



Wireless Location Sensor

Installation and Maintenance Manual



Note: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

Disclaimer: This document has been developed by Andrew Corporation and is intended for the use of its customers and customer support personnel. The information in this document is subject to change without notice. While every effort has been made to eliminate errors, Andrew Corporation disclaims liability for any difficulties arising from the interpretation of the information contained herein. The information contained herein does not claim to cover all details or variations in equipment, nor to provide for every possible incident to be met in connection with installation, operation, or maintenance. Should further information be desired, or should particular problems arise which are not covered sufficiently for the purchaser's purposes, contact Andrew Corporation, Reston, Virginia 20191.

COPYRIGHT

Copyright © 2001-2003 Andrew Corporation. All rights reserved.

All rights reserved. This document, and the Andrew Corporation software to which it refers, are protected by copyright. Both this document and the Andrew Corporation software are furnished under license as provided in such software and may be used only in accordance with that license. No part of this document may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, except as expressly provided in the license or with the prior written permission of Andrew Corporation.

Andrew Corporation
2002 Edmund Halley Drive
Third Floor
Reston, VA 20191
www.geometrix911.com
877-geo-e911
877-436-3911

TRADEMARKS

Geometrix[®] is a registered trademark of Andrew Corporation. Other product and company names mentioned herein may be the trademarks of their respective owners.

Part No. MN-GEO-IM-01 REV E
September 2003

Table of Contents

ABOUT THIS DOCUMENT	V
Safety Warnings	v
Technical Support Options.....	v
Revision History	vi
CHAPTER 1 EQUIPMENT DESCRIPTION	1
1.1 WLS Technical Description	1
1.2 GPS Antenna.....	4
1.3 AOA RFDU and Antenna Switch	5
1.4 Dual-band RF Combiner	8
CHAPTER 2 INSTALLATION.....	11
2.1 Pre-Planning	11
2.2 Rack Mounting.....	12
2.3 Ground Cabling	14
2.4 Power Cabling.....	14
2.5 WAN Cabling.....	15
2.6 Alarm Cabling (optional).....	16
2.7 GPS Cabling	17
2.8 Antenna Cabling	17
2.9 GSM BCCH Antenna Cabling (GSM only)	22
2.10 Diagnostics & Verification.....	23
CHAPTER 3 REPLACEMENT.....	38
3.1 WLS Replacement Procedure	38
3.2 Verification	38
3.3 Defective Unit Disposition.....	39
CHAPTER 4 MAINTENANCE.....	40
4.1 Fan Care	40
4.2 Cable Inspection.....	40
LIST OF ABBREVIATIONS	41

List of Figures

Figure 1-1 WLS Base Station Connections.....	2
Figure 1-2 WLS Front Panel.....	3
Figure 1-3 Two Channel TDOA WLS (WLS2) - Rear Panel	3
Figure 1-4 Four Channel TDOA WLS (WLS4) - Rear Panel	3
Figure 1-5 Four Channel AOA WLS (WLS4A) (Ext. switch) - Rear Panel.....	4
Figure 1-6 GPS Antenna Splitter	5
Figure 1-7 RFDU with External Antenna Switch - Front View	6
Figure 1-8 RFDU with External Antenna Switch - Rear View	6
Figure 1-9 Dual-Band RF Combiner – Rear View	8
Figure 1-10 Dual-Band RF Combiner – Front View, Rack Mount.....	9
Figure 1-11 Dual-Band RF Combiner - Wall Mount with WLS.....	9
Figure 2-1 Center Mount Bracket Configuration	12
Figure 2-2 Front Mount Bracket Configuration	13
Figure 2-3 Wall Mount Bracket Configuration	14
Figure 2-4 WLS/RFDU Power Connector Pin-out.....	15
Figure 2-5 TDOA2 WLS Cabling Diagram	19
Figure 2-6 TDOA4 WLS Cabling Diagram	19
Figure 2-7 AOA Cabling Diagram for one AOA Panel.....	20
Figure 2-8 AOA Cabling Diagram for Multiple AOA Panels	20
Figure 2-9 Mixed TDOA-AOA Multi Sector Cable Diagram.....	21
Figure 2-10 Dual-band Combiner TDOA Cabling Diagram.....	22
Figure 2-11 Noise Source, TDOA Site	26
Figure 2-12 Noise Source, AOA Site.....	26
Figure 2-13 AOA Calibration Test	32
Figure 2-14 WLS Loopback Connector	36

List of Tables

Table 1-1 WLS LED Indicators	3
Table 1-2 WLS Specifications	4
Table 1-3 Cellular “A” RFDU Specifications.....	7
Table 1-4 Cellular “B” RFDU Specifications.....	7
Table 1-5 PCS RFDU Specifications	8
Table 1-6 Dual-Band Combiner Specifications	10
Table 2-1 WAN Cable Pin Assignment	16
Table 2-2 WLS Antenna Cabling	18
Table 2-3 Description of Status Fields	30

About This Document

This manual provides installation and maintenance information for the Geometrix® Wireless Location Sensor (WLS). This is intended for use by base station service personnel responsible for WLS installation and maintenance. Chapter 1 describes the WLS equipment and the interface to the host base station. Chapter 2 provides procedures for a new WLS installation. Chapter 3 details procedures for replacement of previously installed WLS equipment. Chapter 4 describes WLS preventive maintenance.

Reference documentation includes:

- *Geometrix System Overview*,
Part No. MN-GEO-OV-01
- *Geolocation Control System Installation and Maintenance Manual*,
Part No. MN-GEO-IM-02
- *Network Management User Guide*,
Part No. MN-GEO-UG-01
- *Alarm Manager Definition Document*,
Part No. MN-GEO-TP-01

Safety Warnings



CAUTION – There exists a risk of personal injury and equipment damage when handling this equipment. Read and follow instructions in this manual.



CAUTION – Hazardous voltage may be present. To reduce the risk of electric shock and danger to personal health, follow instructions in this manual.



CAUTION - Protect from electrostatic discharge damage when handling the unit prior to ground connection. Wear a grounded electrostatic protection wrist strap when handling.

Technical Support Options

Email:	support@geometrix911.com
Website:	www.geometrix911.com
Technical Support:	(703) 860-9700
Sales & Marketing:	(877) GEO-E911 or (877) 436-3911
FAX:	(703) 860-7385
Mailing Address:	Andrew Corporation 2002 Edmund Halley Drive, 3 rd Floor Reston, VA 20191 USA

Revision History

Version	Date Issued	Scope
A	07/01	Version A Released
B	10/02	Version B Released
C	06/02	Added to Section 1.3 – Figure 1-6,1-7, Tables 1-3 to 1-5 Added to Section 2.1 – Phillips #2 Screwdriver as option to T20 Torx Screwdriver Added to Section 2.2 – Phillips screws as option to #20 Torx Screws Added Section 2.9 - AOA Cabling Added Section 2.10 – AOA Antenna Cabling Procedures Added to Section 2.11 – Comprehensive Diagnostics
D	01/03	Section 1.1 – Added figure 1-5 Section 1.3 – Changed Figure 1-5 and 6 from picture to mech. drawing. Section 1.4 – Added section for dual-band antenna combiner Section 2.1 – Updated breaker requirements Section 2.8 – Updated table 2-2 for AOA and Combined 800/1900 MHz cabling specifications Section 2.9 – Modified figure 2-4 for AOA configurations, Added figures: 2-4 Power Connector Pin-out 2-5 TDOA2 Cabling 2-6 TDOA4 Cabling 2-7 AOA cabling – One Panel 2-8 AOA Cabling – Multiple Panels 2-9 TDOA mixed with AOA 2-10 for combined 800/1900 MHz WLS cabling 2-11 Noise Source – TDOA Site 2-12 Noise Source – AOA Site Figure 4-1 AOA Calibration Test Deleted section (2.10) on “step-by-step” AOA cabling in preference for using diagrams. Section 2.9 – Modified description of GSM antenna connection. Expanded Section 2-10 – Diagnostics and Verification
E	09/03	Andrew Corporation – name change Revised Sections 2.10.1, 2.10.4, 2.10.7, 2.10.8 and 2.10.9 to reflect latest test screens. Section 2.10.6 Added GPS Frequencies to Sweep Added Figure 2-14 WLS Loopback Connector

Chapter 1 Equipment Description

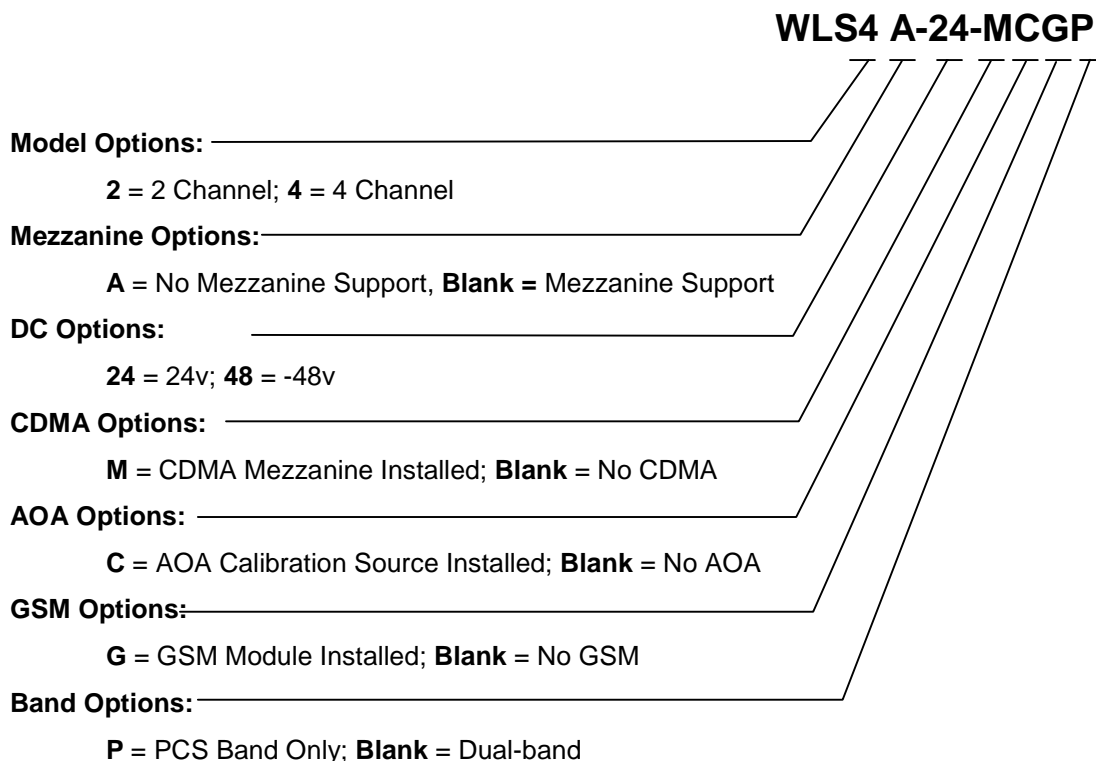
This chapter presents a technical description of the WLS equipment.

1.1 WLS Technical Description

The WLS is a digital receiver unit that makes measurements on a mobile uplink RF signal in order to aid in a location computation. Multiple WLS units work together as coordinated by the Geolocation Control System (GCS) to locate a mobile.

WLS units are available with multiple options from four models: 2-channel, 4-channel, 4-channel with AOA, and AOA ONLY. Two channel WLS's are used for 2-antenna input Time Difference of Arrival (TDOA) processing. This is the most common unit installed. Four channel units are used for 4-antenna input TDOA processing as well as Angle of Arrival (AOA) processing. AOA ONLY units are used for only areas not using TDOA processing. All models are available with +24v and -48v dc power options, a CDMA processing capability option, and a GSM processing capability option.

WLS model numbers are designated as follows:



The WLS is typically installed in an existing base station. It mounts in a base station 19" or 23" rack, and connects to the base station power, receive antenna, CSU/DSU communications and alarm systems. A GPS antenna is required for WLS time synchronization. AOA WLS's require

the installation of separate antennas and associated RF conditioning hardware. Figure 1-1 illustrates the WLS base station connections.

