StreamCaster MIMO Radio User Manual

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Notice

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Revision History

Version	Date	Changes
1.0	September, 2012	Original
1.1	October 9, 2012	Minor Fixes
2.0	January 9, 2012	Updated for StreamScape 2.0
2.1	March 15, 2012	Updated Sensitivity Values. Added cable pinouts
2.2	May 23, 2013	Updated cable pinouts section
2.3	June 5, 2013	Added Tri-Color LED info
3.0	July 1, 2013	Updated for StreamScape 3.0
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3.7	August 20, 2014	Added Safety Disclaimer
3.7.1	September 13, 2014	Updated FCC Clause
3.8	October 23, 2014	Added 10MHz data, added 3822 mechanicals, etc.
3.8.1	October 28, 2014	Added EXT PA related information
3.8.2	November 24, 2014	Added EXT PA Connector Diagram
3.9	March 17, 2015	Updated for SS3.11.3.13
3.10	March 23, 2015	Added SC3822 USB/GPIO Connector Diagram
3.11	May 11, 2015	Updated 5V GPS Voltage for Newer Revs
3.11.1	June 2, 2015	Updated FCC clause to include SC3822
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3.12.1	February 17, 2016	Corrected 3822 Voltage Range in Table 5
3.12.2	April 28, 2016	Added SC4200
3.12.3	August 18, 2016	Added SC4210 to Section 11 FCC Notes
3.12.4	September 15, 2016	Added Custom Frequency Plan instructions
3.12.5	October 7, 2016	Updated Section 12 FCC Notice

3.12.6	December 1, 2016	Updated 3822/4200 Pinout
3.12.6.4	May 22, 2017	Updated for release 3.12.6.4; Added SC4400
3.12.6.5	May 24, 2017	Added Encryption Profile Descriptions
3.12.6.10	August 1, 2017	Added CE info; Added Network Wide Upgrade; Added iPerf description
3.12.6.11	August 24, 2017	Additional CE Updates on Last 2 pages
3.12.6.12	August 30, 2017	More CE Updates
3.12.6.13	October 19, 2017	Final CE Update; Updated SC4200 Mechanical Drawing
3.12.6.14	December 11, 2017	Added disclaimer to Section 5.1.2 Advanced Configuration
3.13.0	March 28, 2018	Updated SC4200 Photo for ODU PTT
3.13.1	May 14, 2018	Added FCC Info for SC4410-235 and SC4480-235
3.15.0.0	May 15, 2018	Added FIPS features
3.15.0.1	July 2, 2018	Added QoS Scheduler feature
3.15.0.2	July 24, 2018	Reformatted FCC Notice section
3.15.0.3	August 15, 2018	Revised Advanced Configurations to match new firmware version
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3.16.1.3	November 11, 2018	Add new LED definitions, and updated screenshots of GUI, revised section 13.4 FCC Identifier N2S-SC44-245, added section 13.5 and 13.6, revised GPS configuration in section 5.1.6, revised Max Power in section 13.6
3.17.0.4	April 2, 2019	Added Virtual IP VLAN to section 5.1.3. Added MAC address and variable GI mode and remove number of retransmissions to section 5.2.1. Updated figure 32 in section 5.1.10. Updated description for network ID in section 5.1.11. Updated figure 26 in section 5.1.4. Added the 4200E/4400E specs.
3.17.0.5	April 24, 2019	Changed section 13.7 to 13.8 and added new section 13.7 Added section 15

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1. General Safety Information

The information that follows, together with local site regulations, should be studied by personnel concerned with the operation or maintenance of the equipment, to ensure awareness of potential hazards.

Switch off supplies before removing covers or disconnecting any RF cables, and before inspecting damaged cables or antennas.

Avoid standing in front of high gain antennas (such as a dish) and never look into the open end of a waveguide or cable where strong RF power may be present.

Users are strongly recommended to return any equipment that requires RF servicing to Silvus Technologies.

CAUTION: This system contains MOS devices. Electro-Static Discharge (ESD) precautions should be employed to prevent accidental damage.

1.1 Health & Safety

Exposure to Non-Ionizing (RF) Radiation/Safe Working Distances

The safe working distance from a transmitting antenna may be calculated from the relationship:

$$D = \sqrt{\frac{P_T \cdot G_R}{4\pi \cdot w}}$$

In which D = safe working distance (meters)

PT = transmitter or combiner power output (watts)

GR = antenna gain ratio = anti log (gain dBi ÷10)

w = power density (watts/square meter)

The RF power density value is determined by reference to safety guidelines for exposure of the human body to non-ionizing radiation. It is important to note that the guidelines adopted differ throughout the world and are from time-to-time re-issued with revised guidelines. For Silvus use, a maximum power density limit of 1w/m² is to be applied when calculating minimum safe working distances.

Important Note: It must be remembered that any transmitting equipment radiating power at frequencies of 100kHz and higher, has the potential to produce thermal and a-thermal effects upon the human body.

To be safe:

a) Operators should not stand or walk in front of any high gain antenna such as dish antennas, nor should they allow anyone else to do so.

b) Operators should not operate any RF transmitter or power amplifier with any of its covers removed, nor should they allow anyone else to do so.

Antenna			Transmitter Power				
Type	**Gain (dBi)**	**Gain Ratio (GR)**	**1W**	**2W**	**4W**	**10W**	**30W**
Omni	3	2	0.4	0.6	0.8	1.3	2.2
Sector	20	100	2.9	4	5.6	9	15.5
Parabolic Dish	35	3162	16	22.5	32	50	87
			Minimum Safe Distance (Meters)				

Table 1 Safe Working Distances

General Safety Notes

- A flashing/steady Red LED status indication is a normal condition, and is not meant to convey a fault condition.
- The Power Disconnect Device for the product is the connector for the external AC/DC Adapter or other DC power source.
- Although the Low Voltage DC powered units are approved for Outdoor use (Dust/Temporary Immersion), the optional AC power option with AC/DC power supply is only certified for indoor use.
- The unit housing serves as a heatsink, and must be mounted on a non-combustible surface.
- The units are not User Serviceable. Contact the manufacturer for further instructions on servicing or repair.
- All symbols, markings and warning statements marked on the equipment are shown below for reference.

Product Symbols

This table describes the symbols marked on the device.

Symbol		Description
	Caution Read User Manual	Please follow all instructions in this User Manual including all warnings, cautions, and precautions before using the Organelle. Unit is not user serviceable. Contact the manufacturer if defective or damaged.
	RoHS Compliant	The product is compliant with the RoHS 2 Directive 2011/65/EU (RoHS 2). (Note: This Symbol may not be marked on device)
	CE	Product complies with the European Union Low Voltage Directive (LVD), RoHS 2 and EMC Directives.
	HOT SURFACE SYMBOL	Please avoid bodily contact with the product housing and do not mount the product on a combustible surface.
	Disposal	Per the European WEEE Directive, please dispose the product in accordance with local regulations

Figure 1 Product Symbols with Definition

- Product cleaning should only be done with a soft cloth and mild detergent, do not use any solvents that might remove case markings or labels.
- The unit, at the end of its useful life is to be disposed in accordance with local regulations, or may be returned to the manufacturer.
- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment and/or equipment performance may be impaired.

1.2 Maximum RF Power Density Limits

The RF Radiation Power Density limit figure recommended by Silvus is based upon guideline levels published in:

a. IEEE standard C95.1 1999 - IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

b. Guidelines for Limiting Exposure to Time-varying Electric, Magnetic & Electromagnetic Fields (up to 300 GHz) published in 1998 by the Secretariat of the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

Both documents define guideline RF power density limits for "Controlled" and "Uncontrolled" environments. An uncontrolled environment is defined as one in which the person subjected to the RF radiation may be unaware of and has no control over the radiation energy received. The uncontrolled environment conditions can arise, even in the best regulated operations and for this reason the limits defined for the uncontrolled environment have been assumed for the RF Central recommended limit.

Documents a) and b) also show the RF power density guidelines to be frequency dependent. Different power density / frequency characteristics are presented in the two documents. To avoid complexity and to avoid areas of uncertainty, Silvus recommends the use of a single power density limit across the frequency range 100 kHz to 300 GHz. The 1w/m² power density limit we recommend satisfies the most stringent of the guidelines published to date.

Footnote: The IICNIRP document may be freely downloaded from the internet at www.icnirp.de/documents/emfgdl.pdf (PDF file).

2. Introduction

The StreamCaster family of MIMO radios was designed with operator ease of use in mind. Each radio is capable of operating in a multitude of configurations that are accessed via simple web pages within the radio. Settings such as transmit power, frequency, channel bandwidth, link adaptation and range control can be accessed by simply using a web browser to log into any radio within the network. This quick start user guide contains all essential information for the user to configure the StreamCaster radio as well as how to run an iperf network test.

3. StreamCaster Network

Each StreamCaster MIMO radio has a fixed static IP address in the 172.20.xx.yy network. The radio operates as a network switch; the user equipment does not need to be on the same subnet as the radio during operation. It is possible to setup a secondary IP address on the radio if the user finds this feature convenient. Setting up a secondary IP address is useful if the user wishes to access the radio's web interface in their network.

4. StreamCaster Hardware Overview

4.1 Hardware Interfaces

SC4400E

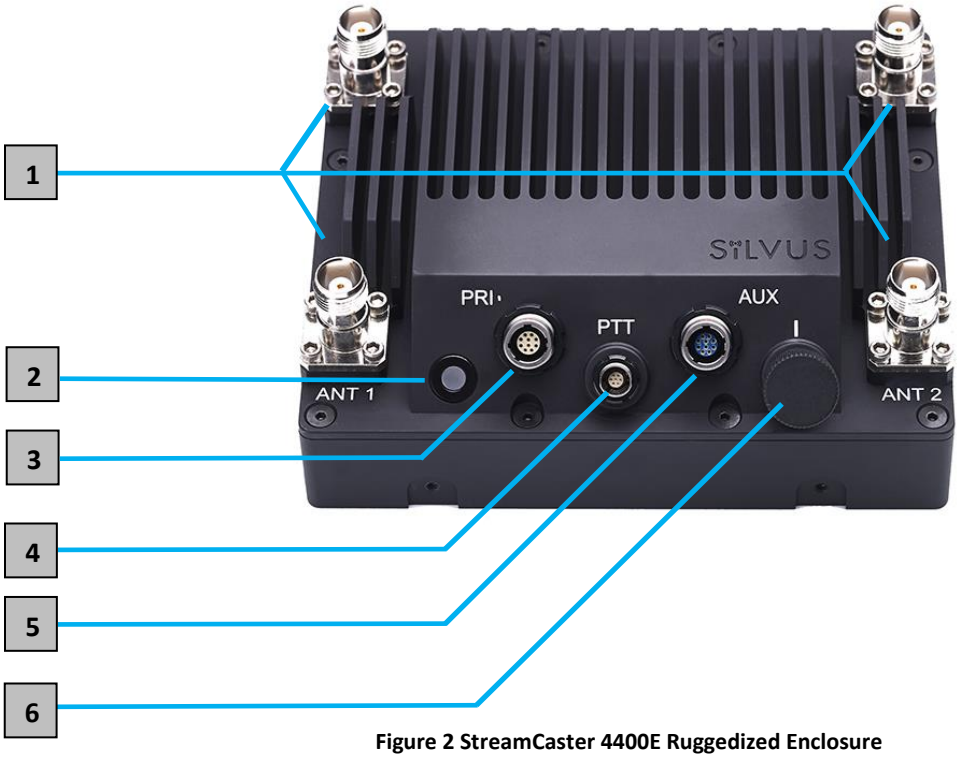


Figure 2 StreamCaster 4400E Ruggedized Enclosure

1 RF Channels 1-4 Connectors [TNC Female]

2 Bi-Color Status LED (See Section 12.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up
- Flashing Green – Radio is fully booted but not wirelessly connected to any other radio
- Green – Radio is wirelessly connected to at least one other radio
- Flashing Red – Spectrum Scan in Progress
- Flashing Red – Radio has recovered from a bad state and has reverted to factory default settings.

- Rapid Flashing Red for 1 second – The battery is less than or equal to 20%. LED will blink red rapidly for 1 second then go back to normal. This will repeat every 5 seconds.
- Rapid Flashing Green – When the multi position switch is rotate to a new position, LED will rapidly flash green while new settings are being applied. LED will resume normal indication after settings have been applied.

3 Power (9-20V), Ethernet, and Serial Port Connector [ODU GK0YAR-P10UC00-000L]

4 Push-to-Talk (PTT) Connector [ODU GKCWAM-P07UB00-000L]

5 AUX Connector [ODU GK0YCR-P10UC00-000L]

6 Power Switch [15-Position Rotating]

SC4200E

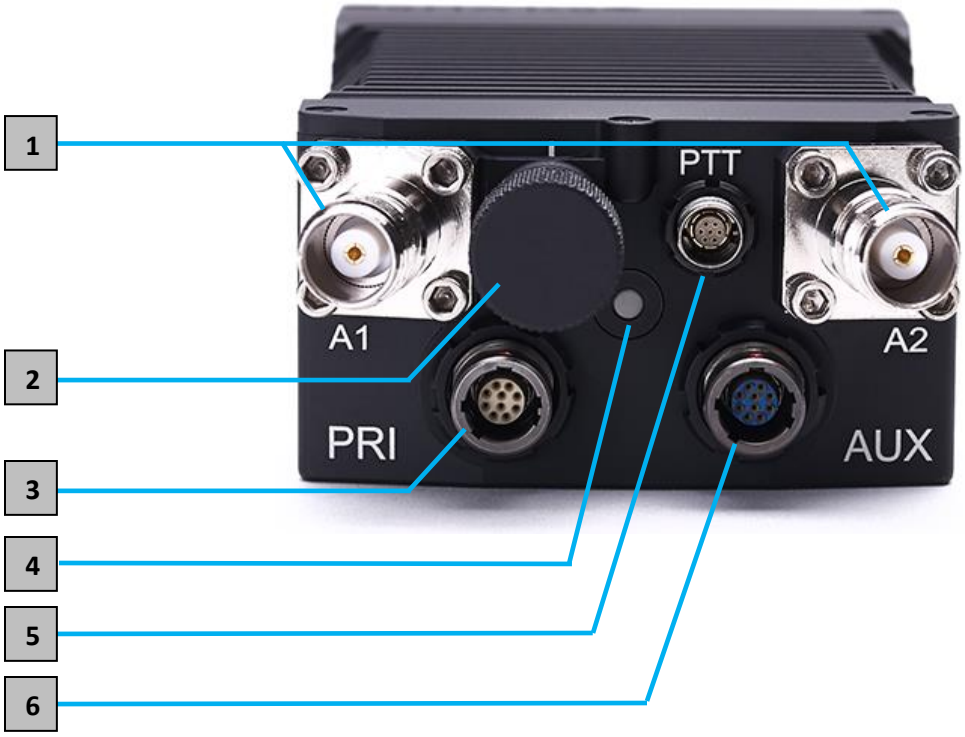


Figure 3 StreamCaster 4200E Ruggedized Enclosure

1 RF Channels 1-2 Connectors [TNC Female]

2 Power Switch [15-Position Rotating]

3 Power (EB Version Only, 9-20V), Ethernet, and Serial Port Connector [ODU GK0YAR-P10UC00-000L]

4 Bi-Color Status LED (See Section 12.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up
- Flashing Green – Radio is fully booted but not wirelessly connected to any other radio
- Green – Radio is wirelessly connected to at least one other radio
- Flashing Red – Spectrum Scan in Progress
- Flashing Red – Radio has recovered from a bad state and has reverted to factory default settings.

- Rapid Flashing Red for 1 second – The battery is less than or equal to 20%. LED will blink red rapidly for 1 second then go back to normal. This will repeat every 5 seconds.
- Rapid Flashing Green – When the multi position switch is rotate to a new position, LED will rapidly flash green while new settings are being applied. LED will resume normal indication after settings have been applied.

5 Push-to-Talk (PTT) Connector [ODU GKCWAM-P07UB00-000L]

6 AUX Connector [ODU GK0YCR-P10UC00-000L]

SC4400:

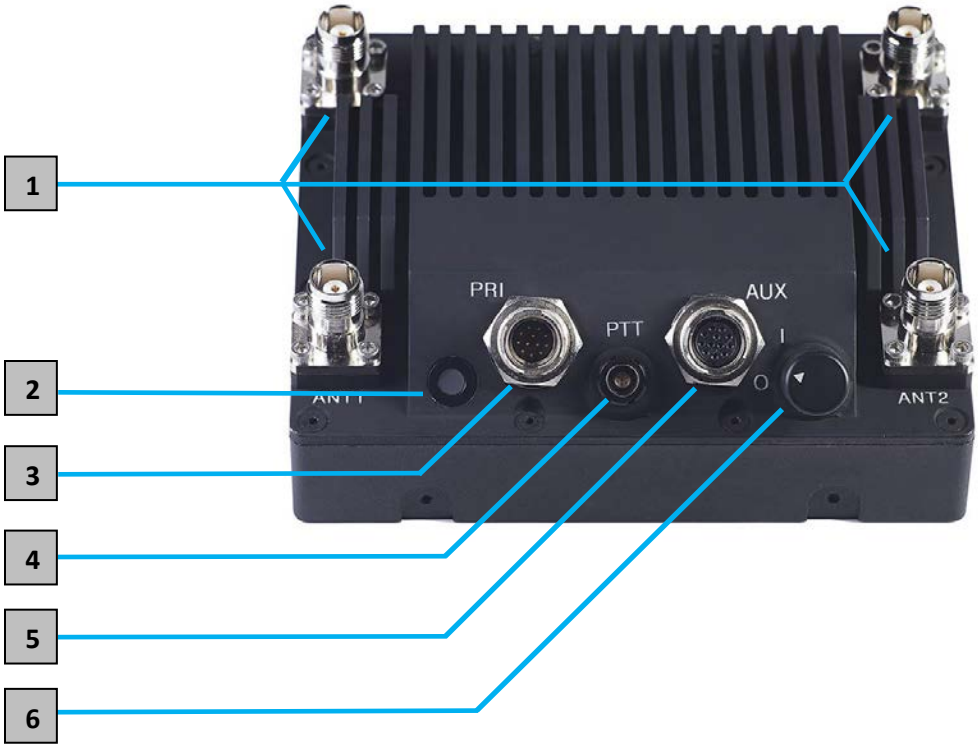


Figure 4 StreamCaster 4400 Ruggedized Enclosure

1 RF Channels 1-4 Connectors [TNC Female]

2 Bi-Color Status LED (See Section 12.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up
- Flashing Green – Radio is fully booted but not wirelessly connected to any other radio
- Green – Radio is wirelessly connected to at least one other radio
- Flashing Red – Spectrum Scan in Progress
- Flashing Red – Radio has recovered from a bad state and has reverted to factory default settings.
- Rapid Flashing Red for 1 second – The battery is less than or equal to 20%. LED will blink red rapidly for 1 second then go back to normal. This will repeat every 5 seconds.

- Rapid Flashing Green – When the multi position switch is rotate to a new position, LED will rapidly flash green while new settings are being applied. LED will resume normal indication after settings have been applied.

3 Power (9-20V), Ethernet, and Serial Port Connector [Hirose LF10WBRB-12PD]

4 Push-to-Talk (PTT) Connector [ODU GKCWAM-P07UB00-000L]

5 AUX Connector [Hirose LF10WBRB-12SD]

6 Power Switch [2-Position Rotating]

SC4200:

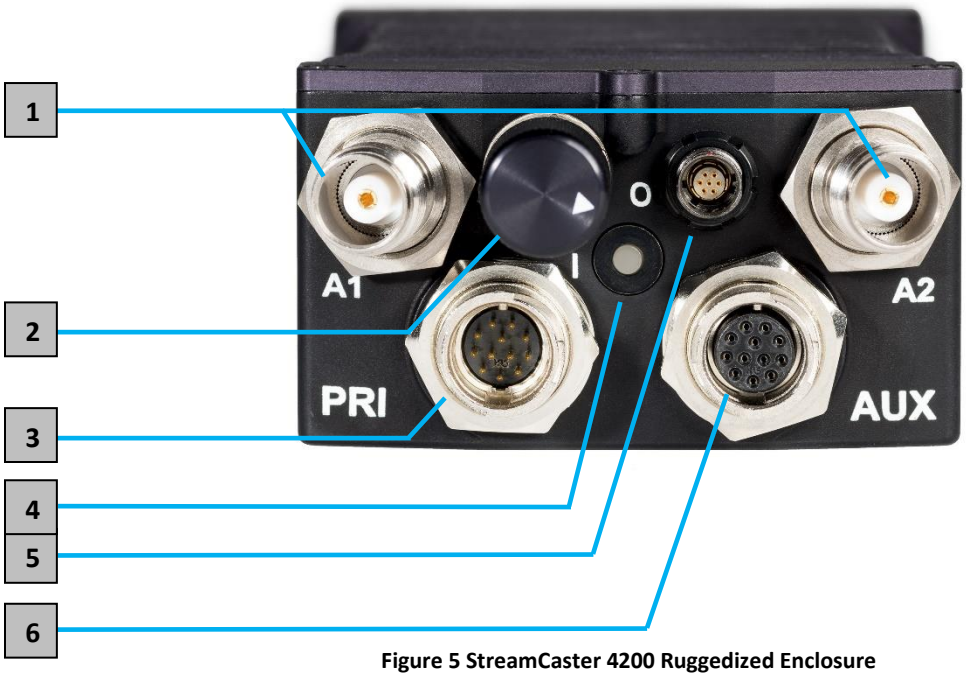


Figure 5 StreamCaster 4200 Ruggedized Enclosure

1 RF Channels 1-2 Connectors [TNC Female]

2 Power Switch [2-Position Rotating]

3 Power (EB Version Only, 9-20V), Ethernet, and Serial Port Connector [Hirose LF10WBRB-12PD]

4 Bi-Color Status LED (See Section 12.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up
- Flashing Green – Radio is fully booted but not wirelessly connected to any other radio
- Green – Radio is wirelessly connected to at least one other radio
- Flashing Red – Spectrum Scan in Progress
- Flashing Red – Radio has recovered from a bad state and has reverted to factory default settings.
- Rapid Flashing Red for 1 second – The battery is less than or equal to 20%. LED will blink red rapidly for 1 second then go back to normal. This will repeat every 5 seconds.

- Rapid Flashing Green – When the multi position switch is rotate to a new position, LED will rapidly flash green while new settings are being applied. LED will resume normal indication after settings have been applied.

5 Push-to-Talk (PTT) Connector [ODU GKCWAM-P07UB00-000L]

6 AUX Connector [Hirose LF10WBRB-12SD]

SC3822:

Figure 6 StreamCaster 3822 Ruggedized Enclosure

1 RF channels 1-2 Connectors [SMA Female]

2 USB/GPIO Connector [Hirose LF10WBRB-12SD]

3 Tri-Color Status LED (See Section 12.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up
- Orange – Radio is fully booted but not wirelessly connected to any other radio
- Green – Radio is wirelessly connected to at least one other radio
- Flashing Red – Radio has recovered from a bad state and has reverted to factory default settings.

4 Power (9-32 VDC), Ethernet, and Serial Port connector [Hirose LF10WBRB-12PD]

SC3500/SC3800:

Figure 4 StreamCaster 3500/3800 Ruggedized Enclosure

1 RF channels 1-4 connectors [TNC Female]

2 Ethernet connector [Mighty-Mouse 801-010-07NF7-10SA]

3 Power (9-20 VDC) and Serial Port connector [Mighty-Mouse 801-010-07NF7-10PA]

4 Tri-Color Status LED (See Section 12.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up
- Orange – Radio is fully booted but not wirelessly connected to any other radio
- Green – Radio is wirelessly connected to at least one other radio
- Flashing Red – Radio has recovered from a bad state and has reverted to factory default settings

5 Power Switch

SC3500/SC3800 with EXT Connector (PA Faceplate Option):

Figure 5 StreamCaster 3500/3800 Ruggedized Enclosure

1 RF channels 1-4 connectors [TNC Female]

2 EXT PA Connector [Mighty-Mouse 801-010-07NF7-25SA]

3 Ethernet connector [Mighty-Mouse 801-010-07NF7-10SA]

4 Power (9-20 VDC) and Serial Port connector [Mighty-Mouse 801-010-07NF7-10PA]

5 Power Switch

6 Tri-Color Status LED (See Section 12.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up
- Orange – Radio is fully booted but not wirelessly connected to any other radio
- Green – Radio is wirelessly connected to at least one other radio
- Flashing Red – Radio has recovered from a bad state and has reverted to factory default settings

4.2 Connector Pinouts

4.2.1 SC4400E Pinouts

SC4400E Power/Ethernet/Serial Connector Pinout		
Enclosure PWR/COMM (GK0YAR-P10UC00-000L)	**Signal**	**Switchcraft Pinout (EN3C2F16X)**
1	5V OUT (For External GPS Puck)	NC
2	GND IN	2
3	VCC IN	1
4	ETH0_MX2N	1
5	ETH0_MX2P	1
6	ETH0_MX1P	NC
7	RS232_RXD	NC
8	RS232_TXD	NC
9	GND	NC
10	ETH0_MX1N	NC

Table 2 SC4400E Power/Ethernet/Serial Connector Pinout

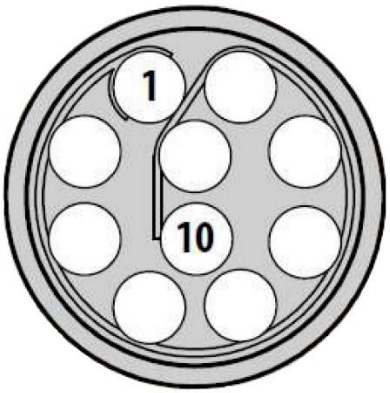


Figure 6 SC4400E Power (Optional)/Serial/Ethernet Pinout Diagram (Cable Side)

SC4400E RS-232 Pinout		
RS-232 (DB9)	**Signal**	**Switchcraft Pinout**
3	TxD	2
2	RxD	1
NC	NC	4
NC	5V OUT	6
NC	NC	5
5	Ground	3

Table 3 SC4400E Serial and GPS Pinout

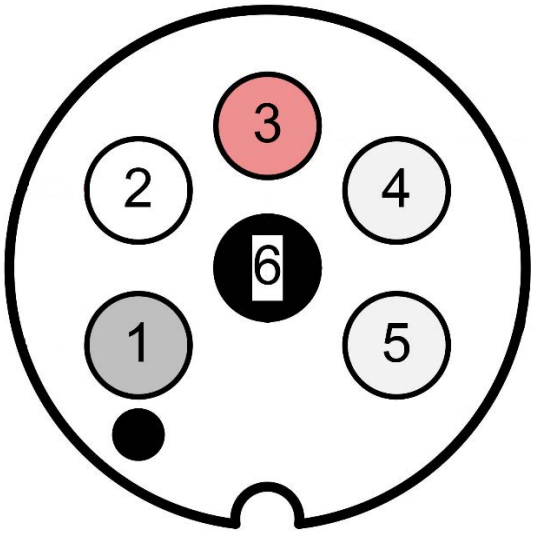


Figure 8 Switchcraft connector on Primary/Power cable

SC4400E AUX Connector Pinout	
Enclosure AUX (LF10WBRB-12SD)	**Signal**
1	USB GND
2	USB1_D-
3	USB1_VBUS
4	USB0_VBUS
5	GPIO1 (BDA control)
6	USB0_D+
7	USB0_D-
8	GND
9	USB1_ID
10	USB1_D+

Table 4 SC4400E USB/GPIO Connector Pinout (USB1 is USB 2.0 OTG, USB2 is USB 2.0 Host Mode Only)

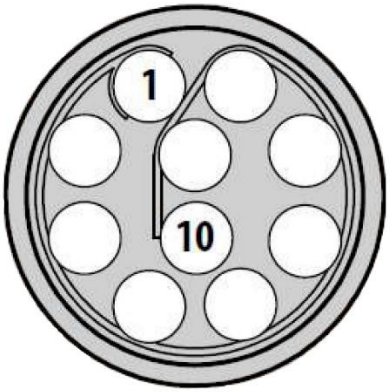


Figure 9 SC4400E AUX Pinout Diagram (Cable Side)

SC4400E PTT Connector	
Enclosure PTT Connector (ODU GKCWAM-P07UB00-000L)	**Signal**
1	RESERVED (Do Not Connect)
2	RESERVED (Do Not Connect)
3	AUDIO_GND
4	PTT
5	SPEAKER_OUT
6	MIC_IN
7	RESERVED (Do Not Connect)

Table 5 SC4400E PTT Connector Pinout

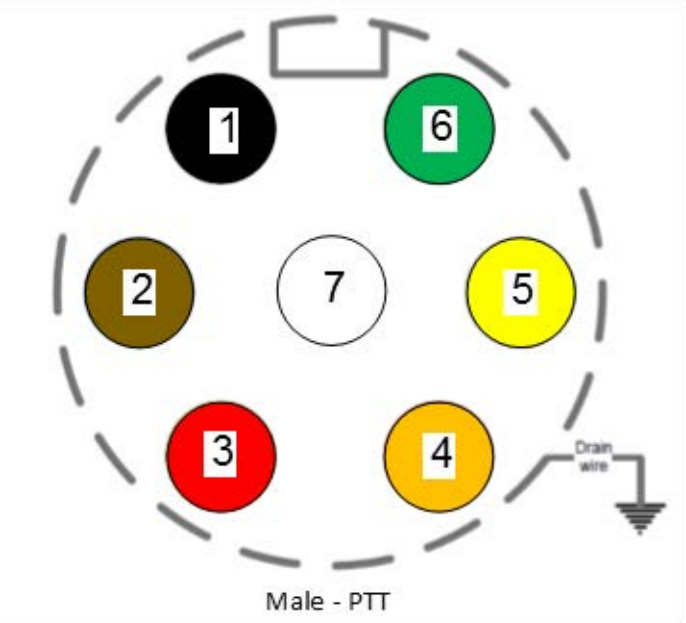


Figure 7 SC4400E PTT Pinout Diagram (Cable Side)

4.2.2 SC4200E Pinouts

SC4200E Power/Ethernet/Serial Connector Pinout		
Enclosure PWR/COMM (GK0YAR-P10UC00-000L)	**Signal**	**Switchcraft Pinout (EN3C2F16X)**
1	5V OUT (For External GPS Puck)	NC
2	GND IN	2
3	VCC IN	1
4	ETH0_MX2N	1
5	ETH0_MX2P	1
6	ETH0_MX1P	NC
7	RS232_RXD	NC
8	RS232_TXD	NC
9	GND	NC
10	ETH0_MX1N	NC

Table 6 SC4200E Power/Ethernet/Serial Connector Pinout

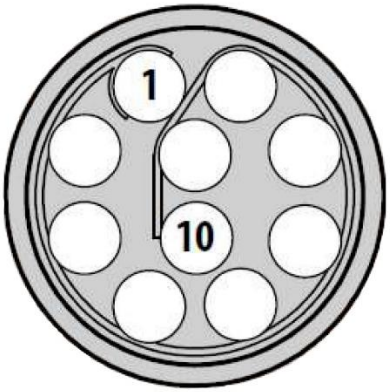


Figure 8 SC4200E Power (Optional)/Serial/Ethernet Pinout Diagram (Cable Side)

SC4200E RS-232 Pinout		
RS-232 (DB9)	**Signal**	**Switchcraft Pinout**
3	TxD	2
2	RxD	1
NC	NC	4
NC	5V OUT	6
NC	NC	5
5	Ground	3

Table 7 SC4200E Serial and GPS Pinout

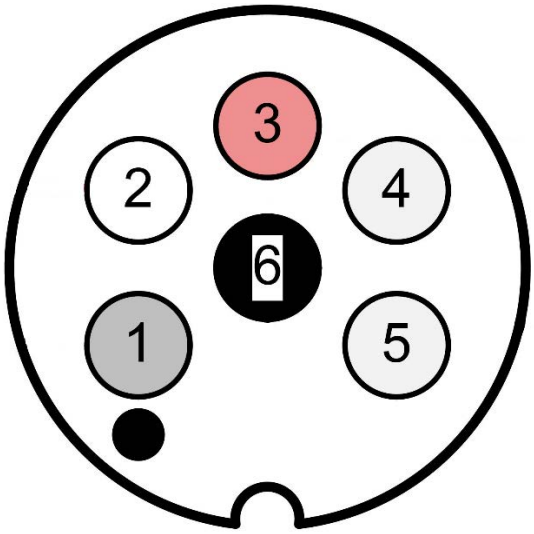


Figure 8 Switchcraft connector on Primary/Power cable

SC4200E AUX Connector Pinout	
Enclosure AUX (LF10WBRB-12SD)	**Signal**
1	USB GND
2	USB1_D-
3	USB1_VBUS
4	USB0_VBUS
5	GPIO1 (BDA control)
6	USB0_D+
7	USB0_D-
8	GND
9	USB1_ID
10	USB1_D+

Table 8 SC4200E USB/GPIO Connector Pinout (USB1 is USB 2.0 OTG, USB2 is USB 2.0 Host Mode Only)

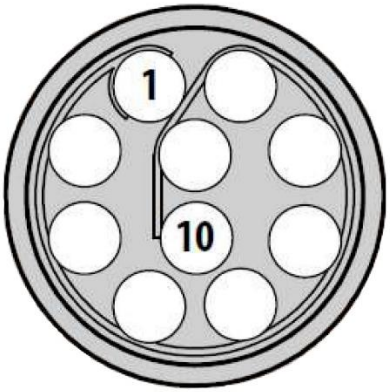


Figure 9 SC4200E AUX Pinout Diagram (Cable Side)

SC4200E PTT Connector	
Enclosure PTT Connector (ODU GKCWAM-P07UB00-000L)	**Signal**
1	RESERVED (Do Not Connect)
2	RESERVED (Do Not Connect)
3	AUDIO_GND
4	PTT
5	SPEAKER_OUT
6	MIC_IN
7	RESERVED (Do Not Connect)

Table 9 SC4200E PTT Connector Pinout

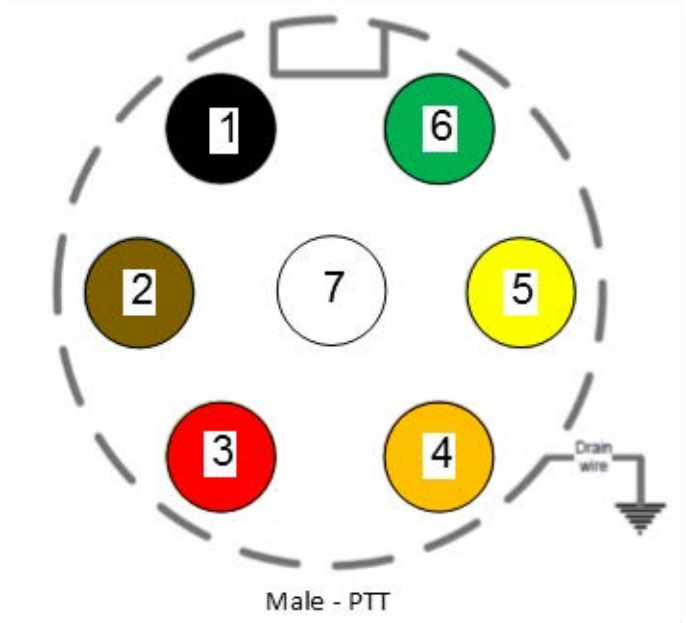


Figure 9 SC4200E PTT Pinout Diagram (Cable Side)

4.2.3 SC4400 Pinouts

SC4400 Power/Ethernet/Serial Connector Pinout		
Enclosure PWR/COMM (LF10WBRB-12PD)	**Signal**	**Switchcraft Pinout (EN3C2F16X)**
1	5V OUT (For External GPS Puck)	NC
2	GND IN	2
3	GND IN	2
4	VCC IN	1
5	VCC IN	1
6	100-Base T ETH0 M2N	NC
7	100-Base T ETH0 M2P	NC
8	100-Base T ETH0 M1P	NC
9	RS232_RXD	NC
10	RS232_TXD	NC
11	RS232_GND	NC
12	100-Base T ETH0 M1N	NC

Table 10 SC4400 Power/Ethernet/Serial Connector Pinout

SC4400 RS-232 and PS/2 (GPS) Pinout			
RS-232	**PS/2 (GPS)**	**Signal**	**Switchcraft Pinout**
3	4	TxD	2
2	5	RxD	1
NC	NC	NC	4
NC	2	5V OUT	6
NC	NC	NC	5
5	1	Ground	3

