THUNDER 255

TETRA Base Station

SMART ROUTE

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1. About This Document

The purpose of this document is to give instructions for the installation & configuration of the TETRA Base Station **THUNDER 255** and to ensure that installation & configurations are carried out correctly.

2. FCC Information

Model Name: Thunder 255

FCC ID: 2BFHD-THUNDER255

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication

3. Abbreviations

TETRA - Terrestrial Trunked Radio
TETRA is a professional mobile radio (PMR). It has been the standard for public safety and commercial use in Europe since 1995. The FCC approved the technology in 2013 for commercial use in the US.

LAN – Local Area Network

A Local Area Network or LAN is a network that interconnects computers and other devices over a small space.

Ethernet API – Application Program Interface for Ethernet

URL - Uniform Resource Locator

A string of characters that identifies the location of a resource

BSU – Base Station Unit

The control center and hub of the TETRA communication network

4. Intended Use

This user manual is intended for well-trained technical/telecom operators and technicians only. Please read the manual carefully to ensure safe and effective use of the product. Installation, commissioning, integration, configuration and maintenance measures concerning the THUNDER 255 may be performed only by properly trained and authorized personnel.

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5. About Thunder 255

The Thunder 255, Smart Route's flagship TETRA base station, is a deployable high-performance TETRA radio base station unit supporting multiple carriers. It is a scalable, dynamic TETRA radio base station system. Thunder 255 comes with configurable software support that enables the system to be configured for transmission over a wide spectrum.

6. Safety Information

6.1. Public Safety at Base Station Installation

Radio frequency (RF) energy might have thermal effects. Hence, base stations must be installed adhering to compliance boundaries in order to ensure public safety. These boundaries prevent exposure levels from exceeding safety limits. Only authorized personnel should access areas within these boundaries.

6.2. Installer Safety

Installers are expected to be aware of RF energy's thermal risks and maintain proper safety distances from antennas. The minimum safe distance is specified in meters.

6.3. Application of SAR measurements

European standards EN 50383, EN 50384 and EN 50385 do not require whole body Specific Absorption Rate (SAR) measurements for transmitters with negligibly low maximum output power levels. The exclusion power levels for SAR are based on worst-case assumptions.

Localized SAR measurements used to assess the absorption rate in specific parts of the body are applicable only if:

1. The distance between the measurement phantom and the energy source is less than 40 cm.
2. The surface area of the energy source is less than 60 cm x 30 cm.
3. The frequency of the energy is between 800 and 3000 MHz

Based on these criteria, the SAR measurements are not applicable to TETRA Base Stations.

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6.4. Compliance boundary for Antennas

The compliance boundary is the safe area around the antenna as defined by the limits in 47 CFR 1.1310. As the antenna is customer provided, Smart Route can only provide a calculation based on a defined antenna type. As the typical application for a TETRA radio would use an omni directional antenna, the antenna gain is defined as 2.15 dB based on the Laird FG4500 base station antenna for 450-470 MHz for the purpose of this calculation. The table below defines the values used and resulting minimum safe distance required.

Table1: Compliance Boundary Dimensions for Thunder 255

Test Frequency	450 MHz (Minimum operational frequency)
Power, Conducted mW (P)	47772.8 (Rated power of +46 dBm + 20 %)
Antenna Gain Isotropic	2.15 dB
Antenna Gain Numeric (G)	1.64
Antenna Type	Laird FG4500 Omni-directional
Limit (f/1500) (L)	0.3
Distance (R) ($R = (\sqrt{(PG/4\pi L)})$ cm	144.2

If a higher gain antenna is used by the customer, the calculations need to be repeated to determine the safe area around the antenna.

6.5. Typical Configuration

The antenna connects to the base station through a connector and cable.

Typical and Worst Case Configurations:

- **Power (P out):** 40 W per antenna (Supports 2 transmit antennas each at 40W average power)
- **Peak Power:** Under 80 W per antenna
- **Number of Transmitter Units:** 2

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7. Caution

Security during installation and maintenance - Follow all installation and maintenance instructions for personnel safety.

Electromagnetic fields – ensure that the installation personnel are aware of the emissions from nearby antennas while connecting a new antenna.

Electrostatic discharge protection - always handle electrostatic sensitive devices with care. Use a grounding strap to prevent discharge damage to the equipment or personnel.

Antenna connectors – make sure that the base station is powered off before disconnecting any antenna connectors. This is an essential step to avoid electrical hazards.

For storage and transportation - Keep the units in their original packaging to prevent mechanical damage, to maintain traceability and to protect against static electricity.

CAUTION: While handling electro-sensitive TETRA units, always wear a snug-fitting grounding wrist strap around your bare wrist. This ensures that your body remains at the same electrical potential as the equipment that is being handled. Use one of the M8 screws on the front panel of the system to attach a lug for a ground strap.

8. Warning

Potential dangers that may cause physical injury or death.

Follow these precautions while using the Thunder 255 Base station

- Read all instructions carefully before installing and using the Thunder 255.

- Keep the manual for the Thunder 255 Base Station for further reference.

- Only trained and authorized personnel should install, commission, integrate or maintain the TETRA Base station of Thunder 255.

- Access to the base station should be limited to authorized personnel only at all times.

- The system may carry potentially lethal voltages. Switch off all power supplies before any maintenance

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- Ensure proper earthing in installation to avoid lethal voltages from capacitors.

- Dispose of the equipment responsibly according to regional regulations. This equipment can release toxic fumes (hydrogen fluoride and hydrogen chloride) when burned.

- This equipment emits radio frequency energy with possible thermal effects. Comply with access boundaries in order to prevent unsafe exposure.

Warning sticker**

WARNING: Do not go beyond the compliance boundary of a live antenna.

Compliance boundaries are based on European standards EN 50383, EN 50384, EN 50385, and Council Recommendation 1999/519/EC and 47 CFR 1.1310

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9. Product Overview

Components and Features

- Portable TETRA base station
- 8 carrier support
- Robust and durable design
- Easy-to-use control interface
- High-quality signal processing

10. Technical Specifications

Frequency bands

Rx: 456.0 – 458.0 MHz	Tx: 451.0 – 453.0 MHz
Rx: 465.4 – 467.7 MHz	Tx: 460.4 – 462.6 MHz
Rx: 472.5 – 475.0 MHz	Tx: 467.5 – 470.0 MHz

Transmitter/Receiver Separation MHz

456 – 475 MHz	5 MHz

RF Power Control	+46 dBm to +28 dBm in 2 dB Steps
RF Power Level Accuracy	+/-2 dB @25 C
	+3/-4 dB over Temperature Range
Max power at TRX output:	+46 dBm Single Carrier per Tx Path
	+42 dBm Two Carriers per Tx Path
	+36 dBm Three Carriers per Tx Path
	+32 dBm Four Carrier per Tx Path

Operating Bandwidth	2.5 MHz
Carrier Spacing	200 kHz minimum
Receiver Static Sensitivity dBm	-117 dBm
Receiver Dynamic Sensitivity dBm	-108 dBm
Operating Ambient Temperature	-30 to 50 °C
Humidity	90% to 95% RH @ +50 °C for 8 hours
Dust/Water intrusion	IP67
Input power	110-120vac
Power Consumption	1000W
Salt Fog	?? hour exposure to 5% saline solution
Width x Height x Depth	27.6 x 17.3 x 12.2 inches
Weight	150 pounds

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11. Setup and Installation

11.1. Site Survey and Planning

1. **Site Selection**:
    - Select the location that satisfies the coverage requirements.
    - For indoor installations select a location that has minimal obstructions
    - Ensure necessary permissions from local authorities / property owners

2. **Pre installation checklist**
    - Familiarize yourself with the general overview of the Thunder 255 installation process by using the installation manual. Ensure full comprehension of the procedure from start to finish.
    - Verify the availability of all necessary tools as outlined in Section 11.5
    - Acquaint yourself with the warnings and precautions detailed in Section 6 to ensure safe handling.