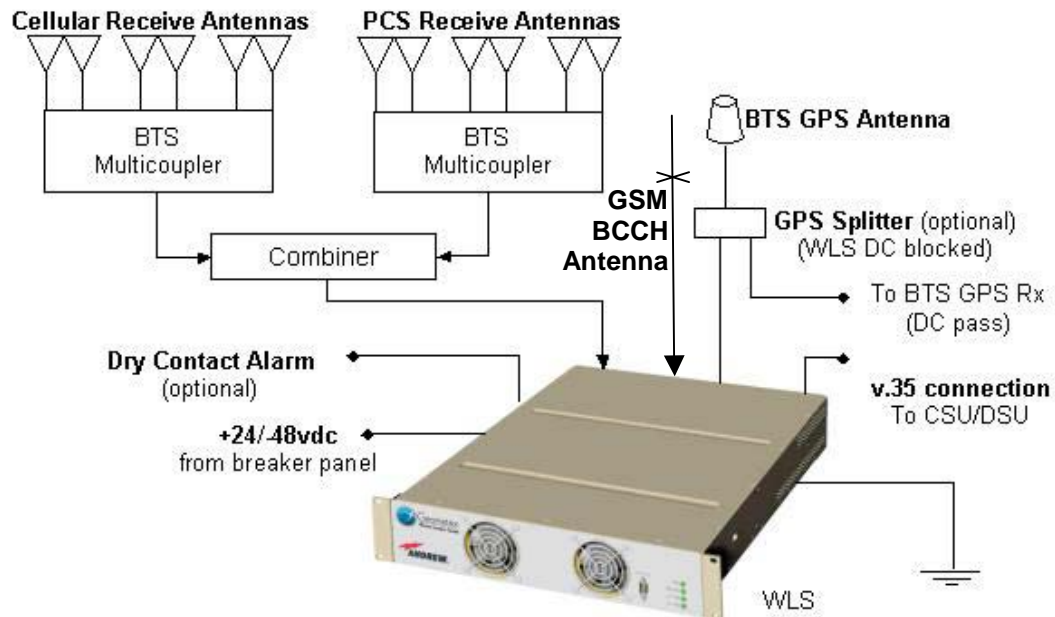


Figure 1-1 WLS Base Station Connections

For modular-cell, micro-cell, or outdoor shelter installations, a self-contained environmentally protected enclosure is available. The outdoor enclosure is designed for flexible mounting options including on top of an existing enclosure, the side of a shelter, or to an existing pole.

For co-located dual-band installations (e.g. PCS overlay), an external RF combiner module is available. This 1U rack-mount unit passively combines inputs from 2-antenna systems into one WLS input. One WLS is used to process signals from both bands.

The WLS front panel is shown in Figure 1-2 below.

Table 1-1 defines the front panel LED indicators. Figure 1-3 depicts the 2-channel WLS rear panel, Figure 1-4 shows the 4-channel WLS rear panel and Figure 1-5 shows the 4-channel WLS for AOA with an external antenna selector switch. Environmental and power specifications are shown in Table 1-2.

The WLS is shipped with system software pre-installed on the internal solid-state disk. Configuration data and software upgrades are automatically downloaded from the GCS at installation. The WLS maintains up-to-date software in coordination with the GCS automatically. No on-site software installation or configuration is required.

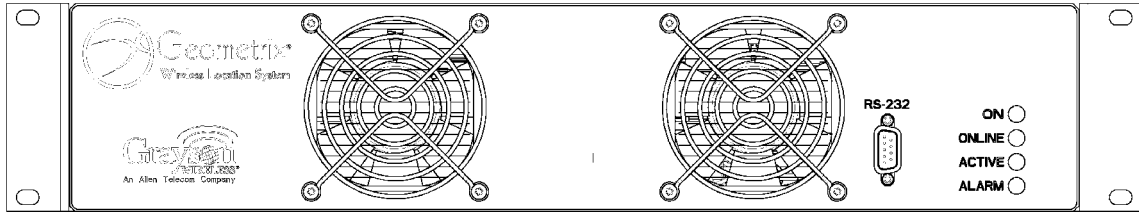


Figure 1-2 WLS Front Panel

Table 1-1 WLS LED Indicators

ON (Green)	Unit is powered up
ONLINE (Green)	Indicates connection established to GCS
ACTIVE (Green)	Illuminated when performing location processing
ALARM (Red)	Indicates a unit hardware failure

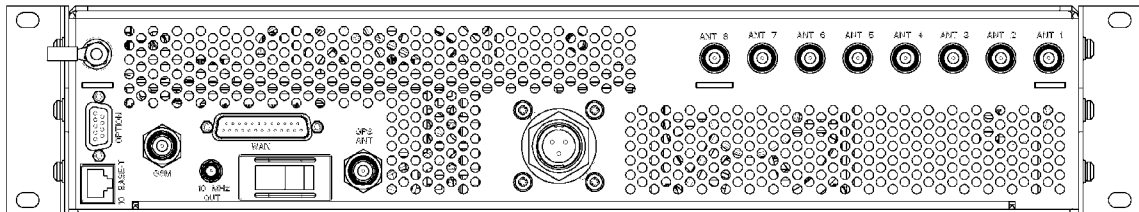


Figure 1-3 Two Channel TDOA WLS (WLS2) - Rear Panel

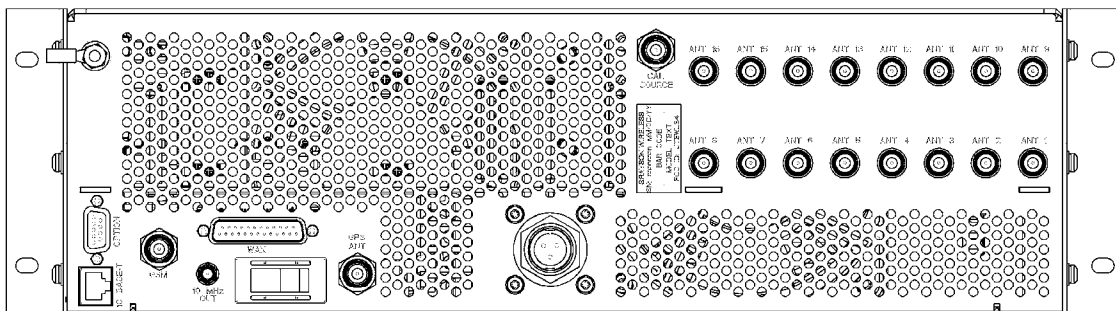


Figure 1-4 Four Channel TDOA WLS (WLS4) - Rear Panel

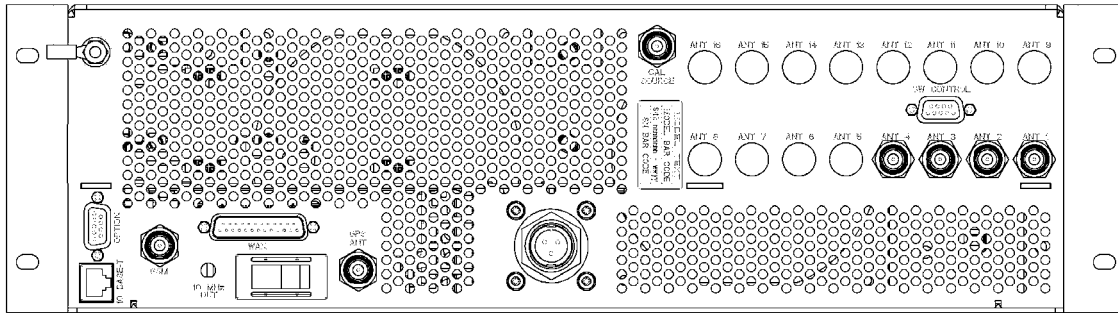


Figure 1-5 Four Channel AOA WLS (WLS4A) (Ext. switch) - Rear Panel

Table 1-2 WLS Specifications

Storage Temperature	-40 to +70 °C
Operating Temperature	-10 to 55 °C The unit will power up at -30°C ambient and require a 15-minute warm-up period to reach full performance.
Relative Humidity (Operating and Storage)	5 to 95% non-condensing
Operating Altitude	Sea level to 3000 meters
Storage Altitude	Sea level to 10000 meters
Size	2-channel 3.5"H x 20"D x 16.9"W 4-channel 5.25"H x 20"D x 16.9"W AOA ONLY 5.25"H x 20"D x 16.9"W
Weight	2-channel 26 lbs 4-channel 31.5 lbs AOA ONLY 31.5 lbs
24v Model Input Power Range	19 to 32 VDC
-48v Model Input Power Range	-42 to -56 VDC
Maximum Power Consumption	2-channel TDOA 100 W 4-channel TDOA 170 W AOA (WLS4A) 170 W
Regulatory Compliance	FCC Part 15 B, NEBS Level 3

1.2 GPS Antenna

In base stations where a GPS antenna does not exist or is not available, a new GPS antenna must be installed. The WLS can provide up to 38 mA of +5 vDC power to the antenna port for powering an active antenna.

If the site has an existing GPS antenna (e.g. CDMA site) a GPS splitter is installed. The splitter passes DC from the base station GPS receiver to the base station GPS antenna as normal. DC is blocked from the WLS at the splitter.

Figure 1-6 shows the GPS antenna splitter and associated mounting bracket.

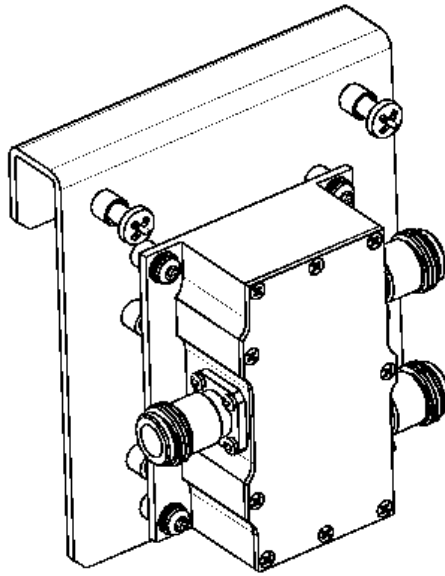


Figure 1-6 GPS Antenna Splitter

1.3 AOA RFDU and Antenna Switch

The RFDU is a set of 4 filter amplifiers designed to support AOA installations. AOA installations require panel antennas separate from the normal receive antennas, and thus require their own preamps and signal conditioning.

For sites employing a single AOA panel, the panel connects directly to the RFDU. For sites employing multiple AOA panels, an external antenna switch provides the ability to connect up to three AOA panels to a single RFDU. Installations using this external switch will use WLS units without an internal switch. Power and control for the external switch is provided by the WLS.

