SOLECTEK

SKYWAY-XL100t 5.9GHz

Point-to-Point (PTP) Wireless Kit

User's Guide

October, 2014

Rev 1.2

Notice

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1. Product Overview

Congratulations on your purchase of Solectek's SkyWay XL100t PTP Radio System, a feature rich, best-in-class wireless solution. This User's Guide will describe the operation of your SkyWay unit in detail.

1.1 SkyWay-XL100t Main Features

The SkyWay-XL100t radio's main features are as follows:

- Field proven OFDM modulation allowing high capacity, near line-of-sight deployment and strong immunity to multi-path.
- MIMO architecture for increased capacity
- Power over Ethernet (PoE) for simplified cable routing.
- Integrated antenna/radio simplifies installation and eliminates lossy RF coax runs.
- Frame aggregation for enhanced data throughput.
- Line speed QoS packet inspection prioritizes latency sensitive, real-time data.
- GPS-based radio location tracking
- Intuitive Web based user interface and Telnet CLI.

1.2 Applicable Models

XL5910 radio w/ 23dBi dual-pol antenna

XL5930 radio w/ 20dBi dual-pol antenna

1.3 Radio Packaging Content

The following items are included in each PTP kit package. Please contact Solectek Sales if there is any missing item.

- SkyWay Radio unit (2)
- Power over Ethernet (PoE) injector + AC to 48V DC power supply (2)
- Pre-assembled, bracket-based mast mounting kit (2)
- Cat5 weatherproofing feedthrough / gland (2)
- Coax/grommet seals
- Warranty and Compliance Card.

NOTE - The requisite Cat5e or CAT6 Ethernet cables are <u>not</u> included in the package. Please contact Solectek for information on available outdoor grade, RF-shielded Ethernet cables. Customers can purchase these cables directly from Solectek or from other sales channels.

1.4 Management Platform Requirement

- GUI/Telnet management
    1. Hardware - Pentium IV (or better) PC;
    2. OS – Windows XP SP2/SP3 or later; Windows 7 Professional 32 or 64 bit or later
    3. Web Browser

- SNMP monitoring: SNMP v2c compatible SNMP manager, running on appropriate PC/Server platform.

2. Summary of Installation Steps

This section summarizes the steps needed to properly configure and install the SkyWay XL100t Radio. As the background and guidelines for much of the radio installation process are well covered in many in-depth publications and training classes, only those steps that uniquely relate to the SkyWay product are covered in this User Guide.

NOTE: Per FCC Part 90.377, this product should NOT be installed at a height not exceeding 8 meters above the roadway bed surface.

A. System Design

- Requirements analysis
- Site Survey
- RF System Design
- IP Network Design
- Physical/Electrical engineering design

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- Initial Configuration
- Bench testing

C. Site Preparation

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- Electrical prep
- Cable routing

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- Antenna alignment

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- Link status + metrics
- Ping connectivity
- Performance testing

- Reliability monitoring

F. Optimization

- RF channel tuning
- Data rate tuning
- QoS

G. Management + Maintenance

- Upgrades
- Access Methods
- Tools
- Diagnostics

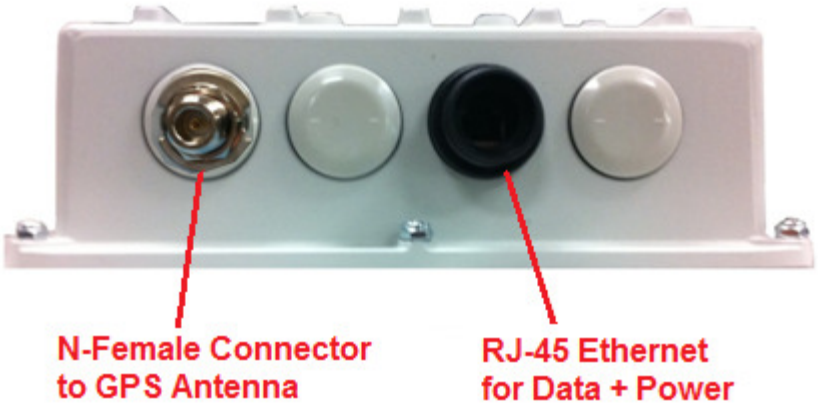
3. System Connections

3.1 Port Description

SkyWay-XL100t radio unit has the following access ports:

- (1) 10/100/ Fast Ethernet + Power Connector
- (1) GPS RF port to be connected to a GPS antenna

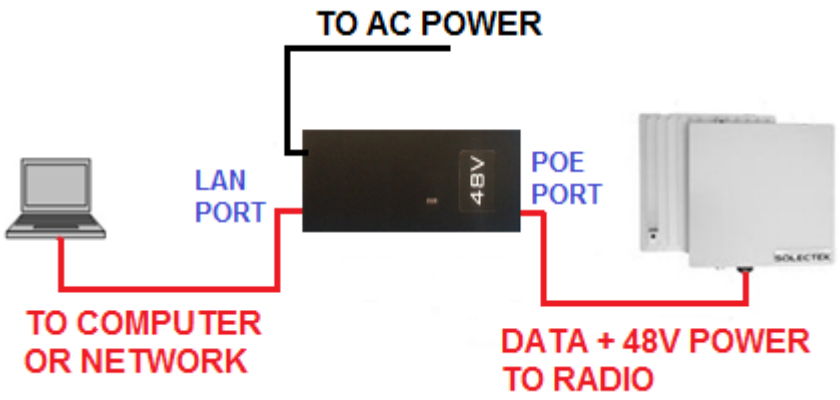
The RJ45 connector is accessed at the bottom of the unit, through a multi-piece waterproofing feed-through. If included, the RF Ports are accessed on the bottom of the unit, which is shown below.



Unit Bottom View – physical interfaces shown

3.2 Connecting the SkyWay Unit to Network

Use the diagram below as a guide to cable your SkyWay test system using a PC or Laptop and a pair of Cat5e/6 cables. An auto-MDIX feature eliminates the need for cross-over cables.



CONNECTION DIAGRAM FOR MASTER UNIT AND SLAVE PTP UNITS

3.3 Initial Log-in

- Open *networking properties* in your Windows OS. Enter the TCP/IP setup window of your wired Ethernet adapter properties page. Set the IP addresses to the following values.

IP Address Setup on your Computer	
Ethernet IP Address	192.168.1.1
Subnet Mask	255.255.255.0

- Open a Web Browser on the Test PC

  At the URL line, type in the following:

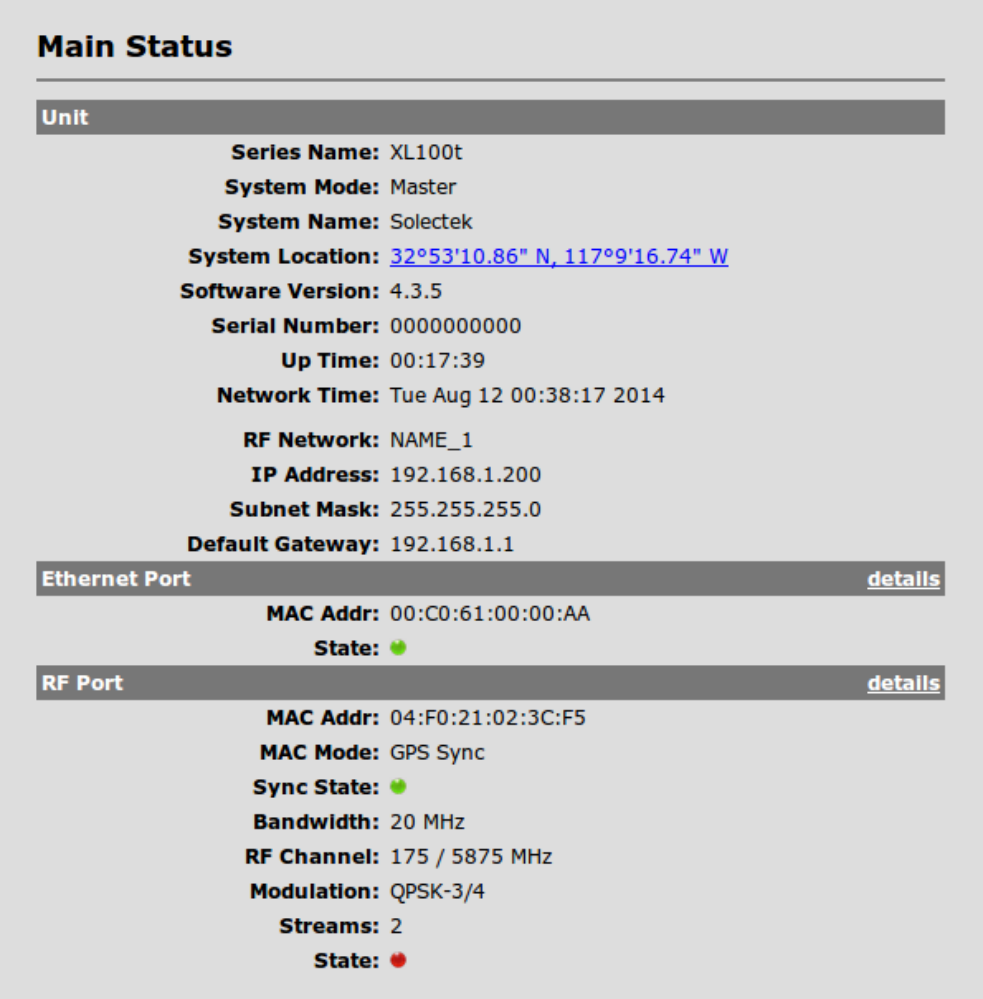
Type of Unit	Default IP Address
Slave Unit	192.168.1.100
Master Unit	192.168.1.200

NOTE – Depending on your computer OS, the above screen may look different. Also, appearance of your GUI will depend on the type and version of your web browser. Please contact Solectek sales and support for detailed information.

- The access username is **admin** and the default password is **admin**.

Default Radio Log-in Info	
User Name	admin
Password	admin

- Click OK on the above Windows screen and the Main Status screen will be displayed, as shown below (Master unit version):



4. Bench testing

Before mounting units into their final location, it is recommended that the system be bench tested to verify basic operation. The following bench test steps are suggested:

Setup. Each radio should be connected and configured per the previous Sections, with a laptop or PC connected to each radio directly (or through a hub/switch).

WARNING – DO NOT connect two radios to the same switch or a loop will be created, which will create a failure of the

NOTE – Make sure that Access Control MAC addresses are correct and that units share the same bandwidth, data rate and security settings. Access Control List (ACL) is enabled as a factory default setting.

It is also important to have identified and prepared the antenna, RF coax and Cat5 solutions that will be used in the intended application.

Positioning. It is important to remember that the SkyWay radio and antenna system generate and transmit a great deal of RF power. During bench testing, antennas should not be pointed directly at each other. Rather, establish a position so there is approximately 180 degrees angular separation and 6 to 10 feet between units. Fine tune the antenna position so that the Local RSSI is between -30 and -60 dBm.

Testing. If the system has been properly configured, the radios will begin communicating immediately. The following steps are recommended to verify operation:

- Link State. On the Main Status screen, verify that the RF Link State is Green (connected).
- Local ping. From each laptop/PC be sure a ping to the local radio is successful.
- Link ping. Now ping from one laptop/PC to the other laptop/PC. This will verify the end-to-end link.
- Traffic test. Using IPERF or equivalent utility, verify traffic can be passed successfully across the link.

NOTE - Keep in mind that the SkyWay-XL100t data rates will stress the performance of the PC hardware, operating system and IP stack. To ensure that this test equipment is not a performance bottleneck, pre-testing PCs, by connecting them directly to each other, is strongly recommended.

NOTE -Using a file transfer to a shared volume or an FTP session on a typical Windows/Intel machine is not adequate to accurately measure throughput.

NOTE - **Units bench tested in an indoor configuration should not be expected to deliver full rated throughput. Benchmarking is typically performed after a system is deployed.**

WARNING – When it is not in use, the GPS port of the GPS-ready Master unit must be sealed to prevent water intrusion. The port is factory configured with a sealing pin. Please leave it in place until you are ready to connect to a GPS controller.

5. Physical Installation

5.1 Introduction

Your SkyWay radio is designed with a mounting system with two degrees of freedom. The radio can be mast, tower, pole or wall mounted using the appropriate hardware. After determining the best location for your radio, installation can begin.

To mount a SkyWay-XL100t radio unit, both the mast mounting kit and Ethernet cable feedthrough need to be correctly assembled. The recommended approach consists of 3 or 4 steps, detailed in the following sections:

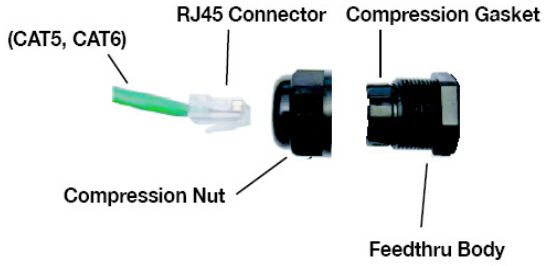
- Ethernet cable / feedthrough assembly
- Bracket preparation
- Mounting
- Antenna mounting (for connectorized units, only)

With the exception of the CAT5 cable, all parts and hardware described in the following sections are included with your SkyWay radio.