- Test all equipment to ensure functionality
- Check for any software or firmware updates prior to the actual installation.
    - Confirm the availability of all required documents listed in the references section
    - Cross-check received cases against the packing list. Document and report if you find any discrepancy
- Ensure the stability of the mounting structure (like stands or shelves for indoor installation and poles for outdoor installations)
    - Inspect the components for any transport related damages.

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11.2. Site preparations

General

- Conduct a site survey to ensure proper preparation and identification of any special requirements (such as the need for lifting equipment).
- Check that the equipment room temperature meets specified limits according to engineering instructions and the Environmental Conditions documentation.
- Verify accessibility to the installation site and visually inspect to ensure compliance with site-specific instructions, cleanliness
- Make sure that the site survey report has been completed and is available.
- Ensure all external connections required for the cabinet installation are available. This includes
    1. earthing points
    2. mains power that adheres to national requirements (AC)
    3. transmission interfaces to the exchange
    4. TX and RX antenna cables
    5. GPS cable etc.
- Confirm the availability of necessary lifting and other equipment for safe installation
- Ensure adequate working space.

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Outdoor Installation:

- Make sure the mounting structure (like a pole) is structurally sound for the installation of the base station and antennas.
- Mark the point for antenna installation at an appropriate height for desired coverage.
- Ensure grounding systems and lightning protection to safeguard the equipment.
- Set up the power supply, including any necessary backup systems like batteries or generators.
- Verify power availability and stability.

Indoor Installation:

- Ensure the mounting structure is suitable for installation with adequate space and ventilation
- Ensure the area is free from potential hazards such as water leaks or excessive dust.
- Plan for proper cable management
- Ensure access to a stable power supply with appropriate grounding.

11.3. Unboxing

- List of items included in the package.
  - Thunder 255 base station
  - Power cord
  - User manual
  - Ethernet cable
  - Mounting brackets (if applicable)
  - Visual guide to the components.

11.4. Connectors (Back panel – Picture is expected. Need to denote with number and description)

AC Power: 110 VAC

Unit Connector: Amphenol PWC-03PMFS-LC7001

Mating Connector: Amphenol PWC-03AFMM-LL7Axx, where xx is length in meters, 01, 02, 03, 04, 05, 07, 10.

Pin Assignment: 1: AC Line, 2: Ground, 3: AC Neutral

GPS Antenna:

SMA Female, Antenna power provided, +5V DC up to 55 mA. Open detection below 4 mA, Short detection above 150 mA.

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RF Connections:

With External Duplexer or separate TX/RX Antennas

TX1: Type N Female, Transmit Output from TX1 Path

TX2: Type N Female, Transmit Output from TX2 Path

RX1: SMA Female, Main RX Antenna Input

RX2: SMA Female, Diversity RX Antenna Input (If supported)

With Internal Duplexer Option

TX1: Type N Female, Transmit Output from TX1 Path and Main RX Antenna Input

TX2: Type N Female, Transmit Output from TX2 Path and Diversity RX Antenna Input (If supported)

LAN:

Unit Connector: Amphenol LTW RCP-5SPFFH-SCM7001, RJ45 Female
Mating Connector: Indoor Application: Any RJ45 Male Connector
Outdoor Application: RCM-00BMMA-SLM7001 (For User provided cable, OD 4.5 to 7.5 mm)

USB: Field Technician Interface

Unit Connector: Sure Seal IPUSB-2BABHD

Mating Connector: USB-B

Fuses:

Digital/RF Module: Littlefuse 0218002.HXP, 2A, 5mm x 20mm
PA1 Module: Littlefuse 0326015.HXP, 15A, ¼" x 1 ¼"

PA2 Module: Littlefuse 0326015.HXP, 15A, ¼" x 1 ¼"

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11.5. Tools needed

The following tools and proficiency in using them is expected while installing THUNDER 255

Table*: Installation Tools

The following tools and proficiency in using them is expected while installing THUNDER 255

Tool	Quantity
12 mm open-end wrench for pole mounting	1
12 mm socket with ratchet for pole mounting	1
Tools for connecting power cord to AC power supply	1
Tools for making RJ-45 cable connection	1
8 mm eyebolts for lifting equipment	2

11.6. Assembly Instructions

Product identification labels

THUNDER 255 base stations are labelled with permanent product identification tags that are designed to last throughout its lifespan. Ensure that these identification labels remain in place and are undamaged.

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12. Initial Setup

12.1. Connecting the Antennas

Connecting the TX/RX and GPS antennas

- Securely mount the TX/RX antenna/ GPS antenna in the desired location.
- Install appropriate lightning surge protection devices on the antenna cables going to the Thunder 255 unit. For indoor installations where the antenna is located outside, lightning surge protection device are to be installed at the building entry point.
- Attach the antenna cables to the respective connector ensuring that there are no loose connections.
- Carefully route the antenna cable towards the Thunder 255 unit avoiding sharp bends
- Attach the other end of the antenna cables into the designated ports on the Thunder 255 unit ensuring that they are securely connected.

12.2. Connecting to Power

a. Plug the mating connector of the power cord into the power port of Thunder 255.
b. Connect the other end of the power cord to an AC power source.

12.3. Powering On

- Press the power button for DIG_RF and PA1.
- Press the power button for PA2 if the 2nd transmit path is to be utilized.
- Wait for the status indicators to light up.

12.4. Connecting Thunder 255 to a network

Indoor Installation:

- Connect an Ethernet cable from your computer to the Ethernet port on the Thunder 255.

Outdoor Installation:

- Pass the connector cable through the back shell of the weatherized connector.
- Attach the RJ-45 connector to the end of cable.
- Plug the RJ-45 connector into the unit.
- Connect the back shell to the unit and tighten it around the cable to create a watertight seal.

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General

- Ensure your computer is configured to obtain an IP address automatically or set a static IP address within the same subnet as the Thunder 255.
- Thunder 255 has a default static IP of 192.168.0.203. To connect to the base station, the private network set up in the computer must be in the same subnet.
- Go to the TCP/IP v4 properties in the Network/ Ethernet settings and assign a manual IP of the format 192.168.0.### to the computer. (Ex: 192.168.0.201)
- (You can find more details on how to setup the network at https://www.wikihow.com/Set-up-a-Private-Network)

12.4.1. Accessing the Web Interface

a. Open a web browser on your connected device.
b. Enter the Thunder 255's IP address in the address bar to access the web interface.
    i. The URL for accessing the Thunderbird-255's web interface is http://192.168.0.203:8124
c. Log in using the default username and password (refer to the product label or manual for default credentials).

User Name: operator
Password: password

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13. Configuration

13.1. Frequency Band

The TETRA radio frequency is configured according to operator's regional band specifications and according to operator's choice within the range. The Tx and Rx frequency ranges of this version of Thunderbird-255 is shown in the table below.

Transmission Frequency Range	Reception Frequency Range
460.41250 – 462.58750 MHz	465.41250 – 467.58750 MHz

13.2. Power On Configuration

The operator can configure the state to which the system will be restored on powering

on after a shut down. You can choose to power on to.

- Transmit disabled – upon choosing this setting, the system will power on to an idle state with all its transmission carriers disabled.
- Return to previous state – upon choosing this setting the unit will power on to the same state where it was left off. I.e. all the transmit carriers that were on will remain on and all those that were off will remain in an off condition.

