



M915S™

**900 MHz Wireless Broadband System
USER MANUAL**

December 15, 2005
Revision A
for Firmware Version 2.0

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Preface

This manual covers basic configuration and installation of the M915S Wireless Broadband System and applies to the following radio part numbers:

M915S-AP	900 MHz Access Point
M915S-SU	900 MHz Subscriber Unit with integrated antenna and connector for external antenna

FCC Information

This device complies with Part 15 of FCC Rules and Regulations. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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 radiates radio-frequency energy; if not installed and used in accordance with these instructions, the unit may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in any 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 correct the interference by one of more of the following measures:

- 1) Reorient the antenna.
- 2) Increase the separation between the affected equipment and the unit.
- 3) Connect the affected equipment to a power outlet on a different circuit from that which the receiver is connected to.
- 4) Consult the dealer and/or experienced radio/TV technician for help.

FCC ID: NCYM915S

Canada: 2945A-M915S

IMPORTANT NOTE: Intentional or unintentional changes or modifications must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty. To comply with FCC RF exposure requirements, the following antenna installation and device operating configurations must be satisfied. The antenna for this unit must be fixed and mounted on an outdoor permanent structure with a separation distance of at least two meters from all persons. Furthermore, it must not be co-located or operated in conjunction with any other antenna or transmitter.

Warranty Information

Radios from Trango Broadband Wireless are warranted from one year from date of purchase. Please see www.trangobroadband.com for a complete description of warranty coverage and limitations.

Firmware Notifications

To receive email notifications regarding firmware upgrades and product announcements, register at <http://www.trangobroadband.com/maillinglist/maillingListAdd.aspx>

Section 1 Introduction

Your Trango Broadband M915S radio system provides a reliable and robust means to deliver broadband access to a wide geographic region through wireless Ethernet connectivity. This section will familiarize you with basic operational concepts, as well as an overview of the various components and hardware of the M915S system.

Overview

The M915S is a highly versatile and cost effective outdoor point-to-multipoint solution for wireless broadband service providers' enterprise connectivity applications. The M915S delivers 3 Mbps over the air, and operates in the 900 MHz license free ISM band. Each radio includes an integrated dual polarized (horizontal and vertical) antenna, as well as a connector for the attachment of an external antenna, such as a Yagi or an omni style antenna. **Note: If you are going to install an external antenna, refer to the M915S Professional Installation Guide. Contact Technical Support for access to the Professional Installation Guide.**

The M915S system consists of two types of radios: Access Points (APs) and Subscriber Units (SUs). Up to 126 subscriber units can be supported by a single AP, which acts as a hub in a star configuration. The AP delivers wireless broadband service (Ethernet connectivity) to one or more SUs according to a proprietary adaptive dynamic polling algorithm called SMARTPolling™. The M915S radio units are backward compatible with M900S radios such that an M915S-AP may be used with M900S-SUs and M915S-SUs may be used with M900S-APs. The main difference in the design is a better front/back ratio on the internal patch antenna to improve co-location at tower sites, a redesigned digital section on the printed circuit board, and a new package for the M915S-SU. Network operators can co-locate multiple APs at a single cell site, thus increasing the aggregate throughput available at each wireless point of presence (POP).

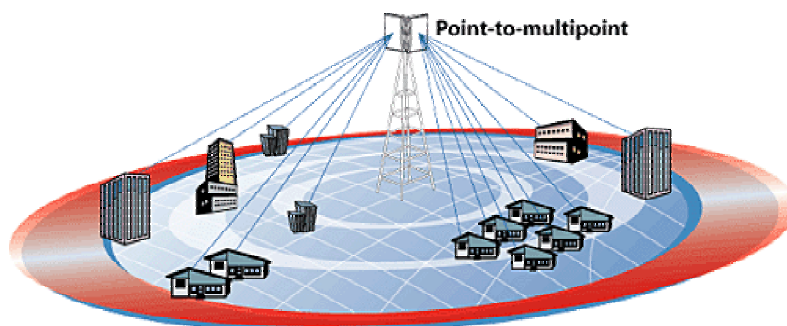


Figure 1: Typical Deployment

The AP typically resides at the center of the point-to-multipoint (PMP) network. It performs all management functions, including the allocation of bandwidth for all associated SUs. The M915S AP provides a host of comprehensive tools and functions.

The M915S system is classified as a Layer 2 multi-point bridge, thus all forms of Ethernet traffic will pass seamlessly over the system. There is no limitation on the number of IP addresses or hardware devices to which an individual subscriber unit may be connected.

Authentication of Subscriber Units is performed using a secure proprietary method, which is based on the MAC address of the subscriber units. In order to establish a wireless link, the MAC address of the SU must be present in the Access Point's SUDB.

Both APs and SUs are IP addressable and can be managed remotely across the network. Users can manage the radios using the telnet command line interface or the graphical HTTP browser interface. The M915S also provides remote firmware upgrade capability utilizing TFTP. APs include a full-featured SNMP agent for the monitoring and controlling of both APs and SUs via SNMP.

The M915S radios are powered using "power-over-Ethernet" for ease and low-cost installation. A single Cat-5 cable carries both Ethernet and DC power to the radio.

Both APs and SUs feature a handy "site survey" tool to check for interference, as well as RSSI tools for optimizing antenna positioning. The M915S also features variable receiver threshold, full power control, dual polarized antennas, and various link diagnostic tools.

SmartPolling™ & Bandwidth Throttling

One of the major advantages of the M915S system is the ability of the AP to handle multiple SU connections and share the 3 Mbps data throughput efficiently. Bandwidth allocation is managed by the AP's SMARTPolling algorithm according to provisioning rules set up by the system administrator. The AP polls each SU in a round robin format to determine if the SU has data to transfer. The SU only transmits the data "upstream" to the AP when the AP gives authorization via a "transmit grant." The SU passes every "downstream" data packet from the AP and identifies packets intended for it. In order for an SU to communicate with an AP, the system administrator must first add the MAC address and ID number of the SU to the SUDB in the AP. The SmartPolling algorithm will poll active SUs more often, thus making the most efficient use of the 3 Mbps bandwidth. Several other parameters are considered in the SmartPolling algorithm including upstream/downstream committed information rate (CIR), upstream/downstream maximum information rate (MIR), and Priority Setting.

Each of the above parameters is set in the AP by the system administrator and cannot be controlled at the SU. These parameters will be covered in greater detail later in this text.

When power is first applied to a properly installed SU, it will scan all available channels listening for a grant from an AP that has a matching Base ID and the SU's MAC in the its SUDB. The SU will then stop on that channel and respond to the AP using maximum RF power. Before the AP can add the SU to the polling list, it must authenticate the SU by verifying the MAC address and performing a ranging operation to the SU. Upon successfully locating and ranging the SU, the AP will then add the SU to the normal polling list. Once the AP is regularly polling the SU, the SU is said to be "associated" to the AP.

Once associated, the AP will send a command to the SU to adjust the SU's RF transmit power based on the Target RSSI parameter set in the AP. This process is referred to as "power leveling".

System operators may limit allowable bandwidth to specific customers utilizing the built-in CIR and MIR settings (measured in kbps) for each SU.

Auto-retransmit Feature (ARQ)

The M915S features ARQ or "Automatic Request for Re-transmission," which is the ability to correct for missing or corrupted packets of data by requesting the sending radio to re-transmit the data. Both the AP and SU units implement a form of ARQ known as "ARQ with Selected Repeat." The use of ARQ is especially important in areas of high interference. The ARQ feature can be turned on or off.

Section 2 Hardware Overview

This section provides details about each radio in the M915S family. The M915S-SU and M915S-AP include built-in, electronically switchable, dual-polarized antennas, as well as a reverse polarity SMA connector for the attachment of an external antenna. Both units are designed for outdoor installation, and are powered by power-over-Ethernet (POE) for ease of installation. The M915S Access Point, as well as the M915S subscriber units, provide channels of operation within the 900 MHz ISM band that spans from 902 MHz to 928 MHz. The channel width is 6 MHz, and the default channel assignments allow for 4 non-overlapping channels.

M915S AP and SU Hardware Components

Each radio comes equipped with a power-over-Ethernet (PoE) J-Box, an AC adapter, and mounting hardware.

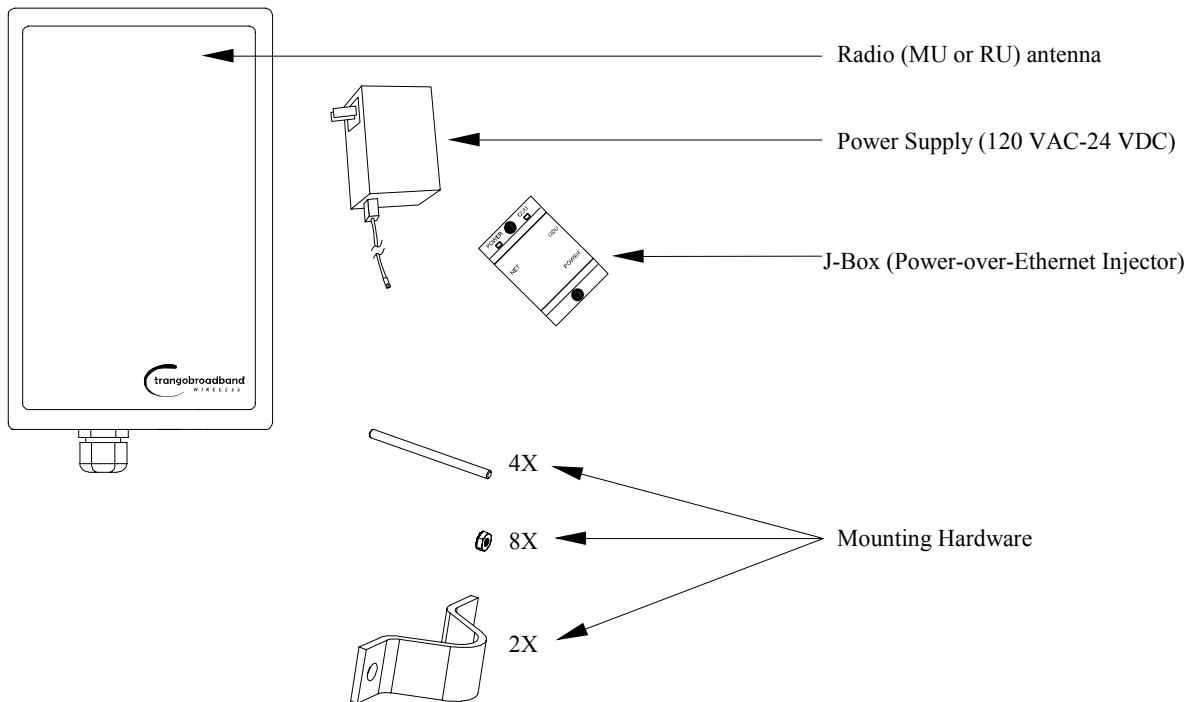


Figure 2: Basic Components of an M915S Radio

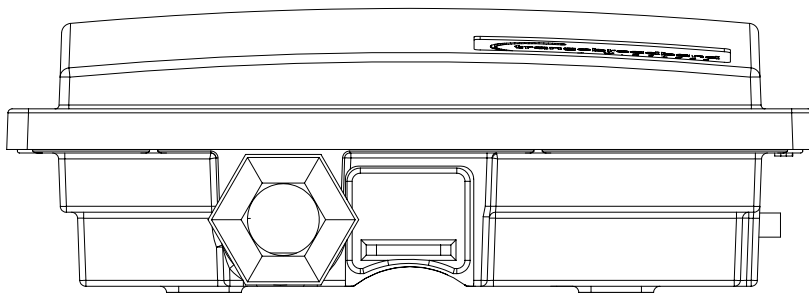


Figure 3: Bottom of Radio

At the bottom of the M915S are two access ports: a twist-on weatherproof cable port for RJ-45 Ethernet (and PoE), and a translucent access cover plug over the unit's diagnostic LEDs and reset button. The LEDs will be discussed later in this text.

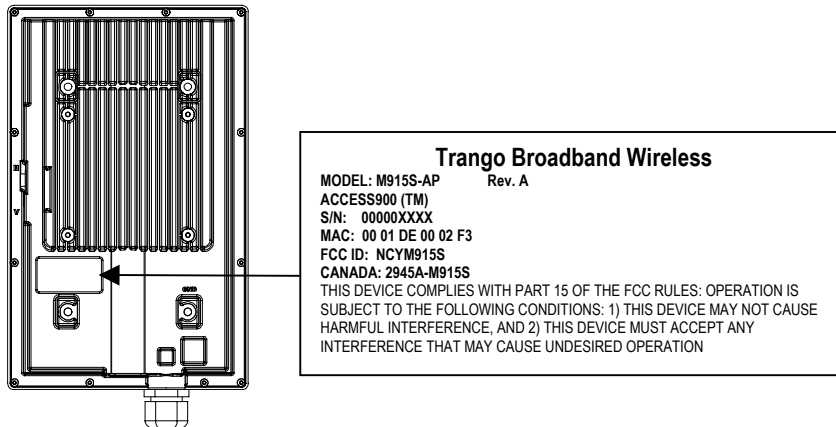


Figure 4: Back of Radio

The radio's model number, FCC ID, MAC ID, and Serial number, are located on the backside of the radio.

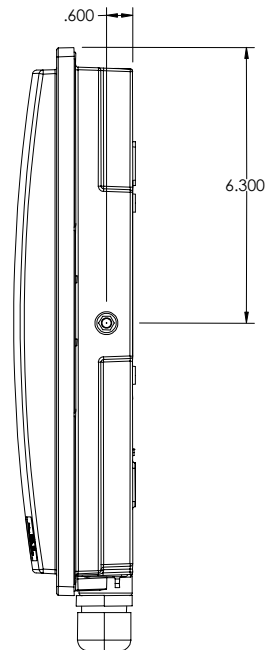


Figure 5: Side of Radio & Location of Reverse Polarity SMA Connector

Section 3 Getting Started

This section explains how to power your radios, establish TCP/IP connectivity to the radios, as well as how to access the HTTP browser and the command line interfaces.

Connections and Power

Connections and powering of the radios is the same for APs and SUs.

- Connect a Cat-5 (straight through) Ethernet cable (we recommend shielded twisted pair) between the ODU (out door unit) port of the J-box and the RJ-45 connector on the radio. Note that this cable will carry power-over-Ethernet (PoE).

- If connecting to a COMPUTER, use a Cross-Over Ethernet cable from the NET port of the J-box to the computer's Ethernet port.