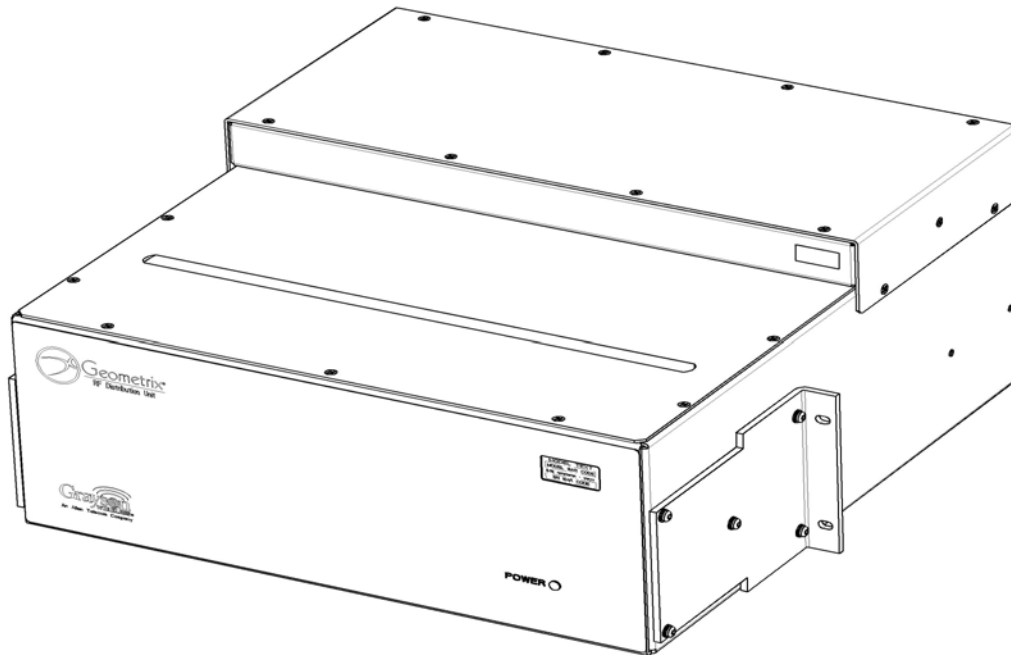


Figure 1-7 RFDU with External Antenna Switch - Front View

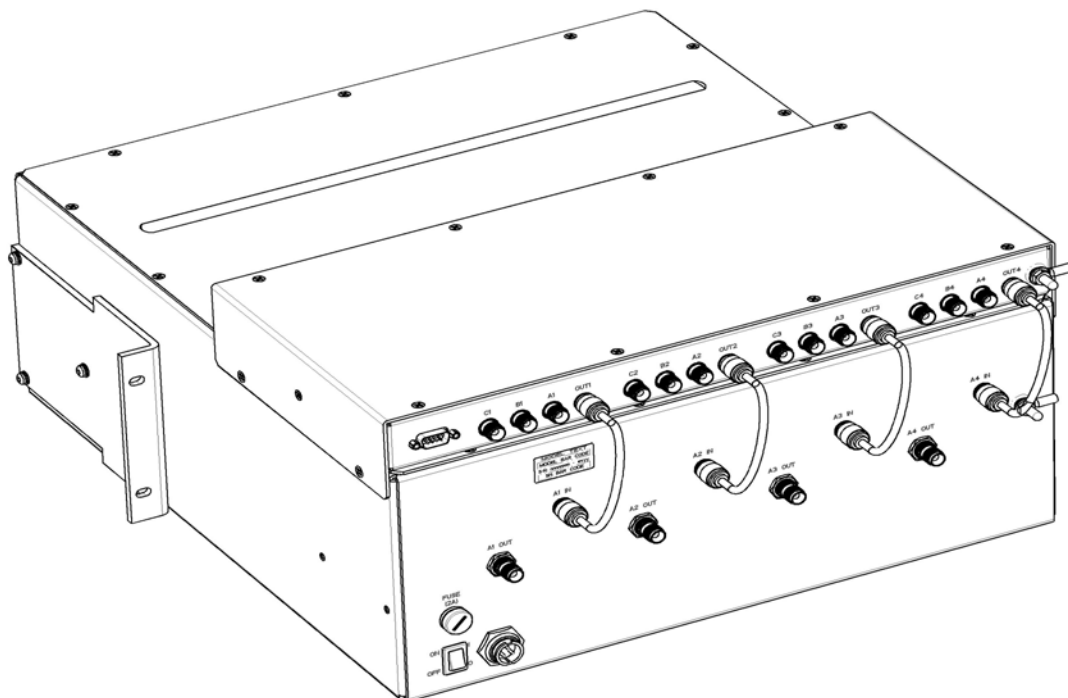


Figure 1-8 RFDU with External Antenna Switch - Rear View

Table 1-3 Cellular “A” RFDU Specifications

Frequency Range	824 – 835, 845 – 846.5 MHz
Gain	16 – 20 dB
Passband Return Loss	15.0 dB min
Impedance	50 ohms
Rejection	20 dB min (806-821 MHz) 30 dB min (821 MHz) 30 dB min (851 – 869 MHz)
Noise Figure	1.75 dB max
OIP3	+33.5 dBm typical +30 dBm min.
Temperature Range	-30°C - +70°C
Dimensions	19" and 23" Rack Mounting
Connectors	Input: TNC female Output: TNC female Power – Three pin circular
Max input level	+10 dBm
Power Requirements	26.5 Vdc @ < 0.8A Operates over 19 – 36Vdc

Table 1-4 Cellular “B” RFDU Specifications

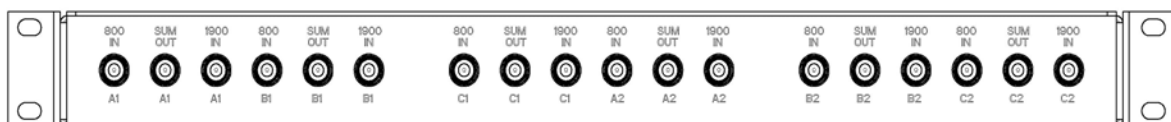
Frequency Range	835-849 MHz
Gain	16 dB min 835 - 847 15 dB min 847-849
Passband Return Loss	15.0 dB min
Impedance	50 ohms
Rejection	20 dB min. (806-821 MHz) 30 dB min. (830 MHz) 30 dB min (851 - 869 MHz)
Noise Figure	1.75 dB max from 835 - 847 MHz 2.75 dB max from 847-849 MHz
OIP3:	+35 dBm typical +32 dBm min.
Temperature Range	-30°C - +70°C
Dimensions	19" and 23" Rack Mounting
Connectors:	Input: TNC female Output: TNC female Power – Three pin circular
Max input level:	+10 dBm
Power Requirements:	26.5 Vdc @ < 0.8A Operates over 19 – 36Vdc

Table 1-5 PCS RFDU Specifications

Frequency Range	1850 - 1910 MHz
Gain	14 –20 dB
Passband Return Loss	15.0 dB min
Impedance	50 ohms
Rejection	60 dB min. (DC - 1825 MHz) 60 dB min. (1930 - 4000 MHz) 40 dB min (4000 - 6000 MHz)
Noise Figure	2.0 dB max
OIP3	+35 dBm min.
Temperature Range	-30°C - +70°C
Dimensions	19" and 23" Rack Mounting
Connectors	Input: TNC female Output: TNC female Power – Three pin circular
Max input level:	+10 dBm
Power Requirements	26.5 Vdc @ < 0.8A Operates over 19 – 36Vdc

1.4 Dual-band RF Combiner

For co-located dual-band installations (e.g. PCS overlay), an external RF combiner module is available. This unit passively combines inputs from 2-antenna systems into one WLS input, which processes signals from both bands. Figure 1-9 illustrates the connections to the Dual-Band Combiner.

**Figure 1-9 Dual-Band RF Combiner – Rear View**

The dual-band combiner may be installed as a 1U rack-mount unit as shown in Figure 1-10, or may be “piggy backed” on the WLS for wall mount installations using available brackets as shown in Figure 1-11.

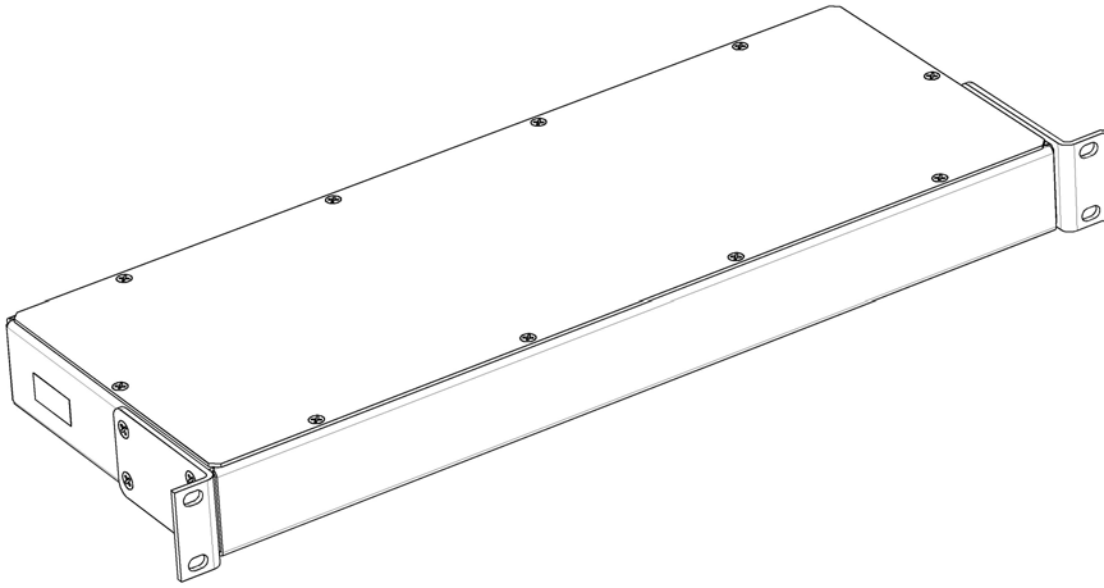


Figure 1-10 Dual-Band RF Combiner – Front View, Rack Mount

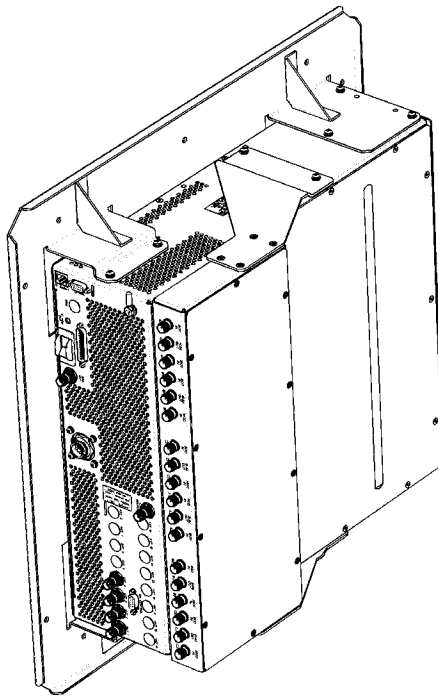


Figure 1-11 Dual-Band RF Combiner - Wall Mount with WLS

Table 1-6 Dual-Band Combiner Specifications

Frequency Range	806-849 MHz, 1850-1910 MHz
Insertion Loss	< 1.5dB
Low Port to High Port Isolation	> 50 dB
High Port to Low Port Isolation	> 50 dB
Input VSWR	< 2.5:1
Output VSWR	< 2.5:1
Connectors	TNC female
Temperature Range	-10°C - +65°C

Chapter 2 Installation

This chapter details the step-by-step procedures for installation of a new WLS unit. Procedures should be followed in the order presented.

2.1 Pre-Planning

Prior to beginning an installation, the following base station items should be in place:

- **19" or 23" Rack Space** – 3.5" of vertical space for the 2-channel WLS, 5.25" for the 4-channel WLS, 5.25" for the RFDU. An additional 1.75 " is required for the Antenna Switch if applicable, and an additional 1.75" is required for the dual-band combiner if applicable.
- **Power** – One dedicated minimum 10A breaker tagged for the WLS equipment, 5A for RFDU, and 20A for Andrew Corporation outdoor enclosure.
- **CSU/DSU Port** – One V.35 port provisioned and actively cross-connected to the GCS. One 56k/64k DS0 connection, nailed through from the WLS to the GCS is required.
- **Multi-coupler ports** (TDOA only) – One active port on each receive antenna multi-coupler.
- **AOA antenna(s)** (AOA ONLY) – Antenna panel(s) mounted on the tower/building and cabled into the base station shelter RFDU.
- **GPS Antenna** – New antenna installed or existing antenna accessible for GPS splitter installation.
- **Chassis Grounding** – One ground connection location in the WLS equipment rack.
- **Alarm Termination** (if applicable) – One set of terminals on alarm panel tagged for WLS equipment.

The WLS equipment is typically shipped in two NEBS GR-63 qualified packages. One contains the WLS unit and the second contains the site-specific installation kit. The installation kit contains all cabling, mounting hardware, grounding supplies and GPS supplies required for installation.

The following tools and supplies are the minimum required for installation:

- #2 Phillips Head Screwdriver
- 3/16" Blade Flat Screwdriver
- T10 Torx Screwdriver
- T20 Torx Screwdriver (or #2 Phillips Screwdriver depending on HW provided)
- Diagonal Flush Cutter

- Terminal Crimp tool
- Adjustable Wrench
- Wire Stripper
- Utility Knife
- Cable ties
- Digital Multimeter
- Laptop PC with HyperTerminal (or equivalent) application installed
- DB-9 (F) – DB-9 (F) null-modem serial cable

2.2 Rack Mounting

1. Attach the WLS mounting brackets to the WLS chassis using supplied #20 torx screws (or Phillips Screws depending on hardware provided) Figure 2-1 and Figure 2-2 show the mounting bracket configurations for center mount (relay style rack) and front mount (open frame rack), respectively.



CAUTION: Do not use screws longer than 1/2". Damage to the WLS may result.

2. Mount the unit in the equipment rack using the supplied rack bolts.

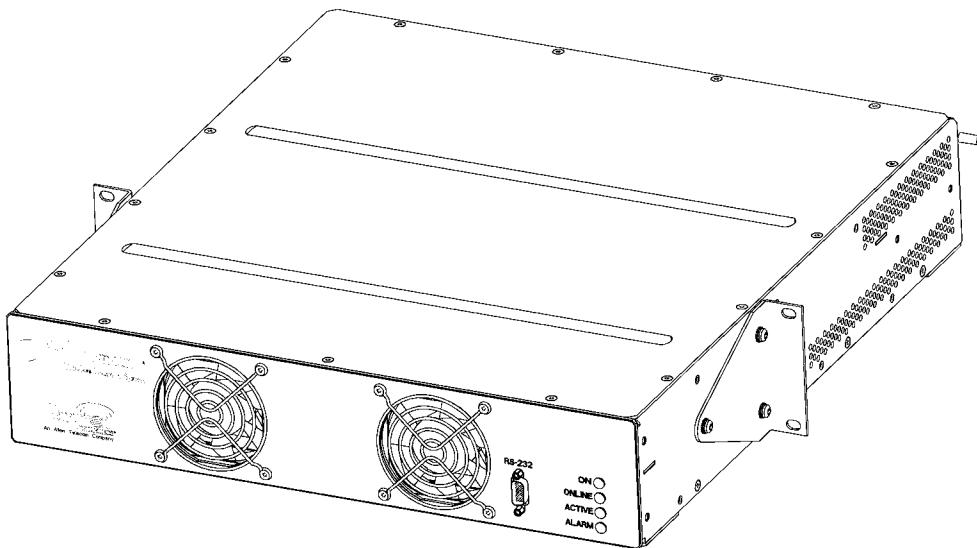


Figure 2-1 Center Mount Bracket Configuration

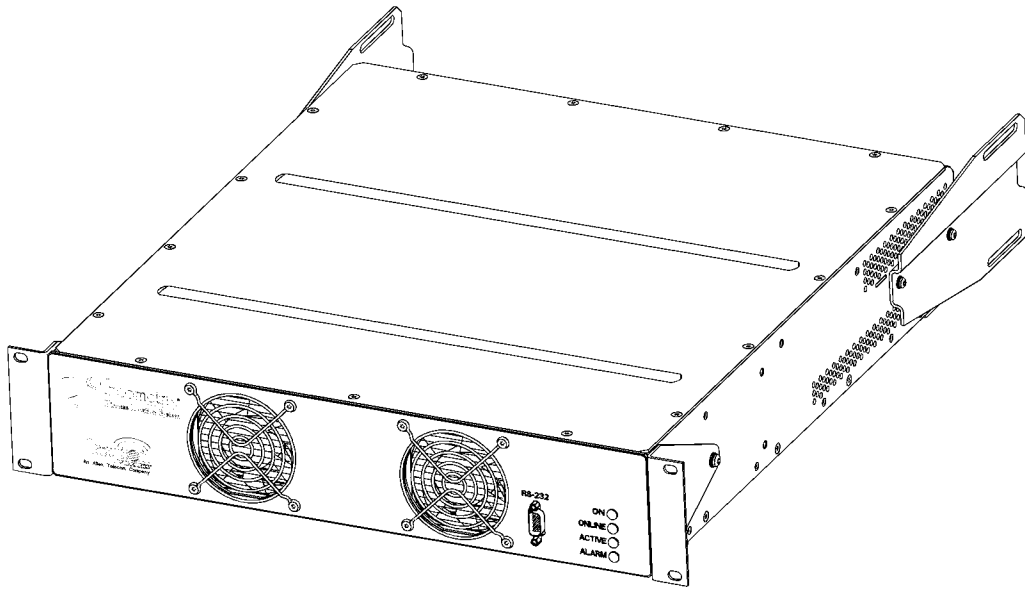


Figure 2-2 Front Mount Bracket Configuration

1. Attach the bracket to the wall using the supplied hardware.
2. Mount the WLS chassis in the bracket using supplied #20 Torx screws (or Phillips Screws depending on hardware provided). Figure 2-3 shows the mounting bracket configurations for wall mount. Refer to Figure 1-11 for wall mounting the WLS with a Dual-Band RF Combiner.

