SIEMENS

INSTALLATION & OPERATION

A53687 AIRLINK MERCURY

SOFTWARE DEFINED RADIO (SDR)

OCTOBER 2021

DOCUMENT NO. COM-00-21-03
VERSION A

Siemens Mobility, Inc.
One Penn Plaza
Suite 1100
New York, NY 10119-1101
1-800-793-SAFE
www.usa.siemens.com/rail-manuals

PRINTED IN U.S.A.

PROPRIETARY INFORMATION

TRANSLATIONS

The manuals and product information of Siemens Mobility, Inc. are intended to be produced and read in English. Any translation of the manuals and product information is unofficial and can be imprecise and inaccurate in whole or in part. Siemens Mobility, Inc. does not warrant the accuracy, reliability, or timeliness of any information contained in any translation of manual or product information from its original official released version in English and shall not be liable for any losses caused by such reliance on the accuracy, reliability, or timeliness of such information. Any person or entity that relies on translated information does so at his or her own risk.

WARRANTY INFORMATION

Siemens Mobility, Inc. warranty policy is as stated in the current Terms and Conditions of Sale document. Warranty adjustments will not be allowed for products or components which have been subjected to abuse, alteration, improper handling or installation, or which have not been operated in accordance with Seller's instructions. Alteration or removal of any serial number or identification mark voids the warranty.

SALES AND SERVICE LOCATIONS

Technical assistance and sales information on Siemens Mobility, Inc. products may be obtained at the following locations:

SIEMENS MOBILITY, INC.
2400 NELSON MILLER PARKWAY
LOUISVILLE, KENTUCKY 40223

TELEPHONE:	(502) 618-8800
FAX:	(502) 618-8810
SALES & SERVICE:	(800) 626-2710
WEB SITE:	www.usa.siemens.com/rail-manuals

SIEMENS MOBILITY, INC.
939 S. MAIN STREET
MARION, KENTUCKY 42064

TELEPHONE:	(270) 918-7800
CUSTOMER SERVICE:	(800) 626-2710
TECHNICAL SUPPORT:	(800) 793-7233
FAX:	(270) 918-7830

FCC RULES COMPLIANCE

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

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

RF EXPOSURE WARNING

This equipment complies with the FCC RF radiation exposure limits set forth for an uncontrolled environment. This transmitter must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must be at least 20 cm from the user and must not be co-located or operating in conjunction with any other antenna or transmitter.

NOTE

NOTE

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.

HUMAN EXPOSURE STATEMENT

This equipment is designed to generate and radiate radio frequency (RF) energy using an external antenna.

When terminated into a non-radiating RF load, the radio is certified to comply with FCC regulations pertaining to human exposure to RF radiation in accordance with the FCC Rules Part 1 section 1.1310 as published in title 47 code of federal regulations and procedures established in TIA/EIA TSB92, Report on EME Evaluation for RF Cabinet Emissions Under FCC MPE Guidelines. Compliance with FCC regulations of the final installation should be assessed and take into account site-specific characteristics such as type and location of antennas, as well as site accessibility of occupational personnel (controlled environment) and the general public (uncontrolled environment). This equipment should only be installed and maintained by trained technicians. Whether a given installation meets FCC limits for human exposure to radio frequency radiation may depend not only on this equipment but also on whether the environments being assessed are being affected by radio frequency fields from other equipment, which may add to the level of exposure. Accordingly, the overall exposure may be affected by radio frequency generating facilities that exist at the time the licensee's equipment is being installed or even by equipment installed later. The effects of any such facilities must be considered in site selection and in determining whether a particular installation meets the FCC requirements.

FCC OET Bulletin 65 provides materials to assist in making determinations if a given facility is compliant with the human exposure to RF radiation limits. Determining the compliance of transmitter sites of various complexities may be accomplished through computational methods. For more complex sites, direct measurement of the power density may be more expedient. Personnel responsible for installing this equipment are urged to consult the listed reference material to assist in determining whether a given installation complies with the applicable limits.