5.2 Ethernet Cable / Feedthrough Assembly

Only a single Ethernet cable is needed to connect the SkyWay radio to the indoor PoE Injector. Since the cable is exposed to the outdoor elements (heat, moisture, and UV light), only outdoor rated, shielded Cat5 Ethernet cable should be used. To ensure all-weather operation, the weatherproofing cable feedthrough (also known as grommet or gland) must be properly assembled onto the Ethernet cable and radio.

The following diagram depicts each of the feed-through parts:



Assembly Steps:

1. Remove the **Compression Nut** and slip it over the Ethernet CAT5 cable as shown below.

2. Feed the Ethernet CAT5 Cable through the **Feedthrough Body** (pre-installed on the enclosure at the factory) and insert the RJ-45 connector to the female connector inside the enclosure.

3. Install the **Compression Nut** and hand tighten until the cable resists slipping when gently pushed or pulled. Lightly wrench-tighten, being careful not to overtorque the **Compression Nut**.

The unit with properly installed feedthrough appears as follows:

NOTE - Removal of the RJ45 plug from the radio requires a tool such as a thin screwdriver, or opened paperclip. Care must be taken not to damage the Feedthrough Body or RJ45 plug.

NOTE - The total combined length of the Ethernet cables between the radio and your network access device (hub/switch/PC) must **not** exceed 300 feet.

NOTE - Once mounted in a permanent location, additional weatherproofing tape (included) should be applied around the assembled fitting to further enhance durability.

5.3 Mounting Bracket and Tools

The following figure shows all components of the mounting kit.

The installation steps will be shown in the next section.

Tools necessary for tightening bolts and nuts are:

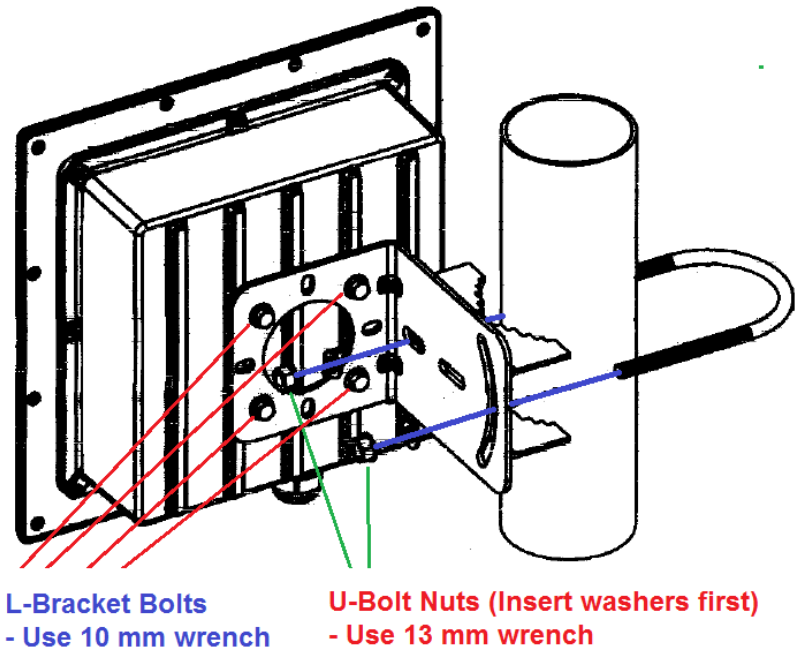
- 10mm wrench for bolts to fasten the L-bracket to the radio enclosure
- 13mm wrench for nuts to tighten U-bolt nuts.

5.4 Unit Mounting

The final installation step involves mounting your SkyWay radio to an outdoor mast.

Refer to the following diagram to perform the installation steps:

- Fasten the L-bracket on the back of the radio enclosure. The hole patterns are symmetric and you can rotate the enclosure by 90 degrees before installing the L-bracket for establishing the radio link with horizontal polarization.
- Using the step bracket and U-bolt, fasten the L-bracket to the mast.



Azimuth alignment – Rotate the enclosure assembly in the horizontal direction

Vertical alignment - The L-bracket has a curved groove which can be used to tilt the enclosure up or down.

Once the alignment is complete, tighten the bolts and nuts firmly.

5.3 Mounting of Separate Antennas

Tower or mast mounting of the antenna should proceed according to the antenna manufacturer's guidelines.

For interfacing to the Solectek radio, the following should be considered:

- To minimize loss, only short lengths of high quality, LMR-400 (or equivalent) RF coax cables should be used.

- For Master unit radios, there are no requirements to connect specific radio ports to specific polarizations on the antenna. Solectek's MIMO system will auto-adjust to accommodate the chosen configuration.

Weatherproofing Ethernet and/or antenna connections is essential. This process prevents water from entering the chassis or cables through the connectors.

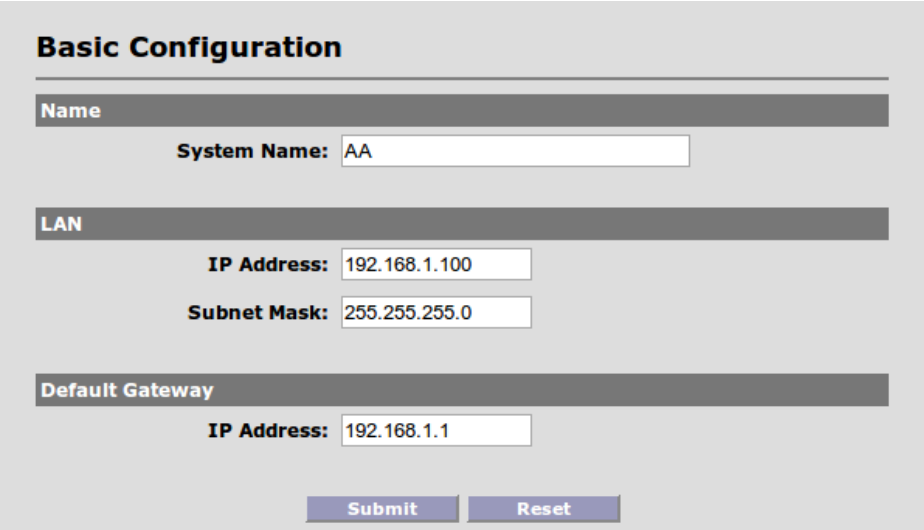
In order to provide an adequate seal, it is advisable to apply three wrappings:

1. electrical tape
2. sealant (such as the butyl mastic which is provided with the product)
3. electrical tape

The first wrapping of tape should be a single layer, followed by a generous wrap of butyl mastic. Finally, apply two layers of electrical tape, completely covering the mastic layer. Wrap the last layer of tape such that water is always directed down and away from connections.

6. IP Configuration

Navigate to **Configuration -> Basic** to access the Basic Configuration screen. The top one is for the Master unit and the bottom one is for the Slave unit.



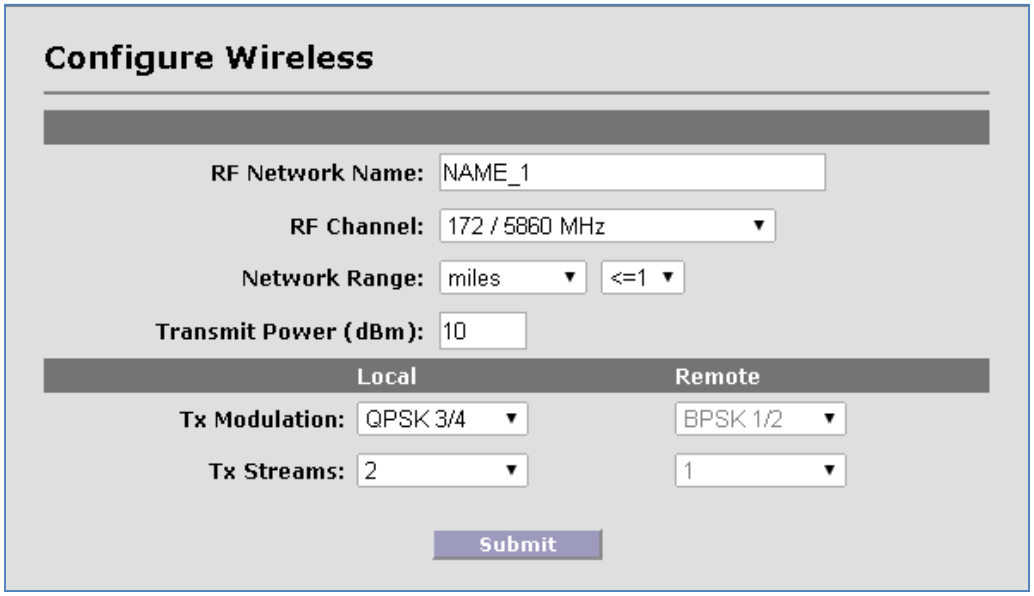
- **System Name** This is an optional description of the unit used to simplify the identification of a particular radio in the wireless network. This parameter is not related to the identification of the unit on your wired local area network. For security purposes, the System Name is not broadcast across the RF link. Name can be up to 32 characters long, and consist of all alphanumerics, plus the following symbols: @ (at sign), - (dash), .(period), ‘ (tick), _ (underscore). Name may not include spaces.

LAN /Default Gateway Configuration

- **IP Address**: IP address of the local unit.
- **Subnet Mask**: Subnet mask of the local unit.
- **Default Gateway**: Default gateway for the local unit.

7. Wireless Configuration

Navigate to **Configuration -> Wireless** to access the Wireless Configuration screen. This screen is for initial parameter settings only (for Slave unit configuration, go to **Configuration -> Clients**). The top screen shown below is for the Master unit and the bottom one is for the Slave unit:



Bandwidth Allows selection of the bandwidth (BW), in MHz, of the RF network. The standard channel is 10 MHz and there are two channels with 20MHz bandwidth.

Both Master and Slave units must be configured with the same Bandwidth setting.

Frequency Allows selection of the center frequency of the RF link, based on the model purchased, region of operation and operating bandwidth. The Frequency setting is available on the Master unit only. The slave unit will follow that of the Master unit.

A sample frequency list for the US FCC ITS band, is as follows:

Channel Number and BW	Frequency Center	Application Product
# 172 – 10MHz	5860 MHz	XL5910 and XL5930
# 174 – 10MHz	5870 MHz	XL5910 and XL5930
# 176 – 10MHz	5880 MHz	XL5910 and XL5930
# 178 – 10MHz	5890 MHz	XL5910 and XL5930
# 180 – 10MHz	5900 MHz	XL5930 Only
# 182 – 10MHz	5910 MHz	XL5930 Only
# 184 – 10MHz	5920 MHz	XL5910 and XL5930
# 175 – 20MHz	5875 MHz	XL5930 Only
# 181 – 20MHz	5905 MHz	XL5930 Only

NOTE – Due to the FCC EIRP regulations, XL5910 PTP kits with 23 dBi antenna cannot be used in certain channels as indicated above (#180, 182, 175, and 181).

Link Distance Should be set to the link distance, rounded up to the nearest mile or km. This parameter is used to optimize the performance across long distance links, accounting for the time of flight of packets from one side to the other.

RF Network Name The wireless network name assigned to this PTP kit only.

NOTE - The RF Network Name should be changed from the default settings, and each PTP link should use a unique RF Network Name.

NOTE - RF Network Name can be up to 32 characters long, and consist of all alphanumerics, plus the following symbols: @ (at sign) - (dash) . (period) ‘ (tick) _ (underscore). RF Network Name may not include spaces.

Transmit Power This parameter sets the RF output power of the radio. Increasing this value will extend the range of the PTP system. However, the maximum available power is limited by the chosen RF modulation and the regulatory entities in each country. The available values are 6, 7, 8, 9 and 10 dBm

Modulation Used to establish the transmit modulation and FEC rate of the OFDM radio. The higher the modulation setting (or “density”), the higher the link data rate, but the lower the receive sensitivity.

From lowest to highest data rates, the available modulation/FEC settings are:

- BPSK- ½
- QPSK- ½
- QPSK- ¾
- QAM16- ½
- QAM16- ¾
- QAM64- ⅔
- QAM64- ¾
- AUTO

From the above screen on the Master unit, Tx/Rx modulations for each client can be set individually. The values can be a specific modulation type or AUTO, using the ACM feature shown below.

Adaptive Coding and Modulation (ACM) The AUTO setting above will enable the ACM function in the network. This feature allows the system to determine the best TX modulation and MIMO settings based on current RF conditions. At power-up (or reset), the ACM function will begin operation at the most robust modulation and MIMO settings (BPSK-1/2, 1 stream). If link conditions warrant, higher order settings will be tested and selected for use.

The ACM function operates continuously, i.e. – if RF link conditions change, then the modulation and MIMO settings will respond in order to maximize link capability without compromising reliability.

The system relies upon user traffic to determine the optimal modulation settings. When ACM is enabled, user traffic must be available in order to bring link performance up to its maximum capability.

ACM is a feature that is enabled on a per-radio basis. It is not necessary for both radios to share the same state ACM enable/disable configuration.

ACM seeks to optimize the TX modulation of the radio on which it has been enabled. Since RF conditions may not be the same on either side of the link, due to impairments such as interference, the system may not select the same TX modulation/MIMO settings for each side.