If connecting to a HUB, SWITCH, or ROUTER, use a Straight-Thru cable.

- Plug the AC adapter into an AC outlet.

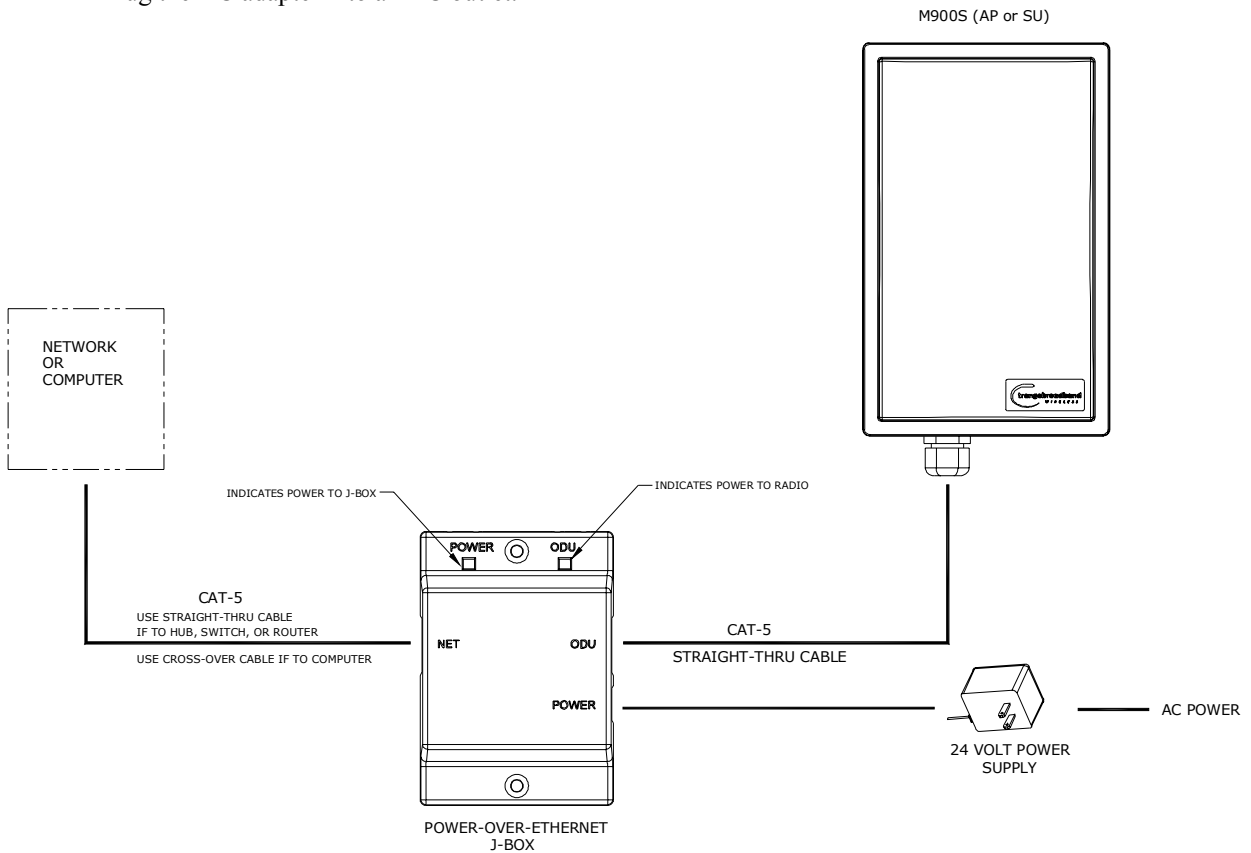


Figure 6: Wiring Diagram

Both green LEDs on the J-box should be lit, indicating power is present at the J-box as well as the radio. You are now ready to configure the radio via the Ethernet port.

Radio Management Concepts

Proper connections to the radios and careful IP/routing & planning will enable the network administrator to access and manage the radios via TCP/IP remotely over the network. Radio management over TCP/IP can be performed from computers connected to the Ethernet side of each radio. Computers connected to the AP can manage the SU over the wireless connection. Computers connected to the SU can manage the AP, provided that switch 7 (TCP/IP for SU) is enabled on the AP. Switches will be covered later in this text.

Opmode

To fully understand radio management of the M915S system, it is important to be familiar with the concept of operation mode or “Opmode.”

APs and SUs can be in one of two Opmodes (“ON” or “OFF”). When in Opmode “OFF,” the AP is not transmitting and it is not attempting to associate with SUs. Alternatively, when in Opmode “ON,” the radio is transmitting and is attempting to associate.

Several functions, such as the site survey function and the SU RSSI function, can only be performed while the radio is in a particular Opmode. See Appendix A – Command Set Reference for a complete listing of commands, and the appropriate Opmode(s) for each command.

Switch Settings

M915S firmware includes several “switches” that are used to set certain operational parameters of the radios. Switch settings can be changed via the HTTP browser interface or the command line interface. For purposes of radio TCP/IP management, the following four switches are important:

Switch 2 (SU) - TCP/IP access to SU from the AP’s side of the network requires that the SU’s switch 2 (SW 2 – TCP/IP for AP) be ON. Default setting for SW 2 (from factory) is ON.

Switch 5 (AP and SU) – In order to utilize the radio’s HTTP Browser interface, switch 5 (SW 5 – Enable HTTP) must be ON. Default setting for SW 5 (from factory) is ON.

Switch 6 (SU) - TCP/IP access from Ethernet port of SU requires that switch 6 (SW 6 – TCP/IP Service for Ethernet Port) be ON. Default setting for SW 6 (from factory) is ON. If SW 6 is OFF, TCP/IP access to SU from it’s Ethernet port is possible only if the SU’s Opmode is “OFF.”

Switch 7 (AP) – TCP/IP access to AP from SU’s side of network requires that the AP’s switch 7 (SW 7 – TCP/IP for SU) be ON. Default setting for SW 7 (from factory) is ON.

Passwords

In order to login to an M915S radio (either through telnet or through the web browser interface), the user must know the IP address and password. Both APs and SUs feature two levels of passwords, Read Write (RW) and Read Only (RO). Be sure to change both passwords (RW and RO) prior to deployment on a live network. Passwords can be changed using the “*password ro* and *password rw* command in either the CLI interface or in the command console of the browser interface.

Reset Button

Pressing the reset button will reset the radio’s IP address and password back to the factory defaults.

Default IP (192.168.100.100) **Default Password** (trango)

Browser Interface

The M915S (both AP and SU) features a convenient and easy-to-use web based configuration and management tool. No additional software is needed on your computer other than a web browser. Most functions can be performed using the browser interface, although several functions can only be performed via command line interface (CLI). The browser interface also includes a Command Console page that allows the user to enter most CLI commands without leaving the browser interface.

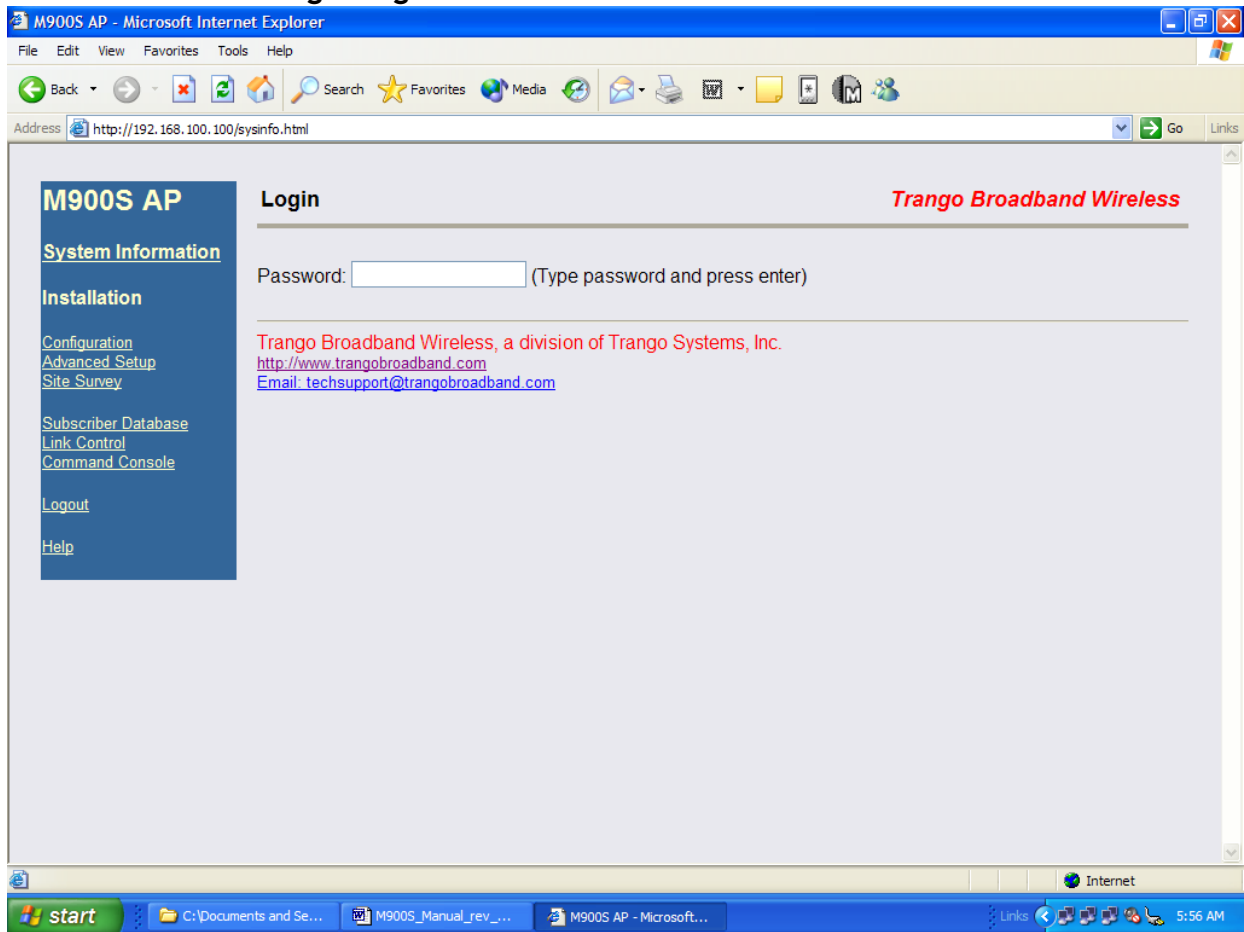
To use the browser interface, the following must be present:

- An Ethernet connection between a PC and the radio
- Ethernet PC connection with IP/subnet that is routable to the radio
- SW 5 ON (default)
- A web browser on the PC (i.e. Microsoft Internet Explorer)

In order to use the browser interface – simply connect the radio to a PC and type the radio’s IP address (default IP address=**192.168.100.100**) into the web browser (i.e. Microsoft Internet Explorer). This will bring up the Login page.

NOTE: Login pages for the AP and SU are similar.


Browser Interface Login Page



Type the password (default **trango**) and continue. This will bring up the radio's System Information page.

Web Browser System Information Page

M900S AP	System Information	Trango Broadband Wireless
<p>System Information</p> <p>Installation</p> <p>Configuration Advanced Setup Site Survey</p> <p>Subscriber Database Link Control Command Console</p> <p>Logout</p> <p>Help</p> <hr/> <p>Current Status</p> <ul style="list-style-type: none"> Base ID 1234 Opmode ON <p>Ch# 1 h 906 MHz</p>	<p>Hardware Version 8005 FPGA Version 03121104 Checksum 75930BDC Firmware Version AP 1p0a1H8005D03123002 Checksum 114D2190 Device ID 00 01 DE 15 5C D0 S/N 01400016 Base ID 1234 AP ID 01 Opmode ON Default Opmode ON System Up Time 0 day(s) 01:36:03 IP 10.8.0.251 Subnet Mask 255.255.255.0 Gateway 10.8.0.1 Telnetd Port 23 listen Tftpd disabled Active Channel 1 h RF Rx Threshold -98 dBm Tx Power -4 dBm Channel Table (MHz) Ch#01 906 Ch#02 912 Ch#03 918 Ch#04 924 Broadcast Packet block SU to SU Communication disabled TCP/IP Service for SU enabled Remarks</p> <hr/> <p>Trango Broadband Wireless, a division of Trango Systems, Inc. http://www.trangobroadband.com Email: techsupport@trangobroadband.com</p>	

 Note: System Information page for the SU is similar and is covered in detail later in this text.

Primary Features and Pages of the Browser Interface:

Navigation Column: Each page features a navigation column that runs along the left-hand side of the page. The model number of the radio is listed at the top of the navigation column. On the bottom of the navigation column is the current status of the radio including its Base ID, current Opmode, channel, antenna selection, and frequency.

The navigation column also features links to each of the following pages:

System Information: This page shows most of the basic configuration parameters of the radio. It is the first page shown after login.

Configuration: The essential parameters, such as Base ID, IP, Subnet, gateway, channel, and antenna polarization, are set here.

Advanced Setup: The advanced RF parameters, such as transmit power, receiver threshold control, and channel center frequencies, are set here.

Site Survey: With Opmode “Off” the user can conduct a spectrum analysis using this page.

Subscriber Database: This is the page for defining which SUs can associate to the AP.

Link Control: This page shows which SUs are associated. This page also provides several tools for evaluating the quality of the wireless link.

Command Console: From this page, the user can run any console command that is not interactive (i.e. *ipconfig*) or time sensitive (*su linktest*). For a complete list of console commands, type "help" or "?" in the entry field.

Logout: This link will end the current browser session with the radio.

Help: The Browser Interface features useful Help pages that explain all listed parameters. To access the Help pages click on the Help link.

Command Line Interface

Although most radio functions can be managed via the browser interface, the command line interface (CLI) provides slightly more functionality, and is usually the management tool of choice for experienced users. The CLI can be accessed through Telnet.

Telnet

Open a command prompt (DOS) session on your PC. Open a Telnet session by typing:


telnet [ip address of radio]

All Trango radios are pre-configured at the factory with a default IP address of 192.168.100.100. The factory default password is *trango*. Once you connect to the radio you will be greeted with the current hardware and firmware information and prompted for a password. Type in the read-write (RW) password and press enter.

Example:


```
C:>telnet 192.168.100.100
Welcome to Trango Broadband Wireless M915S-AP 1p0H8005D04030101
Password:
#>
```

To terminate a CLI session (Telnet or Serial) type the command *logout*.

 Note: Type *help* or *?* for a listing of all the CLI commands. Type *help <command>*, for the syntax of a particular command.