Initially, the power on condition is set to “transmit disabled” on your Thunder 255. This ensures that the TETRA base station does not go online before the carriers are configured. Once the carriers are configured, set to “Return to the previous state” to assure operation resumes after a power outage.

13.3. TX (Tx 1 & Tx2)

13.3.1. On / Off (Need to add description)

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To Enable “Tx 1”, click on the right side of the red bubble next to the “Tx 1” label. The bubble will turn green. Similarly to Enable “Tx 2”, click on the right side of the red bubble next to “Tx 2” label.

13.3.2. Max TX Power

THUNDER 255 can be configured for the TX power & power class based on the number of carriers licensed by the operator. The options available are listed in the drop down menu.

13.3.3. Power Class

THUNDER 255 can be configured for the TX power & power class based on the number of carriers licensed by the operator. The options available are listed in the drop down menu.

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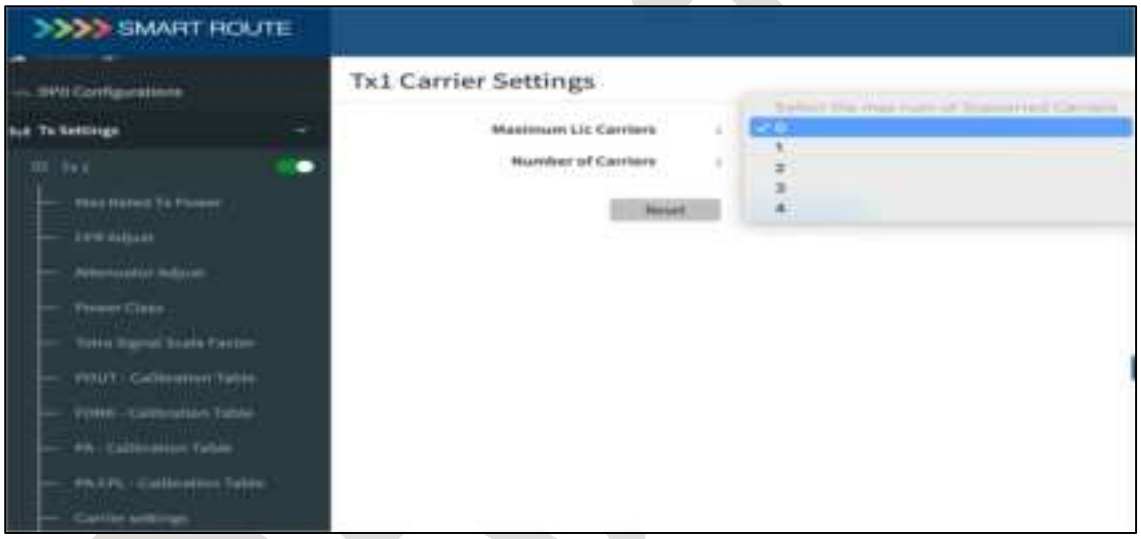
13.3.4. Carrier Setting

THUNDER 255 supports a maximum of 8 carriers. The THUNDER 255 is designed to have two Tx paths with each path supporting 4 carriers.

13.3.4.1. Number of Licensed Carriers

The number of licensed carriers is limited to the maximum number of supported carriers by the system. The number of licensed carriers is to be configured with maximum of 4 carriers per Tx path.



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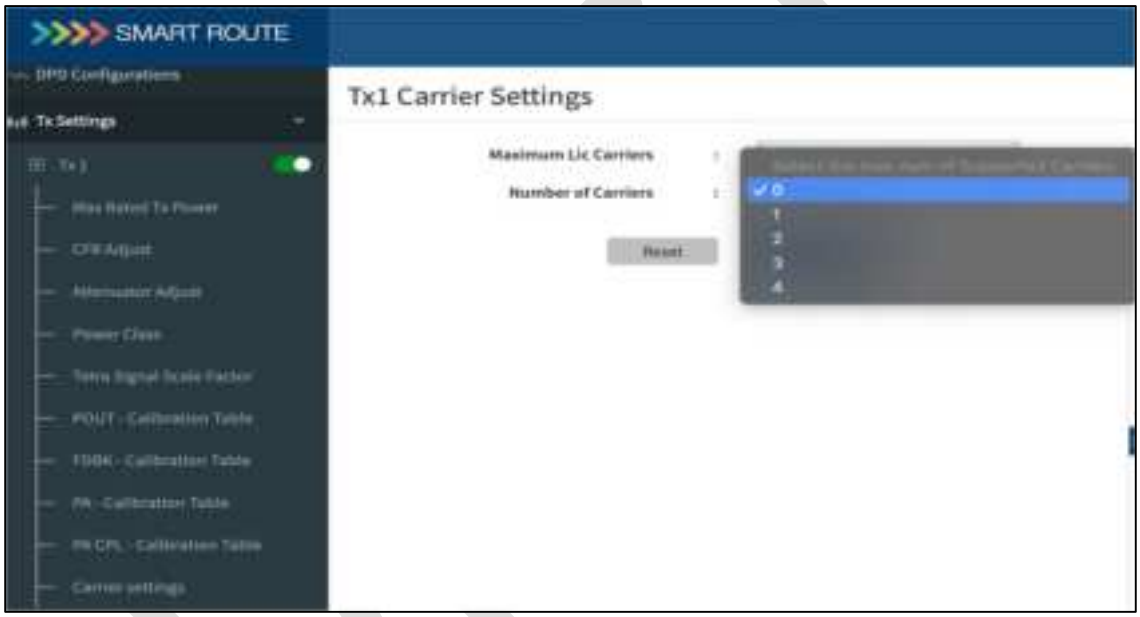
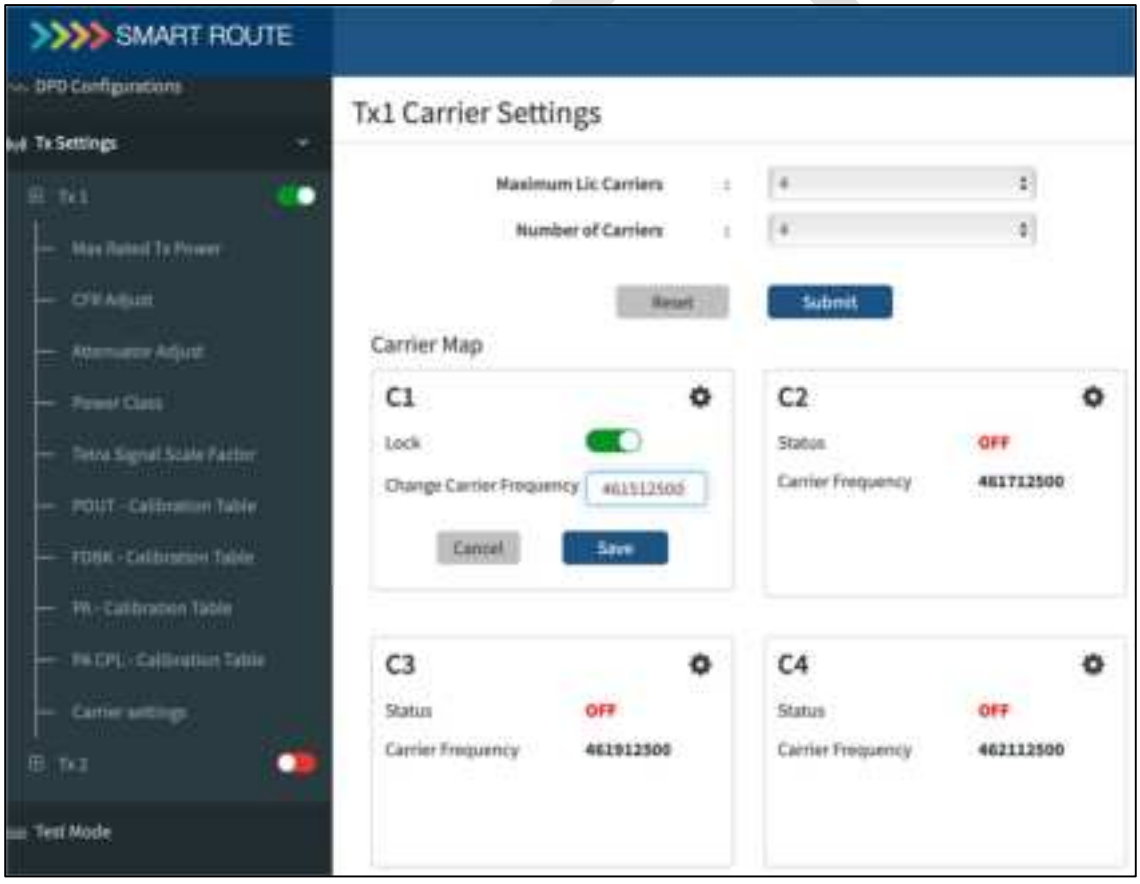
13.3.4.2. Number of Carriers