Table 11 SC4400 Serial and GPS Pinout

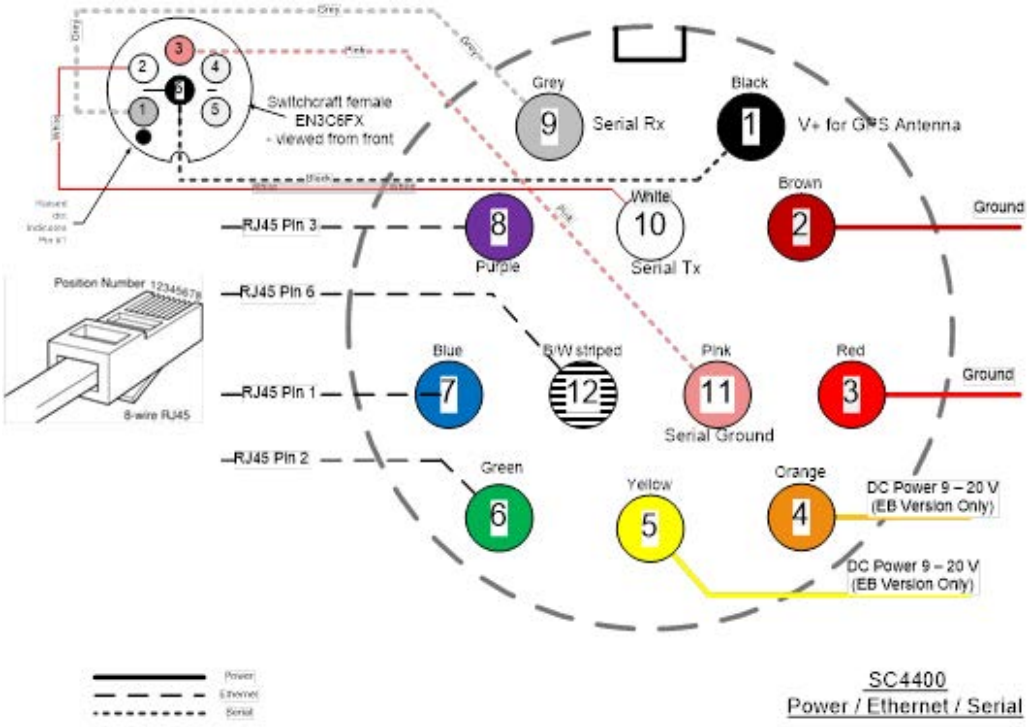


Figure 10 SC4400 Power (Optional)/Serial/Ethernet Pinout Diagram (Cable Side)

SC4400 AUX Connector Pinout	
Enclosure AUX (LF10WBRB-12SD)	**Signal**
1	USB1_GND
2	USB1_D-
3	USB1_VBUS
4	USB2_VBUS
5	GPIO1 (PA Enable 3.3V)
6	USB2_D+
7	USB2_D-
8	RESERVED (Do Not Connect)
9	GND
10	USB1_Sense
11	USB1_D+
12	USB2_GND

Table 12 SC4400 USB/GPIO Connector Pinout (USB1 is USB 2.0 OTG, USB2 is USB 2.0 Host Mode Only)

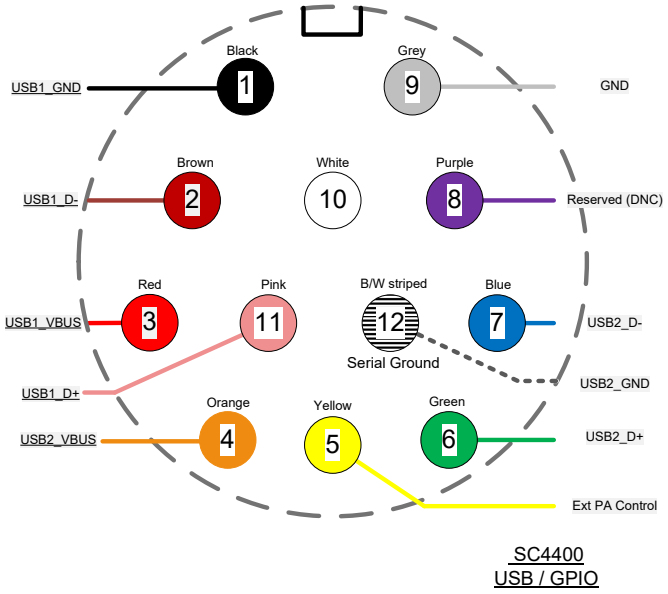


Figure 11 SC4400 AUX Pinout Diagram (Cable Side)

SC4400 PTT Connector	
Enclosure PTT Connector (ODU GKCWAM-P07UB00-000L)	**Signal**
1	RESERVED (Do Not Connect)
2	RESERVED (Do Not Connect)
3	AUDIO_GND
4	PTT
5	SPEAKER_OUT
6	MIC_IN
7	RESERVED (Do Not Connect)

Table 13 SC4400 PTT Connector Pinout

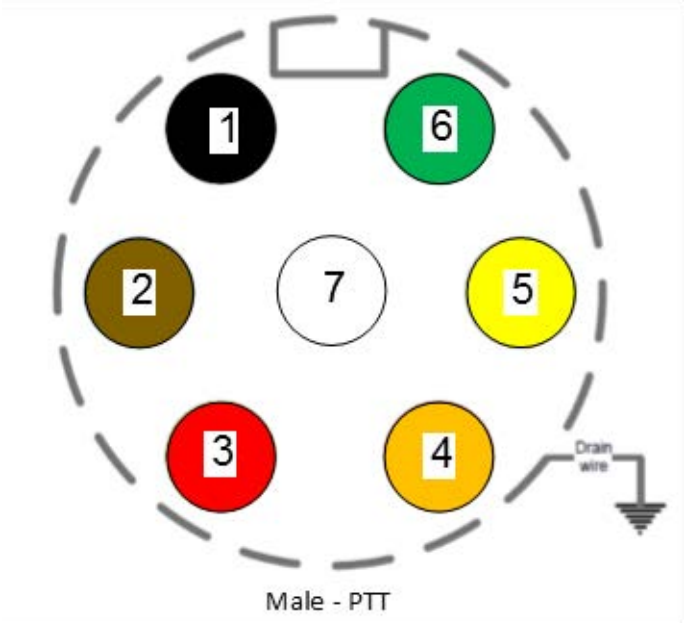


Figure 12 SC4400 PTT Pinout Diagram (Cable Side)

4.2.4 SC4200 Pinouts

SC4200 Power/Ethernet/Serial Connector Pinout		
Enclosure PWR/COMM (LF10WBRB-12PD)	**Signal**	**Switchcraft Pinout (EN3C2F16X)**
1	5V OUT (For External GPS Puck)	NC
2	GND IN (External Power Option Only)	2
3	GND IN (External Power Option Only)	2
4	VCC IN (External Power Option Only)	1
5	VCC IN (External Power Option Only)	1
6	100-Base T ETH0 M2N	NC
7	100-Base T ETH0 M2P	NC
8	100-Base T ETH0 M1P	NC
9	RS232_RXD	NC
10	RS232_TXD	NC
11	RS232_GND	NC
12	100-Base T ETH0 M1N	NC

Table 14 SC4200 Power/Ethernet/Serial Connector Pinout

SC4200 RS-232 and PS/2 (GPS) Pinout			
RS-232	**PS/2 (GPS)**	**Signal**	**Switchcraft Pinout**
3	4	TxD	2
2	5	RxD	1
NC	NC	NC	4
NC	2	5V OUT	6
NC	NC	NC	5
5	1	Ground	3

Table 15 SC4200 Serial and GPS Pinout

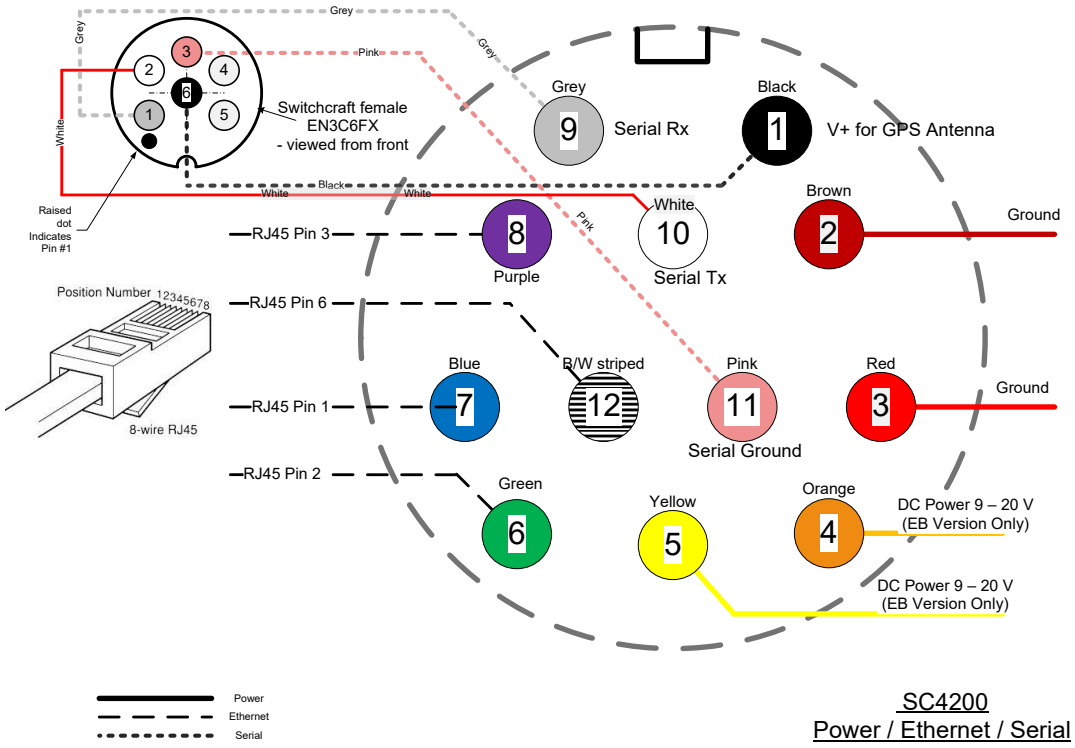


Figure 13 SC4200 Power (Optional)/Serial/Ethernet Pinout Diagram (Cable Side)

SC4200 AUX Connector Pinout	
Enclosure AUX (LF10WBRB-12SD)	**Signal**
1	USB1_GND
2	USB1_D-
3	USB1_VBUS
4	USB2_VBUS
5	GPIO1 (PA Enable 3.3V)
6	USB2_D+
7	USB2_D-
8	RESERVED (Do Not Connect)
9	GND
10	USB1_Sense
11	USB1_D+
12	USB2_GND

Table 16 SC4200 USB/GPIO Connector Pinout (USB1 is USB 2.0 OTG, USB2 is USB 2.0 Host Mode Only)

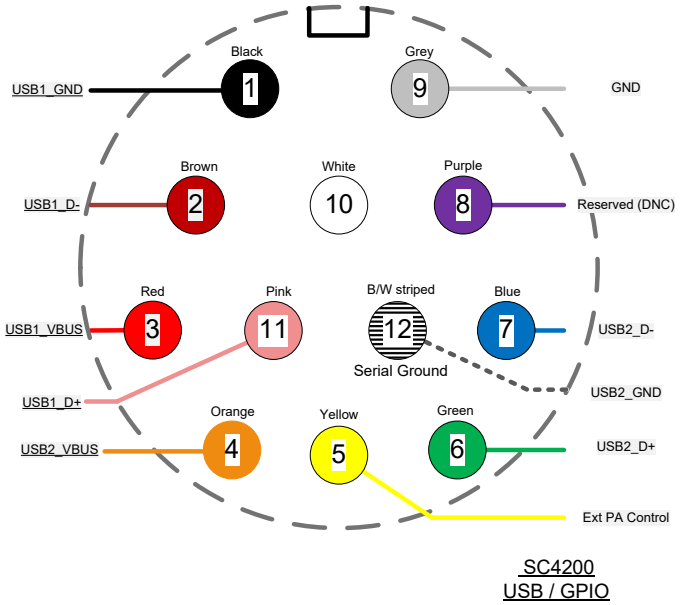


Figure 14 SC4200 AUX Pinout Diagram (Cable Side)

SC4200 PTT Connector	
Enclosure PTT Connector (ODU GKCWAM-P07UB00-000L)	**Signal**
1	RESERVED (Do Not Connect)
2	RESERVED (Do Not Connect)
3	AUDIO_GND
4	PTT
5	SPEAKER_OUT
6	MIC_IN
7	RESERVED (Do Not Connect)

Table 17 SC4200 PTT Connector Pinout

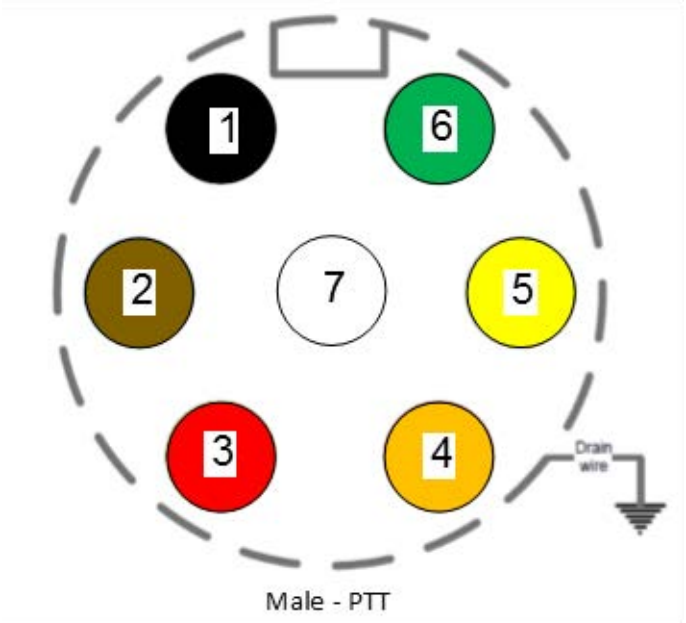


Figure 15 SC4200 PTT Pinout Diagram (Cable Side)

4.2.5 SC3822 Pinouts

SC3822 Power/Ethernet/Serial Connector Pinout		
Enclosure PWR/COMM (LF10WBRB-12PD)	**Signal**	**Switchcraft Pinout (EN3C2F16X)**
1	3.3V (5V on Rev. D Digital and Newer)	NC
2	GND IN	2
3	GND IN	2
4	VCC IN	1
5	VCC IN	1
6	100-Base T ETH0 M2N	NC
7	100-Base T ETH0 M2P	NC
8	100-Base T ETH0 M1P	NC
9	RS232_RXD	NC
10	RS232_TXD	NC
11	RS232_GND	NC
12	100-Base T ETH0 M1N	NC

Table 18 SC3822 Power/Ethernet/Serial Connector Pinout

SC3822 RS-232 and PS/2 (GPS) Pinout			
RS-232	**PS/2 (GPS)**	**Signal**	**Switchcraft Pinout**
3	4	TxD	2
2	5	RxD	1
NC	NC	NC	4
NC	2	3.3V (5V on Rev. D Digital and Newer)	6
NC	NC	NC	5
5	1	Ground	3

Table 19 SC3822 Serial and GPS Pinout

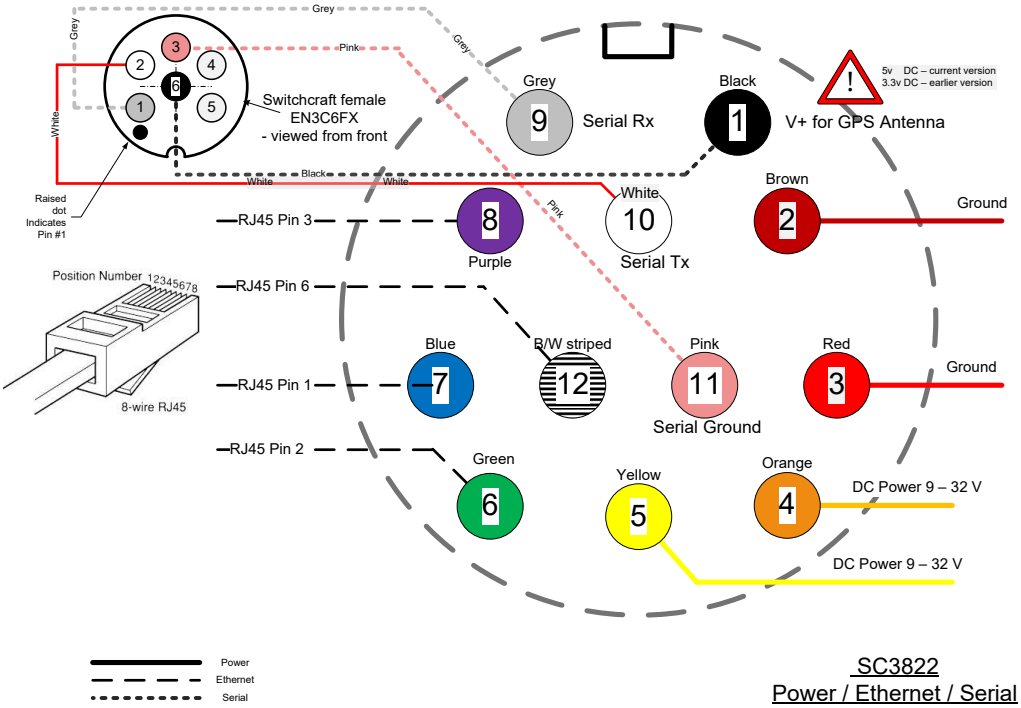


Figure 16 SC3822 Power/Serial/Ethernet Pinout Diagram (Cable Side)

SC3822 USB/GPIO Connector Pinout	
Enclosure USB/GPIO (LF10WBRB-12SD)	**Signal**
1	USB_GND
2	USB_D-
3	USB_5V
4	NC
5	GPIO1 (PA Enable 3.3V)
6	GPIO2
7	GPIO3
8	3.3V
9	GND
10	USB_Sense
11	USB_D+
12	GPIO4

Table 20 SC3822 USB/GPIO Connector Pinout

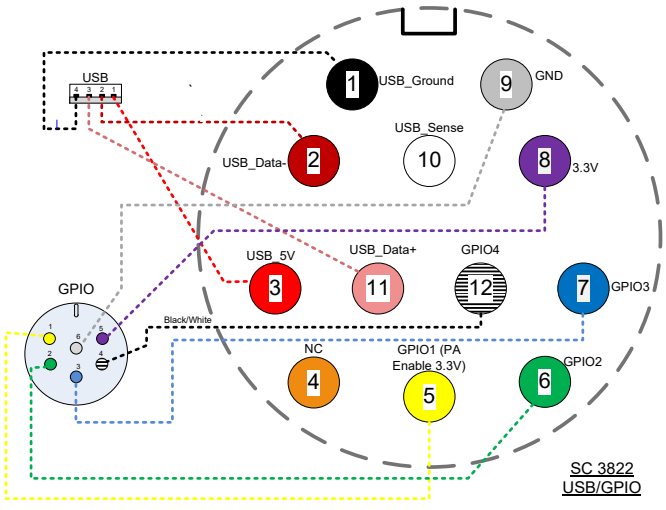


Figure 17 SC3822 USB/GPIO Pinout Diagram (Cable Side)

SC3822 Extension Port Pinout		
Pin #	**Signal**	**Notes**
1-6	VCC_IN	9V - 32V. These pins are directly wired to the VCC_IN on FPC 1.
7-10	GPIO1 – GPIO4	These GPIOs are directly wired to the GPIOs on FPC connector 2.
11-19	Reserved for Testing	Do Not Connect
20	CPU Reset (3.3V)	Wired to PS_SRST_EXT signal on FPC 1
21-54	Reserved for Testing	Do Not Connect
55	GND	
56	ETH1_MX4N	Second Gigabit Ethernet Interface
57	ETH1_MX4P	
58	ETH1_MX3N	
59	ETH1_MX3P	
60	ETH1_MX2N	
61	ETH1_MX2P	
62	ETH1_MX1N	
63	ETH1_MX1P	
64	GND	
65-68	Reserved for Testing	Do Not Connect

Table 21 SC3822 Extension Port Pinout

4.2.6 SC3500/SC3800 Pinouts

SC3500/3800 Power Connector Pinout		
Enclosure Pinout (801-010-07NF7-10PA)	**Signal**	**Switchcraft Pinout (EN3C2F16X)**
1	12V Power Return	2
2	12V Power Return	2
3	12V Power	1
4	12V Power	1
5	TxD	For Serial Comm.
6	RxD	For Serial Comm.
7	RTS	For Serial Comm.
8	CTS	For Serial Comm.
9	Ground	For Serial Comm.
10	3.3V (5V on Rev. E Digital and Newer)	3.3VDC for GPS

Table 22 SC3500/SC3800 Power Connector Pinout

SC3500/3800 RS-232 and PS/2 (GPS) Pinout			
RS-232	**PS/2 (GPS)**	**Signal**	**Switchcraft Pinout**
3	4	TxD	2
2	5	RxD	1
7	NC	RTS	4
NC	2	3.3V (5V on Rev. E Digital and Newer)	6
8	NC	CTS	5
5	1	Ground	3
NA	NA	LED Ground	NA
NA	NA	Green	NA
NA	NA	Red	NA

Table 23 SC3500/SC3800 Serial and GPS Pinout

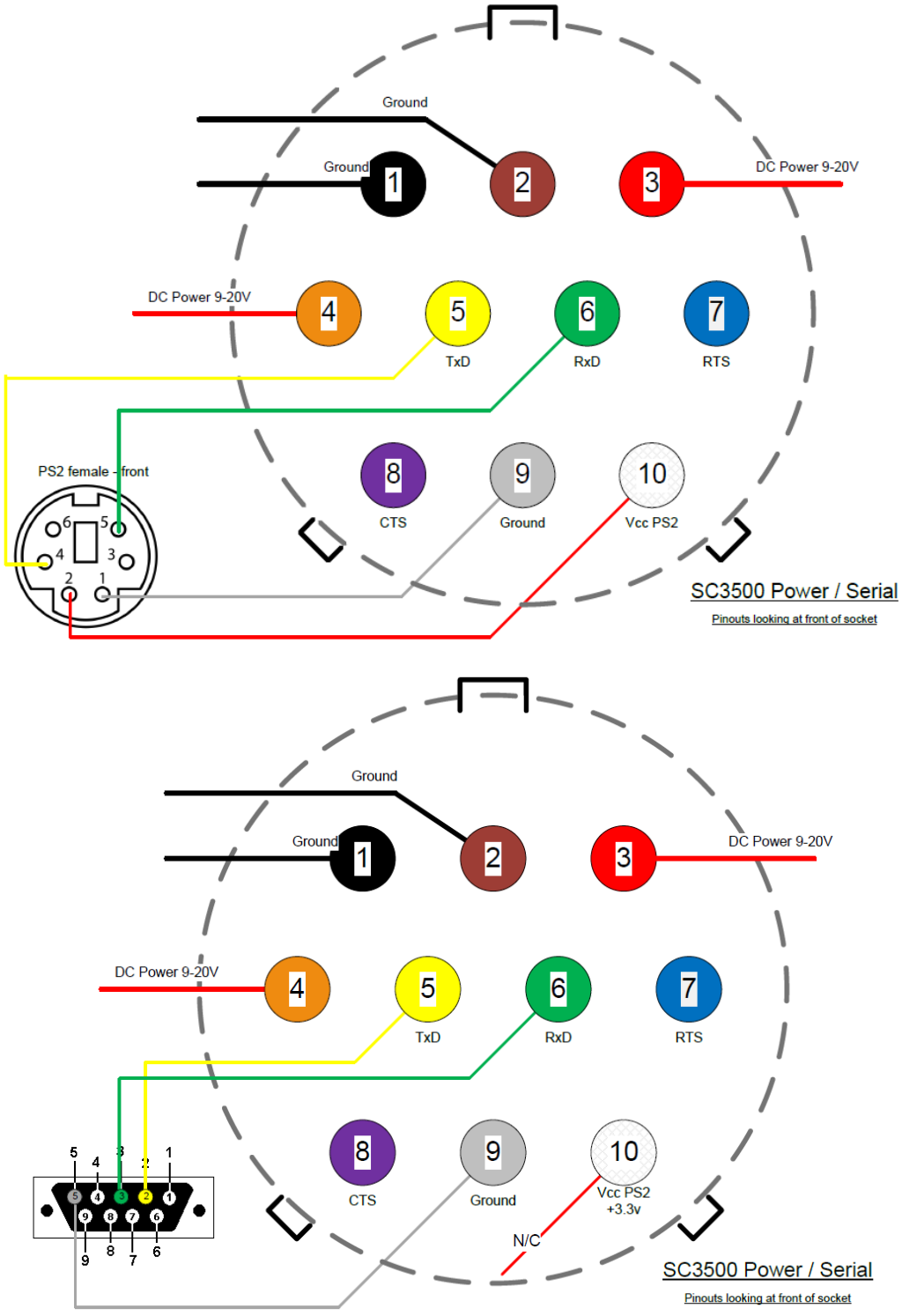


Figure 18 SC3500/SC3800 Power/Serial Pinout Diagram (Cable Side) for GPS (Top) and RS-232 (Bottom)

SC3500/3800 Ethernet Connector Pinout		
Enclosure Pinout (801-010-07NF7-10SA)	**Signal**	**RJ45 Pinout**
1	WHT/BLU	5
2	WHT/BRN	7
3	BRN	8
4	ORG	2
5	WHT/GRN	3
6	WHT/ORG	1
7	BLU	4
8	GRN	6
9	NC	NC
10	NC	NC

Table 24 SC3500/SC3800 Ethernet Connector Pinout

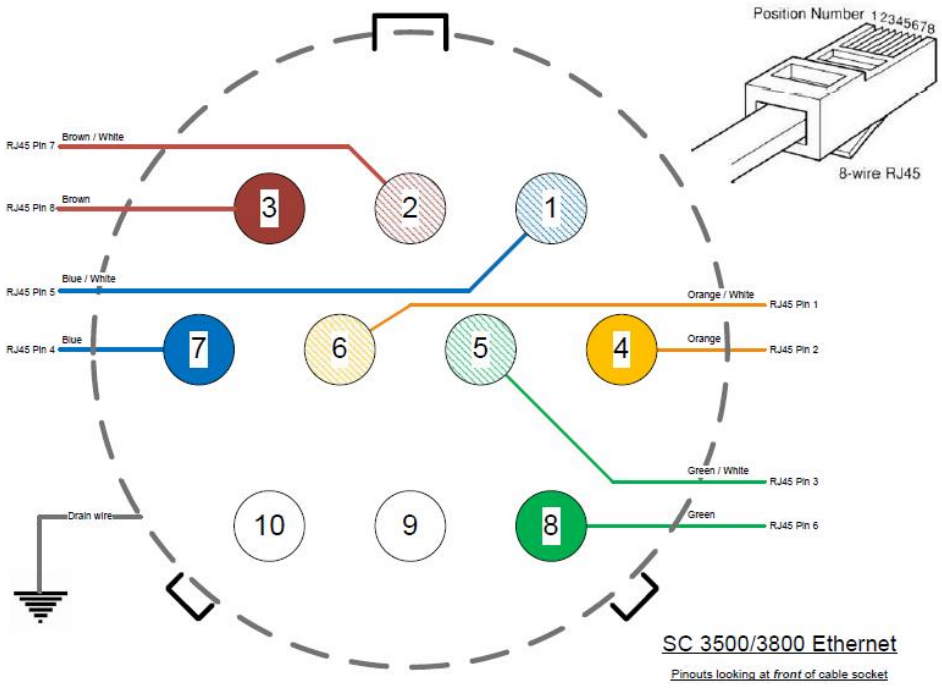


Figure 19 SC3500/SC3800 Ethernet Pinout Diagram (Cable Side)

SC3500/3800 EXT Connector Pinout (PA Faceplate Option Only)	
Enclosure Pinout (801-010-07NF7-25SA)	**Signal**
1	PA On (+3.3V)
2	Ground
3	NC
4	NC
5	NC

Table 25 SC3500/SC3800 EXT Connector Pinout

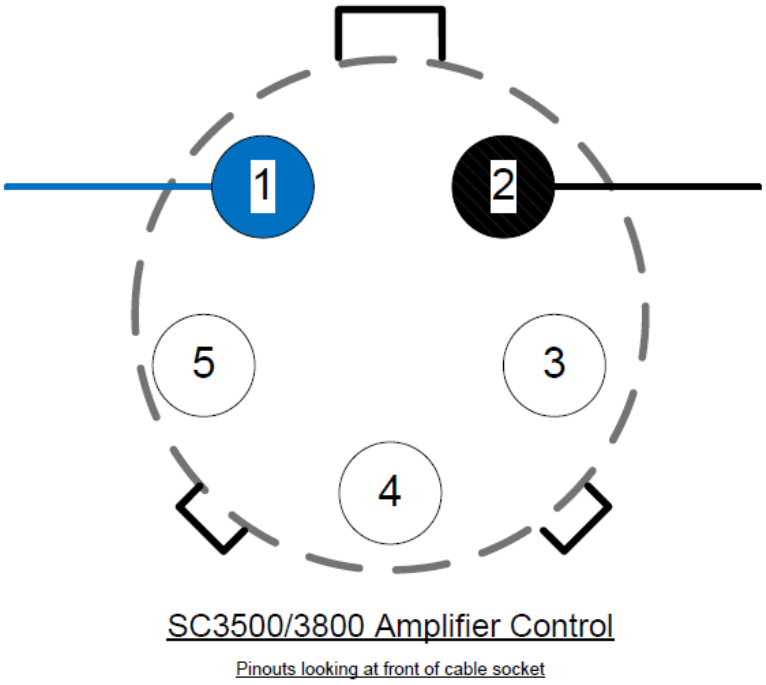


Figure 20 SC3500/SC3800 EXT Pinout Diagram (Cable Side)

4.3 Mechanical and Operating Specifications

SC4400E:

Mechanical

- **Ambient Temp.** -40° to +65° C
- **IP Rating** IP-68 (Dust / Submersible in Water to 20m)**
- **Dimensions** 5.25” x 4.5” x 1.8” (Excluding Connectors)
- **Weight** 2.5 lbs. (40 oz./1.13 kg.)
- **Color** Black Anodized
- **Mounting** 4-Hole Mounting Pattern

Power

- **Voltage/Current** 9 – 20 VDC (± 5%), 5A
- **Power Consumption** 8 W – 43 W @ 8 W TX Power
  8 W – 24 W @ 1 W TX Power
- **Optional External Power Supply (for indoor only)** 12VDC, 5A

Interfaces

- **RF** 4 x TNC(f)
  [N(f) Optional]
- **Primary** Ruggedized Push/Pull Connector
  [1 x Ethernet, 1 x RS232, DC Input]
- **Auxiliary** Ruggedized Push/Pull Connector
  [1 x USB 2.0 Host, 1 x USB 2.0 OTG]
- **PTT (Push-to-Talk)** Ruggedized Break away Connector (Front Panel)
- **Status Indicator** Tri-Color LED
- **Control Interface** Multi-Position Switch
  13 presets plus zeroize crypto
  Web-Based StreamScape™ Network Manager

Mechanical – OEM

- **Dimensions** 4.29” x 3.3” x 0.82”
- **Weight** 9.1 oz (w/ Outer Shields)
- **RF Connectors** SMP (m)

(**) Must have all connectors mated with IP68+ cables/antennas

SC4200E:

Mechanical

- **Ambient Temp.** -40° to +65° C
- **IP Rating** IP-68 (Dust / Submersible in Water up to 20m)**
- **Dimensions** 4.00” x 2.63” x 1.51” (Excluding Connectors)
- **Weight** 0.94 lbs. (15 oz./0.43 kg.)
- **Color** Black Anodized
- **Mounting** 4-Hole Mounting Pattern (Through-Hole)

Power

- **Voltage/Current** 9 – 20 VDC (± 5%), 5A
- **Power Consumption** 4.8 W – 24 W @ 4W TX Power
  4.8 W – 16 W @ 1W TX Power
- **Battery Life** Up to 12 Hours (6.8Ah MBITR Battery)
- **Power Options** Twist-Lock Battery or Front Panel
- **Optional External Power Supply (for indoor only)** 12VDC, 5A

Interfaces

- **RF** TNC(f) (2 Each)
- **Primary** Ruggedized Push/Pull Connector (Front Panel)
  1 x Ethernet, 1x RS232, DC Input (Optional)
- **Auxiliary** Ruggedized Push/Pull Connector (Front Panel)
  1 x USB 2.0 Host, 1 x USB 2.0 OTG
- **PTT (Push-to-Talk)** Ruggedized Breakaway Connector (Front Panel)
- **Status Indicator** Tri-Color LED
- **Management Interface** Multi-Position Switch
  13 presets plus zeroize crypto
  Web-Based StreamScape™ Network Manager

Mechanical – OEM

- **Dimensions** 3.61” x 2.15” x 0.71”
- **Weight** 4.1 oz (w/ Outer Shields)
- **RF Connectors** SMP (m)

(**) Must have all connectors mated with IP68+ cables/antennas

SC4400:

Mechanical

- **Ambient Temp.** -40° to +65° C
- **IP Rating** IP-67 (Dust / Immersion in Water up to 1m)**
- **Dimensions** 5.25” x 4.5” x 1.8” (Excluding Connectors)
- **Weight** 2.5 lbs. (40 oz./1.13 kg.)
- **Color** Black Anodized
- **Mounting** 4-Hole Mounting Pattern

Power

- **Voltage/Current** 9 – 20 VDC (± 5%), 5A
- **Power Consumption** 8 W – 43 W @ 8 W TX Power
  8 W – 24 W @ 1 W TX Power
- **Optional External Power Supply (for indoor only)** 12VDC, 5A

Interfaces

- **RF** 4 x TNC(f)
  [N(f) Optional]
- **Primary** Ruggedized Circular Connector
  [1 x Ethernet, 1 x RS232, DC Input]
- **Auxiliary** Ruggedized Circular Connector
  [1 x USB 2.0 Host, 1 x USB 2.0 OTG]
- **PTT (Push-to-Talk)** Ruggedized Break away Connector (Front Panel)
- **Status Indicator** Tri-Color LED
- **Management Interface** Web-Based StreamScape™ Network Manager

Mechanical – OEM

- **Dimensions** 4.29” x 3.3” x 0.82”
- **Weight** 9.1 oz (w/ Outer Shields)
- **RF Connectors** SMP (m)

(**) Must have all connectors mated with IP67+ cables/antennas

SC4200:

Mechanical

- **Ambient Temp.** -40° to +65° C
- **IP Rating** IP-67 (Dust / Immersion in Water up to 1m)**
- **Dimensions** 4.00” x 2.63” x 1.51” (Excluding Connectors)
- **Weight** 0.94 lbs. (15 oz./0.43 kg.)
- **Color** Black Anodized
- **Mounting** 4-Hole Mounting Pattern (Through-Hole)

Power

- **Voltage/Current** 9 – 20 VDC (± 5%), 5A
- **Power Consumption** 4.8 W – 24 W @ 4W TX Power
  4.8 W – 16 W @ 1W TX Power
- **Battery Life** Up to 12 Hours (6.8Ah MBITR Battery)
- **Power Options** Twist-Lock Battery or Front Panel
- **Optional External Power Supply (for indoor only)** 12VDC, 5A

Interfaces

- **RF** TNC(f) (2 Each)
- **Primary** Ruggedized Circular Connector (Front Panel)
  1 x Ethernet, 1x RS232, DC Input (Optional)
- **Auxiliary** Ruggedized Circular Connector (Front Panel)
  1 x USB 2.0 Host, 1 x USB 2.0 OTG
- **PTT (Push-to-Talk)** Ruggedized Break away Connector (Front Panel)
- **Status Indicator** Tri-Color LED
- **Management Interface** Web-Based StreamScape™ Network Manager

Mechanical – OEM

- **Dimensions** 3.61” x 2.15” x 0.71”
- **Weight** 4.1 oz (w/ Outer Shields)
- **RF Connectors** SMP (m)

(**) Must have all connectors mated with IP67+ cables/antennas

SC3822:

Environmental

	Standard Temperature	Extended Temperature
• **Operating Temp.**	-40° - +55° C	-40° - +65° C
• **IP Rating (Ingress Protection)**	IP-67 (Dust / Immersion in water up to 1m)*	

*Must have all connectors mated and use IP67 or better cables/antennas

Mechanical – Chassis

	Standard	Extended Temperature
• **Dimensions**	4.4” x 3.4” x 1.3”	4.4” x 3.4” x 2.0”
• **Weight**	1.0 lbs. (0.45 kg/16 oz)	1.2 lbs. (0.54 kg/19.2 oz)
• **Color**	a. Black anodized b. FED-STD-595B-34094 (green 383)	
• **Mounting**	4-hole mounting patterns (Through-hole)	

*Standard Temperature enclosure shown. Extended Temp has height of 2”.