Example (to view a list of all commands which start with *su*)

```
#> ? su
su [all | <suid, 1..126>]
su info <suid, 1..126>
su linktest <suid, 1..126>
su password <suid|all> <rw|ro> <new password> <new password>
su ping <suid, 1..126>
su reboot <suid|all>
su sw <suid|all> <sw#, 0..7> <on | off>
su testrflink <suid, 1..126> <r>
su testrflink <all> <r>
sldb add <suid, 1..126> <pr|re> <device id,hex>
sldb cirmir <<suid>|all> <cir dn> <cir up> <mir dn> <mir up>
sldb defaultcirmir [<cir dn> <cir up> <mir dn> <mir up>]
sldb delete <<suid>|all>
sldb dload
sldb gid <<suid>|all> <0..15>
sldb view
survey <time, 1..10 sec> <antenna, h|v|e>
```

 NOTE: The majority of the CLI commands will be covered throughout this text as well as in Appendix A – Command Set Reference.

Troubleshooting

If you can not telnet into the radio or open a browser session, check cable connections, ensure proper use of cross-over vs. straight-through cable, and ensure PC's subnet is routable to radio's IP address. If you still cannot access the radio's management interfaces, consult the troubleshooting guide that is available at www.trangobroadband.com in the Technical Support area of the website.

Section 4 Basic Configuration via Browser Interface

This section describes a few more basic concepts, as well as how to establish a wireless link using the Browser (HTTP) Interface. This section is written to address only the most basic steps in establishing a link in the lab or a bench-top environment. It is highly recommended that you read the other sections of this manual to gain an understanding of all important configuration parameters and procedures prior to deploying your equipment.

In this section you will:


- Learn about AP and SU Basic Configuration Screens and Parameters
- Populate the AP's Subscriber Unit Data Base (SUDB) with at least one SU
- Configure Other Basic AP Parameters
- Configure Basic SU Parameters
- Establish a Wireless Link
- Evaluate Link Quality

The M915S uses the concept of “association” to indicate that the APs and SUs are communicating. If all parameters are properly set, the AP will begin actively searching for the SUs in its SUDB. Once an active SU is detected, the authentication and association process will begin.

Essentials for Establishing a Wireless Link with M915S Series Radios

- Base ID in AP and SU must match
- MAC Address of SU must match an entry in the SUDB
- SU must be set to “autoscan” all channels, or it's channel must be fixed on the same channel as the AP
- AP must be in Opmode “ON”
- SU must be in Opmode “ON”
- Adequate signal strength must be received at each radio

If all of these parameters are met, the wireless link will automatically establish itself and Ethernet traffic will begin to pass between the radios.

 Note: This section utilizes the Browser Interface as the configuration tool. For the equivalent procedure using CLI commands, see Section 5.

Configuring the AP's Subscriber Unit Database (SUDB)

Prior to establishing a wireless link, the user must configure the SUDB in the AP with each SU's MAC address and related settings. The SUDB includes information about each SU. Click on the [Subscriber Database](#) page to add, modify, and delete SUs. The key information for each SU includes the following:

SU ID:	User Definable subscriber unit ID (1...126)
TYPE:	PR Priority or REG Regular. Priority SUs are polled much more frequently than regular SUs. Priority SUs in general will respond to the AP with less latency than regular SUs.
Group:	SU to SU Group # (1..F in hex) for SU to SU communications within the same sector. Note: This SU to SU feature allows interconnectivity between multiple SU's in the same sector, without the need for a router. Only SUs with the same SU to SU group # may communicate with each another. If you do not want the SUs to communicate with each other, choose N/A for SU to SU group. In order to use SU to SU communication, AP switch #3 must be ON. The default setting for switch #3 is OFF.
CIR UP:	Committed Information Rate from SU to AP. Minimum upstream data rate (measured in Kbps) at which the SU will attempt to deliver bandwidth to the AP. Maximum setting is 3000.

- CIR DOWN:** Committed Information Rate from AP to SU. Minimum downstream data rate (measured in Kbps) at which the AP will attempt to deliver bandwidth to this SU. Maximum setting is 3000.
- MIR UP:** Maximum Information Rate from SU to AP. Maximum upstream data rate (measured in Kbps) at which the SU will attempt to deliver bandwidth to the AP. Maximum setting is 3000.
- MIR UP:** Maximum Information Rate from AP to SU. Maximum data rate (measured in Kbps) at which the AP will attempt to deliver bandwidth to this SU. Maximum setting is 3000.
- DEVICE ID:** MAC address of the SU.

Creating an SU in the SU Database.

1. Connect to the AP (see Getting Started) and open the [Subscriber Database](#) page.

M900S AP

Subscriber Database

System Information

Installation

[Configuration](#)
[Advanced Setup](#)
[Site Survey](#)

[Subscriber Database](#)
[Link Control](#)
[Command Console](#)

[Logout](#)

[Help](#)

Current Status

- Base ID
- Opmode OFF

Ch# 4 e 924 MHz

Current Subscriber(s)

SU ID	Type	GID	CIR up	CIR dn	MIR up	MIR dn	Device ID
60	REG	N/A	3000	3000	3000	3000	00 01 DE 16 E3 81

Add / Modify Subscriber

SU ID

Type Regular Priority

Group ID

CIR up Kbps

CIR dn Kbps

MIR up Kbps

MIR dn Kbps

Device ID

Delete Subscriber

SU ID

MIR Threshold (Mbps)

0 1 2 3

2. Enter SU ID (range 1 – 126).
3. Select either PRIORITY or REGULAR.
4. If SU will be part of an SU to SU group, enter the SU to SU group number.
5. CIR up: (SU to AP Committed Information Rate) – minimum upstream bandwidth for the SU in Kbps.

6. CIR dn: (AP to SU Committed Information Rate) – minimum downstream bandwidth for the SU in Kbps.
7. MIR up: (SU to AP Maximum Information Rate) – maximum upstream bandwidth for the SU in Kbps.
8. MIR dn: (AP to SU Maximum Information Rate) – maximum downstream bandwidth for the SU in Kbps.
9. Enter Device ID (MAC Address of the SU).
10. Save and Activate changes.



Important! Always remember to Save and Activate changes, or the SUDB will revert back to its previous state after a power cycle or reboot.



Important! SUs using SU to SU communication must be on the same subnet.

Configure Other Basic AP Parameters

In addition to setting up the SU in the SUDB, the following settings in the AP's [Configuration](#) page must be set (or left at default).

Base ID: Four character, alphanumeric, user definable base station ID. Input of BASEID shall be in the format of xxxx. Where x is any character from the set: {0..9; a..z; A..Z; !@#\$%^&*()_+[]\<>./?}. The Base ID is typically assigned to a single AP or a group of APs at a particular cell site. The Base ID in the AP must match the Base ID in the SU in order for a link to be established. This parameter can only be changed while in Opmode "OFF."

AP ID: User definable AP ID (00-FF). Default is last two digits of MAC ID. One authenticated, the AP will automatically assign its AP ID to the SU. This parameter can only be changed while opmode is "OFF".

IP Address, Subnet Mask, Gateway:

The IP configuration of the radio. Used for configuration and network management purposes. Since this is a layer-II device, these parameters do not play a role in the establishment of the wireless link.

Default Opmode:

Operation mode of the radio after a power cycle or reboot. When the radio enters Opmode "ON," it will be transmitting. When the radio enters Opmode "OFF," the radio will not be transmitting, but can be accessed through the Ethernet port. The radio can be put into Opmode "OFF" regardless of its default Opmode by telnetting into the radio within the first 30 seconds after a power cycle or reboot.

Active Channel/Polarization:

The current channel and antenna polarization of the unit when in Opmode "ON."

To configure the AP's other basic settings, complete the following steps:

1. Connect to the AP (see Getting Started) and open the [Configuration](#) page.

M900S AP

[System Information](#)

Installation

[Configuration](#)

[Advanced Setup](#)

[Site Survey](#)

[Subscriber Database](#)

[Link Control](#)

[Command Console](#)

[Logout](#)

[Help](#)

Current Status

- Base ID 1234
- Opmode ON

Ch# 1 h 906 MHz

Configuration

Base ID (4 characters)

AP ID (00..FF)

IP Address

Subnet Mask

Gateway IP

Default Opmode ON OFF

Switch

- Block Broadcast and Multicast Packets
- SU to SU Communication
- TCP/IP Service for SU

Active Channel **Antenna** E V H

Remarks

[Activate Opmode](#)

[Reboot System](#)

2. Set Base ID, or choose the default Base ID of 0000. (Must match the SU.)
3. Set AP ID (00-FF HEX), or choose the default, which is last two bytes of MAC Address.
4. Set IP, Subnet, and Gateway, or leave at default settings. Keep in mind, if you change the IP Settings of the radio, you will loose your HTTP session when you Save and Activate Settings.
5. Choose Active Channel (1-4).
6. Choose Antenna Polarization (H or V), or choose E for an external antenna. Only use E for M915S-SU-EXT model.
7. Ensure default Opmode is "ON."
8. Save and Activate Settings.
9. If this is the first SU to be added to the SUDB, reboot the AP.

After reboot, the AP will automatically enter its default Opmode (ON) after approximately 40 seconds. At this time it will begin actively searching for all SUs in its SUDB. Once an active SU is detected, the authentication and association process will begin.

Configure Basic SU Parameters

In order to establish a working link, the Base ID in the SU must match the Base ID set in the AP.

SU Basic Setup:

1. Connect to the SU (see Getting Started) and open the [Configuration](#) page.

M900S SU **Trango Broad**

System Information

Installation

[Configuration](#)
[Advanced Setup](#)
[Site Survey](#)

[Command Console](#)

[Logout](#)

[Help](#)

Current Status

- Base ID 0900
- Opmode ON

Ch# 3 e 918 MHz
Associated

- AP ID 00
- SU ID 5

Configuration

Base ID

IP Address

Subnet Mask

Gateway IP

Default Opmode ON OFF

Switch

- Block Broadcast and Multicast Packets
- Auto Scan AP
- TCP/IP Service for AP
- TCP/IP Service for Ethernet Port

Remarks

[Activate Opmode](#)

[Reboot System](#)

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<http://www.trangobroadband.com>

2. Set Base ID. (Must match the AP.)
3. Set IP, Subnet, and Gateway, or leave at default settings. Keep in mind, if you change the IP Settings of the radio, you will lose your HTTP session when you Save and Activate Settings.
4. Ensure default Opmode is "ON."
5. Save and Activate Settings.
6. If in Opmode "OFF," click Activate Opmode.

At this point, if all parameters have been set correctly and the radios are within range, a wireless link between the AP and SU will automatically become established. Once this occurs the SU will be in "associated" status.

Allow approximately 60 seconds for the radios to complete the boot-up cycle and to associate. If the AP is busy servicing many SUs, the association process may take slightly longer.

LED Summary

At this point it is useful to learn about the LEDs that can be found on the bottom of the radio. These LEDs can assist the user in determining radio and link status.