The operator can choose to change the number of active carriers per Tx path at any point of time subject to a minimum of 1 and maximum of 4 for Tx 1 path based on the number of licenses available. Initially, this value is set to zero, i.e. all carriers come disabled before the operator starts configuring them. The Primary (Main Control Channel enabled) carrier is always assigned as the 1st carrier frequency on Tx 1 path. Additional carriers may be configured between the two Tx paths up to the number of licensed carriers for the basestation.



13.3.4.3. Carrier Frequency

Once the Number of Carriers is defined, the carrier settings page will display a carrier map for the selected number of carriers (refer the image below below). Click on the symbol to the right of the Carrier number. This will bring up a red bubble where “OFF” was. Click on the right side of the bubble and it will turn green. Enter the desired frequency in Hz. Then click “Save. The carrier will then display “ON” in yellow indicating that the carrier has been enabled and is ramping the transmit power up slowly to allow DPD adaption to minimize out-of-band emissions. Once the carrier is at the desired power level, the “ON” will turn green. This can take several minutes. While the display is yellow, no other carriers on either Tx path can be enabled or disabled. It is recommended to stay on this page until the “ON” turns green”



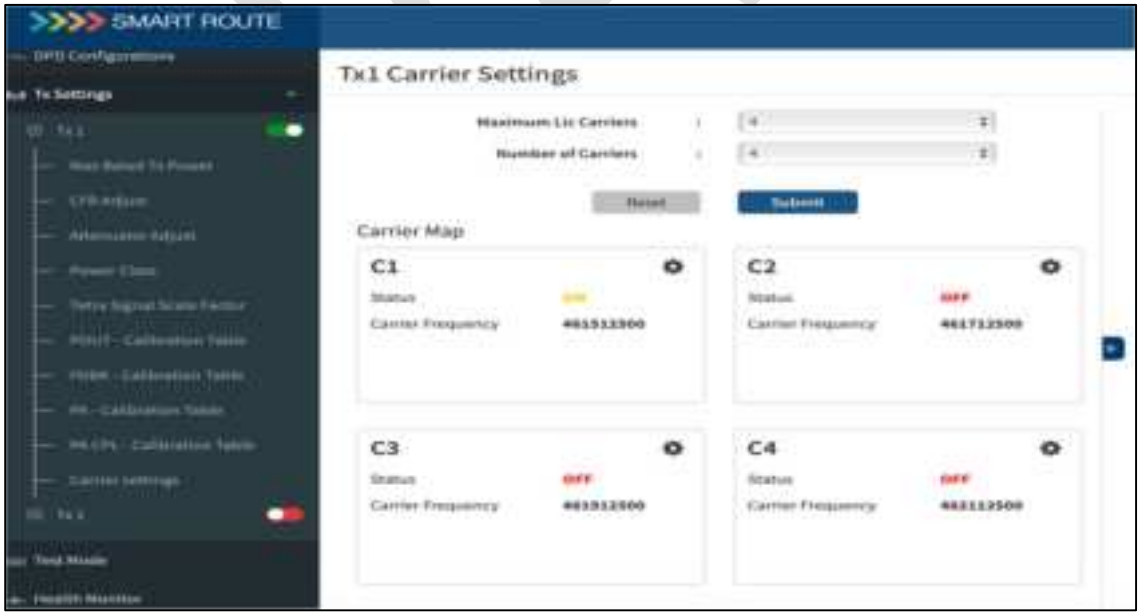
The carrier frequency entered by the operator will be validated upon 'save'. For a frequency to be successfully validated it has to be

- A frequency within the range as specified in section 12.1
- It should be a multiple of 6.25 KHz
- It should be at least 200 KHZ apart from any of the previously entered carrier frequencies

13.3.4.4. Enabling / Disabling Carrier

To change the state of an individual carrier, click on the symbol to the right of the Carrier number. This will bring up a red (locked) or green (unlocked) bubble. Clicking the bubble will toggle the color of the bubble. Click "Save" to execute the change in state. The carrier will then display either "OFF" or "ON" in yellow indicating that the carrier state is changing. Once the state change is complete, the display will either be "OFF" in red or "ON" in green.

To lock all carriers on a Tx Path, click the left side of the green bubble next to the Tx 1 or Tx 2 label on the left hand side of the display. This will immediately lock all carriers on the Tx path and turn the bubble color to red. The Tx path must then be manually unlocked and each carrier unlocked as described previously.



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13.4. User Management

You can add, delete or modify user to the system by following the steps as below.

- On the left pane click on SwMI Settings -> User management
- Click on “Mobile Stations”
- You will see a list of registered mobile stations on the right pane.