In general, the following guidelines should be observed when working in or around radio transmitter sites:

- All personnel should have electromagnetic energy awareness training
- All personnel entering the site must be authorized
- Obey all posted signs
- Assume all antennas are active
- Before working on antennas, notify owners and disable appropriate transmitters
- Maintain minimum 3 feet clearance from all antennas
- Do not stop in front of antennas
- Use personal RF monitors while working near antennas
- Never operate transmitters without shields during normal operation
- Do not operate Base Station antennas in equipment rooms

For installations outside of the U.S., consult with the applicable governing body and standards for RF energy human exposure requirements and take the necessary steps for compliance with local regulations

GENERAL SAFETY PRECAUTIONS

Safety precautions must be observed at all times during all phases of installation, operation, service, and repair of the equipment described in this manual. The following precautions are warnings to be aware of. These warnings and precautions are necessary for the safe operation of the equipment.

- All applicable safety procedures, including the National Electrical Code (NEC), Occupational, Safety, and Health Administration (OSHA), and local code requirements must be observed by personnel.
- Follow all warning notices and instructions marked on the product or included in this manual before installing, servicing, or operating the equipment. Retain these safety instructions for future reference.
- Only a qualified technician familiar with electronic equipment should service equipment.
- Do not perform any unauthorized modifications of equipment.
- When troubleshooting the equipment with electrical current present, be aware of live circuits.
- All equipment must be properly grounded and protected from lightning for safe operation.
- DO NOT operate the transmitter of any radio unless RF connectors are secure, and all connectors are properly terminated.
- Heat sinks on the radio are to dissipate heat and must not be blocked or covered.
- Equipment can become hot during operation. Turn off all power to the equipment and wait until sufficiently cool before touching.

MANUAL SCOPE

This manual is intended for use by experienced technicians familiar with RF equipment. The Mercury radio is not intended to be field repairable. This manual is intended to provide information for installation, configuration, and operation in addition to providing information for troubleshooting to determine if the radio is faulty and needs to be replaced. The Mercury radio should not be opened or dismantled by the customer.

The information in this manual is current as of its publication date. Changes that occur after its printing date are incorporated and noted in the Document History.

DOCUMENT HISTORY

Version	Release Date	Sections Changed	Details of Change
A	10-28-21		Initial Release

TABLE OF CONTENTS

Section Title Page

PROPRIETARY INFORMATION ii
TRANSLATIONS ii
WARRANTY INFORMATION ii
SALES AND SERVICE LOCATIONS ii
FCC RULES COMPLIANCE iii
HUMAN EXPOSURE STATEMENT iv
GENERAL SAFETY PRECAUTIONS v
MANUAL SCOPE v
DOCUMENT HISTORY vi
TABLE OF CONTENTS vii
LIST OF FIGURES x
LIST OF TABLES xi
NOTES, CAUTIONS, AND WARNINGS xii
ELECTROSTATIC DISCHARGE (ESD) PRECAUTIONS xiii
GLOSSARY xiv
1 PRODUCT DESCRIPTION 1-1
1.1 Specifications 1-2
1.2 Ordering Information 1-4
2 INTRODUCTION 2-1
2.1 Summary of Operating Features 2-2
2.2 Mechanical Design 2-3
2.3 Electrical Design 2-4
2.4 Functional Theory of Operation 2-4
2.4.1 Filtering Architecture 2-5
2.5 Security Architecture Authentication and Authorization 2-5
2.5.1 Encryption 2-6
2.6 Detection and Monitoring 2-7
3 INSTALLATION 3-1
3.1 Installation Overview 3-1
3.1.1 Environmental Considerations 3-2
3.1.2 Equipment Ventilation 3-2
3.1.3 Site Grounding 3-2
3.1.4 Input Power Requirements 3-2