Connectors

- **RF** — SMA (f) (2 each)
- **Data / Control** — Ethernet (Gigabit for OEM, 100 Base-T for Enclosed), RS232, USB
- **Power** — Hirose LF Series Circular Connector (Front Panel)
  Samtec QSH (Expansion)

Controls and Indicators

- **Status Indicator** — Tri-Color LED

Power Requirements

- **Voltage** — 9 – 32 VDC
- **Consumption** — 6W – 16W (Duty Cycle and Frequency Dependent)

Mechanical – OEM Board Stack

- **Dimensions** — 3.3” x 2.9” x 0.5” L x W x H
- **Weight** — 3 oz
- **RF Connector** — SMP (m)

SC3500/SC3800:

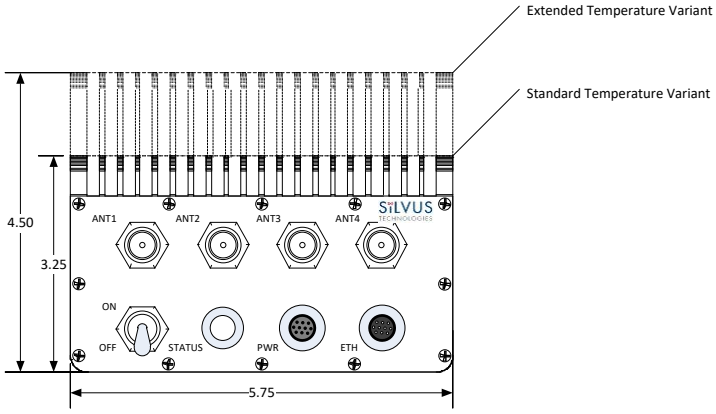
Environmental

	Standard	Extended Temperature
• **Operating Temp.**	-40° - +55° C	-40° - +65° C
• **IP Rating (Ingress Protection)**	IP-67 (Dust / Immersion in water up to 1m)*	

*Must have all connectors mated and use IP67 or better cables/antennas

Mechanical – Chassis

	Standard	Extended Temperature
• **Dimensions**	3.25” x 5.75” x 4”	4.5” x 5.75” x 4”
• **Weight**	3.7 lbs. (1.68 kg/59.2 oz)	4 lbs. (1.81 kg/64 oz)
• **Color**	c. FED-STD-595B-34094 (green 383) d. Black anodized	
• **Mounting**	4-hole mounting patterns (non-penetrating) located on both rear and bottom sides	



Connectors

- **RF** — TNC (f) (4 each)
- **Data / Control** — Ethernet cable, Mighty-Mouse 801 Heavy-Duty, Double-Start 10
- **Power** — Mighty-Mouse 801 Heavy-Duty, Double-Start 10 conductor (m)

Controls and Indicators

- **Power** — On / Off Toggle with detent
- **Status Indicator** — Tri-Color LED

Power Requirements

- **Voltage** — 9 – 20 VDC
- **Consumption** — 12W – 22.5W (Duty Cycle and Frequency Dependent)

Mechanical – OEM Board Stack

- **Dimensions** — 1.9” x 5.25” x 2.9” H x L x W

- **Weight** 8 oz
- **RF Connector** SMP (m)
- **Data Connector** Harwin M80 8-pin (m), (RS232/GPS optional)
- **Power Connector** Harwin M80 8-pin

4.3.1 SC4400E Enclosure Mechanical Drawing

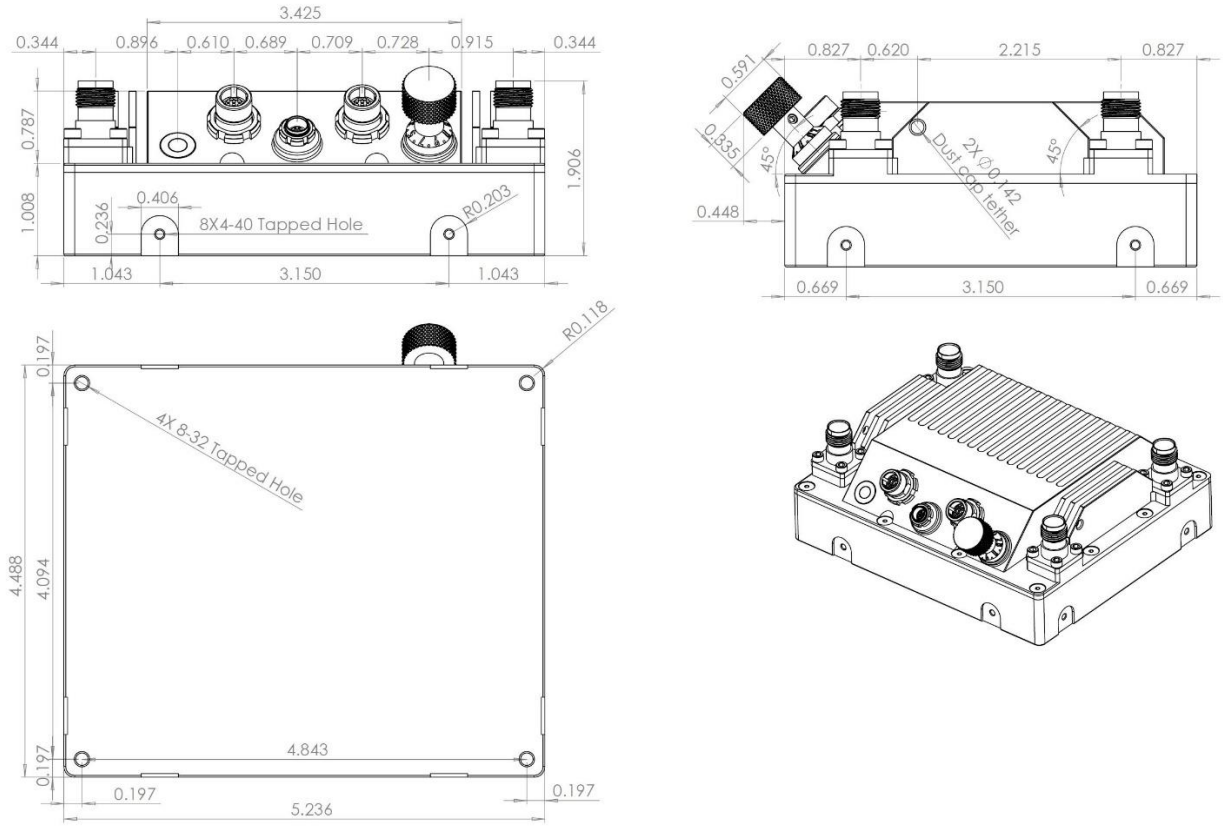


Figure 21 SC4400E Mechanical Drawing (top) and Mounting Pattern (bottom)

4.3.2 SC4200E Enclosure Mechanical Drawing

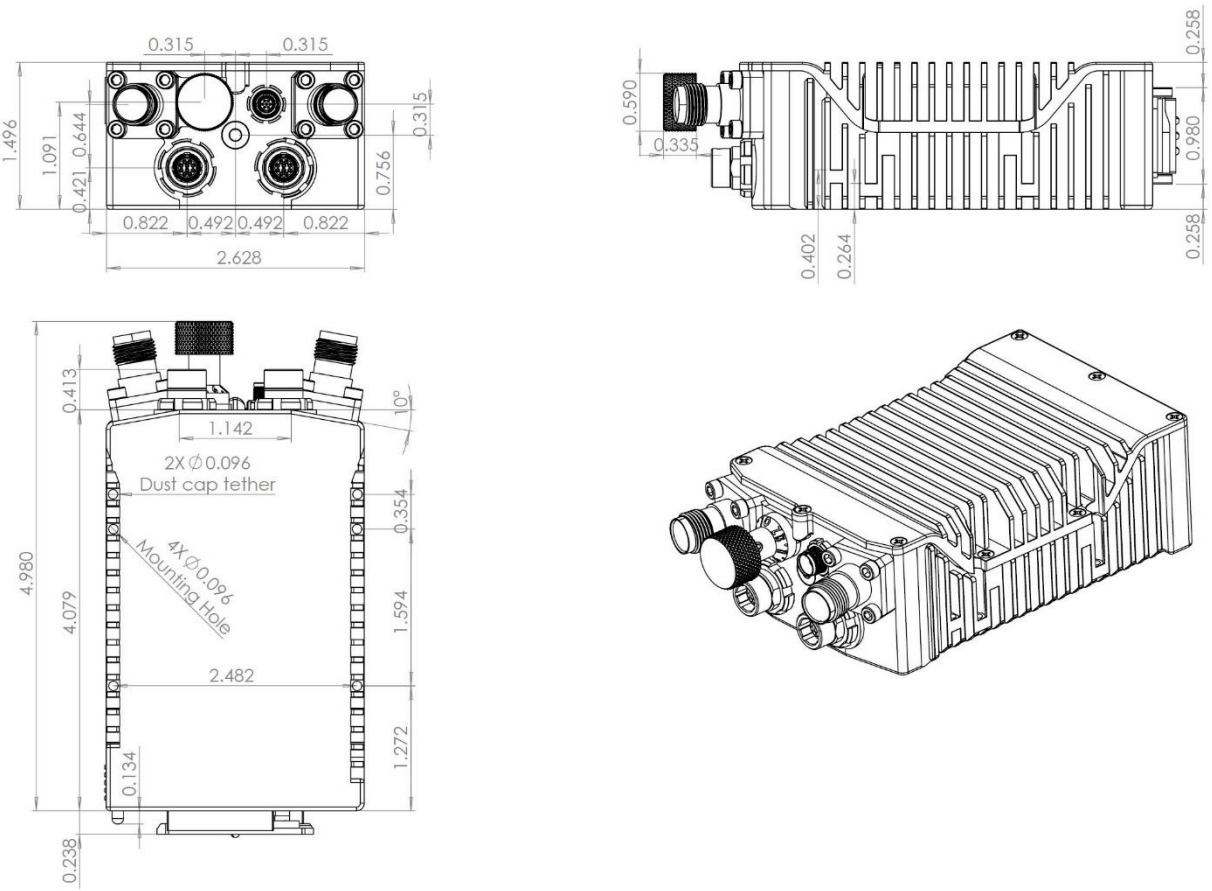


Figure 22 SC4200E Mechanical Drawing (top) and Mounting Pattern (bottom)

4.3.3 SC4400 Enclosure Mechanical Drawing

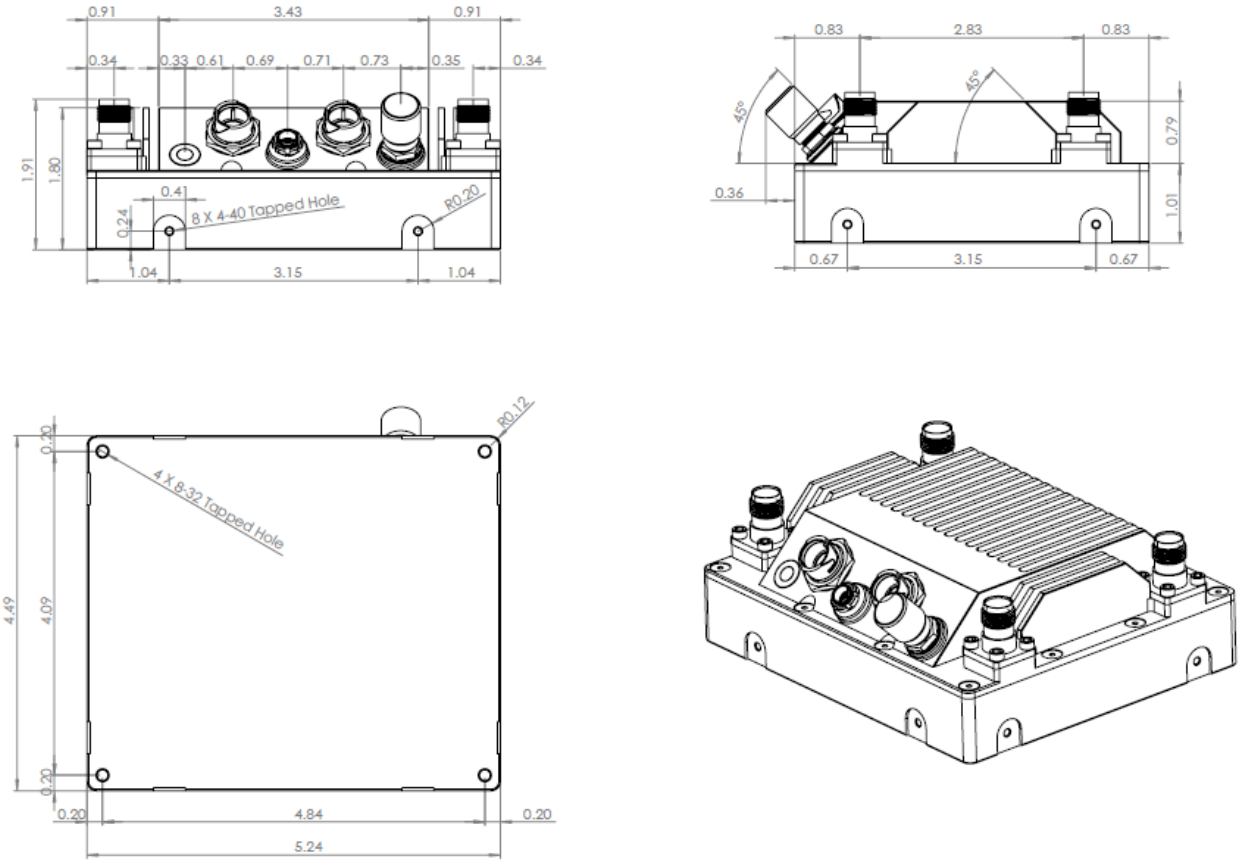


Figure 23 SC4400 Mechanical Drawing (top) and Mounting Pattern (bottom)

4.3.4 SC4200 Enclosure Mechanical Drawing

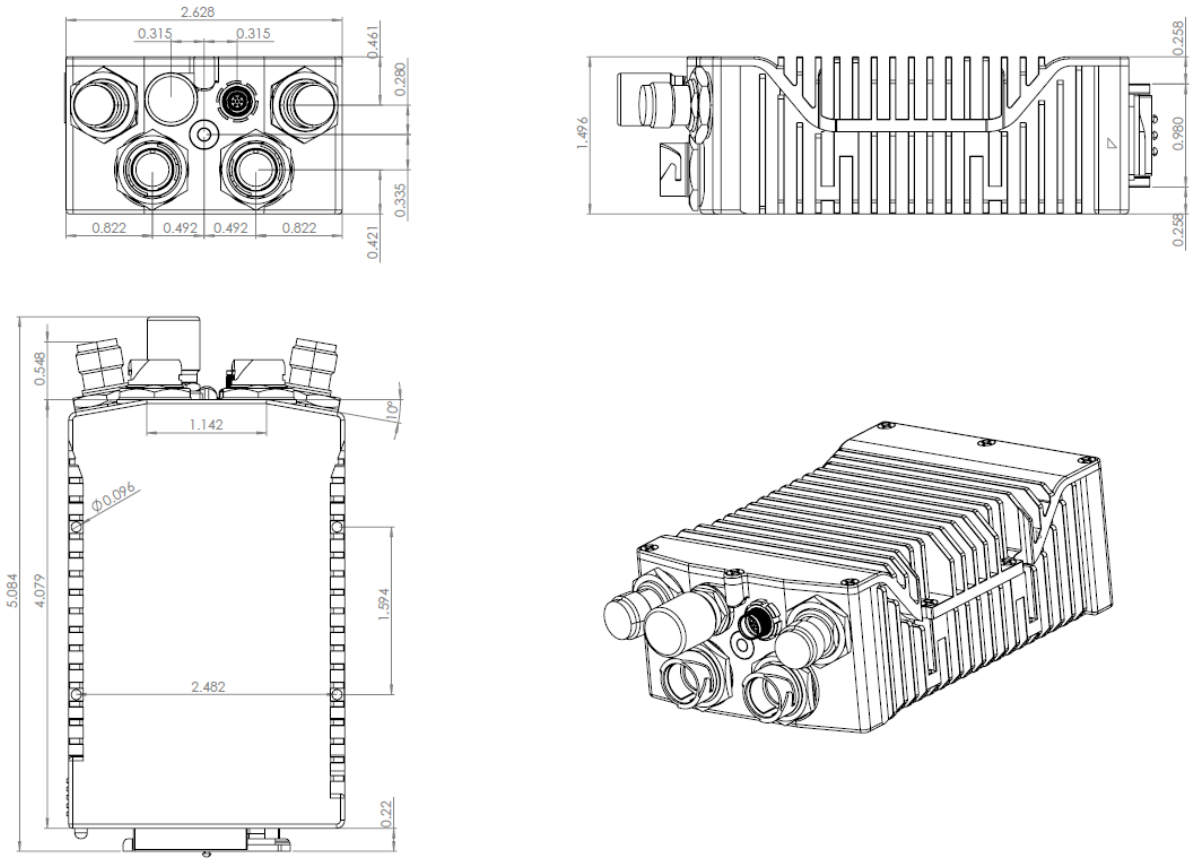


Figure 24 SC4200 Mechanical Drawing (top) and Mounting Pattern (bottom)

4.3.5 SC3822 Enclosure Mechanical Drawing

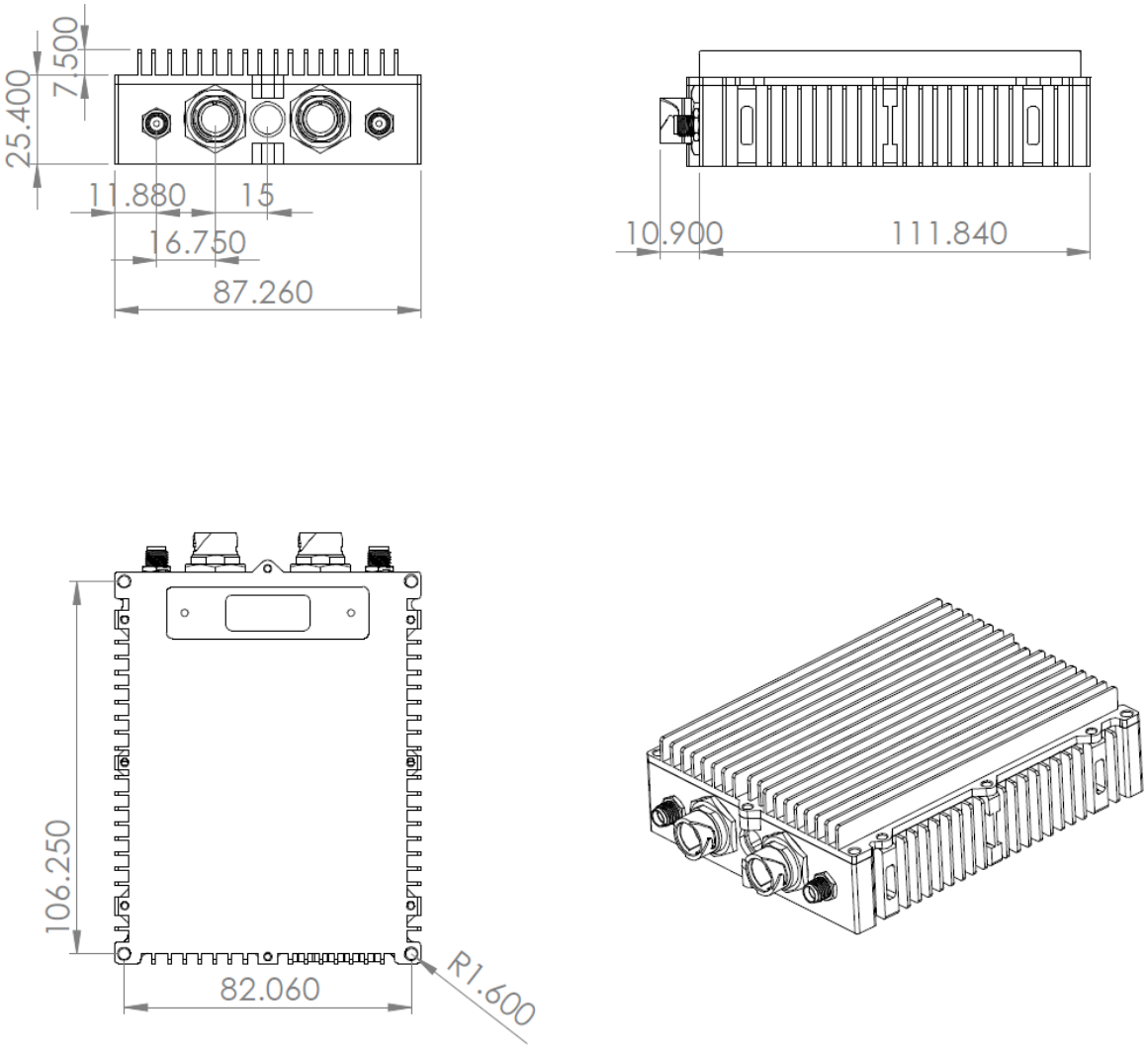


Figure 25 SC3822 Mechanical Drawing (top) and Mounting Pattern (bottom)

4.3.6 SC3500/SC3800 Phase II Enclosure Mounting Pattern

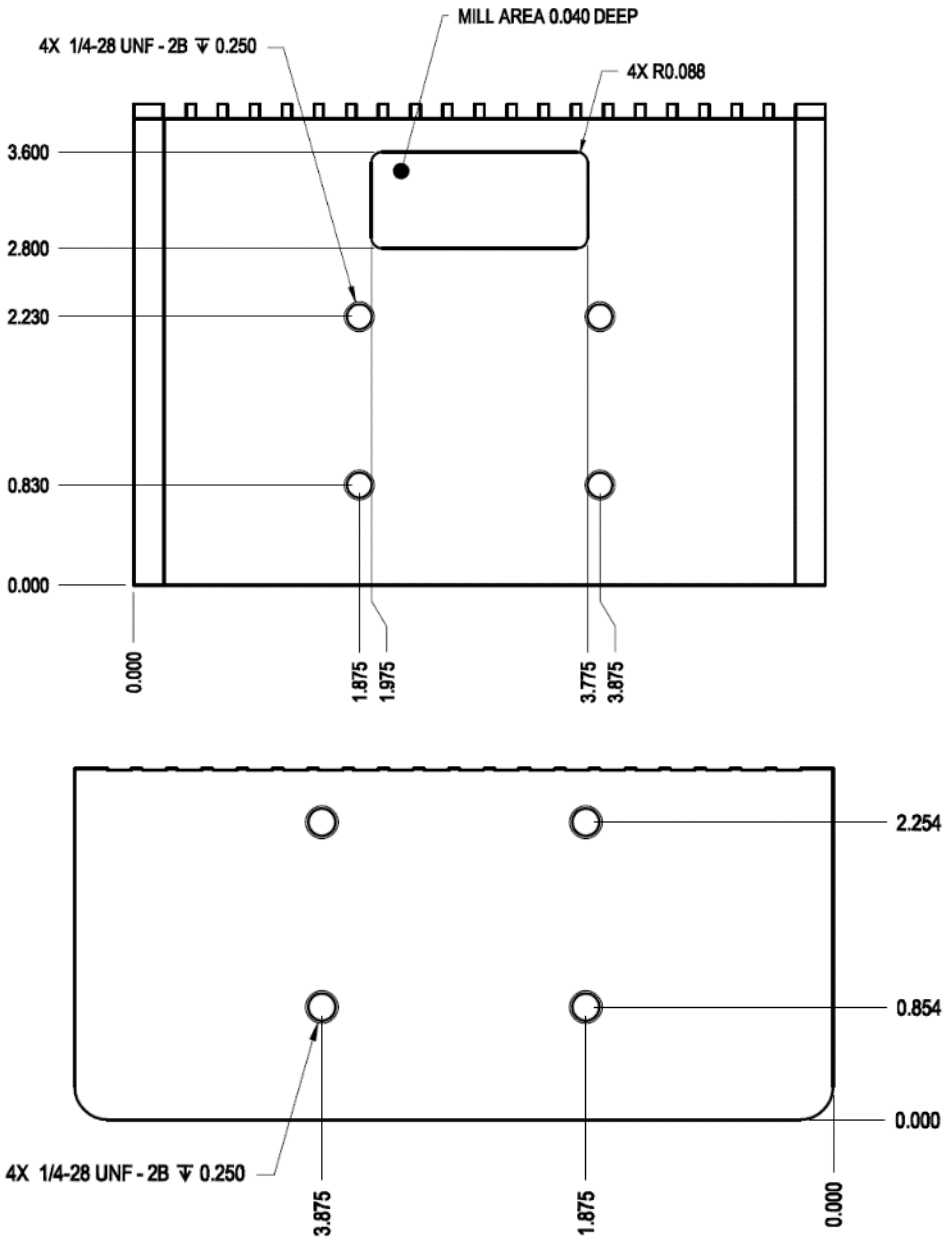


Figure 26 SC3500/SC3800 Phase II Enclosure Mounting Pattern for Back of Enclosure (top) and Bottom of Enclosure (bottom)

4.3.7 SC3500/ SC3800 Phase III Enclosure Mounting Pattern

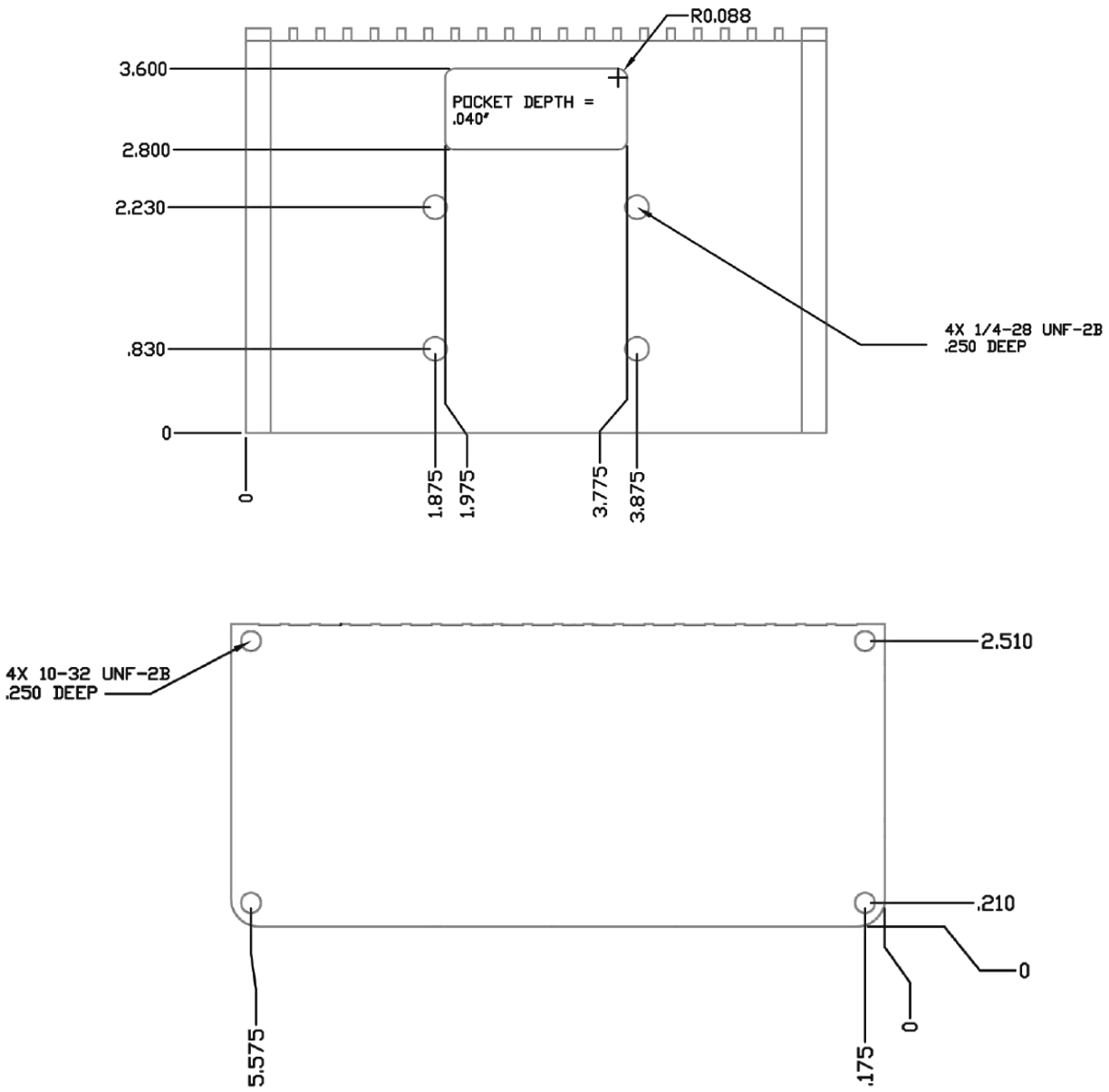


Figure 27 SC3500/SC3800 Phase III Enclosure Mounting Pattern for Back of Enclosure (top) and Bottom of Enclosure (bottom)

4.4 SC4400E Specifications

General

- **Waveform** — Mobile Networked MIMO (MN-MIMO™)
- **Modulation** — BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** — 5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption** — DES Standard, AES/GCM 128/256 Optional (FIPS 140-2), Suite B
- **Tuning Step Size** — 1kHz
- **Data Rates** — Up to 100 Mbps (Adaptive)
- **Error Correction** — 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** — Spatial Multiplexing, Space-Time Coding, TX Eigen Beamforming, RX Eigen Beam Forming
- **No. of Spatial Streams** — 1-2
- **No. of Antennas** — 4

Performance

- **Latency** — 7ms Average (20MHz BW)
- **Sensitivity** — -102 dBm @ 5MHz BW
- **Frequency Bands** — Bands from 400MHz to 6GHz Available Dual Band Optional
- **Onboard Storage** — 64 GB*

Frequency Band Options

Band (Freq. Code)	Frequency Range	Band (Freq. Code)	Frequency Range
UHF (042)	400-450	**Low C Band (455)**	4400-4700
ISM 900 (091)	902-928	**Federal C-1 (467)**	4400-4940
L Band (137)	1350-1390	**High C Band (485)**	4700-5000
Upper L (181)	1780-1850	**5.2GHz ISM (520)**	5150-5250
Broadcast B (206)	2025-2110	**5.8GHz ISM (580)**	5725-5875
Federal S (225)	2200-2300		
S Band (235)	2200-2500		
2.4GHz ISM (245)	2400-2500		

(All bands listed in MHz)

Note: If band of interest is not listed, please contact a sales representative

Footnote: (*) in development

4.5 SC4200E Specifications

General

- **Waveform** — Mobile Networked MIMO (MN-MIMO™)
- **Modulation** — BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** — 5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption** — DES Standard, AES/GCM 128/256 Optional (FIPS 140-2), Suite B
- **Tuning Step Size** — 1kHz
- **Data Rates** — Up to 100 Mbps (Adaptive)
- **Error Correction** — 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** — Spatial Multiplexing, Space-Time Coding, TX Eigen Beamforming, RX Eigen Beam Forming
- **No. of Spatial Streams** — 1-2
- **No. of Antennas** — 2

Performance

- **Latency** — 7ms Average
- **Sensitivity** — -99 dBm @ 5MHz BW
- **Frequency Bands** — Bands from 400MHz to 6GHz Available Dual Band Optional
- **Onboard Storage** — 64 GB*

Frequency Band Options

Band (Freq. Code)	Frequency Range	Band (Freq. Code)	Frequency Range
UHF (042)	400-450	**Low C Band (455)**	4400-4700
ISM 900 (091)	902-928	**Federal C-1 (467)**	4400-4940
L Band (137)	1350-1390	**High C Band (485)**	4700-5000
Upper L (181)	1780-1850	**5.2GHz ISM (520)**	5150-5250
Broadcast B (206)	2025-2110	**5.8GHz ISM (580)**	5725-5875
Federal S (225)	2200-2300		
S Band (235)	2200-2500		
2.4GHz ISM (245)	2400-2500		

(All bands listed in MHz)

Note: If band of interest is not listed, please contact a sales representative

Footnote: (*) in development

SC4400E/SC4200 PTT

Supported Mic Type	Moving Coil or Condenser (Software Configurable)
• **Max Avg. Speaker Output Power**	2.65W with 4 Ohm Speaker Impedance
• **MIC Bias**	2.15V or 3V (Software Configurable); Applied via a 2K Ohm Resistor
• **Recommended Speaker Impedance (Handset)**	4 Ohm to 16 Ohm
• **Recommended Speaker Impedance (Headset)**	75 Ohm to 300 Ohm
• **Recommended MIC impedance**	<= 1K Ohm
• **Peak Speaker Output Voltage**	5.5V
• **Absolute MIC Input Voltage**	3.3V

4.6 SC4400 Specifications

General

- **Waveform** — Mobile Networked MIMO (MN-MIMO™)
- **Modulation** — BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** — 5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption** — DES Standard, AES/GCM 128/256 Optional (FIPS 140-2), Suite B
- **Tuning Step Size** — 1kHz
- **Data Rates** — Up to 100 Mbps (Adaptive)
- **Error Correction** — 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** — Spatial Multiplexing, Space-Time Coding, TX Eigen Beamforming, RX Eigen Beam Forming
- **No. of Spatial Streams** — 1-2
- **No. of Antennas** — 4

Performance

- **Latency** — 7ms Average (20MHz BW)
- **Sensitivity** — -102 dBm @ 5MHz BW
- **Frequency Bands** — Bands from 400MHz to 6GHz Available Dual Band Optional
- **Onboard Storage** — 64 GB*

Frequency Band Options

Band (Freq. Code)	Frequency Range	Band (Freq. Code)	Frequency Range
UHF (042)	400-450	**Low C Band (455)**	4400-4700
ISM 900 (091)	902-928	**Federal C-1 (467)**	4400-4940
L Band (137)	1350-1390	**Federal C-2 (469)***	4400-4990
Upper L (181)	1780-1850	**High C Band (485)**	4700-5000
Broadcast B (206)	2025-2110	**5.2GHz ISM (520)**	5150-5250
Federal S (225)	2200-2300	**5.8GHz ISM (580)**	5725-5875
S Band (235)	2200-2500		
2.4GHz ISM (245)	2400-2500		

(All bands listed in MHz)

Note: If band of interest is not listed, please contact a sales representative

Footnote: (*) in development

4.7 SC4200 Specifications

General

- **Waveform** — Mobile Networked MIMO (MN-MIMO™)
- **Modulation** — BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** — 5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption** — DES Standard, AES/GCM 128/256 Optional (FIPS 140-2), Suite B
- **Tuning Step Size** — 1KHz
- **Data Rates** — Up to 100 Mbps (Adaptive)
- **Error Correction** — 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** — Spatial Multiplexing, Space-Time Coding, TX Eigen Beamforming, RX Eigen Beam Forming
- **No. of Spatial Streams** — 1-2
- **No. of Antennas** — 2

Performance

- **Latency** — 7ms Average
- **Sensitivity** — -99 dBm @ 5MHz BW
- **Frequency Bands** — Bands from 400MHz to 6GHz Available Dual Band Optional
- **Onboard Storage** — 64 GB*

Frequency Band Options

Band (Freq. Code)	Frequency Range	Band (Freq. Code)	Frequency Range
UHF (042)	400-450	**Low C Band (455)**	4400-4700
ISM 900 (091)	902-928	**Federal C-1 (467)**	4400-4940
L Band (137)	1350-1390	**Federal C-2 (469)***	4400-4990
Upper L (181)	1780-1850	**High C Band (485)**	4700-5000
Broadcast B (206)	2025-2110	**5.2GHz ISM (520)**	5150-5250
Federal S (225)	2200-2300	**5.8GHz ISM (580)**	5725-5875
S Band (235)	2200-2500		
2.4GHz ISM (245)	2400-2500		

(All bands listed in MHz)

Note: If band of interest is not listed, please contact a sales representative

Footnote: (*) in development

SC4400/SC4200 PTT

Supported Mic Type

Moving Coil or Condenser (Software Configurable)