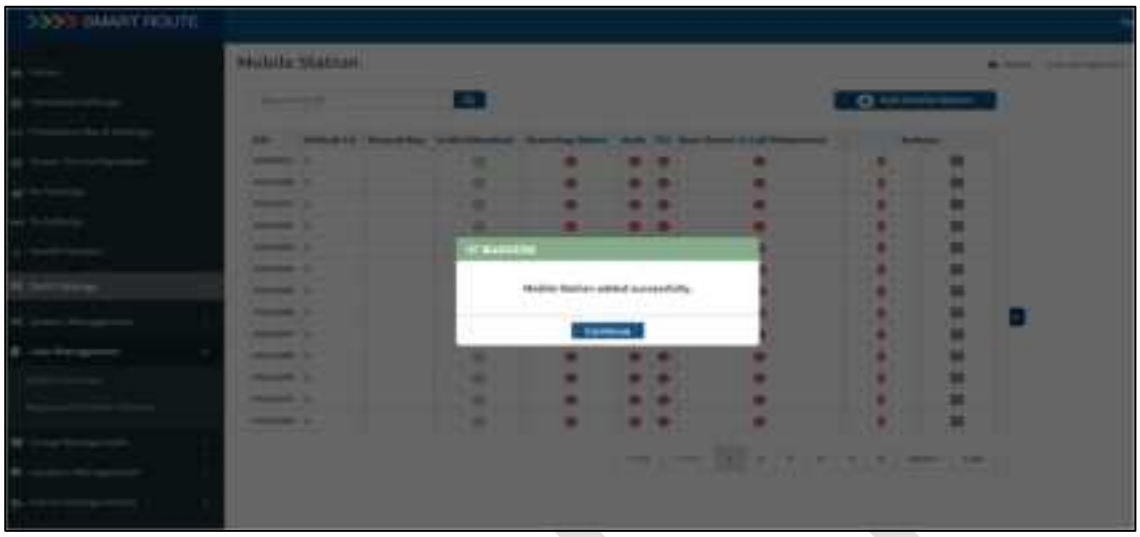
13.4.1. Create

Click on the add mobile station button on the right-hand top corner

The form to add a new mobile station will be displayed

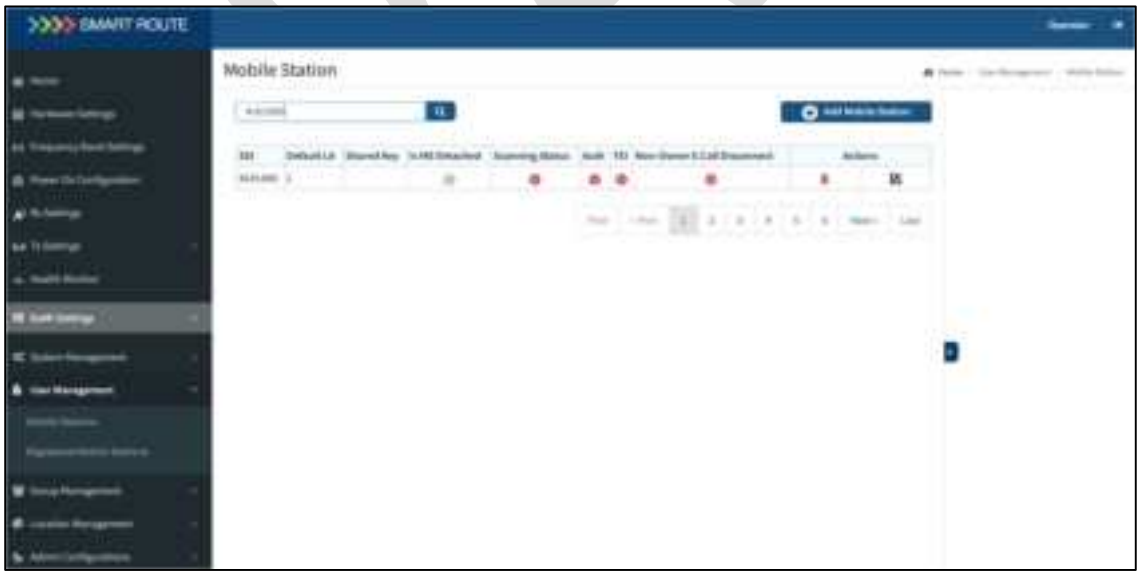
Enter the details for the new user/mobile station and click on add

You will get a confirmation pop up upon successful addition of a new user



13.4.2. Update

Navigate to user management, mobile stations and search for the user you wish to edit using the search box. In the search results select the mobile station / user you need to edit. In the tab actions, click on the edit button.

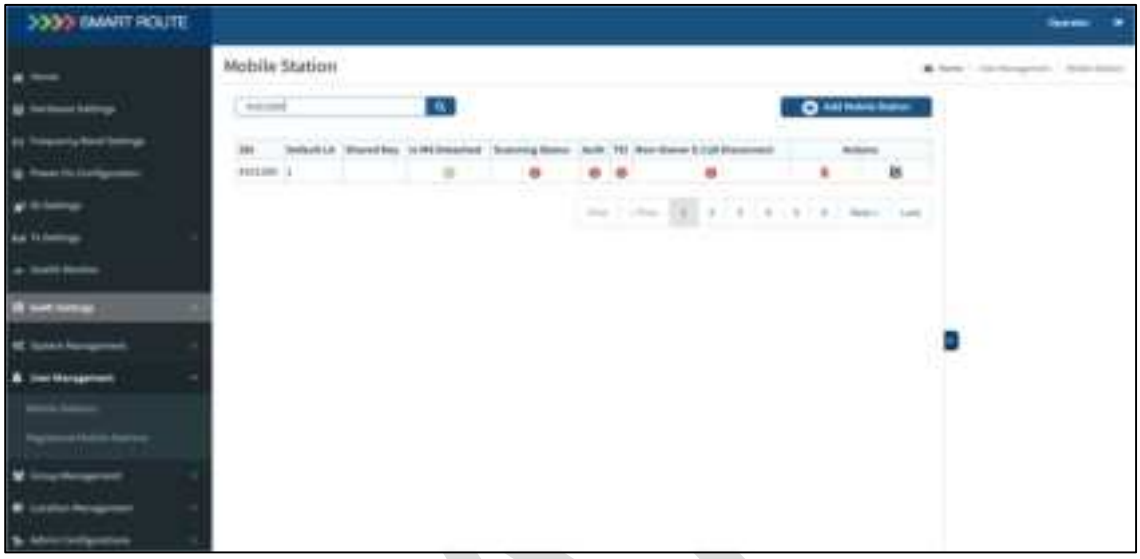


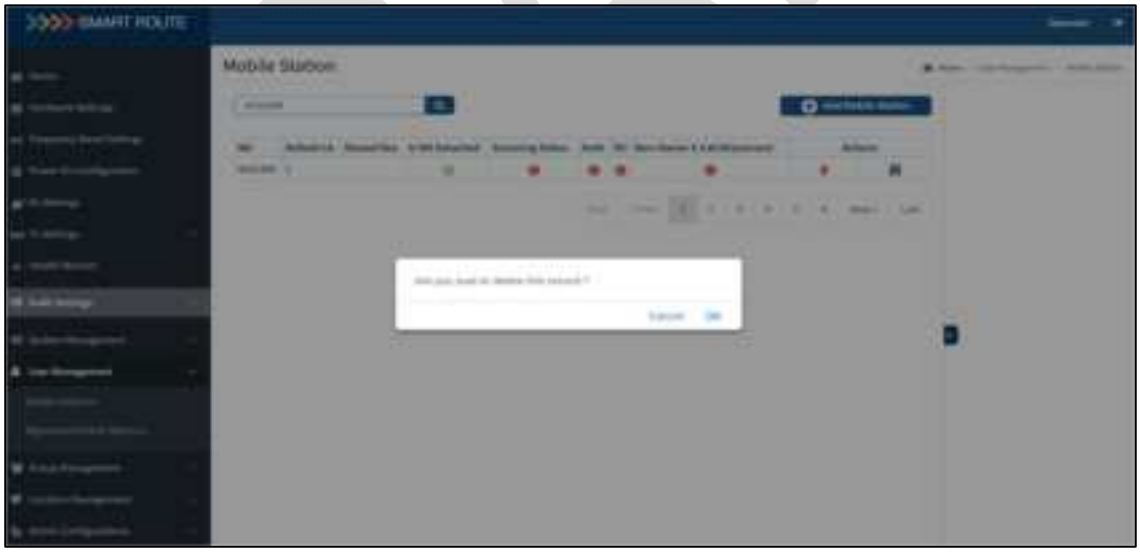
Edit the user details in the form that is displayed. Confirm and save the edit. A pop up appears on successful change of user configuration.

13.4.3. Delete

Click on user management & Navigate to “Mobile Stations”. A list of all mobile stations already added will be displayed.

Search for the mobile station that you want to delete using the search box above the list. The details of the particular user will be displayed. In the tab ‘actions’, click on the recycle button to delete the corresponding user. A pop up will ask you to confirm the action. Click on ‘Yes’ to confirm and to delete the user.