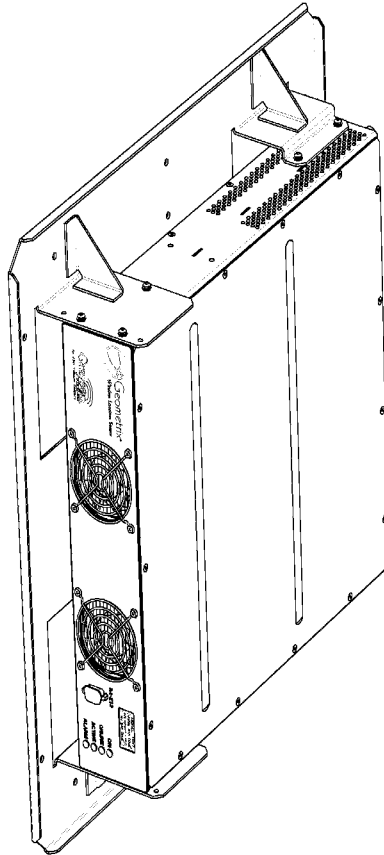


Figure 2-3 Wall Mount Bracket Configuration

2.3 Ground Cabling

1. Cut the ground cable to the appropriate length and crimp the supplied ground lugs to each end.
2. Attach one end to the WLS rear panel grounding post.
3. Attach the other end to a ground location within the WLS rack.
4. Ensure connections are clean and tight.

2.4 Power Cabling



CAUTION: Ensure the base station WLS and RFDU power breakers are in the OFF position prior to connecting power cables.

Power cables are shipped with the circular connector already installed. The opposite cable end is cut to length and terminated with ring terminal lugs during installation. Part number G15A0497-1 is the power cable supplied for 24 VDC installations. Part number G15A0497-2 is the power cable supplied for -48 VDC installations.

NOTE: The RFDU is only available for 24 VDC use.

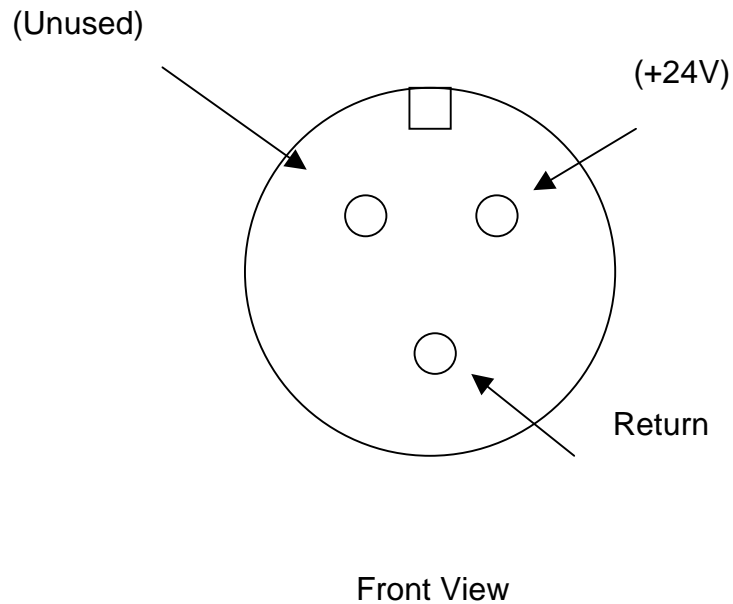


Figure 2-4 WLS/RFDU Power Connector Pin-out

1. Cut the power cable to the appropriate length and crimp on ring terminal lugs.
2. Connect the black lead of the power cable to the base station power panel return bus.
3. Connect the red lead to the base station power panel WLS breaker terminal.
4. Attach the power cable to the WLS rear panel circular power connector.

2.5 WAN Cabling

WAN cables are available in different lengths with both DB-25 and Winchester connector configurations. Do not exceed the V.35 standard maximum cable length of 50'. For CSU/DSU V.35 port compatibility reference, Table 2-1 lists the cable pin assignments for both DB-25 and Winchester style connectors. The WLS is configured as a DTE interface with clocking supplied by the CSU/DSU. The WAN connector on the WLS is DB-25 male.

1. Attach the supplied WAN cable to the DB-25 WAN port on the rear of the WLS.
2. Attach the opposite end of the WAN cable to the CSU/DSU V.35 port provisioned for the WLS.

Table 2-1 WAN Cable Pin Assignment

Signal Name	DB-25 pin assignment	Winchester pin assignment	Signal Name	DB-25 pin assignment	Winchester pin assignment
Shield	1	A	CTS	5	D
TxDATA(B)	14	S	DSR	6	E
TxDATA(A)	2	P	Ground	7	B
TxCk(A)	15	Y	DTR	20	H
RxDATA(A)	3	R	DCD	8	F
RxDATA(B)	16	T	RxCk(B)	9	X
RTS	4	C	TxCk(B)	12	AA
RxCk(A)	17	V			

2.6 Alarm Cabling (optional)

1. Attach the alarm cable, part number G15A0497-1, to the DB-9 OPTION connector on the rear of the WLS.
2. Cut the cable to the appropriate length and terminate on the base station alarm panel. Terminal lugs may be required.

The alarm relay inside the WLS presents a set of Form C contacts at the WLS OPTION connector. Under normal operation, the relay is energized and is released when an alarm occurs. Pin 4 is normally open (NO), pin 2 is normally closed (NC), and pin 1 is alarm common (C). Relay contacts are rated at 0.5A @ 125 VAC and 1A @ 24 VDC. The minimum permissible load is 1mA @ 5 VDC.

The conditions that will generate an alarm are:

- The WLS is turned off
- The WLS unit is over the rated temperature
- The internal 10 MHz frequency reference is not present
- The internal clock phase locked loop is not locked
- A fault condition exists on a digital signal processor board
- An internal power supply voltage is over or under voltage

2.7 GPS Cabling



CAUTION: The WLS unit must be powered off before connecting or disconnecting GPS cables.

1. Connect the GPS antenna cable to the GPS ANT port on the rear of the WLS unit.
2. If a GPS splitter is required:
 - a. Mount the splitter in the cable tray above the GPS receiver rack.
 - b. Disconnect the base station GPS receiver antenna input and attach to the splitter ANT connector.
 - c. Install the supplied jumper cable between the base station GPS receiver antenna input and the splitter BASE GPS port.
 - d. Install the supplied cabling between the WLS GPS ANT port and the splitter E911 GPS port.

Verify proper base station GPS receiver operation locally in the base station and/or via the Network Operations Center (NOC).

2.8 Antenna Cabling

Connect the supplied cabling from the base station multicoupler receive antenna ports to the WLS antenna input ports in accordance with Table 2-2. Notation is shown for up to four antenna faces, alpha, beta, gamma and delta (A,B,G,D). The two receive antennas on each face are designated 0 and 1.

For an omni-directional TDOA site only the two antenna ports set up for the alpha face would be connected (ANT1, ANT5), while for a three sector TDOA site, the alpha, beta, and gamma faces would be the only inputs connected (ANT1, ANT2, ANT3, ANT5, ANT6, and ANT7), leaving the delta inputs (ANT 4 and ANT 8) unused. Note that in the case of a 4-channel WLS, ANT9, ANT10, ANT11 and ANT12 connections are used instead of ANT5, ANT6, ANT7 and ANT8. Figure 2-5 and Figure 2-6 illustrate antenna cabling for 2 and 4 channel TDOA sites respectively.

In the case of AOA, an RFDU is required to provide signal filtering and conditioning. If only one AOA panel is used, connect the four antenna cables directly to the four RFDU input ports (A1 IN through A4 IN) as shown in Figure 2-7. For multiple AOA panels, an external antenna selector switch is used. The four cables from each panel are connected to the appropriate sector inputs (A1-A4, B1-B4 and C1-C4), and the output cables OUT 1 through OUT 4 are connected to the RFDU input ports A1 IN through A4 IN respectively. The RFDU output ports A1 OUT through A4 OUT connect to the corresponding WLS antenna input ports (ANT1, 5, 9 and 13 for WLS4, ANT 1, 2, 3 and 4 for WLS4A). Figure 2-8 illustrates the multiple AOA panel configuration.

For AOA installations, an RF calibration source for AOA panels is provided in the WLS. Attach the AOA panel calibration source cable to the WLS rear panel CAL SOURCE connector. For multiple panel AOA installations, connect the calibration source cables from each panel and from the WLS to the calibration source splitter as shown in Figure 2-8 .

Depending on the number of AOA panels used, not all ports need to be connected.

Where both TDOA and AOA are employed at the same site, attenuators are required at the TDOA inputs to the switch to compensate for the added gain of the RFDU. See Figure 2-9.

In installations utilizing the dual-band combiner, connect input cables from the individual band multicouplers to the appropriate input ports on the combiner. Connect the dual-band combiner output ports (A1 SUM OUT, A2 SUM OUT, etc.) to the corresponding WLS antenna input ports as shown in Figure 2-10.

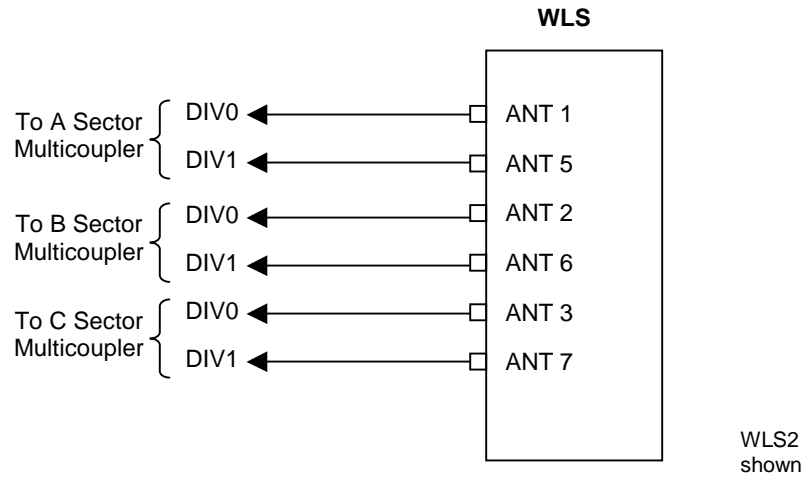
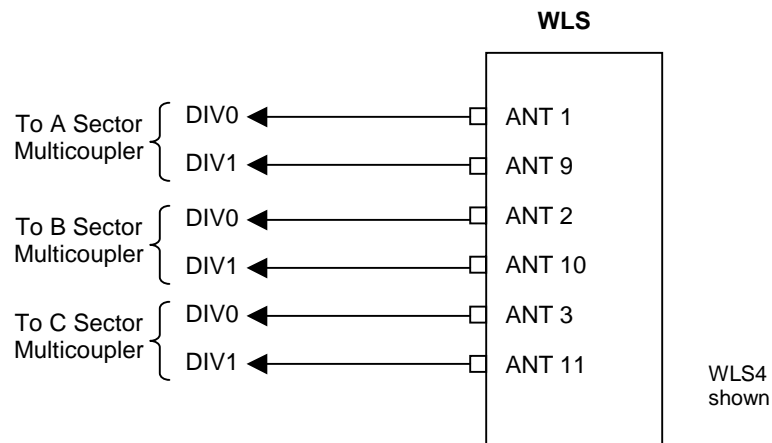
Table 2-2 WLS Antenna Cabling

Technology	ANT1	ANT2	ANT3	ANT4	ANT5	ANT6	ANT7	ANT8	ANT9	ANT10	ANT11	ANT12	ANT13	ANT14	ANT15	ANT16
TDOA2 (WLS 2 model)	A0	B0	G0	D0	A1	B1	G1	D1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TDOA4 (WLS 4 model)	A0	B0	G0	D0	N/C	N/C	N/C	N/C	A1	B1	G1	D1	N/C	N/C	N/C	N/C
AOA (WLS 4 model)	A1 OUT	N/C	N/C	N/C	A2 OUT	N/C	N/C	N/C	A3 OUT	N/C	N/C	N/C	A4 OUT	N/C	N/C	N/C
AOA (WLS 4A model)	A1 OUT	A2 OUT	A3 OUT	A4 OUT	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C
TDOA2 (Dual-band Combiner to WLS 2)	A1 SUM OUT	B1 SUM OUT	C1 SUM OUT	N/C	A2 SUM OUT	B2 SUM OUT	C2 SUM OUT	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C
TDOA4 (Dual-band Combiner to WLS 4)	A1 SUM OUT	B1 SUM OUT	C1 SUM OUT	N/C	N/C	N/C	N/C	N/C	A2 SUM OUT	B2 SUM OUT	C2 SUM OUT	N/C	N/C	N/C	N/C	N/C

Note: Different AOA antenna versions may have different labeling. Ports may be labeled using the nomenclature OL (Outer Left) or as Port 1. Figures are shown for each case.