3.2 Equipment Installation 3-3
3.2.1 Equipment Unpacking and Inspection 3-3
3.2.2 Equipment Mounting 3-3
3.2.3 Radio Grounding Guidelines 3-3
3.2.4 Mechanical Installation 3-4
3.2.4.1 Mounting Procedure 3-4
3.3 Electrical Connection 3-6
3.3.1 DC Power Supply Connection 3-6
3.3.2 Antenna System Connections 3-7
4 GPS SYNCHRONIZATION 4-1
4.1 GPS Synchronization Overview 4-1
4.2 GPS System 4-1
4.2.1 Internal GPS Module 4-1
4.2.2 GPS Antenna 4-2
4.3 System Cable Connections 4-3
4.4 Connection Summary 4-3
4.5 Mandatory Product Labels 4-4
4.6 Post Installation Checklist 4-5
4.6.1 Applying Power 4-5
4.6.2 Verifying Proper Operation 4-5
5 TROUBLESHOOTING 5-1
6 CONFIGURATION 6-1
6.1 Description 6-1
6.2 Remote Access 6-2
6.2.1 Radio Console Access 6-2
6.3 Passwords 6-3
6.3.1 Default Passwords 6-3
6.3.2 Changing Passwords 6-3
6.4 Remote Station Display 6-4
6.5 Radio Ethernet Access 6-4
6.6 WinSCP 6-5
6.6.1 WinSCP Startup Dialog 6-5
6.6.2 WinSCP Configuration of Mercury 6-5
6.6.3 Mercury File Structure 6-6
6.7 Remote Radio Station 6-7
6.8 Maintaining Multiple Configuration File Versions 6-9
6.9 Coordinated Configuration File Changes 6-10

7 OPERATION 7-1
7.1 Description 7-1
7.2 Remote Station (Airlink Mercury) CLI Operation 7-1
7.2.1 Remote Station CLI 7-1
7.2.2 Basic CLI Use 7-1
7.2.3 Temporary Operational Non-Permanent Changes (No Reboot Required) 7-4
8 SOFTWARE UPDATES 8-1

LIST OF FIGURES

Section	Title	Page
Figure 1-1	A53687 Airlink Mercury Radio	1-1
Figure 2-1	A53687 Airlink Mercury SDR Connectors, Indicators, and Controls	2-1
Figure 2-2	Mercury Radio Dimensions	2-3
Figure 2-3	Mercury Radio Block Diagram	2-4
Figure 3-1	Mounting Dimensions	3-3
Figure 3-2	Grounding Point	3-3
Figure 3-3	Airflow Clearance	3-4
Figure 3-4	Mounting Options	3-5
Figure 3-5	Mounting Tabs	3-5
Figure 3-6	Power Input	3-6
Figure 3-7	DC Input Connector Wiring	3-6
Figure 3-8	Antenna Connections	3-7
Figure 4-1	GPS Antenna Connection	4-1
Figure 4-2	Trimble Bullet III GPS Antenna	4-2
Figure 4-3	Airlink Mercury Connections	4-3
Figure 4-4	Mandatory Product Labels	4-4
Figure 4-5	Reference LEDs	4-5
Figure 6-1	Console Port Cable (USB to RJ-45)	6-2
Figure 6-2	Startup Dialog – User Name and Password	6-5
Figure 6-3	Mercury File Structure	6-6
Figure 6-4	Mercury Configuration File	6-7
Figure 7-1	CLI Basic Opening Screen Banner	7-1
Figure 7-2	First Level Commands	7-2
Figure 7-3	View a Connected Measurement Report Example	7-2
Figure 7-4	MS Measurement Report	7-3
Figure 7-5	Set Minimum Remote Station Power	7-4
Figure 7-6	Maximum Transmit Power	7-5
Figure 7-7	Adjust Receive Gain	7-5

LIST OF TABLES

Section Title Page

Table 4-1 Connection Summary....4-4
Table 5-1 Troubleshooting Matrix....5-1
Table 6-1 Mercury Serial Cable Pin-out....6-2
Table 6-2 Console Configuration....6-3
Table 6-3 Remote Station Configuration Files and Functions....6-7

NOTES, CAUTIONS, AND WARNINGS

Throughout this manual, notes, cautions, and warnings are frequently used to direct the reader's attention to specific information. Use of the three terms is defined as follows:

WARNING

INDICATES A POTENTIALLY HAZARDOUS SITUATION THAT, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY. WARNINGS ALWAYS TAKE PRECEDENCE OVER NOTES, CAUTIONS, AND ALL OTHER INFORMATION.