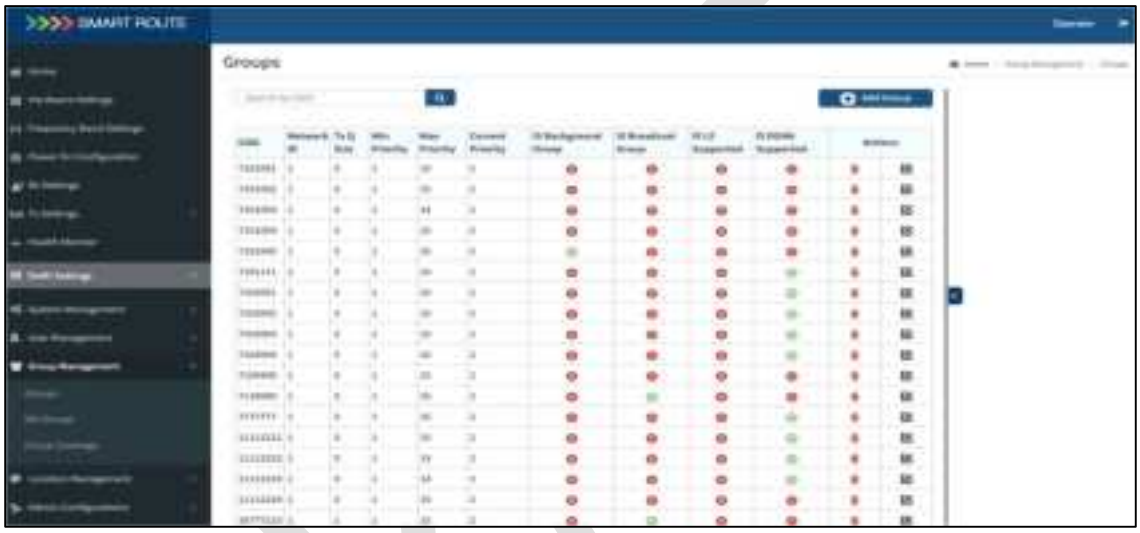


13.5. Group Management

You can also add, configure Talk groups to Thunderbird-255 system similar to radio user addition. You can add, delete or modify settings for user groups by following the steps as below

- On the left pane click on SwMI Settings -> Group Management
- Click on Groups

You will see a list of groups that are already configured to Thunderbird-255



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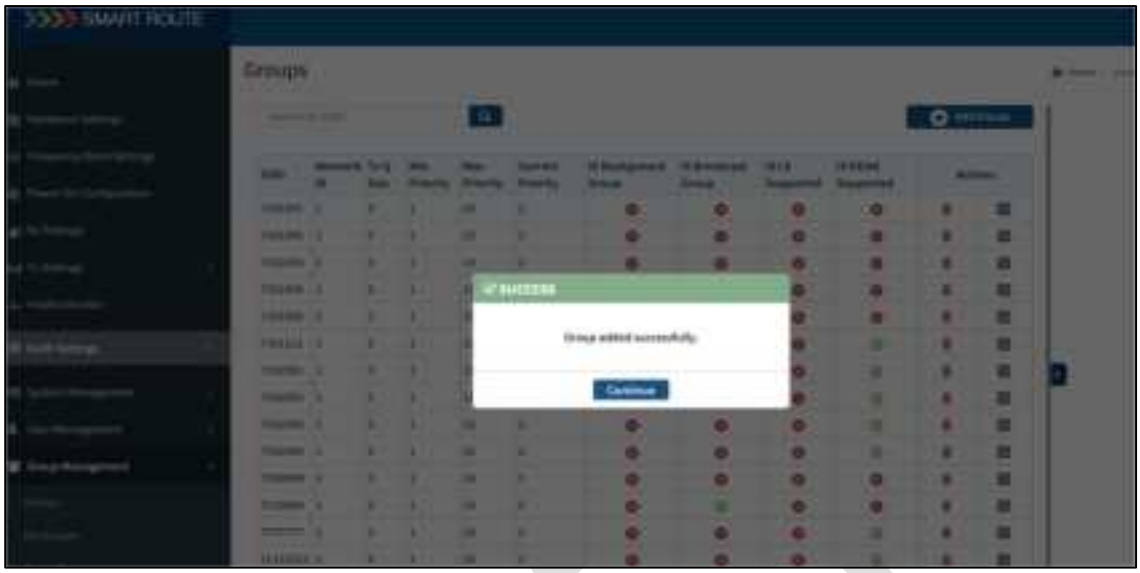
13.5.1. Create

Click on the add group button on the right-hand top corner & and form a to add new groups would appear. Enter the details for the group and click on add.

You will get a confirmation upon successful addition of a new group. Click on 'Continue' to save.



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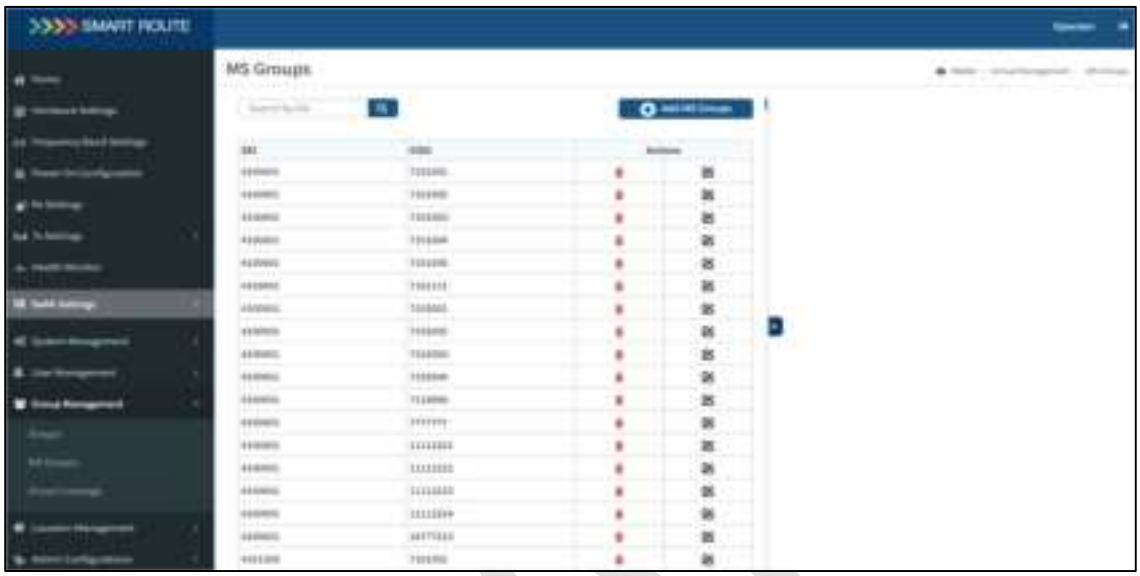
13.5.2. Assign a radio user (SSI) to a talk group (GSSI)

- Click on Group management -> MS Groups
- Click on the Add MS Group button on the right-hand top corner