2.8.1 Cabling Examples

Please refer to the cable diagrams below for more detail for AOA and dual-band RF combiner configurations.

**Figure 2-5 TDOA2 WLS Cabling Diagram****Figure 2-6 TDOA4 WLS Cabling Diagram**

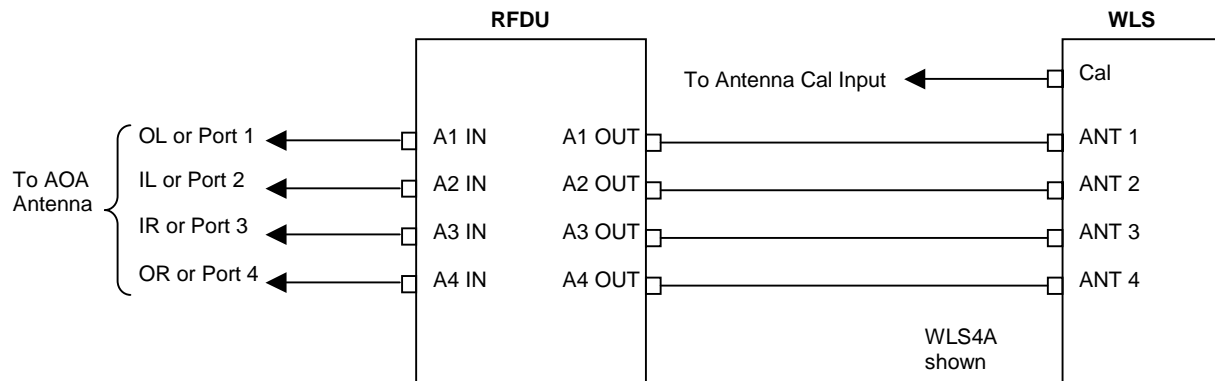


Figure 2-7 AOA Cabling Diagram for one AOA Panel

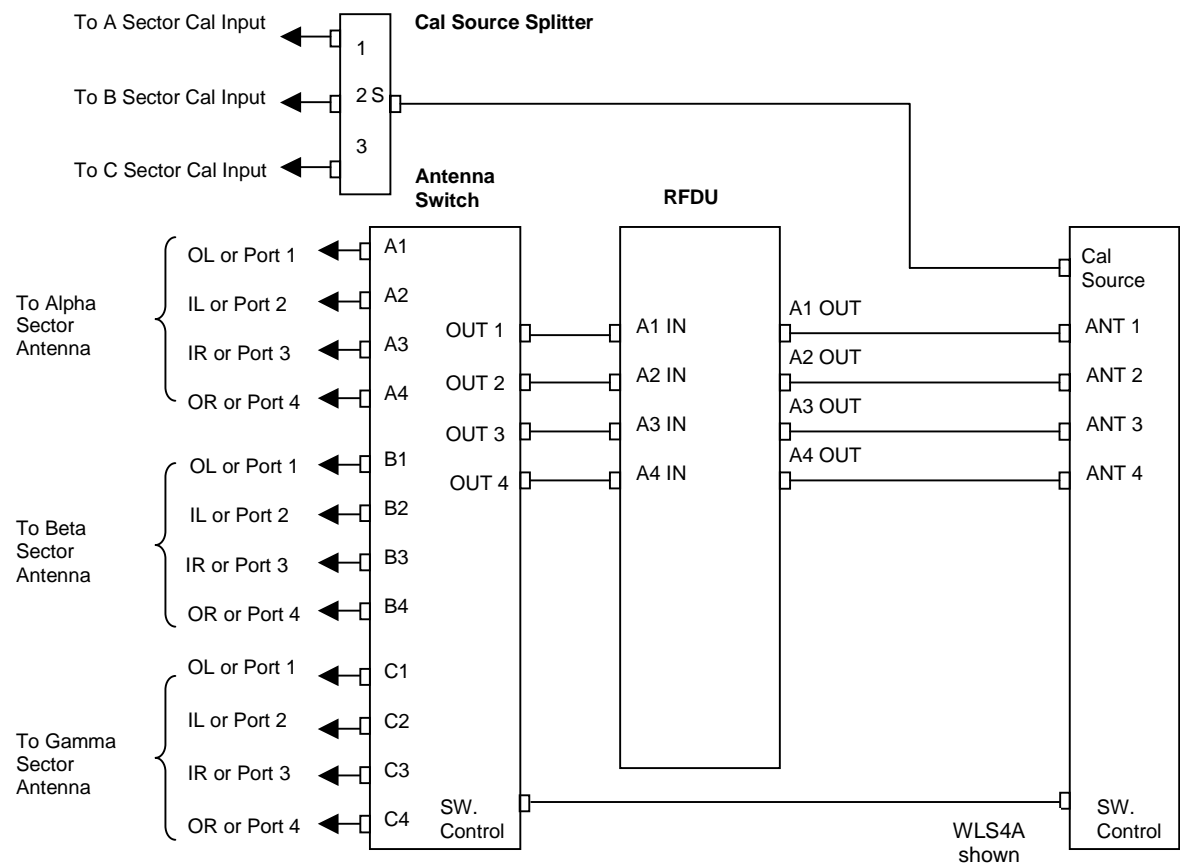


Figure 2-8 AOA Cabling Diagram for Multiple AOA Panels

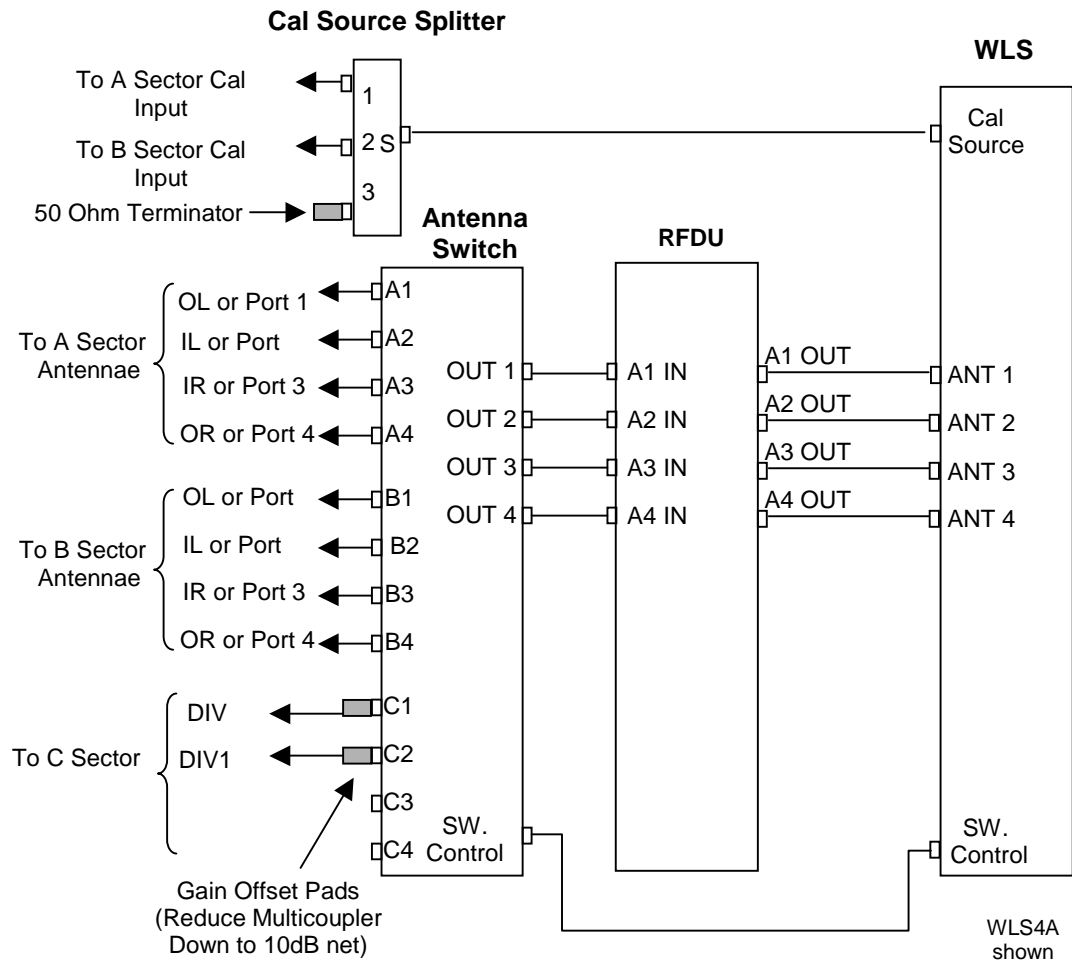


Figure 2-9 Mixed TDOA-AOA Multi Sector Cable Diagram

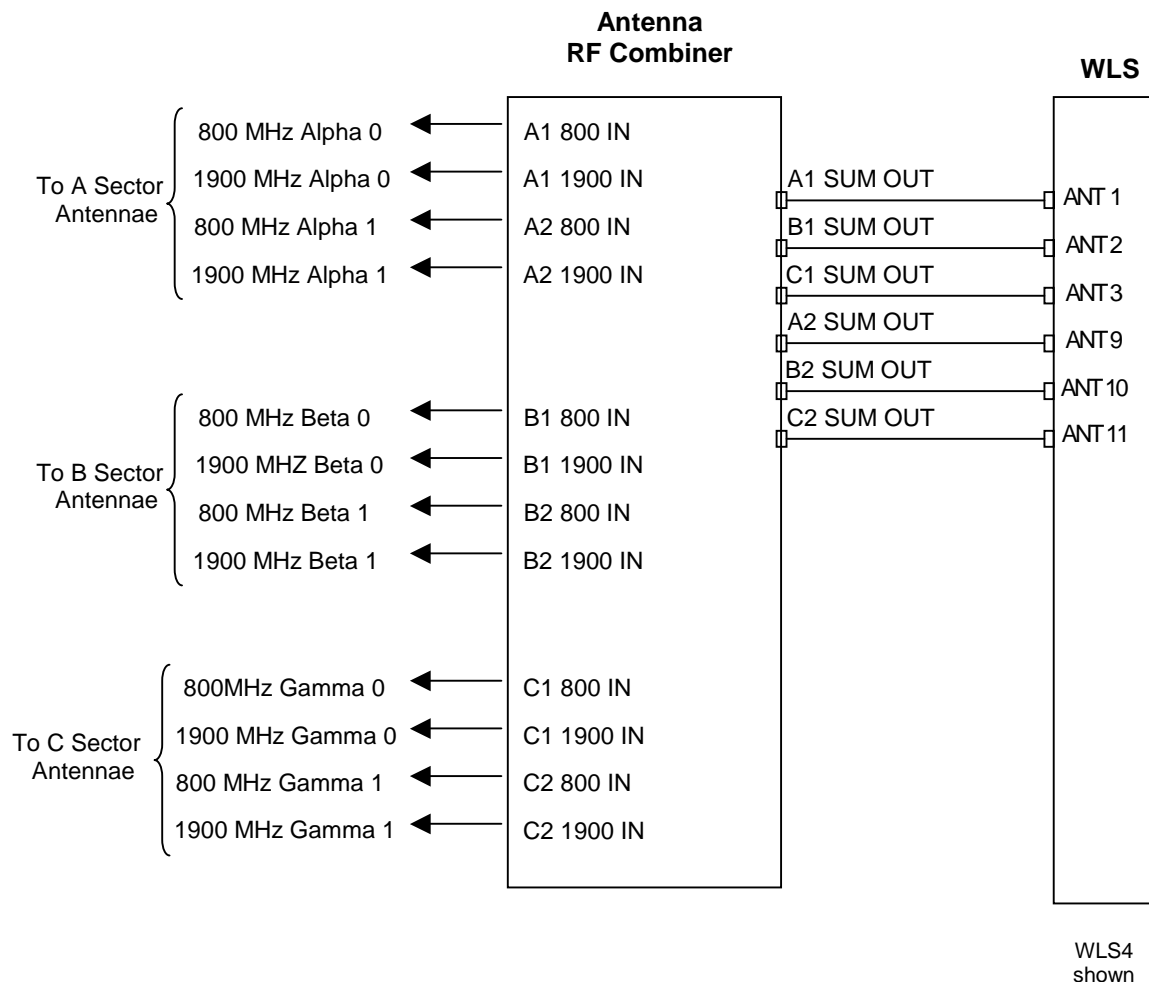


Figure 2-10 Dual-band Combiner TDOA Cabling Diagram

2.9 GSM BCCH Antenna Cabling (GSM only)

In GSM base station installations the WLS requires a forward channel RF signal connection for BCCH synchronization. The WLS GSM port may be connected to an interior whip antenna, an exterior whip antenna, or a BTS monitor port (existing or via an installed directional coupler). Signal levels at the WLS shall be maintained between -40dBm and -90dBm. One cable shall be provided to the WLS. If separate BCCH monitor ports are used for each sector, the sector signals shall be summed together (e.g. using a 3x1 splitter) to a single RF cable for input to the WLS.