CAUTION

REFERS TO PROPER PROCEDURES OR PRACTICES WHICH IF NOT STRICTLY OBSERVED, COULD RESULT IN A POTENTIALLY HAZARDOUS SITUATION AND/OR POSSIBLE DAMAGE TO EQUIPMENT. CAUTIONS TAKE PRECEDENCE OVER NOTES AND ALL OTHER INFORMATION, EXCEPT WARNINGS.

NOTE

Generally used to highlight certain information relating to the topic under discussion.

If there are any questions, contact Siemens Industry, Inc. Application Engineering.

ELECTROSTATIC DISCHARGE (ESD) PRECAUTIONS

Static electricity can damage electronic circuitry, particularly low voltage components such as the integrated circuits commonly used throughout the electronics industry. Therefore, procedures have been adopted industry-wide which make it possible to avoid the sometimes invisible damage caused by electrostatic discharge (ESD) during the handling, shipping, and storage of electronic modules and components. Siemens Industry, Inc. has instituted these practices at its manufacturing facility and encourages its customers to adopt them as well to lessen the likelihood of equipment damage in the field due to ESD. Some of the basic protective practices include the following:

- Ground yourself before touching card cages, assemblies, modules, or components.
- Remove power from card cages and assemblies before removing or installing modules.
- Remove circuit boards (modules) from card cages by the ejector lever only. If an ejector lever is not provided, grasp the edge of the circuit board but avoid touching circuit traces or components.
- Handle circuit boards by the edges only.
- Never physically touch circuit board or connector contact fingers or allow these fingers to come in contact with an insulator (e.g., plastic, rubber, etc.).
- When not in use, place circuit boards in approved static-shielding bags, contact fingers first. Remove circuit boards from static-shielding bags by grasping the ejector lever or the edge of the board only. Each bag should include a caution label on the outside indicating static-sensitive contents.
- Cover workbench surfaces used for repair of electronic equipment with static dissipative workbench matting.
- Use integrated circuit extractor/inserter tools designed to remove and install electrostatic-sensitive integrated circuit devices such as PROM's (OK Industries, Inc., Model EX-2 Extractor and Model MOS-40 Inserter (or equivalent) are highly recommended).
- Utilize only anti-static cushioning material in equipment shipping and storage containers.

For information concerning ESD material applications, please contact the Technical Support Staff at 1-800-793-7233. ESD Awareness Classes and additional ESD product information are also available through the Technical Support Staff.

GLOSSARY

TERM	DESCRIPTION
AAR	Association of American Railroads - An organization that establishes uniformity and standardization among different railroad systems.
AES	Advanced Encryption Standard
BLE	Branch is Less or Equal
BS	Base Station
CBB	Communications Base Board
CLI	Command Line Interface
dBm	decibel milliwatts
DIN	A DIN rail is a metal rail of a standard type widely used for mounting circuit breakers and industrial control equipment inside equipment racks.
DLSF	Down Link Sub Frame
ERP	Effective Radiated Power - The product of the antenna power (transmitter power less transmission-line loss) times either the antenna power gain or the antenna field gain squared.
ESD	Electro Static Discharge
FCC	Federal Communications Commission
FDD	Frequency Division Duplexing
FEC	Forward Error Correction
FFR	Fractional Frequency Reuse
FM	Frequency Modulation
FSK	Frequency Shift Keying - A baseband modulation technique that conveys digital information over analog facilities by associative discrete logical states with pre-defined frequencies.
GPS	Global Positioning System
GUI	Graphical User Interface
HD-FDD	Half Duplex Frequency Division Duplexing
HW	Hardware
IEEE	Institute of Electrical and Electronic Engineers