- **Max Avg. Speaker Output Power** — 2.65W with 4 Ohm Speaker Impedance
- **MIC Bias** — 2.15V or 3V (Software Configurable); Applied via a 2K Ohm Resistor
- **Recommended Speaker Impedance (Handset)** — 4 Ohm to 16 Ohm
- **Recommended Speaker Impedance (Headset)** — 75 Ohm to 300 Ohm
- **Recommended MIC impedance** — <= 1K Ohm
- **Peak Speaker Output Voltage** — 5.5V
- **Absolute MIC Input Voltage** — 3.3V

4.8 SC3822 Specifications

General

• **Waveform**	Mobile Networked MIMO (MN-MIMO™)
• **Modulation**	BPSK, QPSK, 16-QAM, 64-QAM
• **Channel Bandwidth**	5, 10 & 20 MHz (1.25*, 2.5*)
• **Encryption**	DES Standard, AES 128/256 Optional (FIPS 140-2)
• **Frequency Stability**	1 PPM over temp -40° - +85° C
• **Tuning Step Size**	1KHz
• **Data Rates**	85 Mbps UDP & 70 Mbps TCP
• **Error Correction**	1/2, 2/3, 3/4, 5/6
• **Antenna Processing**	Spatial Multiplexing, Space-Time Coding, RX Eigen Beam Forming
• **No. of Spatial Streams**	1-2
• **No. of Antennas**	2
• **Total Power Output**	10mW – 500mW (variable)

Performance

• **Latency**	7ms average
• **Sensitivity**	Varies with MCS index Maximum = -99 dBm (5MHz BW, MCS0) (5 MHz BW, MCS 0)

Frequency Band Specifics

Please note, this table reflects standard frequency bands available, additional bands are frequently added as demands dictate. If your band of interest is not listed, please contact your sales person. (All bands listed in MHz)

Low Band		High Band	
UHF	400-450	**Low C Band**	4400-4700
ISM 900	902-928	**High C Band**	4700-5000
L Band	1350-1390	**5.2GHz ISM**	5150-5250
Broadcast A	1980-2200	**5.8GHz ISM**	5727-5852
Broadcast B	2025-2110		
Federal 'S'	2200-2300		
Federal 'S' + 2.4GHZ ISM	2200-2500		

Footnote: (*) in development

4.9 SC3500 Specifications

General

- **Radio Type** — MIMO Coded-OFDM
- **Subcarrier Modulation** — BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** — 5, 10 & 20 MHz
- **Encryption** — DES Standard, AES 128/256 Optional
- **Frequency Stability** — 1 PPM over temp -40° - +85° C
- **Tuning Step Size** — 1KHz
- **Data Rates** — 85 Mbps UDP & 70 Mbps TCP
- **Error Correction** — 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** — Spatial Multiplexing, Space-Time Coding, Eigen Beam Forming
- **No. of Spatial Streams** — 1-4
- **No. of Antennas** — 4
- **Total Power Output** — 10mW – 1W (variable)

Performance

- **Latency** — 7ms average
- **Sensitivity** — Varies with MCS index

  Maximum = -102 dBm (5 MHz BW, MCS 0)

Frequency Band Specifics

	S Band	C Band
• **Frequency Code '245540'**	2.400 – 2.500 GHz	4.940 – 5.875 GHz
• **Frequency Code '245551'**	2.400 – 2.500 GHz	5.150 – 5.875 GHz
• **Frequency Code '243578'**	2.417 – 2.457 GHz	5.735 – 5.840 GHz

4.10 SC3800 Specifications

General

- **Radio Type** — MIMO Coded-OFDM
- **Subcarrier Modulation** — BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** — 5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption** — DES Standard, AES 128/256 Optional
- **Frequency Stability** — 1 PPM over temp -40° - +85° C
- **Tuning Step Size** — 1KHz
- **Data Rates** — 85 Mbps UDP & 70 Mbps TCP
- **Error Correction** — 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** — Spatial Multiplexing, Space-Time Coding, RX Eigen Beam Forming
- **No. of Spatial Streams** — 1-4
- **No. of Antennas** — 4
- **Total Power Output** — 10mW – 1 W (variable)

Performance

- **Latency** — 7ms average
- **Sensitivity** — Varies with MCS index

  Maximum = -102 dBm (5MHz BW, MCS 0)

Frequency Band Specifics

Please note, this table reflects standard frequency bands available, additional bands are frequently added as demands dictate. If your band of interest is not listed, please contact your sales person. (All bands listed in MHz)

Low Band		High Band	
UHF	400-450	**Low C Band**	4400-4700
ISM 900	902-928	**High C Band**	4700-5000
L Band	1350-1390	**5.2GHz ISM**	5150-5250
Broadcast A	1980-2200	**5.8GHz ISM**	5727-5852
Broadcast B	2025-2110		
Federal 'S'	2200-2300		
ISM2400	2400-2483		
Federal 'S' + 2.4GHZ ISM	2200-2500		

Footnote: (*) in development

5. Web Interface

5.1 Getting Started

Connect a laptop to the StreamCaster radio using the supplied Ethernet cable and turn on the radio. Users can type “ping <IPaddress>” in order to determine whether the radio is fully booted. A web configuration will then be available by typing the radio IP address in a web browser. Please ensure that your laptop is on the same subnet as the radio (172.20.xx.xx by default). Users will be directed to the Basic Configuration page. (See **Figure 28**)

5.1.1 Basic Configuration

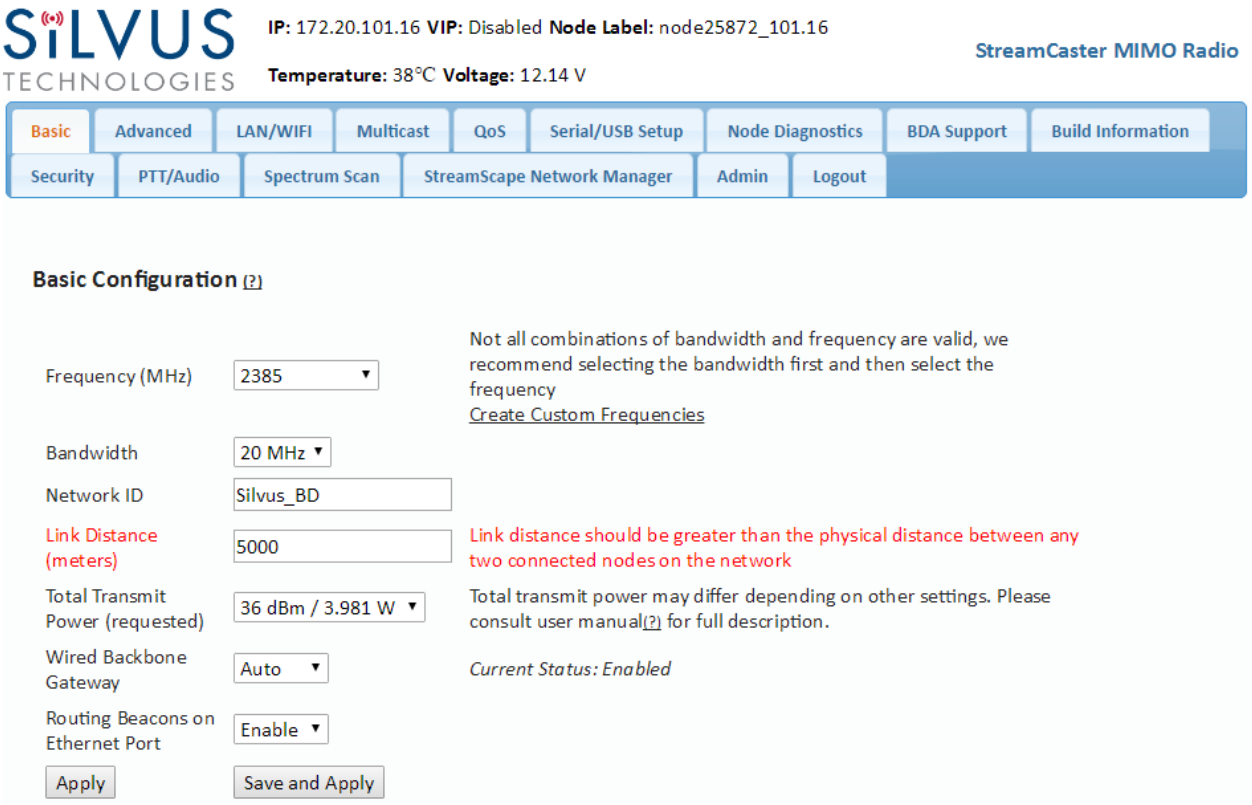


Figure 28 Basic Configuration Page

This page is used to set basic configurations. A brief description of each parameter is given below.

- **Frequency**: This defines the frequency of the signal. There is a drop-down menu for frequency selection. The frequency choices will vary depending on the StreamCaster

model(s) you are using. Please see Section 8 for "Custom Frequency Plan" access and installation instructions.

- **Bandwidth**: This defines the RF bandwidth of the signal.

- **Network ID**: Network ID allows for clusters of radios to operate in the same channel, but remain independent. A radio with a given Network ID will only communicate with other radios with the same Network ID. The Network ID is limited to alphanumeric characters, spaces, and the special character '-'. Character limit is 32 characters.

- **Link Distance**: Set to an approximate maximum distance between any two nodes in meters, e.g., 5000 for 5km (default). It is important to set the link distance to allow enough time for packets to propagate over the air. Failing to set the link distance to an approximate maximum distance can result in over the air collisions and a degradation of performance. It is recommended to set the link distance 10-15% greater than the actual maximum distance.

- **Total Transmit Power**: This defines the total power of the signal (power is divided equally between the radio antenna ports). There is also an option to 'Enable Max Power' which will allow the radio to push to the highest TX power it can support. This will be slightly different on each radio.

- **Wired Backbone Gateway**: This setting pertains to wired backbone functionality (See Section 7: Wired Backbone). For normal operation, set Wired Backbone Gateway to 'Auto'. If multiple radios will be connected to a wired backbone, all radios on the backbone should be set to 'Auto'.

- **Routing Beacons on Ethernet Port**: For radios to be able to communicate and transfer data over a wired link, routing information needs to be sent over the wireline. These packets are broadcast packets that are sent even if there is only one radio on the network. If wired backbone is not being utilized, the user can disable these routing beacons to prevent loading their local network with these routing packets.

- **Apply**: Apply the new values. Values will change back to the default setting after reboot.

- **Save and Apply**: Apply the new values and set the new values as the default.

5.1.2 Advanced Configuration

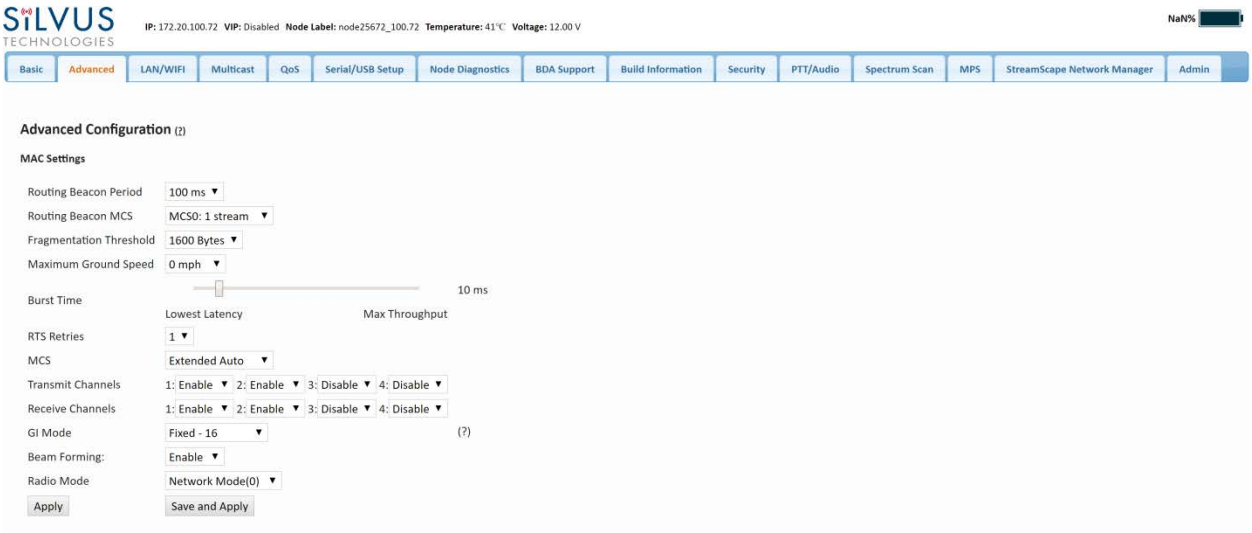


Figure 29 Advanced Configuration Page

This page is used to set the advanced settings. A brief description of each parameter is given below.

MAC Settings:

- **Routing Beacon Period**: Controls how often routing beacons are sent to other radios. A lower Routing Beacon Period results in faster reaction to topology changes. A lower Routing Beacon Period also adds more overhead to the network which scales with the number of nodes in the network. For larger networks, a larger Routing Beacon Period is recommended. Default value is 100ms.

- **Routing Beacon MCS**: Select the MCS that routing beacons are sent at. Higher MCS values require less network overhead and may be beneficial for larger networks. The drawback is that the link will break when the Routing Beacon MCS can no longer be supported.

- **Fragmentation Threshold**: Allows user to determine the minimum over-the-air packet size in bytes. Smaller packet size can improve performance in high mobility while a larger packet size will allow for more throughput. (1600 bytes default).

- **Maximum Ground Speed**: This setting improves performance in high mobility scenarios where the wireless channel may change rapidly. Setting this value to an unnecessarily high value may have an impact as high as 25 percent on overall achievable throughput.

- **Burst Time**: The burst time determines the maximum amount of time each node is allowed to transmit at once. A larger burst time will provide higher throughput at the cost of higher latency. On the other hand, a smaller burst time will provide less latency at the cost of less throughput.

- **RTS Retries:** A node wishing to send data initiates the process by sending a request to send message (RTS). The destination node replies with a clear to send (CTS) message. Any other node that receives the RTS or CTS message will refrain from sending data for a given time. In larger networks, there is a higher probability of collisions occurring when an RTS is sent out. This field defines the number of retries before a packet is dropped. A lower value will result in faster handoffs in mobile situations.

- **MCS**: Choose the modulation and coding scheme (MCS). If this is set as AUTO, the radio will dynamically cycle between a subset of the modes depending on the quality of the link. This is the recommended setting for most users and will provide the maximum data rate that the link can support. The EXTENDED AUTO mode includes 64QAM rate modes on top of those included in the AUTO mode. **Table 26** -
  Table 28 below show the estimated UDP data rate and sensitivity for each MCS. This table assumes a 20MHz bandwidth, 5000 meter link distance and 1600 byte fragmentation threshold.

- **Transmit Channels:** Allows user to Enable or Disable each channel on the radio for TX.

- **Receive Channels:** Allows user to Enable or Disable each channel on the radio for RX.

- **GI Mode:** This feature can be used to improve performance in environments where long delay spread is present and causing intersymbol interference (https://en.wikipedia.org/wiki/Intersymbol_interference). This setting allows the radio to vary its Guard Interval (https://en.wikipedia.org/wiki/Guard_interval) to allow for longer delay spread. When set to 'Extended Auto – GI', the radio will choose between the regular GI, and the user specified longer GI (Cyclic Prefix Length in the next setting) depending on channel conditions.

- **Beamforming (SC4200/SC4400 Only):** Enable or disable TX Beamforming (Up to 2X increase in range when enabled)

- **Radio Mode**: Switch between Network mode and PHY Diagnostics. If the value equals 0, it is in Network mode; if the value equals 1, it is in PHY Diagnostics. PHY Diagnostics mode is only relevant for users who wish to run diagnostic tests on the radio.

- **Apply**: Applies the new values but does not save them to flash.

- **Save and Apply**: Save the new values to flash and apply.

Modulation Modes and Receiver Sensitivity

- Note that listed sensitivity values were measured using a controlled and cabled setup. Actual results may vary by +/- 2dB. Table assumes link distance of 5000m. 10ms, 20ms, and 40ms burst time for 20, 10, and 5MHz bandwidth respectively. 1600 byte Fragmentation Threshold.

- * Modes supported under the AUTO MCS option.

- * Modes supported under the EXTENDED AUTO MCS option in addition to AUTO MCS modes.

- *Modes currently not supported

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC4400/3500/3800 Sensitivity	SC4200/3822 Sensitivity
1	0	BPSK 1/2	1.625	1.03	-102	-99
1	1	QPSK 1/2	3.25	2.06	-100	-97
1	2	QPSK 3/4	4.875	3.09	-97	-94
1	3	16-QAM 1/2	6.5	4.12	-95	-92
1	4	16-QAM 3/4	9.75	6.18	-92	-89
1	5	64 QAM 2/3	13	8.25	-87	-84
1	6	64 QAM 3/4	14.625	9.28	-85	-82
1	7	64 QAM 5/6	16.25	10.30	-80	-77
2	8	BPSK 1/2	3.25	2.06	-100	-97
2	9	QPSK 1/2	6.5	4.12	-97	-94
2	10	QPSK 3/4	9.75	6.18	-94	-91
2	11	16-QAM 1/2	13	8.25	-91	-89
2	12	16-QAM 3/4	19.5	12.38	-88	-85
2	13	64 QAM 2/3	26	16.21	-84	-81
2	14	64 QAM 3/4	29.25	17.62	-82	-79
2	15	64 QAM 5/6	32.5	18.94	-77	-74

Table 26 MCS vs. Sensitivity Chart (5MHz Bandwidth)*

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC4400/3500/3800 Sensitivity	SC4200/3822 Sensitivity
1	0	BPSK 1/2	3.25	2.48	-99	-96
1	1	QPSK 1/2	6.5	4.96	-97	-94
1	2	QPSK 3/4	9.75	7.40	-94	-91
1	3	16-QAM 1/2	13	9.90	-92	-89
1	4	16-QAM 3/4	19.5	14.80	-89	-86
1	5	64 QAM 2/3	26	19.90	-84	-82
1	6	64 QAM 3/4	29.25	22.40	-82	-80
1	7	64 QAM 5/6	32.5	24.0	-77	-78
2	8	BPSK 1/2	6.5	4.96	-97	-94
2	9	QPSK 1/2	13	9.90	-94	-91
2	10	QPSK 3/4	19.5	14.80	-91	-88
2	11	16-QAM 1/2	26	19.90	-89	-86
2	12	16-QAM 3/4	39	29.90	-85	-82
2	13	64 QAM 2/3	52	39.70	-81	-79
2	14	64 QAM 3/4	58.5	43.50	-79	-77
2	15	64 QAM 5/6	65	48.1	-74	-75

Table 27 MCS vs. Sensitivity Chart (10MHz Bandwidth)*

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC4400/3500/3800 Sensitivity	SC4200/3822 Sensitivity
1	0	BPSK 1/2	6.5	4.92	-96	-93
1	1	QPSK 1/2	13	9.82	-94	-91
1	2	QPSK 3/4	19.5	14.73	-91	-88
1	3	16-QAM 1/2	26	19.65	-89	-86
1	4	16-QAM 3/4	39	29.47	-86	-83
1	5	64 QAM 2/3	52	39.29	-82	-79
1	6	64 QAM 3/4	58.5	44.20	-80	-77
1	7	64 QAM 5/6	65	47.45	-78	-75
2	8	BPSK 1/2	13	9.82	-94	-91
2	9	QPSK 1/2	26	19.65	-91	-88
2	10	QPSK 3/4	39	29.47	-88	-85
2	11	16-QAM 1/2	52	39.29	-86	-83
2	12	16-QAM 3/4	78	57.04	-82	-79
2	13	64 QAM 2/3	104	75.00	-79	-76
2	14	64 QAM 3/4	117	85.00	-77	-74
2	15	64 QAM 5/6	130	94.00	-75	-72

Table 28 MCS vs. Sensitivity Chart (20MHz Bandwidth)*

Sensitivity numbers reflect "typical" values. Actual sensitivity will vary by band.

5.1.3 LAN/WIFI Configuration

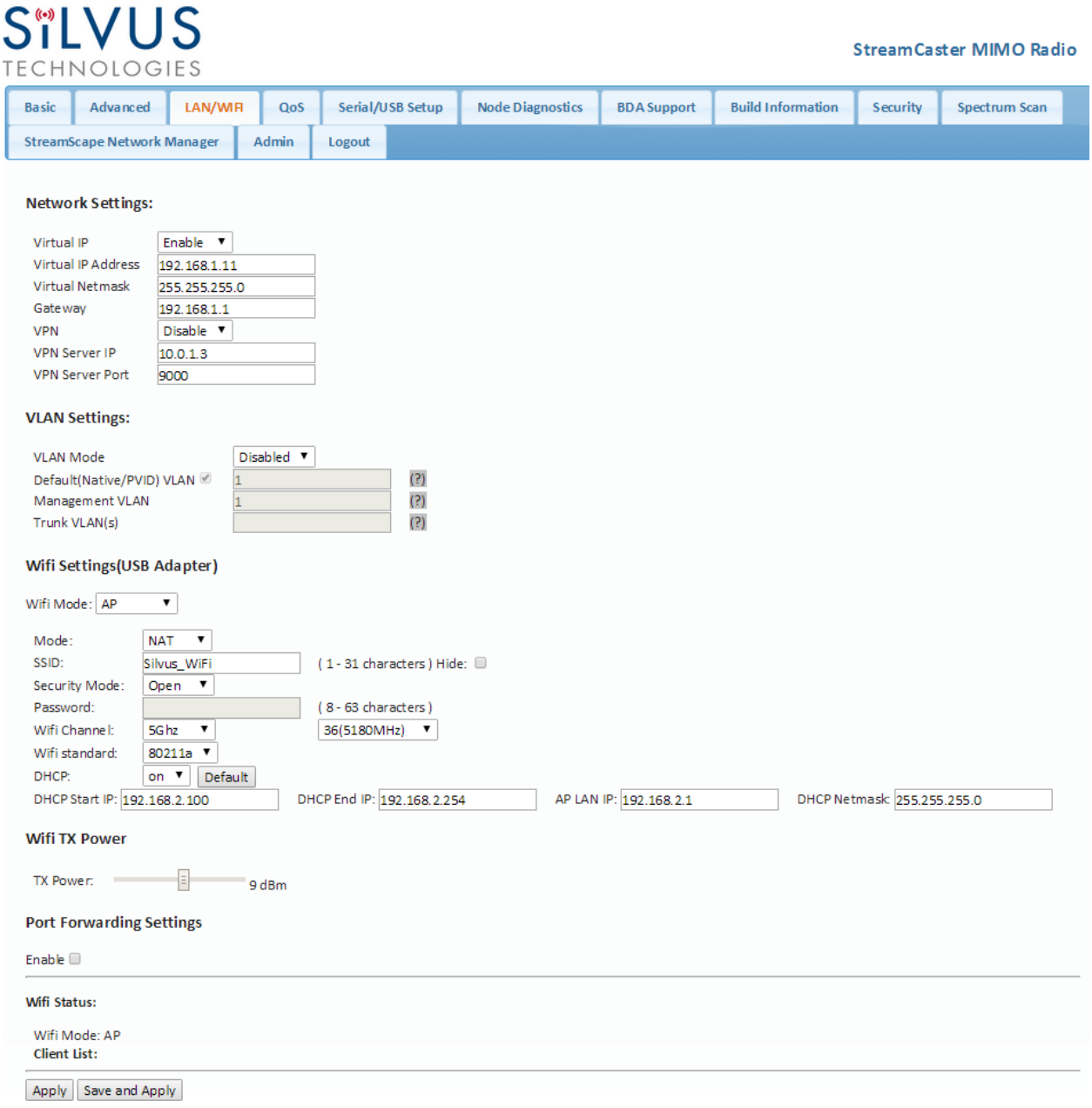


Figure 30 LAN/WIFI Configuration Page

Network Settings:

- **Virtual IP**: Enable or Disable the Secondary IP address for the radio.

- **Virtual IP Address**: Set the secondary IP address for the radio. The user may set this to be on the user's IP network, e.g., 192.168.2.10. Once this secondary IP address is set, the user may access the radio web page using either the native IP address or the secondary IP address. Please note that the secondary IP address should NOT be on the 172.20.xx.xx subnet.

- **Virtual Netmask**: Netmask for the Secondary IP address, e.g. 255.255.255.0.

- **Gateway:** Gateway for local network to allow radio to connect to the internet

- **VPN:** For WAN wired backbone scenarios where radios from two different sites are connected via the internet, a public N2N server is needed to route the data. Here is an example of how to setup an N2N server on a server hosted by Amazon AWS running Ubuntu 12.04:

  Compile:

  git clone https://github.com/lukablurr/n2n_v2_fork ### downloads the code

  cd n2n_v2_fork

  export N2N_OPTION_AES=no

  make clean

  make

  Execute:

  ./supernode -l 9000 -v

  Server will be running on port 9000.

- **VPN Server IP**: IP Address of N2N VPN Server

- **VPN Server Port**: Port that the N2N VPN server is configured to listen on.

VLAN Settings:

VLANs allow users to segregate the Ethernet layer by assigning one or more VLAN IDs to the ports of a VLAN switch. Ethernet packets are only allowed to travel between ports that belong to the same VLAN. To allow concatenating multiple VLAN switches and/or a single physical interface residing on multiple VLANs, a VLAN ID can be inserted to the Ethernet packet header to indicate which VLAN the packet belongs to. This is called VLAN Tagging. A packet that contains a VLAN ID is called a tagged packet. A port on a VLAN switch typically operates in either access mode or trunk mode.

- **VLAN Mode:** Specify 'Access' or 'Trunk' mode for the radio per the 802.1Q standard.
- **Default (Native/PVID) VLAN:** This is the VLAN associated with untagged packets entering the radio. The virtual IP of the radio is available on this VLAN. This is for Access mode only.
- **Virtual IP VLAN:** Virtual IP of the radio will be available on this VLAN. This is for Trunk mode only.
- **Management VLAN:** This is the VLAN used for radio management (e.g. routing and network management). All radios on the network should have the same management VLAN. The 172.20.xx.yy IP of the radio is available only on this VLAN.
- **Trunk VLAN(s):** This setting enables the trunking of VLANs when the radio is connected to an 802.1Q switch. If left empty, only the native and management VLAN traffic will be allowed. User may enter a comma separated list of VLANS, e.g. 4,5,6 or an arry of VLANs in the format of a:b:c where a and c are start and end, and b is step size, e.g. 4:1:7 translates to 4,5,6,7. Any combination of the above is allowed.

WiFi Settings:

Note: Use of this feature requires a Silvus USB-WiFi adapter. The WiFi settings will only display if the WiFi dongle is attached to the radio's USB port before it is powered on.

- **Wifi Mode**: Choose between AP, Client or Disabled. AP mode turns the WiFi dongle into a wireless AP. This mode is useful for connecting phones, tablets, laptops, etc. to the radio in order to pull up the web interface and access other devices in the mesh network. Client mode allows the radio to connect to another wireless AP. This mode is useful for connecting to wireless cameras and other devices which generate their own 'hotspot'. Once set to client mode, a list of detected wireless networks will be displayed with an option to connect.

- **Mode**: When set to AP, the wireless can be configured to be in Bridge Mode or NAT mode. In Bridge mode, the wireless interface is bridged with the Ethernet interface and the rest of the mesh. This is the simplest mode as all data is transparent and at layer 2. NAT mode puts the WiFi wireless traffic on a LAN, and the rest of the Silvus mesh network on a WAN. In effect, this means that a device connected wirelessly via the NAT AP will be able to find any device in the larger mesh network, but not vice versa. NAT mode is recommended for more advanced users who wish to be able to segregate data.

- **SSID**: Define the SSID for the wireless network. Must be between 1-31 characters. User also has the option to prevent the AP from broadcasting it's SSID by checking the 'Hide' box.

- **Security Mode**: Determines whether the AP requires a password to connect.

- **Password**: If 'Security Mode' is set to 'Secure', a password between 8 and 63 characters must be set.

- **Wifi Channel**: The Silvus USB-Wifi adapter supports 20 different Wifi channels in both the 2.4GHz and 5GHz frequency ranges. It is recommended to set the Wifi channel to a frequency that has maximum separation from the mesh network frequency. (i.e. if mesh network is operating at 2.4GHz, it is recommended to set the Wifi frequency somewhere in the 5GHz range). Note that not all user devices support 5GHz Wifi.

- **Wifi Standard**: Specify 802.11b or g wifi standard. Some legacy devices may not be able to connect to an 802.11g network.

- **DHCP**: When enabled, the USB-Wifi adapter will assign IP addresses to connected devices. Note that when the AP is set to 'Bridge' mode, the DHCP will be delivered to the entire mesh. Users should be careful to make sure there is only one DHCP server connected into the mesh network to avoid any conflicts. When DHCP is enabled, the DHCP parameters must be set.

- **Wifi TX Power**: This slider can be used to control the Wifi TX power from 0dBm (1mW) up to 17dBm (50mW).

- **Wifi Status**: Provides status information of the wifi adapter. A list of connected clients will also be shown here.

- **Port Forwarding (NAT Mode Only)**: When in NAT mode, devices on the larger mesh will not be able to locate devices connected to the wireless adapter. This can be overcome by mapping port forwarding for specific data streams.

- **Apply**: Applies the new values but does not save them to flash.

- **Save and Apply**: Save the new values to flash and apply.

5.1.4 Multicast

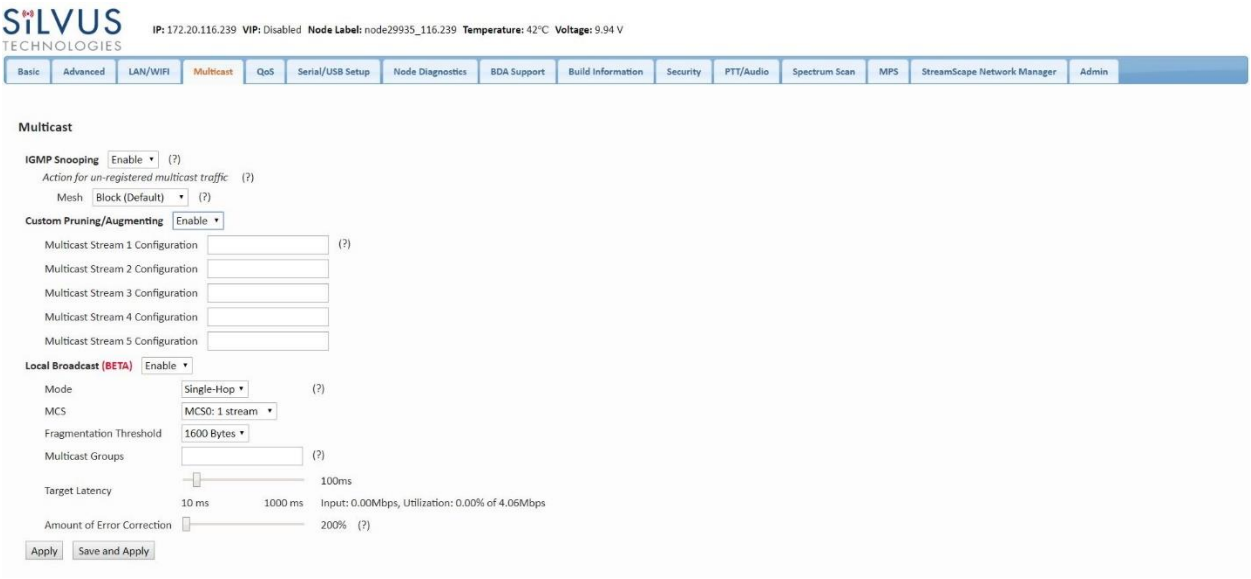


Figure 31 Multicast Configuration Page

- **IGMP Snooping**: Enable or Disable IGMP Snooping for Multicast traffic
- **Mesh**: This option controls default behavior for local and mesh multicast traffic that has no IGMP snooping entries. If set to 'Block', all unregistered multicast traffic will be block. If set to 'Send to All', all unregistered multicast traffic will be sent to all radios.
- **Custom Pruning/Augmenting**: Enable or Disable the Multicast group. The format for the field is Multicast_ip_address, receiver_id1, … receiver_idn If IGMP snooping is disabled, multicast traffic will only be forwarded to the radios in this list. If enabled, multicast traffic will only be forwarded to radios in this list that have client devices requesting this traffic. Traffic may be forced to go to a radio by adding the node with postfix "+". Traffic may be prevented from reaching a radio by adding postfix "-". (e.g. 224.50.50.50 1234, 1235-, 1236+) If receiver_id is -1, it will stop multicast traffic for this group.

Multicast Pruning Examples:

Data for multicast group 224.50.50.51 will be received only by radios with node-ids 1131 and 1261:

224.50.50.51, 1131, 1261

Data for multicast group 224.50.50.51 will be discarded at the transmitter and not put on the air:

224.50.50.51, -1

- **Local Broadcast**: Enable or Disable the Local Broadcast feature. The local broadcast mode can be either single-hop or multi-hop. In single-hop mode, multicast traffic will be transmitted to all radios reachable in a single hop. Traffic will terminate at these nodes. In multi-hop mode, multicast traffic will reach all radios in the mesh, subject to IGMP/custom pruning if applicable. MCS, and fragmentation threshold must be designated for these transmissions. Multicast Groups is a list of multicast IPv4 addresses separated by comma (,), e.g. 224.50.50.50, 224.50.50.51. Traffic for these multicast groups will be sent using Local Broadcast. Target latency will make the node wait for the time set in parameter and collect all data and construct forward error correction packets to send out. Higher latencies are better since the low density parity check code can generate more robust codes resulting in better error correction on the receiver. Amount of Error Correction is the amount of additional error correction packets sent along with the data packets.

5.1.5 Quality of Service (QoS)

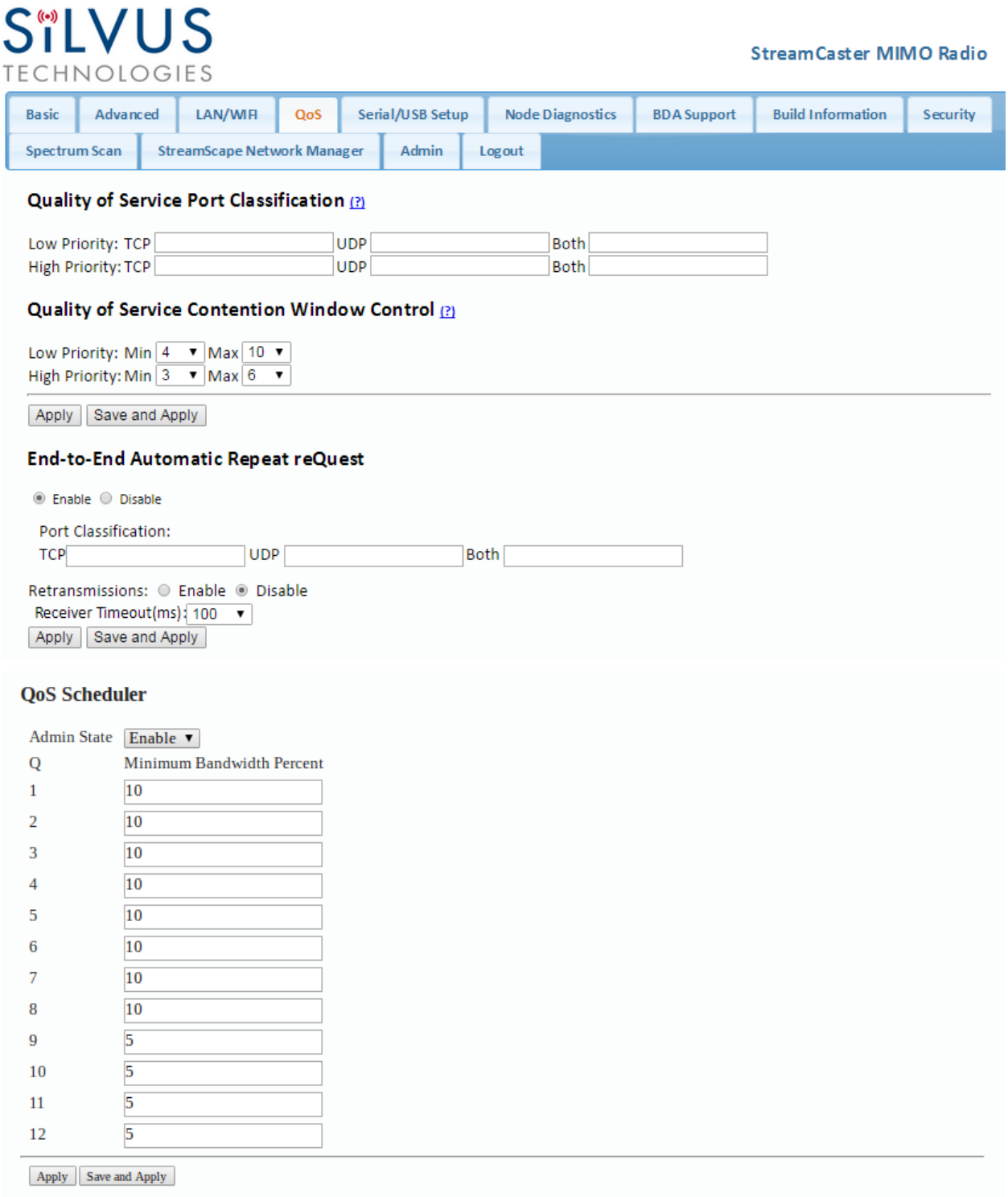


Figure 32 Quality of Service (QoS) Configuration Page

Quality of Service Port Classification:

The Quality of Service configuration page allows the user to make a distinction between low and high priority traffic transmitted through each radio. High priority traffic will always jump to the front of the queue and bypass any awaiting low priority traffic. In instances where the link cannot support the amount of data trying to be transmitted, low priority traffic may be completely shelved in order to ensure that the high priority traffic gets through.