Connect the BCCH antenna cable to the GSM port on the rear of the WLS.

2.10 Diagnostics & Verification

A software utility is run on the WLS to verify the installation. It is assumed the installer/tester has a general knowledge of basic PC operation.

The software will perform a comprehensive check of WLS hardware, WAN connectivity, and external cabling. Results will be presented in a simple pass/fail manner not requiring the user to interpret any data. A series of tests will be initiated each displaying a PASS/FAIL indicator and then a summary PASS/FAIL result will be displayed.

The diagnostic software will not impact the WLS in a negative manner when executed immediately following initial WLS power-up.

2.10.1 Initial Set-up

1. Place the base station power panel circuit breaker in the ON position
2. Place the WLS rear-panel switch in the ON position. Verify that the WLS front panel ON LED is illuminated and the WLS cooling fans are running.
3. Wait approximately 5 minutes for the WLS to connect to the GCS and for synchronization to the latest software configuration. If a new WLS configuration is required, the WLS will re-boot (lights flash) during software update. If successful, the front panel ONLINE light will illuminate. If not, further diagnostics are required. In either case, run the system diagnostics program as shown in the following steps.
4. Connect the laptop serial port to the WLS front panel DB-9 RS-232 port via a serial null-modem cable.
5. In HyperTerminal, or similar utility, connect to the WLS using serial port settings of 57600-8-N-1 with no flow control.

Note: NMS access to WLS diagnostics is provided and replaces the individual telnet sessions. Diagnostics is started from the NMS. The results are reported back to the GCS and stored in a database. The results of the diagnostics test utility may also be run remotely, via a telnet connection into the WLS. To accomplish this, steps 4 and 5 may be replaced by executing *telnet <IP address>* from a GCS command prompt. The WLS <IP address> may be obtained from the GCS Network Management System WLS site detail screen.

6. Login as *root*.
7. Type *diagnostics* to run the WLS diagnostics program. The following menu will appear:

```
DIAGNOSTICS Main Menu [v5.4.0]
0) Exit
1) Tests (2-6)
2) Back plane
3) BPU/RX
4) Noise Correlation/Power
5) Mezzanine
6) GPS
7) AOA Calibration
8) Rf Cabling
9) WAN Port/Ping
10) COM Port
11) Alarm Contacts
```

12) Read Serial/Model Numbers
Enter your choice:

Enter 1 to execute tests 2) through 6). This will begin a series of five subsystem tests. Each will print the test title and a PASS/FAIL indicator after completion. All tests should show a PASS indication. If any do not, a more detailed diagnostic can be run on the failed subsystem using the applicable menu item.

The more detailed diagnostic will provide detailed information (e.g. cable open, no GPS signal, etc.) to aid in troubleshooting. An example of the test display is shown below.

Enter your choice: 1

BPU/RX TEST:

BPU0	
BUST: Host Register	passed
BUST: EEP Conf Read	passed
BUST: CPLD Load	passed
BUST: HAP Default	passed
BUST: P2S ID Read	passed
BUST: Host ISA Timeout	passed
BUST: SHARC Broadcast Load	passed
BUST: Host SRAM Bank 0	passed
BUST: Host SRAM Bank 1	passed
BUST: Host Count Sharcs	passed
BUST: SHARC Single Load	passed
BUST: SHARC MP Access	passed
BUST: Host DMA	passed
BUST: SHARC Ping	passed
BUST: SHARC SRAM	passed
BUST: Semaphore test	passed
BUST: SHARC to Host interrupt	passed
BUST: UART serial test	passed
BUST: Receiver intr test	skipped
BUST: Receiver test	skipped
BUST: PDC test	passed
BUST: P2S test	skipped
BUST: Link Port test	passed
BUST: RTC test	passed
BUST: TT continuous mode	skipped
BUST: TT triggered mode	passed
BUST: 5-wire bus test	passed
BUST: ADC threshold test	passed
BUST: Set defaults	passed

Re-initializing ...
unzip_mcs_files has finished.

BPU/RX Test Result: PASS

BACKPLANE STATUS TEST:

Test Result: PASS

NOISE CORRELATION/POWER TEST:

Test Result: PASS

MEZZANINE TEST:

BPU 0: Testing SDRAM ...
Passed

BPU 0: Testing Secondary Mode...
Passed

CDMA Test:

Passed
 Re-initializing ...
 unzip_mcs_files has finished.

Mezzanine Test Result: PASS

GPS TEST:

Critical Alarms:
 None
 Minor Alarms:
 No Accurate Position Stored in EEPROM

Test Result: PASS

Press any key to continue.

8. After all required RF and WAN cables have been connected (per Sections 2.8 and 2.5 above) to the unit, tests 8 and 9 may be executed to detect if there are any loose or faulty cable connections.
9. If a test fails during the "All Tests" run, then select the failed test title from the corresponding individual test menu. This will provide a more detailed explanation of the failure to aid in troubleshooting.

2.10.2 Back Plane Test

The back plane test will consist of reading the back plane status to check components. An example of the test display is shown below.

Enter your choice: 2

```

BACKPLANE STATUS TEST:
Backplane Status Word:
BPU1 Fault:                : OK
BPU2 Fault:                : OK
39 MHz Reference Oscillator : Locked
10 MHz Reference Oscillator : Present
Over temperature (over 83d C) : False
+12V Supply                : OK
+7V Supply                 : OK
-7V Supply                 : OK
10 MHz Reference           : Enabled
Trigger Out Value         : Logic 0
Supply Shutdown           : Supply On
+5V Supply                : OK
PLL Alarm Lockout         : Disabled
Alarm Relay               : Normal
  
```

Test Result: PASS

Press any key to continue.

Failure of the backplane status test could indicate an over temperature condition, a GPS antenna or receiver fault or a failure of an internal component to the WLS.

2.10.3 BPU/RX Test

The BPU/RX runs checks on the Baseband Processing Unit (BPU) and the wideband receiver hardware. An example of the test display is shown below.

Enter your choice: 3

```

BPU 0:PASS
BPU 1:PASS
BPU/RX Test Result: PASS

```

Press any key to continue.

Tests on BPU 1 are only executed in the case of a 4-channel (TDOA-4 or AOA) WLS. Failure of the BPU/RX test indicates an internal WLS component fault. The failed unit should be returned for repair.

2.10.4 Noise Channel Correlation/Power Test

The Noise Channel Correlation/Power Test software is used to check the RF signal path within the WLS. A noise signal generator, installed as a test source in the internal (Figure 2-11) or external (Figure 2-12) antenna switch, is activated in the front-end of the WLS RF signal path. Signal levels are measured at the back-end and compared to each other (correlated) to check the connections and components along the path. The test is performed for each channel of each installed BPU/Rx.

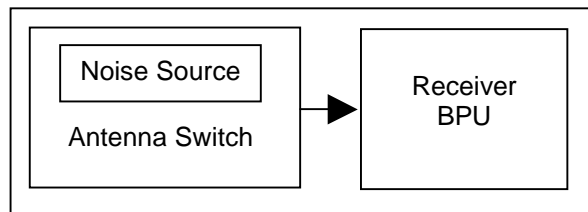


Figure 2-11 Noise Source, TDOA Site

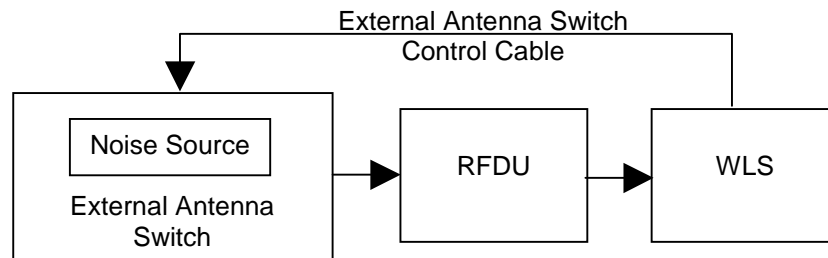


Figure 2-12 Noise Source, AOA Site

An example of the test display is shown below:

```

Enter your choice: 4
NOISE CORRELATION/POWER TEST:

Testing A-Band Cellular Frequency: 830.00 MHz

```

Iter	BPU	Rho	S/N(dB)	pow_ch1(dBm)	pow_ch2(dBm)	TOAdiff(ns)	Status
1	0	0.987	15.64	-88.9	-89.4	1.3	PASS
2	0	0.986	15.35	-89.0	-89.6	2.3	PASS
3	0	0.986	15.37	-89.1	-89.6	1.0	PASS
4	0	0.986	15.37	-89.1	-89.7	1.8	PASS
5	0	0.985	15.28	-89.2	-89.7	1.8	PASS
6	0	0.986	15.34	-89.2	-89.7	1.3	PASS
7	0	0.986	15.49	-88.9	-89.5	1.0	PASS
8	0	0.986	15.39	-89.1	-89.6	0.2	PASS
9	0	0.986	15.40	-89.2	-89.7	2.8	PASS
10	0	0.986	15.33	-89.1	-89.6	1.2	PASS

Noise Test for CELLULAR A band: PASS

The test is run over three frequency bands: Cellular A band, Cellular B band, and PCS band and a results table is displayed for each band. Each test within the specified band is run ten times (denoted by the iteration column above). If the test is run on a four-channel WLS, the test is run on each of the two BPUs.

The test is a measure of BPU channel correlation when the same signal is injected into each of the two channels on the BPU. The measure of correlation (listed in the test results as Rho) must be greater than 0.98 to pass for Cellular band tests, and greater than 0.96 for PCS band tests. The difference in the thresholds is due to lower signal source power in the PCS band, thus the correlation between channels will be lower.

The RSSI is also measured on each channel (listed as pow_ch1 (dBm) and pow_ch2 (dBm)) and must be greater than -105dBm to pass. In addition, the measured time difference between the channels must be less than 50 nanoseconds (shown in the TOAdiff(ns) column in the table). This is a short duration test only, and does not reflect the measurement accuracy obtained under operational conditions, where measurement times are significantly longer.

After the test has completed over all three frequency bands, an overall test result summary table is displayed similar to the one shown below:

Band	Pass?	Required?
Cell_A	YES	YES
Cell_B	YES	YES
PCS	NO	NO

Test Result: PASS

The test software determines which bands are required to pass based on the BPU initialization file (bpu.ini) on the WLS. In the above example table, only the cellular frequency bands are required to pass the test. The overall test result is pass only if all required bands pass the test.

It is important to note that for a two channel WLS or a four channel WLS with an internal switch (non-AOA) the test must pass for all bands, regardless of the band in which the WLS will be used under normal operation. Multicouplers and filters external to the WLS will have no impact on the results of this test. This is not the case for four channel AOA WLS's, which are typically configured with an external switch followed by an external RFDU. In this case only the RF band passed by the RFDU is required to pass the test, since all other bands will be rejected by the RFDU filtering.

On a two channel WLS or a four channel WLS with an internal switch, failure of any of these tests would indicate an internal WLS fault somewhere between the antenna switch and BPU. These units should be returned for repair.

On a four channel AOA WLS, there is typically an external switch connected prior to an RFDU, which then connects to the WLS with RF jumper cables as shown in Figure 2-12. There is also a control cable that runs from the WLS to the external switch. If the noise correlation test fails, check the following items:

- Verify that the RFDU is powered on and that the green power light on the front of the RFDU is illuminated.
- Verify that the control cable between the WLS and the external switch is connected.
- Verify that all jumper cables between the external switch and the RFDU are properly connected.
- Verify that all jumper cables between the RFDU and the WLS are properly connected.

If necessary, the AOA WLS fault may be further isolated by bypassing the RFDU (i.e., cabling the antenna switch directly to the WLS) and re-running the test. If all of the above checks show no problems with the physical installation or the RFDU, then the WLS should be returned for repair.