The RF power settings will not be adjusted by the ACM system.

If the RF power is set above one of the power/modulation thresholds listed in the **Transmit Power** section, the ACM system will not likely reach higher order modulations. For example, if the radio power is set to 23dBm, then the ACM will not be capable of achieving QAM16 or QAM64 operation.

Tx Streams The power of MIMO technology rests on the ability to define the number of data streams that are carried across the two (2) RF links. At all times, the XL100t radios utilize a 2x2 dual-chain MIMO format where 2 RF transmit and 2 RF receive chains are enabled and active. However, these dual chains can be used to carry 1 or 2 data streams. XL100t systems are fixed to 1 stream operation only.

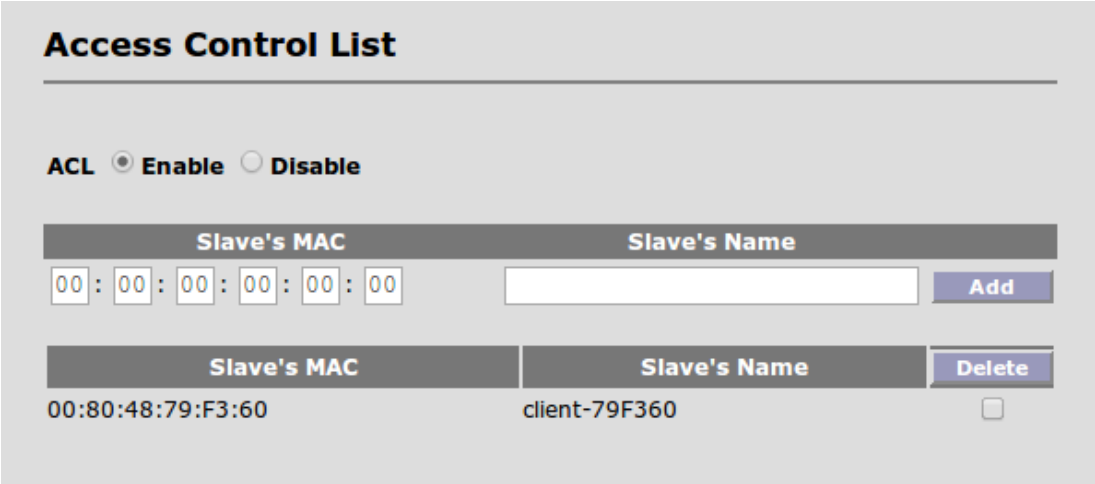
In a 2 stream configuration, unique data is carried across each RF chain, greatly increasing the amount of data capacity over a non-MIMO system. The 100 Mbps capability of the product requires that 2 streams operation be configured.

In contrast, when increased link robustness and noise immunity is desired, MIMO can be used in a 1 stream configuration. In this scenario, the same information is carried across both RF chains, increasing the reliability of reception.

It is recommended that both Master unit and Slave unit share the same Modulation and Stream settings.

8. Access Control

In order to match up with the Slave unit, the Master unit must be configured properly for the Slave unit. Navigate to **Configuration -> ACL** on the Master unit to access the following screen:

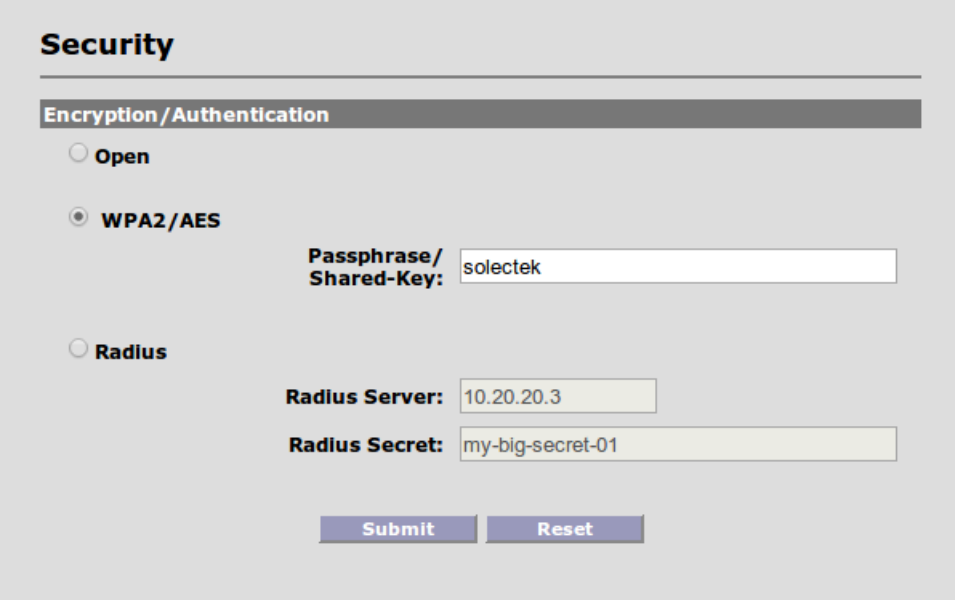


Access Control List (ACL) – enabling the ACL means that the Master unit only accepts Slave unit whose MAC addresses are registered at the Master unit. Disabling the ACL allows any Slave unit that operates with the same RF parameters as the Master unit.

In order to add a new Slave unit, enter the MAC address and the client name (name of your choice) and click the ADD button.

9. Security

Navigate to **Configuration -> Security** to access the Security Configuration screen a shown below.



Three security options are available: Open, AES and Radius. All units on a wireless network must share the same security settings.

Open: Removes all encryption and formal authentication methods. Note that even with the "Open" setting, there is still a MAC address based Access Control system which provides a basic level of security. (See the section on Access Control)

WPA2/AES: Provides 128-bit WPA2/AES data encryption with passphrase/shared-key based authentication.

Radius: This option combines AES data encryption with Radius/802.1x authentication capability, compatible with MS-CHAPv2/EAP authentication servers.

NOTE - AES passphrase and Radius identity / secret / password fields are case sensitive with no spaces allowed. Passphrase must be between 8 and 63 characters in length. The shared-key must be 64 Hex digits.

NOTE - Radius identity must contain an '@' symbol, and is typically in email address format.

10. Spectrum Analysis

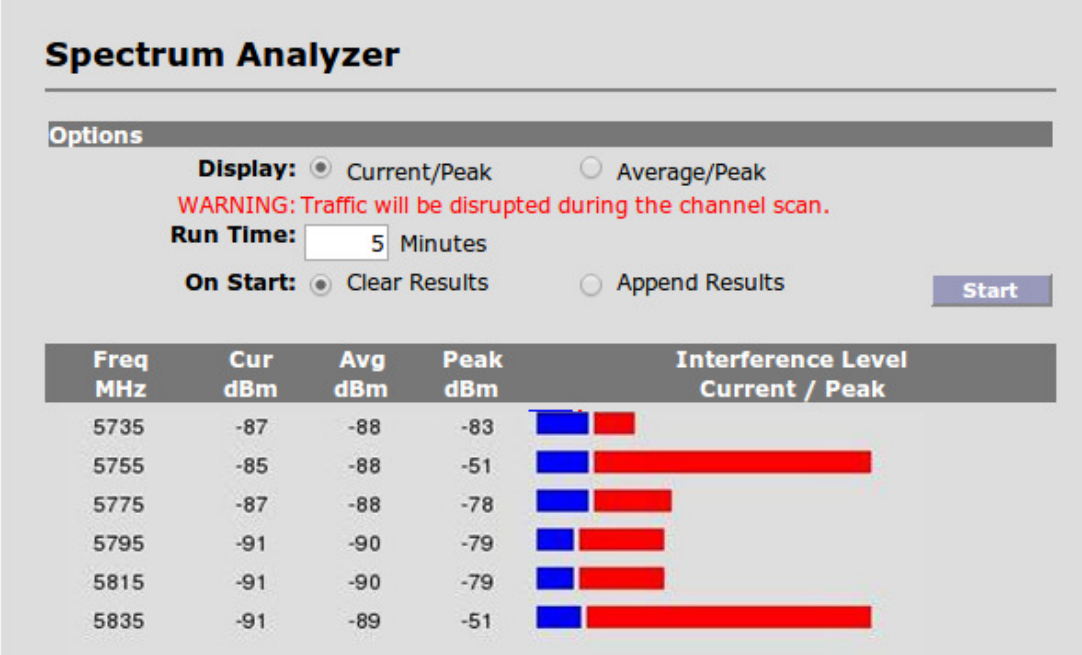
Once the radio has been mounted in its intended location, an embedded RF spectrum analysis tool can be used to survey the site and to aid with the initial channel selection process.

Prior to enabling a spectrum analysis session, ensure that the units are mounted at the desired location and aligned in the general direction of the target radio.

NOTE - If a noise and interference only analysis is desired, do not turn on the remote unit during the spectrum analysis, as the presence of the remote unit will affect the sweep data.

NOTE - Enabling a spectrum sweep will disable RF traffic until (a) the scan is manually stopped, (b) the run time set by the user runs out or (c) the 5 minute test period is complete. The 5 minute test period is based the US channel plan (FCC). International channel plans with larger number of channels may take longer time.

Click **Installation -> Spectrum Analysis** on the Toolbar to access the Spectrum Analysis screen:



In the example screen shown above, the scan shows high levels of interference at 5755 and 5835 MHz, and these channels would be unsuitable choices for satisfactory performance. While any of the remaining 20 MHz channels would be preferable, the channel centered on 5795 is a better candidate, as it is further from the strongest interferers.

There are two display options (Current/Peak and Average/Peak) to assist with analysis. Alternating between the two modes will not erase the collected data.

There are also two scan modes. The first, *Clear Results*, removes all historical scan data and reports only information gathered during the current scan. Alternatively *Append Results* can be selected if displaying aggregated results across multiple scans is desired.

To begin spectrum analysis, click **Start** button. The unit will scan through the available channels and display the results on the bottom of the screen. Numerical results, measured in absolute power (dBm) will indicate the interference and noise levels based on received signals from each channel. The blue bar indicates either the current or average power level (depending on mode selected) and the red bar indicates peak power received during the test interval.

After 5 minutes of scanning, the radio will automatically disable the scan and return to normal operation when the configured Run Time expires. A scan can be terminated sooner by clicking the **Stop** button on radios with local Ethernet access.

11. Antenna Alignment

SkyWay XL100t contains several tools to aid with the antenna alignment process that is essential for Slave units.

Audible Alignment: The radio produces an audible tone allowing antenna alignment without the need for additional monitoring hardware.

CAUTION - A ping, or other network traffic is needed to ensure reliable operation of the alignment feature, in which case the Activity indicated will be in a green state. If no network traffic is detected, the Activity indicator will be in a red state.

The pulsed tone will begin once an RF link has been established, regardless of quality. It is useful to reduce the RF modulation setting to its lowest value (BPSK) during the antenna alignment procedure to maximize the system's link capture envelope/angle.

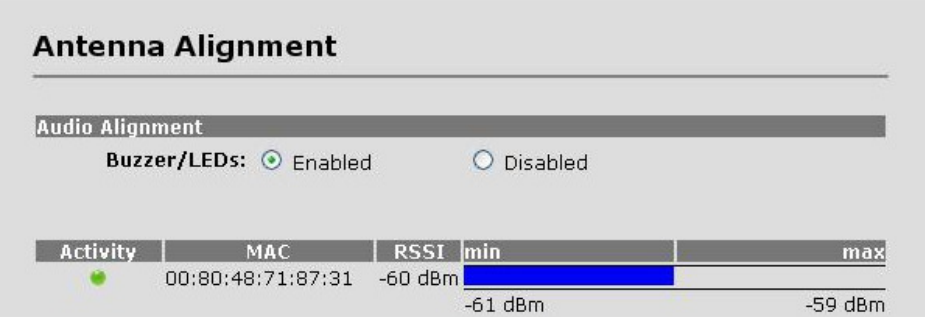
The audible repetition rate will increase as RSSI improves; a higher value will cause a faster rate. To assist with both coarse and fine tuning, the rate is NOT a simple function of RSSI value. Rather, the rate will continue to increase as long as adjustments deliver an improved RSSI. As soon as any degradation (alignment 'overshoot') is detected, the rate quickly falls, regardless of the amount of reduction. Thus, the system is useful for both coarse and fine tuning of the antenna position.

To ensure the system will deliver adequate link reliability, it is recommended that the operator verify the numerical RSSI following antenna alignment.

The audible function is enabled for the first 30 minutes of operation following a power cycle. If desired, the audible function can be manually disabled using the telnet command: *set audioalign 0* or via the **Alignment Page** (below).

Regardless of whether the audible function is enabled or disabled, the unit will emit a short audible tone upon initial power-up.