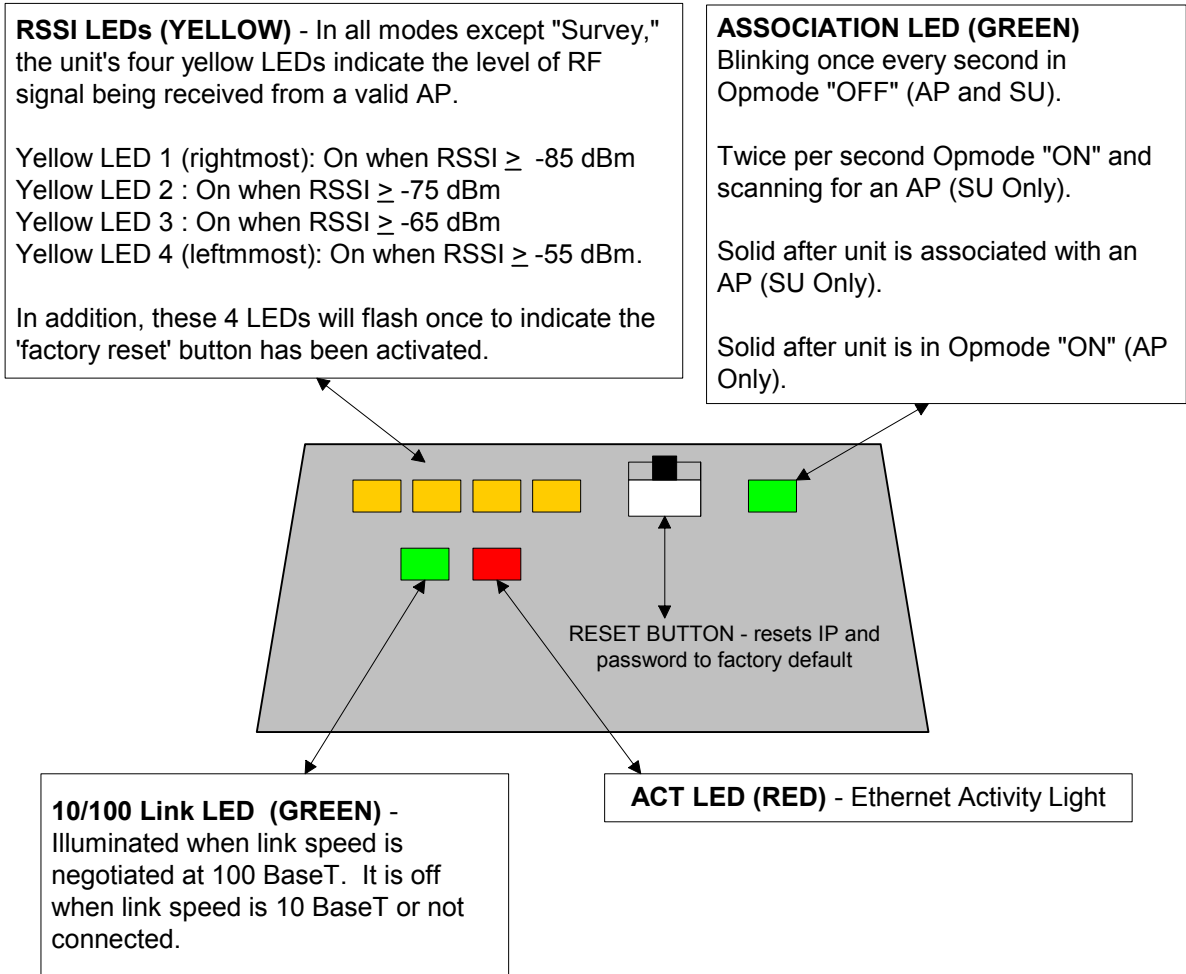


Figure 7: LED Summary

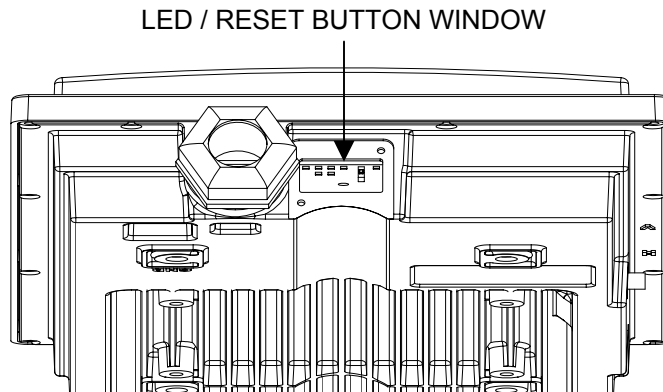
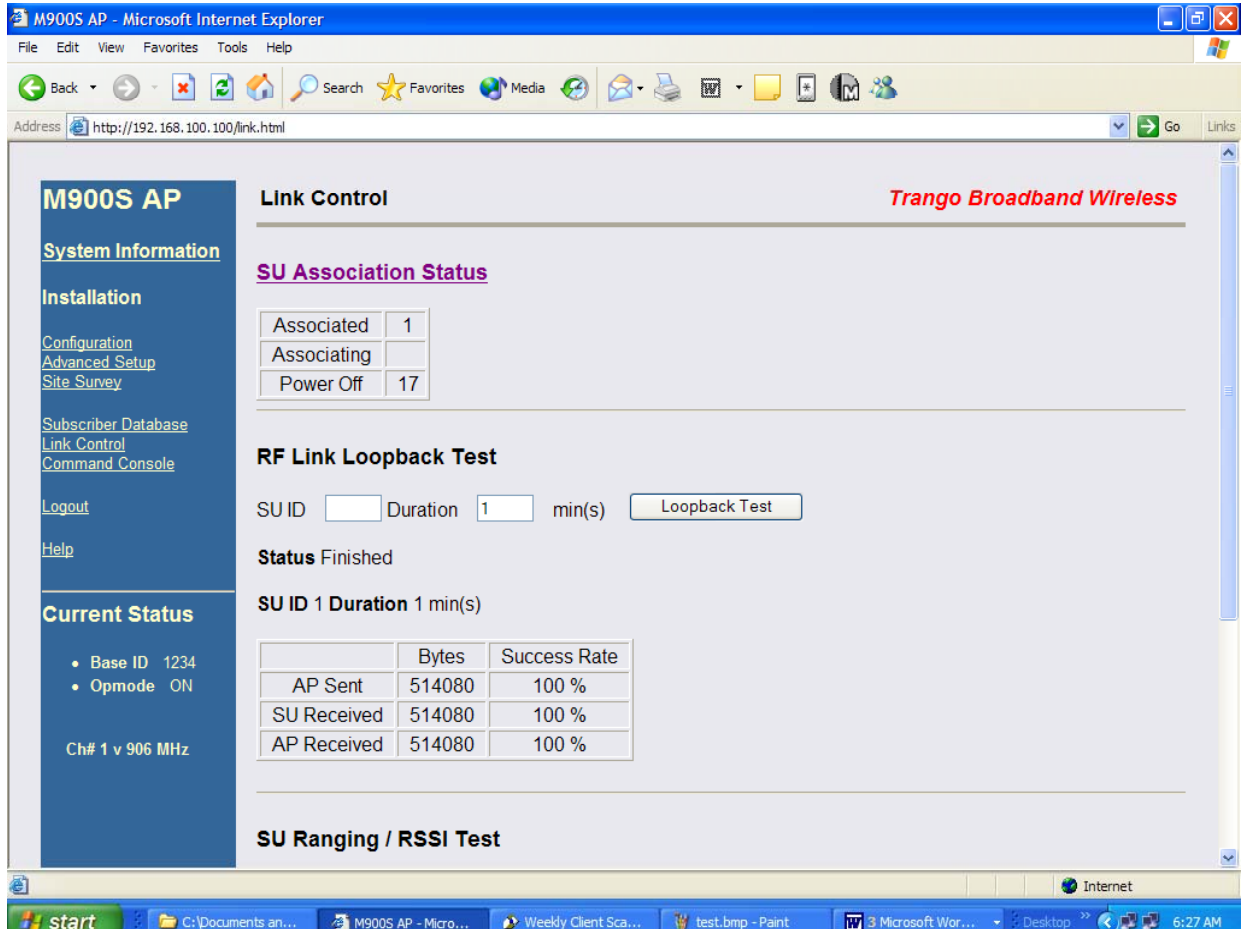


Figure 8: LED and Reset Button Window

Link Control Page

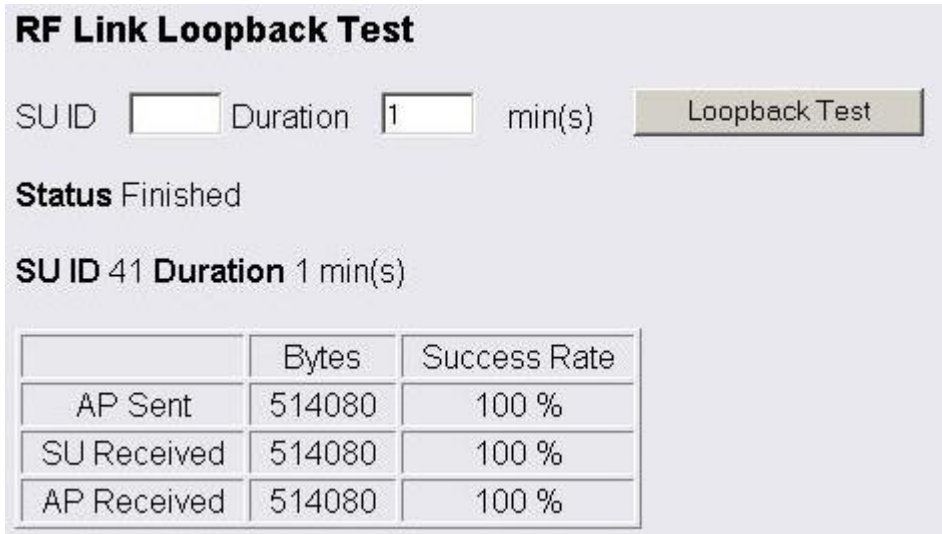
The radio's firmware includes several useful tools to assist in determining which SUs are associated and the quality of each link. One method for verifying link quality is by using the Link Control page.



On this page the user can immediately see which SUs have associated. In the page shown, SU ID# 1 is associated, and SU ID 17 is not. Consider "Power Off" status synonymous with "not associated."

RF Link Loopback Test

The RF Link Loopback test is one of the built-in tools for evaluating the quality of the wireless link. Specify an SU ID and time in minutes to conduct the test. The test is prioritized, so it will take precedence over all other traffic. 1600 byte packets are sent and received between the SU and AP at 50 millisecond intervals over the time specified.



SU Ranging Test

This test reports the SU's distance from the AP in miles, received signal strength for uplink and downlink, and SU Tx Power. Use a link budget calculator to analyze results.

Distance	RSSI from SU	RSSI from AP	SU Tx Power
0.0 mi	-81 dB	-80 dB	26 dBm

Advanced Setup Page

The Advanced Set up page includes several important parameters including RF TX Power, RF RX Threshold, Target RSSI from SU (AP only), and Channel Table.

M900S AP

System Information

Installation

[Configuration](#)
[Advanced Setup](#)
[Site Survey](#)

[Subscriber Database](#)
[Link Control](#)
[Command Console](#)

[Logout](#)

[Help](#)

Current Status

- Base ID 1234
- Opmode ON

Ch# 1 h 906 MHz

Advanced Setup

RF Tx Power
 dBm

RF Rx Threshold (dBm)
 dBm (-98 to -55)

Target RSSI From SU
 dBm (-90 to -50 and must be +5 dB higher than RF Rx Threshold)

Channel Table (906 to 924 MHz)
 Ch#1 Ch#2 Ch#3 Ch#4

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 Email: techsupport@trangobroadband.com

- RF TX Power:** Sets the conducted RF power output of the radio. Highest allowable setting is 26 dBm. Lowest setting is -4 dBm. This value does not include antenna gain. A higher number is more powerful.
- RF RX Threshold:** Sets the receive threshold of the radio. The radio will not process signals received below this level, so it is very useful for interference mitigation. For a smaller radius of operation use a higher threshold (-75 is higher than -80).
- Target RSSI from SU:** Used by the powerleveling process to automatically adjust the RF output power level of all SUs in a sector so the signal strength from each SU as measured at the AP will be roughly equal.
- Channel Table:** Assigns channel numbers to actual frequencies of operation. Default settings allow the largest number of channels (4) within the band, while still maintaining 6 MHz channel spacing.

Site Survey Page

The **Site Survey** page provides a useful tool for detecting and measuring interference. The radio must be in Opmode "OFF" in order to use this feature.

Enter the number of minutes desired for the survey, and select the polarization H, V, or E (for an external antenna). Click "Start Survey." A survey of the default 4 channels will be performed. Results are reported in dBm per channel as average and peak. A channel is reported to be "Clear" if the peak and average are below the RF RX Threshold by more than 8 dB.

M900S AP **Trango Broadband Wireless**

System Information

Installation

- [Configuration](#)
- [Advanced Setup](#)
- [Site Survey](#)

Subscriber Database

- [Link Control](#)
- [Command Console](#)

[Logout](#)

[Help](#)

Current Status

- Base ID 1234
- Opmode OFF

Ch# 1 h 906 MHz

Site Survey

Duration min(s) E V H

Status Finished

Antenna v Duration 1 min(s)

Channel	Avg dBm	Peak dBm	Clear
1	-97	-94	yes
2	-98	-94	yes
3	-97	-94	yes
4	-94	-93	yes

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Section 5 Basic Configuration via CLI

This section covers how to utilize the radio's CLI interface to establish a working wireless link.

In this section the most basic settings using the CLI are discussed. Topics include:

- Access Point Basic Settings
- Subscriber Unit Database Settings
- Subscriber Unit Basic Settings

See Appendix A – Command Set Reference for a complete listing of the CLI commands.

See the “Getting Started” section for a description of how to access the radio via Telnet or Serial Interface.

Access Point Basic Settings

After logging into an AP or SU, it is good practice to type the *sysinfo* command to see the radio's basic system information. Example (Access Point):

```
#> sysinfo
[Hardware Version] 8005
[FPGA Version] 03121104 [Checksum] 75930BDC
[Firmware Version] AP 1p0a2H8005D04010603 [Checksum] AE5D873F
[Device ID] 00 01 DE 15 5C D0 [S/N] 01400016
[Base ID] 1234 [AP ID] 01
[System Up Time] 0 day(s) 00:29:56
[Opmode] on [Default Opmode] on
[IP] 10.8.0.254 [Subnet Mask] 255.255.255.0 [Gateway] 10.8.0.1
[Httpd Port] 80 [Httpd Status] listen
[Telnetd Port] 23 [Telnetd Status] connected (10.8.0.62,1146)
[Tftpd] disabled
[RF Tx Power] -4 dBm
[RF Rx Threshold] -98 dBm
[MIR Threshold] 3 Mbps
[Ch#01] 906 Mhz [Ch#02] 912 Mhz [Ch#03] 918 Mhz [Ch#04] 924 Mhz
[Default Channel] 1 h [Active Channel] 1 h
[Broadcast Packet] block [SU to SU] off [TCP/IP for SU] on
[Remarks]
[RF Rx] 0 kbps [RF Tx] 0 kbps [Eth Rx] 1 kbps [Eth Tx] 0 kbps
```

Many of these parameters can be changed by the user. A description of each of these changeable parameters, along with the related command, is shown in the table below.



Important! When changing settings, it is usually necessary to type the *save ss* command in order to update the radio's flash memory. If you do not type the *save ss* command, the setting will be lost the next time the radio is rebooted or power cycled.

AP SYSTEM INFORMATION PARAMETERS AND RELATED COMMANDS		
AP Parameter	Description	Related CLI Command
Device ID	MAC Address of AP	N/A
Base ID	Specifies the cell or cluster to which the AP belongs. Base ID must match in AP and SU in order to establish a wireless link.	<i>set baseid <baseid></i> Example: #>set baseid aa12

AP SYSTEM INFORMATION PARAMETERS AND RELATED COMMANDS		
AP Parameter	Description	Related CLI Command
AP ID	This parameter provides a unique number for each AP. If Target AP is specified on SU, the SU can only authenticate with the specified AP. The default AP ID is the last two bytes of the MAC address.	set apid <apid> (00-FF in HEX) Example: #>set apid 33
Opmode	Current Opmode of the radio.	opmode on y This sets the radio to Opmode “ON.” If the radio is accessed via the Ethernet port within the first 30 seconds after reboot/power cycle, the Opmode will default to “OFF.”
Default Opmode	Determines the Opmode (“ON” or “OFF”) of the radio after reboot/power cycle. When this parameter is set to “ON,” the radio will progress into Opmode “ON” automatically after a reboot/power cycle.	set defaultopmode <on or off> Example: #>set defaultopmode on
Opmode Start	Determines the amount of time the radio will remain in Opmode “OFF” after reboot/power cycle before progressing to the default Opmode.	set defaultopmode on [<time (sec)>] Example: #>set defaultopmode on 60
IP Subnet Gateway	IP, Subnet, and Gateway address of the radio.	ipconfig [<new ip> <new subnet mask> <new gateway>] Example: #>ipconfig 10.1.1.2 255.0.0.0 10.1.1.1
TFTPD Status	TFTPD status (on or off). TFTPD should be turned on to import a file into the radio (such as new firmware). Default is off. TFTPD will revert to Off after rebooting.	tftpd [<on off>] Example: #>tftpd on