To specify Low/High priority traffic, the user needs to simply input the port number that the traffic will be arriving on. Multiple ports of the same priority can be separated by a comma (i.e. 5001, 6001, 6002). Alternatively, the user can specify a range of ports using a dash (i.e. 5001-5006). Any combination of commas and dashes will work as well (i.e. 5001, 6001-6007, 8000). Any field can be cleared by removing the text and clicking 'Apply' or 'Save and Apply'. If unspecified, traffic is treated as Low Priority.

Quality of Service Contention Window Control:

The Quality of Service Contention Window Control tunes the aggressiveness of CSMA backoffs when collisions occur. The MAC takes random backoffs in the range [0, 2^cw_min]. Every time there is a collision/noise it will increase this cw_min by 1, until it is capped by cw_max.

E.g. 4,10 translates to random backoffs in the range [0,16] in the beginning for a packet. If the first try results in a collision, it will pick another backoff in the range [0,32], then [0,64], until [0,1024]. After successful transmission, backoff is reset to [0,16]. The default is 4,10 for low priority, and 3,6 for high priority. For larger networks, it is recommended to increase the Low Priority minimum to reduce the chance of collisions occurring.

End-to-End Automatic Repeat request (Beta Feature – License Enabled)

The End-to-End ARQ feature provides packet re-ordering capability to the radio. This feature is useful in applications that are sensitive to out of order packets (i.e. video applications where the decoder does not have the ability to re-order packets).

To enable packet reordering, specify the port number of the subject data in the same format as the QoS ports on the source and destination radio. The settings should match on both radios and do not need to be set on any relays.

Retransmissions Disabled – Only packet re-ordering with no end-to-end retransmissions if packets are lost. The receiver timeout is the length of time the receiver waits for out-of-order packets before giving up and delivering the data it has in its buffer. This is similar in concept to

the jitter buffer in common video decoders (e.g. VLC). The worst-case end-to-end delay will be incremented by the receiver timeout value.

Retransmissions Enabled – Packet re-ordering and end-to-end retransmissions enabled in case of packet loss. The retransmission timeout is the time the transmitter will wait before re-sending a lost packet. The worst-case end-to-end delay will be incremented by the retransmission timeout value.

Determining Timeout Value – Both receiver timeout and retransmission timeout should be set to roughly 3 times the end-to-end latency. The end-to-end latency can be found by disabling e2e and doing a ping between the transmitter and receiver.

QoS Scheduler (Beta Feature – License Enabled)

The Quality of Service (QoS) Scheduler feature provides a Hierarchical Token Bucket (HTB) scheduler. The scheduler prioritizes traffic based on the packets DSCP value. There are 12 queues in the scheduler; each with an assignable minimum bandwidth guarantee. First, the minimum guarantees are fulfilled for all queues waiting to transmit traffic out. If there is bandwidth remaining, it becomes available to highest priority traffic (lower number means higher priority) and it will take as much bandwidth as it needs to transmit out its data. Next, the remaining bandwidth will become available to the next lowest priority queue and so on. Traffic flows which map to the same priority will fairly share the available bandwidth using the Fair Queuing with Control Delay (FQ_CoDeL) scheduling algorithm. The feature is applicable to IPv4 and IPv6 untagged and tagged packets. Fragmented packets are not supported. Detailed below is the DSCP to queue/priority mapping.

Queue	Priority	DSCP	TOS	DSCP Name
1	0	0x30	0xC0	CS6
2	1	0x2E	0xB8	EF
3	2	0x28	0xA0	CS5
4	3	0x26	0x98	AF43
		0x24	0x90	AF42
		0x22	0x88	AF41
5	3	0x20	0x80	CS4
6	4	0x1E	0x78	AF33
		0x1C	0x70	AF32
		0x1A	0x68	AF31
7	4	0x18	0x60	CS3
8	5	0x16	0x58	AF23
		0x14	0x50	AF23
		0x12	0x48	AF23
9	5	0x10	0x40	CS2
10	6	0x0E	0x38	AF13
		0x0C	0x30	AF12
		0x0A	0x28	AF11
11	6	0x00	0x00	BE
12	7	0x08	0x20	CS1

Admin State – Enables and disables the scheduler.

Minimum Bandwidth Percent – Sets the minimum bandwidth guarantee for the queues as a percentage of the link rate. The sum of the minimum bandwidth guarantees cannot exceed 100% of the link rate.

5.1.6 Serial/USB Setup

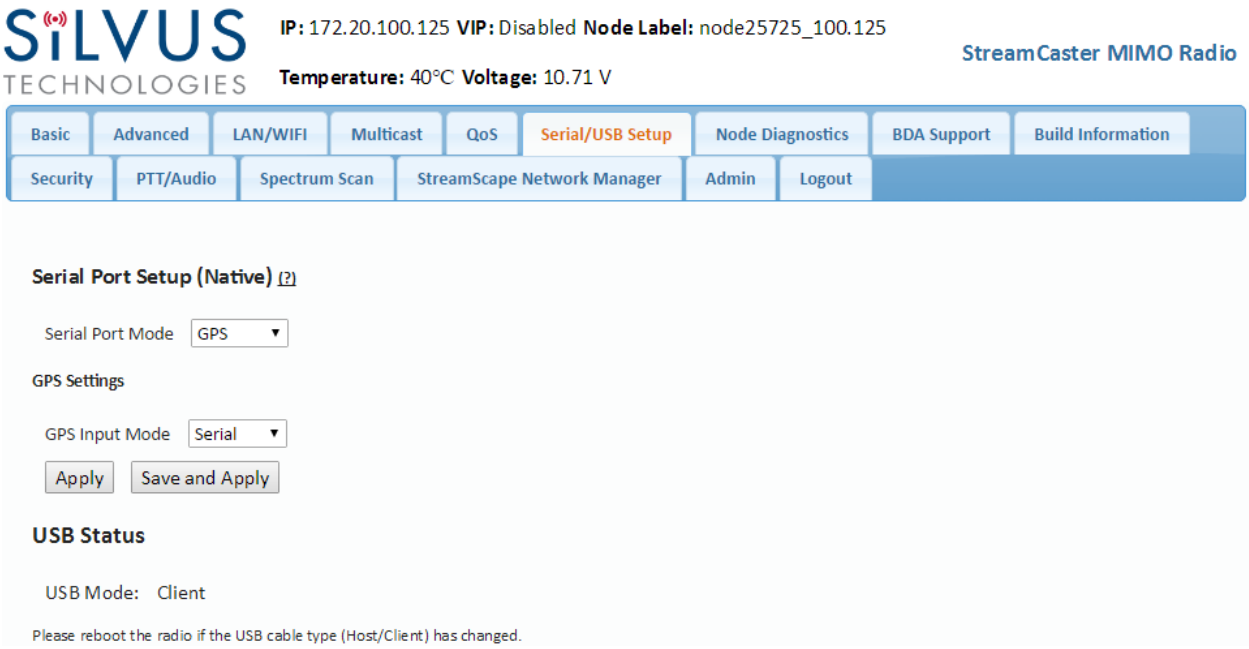


Figure 33 Serial/USB Setup Configuration Page

Serial Port Setup:

Each StreamCaster is equipped with one user configurable serial port. A special power cable and null modem cable are required for access to the radio's serial port. A brief description of each parameter is given below.

- **Serial Port Mode**: The user can select one of four available modes for the serial port: *GPS, RS232, Debug,* and *Disabled*.

    - ***GPS***: In GPS mode, an external serial GPS module can be connected to and powered from the serial port of the radio. A gpsd service daemon running on the node will make the GPS information available to any user on the network from TCP/IP port 2947. For more information on gpsd please see: http://catb.org/gpsd/

      In addition, GPS information can be pushed to the radio via the Ethernet or pulled by the radio from a remote device. If using a remote device to obtain GPS, set the GPS mode to remote, the GPS Server IP to the IP address of the remote device, and the Port. The radio will try to connect via TCP to server on local subnet. It will expect data in GPSd format. If GPS information is pushed to the radio via Ethernet, the radio will listen on specified port and expect GPS data as NMEA Formatted UDP packets.

- ***RS-232***: The RS-232 mode provides a wireless serial connection between any two serial devices connected to StreamCaster radios on the network. In this mode, the user must configure the RS-232 protocol parameters shown in **Figure 33** above. The transport protocol for the serial data can be set as either TCP or UDP. For data that is sensitive to latency such as command and control data, UDP is recommended. For data that cannot tolerate any data loss, such as telemetry data, TCP is recommended.

    - The Peer IP should be the IP address of the radio on the other end of the RS-232 communication.
    - The Peer IP can be the native or virtual IP address, but must be consistent at both ends.
    - Baud rate must match the baud rate of data being sent from the device.
    - Note – An additional 'null modem' cable may be needed at either end, depending upon whether connected device is acting as a terminal or as a control (DTE or DCE)

- ***Debug***: The debug mode is used to gain terminal access to the StreamCaster radio and is available for debug or interface purposes (API commands). The user's terminal client should be set to a baud rate of 115200 for console access to the radio.

- ***Disabled****:* This mode completely disables the serial terminal of the radio.

- **Apply**: Apply the new values but does not save them to flash.
- **Save and Apply**: Save the new values to flash and apply.

USB Status (3822/4200/4400):

The USB port on the 3822/4200/4400 can auto-detect whether the connected device is a USB host or client device. The USB cable should not be unplugged while the radio is running.

5.1.7 Node Diagnostics

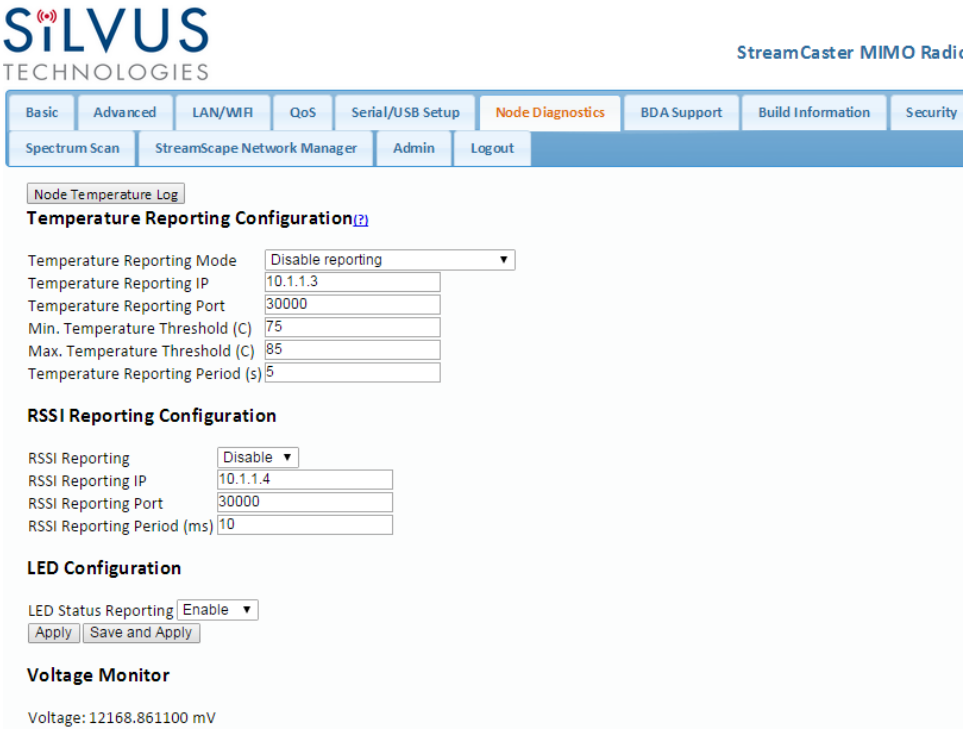


Figure 34 Node Diagnostics Configuration Page

The Node Diagnostics page allows the user to specify an IP and Port number for Temperature and RSSI (Receiver Signal Strength Indication) reports to be delivered to. This is useful for users that intend to feed this information into some other platform for analysis and recording. Section 8 gives more information on the format of streaming reports.

Temperature Thresholds:

In addition to receiving temperature reports, this page can be used to set minimum and maximum temperature thresholds for the radio. The StreamCaster™ family of radios is equipped with on board temperature sensors which are monitored to prevent overheating. Once a radio reaches the maximum temperature threshold, the radio will begin to reduce its transmission time until the temperature falls below the minimum temperature threshold. By default, the min and max values are 75C and 85C respectively.

RSSI Reporting Configuration

This setting allows the users to report the RSSI values every few milliseconds base on users setting.

LED Configuration:

This setting allows the user to disable or enable the LED on the faceplate of the radio.

Voltage Monitor:

Radios built on or after Jan 1, 2015 have the ability to monitor the input voltage, displayed here.

5.1.8 BDA Support

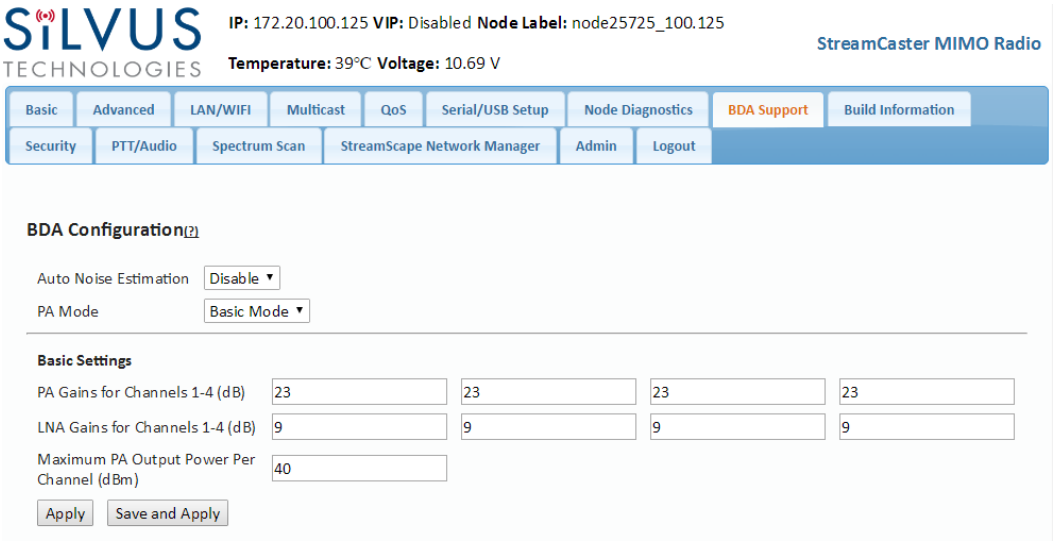


Figure 35 BDA (Bi-Directional Amplifier) Support Configuration Page

The BDA Support page is used to configure the radio to work with an external bi-directional amplifier. These settings should be configured before connecting the amplifier to the radio.

- **Auto Noise Estimation:** When enabled, the radio can automatically estimate the noise in the channel, including any amplification due to the external amplifier. It is preferred that this remain disabled and the LNA gain values be manually input further below, but if the LNA gain values are not known, this can be used instead.

- **PA Mode**: Either set to “No PA” when there is no amplifier present or “Basic Mode” when using an external amplifier.

Basic Settings:

- **PA Gains for Channels 1-4**: Enter the gain (dB) for the power amplifier connected to each channel of the radio.

- **LNA Gains for Channels 1-4**: Enter the gain (dB) for the LNA connected to each channel of the radio.

- **Maximum PA Output Power Per Channel (dBm)**: Enter the maximum output power for each PA.

- **Apply**: Apply the new values but does not save them to flash.

- **Save and Apply**: Save the new values to flash and apply.

5.1.9 Build Information

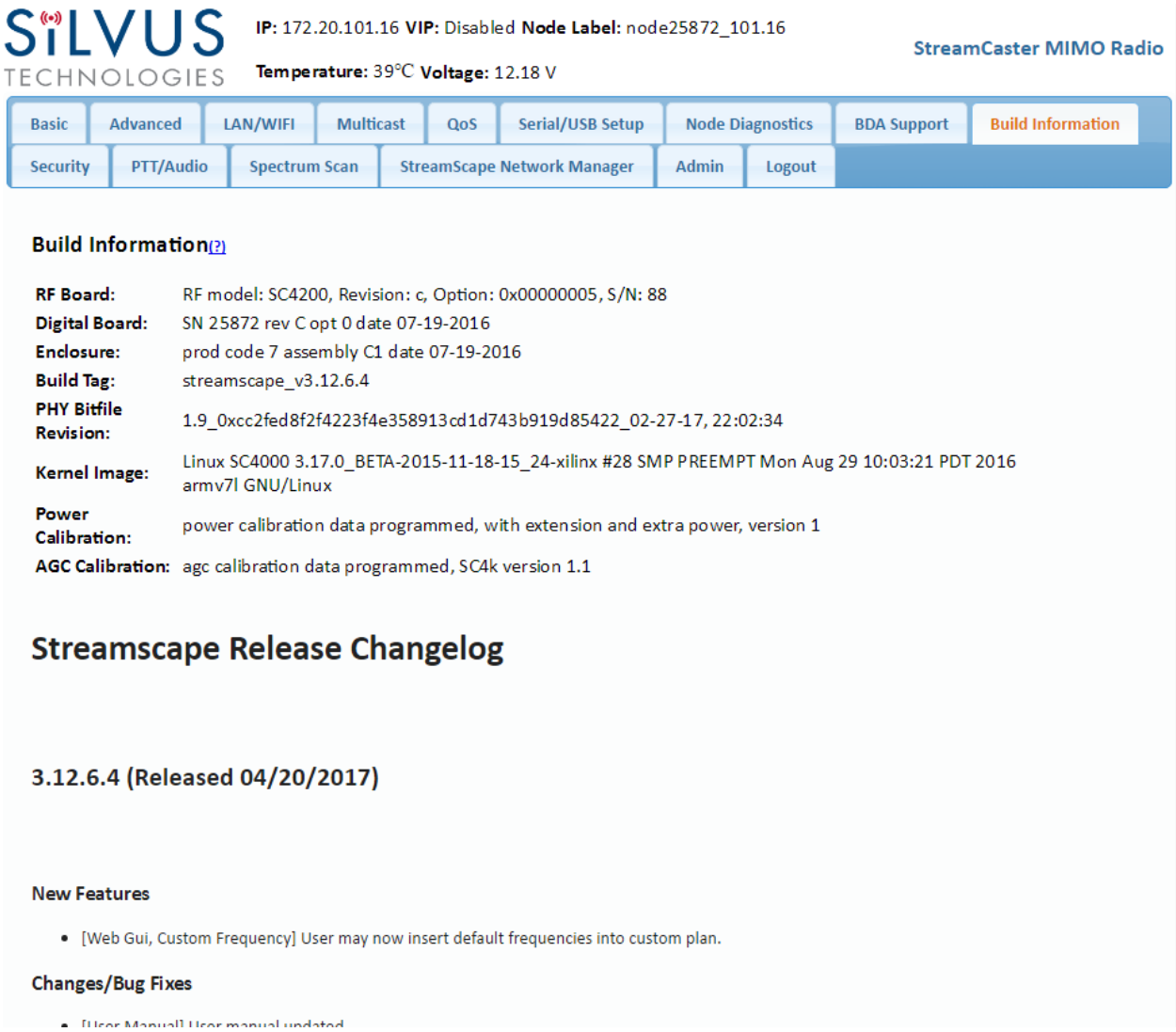


Figure 36 Build Information

The 'Build Information' page provides information about the hardware and firmware loaded onto the radio, as well as the changelog of the currently loaded and past firmware revisions.

5.1.10 Security

The Security section of StreamScape allows users to enable/disable encryption, upgrade radios, and load license files for enabling features such as AES encryption.

Encryption:

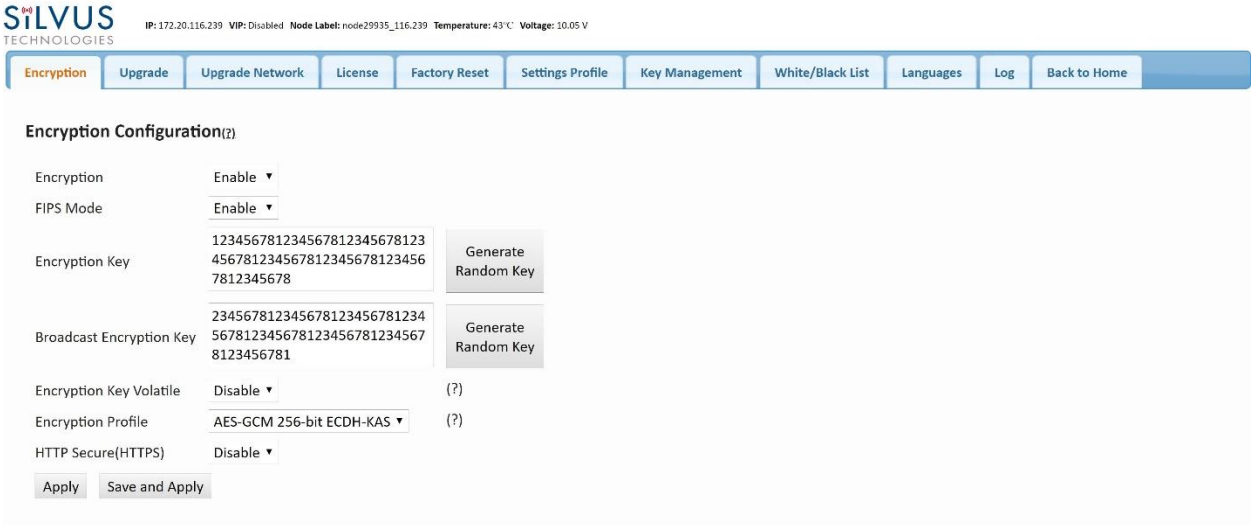


Figure 37 Security (Encryption)

- **Encryption**: Enable or disable encryption.

- **FIPS Mode**: Enabling FIPS mode is the first step to making the radio FIPS compliant (see Section 6.1 Enable FIPS Mode for details). Enabling/disabling will require a reboot and will erase all setting profiles, reset the encryption key, both SSH keys, the HTTPS certificate, and the login passwords to their factory default. Enabling will also turn on HTTPS and Login Authentication. After reboot, the operator must perform the following steps to complete the FIPS compliant process.

    - Update the web login password to something other than “HelloWorld”
    - Create new SSH keys and HTTPS certificate.
    - Update encryption key or click “Generate Encryption Key” and save.

- **Encryption Key**: Set an encryption key if encryption is enabled.

- **Encryption Profile**: Choose between various encryption profiles. Available options are:

    - **DES 56 bit** – DES encryption using 56 bit keys. This mode is backwards compatible with legacy SC3500/3800 radios.
    - **AES 128/256** – AES encryption using 128/256 bit keys. This mode is backwards compatible with legacy SC3500/3800 radios.
    - **AES-GCM 256 ECDH-KAS** – FIPS compliant AES encryption in GCM mode with authentication and ECDHE based re-keying. This is the recommended mode on the 4K series as it is the most secure and provides the highest throughput under varied conditions. It is currently undergoing FIPS certification for the 4K series.

- **HTTP Secure (HTTPS):** Enable or disable HTTPS access to StreamScape.

Upgrade:

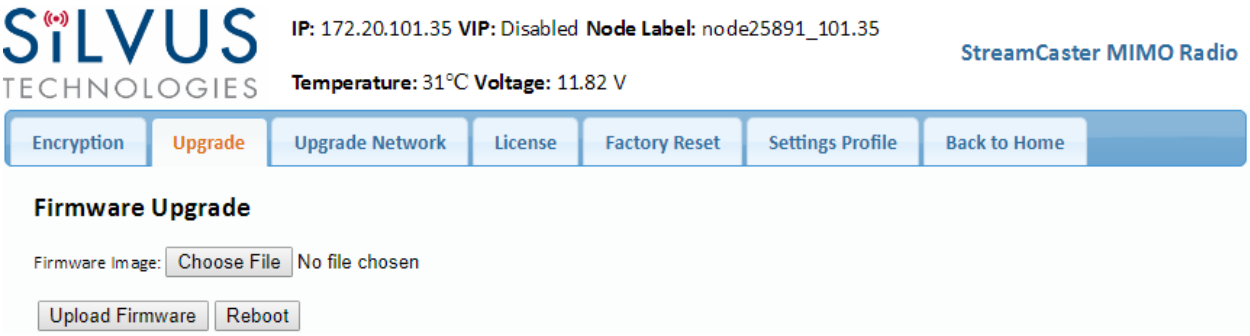


Figure 38 Security (Upgrade)

The firmware can be upgraded by simply choosing the upgrade image from your desktop and uploading it to the radio. This field can be used to upgrade the radio root file system, linux kernel, or uboot.

Upgrade Network:

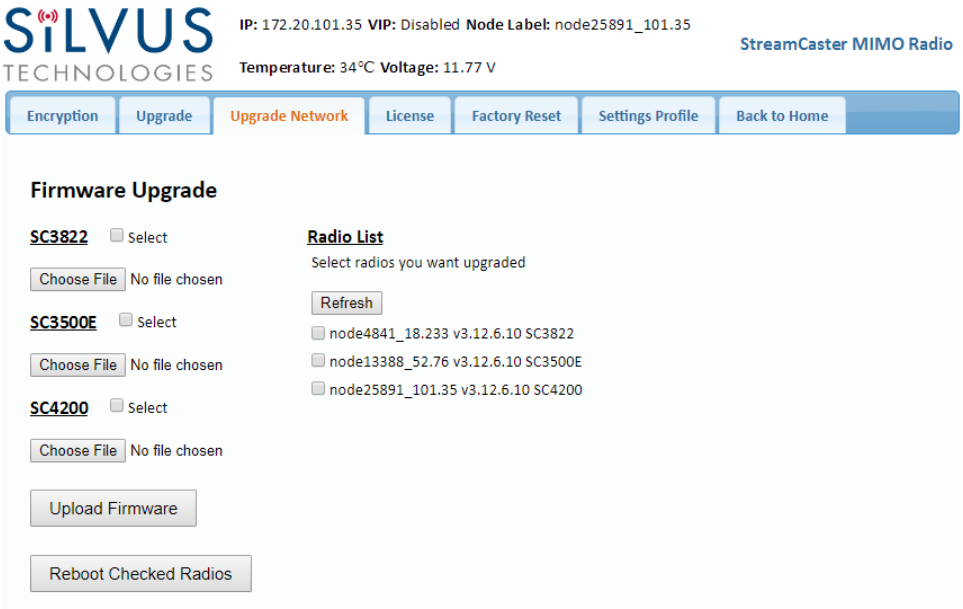


Figure 39 Security (Upgrade Network)

Starting with firmware version 3.12.6.8, multiple radios within the same network can be upgraded all at once. Users can simply choose the appropriate firmware file for the corresponding radio models to apply the upgrade to all the radios in the network. Currently, this feature is not available in HTTPS mode.

License:

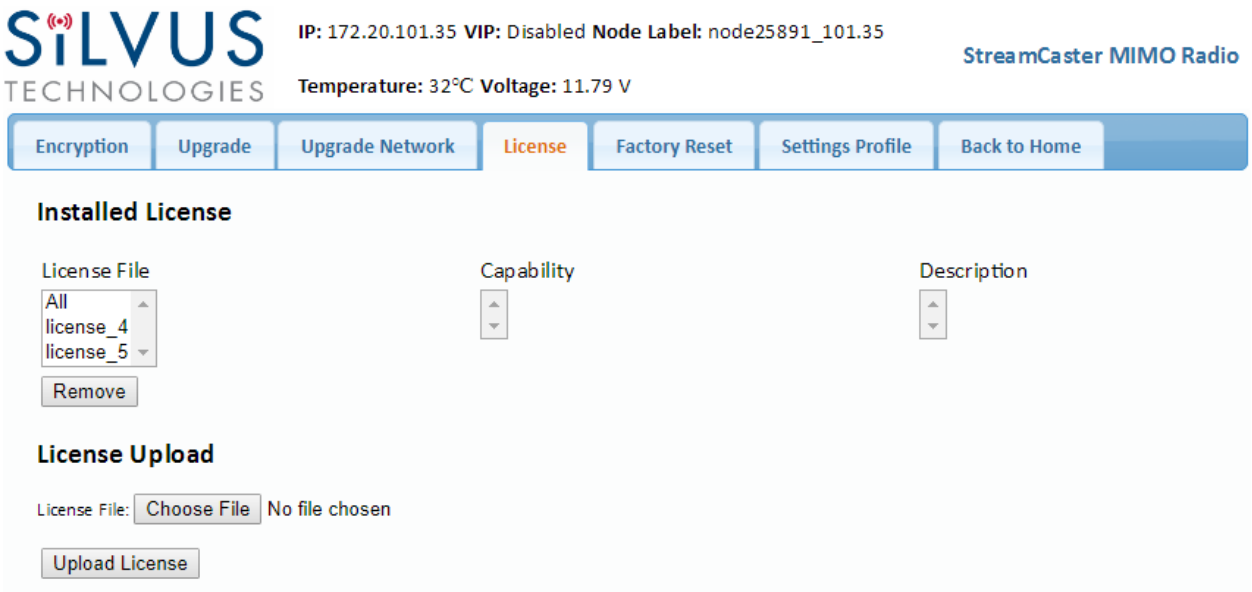


Figure 40 Security (License)

Features such as encryption levels and frequency ranges can be enabled by license keys obtained from Silvus. New license keys can be uploaded to the radio on this page.

Factory Reset:

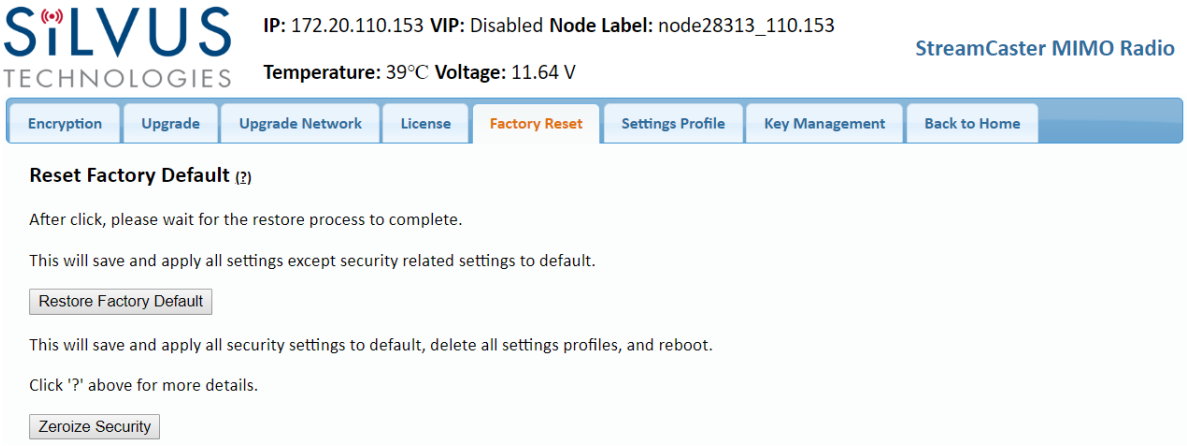


Figure 41 Security (Factory Reset)

- **Restore Factory Default:** Restores all settings to default except those related to security (such as login passwords, encryption keys, FIPS mode, etc.). This is useful if the user changed some advanced settings and now they don't know how to get to the defaults.

- **Zeroize Security:** This will set login passwords and all security keys to their defaults. This includes the Encryption Key, SSH Login Key, SSH Host Key, HTTPS Certificate, and Encryption Key Volatile. It will also erase all settings profiles. Also, if FIPS mode is off, it will turn off HTTPS and login mode. The current FIPS mode will not be changed.

Settings profile:

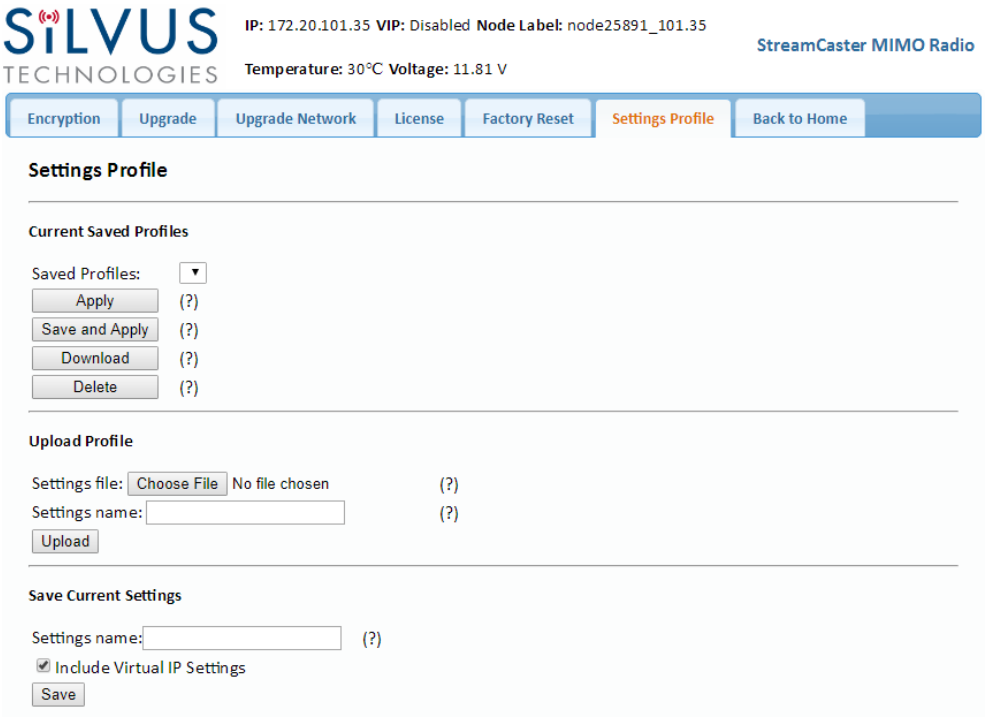


Figure 42 Security (Setting Profile)

- **Current Saved Profiles:** Select a saved profile and apply the settings to use the selected profile. The profile stored can be downloaded or deleted.
- **Upload Profile:** Select a downloaded profile from the computer and upload to the radio as a saved profile.
- **Save Current Settings:** Store the current settings on to the radio for future access. Note that the FIPS mode setting is not saved in the profile. You must manually enable/disable it after applying the profile.

Key Management:

Figure 43 (Key Management)

This page is used to manage the radio's SSH login keys, SSH host key, and HTTPS Certificate. All key pairs used are elliptic curves.

- **SSH Login Keys:** In order to SSH into the radio, you must first generate a key pair and upload the public key onto the radio. A common way this is done on a computer is through the command `*ssh-keygen -t ecdsa -b 521*`. You will need to do this for each machine that wants to SSH into the radio, or you can share a single key pair amongst machines.

- **SSH Host Key:** This key is used for authenticating the radio to all machines that want to connect to it via SSH. A common way this key is generated on a computer is *'openssl ecparam -name secp521r -genkey -noout -out yourfilename`*. You may either upload your own key or generate one on the radio. Once you upload/generate a new key, the previous one is gone. You can get the original key by Factory Reset -> Zeroize. (Note that the generated text from the above command will encode both a private and public key in the text).