Alignment Page: An alternative tool to assist with antenna alignment is the Antenna Alignment page. Navigate to **Installation -> Antenna Alignment** to display the following page:



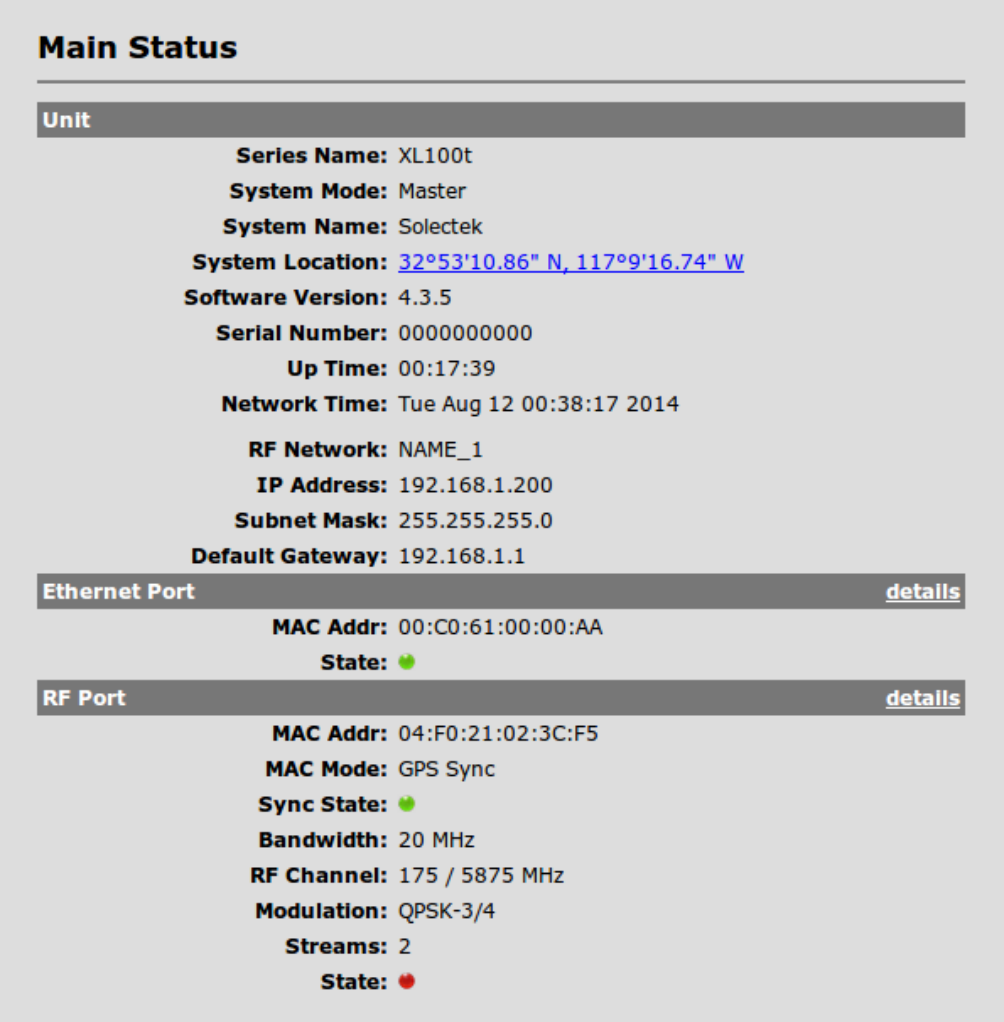
On this page is a dynamic display of the RF link state and local RSSI, in both numerical and graphical format. In addition to displaying current RSSI, the bar graph format has an auto-scale function which tracks the minimum and maximum achieved RSSI values since power-up.

NOTE – Fluctuations in RSSI values up to ±2 dB should be expected. This should be considered normal behavior of the radio.

12. Verifying Operation

12.1 Main Status Screen

The basic status can be viewed in the Main Status screen:

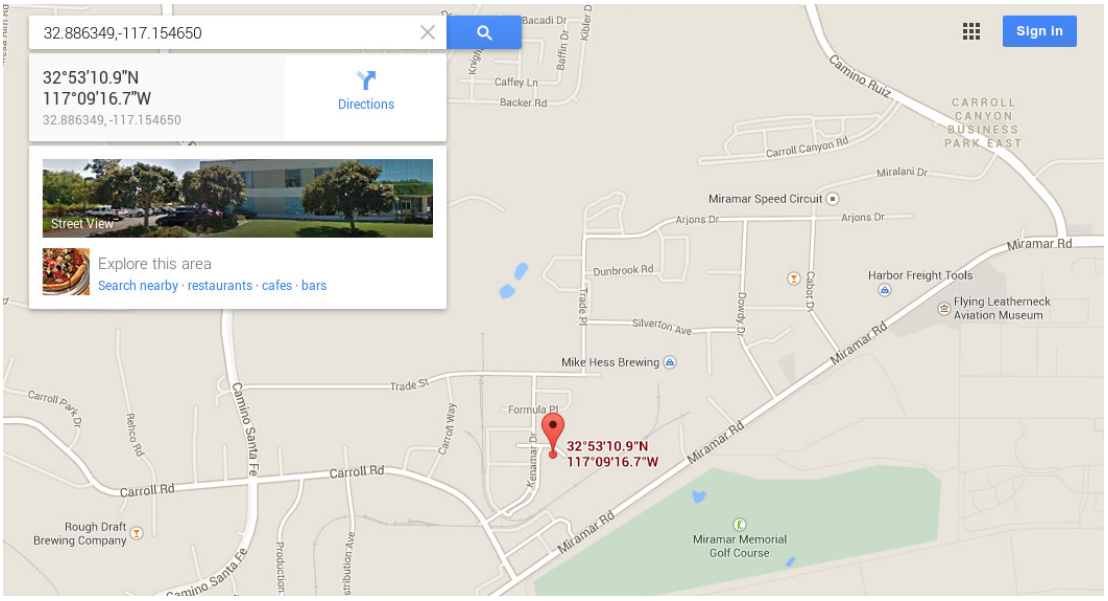


This screen updates periodically and thus displays current field values. Navigate to the **Configuration** screen if setting changes are necessary.

There are several noteworthy items:

Software Version The currently installed, operating image version.

System Location Each radio unit included a built-in GPS module and the administrator can locate the unit's location real-time for asset tracking purposes. The current GPS coordinates are displayed here and clicking the hyperlink will open up a Google map in another window such as the following:



Up Time The elapsed time that the unit has been running since the last reboot or power cycle.

Ethernet Port – details of the Ethernet port status can be viewed by clicking the details on the right side of the screen. The actual screen is shown in Section C below. The Ethernet Port MAC address is shown for diagnostics purposes, but has no effect on the Master unit to client wireless connection.

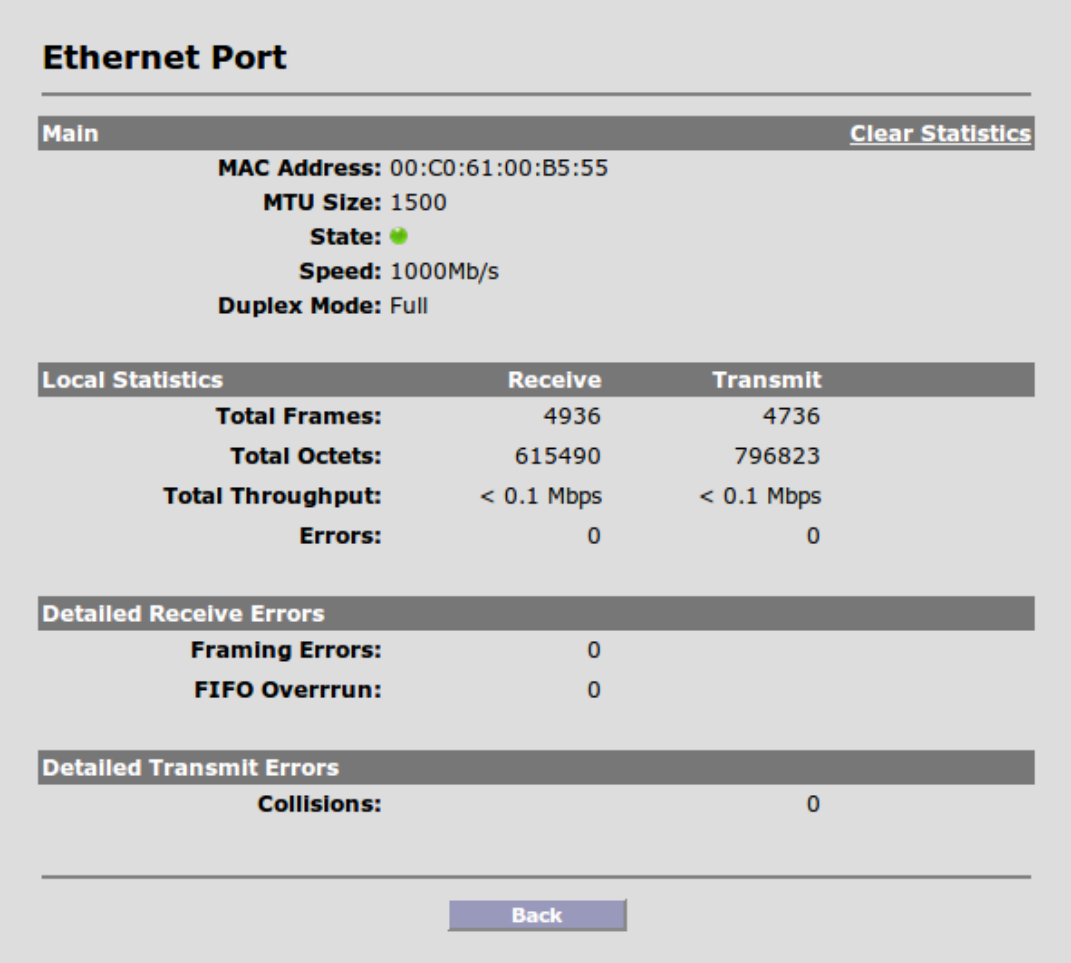
RF Port – The RF Port MAC address is what is used by access control and thus must be entered into the access control list at the Master unit.

State (RF Port) The link state has two values.

Green – An RF link has been established

Red – An RF link is NOT established.

Clicking on the details button on the Ethernet port and RF port will show the following screen.



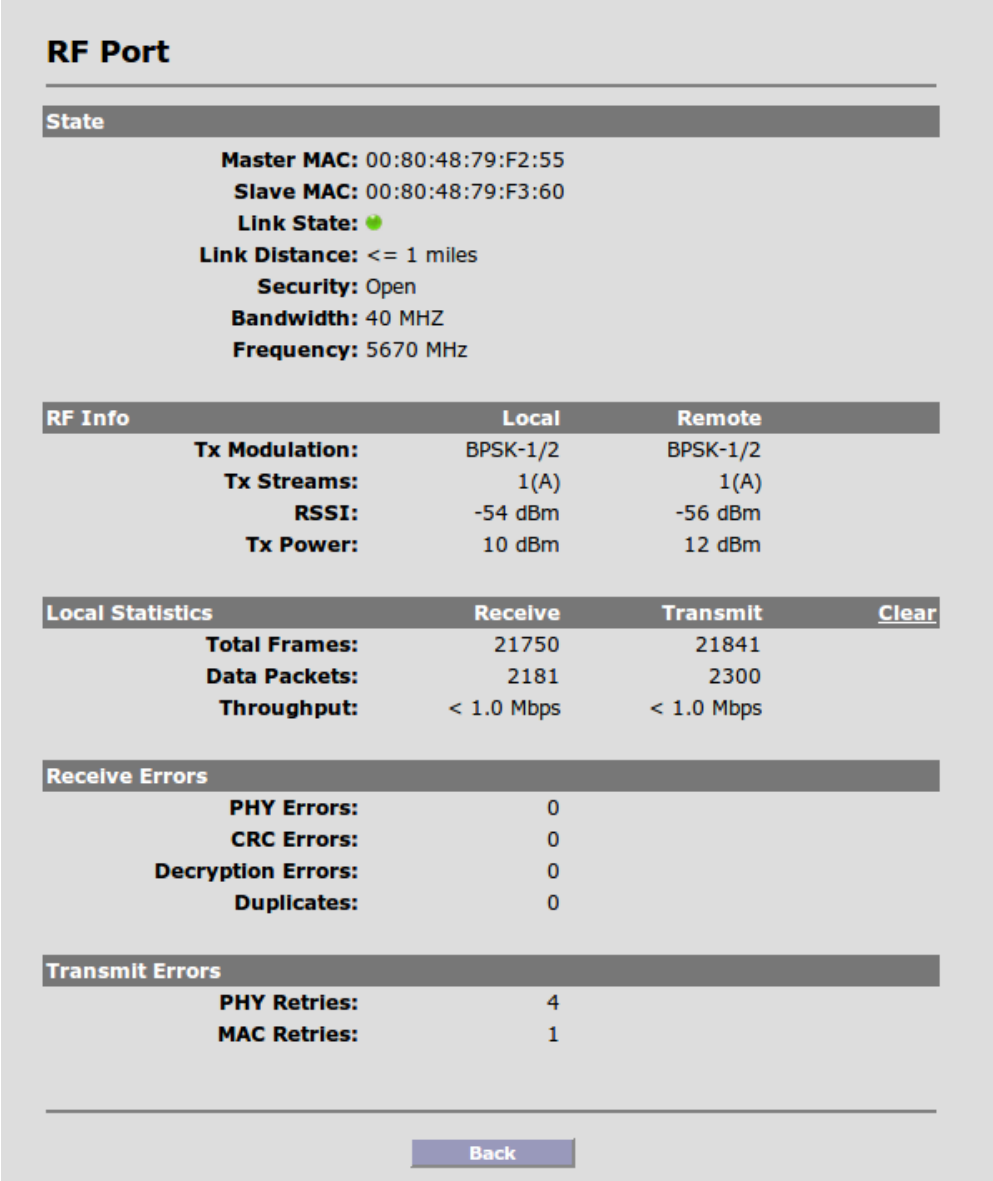
MTU Size The maximum datagram size that the system is able to transmit. Note that this refers to Ethernet payload not total Ethernet frame size. This parameter is not user configurable.