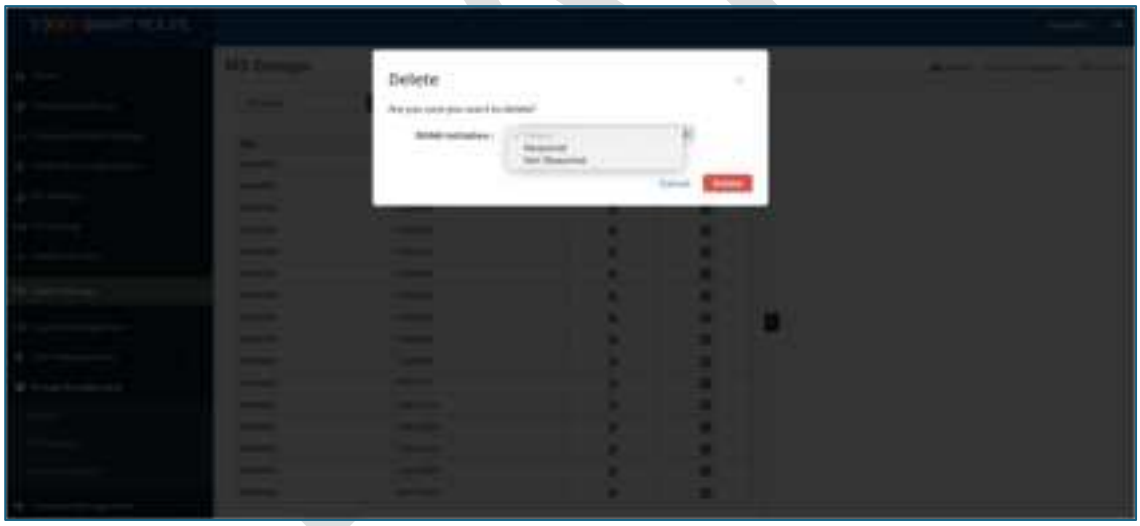
- This option opens an editable form, in which a new assignment to be done as shown below
- Enter the SSI, GSSI and other required information.
- Addition of a Radio user to a Talk group initiates DGNA notification to add the radio to the group immediately.



13.5.3. Unassign a radio user (SSI) from a talk group (GSSI)

- Click on Group management
- Go to MS Groups

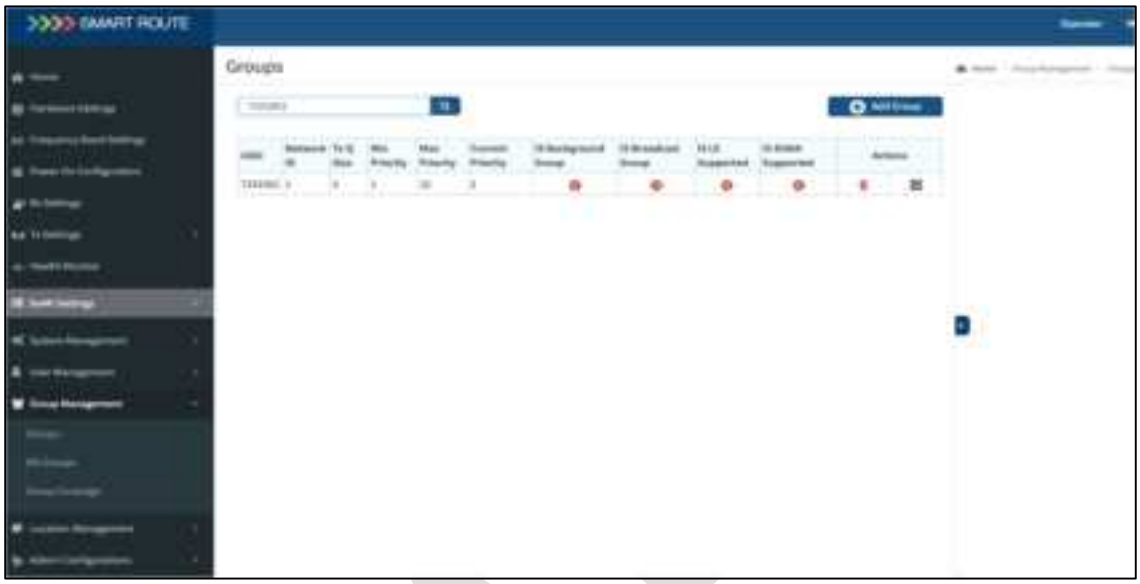
- Search for the Radio user by SSI, and select delete option under Actions
- Select corresponding delete option under actions for the Talk group which has to be removed for the Radio user.
- Doing that would show a pop up to select DGNA action to be done.
- Select appropriate DGNA action and confirm.



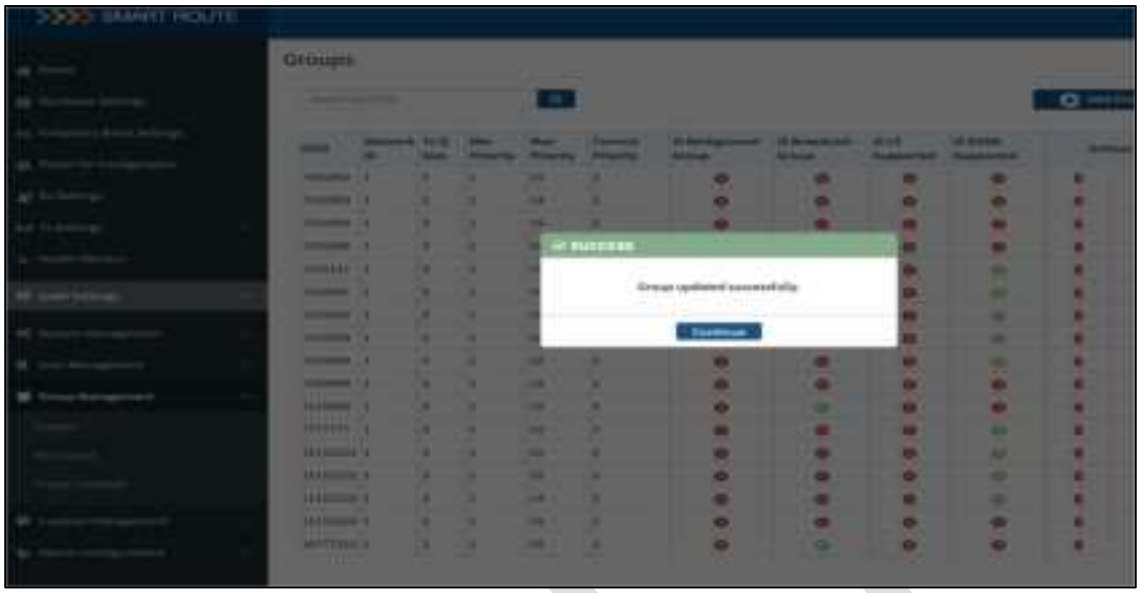
13.5.4. Update

- Click on Group management -> Groups
- Search for the group you wish to edit using the search box
- From the search results select the group that you need to edit

- Under actions, click on the edit button corresponding to the particular group
- Edit group details in the form that is displayed



Enter the new values in respective fields and save it.