- **HTTPS Certificate:** This certificate is used to establish a HTTPS connection. If you are using a factory default or radio generated certificate and haven't added an exception of this certificate to your browser, you will see a message like below from your browser. This is because the certificate is signed by the radio and not a trusted Certificate Authority. You can bypass this by clicking "ADVANCED" in chrome, (or adding an exception in Firefox). The simplest way to generate a new certificate is to click "Generate Certificate and Save" button. If you are on HTTPS when you do this, you must also refresh the page. If you want to generate your own certificate, you must first generate a key pair (secp256r1, secp384r1, or secp521r1). Then create a X.509 certificate and append your private key to it. Copy the certificate text to the "Add a HTTPS Certificate" section, then click "Add Certificate and Save."

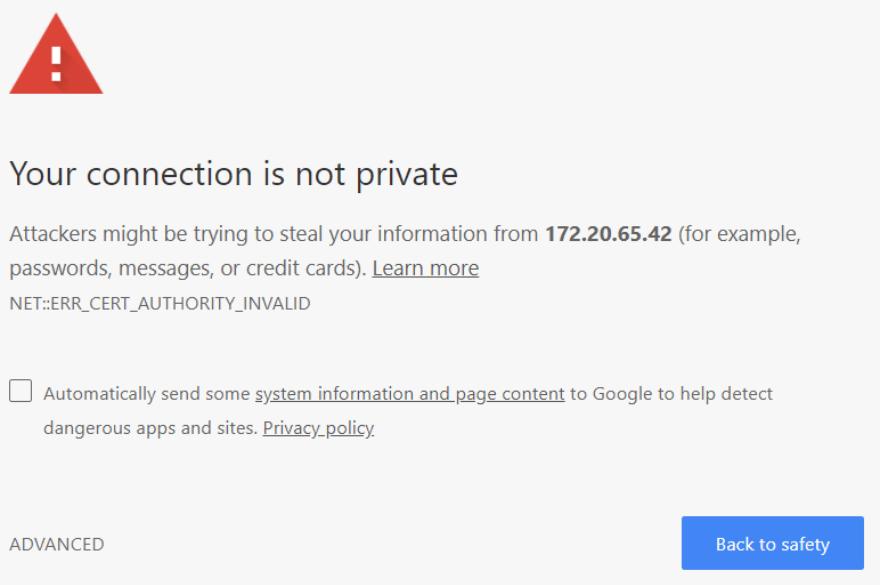


Figure 44 (Chrome Browser Warning)

5.1.11 PTT (SC4400/SC4200 Only)

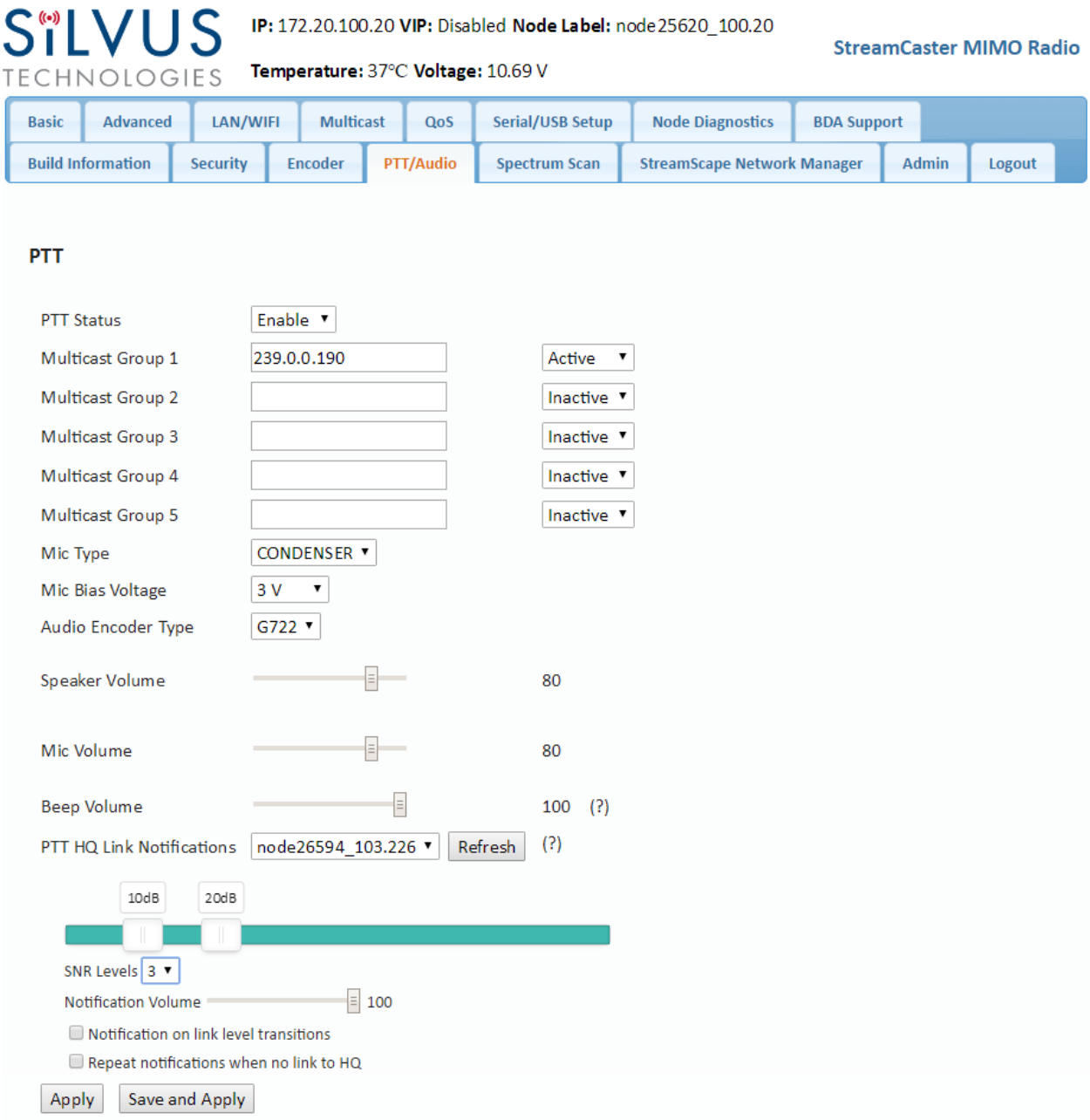


Figure 45 PTT (Push-to-Talk)

The PTT page can be used to configure talk groups (Multicast Groups) and speaker/mic settings for PTT enabled radios. Radios will only communicate with other radios that are subscribed to the same 'Multicast Group'. Radios can be active in multiple talk groups.

Multicast Group – Input the IP address of the multicast group. Radios will only communicate to radios within the same group. There are three different modes to select which dictate how a radio behaves within a group:

- **Active:** Radio may send and receive PTT audio on this group.
- **Inactive:** Group is disabled, no PTT audio will be sent or received.
- **Monitor:** Radio may listen to PTT audio from other users on this group, but may not talk.

Mic Type – Supported MIC types are Moving Coil or Condenser. The input amplification is adjusted based on the Mic Type chosen on this page

Mic Bias Voltage – Options are 90% (3V) or 65% (2.15V).

Audio Encoder Type – Default option is 'Variable Rate Code (OPUS)'. 'G.722 (high quality)' and 'G.711' are also supported for backwards compatibility

Speaker Volume – Moving slider adjusts the gain on the speaker

Mic Volume – Moving slider adjusts the gain on the microphone

Beep Volume + PTT Override – When the PTT button is pressed while another user is speaking, a warning beep will be played. This setting controls the volume of the Beep as a percent (%) of the speaker volume above. Pressing the PTT button three times (and holding on the third) within 1s will allow a user to override the channel and speak.

PTT HQ Link Notifications – When the PTT button is pressed twice within 1s, an audio notification will read out the SNR level to the user-specified HQ node. If the level transitions option is enabled, the notification will be played automatically when the SNR crosses the specified thresholds. The SNR thresholds can be set by first choosing the number of levels desired, and then moving the sliders accordingly.

5.1.12 Spectrum Scan

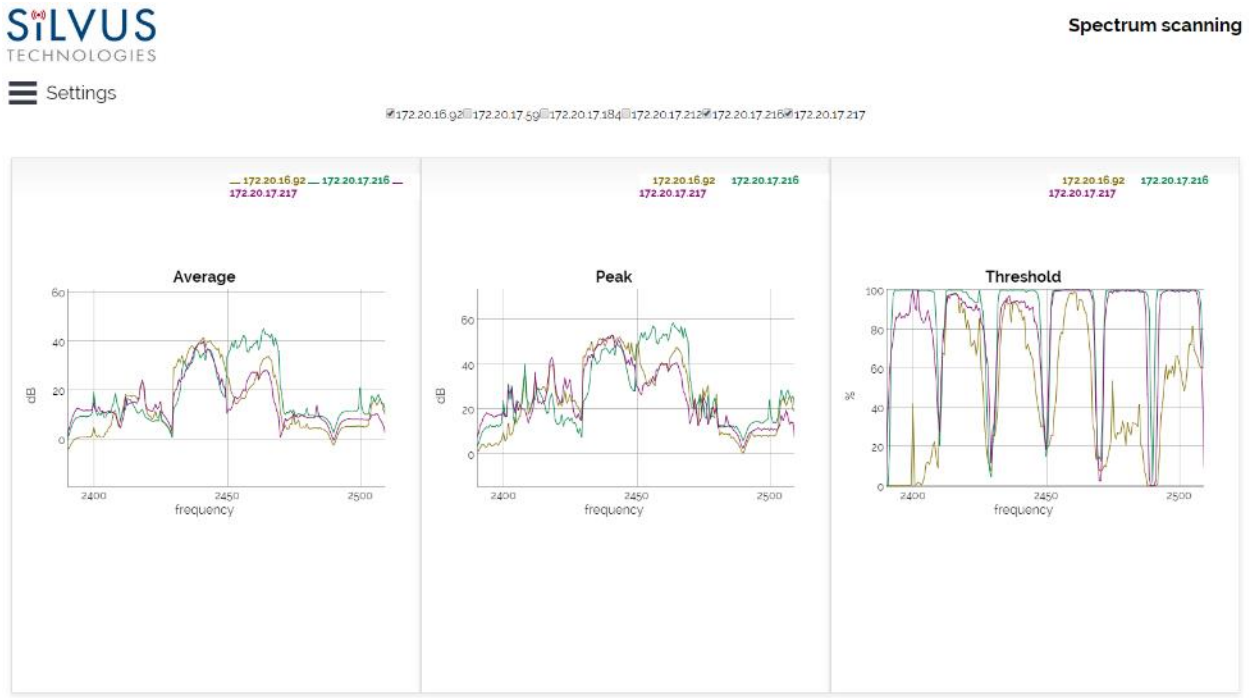


Figure 46 Spectrum Scan Results

The spectrum scan feature turns a Silvus network of radios into a distributed spectrum analyzer. When a scan is initiated, each selected radio in the network will go offline, perform a scan of the requested range, and report back. **Figure 46 Spectrum Scan** above shows the results from a scan of a network of 6 radios. The checkboxes at the top allow users to show or hide plots from specific radios. The three plots provided are:

Average – Displays the average power over the time duration specified in the settings.

Peak – Displays the peak power seen at any point during the scan for each frequency. This is the equivalent of the 'Max Hold' feature on common spectrum analyzers.

Threshold – Displays the duty cycle of interference stronger than the user specified 'Threshold' power. In the example above, the threshold was set to 5dB. The plot is showing the percentage of time that the measured power is more than 5dB above the radio's noise floor.

Settings:

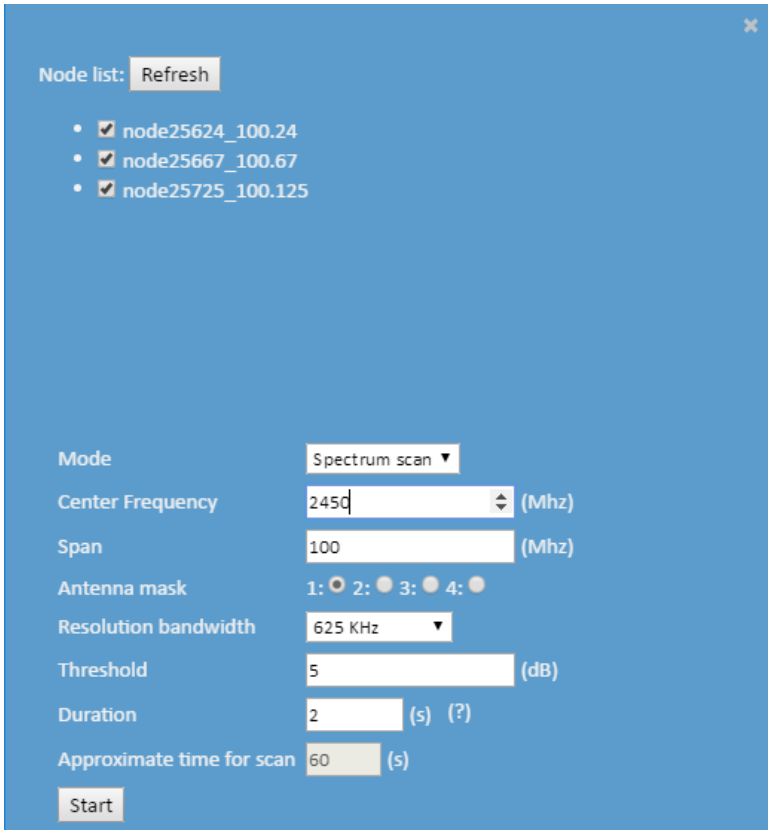


Figure 47 Spectrum Scan Settings

Clicking the settings button at the top left of the window will show the settings pane as shown in **Figure 47 Spectrum Scan Settings** The node list shows the list of nodes currently connected into the mesh network. Any nodes selected will be used as part of the spectrum scan. Nodes that are unchecked will resume normal operation. Note that an unchecked node will continue transmitting in the frequency channel it is operating in and its transmission will show up in the scan results of scanning radios.

Mode – Set to Spectrum Scan or Zero Span. Spectrum Scan mode provides plots of signal strength over frequency. Zero Span provides a plot of power over time in a 20MHz Bandwidth (see **Figure 49 Zero Span Results** below.

Spectrum Scan Mode:

Center Frequency – Specify the center frequency of the scan.

Span – Specify the span of the scan, centered on the center frequency. (e.g. Center freq of 2450MHz and span of 100MHz will scan 2400-2500MHz). A large span will take longer to complete.

Antenna Mask – Choose which antenna on the radio to use for scanning. If there are 2 antenna radios in the network antenna 1 or 2 must be chosen.

Resolution Bandwidth – Specify the RBW for the scan. A smaller RBW will provide a more detailed plot, but will take longer to complete the scan. 625KHz is a good balance between scan detail and time of scan.

Threshold – Specify the threshold for measurement of the duty cycle of interference.

Duration – Duration of each scan. A longer duration will provide better accuracy but will take longer to complete.

Approximate time for scan – Approximate time that the network will be down for the scan to complete.

Zero Span Mode:

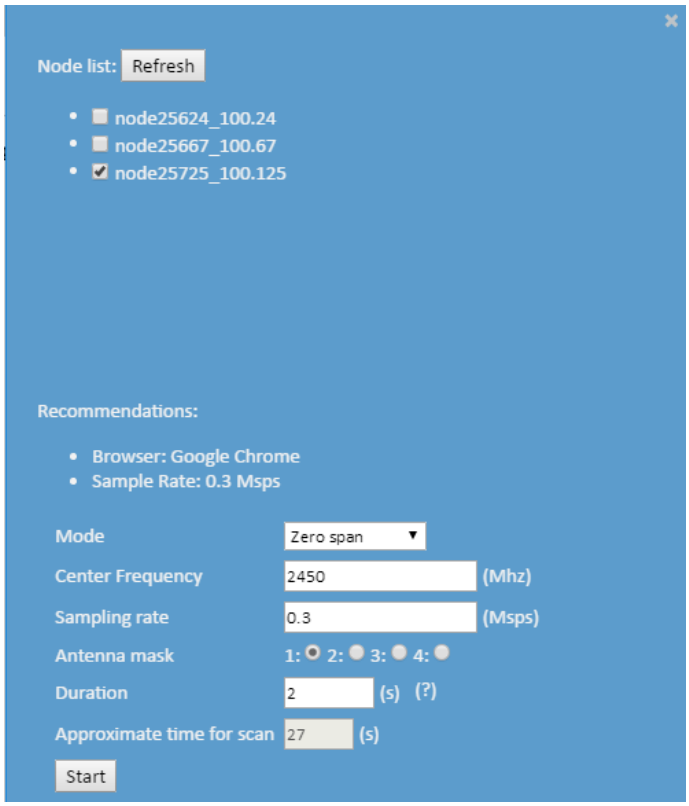


Figure 48 Zero Span Settings

In the Zero Span mode, the radio will provide a plot of the power measured in a 20MHz bandwidth across time. Zero Span can only be conducted on one radio in the network at a time. Other radios in the network will continue to operate and transmit so a zero span

scan should not be conducted within the same frequency that the mesh network is operating in.

Center Frequency – Specify the center frequency of the scan.

Sampling Rate – Set the sampling rate of the scan. (0.3Msps recommended)

Antenna Mask – Choose which antenna on the radio to use for scanning. If there are 2 antenna radios in the network antenna 1 or 2 must be chosen.

Duration – Duration of each scan. A longer duration will provide better accuracy but will take longer to complete.

Approximated time for scan – Approximate time that the network will be down for the scan to complete.

Figure 49 Zero Span Results

5.1.13 MPS (Multi-Position Switch)

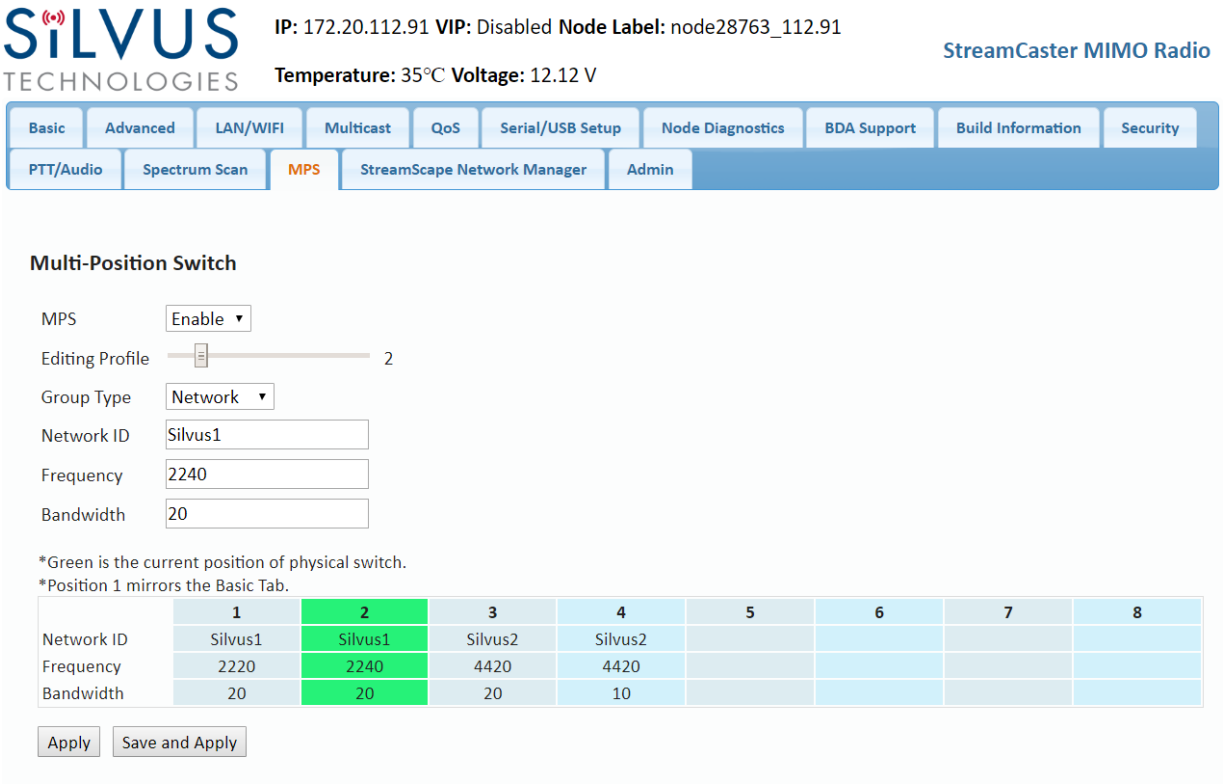


Figure 50 Multi-Position Switch

The Multi-Position Switch allows you to change various settings of the radio by using the new physical switch, no web GUI required (This is not available on all radios).

You must first configure the settings you want to correspond with each switch position. The "Editing Profile" slider represents which position is currently being edited. "Group Type" represents the collection of settings that will be applied. Only one "Group Type" is active at a given time. When the MPS switch is turned, the LED light on the radio will quickly flash green. This means the settings are being applied for this position. When the LED stops quickly flashing, the settings have been applied.

Position 1 is special. Any time settings are updated from the GUI without using the MPS page (i.e. Basic Tab, PTT/Audio Tab), position 1 will be updated with those results. The green highlight shows the current position of the physical switch.

If the radio boots up in position "Z," MPS will be disabled until the radio is rebooted in another position.

5.1.14 Admin Settings

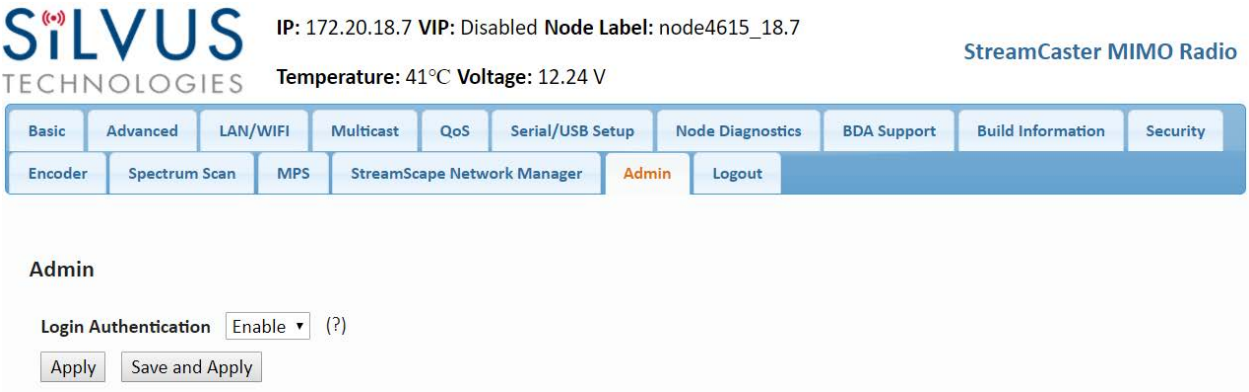


Figure 51 Admin Settings

The Admin Settings page provides the option of password protecting access to Streamscape. There are three usernames, Basic, Advanced, and Admin, each with increasing privileges on the GUI and backend API. For example, only Admin can access the Security tab. To enable, set the Login Authentication to Enable and provide a password. Once Login Authentication is enabled, access to Streamscape will require a username and password as shown below. To change the password, click "Change Password," then select the username whose password will change, type the Admin password, then type the new password.

Figure 52 Login

Reset Password:

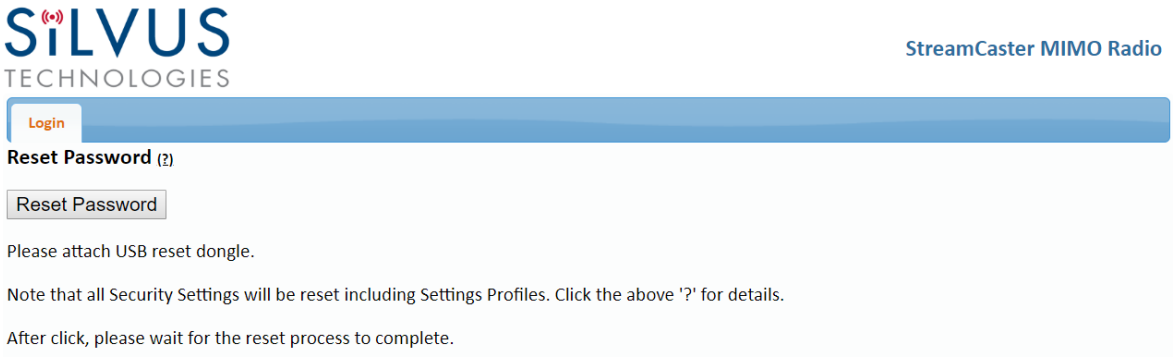


Figure 53 Reset Password

If a user forgets the password, click “Forgot Password.” They can reset the password using a USB flash drive and a password reset key provided by Silvus. On the USB, the password reset key file must be called reset_pass.txt.signed. Note that since the SC3500 and SC3800 do not have USB ports, you will not be able to set a password for these radios.

This will set login passwords and all security keys to their defaults. This includes the Encryption Key, SSH Login Key, SSH Host Key, HTTPS Certificate, and Encryption Key Volatile. It will also erase all settings profiles. Also, if FIPS mode is off, it will turn off HTTPS and login mode. The current FIPS mode will not be changed.

5.2 StreamScape Network Manager

Silvus' StreamScape Network Management Utility was designed to monitor the status of a Silvus mesh network in real-time. The graphical interface network map, shown in **Figure 44**, allows users to quickly and effortlessly view the network topology and configure key parameters of the network. For ease of use, the Silvus StreamScape utility is designed to be accessible from a Firefox or Chrome web browser.

5.2.1 Network Topology

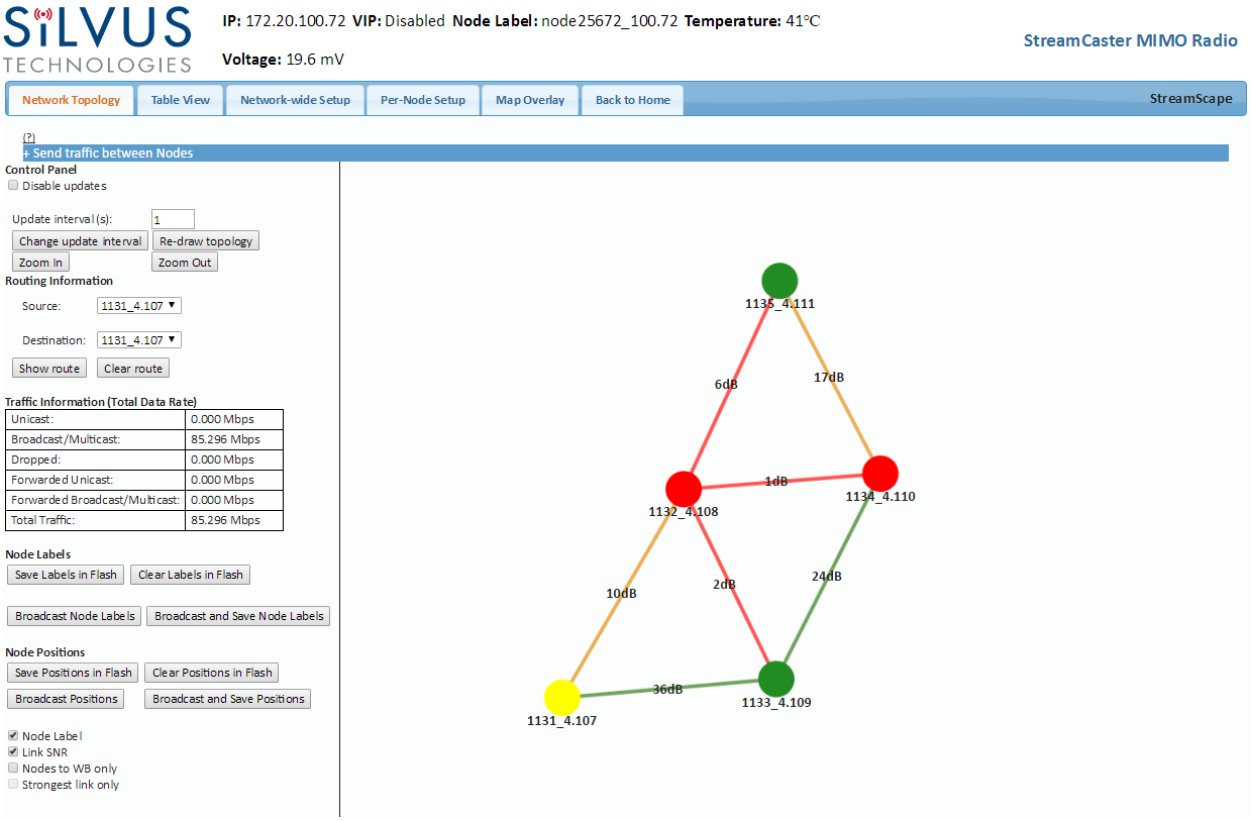


Figure 54 Silvus StreamScapeNetwork Manager

The network topology provides the user with real-time visual feedback of the network. Users will be able to determine several network characteristics at a glance with the following features:

- **Color Coded Link Health –** Color coding of each link in the network allows the user to quickly identify the weak links within a network. A link between two nodes will transition from green to yellow to red as the link weakens while also displaying the SNR of the link. This can be seen in **Figure 55**.

- **Route Health –** The Silvus StreamScape Utility will alert the user when too many packets are being routed through a single node. In such cases, a node will change from green to yellow to red as the packet queue increases (see '1132_4.108' and '1131_4.107'in **Figure 55**). This will allow the user to recognize the issue and rearrange the network accordingly. Table below also shows the values for each scenario.

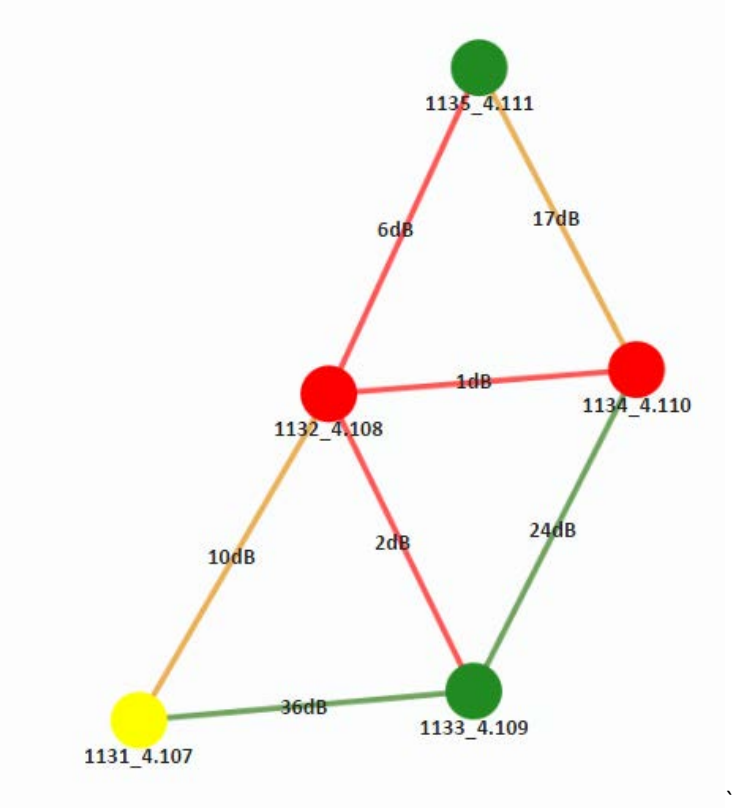


Figure 55 Example Network Topology

	Green	Orange	Red
Link	>20dB	10-20dB	<10dB
Node	<10 Packets in Queue	10-100 Packets in Queue	>100 Packets in Queue

Table 29 Color Coding for Links and Nodes

- **Routing Information –** The user can view the routing path between any 2 nodes within a network by simply specifying the source and destination node in the Control Panel on the left hand side. The path will turn bold as shown in **Figure 56** for the path from ‘node4411’ to ‘node4569’.

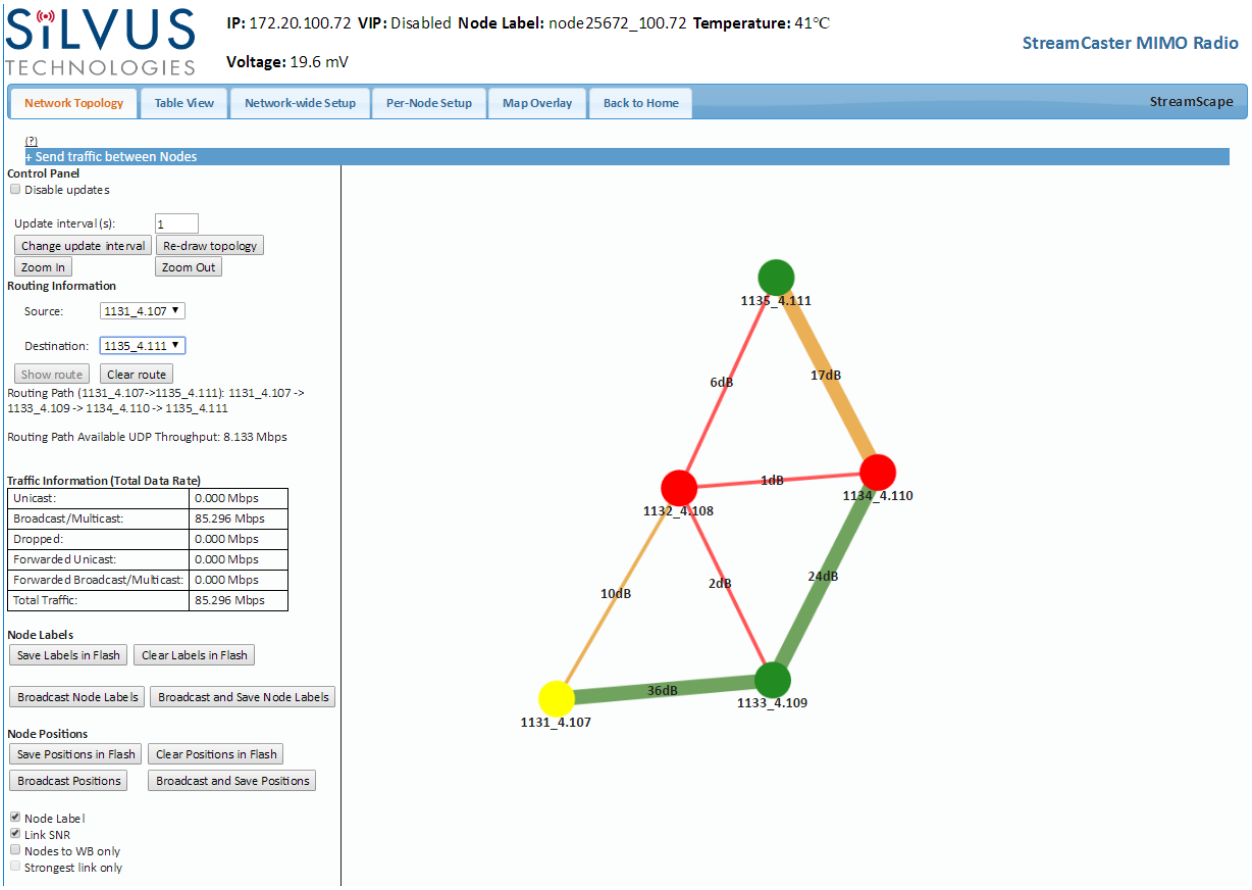


Figure 56 Routing Path

- **Custom Node Naming –** Naming each node in the network is as simple as double-clicking on the node name and typing in a new name as shown in **Figure 57**. Once this is done, the user need to hit enter to keep the node name. Otherwise it will change back to what it was. This feature enables quick identification of nodes in the field and is especially useful in mission critical situations with many mobile assets. The user can click on the ‘Save Labels in Flash’ button in the left pane to store the node names to the radio’s flash memory. This will store the names on the radio even after the radio is powered off. The saved labels can also be cleared back to the defaults by clicking ‘Clear Labels in Flash’. The node labels set in one radio can also be broadcasted to other radios in the network by clicking the ‘Broadcast Node Labels’ button.