State: There are two states, Green – Port Up. Red – Port Down.

Total Frames: Total number of frames received and transmitted by the Ethernet port.

Total Octets: Total number of octets (bytes) received and transmitted by the Ethernet port.

The RF Port (navigate to the **details** button on the Main Status screen next to each client's description) also has its own detailed screen:



RF Info – This section shows values seen from local and remote unit. Values are displayed from its own perspective. Local RSSI, for example, means the RSSI read from the local receiver.

Tx Streams – This indicates whether the unit is being operated with 1 data stream or 2 data streams over the RF channel. The ACM operation is indicated by the designation of an 'A' in parenthesis. Fixed operation is indicated by an 'F.'

Local Statistics – These are values experienced by the local unit. Receive Column details values at the local unit receiver and Transmit Column details values at the local unit transmitter.

Throughput – Please note that the throughput value displayed here do not refer to the radio link capacity. Rather, it refers to the instantaneous throughput over a short time period measured by the unit. The value here is meaningful for estimating the traffic amount if such traffic can be sustained over some time period. Due to framing overhead, actual IP throughput will be less.

Total Frames: Total number of aggregated RF data frames received and sent by the unit.

NOTE – Total Frames number from RF port number should not be expected to match the Ethernet frames count. Packet framing, aggregation and QoS operations will all affect the manner in which data is transported from Ethernet to RF port.

Data Packets: Total number of data packets prior to aggregation, on the transmit side, and following de-aggregation, on the receive side.

Receive Errors: Total number of Errored Frames received by the local unit.

NOTE - When diagnosing link problems, it's useful to clear the RF statistics and allow 5-20 minutes of new data to accumulate. This will provide an accurate picture of the current link conditions. On occasion, it may be useful to sample a longer time period, up to 24 hours in some cases, as the influence of external interference sources can vary across time due to usage patterns. In many situations, some amount of errors may be expected and unavoidable.

NOTE - RF Frames which are significantly damaged can not be accurately attributed to a paired radio and will not be counted towards receiver errors.

NOTE - Some amount of error is expected and unavoidable in most wireless link. Retransmissions will be transparently handled by the radios and by any TCP-IP hosts connected to the link. For evaluating link quality, the figure of interest is the Frame Error Rate, which can be obtained by dividing the number of errored frames by the total number of frames.

In general, a Frame Error Rate less than 10% will have little or no noticeable effect on throughput.

Transmit Errors: Total number of frames transmitted by the local radio that were not successfully acknowledged by the remote radio.

Errors of this type can be attributed to two causes: (a) Data packet not received by remote radio, or (b) Acknowledgement packet from remote radio not received by local radio.

NOTE - Because the SkyWay XL100t radio is a TDD system and uses the same frequency for both transmit and receive, it is often instructive to compare RX and TX error counts on both sides of the link so that RF impairments can be isolated to the appropriate link direction and radio.

For example, if Radio A has a large number of TX errors and Radio B has a large number of RX errors, one could conclude that the RF link from A => B was impaired. Sources of potential interference at Radio B could then been investigated.

Bridging Status of the RF and Ethernet ports can be monitored by going to Status->Bridging:

Bridging Status

Port	MAC Address	Local	Age Time
RF	00:80:48:79:F2:55	yes	0.00
RF	00:80:48:79:F3:60	no	232.09
ETH	00:C0:61:00:B5:55	yes	0.00
RF	00:C0:61:00:B5:56	no	0.10

13. Quality of Service (QoS)

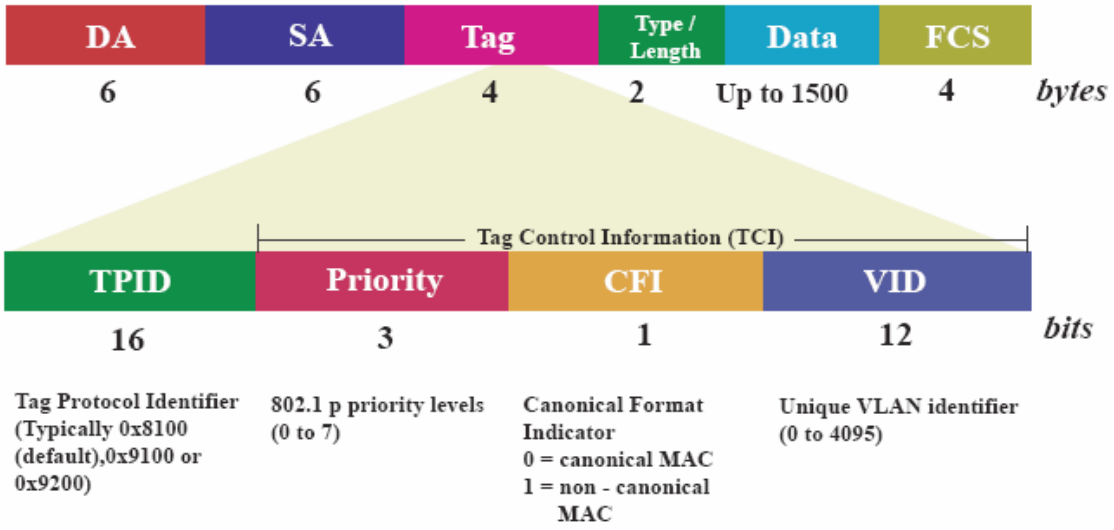
Introduction

The XL100t QoS model is based on the Wireless Multimedia Extensions (WME). This is also known as Wi-Fi Multimedia (WMM) and is a Wi-Fi Alliance inter-operability certification, derived from the IEEE 802.11e standard. It provides basic Quality of service (QoS) features to IEEE

802.11 networks. WMM prioritizes traffic according to four Access Categories (AC) - voice, video, best effort, and background. However, it does not provide guaranteed throughput.

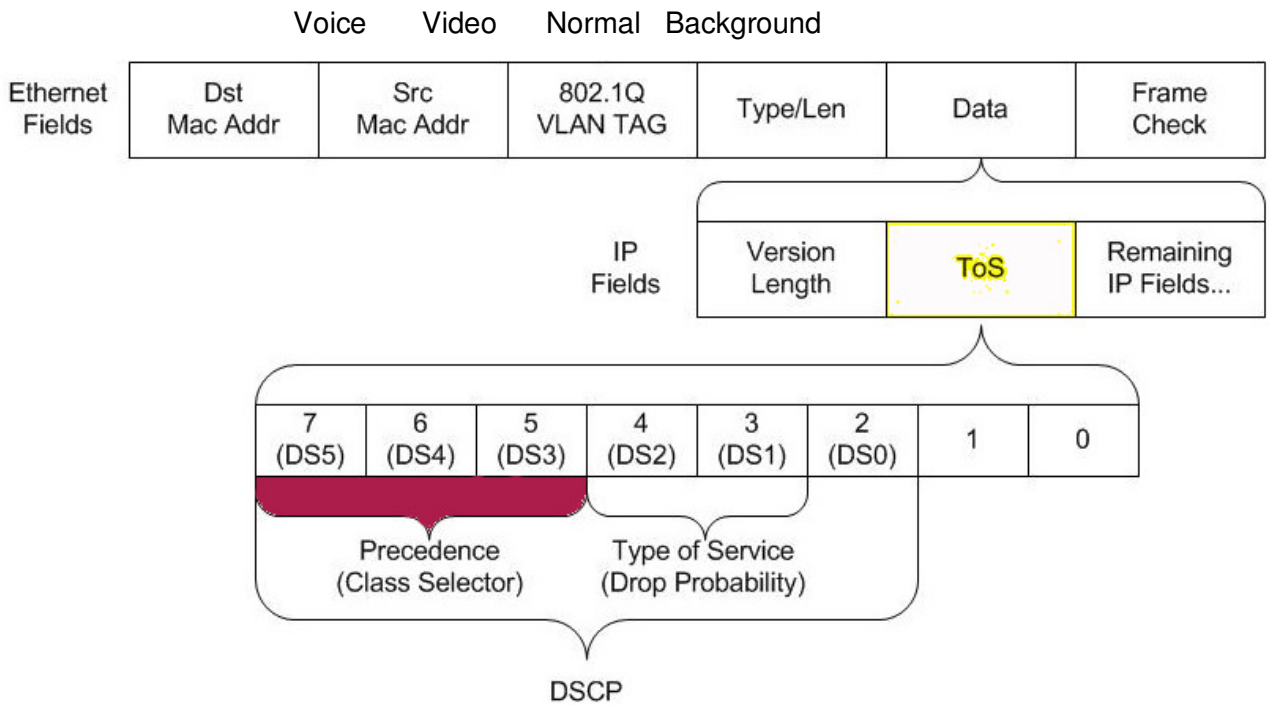
QoS Implementation in Access

The software driver basically classifies the PDU's based on VLAN priority (if present) and IP Precedence bits. The first classification is with VLAN priority bits. If the incoming traffic has a VLAN ID present the classification is done as shown in the figure and table below.



VLAN Priority	Class of Service
0	Best Effort
1	Background
2	Background
3	Best Effort
4	Video
5	Video
6	Voice
7	Voice

After the VLAN classification, the IP packets are classified according to Precedence bits (3 bits) of the IP TOS field. These precedence bits map to Diff Serve Code Points (DSCP) bits (DS5-DS3). Bits 0 and 1 of the TOS field are reserved and are always 0.



Precedence	Class of Service
0	Best Effort
1	Background
2	Background
3	Best Effort
4	Video
5	Video
6	Voice
7	Voice

If there is no classification, (no VLAN and IP TOS 0) the packet falls under the Best Effort class. If the packet has both VLAN and IP precedence values, the maximum of the two priorities (VLAN/IP) is used.

The following table shows the mapping of class of service on various DSCP/TOS values.

Class of Service	IP Precedence (3 bits)	DSCP (6 bits)	TOS (8 bits)
Best Effort	0,3	0x0 (0) 0x18 (24) 0x1A (26) 0x1C (28) 0x1E (30)	0x0 0x60 0x68 0x70 0x78
Background	1,2	0x8 (8) 0xA (10) 0xC (12) 0xE (14) 0x10 (16) 0x12 (18) 0x14 (20) 0x16 (22)	0x20 0x28 0x30 0x38 0x40 0x48 0x50 0x58
Video	4,5	0x20 (32) 0x22 (34) 0x24 (36) 0x26 (38) 0x28 (40) 0x2E (46)	0x80 0x88 0x90 0x98 0xA0 0xB8
Voice	6,7	0x30 (48) 0x38 (56)	0xC0 0xE0

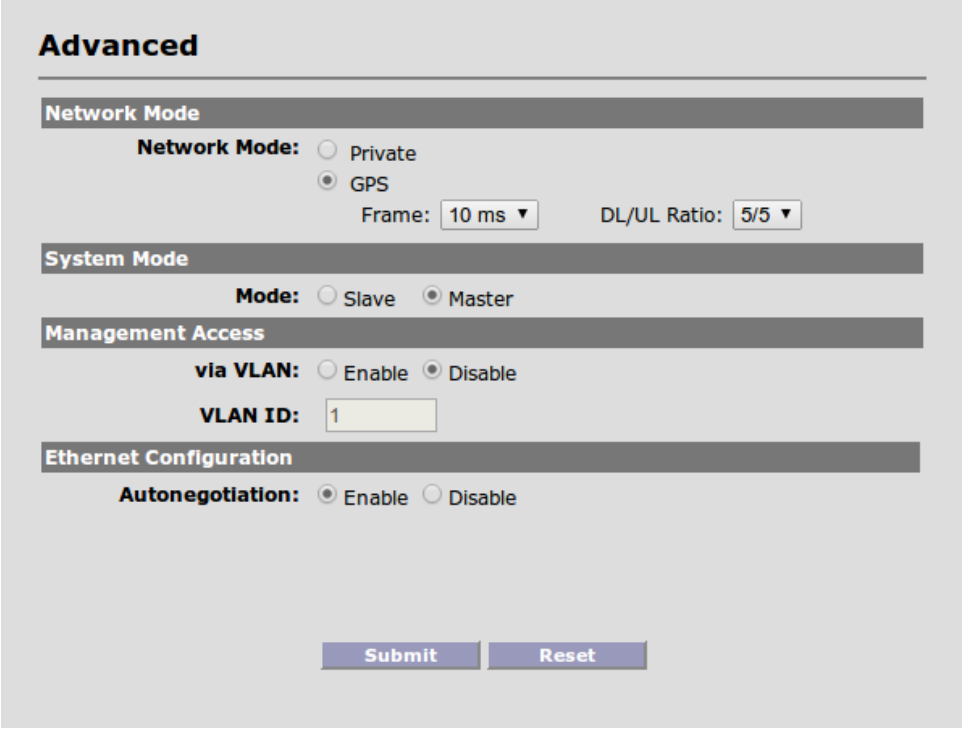
Queue mapping

The table below shows the mapping of different types of traffic to hardware queues. The Hardware MAC consists of 10 Queues starting from 0 to 9. Highest priority Queue is 9 and typically used for beacons. Next highest priority is 8 and is associated with beacon gated frames. The remaining 8 queues are used for different types of traffic classes. XL100t only uses queues 0-3 and 9.

