)
    a. Significant data transmit or receive
    b. Software update(s) may be occurring
    c. Obstruction causing antenna to stay in acquisition mode
    d. Snow melt mode activated
2. Steady low power draw (~20 watts)
    a. Antenna is not trying to power on
        i. Sleep mode may be activated
        ii. Antenna may be in self-protect mode (thermal shut down)
2. Regular power cycles without user command (specific to a DC power source):
    a. Antenna will reboot if DC converter drops below 12VDC
    b. Low voltage may be occurring sporadically due to the dynamic power draw of the antenna either during acquisition or during a transmit or receive.
    c. Possible corrective actions:
        i. Increase the supplied voltage (closer to the upper limit of 36VDC)
        ii. Decrease any voltage loss due to cabling
        iii. Ensure that the power source is capable of suppling adequate power and that it is not being current limited (>480W recommended)

Customer Support

support@copasat.com

+1 (727) 647-6110

www.copasat.com

Additional Resources

Vendor Support

- https://support.starlink.com/
- https://cradlepoint.com/support/

Phone Applications

iOS

StarLink App by SpaceX 

Speedtest by Ookla 

Cradlepoint NetCloud 

Google Play

StarLink App by SpaceX 

Speedtest by Ookla 

Cradlepoint NetCloud 

Support Videos:

StarLink Antenna Reboot: https://www.starlink.com/videos/10

Disposal

Proper disposal of this product is the responsibility of the user. Due to the varying nature of local regulations governing the disposal of electronic/hazardous/recyclable (as applicable) waste, CopaSAT, LLC cannot provide specific disposal instructions. Users must comply with all applicable federal, state, and local laws and regulations. This may include, but is not limited to, recycling, collection, and disposal programs. For disposal information, please contact your local waste management authority.

Disposal of Electronic Waste. This product contains electronic components. Do not dispose of this product in household waste.

Caution: This product contains lead and other hazardous materials.

Warranty

Warranty Overview

When you buy a STORM, you'll receive a 12-month manufacturer's warranty covering all hardware outlined in the original purchase agreement. Notably, this includes the StarLink or StarShield antenna, regardless of whether it was supplied to CopaSAT by the government or the customer. After the initial 12 months, any extended warranty will not cover government or customer-supplied equipment. Warranty coverage begins from the moment the product is shipped from the manufacturer.

Extended warrant periods are available for purchase prior to shipment.

Warranty Period Descriptions

Item / Part Number	Description	Warranty Period from the date of shipment
-	Standard Manufacturer Warranty	Through month 12 Example: Ship 1/1/2024, Warranty concludes 12/31/2024
CS-CSXW-02	CopaSAT STORM, Extended Warranty Year 2	Through month 24 Example: Ship 1/1/2024, Warranty concludes 12/31/2025
CS-CSXW-03	CopaSAT STORM, Extended Warranty Year 3	Through month 36 Example: Ship 1/1/2024, Warranty concludes 12/31/2026
CS-CSXW-04	CopaSAT STORM, Extended Warranty Year 4	Through month 48 Example: Ship 1/1/2024, Warranty concludes 12/31/2027
CS-CSXW-05	CopaSAT STORM, Extended Warranty Year 5	Through month 60 Example: Ship 1/1/2024, Warranty concludes 12/31/2028

Warranty and Exclusion of Warranty

The warranties stated herein are in lieu of all other warranties, express or implied, and of all other obligations or liabilities on the part of CopaSAT, and CopaSAT neither assumes nor authorizes any other person to assume for it any other liability. Buyer expressly waives any right, claim or cause of action that might otherwise arise out of purchase or use of CopaSAT's products or service. No product is warranted to be fit for any particular use or application. CopaSAT warrants its products to be merchantable and to be free from defects caused by faulty material or poor workmanship.

CopaSAT's liability under this warranty is limited to the obligation to repair, or, at its sole option, to credit Buyer's account with purchase price of, or to replace without charge F.O.B. factory and part of, any such product found to be defective under normal use and service within the period of time applicable to the particular product provided:

(a) CopaSAT is promptly notified in writing upon the discovery of any defects

(b) Buyer follows CopaSAT's instructions and applicable procedures as to the disposition or return of the products to CopaSAT, an authorized and designated CopaSAT licensee or service organization,

(c) Buyer assumes payment of all transportation charges,

(d) Exclusions from Warranty Coverage: This warranty does not cover damage or defects resulting from acts of nature, accidents, unauthorized modifications, improper installation, improper maintenance, misuse, abuse, neglect, or failure to follow CopaSAT's instructions and applicable procedures as outlined in the CopaSAT's Operating and Maintenance Manual.