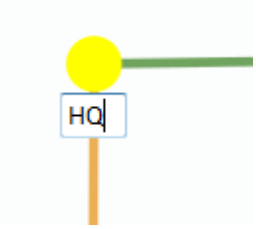
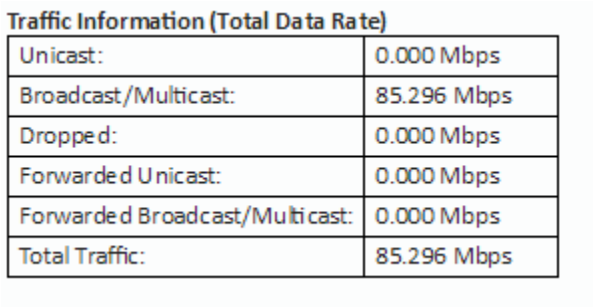


Figure 57 Custom Node Naming

- **Traffic Information –** The traffic information is shown in table form on the left side of the web GUI. It contains all the current network traffic information of the entire network.



Traffic Information (Total Data Rate)

Unicast:	0.000 Mbps
Broadcast/Multicast:	85.296 Mbps
Dropped:	0.000 Mbps
Forwarded Unicast:	0.000 Mbps
Forwarded Broadcast/Multicast:	0.000 Mbps
Total Traffic:	85.296 Mbps

Figure 58 Traffic Information

- **Individual Node Characteristics –** By simply rolling the mouse over any node in the network, users can view key operating characteristics of the node. **Figure 59** shows an example of this for 'node12593'. The characteristics shown are:

  - **Node ID**: The unique node ID assigned to each node at time of manufacture. This cannot be changed.

  - **IP**: IP address of the node.

  - **MAC:** MAC address of the node.

  - **Connections**: Number of direct connections to node. Each directly connected node is listed in the following format:

    <Node Name> <RX SNR> <TX MCS> <Pkts in TX Queue> <Num. of Spatial Streams>

<Air Time %><Data Rate (Mbps)><RSSI Ch1> <RSSI Ch2> <RSSI Ch3> <RSSI Ch4>

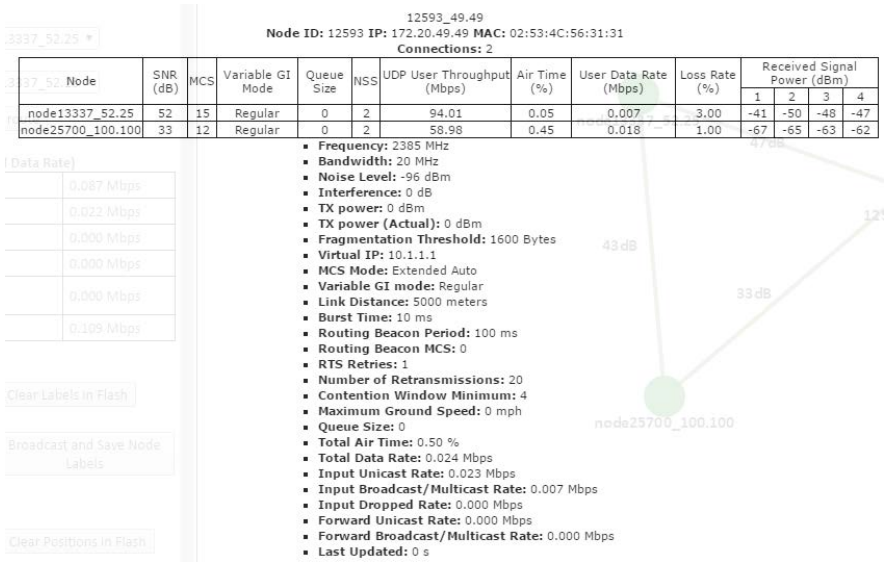
Notes:

- The 'Air Time' specifies the percentage of time the radio is transmitting.
- Data rate shown is actual user data rate in Mbps.
- MCS or NSS of N/A signifies that no data has been sent to that radio yet.

- **Frequency:** RF center frequency of the node.
- **Bandwidth:** RF bandwidth of the node.
- **Noise Level:** Received noise level of the node.
- **Interference:** Approximate in-band interference level.
- **TX Power:** Total target transmit power of node.
- **TX Power (Actual):** Actual transmit power of node. This value may differ from the target transmit due to temperature variation or inability to transmit a clean signal with the selected MCS at the target power.
- **Fragmentation Threshold:** Chosen fragmentation threshold.
- **Virtual IP:** Secondary IP address of node (0 if none set).
- **MCS Mode:** Transmit MCS of node.
- **Variable GI mode:** The variable GI mode setting for this node.

- **Link Distance:** Link distance setting of node.
- **Burst Time:** Burst time setting of node.
- **Routing Beacon Period:** Routing Beacon Period setting of node.
- **RTS Retries:** RTS Retry setting of radio.
- **Contention Window Minimum:** Low Priority Contention Window Minimum setting of node.
- **Maximum Ground Speed:** Maximum Ground Speed setting of node.
- **Queue Size:** Number of packets currently waiting to be transmitted.
- **Total Air Time:** Total percentage of air time being used by this radio.
- **Total Data Rate:** Total data rate in Mbps being transmitted from this radio.
- **Input Unicast Rate:** Total data rate pushed into the radio as Unicast
- **Input Broadcast/Multicast Rate:** Total data pushed into the radio as Multicast
- **Input Dropped Rate:** Total data rate dropped by the radio
- **Forwarded Unicast Rate:** Total data rate forwarded by the radio as Unicast
- **Forwarded Broadcast/Multicast Rate:** Total data rate forwarded by the radio as Multicast

- **Last Updated:** Duration that has passed in seconds since last update.



Node	SNR (dB)	MCS	Variable GI Mode	Queue Size	NSS	UDP User Throughput (Mbps)	Air Time (%)	User Data Rate (Mbps)	Loss Rate (%)	Received Signal Power (dBm)			
										1	2	3	4
node13337_52.25	52	15	Regular	0	2	94.01	0.05	0.007	3.00	-41	-50	-48	-47
node25700_100.100	33	12	Regular	0	2	58.98	0.45	0.018	1.00	-67	-65	-63	-62

Figure 59 Individual Node Characteristics

- **Link Characteristics –** By simply rolling the mouse over any link in the network, users can view key operating characteristics of that link. **Figure 60 Link Characteristics** shows an example of this for the link between ‘node25700’ and ‘node12593’. The characteristics shown are:

  - **SNR**: The SNR of the link in each direction.

  - **MCS**: The MCS used to transfer data in each direction.

  - **UDP User Throughput:** The estimated UDP User Throughput available for each direction of the link. This is estimated based on the current MCS used for transmission.

  - **Queue Size:** Number of packets in TX Queue in each direction.

  - **NSS:** Number of Spatial Streams in each direction.

  - **Air Time:** Percentage of air time used in each direction

- **Data Rate:** Data rate in each direction

- **Data Loss Rate:** Percentage of data lost during transmission

- **Received Signal Powers:** Received signal power for each antenna in each direction.

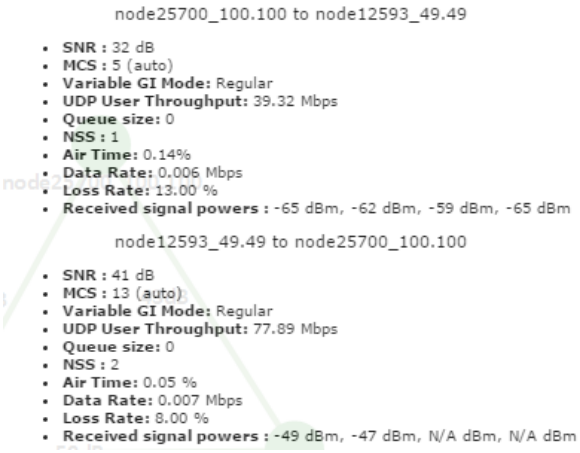


Figure 60 Link Characteristics

- **Send Traffic Between Nodes –** Users can send test traffic across radios within a network using the built-in iPerf feature. This feature can be accessed by clicking the blue bar at the top of the topology view, titled “Send traffic between nodes”. This will open up a drop down menu where users can specify UDP/TCP data, source/destination, port, time to send, and datagram size.

  - **Source:** Radio that sends data (Client)

  - **Destination:** Radio that is listening (Server)

  - **Destination port:** Port number for the data transfer

  - **Time to Send:** Amount of time user wants to send data

  - **Bandwidth to Send:** Data rate to send, in Mbps

  - **Datagram Size:** Size of the datagram

  - **Effective Bandwidth:** The actual network load.

  - **Jitter:** The variation in delays in the received packet.

  - **Lost/Total Datagrams:** The amount of packets lost vs total packets sent

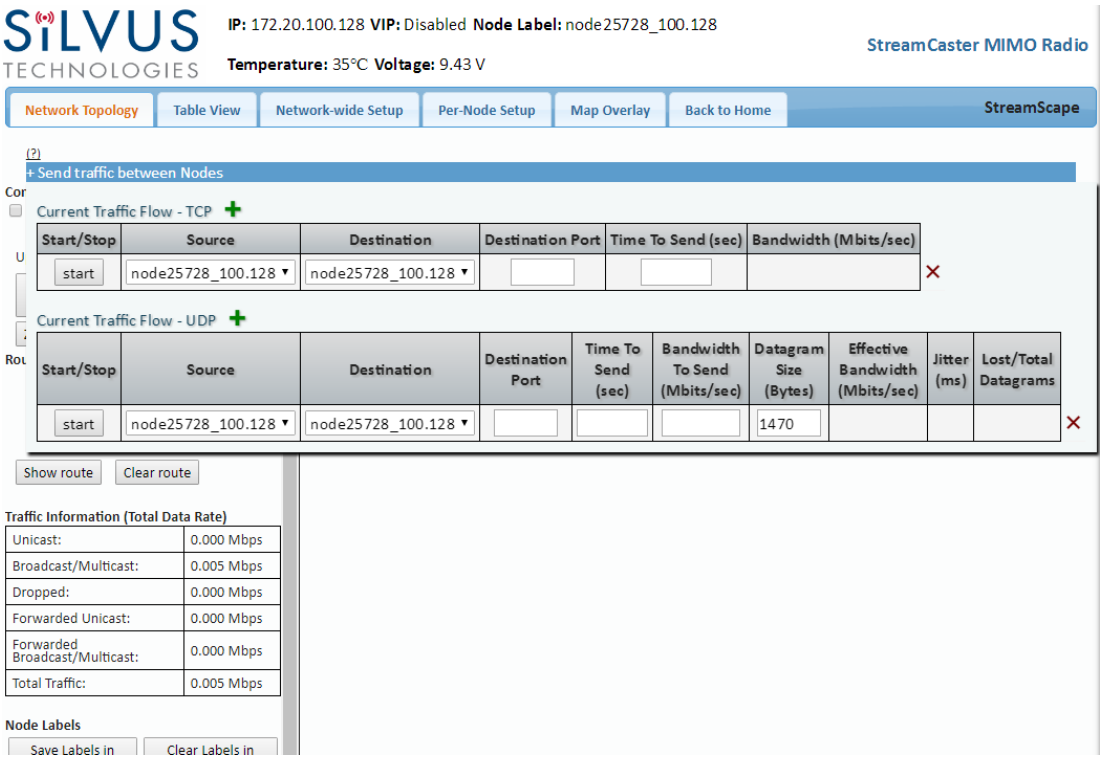
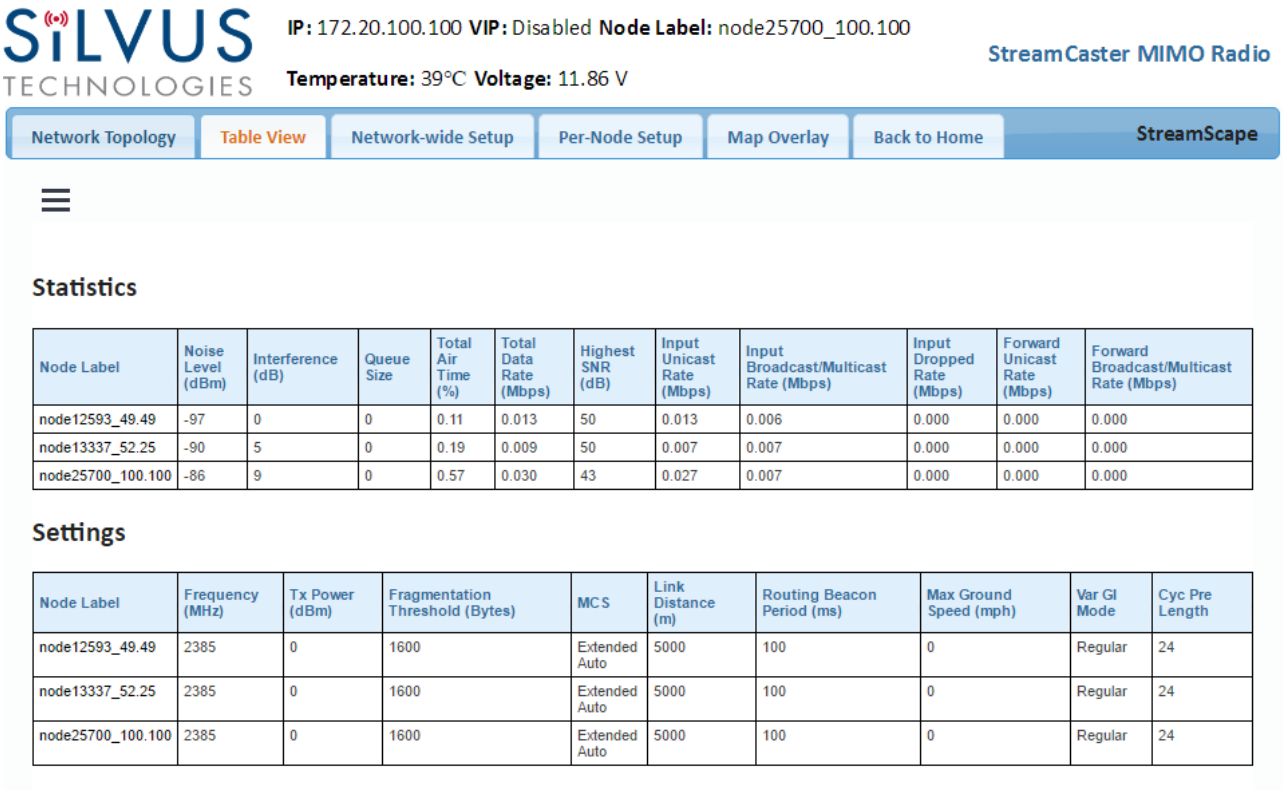


Figure 61 iPerf Function within GUI

5.2.2 Table View



Node Label	Noise Level (dBm)	Interference (dB)	Queue Size	Total Air Time (%)	Total Data Rate (Mbps)	Highest SNR (dB)	Input Unicast Rate (Mbps)	Input Broadcast/Multicast Rate (Mbps)	Input Dropped Rate (Mbps)	Forward Unicast Rate (Mbps)	Forward Broadcast/Multicast Rate (Mbps)
node12593_49.49	-97	0	0	0.11	0.013	50	0.013	0.006	0.000	0.000	0.000
node13337_52.25	-90	5	0	0.19	0.009	50	0.007	0.007	0.000	0.000	0.000
node25700_100.100	-86	9	0	0.57	0.030	43	0.027	0.007	0.000	0.000	0.000

Node Label	Frequency (MHz)	Tx Power (dBm)	Fragmentation Threshold (Bytes)	MCS	Link Distance (m)	Routing Beacon Period (ms)	Max Ground Speed (mph)	Var GI Mode	Cyc Pre Length
node12593_49.49	2385	0	1600	Extended Auto	5000	100	0	Regular	24
node13337_52.25	2385	0	1600	Extended Auto	5000	100	0	Regular	24
node25700_100.100	2385	0	1600	Extended Auto	5000	100	0	Regular	24

Figure 62 Table View

The table view tab shows all the statistics and setting profiles in table view. Users can select what is needed through the drop-down menu on the upper left side. The dropdown is shown in **Figure 63 Table View (Settings)**

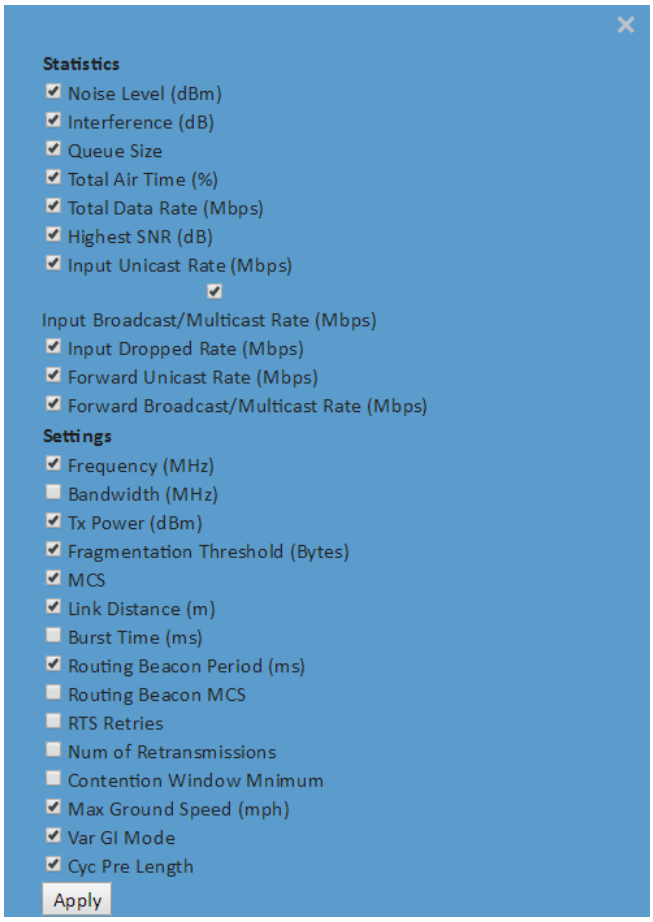


Figure 63 Table View (Settings)

5.2.3 Network-wide Setup

Using the network-wide setup users can configure key parameters of every node in the network with just one click. Users simply need to check off the parameters they wish to be updated across the network and click on *Apply* to apply but not write new values to flash or *Save and Apply* to apply and save values to flash. The *Broadcast Update Interval* field determines how often, in seconds, the new parameters will be broadcast to the entire network. A list of all nodes will appear on the right with a check box next to each node. This box will be checked off as each node receives the update.

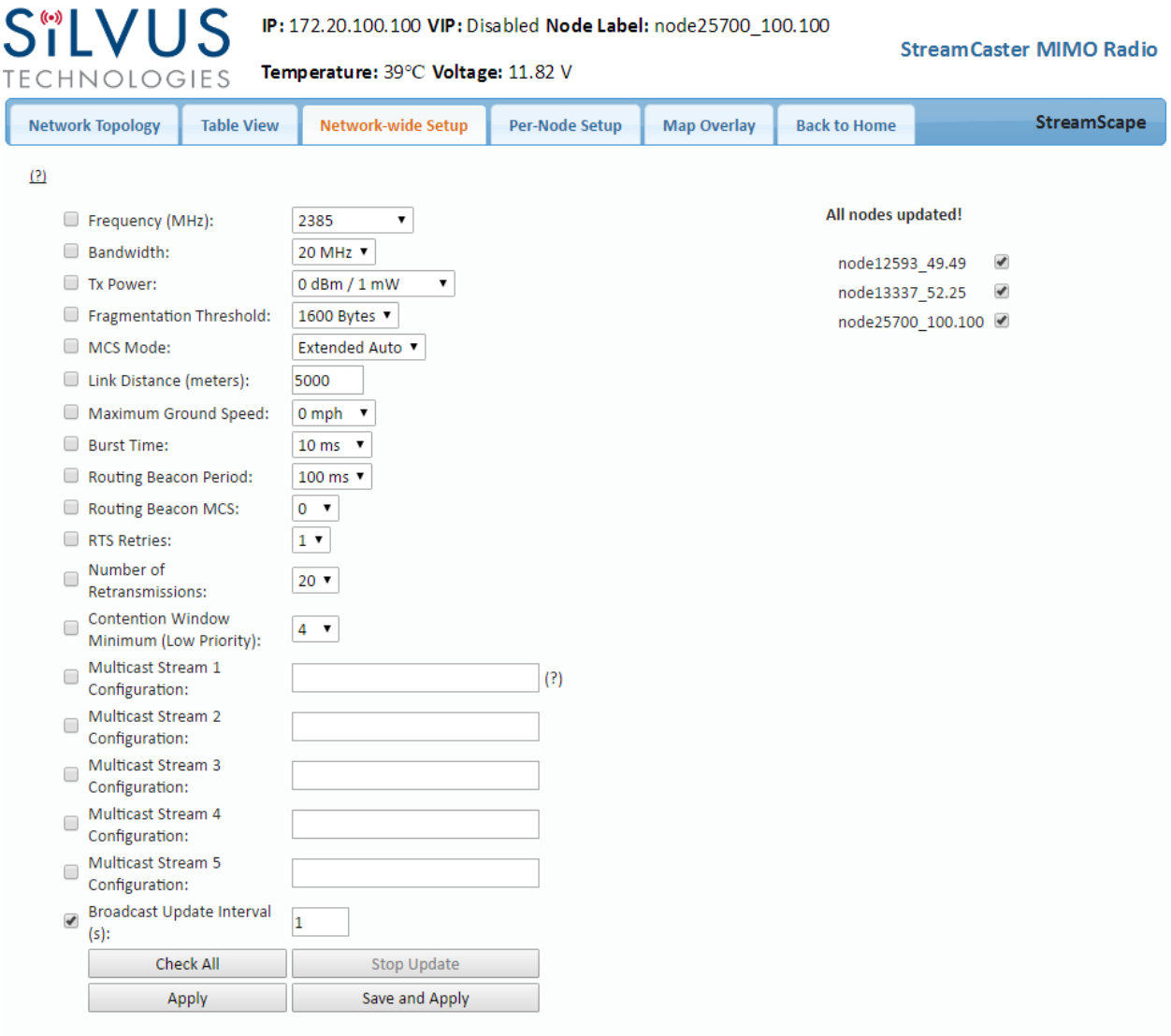


Figure 64 Network-wide Setup

5.2.4 Per-Node Setup

The per-node setup can be used to modify key parameters of individual nodes within the network. As shown in **Figure 65**, users will see a list of all nodes available within the network. The directly connected node is listed first with the rest ordered lexically. From here, users can click on an individual node and modify its parameters. Any parameters changed from this interface can either be applied or saved and applied.

In addition, this page can be used to upgrade a radio's firmware by simply choosing the upgrade image from your desktop and uploading it to the radio. This field can be used to upgrade the radio root file system, linux kernel, or uboot. The upgrade system accepts the root file system image for upgrade or a tar file containing up to 3 files (uboot, kernel, rootfs) for upgrade. A radio reboot will be required after update before the changes take effect.

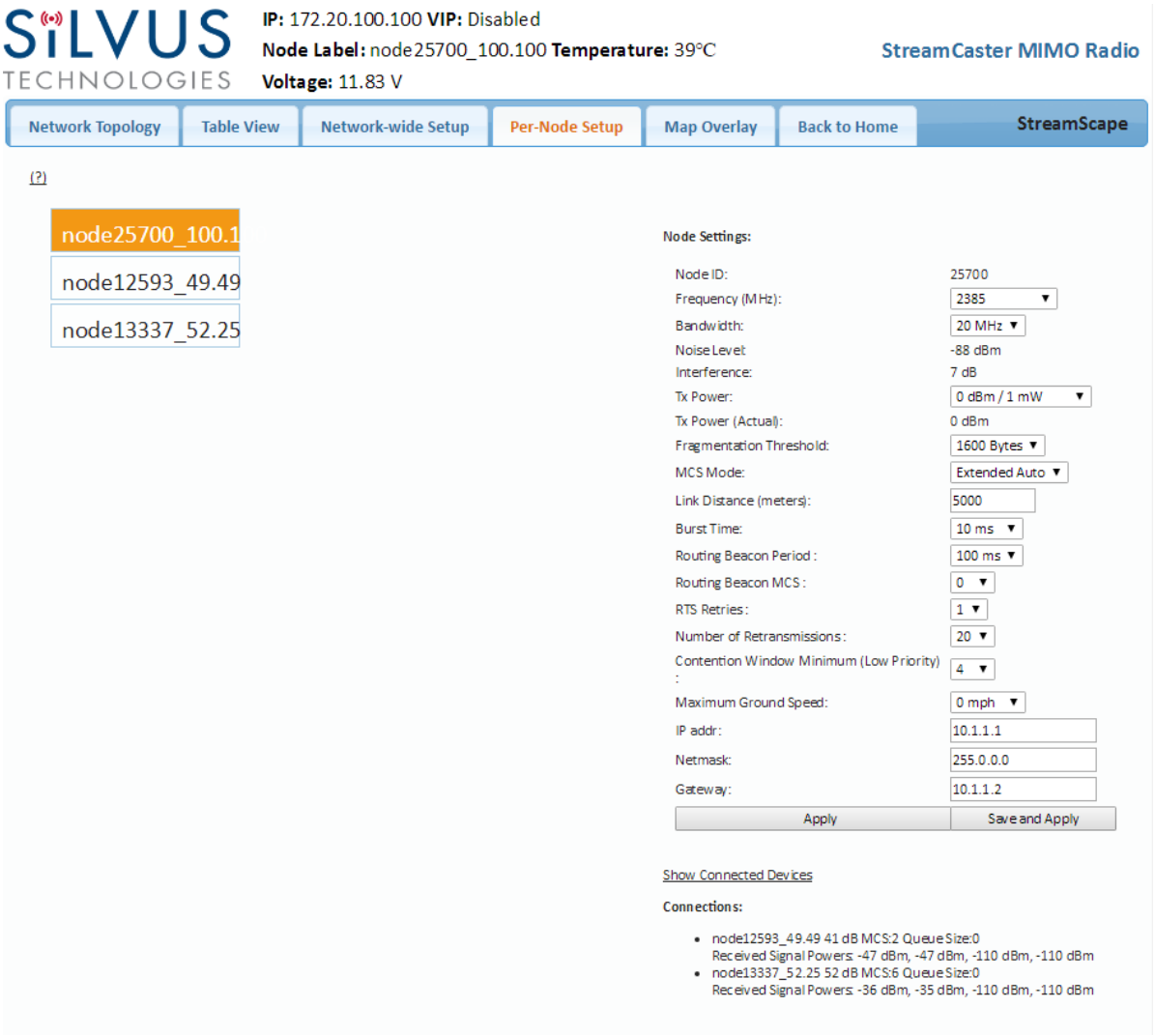


Figure 65 Per-Node Setup

5.2.5 Map Overlay

The Map Overlay page provides an easy to use method of tracking the location of nodes in real-time. Nodes with GPS modules attached will be placed on the map as shown in **Figure 66**.

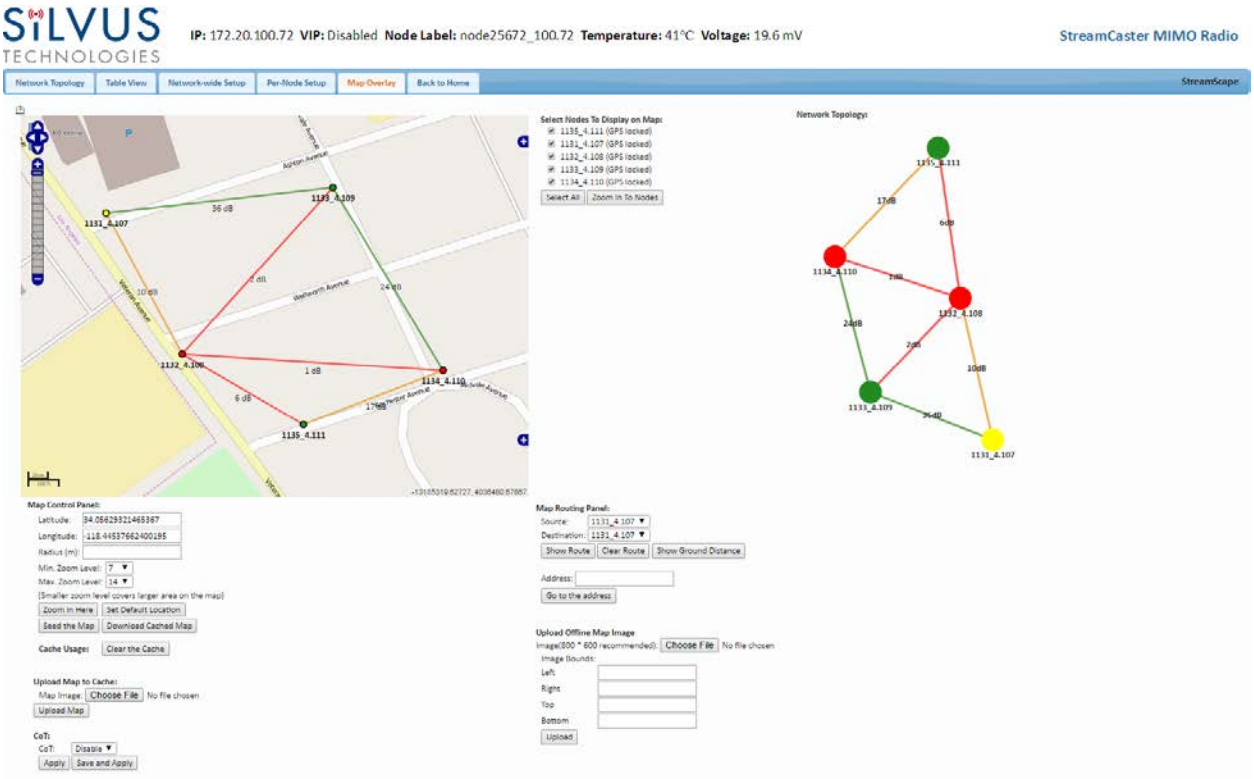


Figure 66 Map Overlay

For convenience, a small copy of the network topology is displayed on the right-hand side of the page. This allows users to clearly view the network characteristics in instances where nodes are physically close to one another and difficult to distinguish on the map overlay.

5.2.5.1 Map Options

There are 4 map options currently available in the Map Overlay view. The default map is OpenStreet Maps. OpenStreet Maps and OpenStreet Maps Silvus can be saved to the radio's internal memory for offline use. For instructions to Download OpenStreet Maps into the radio, see section 5.2.5.2. OpenStreet Maps Silvus is a version of OpensStreet maps which is hosted on Silvus' servers in case of an interruption in service with OpenStreet Maps. The Silvus maps currently only cover the United States.

In Addition to OpenStreet Maps, Google Maps and Google Satellite are also available. This can be changed by clicking the '+' symbol at the top right of the map:

Figure 67 Google Maps

Note that Google Maps and Google Satellite require an active internet connection on the viewing computer. These maps cannot be saved for offline use.

Offline Map Image:

In addition to the preset map options, the user can also upload a custom image or blueprint in place of the map.

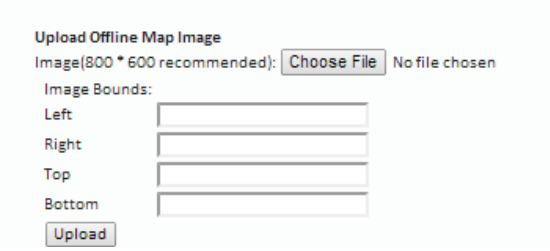


Figure 68 Offline Map Image

To upload a custom image (800 x 600 pixels recommended), first choose the file from your desktop. You will then need to provide the image bounds. These bounds will be the latitude of the left and right bounds of the image and longitude of the top and bottom bounds of the image. Once entered, click upload and there will now be a 4th option when clicking the '+' at the top left of the map overlay.

5.2.5.2 Downloading Maps

An internet connection is required to obtain map data, however, users can cache map data on a node beforehand. For map caching follow these steps:

1. Attach the radio to a laptop and open the advanced tab.
2. Set the Virtual IP address, netmask and gateway to values appropriate for your local network. Your local network should be able to access the internet.
3. Attach the radio to your local network and open the Map Overlay tab.
4. Input the address of the location you wish to download
5. You now have two options for caching map data:
    a. Zoom/pan around the area you are interested in at the zoom level you will be using. This will automatically cache the map data at this zoom level.
    b. Fill in the radius field (in meters), set the Min/Max zoom levels and click on 'Seed the Map'. This is a beta feature and will attempt to cache the entire area for all appropriate zoom levels. Users should be careful in using this feature since it may take some time and will use up the radio's available memory. For reference, a radius of ~3000m will use approximately 5 percent of the total memory.

5.2.5.3 Manual GPS for Nodes without GPS Module

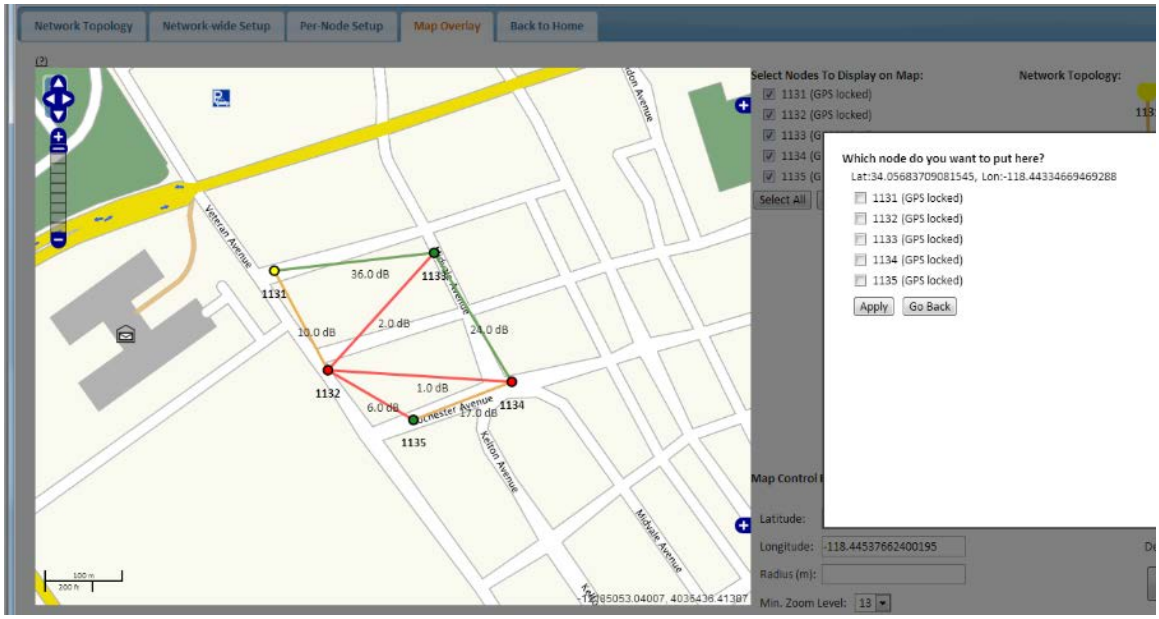


Figure 69 Placing Nodes on the Map

If there are nodes within the mesh that do not have a GPS module connected, or are located in an area with no GPS connectivity, the user can easily place the node on the map by right clicking on the desired location on the map and choosing which node to place there. These values will be ignored if GPS coordinates are available via a GPS module.

5.2.4.4 Cursor on Target

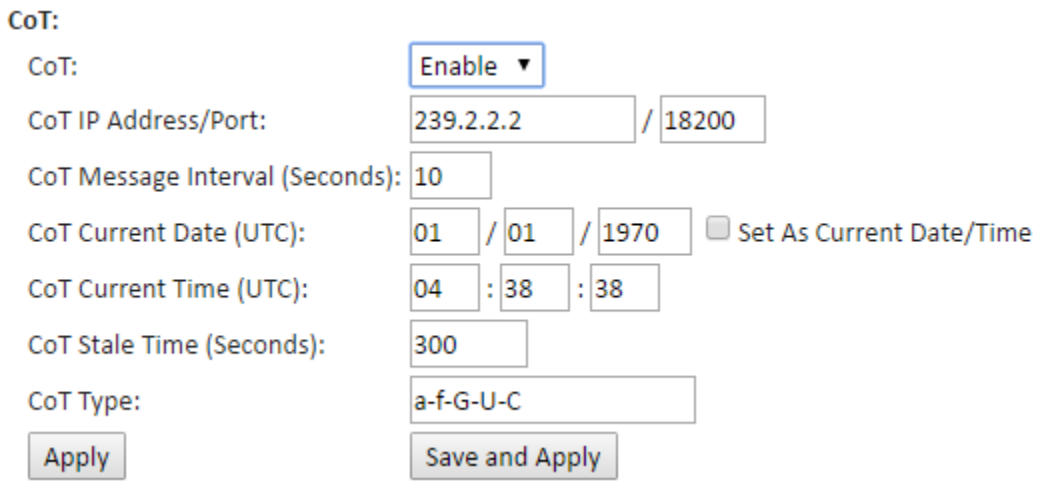


Figure 70 Cursor on Target Settings

Cursor on Target is an exchange standard that is used to share information about targets.