AP SYSTEM INFORMATION PARAMETERS AND RELATED COMMANDS		
AP Parameter	Description	Related CLI Command
MIR Threshold (Kbps)	User specified MIR Threshold. To specify total throughput level that the AP will serve only CIR (committed information rate) to associated SUs. When MIR Threshold is disabled, the AP will serve MIR for all its SUs. When MIR Threshold is activated, and the network traffic exceeds the MIR Threshold, the AP will only serve CIR for all its SUs. When MIR Threshold is activated, and the network traffic does NOT exceed the MIR Threshold, the AP will still serve MIR for all its SUs.	<i>mirth</i> [<0..3, Mbps>] Example: #>mirth 2
Active Channel	Current RF channel	<i>freq</i> [<ch#>] Example: #>freq 3 This command will change the channel of the AP to 3.
Antenna	Current antenna selection: (h)horizontal, (v)vertical, (e)external	<i>antenna</i> [<v h e>]
RF RX Threshold	Specifies the receiver sensitivity of the AP. It is a powerful tool when the radio is in a noisy environment. AP will block out any signal received which is below the RF Rx threshold. Separate settings exist for both ISM and UNII bands.	<i>rfrxth</i> <-90 -85 -80 -75 -70 -65> example: #>rfrxth -70
RF TX Power	Current transmit power of the AP not including antenna gain.	<i>power</i> <set> <min max <dBm> Example: #>power set 10
Channel Table	Assigned frequencies to channels. All channels may be re-assigned as desired by the administrator.	<i>freq writechannel</i> [<ch#> <freq>] Example: #>freq writechannel 3 910 This command will change channel 3 to 910 Mhz.
Broadcast Packet Filter	This software switch (0) enables/disables the blocking of Ethernet control packets, except ICMP and ARP, to reduce the amount of unnecessary overhead introduced to the wireless link.	<i>sw 0</i> [<on/off>] (default is on) Example: #>sw 0 on note: All switch settings (0-7) are set using the <i>sw #</i> [<on/off>] command.
SU to SU	This software switch (3) enables/disables the SU to SU feature. When SU to SU is	<i>sw 3</i> [<on/off>] (default is off) Example: #>sw 3 on

AP SYSTEM INFORMATION PARAMETERS AND RELATED COMMANDS		
AP Parameter	Description	Related CLI Command
	turned on, multiple SU's within the same sector (meaning associated to that AP) can communicate with each other, provided they have the same SU2SU group number.	
TCP/IP for SU	This software switch (7) when on, allows users on the SU side of the network to telnet or HTTP into the AP.	<i>sw 7 [<on off>]</i> (default is on) Example: #>sw 7 off
Remarks	User definable radio information (i.e. customer name, address of installation, and so on). A maximum of 28 characters can be stored.	<i>remarks [<remarks>]</i> Example: #>remarks 123 Elm Street

Subscriber Unit Database (SUDB) Settings

Once you are familiar with the basic system information presented above, you are ready to add one or more SUs to the SUDB. There are five basic commands related to the SUDB: *sudb add*, *sudb cirmir*, *sudb defaultcirmir*, *sudb view*, and *save sudb*.

Adding an SU

To add an SU to the database, you will need to know the following information:

1. MAC ID of the SU (printed on the back of the SU).
2. Polling priority, either PRIORITY or REGULAR.


 Note: SUs designated as PRIORITY will get polled more often by the AP.

To add an SU to the database, use the following command and syntax:

```
sudb add <suid> <pr|reg> <device id>
suid: SU ID
pr: priority user
reg: regular user
<device id>: xx xx xx xx xx xx in hexadecimal (this is the MAC address of the SU)
```

Example:
#>sudb add 5 pr F3 3C 50 67 89 D4

In this example an SU #5 was added as a Priority SU . The MAC ID of the SU is F3 3C 50 67 89 D4.

 Note: You can add up to 126 entries in the SUDB.

CIR / MIR Commands

The default CIR/MIR setting is 3000 kbps for upstream and downstream.

To change the SU's CIR/MIR settings, use the following command:

```
sudb cirmir <suid|all> <cir dn> <cir up> <mir dn> <mir up>
```

Example:

```
#>sudb cirmir 5 128 256 3000 3000
```

In this example, SU #5's CIR downstream was set to 128, and its CIR upstream to 256. MIR upstream and downstream were set to 3000.

To change the default CIR/MIR values, use the following command:

```
sudb defaultcirmir <default cir dn> <default cir up> <default mir dn> <default mir up>
```

Example:

```
#>sudb defaultcirmir 256 256 512 512
```

To view the entries in the SUDB, type the command **sudb view**.

To save the changes you have made to the SUDB, type **save sudb**.

Other important SUDB related commands are **sudb delete** and **sudb modify**. See Appendix A for a descriptions of these commands.



Important! After updating the SUDB, type the command **save sudb** to save your changes. If you do not save, the SUDB file will revert back to its previous state after power cycle or reboot.

Subscriber Unit Basic Settings

Login to the SU. To receive a comprehensive snapshot of the system's configuration info and status, type the command **sysinfo**.

```
#> sysinfo
[Hardware Version] 0005
[FPGA Version] 03121104 [Checksum] 75930BDC
[Firmware Version] SU 1p0a2H0005D04010603 [Checksum] F4658C90
[Device ID] 00 01 DE 16 E3 7F [S/N] 01500031
[Base ID] 1234 [AP ID] 01 [SU ID] 1
[System Up Time] 0 day(s) 00:37:02
[Opmode] on [Default Opmode] on
[IP] 10.8.0.245 [Subnet Mask] 255.255.255.0 [Gateway] 10.8.0.1
[Httpd Port] 80 [Httpd Status] listen
[Telnetd Port] 23 [Telnetd Status] connected (10.8.0.62,1147)
[Tftpd] disabled
[RF Tx Power] -4 dBm
[RF Rx Threshold] -98 dBm
[Ch#01] 906 Mhz [Ch#02] 912 Mhz [Ch#03] 918 Mhz [Ch#04] 924 Mhz
[Default Channel] 1 v [Active Channel] 1 h [Associated] Y
[Broadcast Packet] block [Auto Scan AP] on [TCP/IP for AP] on [TCP/IP for Local Eth]on
[Remarks]
[RF Rx] 3 kbps [RF Tx] 3 kbps [Eth Rx] 0 kbps [Eth Tx] 0 kbps
[ARQ RF Tx Retry] 197 [ARQ RF Tx Retry Maxed Out] 0
```

Many of these parameters can be changed by the user. A description of each of these changeable parameters, along with the related command, is shown in the table below.

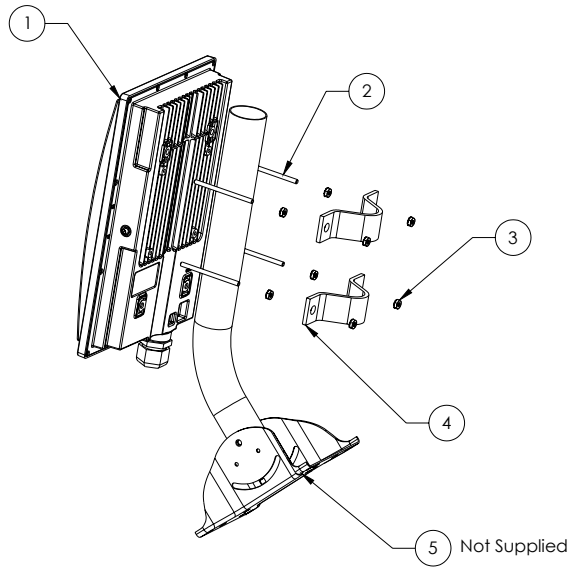


Important! When changing settings, it is usually necessary to type the **save ss** command in order to update the radio's flash memory. If you do not type the **save ss** command, the settings will be lost the next time the radio is rebooted or power cycled.

SU SYSTEM INFORMATION PARAMETERS AND RELATED COMMANDS		
SU Parameter	Description	Related CLI Command
Device ID	MAC Address of the SU	N/A
Base ID	Specifies the cell or cluster to which the SU belongs.	set baseid <baseid> Example: #>Set baseid aa12
Target AP	If unique AP ID selected, the SU can only associate with the specified AP. If ALL is selected, the SU can associate with any AP with a matching BASE ID.	targetap <apid> Examples: #>targetap 33 #>targetap all
Opmode	Current Opmode of radio.	opmode on y - set Opmode to "ON." (note: "y" is necessary if default Opmode is "OFF.") opmode off – set Opmode to "OFF."
Default Opmode	Determines the Opmode ("ON" or "OFF") of the radio after reboot/power cycle. When this parameter is set to "ON," the radio will progress into Opmode "ON" automatically after reboot/power cycle.	set defaultopmode <on or off> Example: #>set defaultopmode on
IP Subnet Gateway	IP, Subnet, and Gateway address of radio.	ipconfig [<new ip> <new subnet mask> <new gateway>] Example: #>ipconfig 10.1.1.3 255.0.0.0 10.1.1.1
TFTPD	TFTPD status (on or off). TFTPD should be turned on to import a file into the radio (such as new firmware). Default is off. TFTPD will revert to off after reboot/power cycle.	tftpd [<on off>] Example: #>tftpd on
RF TX Power	Current transmit power of the SU not including antenna gain. This is controlled by the AP.	Informational Parameter – can not be manually changed by user.
Active Channel	Shows the channel used in the current association, and "Associated" or "Disconnected" depending on the association status.	If Autoscan AP (SW 1) is on, the active channel (and antenna selection) will be set once the SU scans and begins the association process with an AP. If Autoscan AP is off, the active channel is set by the user, using the <i>freq</i> command. freq [<ch#> <v h>] Example: #>freq 3 This command will change the channel of the AP to 3. Use the antenna command to select an antenna

SU SYSTEM INFORMATION PARAMETERS AND RELATED COMMANDS		
SU Parameter	Description	Related CLI Command
		polarization. antenna [<h v e>]
Broadcast Packet Filter	This software switch (0) enables/disables the blocking of Ethernet control packets, except ICMP and ARP, to reduce the amount of unnecessary overhead introduced into the wireless link. Default setting is ON.	sw 0 [<on off>] Example: #>sw 0 on
AP Autoscan	This software switch (1) is to turn AP autoscan on or off.	sw 1 [<on off>] (default is on)
TCP/IP for AP	This software switch (2) when on, allows users at the AP side of the network to telnet or HTTP into the SU.	sw 2 [<on off>] (default is on) Example: #>sw 2 off
TCP/IP for Local Ethernet Port	This software switch (6) when on, allows users on the wired side of the SU to telnet or HTTP into the SU regardless of the Opmode.	sw 6 [<on off>] (default is on)
Remarks	User definable radio information (i.e. customer name, address of installation, and so on). A maximum of 28 characters can be stored.	remarks [<remarks>] Example: #>remarks 678 Oak Ave
Counters: RF TX RF RX Eth TX Eth RX	This is an average of wired and wireless, transmit and received traffic in kilobits per second.	Informational Parameter

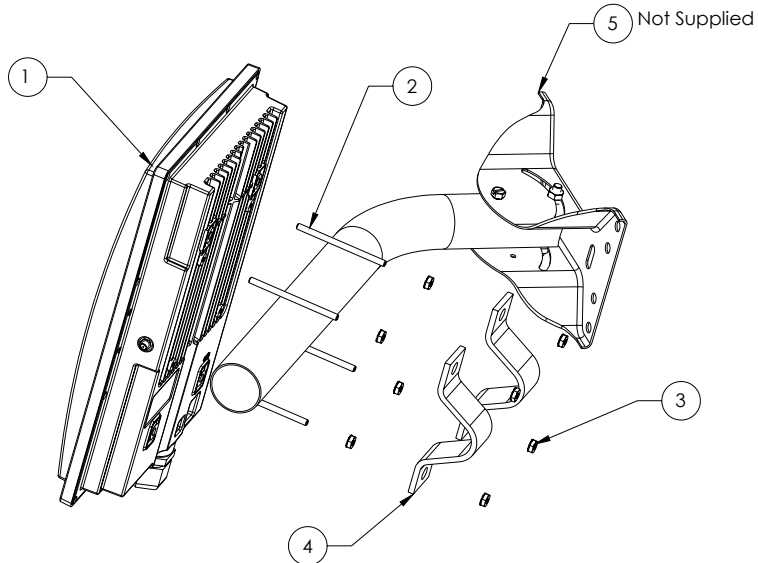
Section 6 Mounting Hardware



ITEM NO.	PART NUMBER	QTY.
1	Radio	1
2	#10 x 3" Threaded Rod	4
3	#10 Keps Nut	8
4	"V" Bracket	2
5	Mono Pod Mount (Not Supplied)	1

Figure 9: M915S Mounting Hardware Assembly

Alternate Mounting Configuration



ITEM NO.	PART NUMBER	QTY.
1	Radio	1
2	#10 x 3" Threaded Rod	4
3	#10 Keps Nut	8
4	"V" Bracket	2
5	Mono Pod Mount (Not Supplied)	1

Figure 10: Alternative Mounting

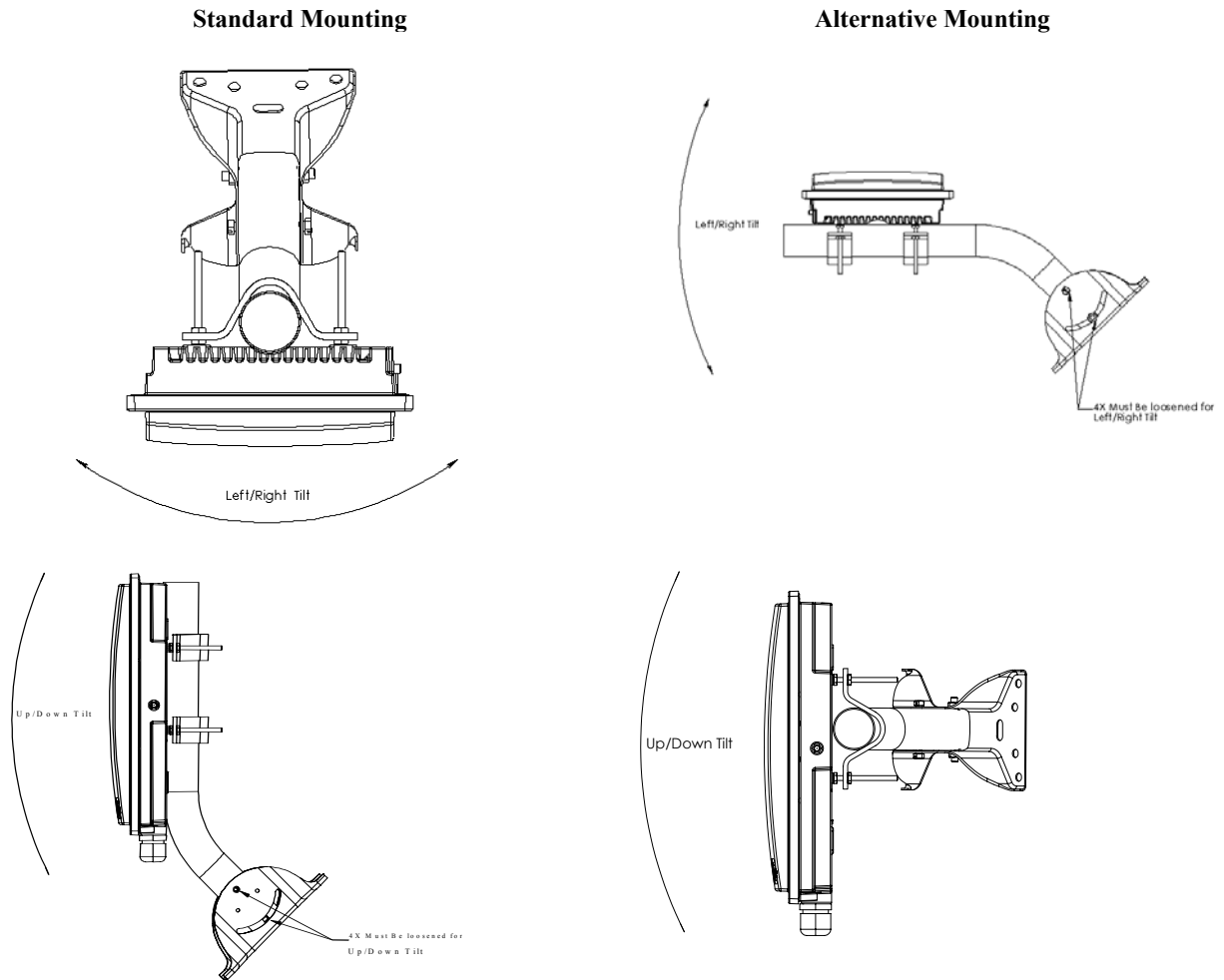


Figure 11: Articulation for M915S with Mono Pod Mount (not supplied)

Cabling and Grounding Considerations

Grounding Example

Proper mounting of the radio includes considerations for grounding. Please note that if the radio is attached to a metal pole that is earth-grounded, no other grounding is necessary. If the radio is not earth-grounded via the mounting bracket, you must attach a grounding wire to the grounding stud on the back of the radio as in the adjacent diagram.