13.5.5. Delete

- Click on Group management
- Go to Groups
- A list of all user groups already registered will be displayed
- Use the search box above the list to search for the group that you want to delete

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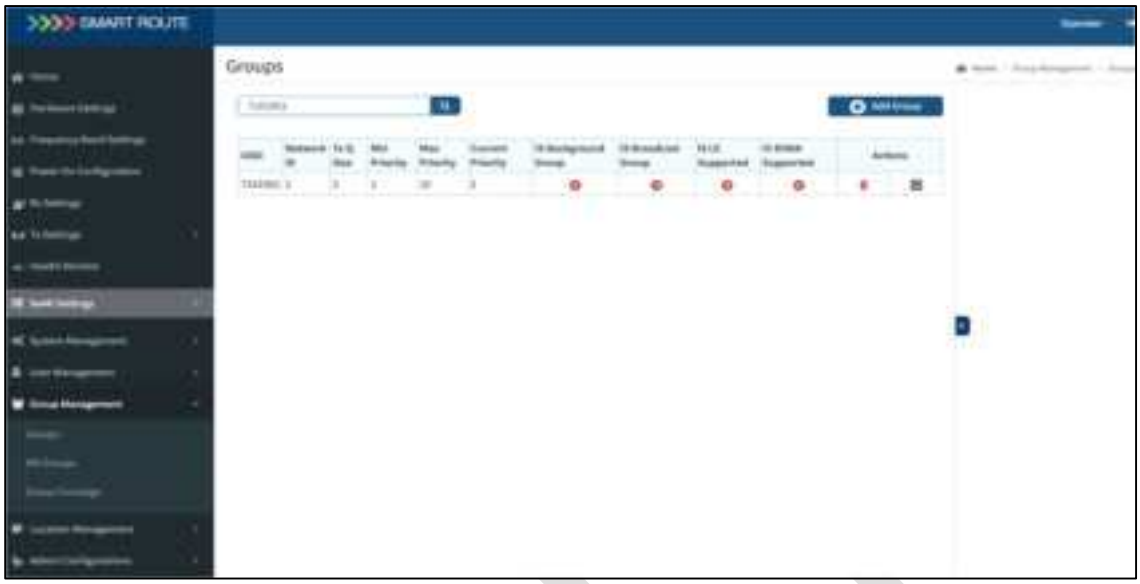
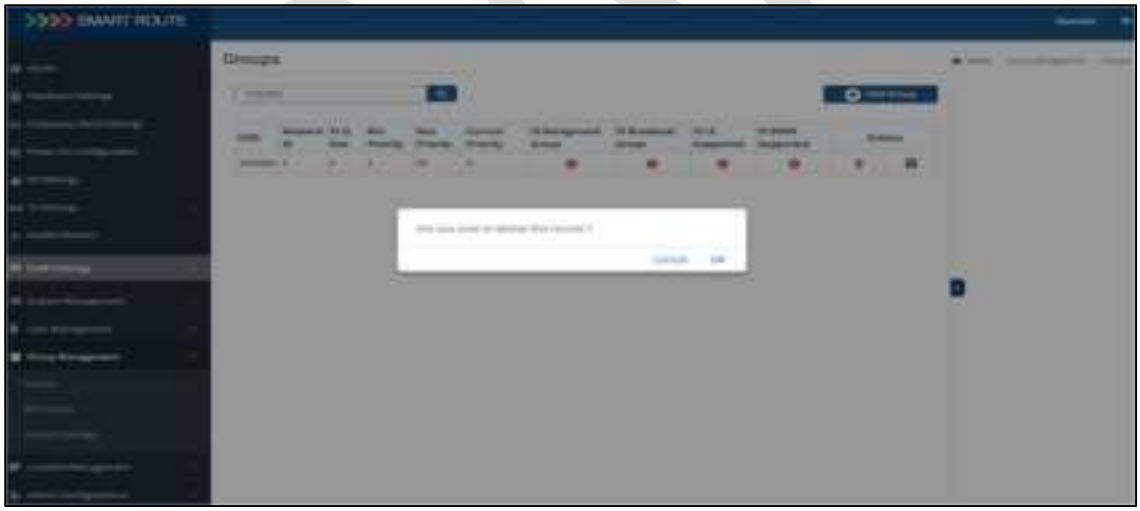


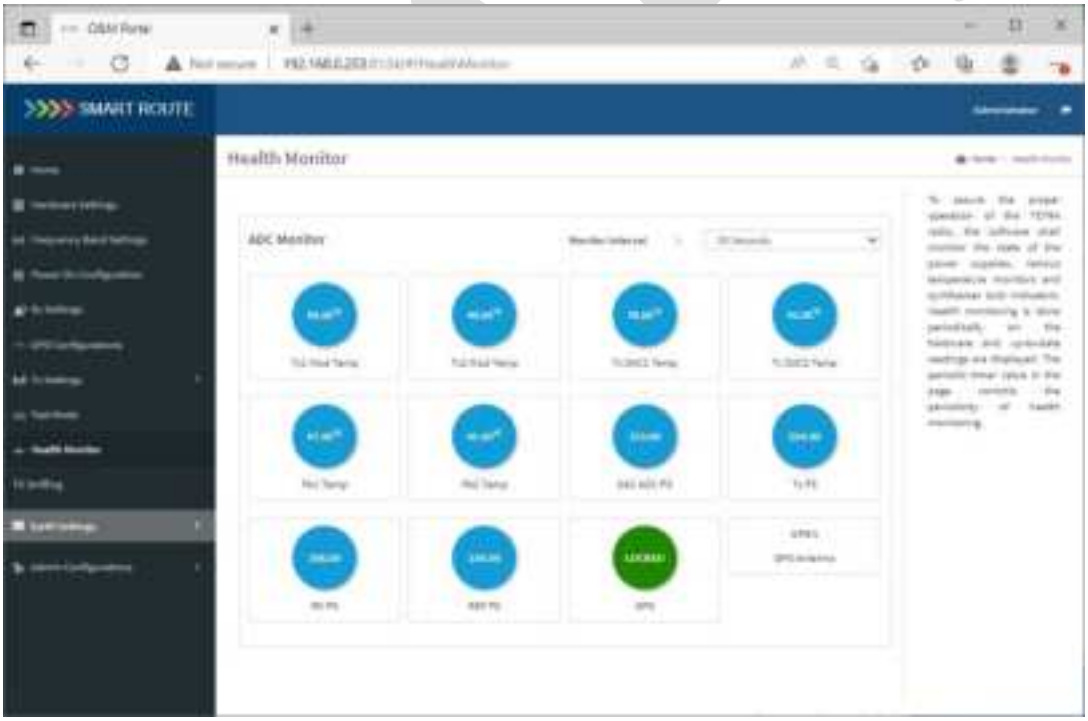
- The details of the particular group will be displayed
- Under actions, click on the recycle button to delete the corresponding group
- Click ‘Yes’ on the popup dialogue box to confirm and to delete the group.



14. Trouble Shooting

14.1. Health Monitor

To assure the proper operation of the TETRA radio, the software monitors the state of the power supplies, various temperature monitors, GPS Status and synthesizer lock indicators periodically. The current state of some of the monitored conditions are displayed on the Health Monitor screen as shown below. Temperatures are indicative of the various board and PA temperatures. If defined thresholds are exceeded, an alarm will be raised and transmission halted. Operator action is required to return carriers to service once the fault condition has cleared. The Power Supply (PS) monitor values are compared to internal thresholds for each board to validate the proper power supply voltages on that board. Valid Power Supply values are indicated by Blue. A Power Supply failure will be indicated by red.



14.1.1. GPS Status

The GPS status is displayed as two items. The GPS indicator shows the current state of the GPS receiver. Displayed values are as follows:

"INVALID", indicating that the GPS receiver is initializing after power on;
"LOCKED", indicating that the GPS receiver is locked to the satellite constellation and frequency reference is synchronized to GPS;
"UNLOCKED", indicating that the GPS signal has been lost and a time in seconds is displayed indicating the holdover time. If the GPS signal is not restored prior to the holdover time reaching 86400 seconds (24 hours), transmission will be disabled.

The second indicator shows the state of the GPS Antenna. Displayed values are as follows:

"INVALID", indicating that the GPS receiver is initializing after power on and has not reported the state of the antenna connection;
"OPEN", indicating that the current draw is below 8 mA which is a valid condition if the GPS signal is coming from a distribution system and the antenna is not being powered by the Thunder 255;
"NORMAL", indicating the antenna is drawing between 8 and 150 mA;
"SHORT", indicating the antenna is drawing more than 150 mA. This conditions should be investigated by the operator should it be observed.

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