2.10.5 CDMA Mezzanine Test

If a mezzanine card is installed (CDMA site), then the CDMA mezzanine test is used to verify correct performance. If a mezzanine card is not installed, then the test will be bypassed. The mezzanine test checks all SDRAM memory, checks all registers and communication interfaces and simulates real signals via stored data. The test is run over multiple iterations (up to 10) to check for failures.

An example of the test display is shown below:

```
Enter your choice: 5

MEZZANINE TEST:
BPU 0: Testing SDRAM ...
Writing ramp data to SDRAM ...
Comparing SDRAM to expected values...
Passed

BPU 0: Testing Secondary Mode...
Passed

CDMA Test:
Simulating Data...
Loading Data...
Collecting Data ...
Iteration 1: Test Result: PASS
Simulating Data...
Loading Data...
Collecting Data ...
Iteration 2: Test Result: PASS
Simulating Data...
Loading Data...
Collecting Data ...
Iteration 3: Test Result: PASS
:
:
Simulating Data...
Loading Data...
Collecting Data ...
Iteration 10: Test Result: PASS
PASS
Re-initializing ...
unzip_mcs_files has finished.

Mezzanine Test Result: PASS

Press any key to continue.
```

Failure of a mezzanine test indicates an internal WLS board fault. The failed unit should be returned for repair.

2.10.6 GPS Test

The GPS Test reads the GPS receiver status and checks for satellite tracking and alarm conditions.

Minor Alarms

A minor alarm will indicate a condition that the user should be alerted to, but does not indicate an immediate impairment to functionality. The alarms will include:

- Oscillator voltage near rail
- Antenna input connection is open, i.e., the input is not drawing sufficient current
- Antenna input is shorted, i.e., the input is drawing too much current
- No satellites are usable
- Oscillator is not being disciplined to GPS
- Self Survey procedure in progress
- No accurate position stored in EEPROM
- A leap second is pending
- Test mode in progress
- Accuracy of position being used for a time-only fix is questionable
- Detected one or more EEPROM segments corrupt at reset
- Almanac not current or complete

Critical Alarms

A critical alarm will indicate a condition that severely impairs the function of the GPS module. These alarms will include:

- ROM Checksum Error detected at reset
- RAM Check failed at reset
- FPGA Check failed at reset or during operation
- Oscillator control voltage is at a rail

Failures

The summary result will indicate FAIL if any of the following conditions exist:

- Presence of any critical alarms
- Minor alarm, Oscillator voltage near rail
- Minor alarm, Antenna input connection is open, i.e., the input is not drawing sufficient current
- Minor alarm, Antenna input is shorted, i.e., the input is drawing too much current
- Minor alarm, No satellites are usable
- Minor alarm, Self Survey procedure in progress
- Decoding Status not set to "Doing Fixes"
- Disciplining Activity not set to "Phase Locking"
- PPS Quality > 1000 ns

An example of the test display is shown below. Table 2-3 provides descriptions of the various status fields.

Note: Some detailed status information is presented for information purposes only.

```
Enter your choice: 7
```

GPS TEST:

```
Critical Alarms:  None
```

```
Minor Alarms:
```

```
Self Survey In Progress
```

No Accurate Position Stored in EEPROM

```
Decoding Status:    Doing Fixes
Disciplining:       Phase Locking
PPS Driver Switch:  On
PPS Quality:        6.11 ns
PPS Polarity:       Positive
10 MHz Quality:     -0.14 ppb
Temperature:        35.79 deg C
DAC Value:          85769
DAC Voltage:        0.21 volts
Press any key for more stats.
```

```
Pdop:  3.36      Hdop:      2.51
Vdop:  2.24      Tdop:      1.87
Disc Time Constant: 100.0 sec
Disc Damping Fact:  1.200
Hold Over Duration: 0 secs
Receiver mode:       Full Position (3D)
Disciplining mode:   Normal
Latitude:            38.951807 degrees
Longitude:           -77.363371 degrees
Altitude:            117.581690 meters
Fix Dimension:       3D Fix
Fix Mode:            Manual
Num Satellites:      5
Satellite PRNs:
24 5 1 7 4
Time Valid:          Yes
Yr 2002              Mnth 4              Day 19
Hr 17                Min 2               Sec 59
Timing Flag 0        UTC Offset 13       Week No 1162   Tow 493379
S/W version App Layer: 2.20 [03/16/01]
Core: 10.1 [02/05/99]
Test Result: PASS
```

Press any key to continue.

Table 2-3 Description of Status Fields

Status	Description
Decoding Status: Decoding status of GPS receiver	Doing Fixes GPS Time not found PDOP too high No usable satellites Only 1, 2, or 3 usable satellite(s)
Disciplining Activity: Current activity of the disciplining mechanism	Phase Locking Oscillator warming up Frequency locking Placing PPS Initializing loop filter Compensating OCXO Inactive
PPS Driver Switch:	PPS signal output (Should always be on)
PPS Quality	Estimate of PPS offset to UTC (ns)

Status	Description
PPS Polarity	PPS signal polarity (Should be Positive)
10 MHz Quality	Estimate of UTC offset (ppb)
Temperature	Temperature (deg C) as reported by the on board temperature sensor.
DAC Value	Offset binary (0x00 – 0xFFFF)
DAC Voltage	Voltage output of the DAC –5V to +5V
Pdop	Position Dilution of Precision. A unit-less figure of merit that describes how an uncertainty in pseudo-range affects position solutions.
Hdop	Horizontal Dilution Precision
Vdop	Vertical Dilution Precision
Tdop	Time Dilution of Precision
Disc Time Constant	Time constant of discipline control loop (5-100 seconds).
Disc Damping Factor	Damping factor of the discipline control loop.
Holdover Duration	Amount of time (in seconds) that the GPS receiver has been operating without satellite coverage.
Receiver mode	Automatic (2D/3D) Single Satellite (Time) Horizontal (2D) Full Position (3D) DGPS Reference Clock Hold (2D) Overdetermined Clock
Disciplining mode	Normal, Power-Up Auto Holdover Manual Holdover Recovery Disabled
Latitude	Degrees –90° to 90° (Negative values represent southern longitudes. Positive values represent northern longitudes)
Longitude	Degrees –180° to 180° (Negative values represent western longitudes. Positive values represent eastern longitudes.)
Altitude	Meters
Fix Dimension	Overdetermined (OD) 2-dimensional 3-dimensional

Status	Description
Fix Mode	Automatic/Manual
Num Satellites	(0-12)
Satellite PRNs	PRN Code, which serves as identification of satellite (0-12).
Time Valid	Indicator of time validity (Yes/No)
UTC Time	Year/Month/Day/Hr/Min/Sec Timing Flag: UTC/GPS timing information. UTC Offset: the current integer leap second offset between GPS and UTC. According to Time (UTC) = Time (GPS) – UTC offset.
GPS Time	Time Of Week (TOW): GPS seconds of week since Sunday at 00:00:00. Week No: GPS week number, GPS week Number 0 started on Jan 6th, 1980.

Failure of the GPS test could indicate a GPS antenna, GPS cable or GPS splitter fault, all external to the WLS, which would require repair. The test could also indicate a fault in the GPS receiver internal to the WLS, which should be returned for repair.

To verify proper GPS antenna, cable and splitter operation, a sweep test can be performed using the Garmin GPS-3 Test Set.

GPS frequencies to sweep for are:

- L1 Band frequency: 1575.42 Mhz
- L2 Band frequency: 1227.6 Mhz

For further information, check the GPS Information Web Site:

<http://tycho.usno.navy.mil/gpsinfo.html>

2.10.7 AOA Calibration Test

The AOA Calibration Test checks the calibration signal power to each input on the internal WLS BPU. A test signal is generated by the AOA calibration source in the WLS and sent to the AOA antenna via the calibration cable (Figure 2-13). The signal is received back from the antenna via the four antenna element cables, through the antenna switch and RFDU.

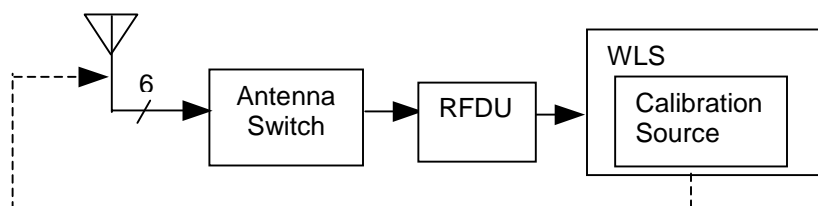


Figure 2-13 AOA Calibration Test

The AOA Calibration Test will only run on AOA WLS sites. The test automatically determines if a WLS is AOA capable and which sectors are configured for AOA. It also determines the frequency band(s) being filtered by the RFDU from the BPU initialization file. On each AOA sector, the calibration signal level is measured on all four channels in the cellular A and B frequency bands and in the PCS band.

To pass the test, the received signal level must be greater than a minimum threshold of -70 dBm and the signal power of channels 2 through 4 must be within 5dB of channel 1, the reference channel. The test is only required to pass in the frequency bands being passed by the RFDU.

Note: The AOA Calibration test results are only valid after all AOA antenna cables are connected to the WLS and RFDU/antenna switch hardware.

An example of the test display for a WLS configured with one AOA sector and a PCS RFDU is shown below.

```

Enter your choice: 7

AOA CALIBRATION TEST:
Sector 1 AOA Capable
Sector 2 Not AOA Capable
Sector 3 Not AOA Capable
Sector 4 Not AOA Capable

Cal signals in all required bands must be > -70.000000 dBm

Testing Cellular A Band:
Frequency: 830.000 MHz

Cal Signal Sector 1 / Chan 0 / Chan RSSI: -103.96 dBm --> low signal
Cal Signal Sector 1 / Chan 1 / Chan RSSI: -104.61 dBm --> low signal
Cal Signal Sector 1 / Chan 2 / Chan RSSI: -105.32 dBm --> low signal
Cal Signal Sector 1 / Chan 3 / Chan RSSI: -104.63 dBm --> low signal

Test Result: FAIL

Testing Cellular B Band:
Frequency: 840.000 MHz

Cal Signal Sector 1 / Chan 0 / Chan RSSI: -104.22 dBm --> low signal
Cal Signal Sector 1 / Chan 1 / Chan RSSI: -104.55 dBm --> low signal
Cal Signal Sector 1 / Chan 2 / Chan RSSI: -113.65 dBm --> low signal
Cal Signal Sector 1 / Chan 3 / Chan RSSI: -105.34 dBm --> low signal

Test Result: FAIL

Testing PCS A Band:
Frequency: 1856.040 MHz

Cal Signal Sector 1 / Chan 0 / Chan RSSI: -39.95 dBm
Cal Signal Sector 1 / Chan 1 / Chan RSSI: -40.71 dBm
Cal Signal Sector 1 / Chan 2 / Chan RSSI: -39.96 dBm
Cal Signal Sector 1 / Chan 3 / Chan RSSI: -40.37 dBm

Test Result: PASS

Calibration Test Results
Band      Pass?    Required?
Cell_A    NO       NO
Cell_B    NO       NO
PCS       YES      YES
Test Result: PASS

```

Failure of the AOA calibration test most likely indicates faulty calibration cables or faulty antenna cables. Failure could also indicate a fault in an antenna, RFDU, or antenna switch. It is unlikely that failure would indicate a WLS fault, unless the Noise Correlation / Power test also indicates failure. The Noise Correlation / Power test may also be used to localize problems in the RFDU or antenna switch.

2.10.8 RF Cabling Test

The RF Cabling Test detects the presence of an external amplifier, such as a multicoupler, prior to the WLS. This test is used primarily to validate that the RF jumper cables between the multicoupler and the WLS are physically installed, and that the multicoupler is actively amplifying. This test does *not* verify the connection of antennas to the inputs of the multicoupler, nor does it determine if the RF jumper cables are misconnected between channels or sectors. Also, in release 5.3.7 and later, this test does not attempt to determine which RF bands are being filtered within the multicoupler.

The test runs over multiple frequency bands, and does not require that there be active calls in the bands being tested. Each properly cabled WLS port should pass each test regardless of band. For example, if the WLS is connected to a cellular A-band multicoupler, the test will normally indicate a pass condition for measurements in all RF bands, including cellular A, B, PCS, and iDen. This is because thermal noise generated within the multicoupler broadband amplifier is not affected by input band filtering. In the absence of any RF signal inputs to the multicoupler, the RF spectrum output over all bands should be relatively uniform, with the level being determined by the amplifier noise figure and gain.

Note: In this test, the signal levels shown are not true RSSI, or received signal strength at the antenna, as it does not account for any gains prior to the WLS. It will only be an accurate assessment of RSSI if there is no external amplification applied during the test.

The RF Cabling Test determines that a cable is connected to the WLS if, averaging over all bands:

- The minimum average signal level is greater than -109dBm, or
- The maximum average signal level is above -104dBm.