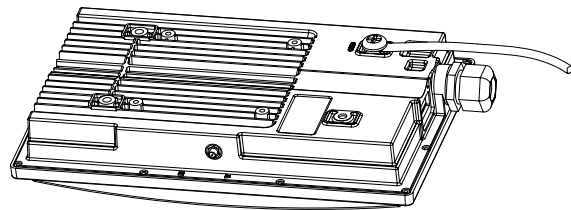


Figure 12: Grounding of the Radio

Installation Notes

Access to the radio's RJ-45 Port and LED status lights are purposely located at the bottom of the radio to minimize the risk of water intrusion. **Do not mount the radio upside down.**

The J-Box is not a weatherized device, and must be located either indoors or in a weather-protected cabinet.

Shielded twisted pair Cat-5 cable is recommended for all installations unless the cable is placed in metal conduit. The shield within the Cat-5 cable does not need to be grounded if the radio itself is grounded.

It is important to consider that most Cat-5 cable will deteriorate over time if exposed to the weather (especially direct sunlight). Conduit (metal or PVC) is recommended to protect the cable. The radio cable entry point uses NPT 3/4 pipe threads to allow conduit fittings to be used.



Important! The Ethernet port compression washer should be loosely tightened around the cat-5 cable to allow pressure equalization within the radio enclosure. Leave approximately 1 mm around the cat-5.

It is important to provide strain relief and a drip loop for STP Cat-5 cables. Do not mount the radio upside down.

Section 7 Deployment

Once you are familiar with the basic operation of the radios you are ready for deployment in the field. The deployment process consists of the following steps:

- Site Selection
- Site Survey
- Channel Planning
- SU Antenna Alignment
- Link Management Commands

Site Selection

Proper site selection for your AP will help ensure a successful deployment. Site selection will depend on a wide variety of factors, but from the radio's performance standpoint, please consider the following:

- Path from AP to SU should provide as few obstructions as possible, thus it is advisable to place the AP as high as possible on a tall building or tower.
- Ethernet cable limit is 300 feet from Ethernet device (router, switch) to the radio.
- Radios require grounding for optimal performance.
- AP provides sector coverage of 60° azimuth and 60° elevation.
- Consider nearby sources of interference that could degrade the performance of the radio. Mount radios as far from sources of interference as possible.
- Perform a site survey to determine noise level and relative clarity of channels at chosen installation location.

Site Survey

Both the AP and SU provide a powerful on-board site survey tool. This tool will tell you if there is interference present in the 900 MHz ISM band.

Command: *survey* <time> <antenna>

In order to use the survey command, the radio must be in Opmode "OFF." The survey can be performed for up to 10 seconds per channel (incrementing by 2 MHz), and for the horizontal polarization, vertical polarization, or an external antenna.

Prior to performing the site survey, place the radio in the installation spot and aim the radio in the desired direction.

After the specified period, the results of the test will provide you with a listing of each channel in the band, the average signal received, and the maximum signal received during the survey period.

In general you will be looking for frequencies with interference signal strength of -85 dBm or lower. If interference is present on various channels, it is recommended that you chose clean channels or alternate polarizations for your deployment. If it is not possible to use a clean channel/polarization combination, there are various methods available to mitigate the affects of interference. These methods include the use of the RFRX Threshold settings, or the use of external shields and external narrower beam antennas.

```
Example:\
#> survey 2 v
```

Press [space] then [enter] to stop

```
880 MHz      peak  -94 dBm  avg  -99 dBm
882 MHz      peak  -94 dBm  avg  -99 dBm
884 MHz      peak  -94 dBm  avg  -99 dBm
886 MHz      peak  -94 dBm  avg  -99 dBm
888 MHz      peak  -94 dBm  avg  -99 dBm
890 MHz      peak  -94 dBm  avg  -98 dBm
892 MHz      peak  -93 dBm  avg  -95 dBm
894 MHz      peak  -92 dBm  avg  -92 dBm
896 MHz      peak  -91 dBm  avg  -91 dBm
898 MHz      peak  -90 dBm  avg  -90 dBm
900 MHz      peak  -91 dBm  avg  -92 dBm
902 MHz      peak  -92 dBm  avg  -93 dBm
904 MHz      peak  -92 dBm  avg  -93 dBm
906 MHz Ch 1 peak  -92 dBm  avg  -94 dBm
908 MHz      peak  -92 dBm  avg  -94 dBm
910 MHz      peak  -91 dBm  avg  -93 dBm
912 MHz Ch 2 peak  -92 dBm  avg  -92 dBm
914 MHz      peak  -91 dBm  avg  -92 dBm
916 MHz      peak  -92 dBm  avg  -94 dBm
918 MHz Ch 3 peak  -92 dBm  avg  -92 dBm
920 MHz      peak  -92 dBm  avg  -93 dBm
922 MHz      peak  -89 dBm  avg  -90 dBm
924 MHz Ch 4 peak  -89 dBm  avg  -89 dBm
926 MHz      peak  -88 dBm  avg  -90 dBm
928 MHz      peak  -57 dBm  avg  -70 dBm ***
930 MHz      peak  -65 dBm  avg  -66 dBm ***
932 MHz      peak  -69 dBm  avg  -70 dBm ***
934 MHz      peak  -76 dBm  avg  -78 dBm *
936 MHz      peak  -93 dBm  avg  -94 dBm
938 MHz      peak  -85 dBm  avg  -90 dBm
940 MHz      peak  -83 dBm  avg  -88 dBm
942 MHz      peak  -83 dBm  avg  -89 dBm
944 MHz      peak  -94 dBm  avg  -99 dBm
946 MHz      peak  -94 dBm  avg  -99 dBm
948 MHz      peak  -94 dBm  avg  -99 dBm
950 MHz      peak  -94 dBm  avg  -99 dBm
```

In this example of a survey on vertical polarization for 2 seconds on each 2 MHz portion of the spectrum, the largest amount of interference was detected at frequency 930 MHz (out-of-band).

The asterisks, ****, indicate the highest amounts of interference detected and correspond to the number of yellow colored LEDs lit when opmode is on.

Note that the survey covers spectrum outside the operational range of the radio to allow detection of paging/cellular services that may desensitize the receiver section of the radio.

Once the site survey is completed, you are ready to install your radios. It is recommended that APs be installed first. The reason for this is that the SU has a built-in RSSI tool that will help you properly aim the SU at the AP to achieve maximum signal strength.

AP Search and SU Antenna Alignment

Once the AP is installed and aligned in the correct general direction, it is time to install the SU. The hardware installation of the SU is identical to that of the AP, including considerations for line-of-sight, cable distances, cable type, weather sealing, and grounding.

Once the SU is installed and aimed in the general direction of the AP, it is time to perform an RSSI (relative signal strength indicator) test to determine the signal strength from the AP, and to precisely align the SU antenna for maximum signal strength.

Although it is possible to rely upon the SU's LEDs for alignment, more precise RSSI readings are available from the command *ssrsi*.

In conjunction with the RSSI command, it is also useful to perform the *apsearch* command that will tell you which AP is providing an adequate signal at the location of the SU.

AP Search

1. Ensure AP is in Opmode “On.”
2. Run the *apsearch* command to verify which AP is providing the strongest signal strength.

```
#> apsearch
```

Press [space] then [enter] to stop

In this example, an AP is detected on channel 1, polarization horizontal. Further, the Base ID is 1234, and the MAC address is 00 01 DE 15 5C D0.

```

1  906 Hz  1234  DE 15 5C D0 [H:  -32 dBm] [V:  -50 dBm] [E:  -78 dBm]
2  912 Hz  ----  FF FF FF FF [H:  -80 dBm] [V:  -86 dBm] [E:  -99 dBm]
3  918 Hz  ----  FF FF FF FF [H:  -85 dBm] [V:  -86 dBm] [E:  -99 dBm]
4  924 Hz  ----  FF FF FF FF [H:  -82 dBm] [V:  -81 dBm] [E:  -99 dBm]

```

RSSI Command for Antenna Alignment

Step 1 Telnet into the SU (while in Opmode “OFF”). Use the *freq* and *antenna* command to note the radios current settings.

Step 2 Run the *rss* command. The telnet session screen will begin a continuous readout of the received signal strength. As you read the RSSI reading, move the antenna in the horizontal and vertical planes until the maximum RSSI reading is achieved. To allow for plenty of fade margin, we recommend a continuous RSSI reading of -78 dBm or better. An RSSI of -88 dBm will allow you to establish a wireless link, but there may not be sufficient fade margin for reliable and continuous operation.

Example 1 has the wrong freq and antenna settings:

```
#> rssi
[  1] peak -80 dBm  avg -93 dBm
[  2] peak -80 dBm  avg -97 dBm
[  3] peak -99 dBm  avg -99 dBm
```

Example 2 has the correct freq and antenna settings:

```
#> rssi
[  1] peak -33 dBm  avg -74 dBm **
[  2] peak -33 dBm  avg -68 dBm ***
[  3] peak -33 dBm  avg -64 dBm ****
```

Step 3 If it is not possible to receive an adequate RSSI reading, it may be necessary to reorient the AP (up/down, left/right), to increase the output power of the AP, or to move the SU to a location with better line-of-sight conditions to the AP. Alternatively consider using external antennas on either the AP or SU or both.

Once you are satisfied with the RSSI reading, tighten down the SU in the optimum position. To stop the RSSI continuous readout, hit SPACE ENTER.

SU Alignment Using LEDs

The LED RSSI indicators on the bottom of the radio provide a handy alignment tool. If all four LEDs are lit, the unit is receiving -60 dBm or stronger. If no LEDs are lit, there is not sufficient signal strength to establish a wireless link.

Lit LEDs Signal Strength

```

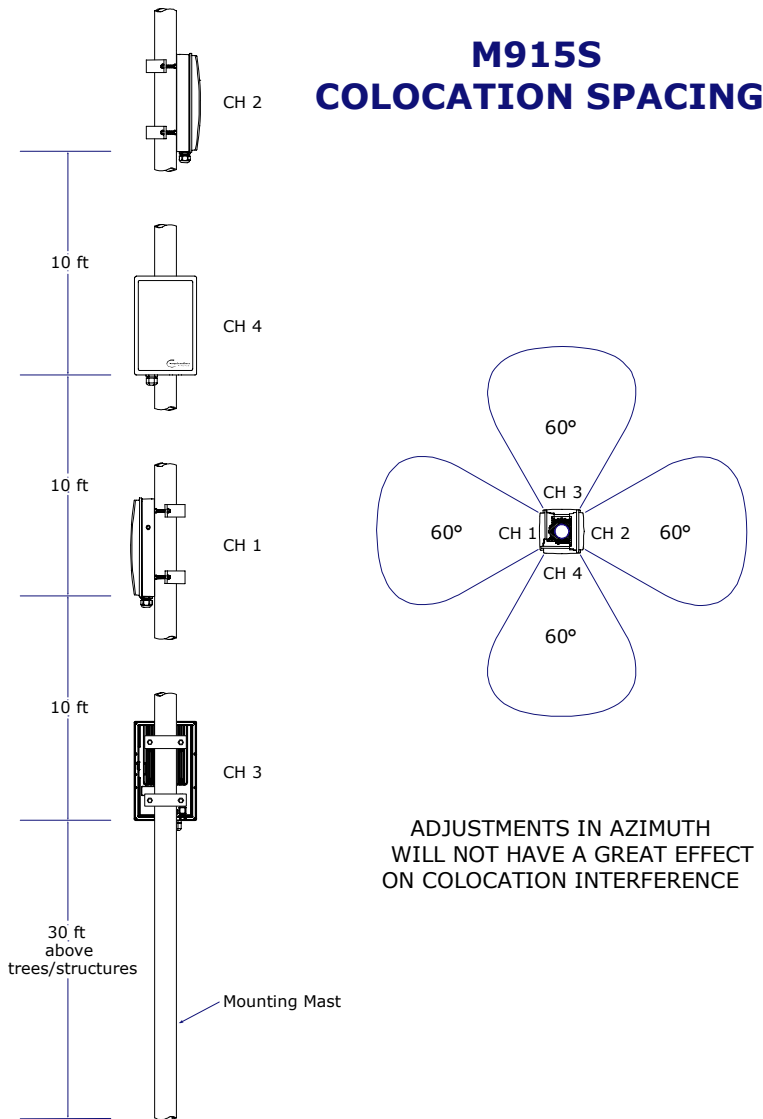
0 LED      -80 dBm
1 LED      -75 dBm
2 LED      -70 dBm

```

- 3 LED -65 dBm
- 4 LED -60 dBm

Collocation and Channel Planning

With proper channel planning and adherence to installation guidelines, multiple M915S APs may co-exist and operate interference-free on the same tower or building. The main consideration when collocating APs is to ensure at least 10 ft. of vertical separation. See the diagram below for collocation spacing, and a suggested channel plan.