Queue number	Traffic Type	
0	Best Effort	Lowest Priority
1	Background	
2	Video	
3	Voice	
4	Not used	
5	Not used	
6	Not used	
7	UAPSD - Not used	
8	CAB - Not used	
9	Beacon	Highest Priority

14. Advanced Modes

An advanced configuration section is available under **Configuration** -> **Advanced**, as shown below, the top picture is for the base and the bottom picture is for the Slave unit:



Network Mode

The PTP system has two MAC layer operating modes:

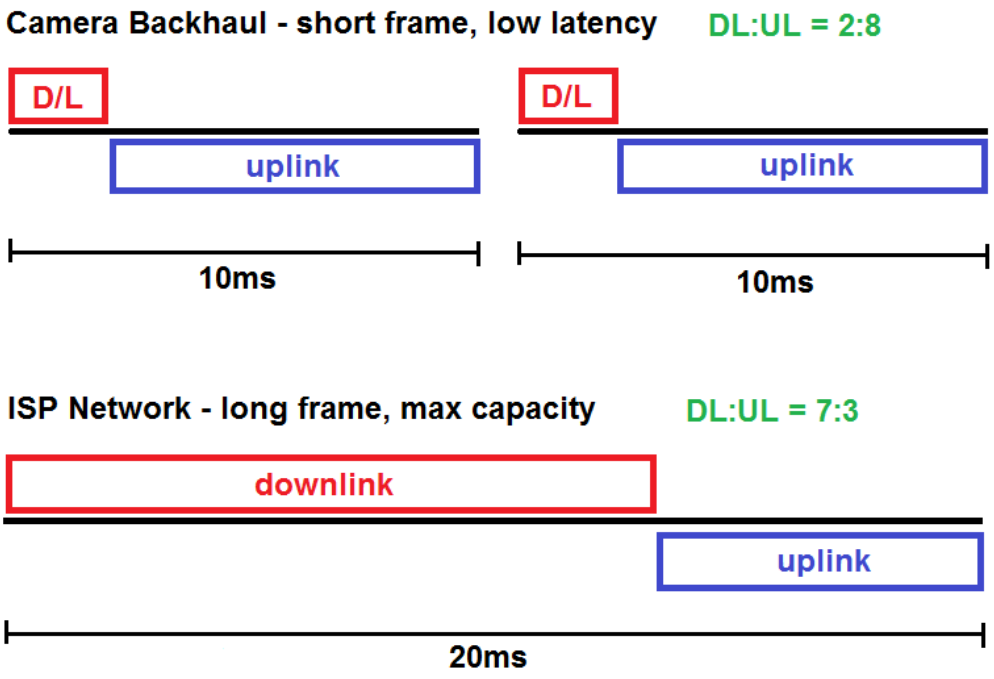
Polling MAC: Polling MAC is superior when the application case involves heavy traffic.

Private Network Mode: In certain situations, customers may prefer to use Private network Mode. For example, performance may be better in a private network where there is a lot of Slave unit to Slave unit traffic (office branches, server located at a Slave unit building, etc)

GPS Mode: This mode should be used when there are co-located Master units at the same time. In order to use this mode, the Master unit must be a GPS-ready version, e.g. AS5802 instead of AS5800. The GPS port on the Master unit must be connected to a GPS sync controller.

- **Frame** – This refers to the time slot (frame) duration that the Master unit allows for each downlink / uplink cycle. The default value is 10ms. The other choice is 20ms.
- **DL/UL Ratio** – Each time slot is divided into downlink traffic (DL) and a uplink traffic (UL). The default is 5:5 (most Enterprise network). Available DL/UL radios are 9:1, 8:2, 7:3, 6:4, 5:5, 4:6, 3:7, 2:8, and 1:9.

The concepts of frame sizes and DL/UL ratios are explained in the following diagram. The Master unit operates in a 10ms or 20ms cycle during which downlink and uplink portions are defined by the DL/UP ratio. During the downlink portion, the Master unit will send data to Slave units using polling MAC and then the Master unit switches to the uplink portion and Slave units will send data during that portion of the cycle. This cycle continues during the period defined by the frame size (10ms or 20ms).



DL/UP ratios should be set in accordance with the application. For example, ISP networks tend to be downlink heavy with subscriber downloading web contents. In that case, the 7:3 ratio may be appropriate. For IP camera backhaul, the traffic is dominated by uplink traffic coming from cameras attached to Slave units. In that case, the 2:8 ratio may be suitable.

The longer 20ms frame size reduces the overhead and increase the throughput, but the drawback is a higher overall latency due to longer cycles. It may not be suitable for latency-sensitive, real-time applications.

CAUTION – Extreme ratios such as 9:1 and 1:9 should be avoided for most applications, particularly with the 40MHz channel size operation.

System Mode

A PTP unit can be either a Master unit or Slave unit. One side must be chosen as Master and the other as Slave. The functions are very similar between the two units, but the Master unit has a few more control parameters, for which the Slave unit will follow the Base configuration.

Management Access

Via VLAN Enable/Disable. If access to the Web GUI will be from a PC within a VLAN, then this feature should be **Enabled**. If access is from a PC outside of a VLAN, then this feature should be **Disabled**.

VLAN ID: The ID should be set to match the VLAN ID used on your management PC. This setting does not affect any other VLANs running on your network or the ability to pass VLAN traffic.

WARNING - Enabling Management Access via VLAN will *lock-out* HTTP and Telnet access if attempting to connect from a PC without the proper VLAN configuration. Access to units with an unknown VLAN configuration can be recovered through the use of Solectek's *Recovery* utility software on radios running recent revisions of software. Check with Solectek Support for details.

Ethernet Configuration – This section allows users to configure the Ethernet port manually, particularly for interfacing with older hardware. Solectek strongly recommends using auto-negotiation default mode in most cases.

NOTE - Autonegotiation is REQUIRED for 1000BASE-T operation, per the IEEE 802.3-2002 standard: "a) To negotiate that the PHY is capable of supporting 1000BASE-T half duplex or full duplex transmission. b) To determine the MASTER-SLAVE relationship between the PHYs at each end of the link."

15. Telnet

Using the radio's IP address, the system can be managed using a Telnet connection. The login and password are the same for a Telnet session as for the HTTP GUI.

Sessions can be initiated from both the Ethernet and RF side of the Network, and multiple sessions are permitted.

Commonly used commands include:

>status

>get rssi

>get counters

>show log

>uptime

>get <to see read commands>

>set <to see write commands>

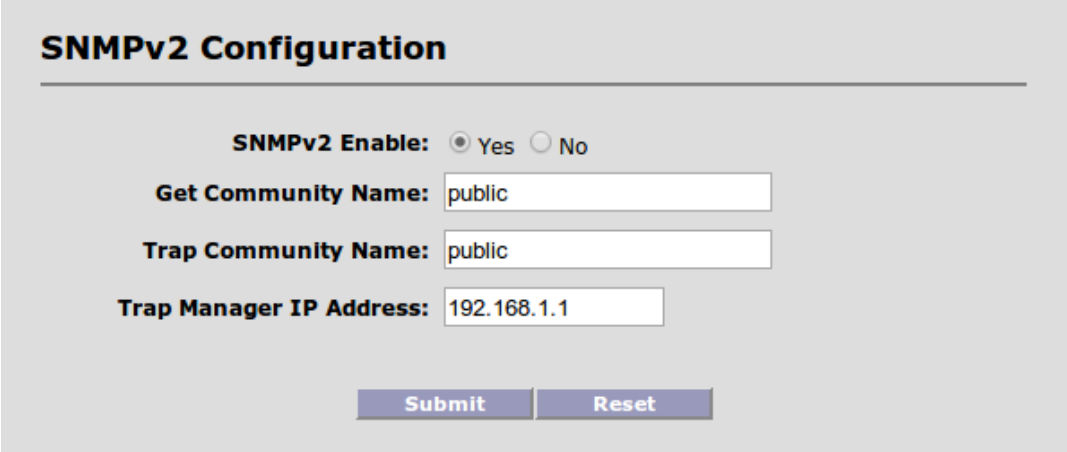
>? <to see other commands>

See Appendix B for a complete Telnet command set, syntax and usage.

16. SNMP

The SkyWay management system includes '*get'* support for SNMP v2c via standard and private MIB tables. This screen is available at the Master unit only.

Navigate to **Management** -> **SNMP** to access the SNMP Configuration screen:



SNMP Enable: For security purposes, the SNMP engine can be disabled, if not used.

Community Names and **Trap Manager IP Address** fields should be entered based on the configuration of your SNMP Manager software.

The private MIB is available on Solectek's Support website or from Solectek Technical Support personnel.

For further information about SNMP management, the following documents available on Solectek's Support Website may be helpful:

- *SkyWay SNMP Usage Guide*
- *SNMP Objects for Monitoring SkyWay*

NOTE - SNMP community fields are case sensitive with no spaces allowed. Fields must be between 1 and 64 characters in length.

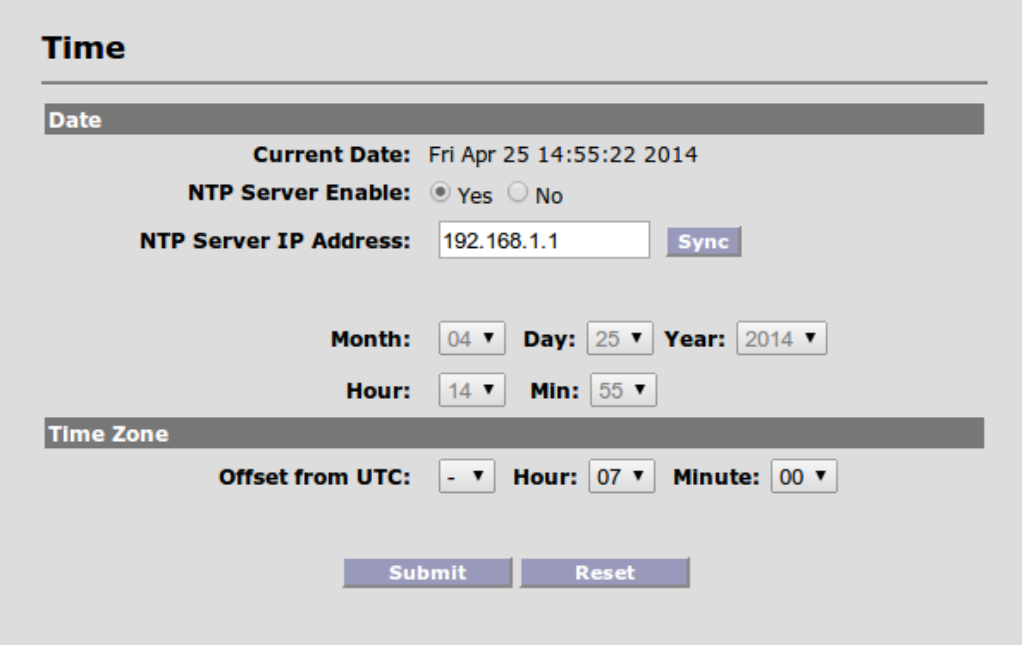
NOTE - Legal characters are: all alphanumerics, plus the following symbols:

@ (at sign) - (dash) . (period) ' (tick) _ (underscore)

17. Network Time

Using the Network Time Protocol (NTP), the SkyWay XL100t radio can be time synchronized to an NTP v3/v4 time server as defined by www.ntp.org.

To setup this feature, navigate to **Configuration** -> **Advanced** to access the Date and Time feature configuration:



To time synchronize the radio, the NTP server IP address must be established and the 'sync' button pressed. If connection is successful, the local time/date will be updated to match NTP time.

An NTP resync will occur automatically twice per day.

If the NTP server is off-line, time is still kept locally on the radio. However, a reboot of the unit will blank the time. A re-connection to the NTP server or manual re-configuration of the time is required to correct the time/date.

Time zone information must be entered manually as a fixed offset from UTC. Once entered, this information is stored in non-volatile local memory and does not need to be re-entered.

All changes, except for the NTP Sync function, should be followed by a 'Submit' to make active.

18. Password Management

Navigate to **Management** -> **Password** to access the Login configuration screen:

Enter New Password: Enter the new password.

Confirm Password: Re-enter the new password for confirmation.

Select the “Change” button.

The browser will popup a new login window. You must log back in to the system with the new password.

At the time of the first password change, a password ‘hint’ prompt will be displayed.

Once established, this hint answer can be used to reset the admin password, if it has been forgotten, via the ‘recover’ Telnet login, as follows:

> Login: recover

> Password: (default)

Once logged in as ‘recover’, the hint will be given:

> What is the name of your favorite pet?

Upon successful answer, the admin password can then be changed.