An example of a WLS with only antenna face 1 connected to a multicoupler is shown below:

```
Enter your choice: 8

RF CABLING TEST:
Checking average signal levels at WLS input ports ...
(Does not account for gains external to the WLS.)

Antenna Face 1 - Cabled for TDOA
  Cellular A Band
    Input: 1: Ave Signal Level: -112.9 dBm Max: -112.6 dBm (at 825.63 MHz)
    Input: 5: Ave Signal Level: -113.5 dBm Max: -113.2 dBm (at 828.99 MHz)
  Cellular B Band
    Input: 1: Ave Signal Level: -113.4 dBm Max: -113.0 dBm (at 842.82 MHz)
    Input: 5: Ave Signal Level: -113.7 dBm Max: -113.2 dBm (at 843.78 MHz)
  PCS A Band
    Input: 1: Ave Signal Level: -111.0 dBm Max: -110.5 dBm (at 1857.84 MHz)
    Input: 5: Ave Signal Level: -111.6 dBm Max: -111.2 dBm (at 1857.84 MHz)
  PCS B Band
    Input: 1: Ave Signal Level: -112.4 dBm Max: -111.8 dBm (at 1870.62 MHz)
    Input: 5: Ave Signal Level: -112.6 dBm Max: -112.1 dBm (at 1873.02 MHz)
  IDEN Band
    Input: 1: Ave Signal Level: -112.3 dBm Max: -111.8 dBm (at 810.31 MHz)
    Input: 5: Ave Signal Level: -112.8 dBm Max: -112.3 dBm (at 810.91 MHz)

Antenna Face 2 - Cabled for TDOA
.
```


Antenna Face 4 - Cabled for TDOA

WLS input cable connection thresholds:

Low: -109 dBm, High: -104 dBm

- Cable considered connected if min avg level is above low threshold OR
max avg level is above high threshold

- 4th sect delta column is the min avg level of the each port minus the
min avg level of the 4th sector port. This is useful when the 4th sector
is known to be unused, and can be used as a reference level to other ports.

WLS Input	Avg Signal Levels (dBm)		4th sect delta(dB)
	Min	Max	
1	-100.7	-98.0	10.5
2	-111.2	-109.3	0.0
3	-111.1	-109.4	0.1
4	-111.2	-109.3	
5	-102.6	-99.5	9.4
6	-111.6	-109.7	0.4
7	-111.5	-109.5	0.5
8	-112.0	-109.3	

RF CABLING TEST RESULTS:

WLS Input	Connected?	Required?
1	YES	YES
2	NO	NO
3	NO	NO
4	NO	NO
5	YES	YES
6	NO	NO
7	NO	NO
8	NO	NO

Test Result: PASS

Press any key to continue.

The test software determines which WLS input ports are required to be connected based on the WLS bpui.ini file. The test result will be PASS if all required WLS inputs are connected. Otherwise the test result will be FAIL. Possible causes for a failure are also displayed.

2.10.9 WAN Port/Ping Test

The WAN Port/Ping Test is used to verify DS0 connection from the WLS to the GCS located at the MSC. The test can also check for the presence of a WAN loop back, either via the CSU/DSU in loop back mode or via a WLS WAN port loop back plug. Note: This test requires access to the WLS unit through the front panel RS-232 serial port.

The WAN Port/Ping Test will try to ping the GCS. If this is successful then the PPP connection is determined to be operational and the DS0 connection is operational. In addition, a loop back test will be performed. An example of the test display is shown below.

Enter your choice: 9

WAN/PING TEST:

PING gcs (10.0.0.131): 56 data bytes

--- gcs ping statistics ---

10 packets transmitted, 10 packets received, 0% packet loss

round-trip min/avg/max = 0/1/10 ms

Ping: Pass

The WAN Loopback Test can only be executed when
accessing the unit through the serial port.

Proceed with Test(y/n): n

Press any key to continue.

Failure of the WAN Port/Ping test indicates a lack of end-to-end connectivity between the WLS and the GCS. Failure may indicate a fault in the CSU/DSU provisioning, a fault in the T1 DACS

connections, a WLS WAN port cable failure or problems within the carrier T1 network. Additional loopback tests should be performed at various locations along the T1 signal chain to isolate the fault. The WAN test requires that personnel be located at the WLS site to add/remove loopback connectors. If the test is run remotely (e.g. via telnet) the connection to the WLS is generally made via the WAN port, thus validating it's operation and this test does not need to be run.

Testing the WLS WAN port requires a female DB-25 loopback connector be put on the WLS' rear DB-25 port. The pinout and connections for the WLS loopback connector are shown below.

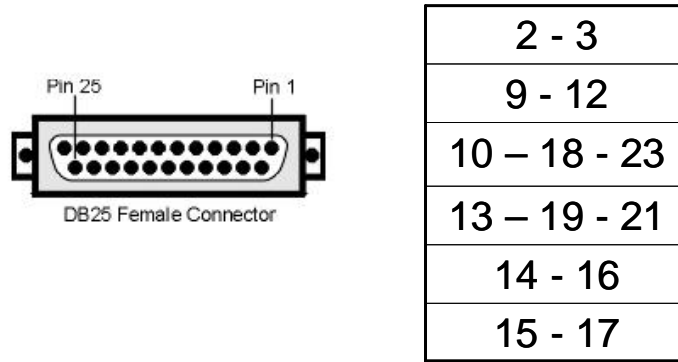


Figure 2-14 WLS Loopback Connector

2.10.10 COM Port Test

This test is optional. It is not performed during the "All Tests" procedure. This test performs a loopback test on the front-panel RS_232 serial port. This test requires that access to the WLS under test is made via a local Ethernet or WAN port connection, and a RS-232 hardware loopback plug is installed on the serial port.

An example of the test display is shown below.

```
Enter your choice: 10

COM PORT TEST:
Test Result: PASS

Press any key to continue.
```

Failure of the COM port test failure indicates an internal WLS hardware fault. The failed unit should be returned for repair.

2.10.11 Alarm Contacts

The alarm contact menu option provides a tool for manually opening and closing the WLS alarm relay contacts. This is intended for use in NOC coordinated dry-contact alarm relay testing. An example of the display is shown below.

```
Enter your choice: 11

CHANGE ALARM RELAY OPERATION
0 Normal Operation
1 Force Alarm
: 1
Relay Forced into 'Alarm' position
```

Press any key to continue.

Enter your choice: 11

CHANGE ALARM RELAY OPERATION

0 Normal Operation

1 Force Alarm

: 0

Normal Alarm Relay Operation

Press any key to continue.

Chapter 3 Replacement

This chapter provides detailed instructions for replacement of an installed WLS unit. For safety, the steps should be followed in the order presented.

3.1 WLS Replacement Procedure

1. Place the WLS rear panel power switch in the OFF position.
2. Place the WLS circuit breaker on the base station power panel in the OFF position.
3. Disconnect the power cable from the rear panel of the WLS unit.
4. Disconnect the GPS Antenna, WAN, GSM antenna (if applicable), AOA calibration source (if applicable) and alarm (if applicable) cables from the rear panel of the WLS unit.
5. Disconnect the antenna input cables from the rear of the WLS unit. Ensure the cables are properly labeled to identify their source for reconnection into the new unit.
6. Disconnect the ground cable from the rear of the WLS unit.
7. Remove the rack bolts and take the WLS unit out of the rack. Save the rack bolts for installation of the new unit.
8. Remove the WLS mounting brackets from the de-installed WLS and reattach to the replacement WLS unit. Ensure the bracket orientation remains the same.
9. Install the replacement WLS unit in the rack using the rack bolts removed in step 7 above.
10. Connect the ground cable to the rear of the WLS unit.
11. Connect the antenna input cables to the rear of the WLS unit. Refer to Table 2-2 for connection information.
12. Connect the GPS antenna, WAN, GSM antenna (if applicable), AOA calibration source (if applicable), and alarm (if applicable) cables to the corresponding connection on the rear of the WLS unit.
13. Connect the power cable to the rear of the WLS unit.
14. Place the WLS circuit breaker on the base station power panel in the ON position.

3.2 Verification

Following WLS replacement, the following steps should be followed to verify proper operation.

1. Place the WLS rear panel power switch in the ON position.
2. Verify that the front panel ON LED is illuminated and the WLS cooling fans are running.

3. Wait approximately 5 minutes for the WLS to connect to the GCS and synchronize to the latest software configuration.
4. Verify the front panel ONLINE LED is illuminated.
5. Verify with the NOC that the alarm condition that prompted the WLS replacement has cleared.

3.3 Defective Unit Disposition

Defective units may be returned to Andrew Corporation for repair or replacement under the terms and conditions of the warranty or service contract in place. To return a unit, call the Andrew Corporation Geometrix Customer Service department at 1-877-geo-e911 or 1-877-436-3911 and request a Returned Goods Authorization (RGA) number. To avoid damage in shipping, equipment should be returned in original Andrew Corporation WLS packaging.

Ship To:

Andrew Corporation
Attn: RGA# _____
140 Vista Centre Drive
Forest, VA 24551

Chapter 4 Maintenance

This chapter describes WLS maintenance procedures.

4.1 Fan Care

WLS Front panel fan filters should be inspected monthly and cleaned any time visible debris/dust is observable on the mesh. Fan filters should be cleaned using a brush attachment on a vacuum that allows contact with the filter mesh.

4.2 Cable Inspection

All cables connected to the WLS should be inspected annually for wear and damage. Particular attention should be paid to corrosion on either the ground or RF cables. RF cables should also be checked for nicks or excessive bends. Cable problems should be corrected with replacement cables.

List of Abbreviations

ADC	Analog to Digital Converter/Conversion
ALI	Automatic Location Identification
ANI	Automatic Number Identification
AMPS	Advanced Mobile Phone Service
AMU	Abis Monitoring Unit
AOA	Angle of Arrival
APCO	Assn of Public Safety Communications Officials
BCCH	Broadcast Control Channel
BPU	Baseband Processing Unit
BSC	Base Station Controller
BTS	Base Transceiver Station
CAS	Channel Associated Signaling
CCS	Common Channel Signaling
CDMA	Code Division Multiple Access
CEP	Circular Error Probability
CGI	Cell Global Identity
CMRS	Commercial Mobile Radio Service
CPLD	Complex Programmable Logic Device
CSU	Channel Service Unit
DACS	Digital Access and Cross-Connect System
DCE	Data Communications Equipment
DDC	Digital Down Converter
DF	Direction Finding
DGPS	Differential Global Positioning System
DID	Direct Inward Dialing
DS0	Digital Signal 0 (64 kbps carrier)
DSU	Data Service Unit
DSX	Digital Signal Cross-connect
DTE	Data Terminal Equipment
DTP	Drive Test Platform
EEPROM	Electrically Erasable Programmable Read Only Memory
ESN	Electronic Serial Number
FPGA	Field Programmable Gate Array
FTP	File Transfer Protocol
GCS	Geolocation Control System
GSM	Global System for Mobile Communications

HAP	Host Access Port
Hdop	Horizontal Dilution of Precision
HSRP	Hot Standby Redundant Protocol
iDEN	Integrated Dispatch Enhanced Network
IL	Inside Left
IR	Inside Right
LAPD	Link Access Protocol on the D-channel
LBW	Left Beam Width
LEC	Local Exchange Carrier
LIM	Line Interface Module
LOM	Lights Out Monitoring
MIB	Management Information Base
MPC	Mobile Position Center
MSC	Mobile Switching Center
NASNA	Nat'l Assn of State Nine-One-One Administrators
NCAS	Non-Call path Associated Signaling
NEBS	Network Equipment Building Standards
NENA	National Emergency Number Association
NIC	Network Interface Card
NMS	Network Management System
NOC	Network Operations Center
NPA	Numbering Plan Area (Area code)
NPD	Number Plan Digit
NPRM	Notice of Proposed Rule Making
OA&M	Operation, Administration, and Maintenance
OEM	Original Equipment Manufacturer
OL	Outside Left
OR	Outside Right
ORI	Origination Request Invoke
PCB	Printed Circuit Board
PCI	Personal Computer Interface
PCS	Personal Communications System
PDE	Position Determining Entity
Pdop	Position Dilution of Precision
PICMG	PCI Industrial Computer Manufacturers Group
PLL	Phase Lock Loop
PN	Pseudo Random Noise
POTS	Plain Old Telephone Service
PPP	Point to Point Protocol
PPS	Precise Positioning Service

	Pulse Per Second
PSAP	Public Safety Answering Point
RBW	Right Beam Width
RF	Radio Frequency
RFDU	Radio Frequency Distribution Unit
RGA	Return Goods Authorization
RMS	Root Mean Square
Roamer	Wireless user operating away from his home network coverage area.
RSSI	Received Signal Strength Indication
RTC	Real Time Clock
Rx	Receiver
SCP	Service/Signal Control Point
SNMP	Standard Network Management Protocol
SOI	Service Order Interface
TDMA	Time Division Multiple Access
TDOA	Time Difference of Arrival
Tdop	Time Dilution of Precision
TIA	Telecommunications Industry Association
TOW	Time of Week
UTC	Coordinated Universal Time
Vdop	Vertical Dilution of Precision
VLAN	Virtual Local Area Network
WBR	Wide Band Receiver
WID	Wireless Integration/Interface Device
WLS	Wireless Location Sensor