Link Management Commands

Once the radios are properly aligned for maximum RSSI, ensure the SU's default Opmode is "ON" and that all configuration parameters are correct.

Reboot the SU. Once the SU enters Opmode "ON," the authentication process will begin, and the two radios will begin to associate. From the AP side there are several basic diagnostics commands, such as *su ping*, *su status*, and *su testrflink*, to ensure that a reliable RF link has been established. It may take one minute or more for the association process to complete. This process may take longer if there are many SUs in the sector.

In establishing and diagnosing the quality of the link between the AP and SU(s), there are a few commands that are especially useful. All of these commands are performed at the AP. A summary of these commands follows:

su

Displays the status of all SUs in the AP's SUDB. SUs in the SUDB will appear by SU ID, and are classified into one of the following status categories: Associated, Associating, and OFF.

Example:

```
#> su
[Priority] 88
[0]
[1]
[2]
[3] 88
[4]
[5]
[Associating]
[Power Off]
Success.
```

 **Note:** In this, and the following, examples the SU ID is 88

su ping <su#>

AP will send 10 RF pings to the designated SU ID. The response from each ping will indicate latency (in micro-seconds) and the strength (RSSI) of the signal received back from the SU for each of the 10 pings. Note this command will also tell you the distance from the AP to the SU.

Example:

```
#> su ping 88
[#Begin]
[001]
Ping #0 -> -57 dB 374 us 0.0 mi
Ping #1 -> -57 dB 373 us 0.0 mi
Ping #2 -> -57 dB 373 us 0.0 mi
Ping #3 -> -56 dB 373 us 0.0 mi
Ping #4 -> -56 dB 373 us 0.0 mi
Ping #5 -> -56 dB 374 us 0.0 mi
Ping #6 -> -57 dB 373 us 0.0 mi
Ping #7 -> -57 dB 374 us 0.0 mi
Ping #8 -> -56 dB 374 us 0.0 mi
Ping #9 -> -56 dB 373 us 0.0 mi
[#End]
Avg = -56 dB
```

Success.

su <su #>

AP will poll the SU for SU's current status and will provide information such as SU range from AP, signal strength received at SU from AP, SU temperature, etc. .

Example:

```
> su 88
[ 88] pr [as] y [d] 0.0 [rssi at ap] -60 dBm [rssi at su] -33 dBm
```

Deployment

```
[ip] 192.168.100.120 [subnet] 255.255.255.0 [gateway] 192.168.100.120
[mac] 00 01 DE 16 E3 7F
[hw ver] 0005 [fpga ver] 03121104 [fpga chksum] 75930BDC
[fw ver] 1p0a2 [fw chksum] F4658C90 [fw datecode] 04010603
[default channel and antenna] 3 h [active channel and antenna] 3 h
[tx power] 26 dBm
[ch#1] 906 [ch#2] 912 [ch#3] 918 [ch#4] 924
[remarks]
[RF Tx Retry at AP] 0 [RF Tx Retry Maxed Out at AP] 0
[RF Tx Retry at SU] 0 [RF Tx Retry Maxed Out at SU] 0
```

Success.

su linktest <su#>

This command checks the integrity of the wireless link from the standpoint of performance (throughput) and over-the-air packet loss. The AP will send 100 (1600 byte) packets to the SU, and the SU will return the packets it receives to the AP. A perfect link (without dropped packets) will yield average throughput of 3,000 kbps. If heavy packet loss occurs, it may be caused by interference or multi-path.

Example:

```
#> su linktest 88
[suid] 88 [pkt len] 1600 bytes [# of pkts per cycle] 100 [cycle] 10

0 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps
1 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps
2 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps
3 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps
4 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps
5 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps
6 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps
7 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps
8 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps
9 [AP Tx] 100 [AP Rx] 100 [AP RxErr] 0 [SU Tx] 100 [SU Rx] 100 [SU RxErr] 0 866 ms 2956 kbps

[AP Total nTx] 1000 pkts
[AP Total nRx] 1000 pkts
[AP Total nRxErr] 0 pkts

[SU Total nTx] 1000 pkts
[SU Total nRx] 1000 pkts
[SU Total nRxErr] 0 pkts

[AP to SU Error Rate] 0.00 %
[SU to AP Error Rate] 0.00 %

[Avg of Throughput] 2956 kbps

#> Success.
```

su testrflink <su#>

This command also checks the integrity of the wireless link from the standpoint of over-the-air packet loss. Relative to the linktest command, however this test does not provide as much detail. In this test the AP will send 20 large (1512 byte) packets to the SU, and the SU will in turn send the same 20 packets back to the AP. The expected result of an error free link is 20..20..20, indicating (in the following sequence) 20 packets sent from the AP, 20 packets received back at the AP, and 20 packets received at the SU. Any results other than 20..20..20 indicate a performance problem, and are most likely due to interference or an inadequate signal to noise ratio. For thorough results, it is recommended that you run the command repeatedly for at least 1 minute or more to determine if packets are passing without error consistently over time.

The “r” is used in this command to repeat the RF link test repeatedly until the user terminates the test by hitting SPACE ENTER.

Example:

```
#> su testrflink 88 r

Press [space] then [enter] to stop
[len] 1512
[suid] 88
[  0] .....[AP Tx] 20 [AP Rx] 20 [SU Rx] 20
[  1] .....[AP Tx] 20 [AP Rx] 20 [SU Rx] 20
[  2] .....[AP Tx] 20 [AP Rx] 20 [SU Rx] 20
[  3] .....[AP Tx] 20 [AP Rx] 20 [SU Rx] 20
[  4] .....[AP Tx] 20 [AP Rx] 20 [SU Rx] 20
[  5] .....[AP Tx] 20 [AP Rx] 20 [SU Rx] 20
```

Success.

As another example, a result of 20..10..18 would indicate 20 packets sent from the AP, 18 packets received at the SU, and 10 packets received back at the AP. You might expect this type of results from Fresnel zone infringements, interference, or multi-pathing.

ARQ with Selected Repeat and Multirate Feature

The M915S features ARQ or “Automatic Request for Re-transmission,” which provides the ability to correct for missing or corrupted packets of data by asking the sender to re-transmit the data.

Both the AP and SU units implement a form of ARQ known as “ARQ with Selected Repeat.”

The units makes a first attempt at transmitting a data frame using the 3.250 Mbps rate. Then, if a re-try is required, the 2nd attempt will also be at 3.250 Mbps. The 3rd and 4th attempts will be at a rate of 1.625 Mbps. After the 4th attempt there will be no more re-tries and a counter describing “maximum retries reached” will be incremented.

- A minimum of 100ms is placed between re-transmission requests.
- The units buffer up to 600 frames, or 4 seconds worth, of RF TX Data frames to support the ARQ algorithm.
- The AP unit maintains counters concerning the ARQ algorithm on a per SU basis. The counters include the following data:
 - Total Transmitted Frames
 - Total Retransmission Attempts
 - Total “Maximum Attempts Reached”

The SU unit maintains counters concerning its use of the ARQ algorithm. The counters include the same data as in the AP.

Section 8 Management

Section Topics:

- Radio Management Access using TCP/IP
- SU Management from the AP's command set
- SNMP

Radio Management Access Via TCP/IP

The IP Address of an M915S radio is for management purposes only. The IP address is not used for purposes of routing or passing traffic. Users should take care to set appropriate IP schemes for all management activities including upgrading the radio's firmware. It is not uncommon for users to assign public IP addresses to the radios so that they can be accessed from anywhere via the Internet. In order to gain TCP/IP access to SU (from either side of the wireless network), ensure that SU Switches 2 and 6 are turned on. In order to gain TCP/IP access to the AP from the SU side of the wireless network, ensure that AP Switch 7 is turned on.

SU Management from AP

The AP provides functionality and several commands that permit the management of associated SUs. In fact, most system management functions are performed by issuing commands from the AP. Presented below are a few examples of these commands:

su ping <suid>

su status <suid>

su ipconfig <suid> <new IP> <new subnet> <new gateway>

su password <suid | all> <rw | ro> <new password> <new password>

su reboot <all|suid>

su testrflink <all|suid> [<r>]

su sw <suid> <sw #> <on|off>

Note: SU commands issued from the AP will automatically update the SU's flash memory. No *save ss* command is necessary.

As an example, you can remotely change the password for a single SU or all SUs in a sector:

su password <suid | all> <rw | ro> <new password> <new password>

Example:

```
#>su password all rw hello hello
```

to remotely change the read write password on all SUs to "hello"

As another example, to change an SU's IP, subnet, and gateway: *su ipconfig <suid> <new ip> <new subnet> <new gateway>*

Type the following:

```
#>su ipconfig 7 192.168.10.10 255.255.255.0 192.168.10.1
```

In this example SU #7's IP address was changed to 192.168.10.10, the subnet mask to 255.255.255.0, and the gateway to 192.168.10.1.

A complete description of these commands and many others can be found in Appendix A – Command Set Reference.

The Trango SNMP solution supports MIB-II (system only) and the Trango proprietary Management Information Base (MIB). The SNMP agent resides on the AP ONLY. The AP gathers health, status, and performance statistics from all SUs locally, then responds back to the SNMP manager upon request.

Users interested in using the SNMP functionality should review the entire M915S MIB for a complete understanding of its features. The M915S MIB is available for download at:

<http://www.trangobroadband.com/support/downloads.htm>

The following is an overview of a few of the more commonly used SNMP objects in the M915S system.

Objects for Monitoring and Control

SU Bandwidth Monitoring

- **suEthRXAvgThroughputLog** – Average payload data throughput (in Kbits/sec) received on the Ethernet port over the period specified by suStatisticsSamplePeriod (1 ~ 60 minutes).
- **suEthTXAvgThroughputLog** - Average payload data throughput (in Kbits/sec) transmitted from the Ethernet port over the period specified by suStatisticsSamplePeriod (1 ~ 60 minutes).
- **suFRXAvgThroughputLog** - Average payload data throughput (in Kbits/sec) received over the RF link over the period specified by suStatisticsSamplePeriod (1 ~ 60 minutes).
- **suRFTXAvgThroughputLog** - Average payload data throughput (in Kbits/sec) transmitted over the RF link over the period specified by suStatisticsSamplePeriod (1 ~ 60 minutes).
- **suRFInOctets** – Number of octets of payload transmitted from the AP’s RF port.
- **suRFOutOctets** – Number of octets of payload received on the AP’s RF port.

AP Bandwidth Monitoring

- **aptrafficEthRXAvgThroughputLog** – Average payload data throughput (in Kbits/sec) received on the Ethernet port over the period of 1 minute.
- **aptrafficEthTXAvgThroughputLog** – Average payload data throughput (in Kbits/sec) transmitted from the Ethernet port over a period of 1 minute.
- **aptrafficFRXAvgThroughputLog** – Average payload data throughput (in Kbits/sec) received over the RF link for a period of 1 minute.
- **aptrafficRFTXAvgThroughputLog** – Average payload data throughput (in Kbits/sec) transmitted over the RF link for the period of 1 minute.
- **aptrafficEthInOctets** – Number of octets of payload received on the Ethernet port.
- **aptrafficEthOutOctets** – Number of octets of payload transmitted from the Ethernet port.
- **aptrafficRFInOctets** – Number of octets of payload received on the RF port.
- **aptrafficRFOutOctets** – Number of octets of payload transmitted from the RF port.

Link Status Monitoring –Various traps are defined as follows:

- Cold start – when SNMP agent starts running
- Link Up – when the AP enters Opmode “ON”
- Link Down – when the AP reboots
- SU Link Up – when SU associates to the AP
- SU Link Down – when SU disassociates from the AP
- “AP” Opmode Failure – when AP fails to enter Opmode “ON”

AP and SU Control – SNMP also provides several control capabilities. The majority of the features available on the CLI are also available via SNMP. Here are a few of these features:

- Add/delete subscriber
- Change channel
- Set power
- Set radio sensitivity

Review the Trango M915S MIB for the complete listing of MIB Objects.

SNMP Setup

Trango Broadband provides only the MIB portion of the SNMP Management system. The radios act as individual agents, and it is up to the user to provide an SNMP Manager software from a third party vendor. Below is an example of the setup process for SNMPc from Castle Rock™.

1. Unzip trangopkg.zip file to a local temporary directory.
2. Go to your local temporary directory, you will see 4 files shown below.
 - a. trango_M915Sap_1p0.mib – M915S AP MIB file
 - b. trango.ico – M915S AP icon
 - c. autoico.txt – instruction file (Selects Trango icon automatically during initial set-up.)
 - d. Readme.pdf – Configuration Guide
3. Copy trango_M915Sap_1p0.mib file to C:\Program Files\SNMPC Network Manager\mibfiles
4. Copy autoico.txt file to C:\Program Files\SNMPC Network Manager\mibfiles
5. Copy trango.ico file to C:\Program Files\SNMPC Network Manager\bitmaps
6. The MIB needs to be compiled into the SNMPC database

By default, the Read Community is set to “**public**”, and Write Community is set to “**private**,” in the AP. The Trap Community is “**SNMP_trap**.” The manager needs to have the same settings in order to communicate with the AP successfully.

To send traps from the AP, set the following:

- trap destination IP (Trango MIB object trapconfig–trapconfigInfo)
- trap community string (Trango MIB object trapconfig–aptrpTable–AptrpEntry)
- enable each trap (Trango MIB object traconfig–aptrpTable–AptrpEntry)

For all the set operations, set object SaveAndActivate at apsystem-apsystemInfo to write the information to FLASH.