- **CoT:** Enable/disable cursor on target
- **CoT IP Address/Port:** IP address/port for the communication to establish
- **CoT Message Interval (Seconds):** How often to send CoT messages
- **CoT Current Date (UTC):** Time stamp of the date. If *Set AS Current Date/Time* is selected, it will be set as the current time displayed on your computer
- **CoT Current Time (UTC):** Time stamp of the time
- **CoT Stale Time (Seconds):** Data outside of this time window becomes invalid
- **CoT Type:** The event type of the target

6. FIPS Mode

6.1 Enable FIPS Mode

The following steps are required to make the radio FIPS compliant.

1. Enable FIPS mode under Security -> Encryption tab. This will require a reboot and will erase all setting profiles, reset the encryption key, both SSH keys, the HTTPS certificate, and the login passwords to their factory default. It will also turn on HTTPS and Login Authentication.

2. After the radio comes back online, you will need to login to continue. You must change the default password of "HelloWorld," for all three users. Do this by clicking "Change Password," and then follow the instructions in section 5.1.13 Admin Settings.

3. Next go to Security -> Key Management. You must change the SSH Login Key, SSH Host Key, and HTTPS Certificate from their defaults. See section 5.1.10 under Key Management for details.

4. Now you must create an encryption key that will be shared amongst all radios on a network. For initial setup, you must have a direct connection to each radio from your laptop (since a mesh cannot be formed without a shared encryption key). On the first radio, click Generate Random Key, then click Apply. For the rest of the radios, instead of clicking Generate Random Key, copy/paste the first generated key to the rest of the radios under the same section.

    - If you want to change the encryption key after initial setup, you must carefully sequence the order in which you change the keys if you don't have a direct connection to all radios. First change the radios at the very edge of the network. As soon as you do this, those radios will be disconnected from the network. Now change the new radios at the edge of the network. After you have changed the encryption key for all radios on the network, they will all reconnect again.

6.1.1 Potential User Errors

- Do not use the same encryption key you were using in non FIPS mode because these may have been broadcasted in plain text. Generate new ones once in FIPS mode.

6.2 List of Security Parameters

- **Passwords (Basic, Advanced, and Admin User):** Used to login to the radio as either Basic, Advanced, or Admin user.
- **Encryption Key (also called RF-Auth-Key):** This is a 256-bit sequence, represented as 64 hex numbers. It is used to establish an encrypted connection in a network.
- **SSH Host Key:** This key is used for authenticating the radio to all machines that want to connect to it via SSH.
- **SSH Login Key(s):** These are ecdsa private/public key pairs. They are used for authorizing SSH access to the radios. These key pairs are used instead of passwords since they are more secure.
- **TLS Host Key (also called HTTPS Certificate):** This certificate is used to establish a HTTPS connection. The underlying elliptic curve keys can be either secp256r1, secp384r1, or secp521r1.

7. Wired Backbone

Wired Backbone extends the StreamCaster mesh functionality over LAN (Ethernet) and WAN (Internet) links. This feature is transparent to end-users - they do not have to re-configure their devices in any manner to use this feature.

The StreamCaster routing protocol will automatically detect and route data on wired links to preserve air bandwidth.

7.1 LAN Backbone

The LAN backbone feature allows more than one radio to be connected to a LAN.

7.1.1 Implementation

One of these radios must be configured as a "gateway" radio. This radio then begins listening promiscuously on its ethernet interface to "register" all devices on the LAN as being connected to the gateway radio. At the same time, it auto-detects other non-gateway radios connected to the LAN and establishes "wired" links to them. StreamScape Web GUI will show LAN links with SNR of 150 dB to differentiate from wireless links.

The non-gateway radios do not register any devices, they merely act as relays. The gateway radio will forward traffic originating from the LAN, destined for a device attached to a wireless radio, to the non-gateway radio that is closest to the destination. Similarly, any traffic originating from a device attached to a remote wireless radio, destined to a device on the LAN will be forwarded by non-gateway radios to the gateway radio. The gateway radio will then send it to the device.

Currently we support data rates of up to 65 Mbps on the LAN without encryption. Since all LAN traffic goes via the gateway radio, this is the upper limit of all traffic that can enter or go out of the LAN from/to devices connected to wireless radios. Of course, this limit does not affect the throughput between two devices connected directly to the LAN backbone.

7.1.2 Use Case

Consider the following scenario. A business wants to do video monitoring of its grounds. High speed LAN hookups are available only in the HQ building. They want to use the StreamCaster radios on towers to provide complete coverage of the grounds. All video feeds are sent back and displayed at the HQ. To conserve air bandwidth and possible interference to other users, we want video data to go through the high-speed LAN backbone as much as possible. The below diagram shows the scenario.

Towers 1-3 are equipped with IP cameras attached to StreamCaster radios 1-3. Radios 4-6 are mounted on three sides of the HQ building with their Ethernet interfaces connected to the high-speed LAN. Tower 1 can only communicate wirelessly with radio 4, Tower 3 with radio 5 and Tower 2 with radio 6. Video from Tower 1 will flow wirelessly to radio 4, then via the LAN backbone to the HQ viewer which is also attached to the LAN backbone. Even though the radios 4-6 may communicate wirelessly, they will choose to do so via the LAN backbone.

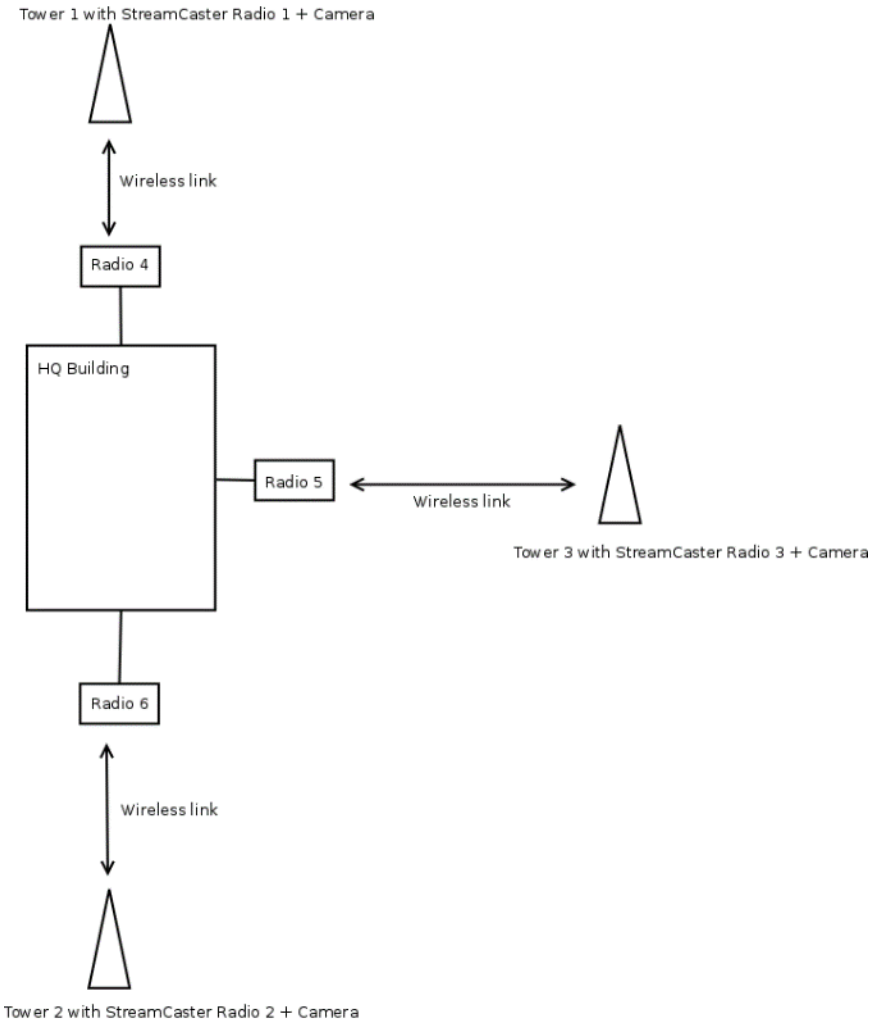


Figure 71 LAN Backbone Example

7.2 WAN Backbone with Roaming

The WAN backbone feature allows the wireless mesh network to extend over Internet links. Multiple geographically separate “sites” can be connected into one single layer 2 network as long as each site has

an uplink to the Internet. The roaming feature allows mobile devices connected to StreamCaster radios to roam from one site to another without any network re-configuration.

7.2.1 Implementation

Each site wishing to become part of the wireless mesh needs to connect one StreamCaster radio to its LAN. Such a radio has to be configured to connect to a remote VPN server using the N2N protocol. Radios from multiple sites will be connected at layer 2 via the N2N VPN server creating a single broadcast domain for such nodes. By broadcasting routing packets in this domain, the nodes will auto-detect each other and establish WAN links. Such links will appear on the StreamScape GUI with a link SNR of 120 dB to differentiate from LAN links (150 dB) and wireless links.

The N2N VPN server will try to establish peer-to-peer links between the radios if it can. Under some cases (e.g. symmetric NATs), this is not possible, in which case traffic between the peers is relayed by the N2N server.

The N2N server can be hosted at any server with a public IP on the Internet. As a proof-of-concept, a server has been set up on Amazon Web Services. Currently we support up to 10 Mbps unencrypted between any two sites.

7.2.2 Use Case

Consider a military scenario where a platoon of soldiers begins its mission at an HQ, then breaks up into two groups. Each group has at least one soldier with an uplink to the Internet (provided by a 4G card). The HQ also has an uplink to the Internet. Every soldier and the HQ have a StreamCaster radio attached to their devices.

The soldiers in the two groups want seamless and transparent communication between 1) other soldiers in the same group 2) soldiers in the other group 3) back to HQ. Some lone soldiers (e.g. Soldier A with a StreamCaster radio) may break up from each group and move about on their own. As they get close to group 1, 2 or the HQ, they should be able to immediately establish communication and talk to all other soldiers in the network.

The StreamCaster radios connected to the uplinks in Group 1-2 and the HQ will automatically connect and form WAN links.

Note that the WAN and LAN backbone are complementary features. E.g. at the HQ, multiple radios can be connected to a LAN backbone so that any approaching soldier or group has a direct line of sight wireless connection to the HQ.

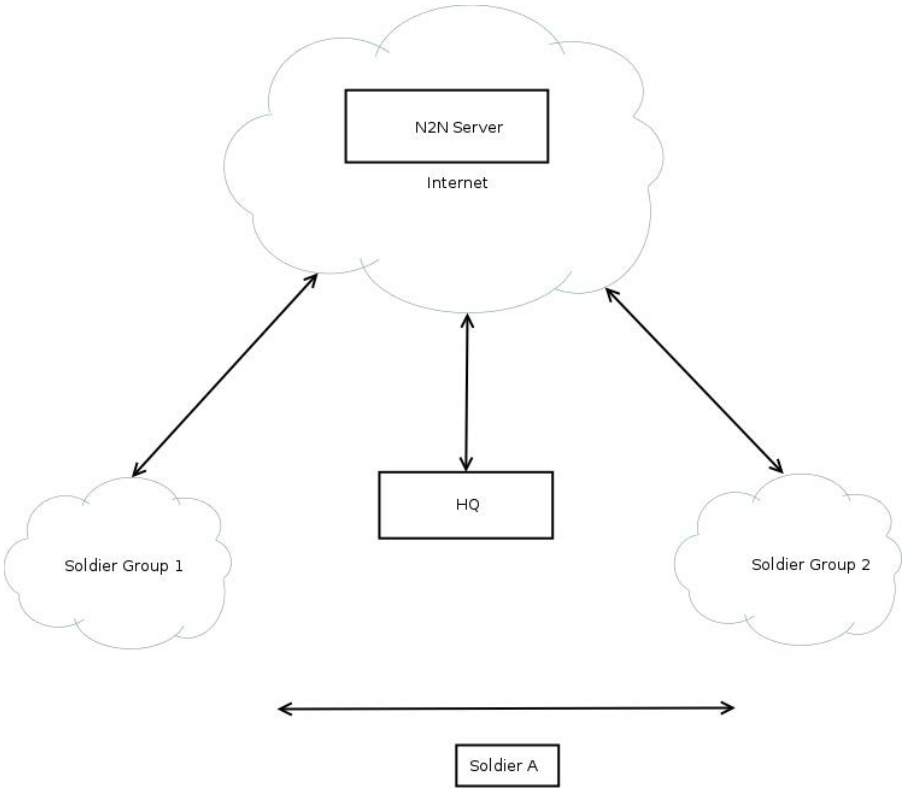


Figure 72 WAN Backbone Example

8. Custom Frequency Plan

8.1 Accessing and Installing CFP

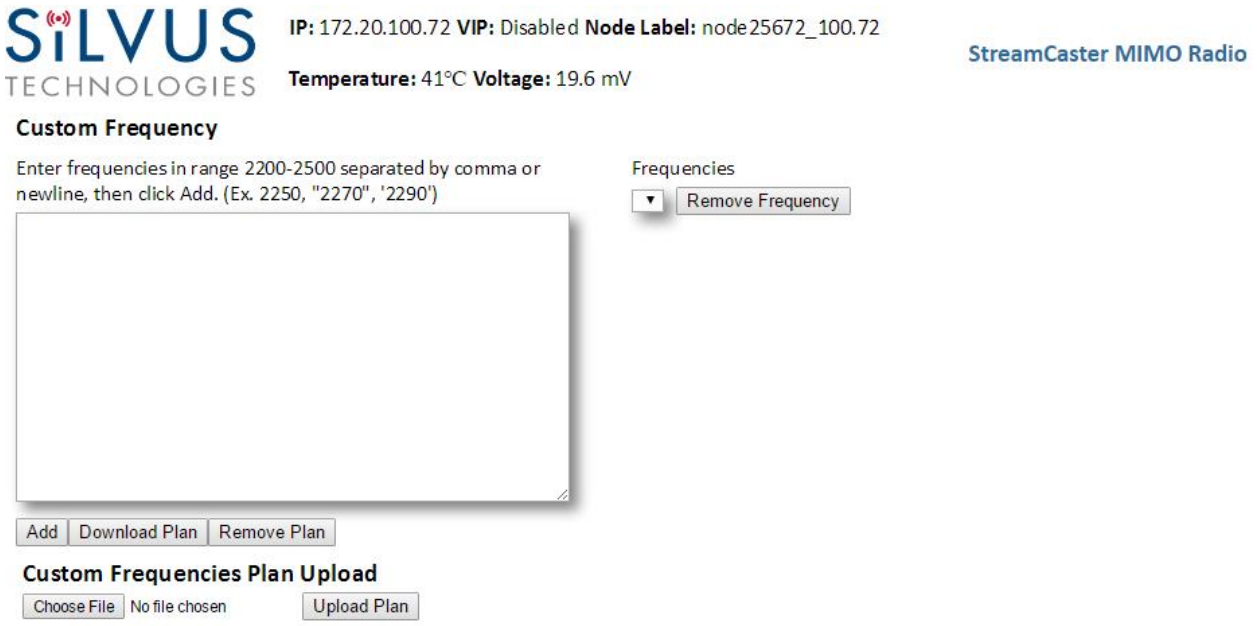


Figure 73 Custom Frequency Page

There are two ways to install the frequency plan. The first method is simpler. Users can simply click on *Create Custom Frequencies* next to the frequency selection window to get to the custom frequency page shown in **Figure 63**.

- **Add:** Add the frequencies in the text box to the list
- **Download Plan:** Download the frequency plan the radio is currently using
- **Remove Plan:** Removing the entire frequency plan. If this field is left empty, the radio will use the default frequency plan.
- **Download Plan:** Download the current frequency plan to a file that can be uploaded to other radios.
- **Remove Frequency:** Remove the currently selected frequency.
- **Custom Frequencies Plan Upload:** Upload the selected frequency plan.

The second method requires accessing the hidden Custom Frequency Plan page. Note radios on older firmware only support this method.

The hidden Custom Frequency Plan page can be accessed via http://<radio IP>/custom_freq.sh

The interface will allow an upload of a custom frequency plan file which should be in the following format:


```
{
    "type": "custom_frequency_plan",
    "name": "cfp_example",
    "description": "CFP Example",
    "frequencies": [
      "2412",
      "2417",
      "2422",
      "2427",
      "2432",
      "2437",
      "2442",
      "2447",
      "2452",
      "2457",
      "2462",
      "2467",
      "2472",
      "5745",
      "5765",
      "5785",
      "5805",
      "5825"
    ]
}
```

(Put the above format in a Text file. Name/description can be changed)

Custom Frequency Plan Text file example:
https://drive.google.com/file/d/0ByThlCSjgHe1TDMtZ2xDXzhEblE/view?usp=sharing

The numbers can be changed to the frequencies desired. The name of the text file does not matter in order to be utilized. After uploading the file, the web interface will be populated with the Custom Frequency Plan.

Note:
Once installed, the Custom Frequency Plan will be cross-checked with hardware capability and the licensed frequency range previously installed on the radio. The Custom Frequency Plan will only change what is displayed. It will not give new frequencies that are previously out of licensed range.

9. Streaming Response

Some users may be interested in streaming specific information from the radio e.g. RSSI, noise floor, temperature, etc. After enabling the response, they need using the above commands, the radio will transmit the desired information in the form of UDP packets to a specific IP address and port. The format of each report message will be in the type-length-value format as shown below:

TYPE LENGTH VALUE TYPE LENGTH VALUE …

- TYPE and LENGTH will be 16-bit unsigned integers in network-endian format.
- TYPE indicates the kind of information being transmitted. Pre-defined types are listed later in this document.
- LENGTH indicates the length of the VALUE field in bytes, including the terminating null byte.
- VALUE will be ASCII-encoded text terminated with a null byte ('\0').
- A single report will comprise of a set of type-length-value fields beginning with a “begin” report type. It will have a type which is specific to the type of report being generated, length of 1 byte and a value of an empty string (“”). Note the empty string is still null terminated.
- Each report will end with an end of report which has type 1 (type = end of report, length = 1, value = "").
- **T**he empty string listed above has a NULL character and has length 1. Any length number in the streaming report includes the NULL character
- A UDP packet may contain more than one report.
- The UDP packets have a maximum size of 1400 bytes.

9.1 RSSI and Noise Floor Reporting

The type/length/value for RSSI and noise floor reporting are listed in the following table:

Report Type	Data Type	Information
5009	Empty string ""	Begin of RSSI report
5010	Float	Revision number for RSSI report
5000	Integer	Raw signal power of first antenna, represented in half dBm steps.
5001	Integer	Raw signal power of second antenna represented in half dBm steps.
5002	Integer	Raw signal power of third antenna represented in half dBm steps.
5003	Integer	Raw signal power of fourth antenna represented in half dBm steps.
5004	Integer	Raw noise power represented in half dBm steps.
5005	32-bit integer	Sync signal power (from digital domain, see note below).
5006	32-bit integer	Sync noise power (from digital domain, see note below).
5007	16-bit integer	Node ID of the radio.
5008	32-bit integer	Report sequence number, increments for every report, resets after 9999.
1	Empty string ""	End of report.

Table 30 RSSI Reporting Format

Note:

The sync noise and power (types 5005, 5006) are special values obtained after packet processing in the digital domain. They cannot be directly compared to the raw signal and noise values. To obtain an SNR from these values the user needs to run the below formula on these values:

X = sync signal power;

Y = sync noise power;

Z = (Y-X)/51

SNR_mw = (X – 12 * Z)/(64 * Z)

SNR_db = 10 * log(SNR_mw)/log(10)

SNR_db is the SNR in dB and it is averaged across all antennae.

The SNR obtained above is more accurate when the real SNR goes below 10 dB. Above 10 dB, the SNR obtained from the raw signal and noise values are more accurate.

Below is an example of the RSSI report:

Report Type	Length	Information
5009	1	""
5010	4	"1.0"
5008	5	"2333"
5000	5	"-43"
5001	5	"-31"
5002	5	"-28"
5003	5	"-66"
5004	5	"-190"
5005	8	"8604568"
5006	8	"8861322"
5007	5	"1025"
1	1	""

Table 31 Sample RSSI Report

The corresponding raw UDP dump in hexadecimal format is attached below. For the purpose of easier reading, each byte is separated by a space, and each item is separated by a new line. The real streaming report is continuous without any spaces or newlines and is currently 109 bytes long.

13 ffffff91 0 1 0

13 ffffff92 0 4 31 2e 30 0

13 ffffff90 0 5 32 33 33 33 0

13 ffffff88 0 5 20 2d 34 33 0

13 ffffff89 0 5 20 2d 33 31 0

13 ffffff8a 0 5 20 2d 32 38 0

13 ffffff8b 0 5 20 2d 36 36 0

13 ffffff8c 0 5 2d 31 39 30 0

13 ffffff8d 0 a 20 20 38 36 30 34 35 36 38 0

13 ffffff8e 0 a 20 20 38 38 36 31 33 32 32 0

13 ffffff8f 0 5 31 30 32 35 0

0 1 0 1 0

9.2 Temperature Reporting

The type, length and value for temperature reporting are listed in the following table:

Report Type	Data Type	Data
8	Empty string ""	Begin of temperature report.
9	Float	Revision number for temperature report.
2	Integer	Current Temperature on the radio.
3	Integer	Maximum Temperature reached on the radio after last booting.
4	Integer	Overheat Count: number of times the radio temperature has exceeded temp_reporting_max_threshold.
1	Empty string ""	End of report

Table 32 Temperature Reporting Format

9.3 Voltage Reporting

The type, length and value for temperature reporting are listed in the following table:

Report Type	Data Type	Data
4001	START REPORT	Indicates start of voltage monitoring report
1	END REPORT	Indicates end of report
4003	REVISION_REPORT	Indicates revision of this report, currently always “1.1”
4004	CUR_VOLTAGE_REPORT	Current voltage value as a floating point string
4005	MIN_VOLTAGE_REPORT	Minimum voltage seen so far, as a floating point string
4006	MAX_VOLTAGE_REPORT	Maximum voltage seen so far, as a floating point string
4007	UNDERVOLTAGE_COUNT_REPORT	Number of times voltage dropped below min threshold, as an integer string
4008	OVERVOLTAGE_COUNT_REPORT	Number of times vltage spiked above max threshold, as an integer string.

Table 33 Voltage Reporting Format

10. Setting up an Iperf Test

10.1 Required Equipment

- Two laptops with jperf installed. It is beyond the scope of this manual to cover the installation and operation of these tools. The laptops must be on the same subnet but not necessarily the same subnet as the radios (172.20.xx.yy). It is not required for the user to set a secondary IP address on the radio to perform this test. It is recommended the iperf or jperf tests are first conducted between the laptops using an Ethernet switch or cross-over Ethernet cable between them to verify the laptops and iperf/jperf tools.
- Two or more StreamCaster radios properly configured.

10.2 Running Iperf Test

- Connect a laptop to one StreamCaster radio using the Ethernet cable.
- Connect the other laptop to another StreamCaster radio.
- Power up the radios and verify the radios are booted and connected wirelessly.
- At the receiver side type the following in a terminal
    - iperf –s –u -i 1
- At the transmitter side type the following in a terminal
    - iperf –c receiver_laptop_ip_address –u –i 1 –b 1M –t 60

11. Precautions and Recommendations

11.1 Saving the Radio Configuration

It is very important that the radio does not lose power during any configuration changes in which the user requests a “save and apply” operation. Partial saving of the configuration to the radio due to power interruption may disable the radio requiring reprogramming at the factory. Also, please wait for a “done” feedback at the web interface before proceeding to any other configuration changes.

12. Troubleshooting

12.1 LED Issues

- If flashing red LED is present, radio is in safe boot mode. Click save and apply to resume normal operation.
- If LED is orange and node won't connect to another node, click "restore factory defaults" on both radios to ensure all settings are reverted to factory settings.

12.2 Intermittent Link

- In a long range scenario if SNR is good but link drops unexpectedly check link distance parameter and make sure that the link distance is set the same on all radios and sufficiently large enough.
- Check interference levels as strong interference can result in an intermittent link.

13. FCC Notice

13.1 FCC Identifier: N2S-SC3500

Silvus Model #: SC3500-243541

Equipment Class: Digital Transmission System

The following parameters must be used to be compliant to the appropriate FCC requirements:

Antenna: 3dB Omni (AOV3T245515575)

Bandwidth: 20MHz

Maximum Output Power across Frequency Range #1: 495.28mW from 2427MHz to 2447MHz

Maximum Output Power across Frequency Range #2: 493.62mW from 5745MHz to 5830MHz

13.2 FCC Identifier: N2S-SC3822

Silvus model #: SC3822-245580

Equipment Class: Digital Transmission System

The following parameters must be used to be compliant to the appropriate FCC requirements:

Antenna: 3dB Omni (AOV3T245515575)

Bandwidth: 20MHz

Maximum Output Power across Frequency Range #1: 268.64mW from 2420MHz to 2450MHz

Maximum Output Power across Frequency Range #2: 329.02mW from 5760MHz to 5810MHz

13.3 FCC Identifier: N2S-SC42-245

Silvus model #: SC4210-245-BB, SC4240-245-BB

Equipment Class: Digital Transmission System

The following parameters must be used to be compliant to the appropriate FCC requirements:

Antenna: 2.1dBi Omni Antennas (AOV2S230515)

Bandwidth: 10MHz

Maximum Output Power @ Frequency #1: 810.17mW @ 2430MHz

Maximum Output Power @ Frequency #2: 795.3mW @ 2440MHz

13.4 FCC Identifier: N2S-SC44-245

Silvus model #: SC4410-235-SBST, SC4480-235-SBST

Equipment Class: Digital Transmission System

The following parameters must be used to be compliant to the appropriate FCC requirements:

Antenna: 2.1dBi Omni Antennas (AOV2S230515)

Bandwidth: 10MHz

Maximum Output Power @ Frequency #1: 582.1mW @ 2430MHz

Maximum Output Power @ Frequency #2: 523.6mW @ 2440MHz

13.5 FCC Identifier: N2S-SC42-520

Silvus model #: SC4210E-520-BB, SC4240E-520-BB

Equipment Class: Digital Transmission System

The following parameters must be used to be compliant to the appropriate FCC requirements:

Antenna: 6dBi Omni Antennas (Peak Antennas CO520-6-LS)

Bandwidth: 20MHz

Maximum Output Power @ Frequency #1: 414.03mW @ 5220MHz

Maximum Output Power @ Frequency #2: 498.92mW @ 5240MHz

13.6 FCC Identifier: N2S-SC44-520

Silvus model #: SC4410E-520-SBST, SC4480E-520-SBST

Equipment Class: Digital Transmission System

The following parameters must be used to be compliant to the appropriate FCC requirements:

Antenna: 6dBi Omni Antennas (Peak Antennas CO520-6-LS)

Bandwidth: 20MHz

Maximum Output Power @ Frequency #1: 241.48mW @ 5220MHz

Maximum Output Power @ Frequency #2: 246.52mW @ 5240MHz

13.7 FCC Identifier: N2S-SC42E-245

Silvus model #: SC4210E-245-EBEquipment Class: Digital Transmission System

The following parameters must be used to be compliant to the appropriate FCC requirements:

Antennas: 2.1dBi Omni Antennas (Silvus AOV2D230515) & 4dBi Omni Antennas (Silvus AOV4S235)

Bandwidth: 10MHz

Maximum 10MHz Bandwidth Output Power @ Frequency #1: 789.84mW @ 2430MHz

Maximum 10MHz Bandwidth Output Power @ Frequency #2: 790.06mW @ 2440MHz

Bandwidth: 20MHz

Maximum 20MHz Bandwidth Output Power @ Frequency #1: 123.82mW @ 2440MHz

13.8 Notes

This equipment has been tested and found to comply with the limits for a class B digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can

be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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

In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of the manufacturer could void the user's authority to operate the equipment.
To satisfy RF exposure requirements, this device and its antennas must operate with a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

14. Notes Regarding CE Mark (SC4200-206-EB and SC4400-206-SBST models only)

The following Silvus Technologies models are declared to conform to CE Mark requirements:

Silvus P/N: SC4240-206-EB, SC4480-206-SBST

Relevant standards:

ETSI EN 302 064 V2.1.1 (2016-09), Wireless Video Links, Harmonized Standard

ETSI EN 301 489-1 V2.2.0 (2017-03), EMC, Common Technical Requirements

ETSI EN 301 489-28 V1.1.1 (2004-09), EMC, Specific conditions for wireless digital video links

EN 60950-1, Information Technology Equipment, Safety

Frequency range: 2025-2110 MHz

Maximum RF power: 500 mW per channel, up to a maximum EIRP of 1.6 watts for the SC4240-206-EB, and 3.2 watts for the SC4480-206-SBST

Antenna: 2.15dBi Omni Antennas (AOV2D230515)

Cable: Silvus cable assembly (SC22-PRICBL02-6)

External Bandpass Filter:

Microwave Filter Co. model 3813

(a filter of equivalent performance may also be used, contact Silvus Technologies customer support for more information)

AC Adapter (if used): EDAC Power Electronics EA10523C-120 (this adapter is approved for indoor use only) (this adapter was certified by the manufacturer to IEC 60950-1)

External DC supply: If the customer provides DC power from their own source, the supply should be fused for a 5-amp circuit.

Safe Working Distance:

Maintain safe working distance of minimum 20cm. For more details, refer to TUV report no. SD72128709-0617A-0617C, “Radio Frequency Exposure Verification of the Silvus Technologies Inc. StreamCaster SC420-206 and SC4480 Tactical MIMO Radio EN 62311 January 2008” (copy of report available upon request). The CE Mark Technical File is available upon request for inspection.

To satisfy RF exposure requirements, this device and its antennas must operate with a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with RED RF Exposure requirements.

This equipment has been constructed so that the product complies with the requirement of with Article 10(2) as it can be operated in at least one Member State as examined and the product is compliant with Article 10(10) as it has no restrictions on putting into service in all EU member states.

See restrictions mentioned in ERC Recommendation 25-10, Table 7-C2, for guidance of restrictions applicable to specific countries.

Table 7-C2: additional information regarding the national conditions for the identified tuning ranges for video PMSE applications - Band C2

Frequency Band	Country	Implementation	Conditions/remarks
C2 2025-2110 MHz	AUT	L*!	Max. 10MHz Channels, max. 20dBW eirp; 2070-2090 MHz: Restricted to Broadcasters only. 2090-2110 MHz: Restricted to fire brigades and private users
	AZE	Y*	On a secondary basis
	BIH	L	PBS old MW link systems for PMSE. Military use in 2025-2110 MHz
	BUL	Y	ECC Report 219. Available for Cordless Cameras, Portable video links and Mobile video links
	CZE	Y*	The band may be used in the coordination with the Ministry of Defence of the Czech Republic. https://www.ctu.eu/sites/default/files/obsah/o-ctu/rsup-p_06_09-2014-07_en_.pdf, new version is avalaible only in czech https://www.ctu.cz/sites/default/files/obsah/ctu/vyzva-k-uplatneni-pripominek-k-navrhu-opatreni-obecne-povahy-casti-planu-vyuziti-radioveho-spektra-c.pv-p/6/xx.2017-yy-pro-kmitoctove-pasmo-1900-2200-mhz/obrazky/pv-p6-2017.pdf
	D	N	Deviations from the specifications in the Frequency Plan (FreqP) could be permitted for a limited time in accordance with §58 TKG. This is provided that the frequency usages indicated in the Frequency Ordinance (FreqV) and the Frequency Plan are not adversely affected (for more details see: https://www.bundesnetzagentur.de/cln_1412/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/SpezielleAnwendungen/Kurzzeitzuteilungen/kurzzeitzuteilungen-node.html)
	DNK	Y*	
	E	N	Band not available
	EST	L*	2075.25-2110 MHz SAP/SAB. See Regulation of Ministry of Communication and Economical Affairs 21.05.2013 No 35. Otherwise governmental use.
	F	L*!	Temporary licenses, e.i.r.p. max = 10 dBW. Use of 10 MHz bandwidth centered on 2055 MHz and 2095 MHz for ground-to-ground link and 10 MHz bandwidth centered on 2065 MHz and 2105 MHz for air-to-ground link. Coordination required between assigning authorities (la Défense and Space) regarding the use of the other available bands in order to avoid harmful interference. ARCEP Decision 2016-1130
	FIN	L*!	Cordless cameras, temporary use on a case- by-case basis. Standard EN 302064. Other use includes military use and space operation
	G	Y*!	Technology and application neutral but typically used for wireless cameras, typically licensed at 100 mW e.r.p.
	GEO	L*	
	GRC	L*!	Cordless Cameras. Portable/Mobile video links. 2087.5- 2108.5 MHz : not available (exclusive use by security services)
	HNG	N	Band not available (governmental use). However, the band may be used for short-term PMSE use if the user demand makes it necessary at certain occasions like main events. In this case the authority handles the requests on a case-by-case basis and if the frequency use can be authorised the users receive an individual license
	HOL	L*	2070-2110 MHz for ENG-OB only

Possible implementation status: Y = the whole band is available for PMSE L = Limited availability N = the band is not available for PMSE * - Individual licence may be required ! – restrictions apply (e.g. geographical restrictions)

Table 34 Additional Restrictions on Band C2

EU DECLARATION OF CONFORMITY

Number: *xxxxxxxxxx*

Name and address of the Manufacturer

Silvus Technologies, Inc.,
10990 Wilshire Blvd., Suite #1500
Los Angeles, CA 90024 U.S.A

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration

Product information	StreamCaster SC4240-206-EB, SC4480-206-SBST
Additional information	SW version : v3.12.6.4 for both models HW version : C5 for SC4240-206-EB, B1 for SC4480-206-SBST

The object of the declaration described above is in conformity with the relevant Union harmonisation legislation:

- References to the relevant harmonised standards used or references to the technical specifications in relation to which conformity is declared

Radio Equipment Directive 2014/53/EU	RoHS Directive 2011/65/EU
EN 301 489-1 V2.1.1 *EN 301 489-28 V1.1.1* *EN 302 064 V2.1.1* *EN 60950-1:2006+A11:2009+A1:2010+A12:2011+A2:2013* *EN62311:2008*	*EN 50581:2012*

The notified body Name: *TÜV SÜD BABT*
Number: *0168*

performed
- a conformity assessment of the technical construction file

and issued the certificate

Additional information

N/A

Signed for and on behalf of: Silvus Technologies

Authorised Representative:

Name and Surname / Function:

Weijun Zhu, Vice President of Engineering

Date of issue: 9/12/2017

15. ISED Canada Notice

15.1 IC: 24980-SC42E245

Silvus model #: SC4210E-245-EB

Equipment Class: Digital Transmission System

The following parameters must be used to be compliant to the appropriate ISED requirements:

Antennas: 2.1dBi Omni Antennas (Silvus AOV2D230515) & 4dBi Omni Antennas (Silvus AOV4S235)

Bandwidth: 10MHz

Maximum 10MHz Bandwidth Output Power @ Frequency #1: 789.84mW @ 2430MHz

Maximum 10MHz Bandwidth Output Power @ Frequency #2: 790.06mW @ 2440MHz

Bandwidth: 20MHz

Maximum 20MHz Bandwidth Output Power @ Frequency #1: 123.82mW @ 2440MHz

15.2 IC Statement: English

This radio transmitter SC24980-SC4210E245has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

1. Omnidirectional antenna, Silvus P/N A0VD230515, maximum antenna gain 2.1 dBi, 50 ohm
2. Omnidirectional antenna, Silvus P/N A0V4S235, maximum antenna gain 4dBi, 50 ohm

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

(1) This device may not cause interference.
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

15.3 IC Statement: French

Le présent émetteur radio [identifier le dispostif par son numéro de certification d'ISED] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenna énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cetter liste, et dont le gain est supérieur au gain maximal indiqué, pour tout type figurant sur la liste, sont strictement interdits pour l'expolitation de l'émetteur.

1. Omnidirectional d'onde, Silvus P/N A0VD230515, le gain max 2.1 dBi, 50 ohm
2. Omnidirectional d'onde, Silvus P/N A0V4S235, le gain max 4 dBi, 50 ohm

L'émettur/récepteur exempt de licence conenu dans le présent appareil est conforme aux CNR Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

(1) L'appareil ne doit pas produire de brouillage;
(2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.