CAUTION - It is strongly advised that the admin password, and hint answer be recorded and stored in a secure location.

NOTE - Password & hint fields are case sensitive and no spaces are allowed. Password & hint should be 6-32 characters in length. To avoid a ‘weak password’ warning when changing the password via Telnet, it is required that passwords contain a mix of uppercase letters, lowercase letters, numbers and symbols.

19. Upgrading the Software

There may be new software releases from Solectek periodically posted on Solectek's support portal and available from Solectek Technical Support.

The software is comprised of three sections: Firmware, Kernel and Bootloader. However, only a single upgrade operation is required to bring all three up to the latest revision.

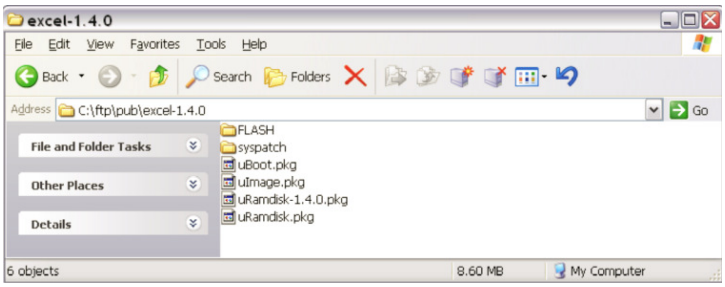
Upgrading the software will not affect the system configuration, but does require a short period of system downtime to complete the process.

NOTE - A PC based FTP server program running on a locally connected PC is required to complete the following upgrade procedure. Solectek recommends FileZilla, a free, open-source FTP server program available via http://filezilla-project.org/

Once the FTP server is installed, the following procedure should be followed:

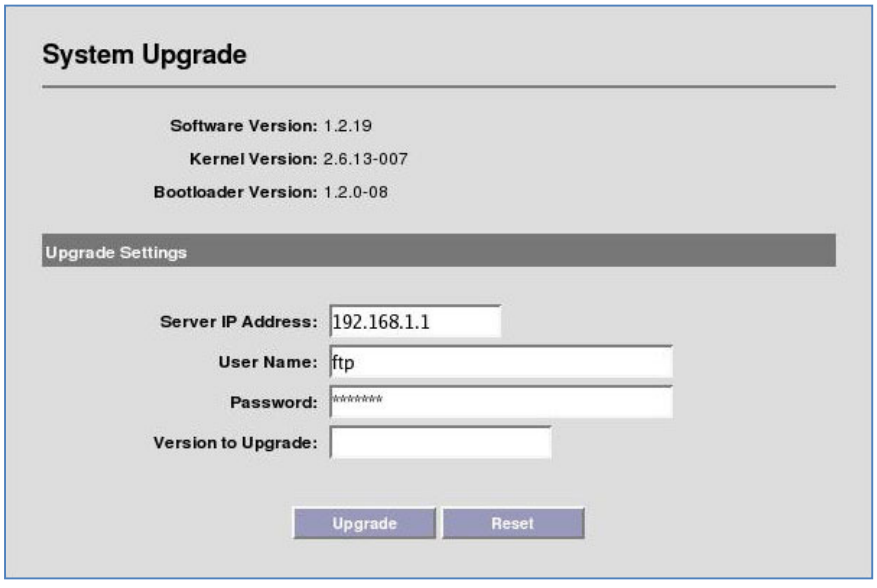
1. Copy .zip software release package from Solectek website or Technical Support to FTP Server desktop.
2. Unzip / extract files to any convenient directory.
3. Navigate into the extracted fileset to reach the SetupFirmware.exe tool.
4. Launch tool by double-clicking on tool icon; the following screen will be displayed:

5. Press the 'Browse' button and select the folder that has been configured as Home Directory in the FTP server software.
6. Press the 'Start' button. This begins a file copy operation and ensures that all upgrade files and folders are properly moved into the FTP directory. Once complete, the resulting FTP file structure should appear as follows:



7. On the Radio management GUI, navigate to **Management** -> **Upgrade** to access the Upgrade screen (see sample below).
8. Enter the FTP Server IP Address, Username and Password information as requested.
9. Enter the three digit software version to be loaded onto the Radio. Format will be x.y.0 (e.g. – 1.4.0).
10. Press the 'Upgrade' button to begin the file transfer process.
11. Once complete, the unit must be rebooted for the upgrade to take effect.

WARNING - Do not power down or unplug the unit during the upgrade process. Software image corruption may occur if power is disrupted during the flash write process.



If the upgrade fails to complete, or times out:

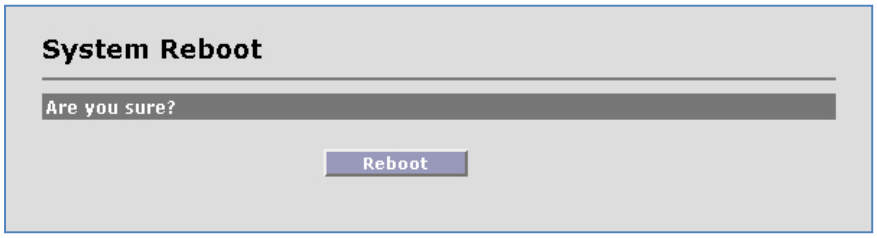
- Verify the FTP user account has read permission on the target folder.

- Verify that the FTP server's software firewall is disabled. For example, Windows XP has an integrated firewall that can block the upgrade.

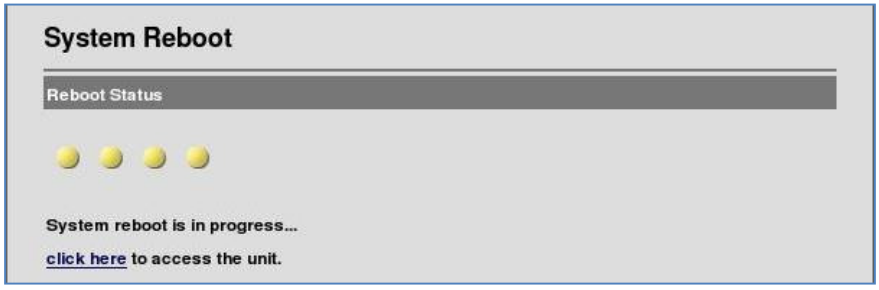
- Retry Upgrade procedure.

20. System Reboot

Navigate to **Reboot** to access the System Reboot function:



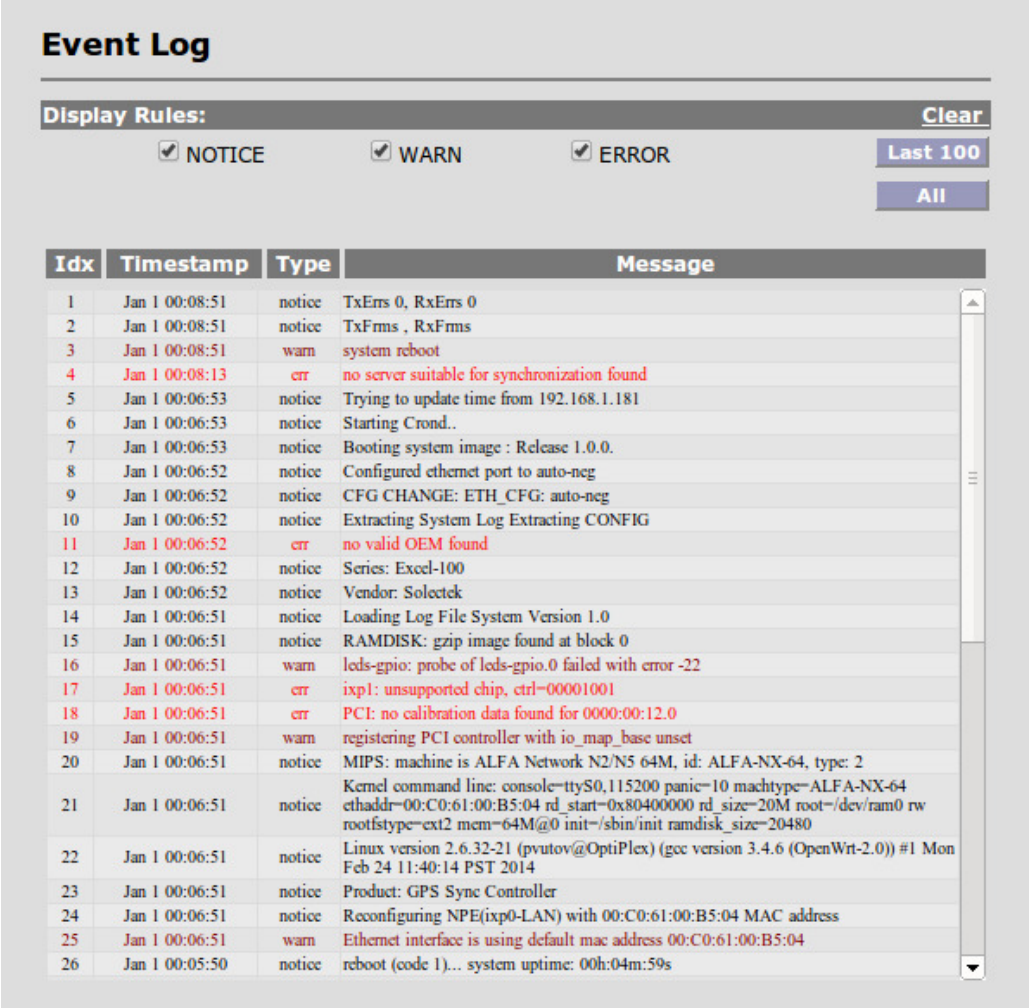
Click on the **Reboot** button to reset/reboot. The reboot process will take approximately 60 seconds. Once the rebooting is done, you can use the **Click Here** button below to access the user interface again.



21. Event Log

The Event Log displays all major events that may be noteworthy for the system administrator for both monitoring and troubleshooting purposes.

Navigate to **Status** -> **Event Log** to access the Event Log Screen:



There are three categories of events:

Notice: This is informational in monitoring the operation of the unit. A Notice entry is part of the normal operation.

WARN: This may indicate something wrong with the unit or operation. For example, downing of the RF port may be due to malfunction or user intervention (power off).

ERROR: This is indicative of unanticipated or erroneous operating conditions.

22. Log/Configuration Transfer

For diagnostic purposes, the Event Log and System Configuration database can be transferred from the Radio to a local PC via FTP. The default names of these files are as follows:

CONFIG_VARS-"system_name".MMDDYYhhmm

events-"system_name".MMDDYYhhmm

clients-"system_name".MMDDYYhhmm

Navigate to **Diagnostics -> File Upload** to access the following screen:

FTP Server IP Address: Local FTP server address.

User Name: User name used to login to the FTP server.

Password: Password used to login to the FTP server.

File Directory: Location on Local FTP server to save Event and Configuration files. If left blank, files will be transferred to the FTP server's home directory.

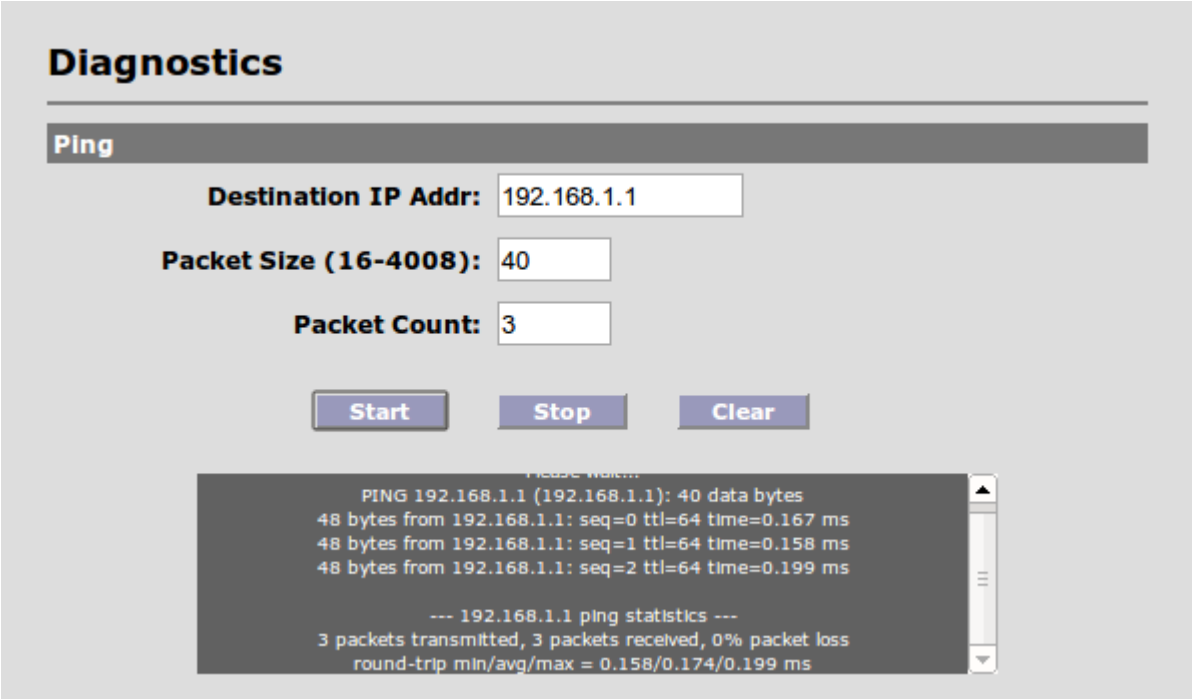
NOTE - FTP Username and password fields are case sensitive with no spaces allowed. Fields must be between 1 and 32 characters in length.