(e) Products were not purchased under terms granted in lieu of warranty. Products not manufactured by carry the same warranty which CopaSAT receives from the manufacturer of the product and no other warranty. All ordered replacement parts or parts replaced during the warranty period assume the unexpired portion of the original parts warranty. After expiration of the original warranty period, ordered replacement parts manufactured by CopaSAT are warranted for ninety (90) days from shipment.

(f) Limitation of Liability for Consequential Damages: In no event shall CopaSAT be liable for any consequential, incidental, indirect, special, or punitive damages, including but not limited to loss of profits, loss of data, or interruption of business, arising out of or in connection with the purchase, use, or performance of CopaSAT 's products, even if CopaSAT has been advised of the possibility of such damages.

Appendix A – SpaceX Radiation Hazard High Performance Antenna

Radiation Hazard Analysis

High Performance Phased Array Earth Station In Motion

Introduction

This analysis calculates the non-ionizing radiation levels for a SpaceX Services, Inc. ("SpaceX Services") high-performance phased array earth station for use on moving platforms ("HP ESIM"). The calculations performed in this analysis comply with the methods described in FCC Office of Engineering and Technology Bulletin, Number 65 (Edition 97-01) ("Bulletin 65"). This analysis demonstrates that SpaceX Services HP ESIMs are compliant and will not result in exposure levels exceeding the applicable radiation hazard limits.

Bulletin 65 and Section 1.1310 of the Commission's rules specify two separate tiers of exposure limits: one for Occupational/Controlled Exposures and one for General Population/Uncontrolled Exposures. Limits for Occupational/Controlled Exposures apply in situations where persons are exposed as a consequence of their employment and are fully aware of and can control their exposure. These limits also apply in situations where a person is transient through a location where such limits would otherwise apply provided the person is made aware of the potential for exposure. The limits for General Population/Uncontrolled Exposure apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

SpaceX Services will ensure installation of HP ESIM terminals on vehicles, vessels, and aircraft by qualified installers who have an understanding of the antenna's radiation environment and the measures best suited to maximize protection of the general public and persons operating the vehicle and equipment. Many HP ESIMs will be deployed in Occupational/Controlled Environments. When deployed as ESAAs, they will be installed on the top of commercial aircraft, well away from the public—whether on the airport tarmac (where the public is not allowed) or in flight. In addition, many installations will be made on vehicles and vessels in areas that are inaccessible to the public as well. However, some HP ESIMs will likely be deployed in General Population/Uncontrolled Environments as well. Accordingly, SpaceX will deploy two versions of these terminals that differ only in the software that determines their maximum duty cycle, and will ensure that the higher duty cycle is only deployed in areas that are not accessible to the general public. As a result, this analysis discusses the Maximum Permissible Exposure ("MPE") limit for both the Occupational/Controlled exposures and for General Population/Uncontrolled exposures, which for the Ku-band frequencies used by these HP ESIMs is a power density equal to 5 mW/cm2 averaged over a six-minute period and 1 mW/cm2 averaged over a thirty-minute period, respectively.[1] [1] *See* 47 C.F.R. § 1.1310(e).

As described in the definitional section below, this report analyzes the maximum power density levels in the vicinity of an HP ESIM antenna in three regions: (1) the far field, (2) the near field, and (3) near the main reflector surface. These radiation regions were analyzed using the definitions and formulas in Bulletin 65 for aperture antennas. Note that the SpaceX Services HP ESIM is a flat phased array, such that the other region normally included in analyses for parabolic dishes.

(i.e., between the main reflector and the feed) is not applicable in this case.[2] The results of this analysis are summarized in Table 1 (for the General Population/Uncontrolled version) and Table 2 (for the Occupational/Controlled version), each of which identifies the potential exposure under worst-case operating conditions.

HP ESIM Description

The HPESIM is a flat phased array capable of steering its beams to track NGSO satellites passing within its field of view. As the terminal steers the transmitting beam, it also adjusts the power to maintain a constant level at the receiving antenna of its target satellite to the extent possible, compensating for variations in antenna gain and path loss associated with the steering angle. At the phased array's equivalent of an "antenna flange," the highest transmit poweris4.0W. There is no difference in transmit power between HPESIMs at the center or edge of the spot or between clear sky or heavy rain conditions.