Appendix A Command Set Reference

(ro = read only access, rw = read write access)

Command	Radio	Description	Access
?	AP/SU	Display complete list of commands and syntax	ro/rw
? <command>	AP/SU	Display specific command syntax	ro/rw
antenna	AP/SU	Display current antenna setting (h=horizontal, v=vertical, e=external)	ro/rw
antenna <e h v>	AP/SU	Select antenna mode (h=horizontal, v=vertical, e=external)	rw
aprssi <ch#> <antenna, h v e>	AP/SU	Scan two strongest APs (Opmode "OFF" only)	ro/rw
apsearch	AP/SU	Scan all channels to look for APs (Opmode "OFF" only)	ro/rw
arq	AP/SU	Display current ARQ settings	ro/rw
arq <on/off>	AP/SU	Enable/disable ARQ	rw
bye	AP/SU	Same as "logout"	ro/rw
eth link	AP/SU	Display current Ethernet setting	ro/rw
eth link <100fdx 100hdx 10fdx 10hdx aneg>	AP/SU	Change Ethernet duplex setting	rw
exit	AP/SU	Same as "logout"	ro/rw
freq	AP/SU	Display current channel	ro/rw
freq <ch#>	AP/SU	Change current channel	rw
freq channeltable	AP/SU	Display channel table	ro/rw
freq writechannel [<ch #> <freq>]...	AP/SU	Modify center frequency of channel. <ch #> = 1..4 <freq> = 906..924 Note: This command automatically writes to flash memory.	rw
help	AP/SU	Display complete list of commands and syntax	ro/rw
help <command>	AP/SU	Display specific command syntax	ro/rw
ipconfig [<new ip> <new subnet mask> <new gateway>]	AP/SU	Assign radio's IP, subnet mask, and gateway IP	rw
linktest <txrx rxtx> [<pkt len, bytes> [<# of pkts> [<# of cycle>]]]	AP/SU	Loopback test to check quality of the wireless link. Variable parameters include: pktlen = 64..1760, # 0 pkts = 1..500 # of cycles = 1..100000	ro/rw
logout	AP/SU	Log out of radio	ro/rw
maclist	AP/SU	Display current MAC table (MAC addresses of attached devices)	ro/rw
maclist reset	AP/SU	Display or reset current MAC table	ro/rw
mirth	AP	Display MIR (Maximum Information Rate) Threshold	ro/rw
mirth <0..3, Mbps>	AP	Assign MIR Threshold default = 3 Mbps mirth 0 = Always On mirth 3 = Disable MIR Threshold	rw
opmode	AP/SU	Display current Opmode	ro/rw
opmode on [<y>]	AP/SU	Set Opmode to be "ON" and use "y" if Opmode is not as same as default Opmode	ro/rw
password <rw/ro> <new pwd> <new pwd>	AP/SU	Specify new password (max 15 octs) rw=read/write password, ro=read only password	rw
ping <ip address>	AP/SU	Ping local Ethernet device Note: This command only works for local Ethernet devices, not SU or any device behind SU.	ro/rw
power	AP/SU	Display current TX power level default = max. power value	ro/rw
power set <min max <dBm>	AP/SU	Specify TX power for both band Note: SU's power will be adjusted by AP during association process (power leveling)	rw

Command	Radio	Description	Access
pppoeonly	SU	Display current PPPoE filter setting	ro/rw
pppoeonly <on off>	SU	Change PPPoE filter setting With PPPoE filter set to ON, only PPPoE packets will pass Default: off – Pass All Packets	rw
reboot	AP/SU	Reboot unit	ro/rw
remarks	AP/SU	Display remarks	ro/rw
remarks <str,31 octs>	AP/SU	Overwrite remarks	rw
reset	AP/SU	Reset radio's system settings back to factory defaults, then reboot	rw
rfrxth	AP/SU	Display current RF RX Threshold	ro/rw
rfrxth <-98..-55>	AP/SU	Change current RF RX Threshold default = -98 dBm	rw
rssi	AP/SU	Display current RX RSSI Opmode "OFF" only on AP	ro/rw
save <mainimage fpgaimage> <current chscksum> <new checksum>	AP/SU	Save new firmware. This command gets new firmware image from TFTP buffer, verifies checksum and writes to flash memory at main or FPGA image section.	rw
save subd	AP	Save SUBD into flash memory	rw
save <systemsetting ss>	AP/SU	Save current configuration into flash memory	rw
set apid <ap-id>	AP	Set AP ID, <ap-id> = 1..255	rw
set baseid <base-id, 4 oct>	AP/SU	Set base station id Base ID = XXXX where X = any alphanumeric character except "/"	rw
set defaultopmode <on off>	AP/SU	Set default Opmode to "ON" or "OFF" Factory set default Opmode is "OFF"	rw
set httpport [<port #>]	AP/SU	Set or display HTTPD port number port # = 1..65534 default port = 80	rw
set snmpcomm <read write trap id# trap all>	AP/SU	Set SNMP read or write or trap community string	rw
set telnetport [<port #>]	AP/SU	Specify telnet port, <port #> = 1..65534 Default port = 23	rw
snmpsample <min, 1..60>	AP/SU	Set SNMP sample period	rw
su password <suid all> <rw ro> <new password> <new password>	AP	Change read/write or read-only password of all or a specific subscriber	rw
su <all suid>	AP	Display all or specific SU information in SUBD	ro/rw
su info <suid>	AP	Command issued from the AP to gather information about specific SUs. <ol style="list-style-type: none"> 1. Distance 2. RSSI at AP 3. RSSI at SU 4. IP address 5. Subnet address 6. Gateway address 7. Device ID 8. Hardware version 9. FPGA version 10. FPGA checksum 11. Firmware version 12. Firmware checksum 13. Firmware datecode 14. Broadcast/multicast packet filter on/off 15. Auto scan AP on/off 16. TCP/IP for AP on/off 17. HTTPD on/off 18. TCP/IP service for Ethernet port on/off 19. Default channel and antenna 20. Active channel and antenna 21. TX power 	ro/rw

Command	Radio	Description	Access
		22. Remarks 23. RF TX retry at AP, RF TX retry maxed out at AP RF TX retry at SU, RF TX retry maxed out at SU	
su ipconfig <suid> <new IP> <new subnet> <new gateway>	AP	Change IP, subnet, gateway for specified SU	rw
su linktest <suid>	AP	Perform linktest for specified SU	ro/rw
su ping <suid>	AP	Request SU's ranging and RSSI information	ro/rw
su reboot <all suid>	AP	Reboot a specific SU or all SUs	rw
su sw <suid> <sw #> <on off>	AP	Change switch settings on specified SU	rw
sudb add <suid> <pr> <mac>	AP	Add new SU to SUDB	rw
sudb cirmir <<suid> all> <cir dn> <cir up> <mir dn> <mir up>	AP	Change SU's CIR/MIR settings	rw
sudb defaultcirmir	AP	Display default CIR and MIR in SUDB	ro/rw
sudb defaultcirmir <cir_dn, 0..3000> <cir_up, 0..3000> <mir_dn, 0..3000> <mir_up, 0..3000>	AP	Change default CIR and MIR	rw
sudb defaultcirmir <default cir dn> <default cir up> <default mir dn> <default mir up>	AP	Set MIR/CIR values to default values	rw
sudb delete <suid all>	AP	Delete SU in SUDB	rw
sudb dload	AP	Download SUDB file from TFTP buffer and write to flash memory. This command is used to load a text file that contains the SUDB into the AP. This command can be useful if there are large numbers of SUs in the sector.	rw
sudb gid <suid all> <0..15>	AP	Change SU's gid	rw
sudb view	AP	Display all SUDB	ro/rw
survey <search time, sec> <antenna, h v e>	AP/SU	Spectrum analysis of the entire band (and near band) <search time> = 1..10 sec per channel Opmode "OFF" only	ro/rw
Sw	AP/SU	Display current sw setting	ro/rw
sw 0 [<on off>]	AP/SU	set sw #0 – enable or disable packet filter for broadcast/ multicast packets on = filtering default = on	rw
sw 1 [<on off>]	SU	Enable or disable SU's autoscan AP feature If on, SU will automatically scan each channel and antenna port searching for AP. default=on	rw
sw 2 [<on off>]	SU	Enable or disable SU's TCP/IP service for AP Allows TCP/IP access to SU from AP side of network via wireless link. default = on	rw
sw 3 [<on off>]	AP	Enable or disable SU to SU (peer to peer) service default = off	rw
sw 5 [<on off>]	AP/SU	Enable or disable HTTPD (browser interface) default = on	rw
sw 6 [<on off>]	SU	Enable or disable TCP/IP service for Ethernet port while SU is in Opmode "ON" default = on	rw
sw 7 [<on off>]	AP	Enable or disable TCP/IP service for SU. Allows TCP/IP access to AP from SU side of network via wireless link. default = on	rw
sysinfo	AP/SU	Display system configuration	ro/rw
targetap	SU	Display the SU current setting for target AP	ro/rw
targetap all	SU	SU will associate with any AP with the same Base ID "all" is the default setting.	rw
targetap only <mac1, hex> [<mac2, hex>]	SU	SU will only associate with AP with specified MAC addresses.	rw
targetrssi	AP	Display SU Target RSSI in dBm. This setting is used in the SU power leveling process.	ro/rw
targetrssi <dBm, -90..-50>	AP	Change target RSSI. Note: Target RSSI must be +5 dB more than rfrxth (RFRX Threshold).	rw

Command	Radio	Description	Access
		default = -60	
tftpd	AP/SU	display current TFTP status (status is either on or off) This command will also list any contents of the TFTP buffer.	ro/rw
tftpd <on off>	AP/SU	enable or disable TFTP service. TFTP must be on in order to upload new firmware or new SUDB file.	rw
updateflash <systemsetting ss>	AP/SU	Save current settings. This command can be issued in several ways: save ss, updateflash systemsetting, save systemsetting, and updateflash ss	rw
updateflash <mainimage fpgaimage> <current chcksum> <new checksum>	AP/SU	Retrieve uploaded firmware from TFTP buffer, verify checksum, and write to flash memory at main or FPGA image section.	rw
updateflash sudb	AP	Save SUDB into flash memory	rw
ver	AP/SU	Display firmware and date codes <ul style="list-style-type: none"> 1. Version number and date code 2. Firmware and FPGA version code 3. Firmware and FPGA image checksum 	ro/rw

Appendix B Specifications

All specifications apply to the M915S-AP and M915S-SU, unless otherwise noted.

Radio Transmit Specifications

Storable Channels:	4 memory locations
Agility:	906 to 924 MHz in 1 MHz increments
Default channels:	
Channel 1:	906 MHz
Channel 2:	912 MHz
Channel 3:	918 MHz
Channel 4:	924 MHz
Power Control Range:	Max: +26 dBm +/- 1 Min: -4 dBm +/- 2 Step: 1 dB
Pout:	+26 dBm max
Ant. Gain:	10 dBi typical
EIRP:	+36 dBm typical (4 Watts)
Freq. Stability:	+/- 1.5 ppm PLL stabilized (+/-2.5ppm) over temperature
Freq. Plan:	Single upconversion, 140 MHz IF
Modulated BW:	6.5 MHz (null to null, 40 dB down)
2 nd Harmonic atten:	Per CFR47 part 15.407
LO Supression:	Per CFR47 part 15.407

Receiver Specifications

Storable Channels:	4 memory locations
Agility:	906 to 924 MHz in 1 MHz increments
Default channels:	
Channel 1:	906 MHz
Channel 2:	912 MHz
Channel 3:	918 MHz
Channel 4:	924 MHz
Cascade Noise Figure:	< 7 dB
Receiver Sensitivity:	
3.250 MBPS Rate: (1x10 ⁻⁶ BER)	- 90 dBm typical-1600 byte packet - 90 dBm typical-64 byte packet
1.625 MBPS Rate: (1x10 ⁻⁶ BER)	- 91 dBm typical-1600 byte packet - 91 dBm typical-64 byte packet
Image Rejection:	> 90 dB
Frequency Plan:	Single conversion, IF at 140 MHz
LO stability:	+/- 1.5 ppm PLL stabilized (+/-2.5ppm) over temperature

Ethernet I/O Specifications

Data Input/Output:

Connector:	Shielded RJ-45 Jack
Signaling Format:	IEEE802.3i (10baseT) and IEEE802.3u (100baseT) compliant

Auto-Negotiation: Fully supports IEEE802.3-2002 Sect. 2 Clause 28
Bridging Frame Size: 60 to 1600 bytes
Mgmt Frames: 60 to 1472 bytes (includes PING, TELNET, TFTP, HTTP)

Protection: Bi-directional transient voltage protection diodes on all data lines
compliance with:
IEC61000-4-2 (ESD)
IEC61000-4-4 (EFT)
IEC61000-4-5 (Lightning)

Power Specifications

Input Voltage: Input voltage range at unit is 10.5 VDC to 24 VDC max

Power is supplied via the unused pins of the RJ-45 Jack. Power is injected into the Ethernet cable using a junction box (provided).

Current Cons.: 400 mA in transmit and receive modes at max power using 24 V standard adapter (8 W) and 10 ft cable from J-BOX to unit

Protection: 28 volt Transient Voltage Suppression (TVS) on power input
Note: Voltages above 28 volts will cause damage to unit.

Mechanical and Environmental Specifications

General

Material: High Temp Polycarbonate radome and diecast metal enclosure (AP_
High temp ABS enclosure (-SU)
Size: 12.5" x 8" x 2.75" including mounting studs
Weight: <4 lb
Mounting: 2 U-Brackets, all-thread rod, nuts and washers (-AP)
Articulating pole mount (-SU)

Connectors/Indicators

RF Output: Integral internal patch antenna per Part 15C, 15.203
External RP-SMA-f connector for external antenna

FCC Compliance: The transceiver shall comply with the following:
FCC part 15.247
FCC Part 15.207(a)

Operating Temp: -40° to 60° C
Storage: -40° to 85° C
Humidity: 100 % (When sealed properly.)
NEMA Rating: NEMA 4
Shock: Sustain 3 axis drop from 5 feet

Standard External Power Supply

24 Volt DC Power adapter and J-Box supplied with product.

Type: Linear wallmount transformer
Input: 120 VAC
Output: 24 VDC +/- 1 V
Max current: 1000 mA
Connector: 5mm DC Barrel-type Plug

Standard External Power-over-Ethernet Junction Box

Type: In-line female-to-female RJ-45 adapter for CAT-5 Ethernet cable
Connectors:

Eth. In: Shielded RJ-45 Jack
DC Input: 5mm DC Barrel-type Jack
Eth. Out & DC Out: Shielded RJ-45 Jack
Pinout for Eth. Out: Power (+) on pins 7+8, ground (-) on pins 4+5 and eth. data on pins 1,2,3 & 6
Indicators: 2 LEDs to indicate power and a connection to radio
Protection: Resettable fuse for DC input

Integrated Antenna (M915S-SU and M915S-SU-EXT)

Type: Dielectric-loaded Patch Antenna
Polarization: Vertical or Horizontal Polarization, electrically selectable
Frequency: 902 to 928 MHz
Gain: +9 dBiL +/- 1 dB
Az Beamwidth: 60° (3 dB pts)
El Beamwidth: 60° (3 dB pts)
Cross Pol: >15 dB
Front/Back Ratio: 15 dB
VSWR: < 2.0:1 over Bandwidth