NOTE - Legal characters are: all alphanumerics, plus the following symbols:

@ (at sign) - (dash) . (period) ‘ (tick) _ (underscore)

23. Diagnostics

For access to diagnostic tools, navigate to **Diagnostics => Time/Ping** menu to view the following:



The ping tool can be used to isolate an issue to the wireless link only, not involving other network elements such as switches and host computers. You can ping the remote unit from the unit you are accessing via the user interface.

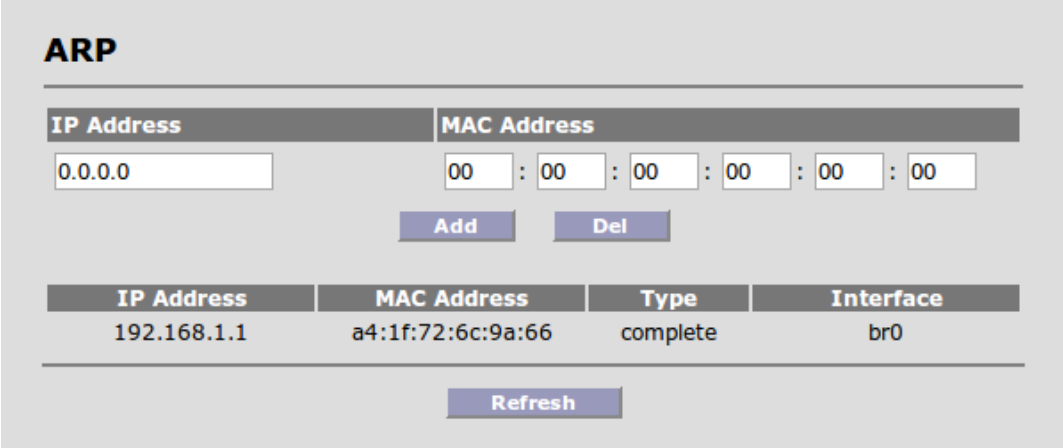
Destination Add: The IP address of the device to be pinged.

Packet Size: The size of the ping packets to be sent (in bytes).

Packet Count: The number of packets to be sent to the destination IP address.

Click on the **Start** button to initiate the ping session. Click **Stop** to terminate it.

You can also manage and view the status of ARP for both Master unit and Slave unit, as shown in the screen below:



Appendix A: Factory Configuration

WIRELESS	
Radio Spectrum bandwidth	20 MHz
Frequency (Master unit-only)	Product & Region Specific
RF Power	17 dBm
Modulation	QAM16-1/2
Streams	1
Distance	1 miles
RF Network Name	Name_1 (Master unit)
Security	Open
Access Control List (ACL)	Enabled

LAN	
IP Address (Slave unit) IP Address (Master unit)	192.168.1.100 192.168.1.200
IP Mask	255.255.255.0
IP Gateway	192.168.1.1
Login Name / Password	admin / admin
Ethernet Port	Auto

Appendix B: Telnet Commands

Command	R/W	Default	Usage	Description
acl	RW	enabled	*acl* add [mac] [client-name] acl del [mac] acl show *acl* [enable | disable]	Master unit only Add/Delete/Show entries in the RF access control list. Enable or Disable acl function
arp	RW		*arp [OPTION]* *Options:* *-a Display (all) hosts* *-s Set new ARP entry* *-d Delete a specified entry* *-v Verbose* *-n Don't resolve names* *-i IF Network interface* *-D Read [hwaddr] from given device* *-A, -p AF Protocol family*	Manipulate the system ARP cache
audioalign	RW	1800 secs	*set audioalign* [duration_secs] *show audioalign*	Set/show Audio Antenna Alignment duration in seconds. Duration 0 disables alignment tone.
bridge	R		show *bridge*	Show Bridge Table
bw	RW	20	set *bw* [20 | 40] show *bw*	Set RF bandwidth in MHz
chanplan	R	Varies by Model, Region	show chanplan	Show channel plan.
cfgdiff	R		cfgdiff [boot]	Shows differences between current configuration and default
clear	W		*clear*	Clears all Ethernet & RF Port counters
clearevtlog	W		*clearevtlog*	Clear event log
clientcfg	R/W		*clientcfg <mac> [--name <name>] [--dlmod <dlmod>] [--dlstr <dlstr>] [--*	Show status of and make changes to configured

			ulmod <ulmod>] [--ulstr <ulstr>]	clients
clientstat	R		*clientstat <mac>* *clientstat show - show the status of all connected clients*	Show status of connected clients
connections	R		*show connections*	Show active connections
counters	R		show *counters*	Show RF statistics
date	RW		*date* [-u]... [MMDDhhmmYYYY Options: -u Apply the UTC time zone offset to the date	Display or set current date
default	W		*default*	Restores system to factory defaults
distance	RW	16	set *distance* [miles_or_kilometers] - based on metric setting show *distance*	Set distance in miles or kilometers
encrypt	RW	open	set *encrypt* [open | AES | radius] show *encrypt*	Open: no authentication/encryption AES: PSK authentication / AES encryption Radius: 802.1x authentication / AES encryption
ethcfg	RW	auto	set *ethcfg* [auto-neg | 10baseT-HD | 10baseT-FD | 100baseTx-HD | 100baseTx-FD] show *ethcfg*	Set ethernet speed and duplex
exit	W		*Exit*	Logout from Telnet session
freq	RW	Varies by region	set *freq* [frequency] show *freq*	Set RF frequency in MHz
ftppass	RW	p	set *ftppass* [password] show *ftppass*	Set remote ftp server password
ftpuser	RW	ftp	set *ftpuser* [user] show *ftpuser*	Set remote ftp server username

get	R		*Get*	Get commands
gwaddr	RW	192.168.1.1	set *gwaddr [a.b.c.d]* *show gwaddr*	Set default gateway IP address
help	R		*help*	Show commands
history	R		*history*	Show command history
ipaddr	RW	192.168.1.100 Slave unit 192.168.1.200 Master unit	set *ipaddr* [a.b.c.d] show ipaddr	Set IP address
ipmask	RW	255.255.255.0	set *ipmask* [a.b.c.d] show ipmask	Set IP netmask
log	R		show *log*	Show Event Log
logout	W		*logout*	Logout from Telnet session
macaddrs	R		show macaddrs	Show Ethernet and RF MAC addresses
metric	W	miles	set metric [miles | kilometers]	Set Distance metric
mod	RW	QAM16 ½	show mod set mod [bpsk-1/2 | qpsk-1/2 | qpsk-3/4 | qam16-1/2 | qam16-3/4 | qam64-2/3 | qam64-3/4 | AUTO]	Show Current Modulation
name	RW	(blank)	set *name* [name] show name	Set system name
ntpaddr	RW	192.168.1.1	set ntpadd [a.b.c.d] show ntpaddr	Set NTP server address
password	W	Factory default: admin Customer default: retains password	*password* [guest]	Change admin password or guest password
patchlist	R		show patchlist	Show system patches

ping	W		*ping* [OPTION]... Host Options: -c CNT Send only CNT pings -s SIZE Send SIZE data bytes in packets (default=56) -I iface/IP Use interface or IP address as source -q Quiet, only displays output at start and when finished	Test network connectivity
power	RW	17	set *power* [rfpower] show power	Set RF Transmit power, in dBm
product	R	retains product	show *product*	Show product type
psk_phrase	RW	my-big-secret-01	set *psk_phrase* [phrase] show psk_phrase	Set pre-shared key passphrase
radius_pass	RW	abcd1234	set *radius_pass* [password] show radius_pass	Slave unit only Set Radius user password
radius_secret	RW	my-big-secret-01	set *radius_secret* [secret] show radius_secret	Master unit only Set Radius secret
radius_server	RW	10.20.20.3	set radius_server [server_ipaddr] show radius_server	Master unit only. Sets Radius Server IP address
radius_timer	RW	86400	set *radius_timer* [period] show radius_timer	Master unit only Set Radius reauthentication period, in Seconds
radius_user	RW	wpa1@host.local	set *radius_user* [name] show radius_user	Slave unit only Set Radius client user name
reboot	W		*reboot*	Reboot system
rfnetname	RW	NAME_1	set *rfnetname* [netname] show *rfnetname*	Set RF Network Name
rmod	RW		set rmod [macaddr] [streams] [bpsk-1/2 | qpsk-1/2 | qpsk-3/4 | qam16-1/2 | qam16-3/4 | qam64-2/3 | qam64-3/4| AUTO]	Set Remote Modulation/Streams on

route	R		show *route*	Show IP route table
rssi	R		show *rssi*	Show Local Recv Signal Strength
savecfg	W		*savecfg*	Save configuration to permanent memory
serialnum	R		show *serialnum*	Show system serial number
set	R		*set ?*	Set ? for commands
show	R		*show*	Show commands
snmp	RW	enabled public – for all strings 192.168.1.1 for trap manager	set snmp enable=[yes|no] set snmp [read-community|rc]=[abcdef] set snmp [trap-community|tc]=[abcdef] set snmp [trap-manager|tm]=[a.b.c.d] show snmp	Set SNMP configuration parameters
status	R		*status*	Show system status
streams	RW	1	*show streams* *set streams* [1 | 2]	Show / Set the number of MIMO data streams. Limited to 1 for Access 50.
sysmode	RW	retains sysmode	*show sysmode* *set sysmode [MULTIPOINT_MASTER | MULTIPOINT_SLAVE]*	Show / Set the MULTIPOINT operating mode
tz	RW	"+00:00"	*tz* [+hh:mm | -hh:mm]	Set/Show time zone
updatesw	W		*updatesw [options] [swver]* *Options: -v -verbose output* *-b -update uboot* *-k -update kernel* *-r -update rootfs* *-h -use http* *-i -ignore existing configuration* *-f -force the update*	Download and install new system software
upload	W		*upload* config [remotefile] upload syslog [remotefile]	Upload files to remote server
uptime	R		*uptime*	Display current system uptime
version	R		*version*	Display current software

				version
vlan	RW	disabled	*vlan* [enable | disable]	Enable/Disable management via VLAN
vlanid	RW	1	set *vlanid* [vlan id] show vlanid	Set VLAN ID for management channel

Appendix C: Regulatory Information

1. FCC Radio Frequency Interference Statement (5.9 GHz version)

FCC ID: KA359WAN1

This device is certified to comply with Part 15 of Federal Communications Commission (FCC) Rules. Operation is subject to the following two conditions:

1. It may not cause harmful interference.

2. It must accept any interference that may cause undesired operation.

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

2. U.S. Government Restricted Rights Legend

The Product is provided with Restricted Rights. Use, duplication, reproduction or disclosure by the Government is subject to restrictions in subdivision (c)(1)(ii) of the Rights in Technical Data and Computer Product clause at 252.227-7013 and in subparagraphs (a) through (d) of the Commercial Product-Restricted Rights Clause at 52.227-19. Contractor/Manufacturer is Solectek, 8969 Kenamar Dr, Suite 113, San Diego, CA 92121.

3. Radio Transmission Notice

This product is a low power (less than 1 Watt), OFDM radio system pre-set to transmit and receive signals in the 5.850 – 5.925 GHz frequency bands. This product has been certified by the U.S. Federal Communications Commission for use in the United States of America in that band. Other markings on the unit label shall indicate regulatory compliance in other international areas.

Any prospective user of this product outside the United States of America should, prior to such use, contact the government department or other agency responsible for assigning radio frequencies in the country in which use is proposed to determine whether such department or agency has any objection to operation of the product given current regulatory label markings on said product, and whether there are any other local devices generating signals in that band which might be expected to interfere with the operation of this product.

Solectek shall not be responsible for any operation of this product which is in violation of local law, creates interference harmful to other local devices, or results in a malfunction of this product caused by outside interference.

This device must be professionally installed and used in strict accordance with the manufacturer's instructions. The installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded, including the requirements of FCC Part 15.203

However, there is no guarantee that interference to radio communications will not occur in a particular commercial installation. In case the device does cause harmful interference with an authorized radio service, the user/ operator shall promptly stop operating the device until harmful interference has been limited. Solectek Corporation is not

responsible for any radio or television interference caused by unauthorized modification of this device or the substitution or attachment of connecting cables and equipment other than specified by Solectek Corporation. The correction of interference caused by such unauthorized modification, substitution, or attachment will be the responsibility of the user.

4. Warning

The antennas used for this transmitter must be installed to provide a separation distance of at least 100 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter

This device has been designed to operate with the antennas listed below, and having a maximum gain of 23 dBi. Antennas not included in this list or having a gain greater than 23 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

- ***MTI Wireless 5.9 GHz 60, 90, and 120 deg Sector antenna***
- ***ARC Wireless Solutions 5.9 GHz 23dBi/20dBi Dual Polarization Panel Antenna***

The use of the last two Antennas above shall be restricted to Point-to-Point use only.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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

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