The HPESIM transmits bursts of information at designated times that are assigned to the terminal by the network. The duty cycle of the uplink transmissions is controlled by the network and independently monitored by the software controlling the HPESIM; this ensures that the transmit duty cycle of a terminal cannot exceed a specified level under any circumstances.

Explanation of the Analysis

The "Calculated Values" in Tables1and 2are the exposure rates calculated using the formulae from Bulletin 65 for a system with continuous (100% transmit duty cycle) transmission. SpaceX Services HPESIMs, however, transmit only short bursts of data periodically as instructed by the network and are neither designed for nor capable of continuous transmission. Therefore, in order to compute the effective radiated energy of a SpaceX Services HPESIM, the terminal's maximum possible transmitter duty cycle has been used to adjust the values calculated using the Bulletin 65methodology. Accordingly, the calculated figures reflect the total potential for human exposure based on the length of time that the HP ESIM transmits energy during the relevant period for consideration.

Results of Analysis

This analysis demonstrates that the SpaceX Services HPESIM is not a radiation hazard because the terminal does not exceed the MPE limit of 1 mW/cm^2 averaged over a thirty-minute period.

Conclusion

This radiation hazard analysis demonstrates that SpaceX Services HPESIMs will not result in exposure levels exceeding the applicable MPE limits.

Bulletin 65 also calls for consideration of the transition region between near field and far field. However, the power density in the transition region will be less than the maximum power density in the nearfield and more than the minimum power density in the far field for the purpose of evaluating potential exposure. Accordingly, if the analysis demonstrates compliance for both the near field and far field, it necessarily demonstrates compliance for the transition region.

Definitions

1) Far Field Region

The far field region extends outward from the antenna surface, beginning at a distance of $\frac{0.6D^2}{\lambda}$ meters where the D is the diameter of the antenna. The maximum power density is calculated using the equation recommended in Bulletin 65.

2) Near Field Region

The near field region is a volume co-incident with the direction of the main beam extending outward from the antenna surface the length of the near field $\frac{D^2}{4\lambda}$ meters.

3) Transition Region

The transition region is located between the near field region and the far field region. This region has a power density that decreases with increasing distance. Therefore, the power density in the transition region will be less than the maximum power density in the near field and more than the maximum power density in the far field for the purpose of evaluating potential exposure.

4) Region Near the Antenna Surface

The power density near the antenna surface can be estimated as equal to four times the power divided by the area of the main reflector surface (phased array illumination is uniform).

TABLE 1: RADIATION FROM SPACEX HP PHASED ARRAY EARTH STATION IN MOTION

Input Parameters

Antenna Dimensions	$D_1 = 0.52$ m, $D_2 = 0.48$ m
Frequency	$f = 14.5$ GHz
Max Power into antenna	$P_{max} = 4.0$ W
Max EIRP	$EIRP_{max} = 6606.9$ W $10\log(EIRP_{max}) = 38.2\ dBW$
Aperture efficiency [%]	$\eta = 74.2\%$
Maximum Transmit Duty Cycle	$DTx = 15.5\%$

Calculated Values

Wavelength	$\lambda = \frac{c}{f} = 0.0207\ m$
Area of Reflector	$A = 0.2496\ m^2$
Max Antenna Gain	$G_{max} = \frac{\eta 4\pi A}{\lambda^2} = 5437$ $10\log(G_{max}) = 37.35\ dBi$
Length of Near Field	$R_{nf} = \frac{D_1^2}{4\lambda} = 3.27\ m$
Beginning of Far Field	$R_{ff} = 0.6\frac{D_1^2}{\lambda} = 7.84\ m$

Maximum Power Density Calculations

Power Density in Far Field	$S_{ff} = DTx\frac{EIRP_{max}}{4\pi R_{ff}^2} = 0.13\ \frac{mW}{cm^2}$
Power Density in Near Field	$S_{nf} = DTx\frac{4\eta P_{max}}{A} = 0.74\ \frac{mW}{cm^2}$
Power Density at Antenna Surface	$S_{ref} = DTx\frac{4P_{max}}{A} = 0.99\ \frac{mW}{cm^2}$