TERM	DESCRIPTION
IF	Intermediate Frequency
IP	Internet Protocol - ISO Model Layer 3 (network) protocol that performs proper routing of packets.
IRF	Intermediate & Radio Frequency Module
LAN	Local Area Network - A limited network where the data transfer medium is generally wires or cable.
LED	Light Emitting Diode
NEMA	National Electrical Manufacturers Association
NIST	National Institute os Standards and Technology
NMS	Network Management System
OFDMA	Orthogonal Frequency-Division Multiple Access
OTAR	Over the Air Re-keying
PA	Power Amplifier
PROM	Programmable Read Only Memory
PSU	Power Supply Unit
PtMP	Point-to-MultiPoint
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying - A method of modulating a carrier signal in such a way that each cycle carries four bits of information.
RF	Radio Frequency
RFM	Radio Frequency Module
RS	Remote Station
RS232	EIA interface standard between DTE and DCE, employing serial binary data interchange.
RS422	EIA interface standard that extends transmission speeds and distances beyond RS232, employing a balanced-voltage system with a high level of noise immunity.
RSSI	Received Signal Strength Indication - A numerical value indicating the relative strength of the received carrier.
RTU	Remote Terminal Unit
RX	Receive

TERM	DESCRIPTION
SAW	Surface Acoustic Wave
SCADA	Supervisory Control and Data Acquisition
SDR	Software Defined Radio
SMA	Sub-Miniature version A
SNMP	Simple Network Management Protocol
SSH	Secure Shell
SW	Software
TDD	Time Division Duplexing
TX	Transmit
ULSF	Up Link Sub Frame

SECTION 1
PRODUCT DESCRIPTION

1 PRODUCT DESCRIPTION

The Airlink Mercury Software Definable Radio (SDR) is an ultra-compact, low-cost, Endpoint Radio for mission-critical data applications including industrial field area devices. The Airlink Mercury Radio, with its superior receiver sensitivity and support for narrower transmit channels, ensures maximum range from an Airlink Base Station and support for challenging RF environments.

Airlink Mercury's low power consumption allows for deployment in Mission Critical IoT (MC-IoT) applications with battery and solar power supplies.

When connected to an Airlink Base Station, the Airlink Mercury radio serves as a remote Ethernet bridge with QoS support from Airlink Base Stations. The Airlink Mercury Radio enables the deployment of low data rate, multi-protocol intelligent devices including support for SCADA RTUs, IEDs, Fault Circuit Indicators, Capacitor Bank controls, and backhaul of low range sensor networks based on Wi-Fi, BLE, LoRa, Sigfox, etc. Airlink Mercury Radios can be deployed on a massive scale in an Airlink network with hundreds of radios operating on a single Base Station.

The Airlink Mercury radio operates in a wide range of licensed frequencies (100 MHz to 1 GHz) with configurable channel bandwidths between 1 kHz and 50 kHz. Airlink Mercury employs a single band AMC 1x6 sub-channel to communicate with Airlink Base Stations in standard narrow channel sizes.

The Airlink Mercury radio is a building block within the Airlink MC-IoT Point to Multipoint (PtMP) multicell, multisector system. It is designed to serve MC-IoT low throughput endpoints along with the Airlink Remote Radio serving high throughput endpoints. Both types of remote radios operate simultaneously with an Airlink MC-IoT sector Base Station.

Figure 1-1 A53687 Airlink Mercury Radio

1.1 Specifications

RADIO SPECIFICATIONS	
Frequency Range	100 MHz to 1 GHz
Channel Sizes	1 kHz to 50 MHz
Throughput	Up to 150 Mbps
TX Power	25 dBm (0.3 Watts) @ Antenna Port
RX Sensitivity	@ 12.5 kHz: -125 dBm @ 25 kHz: -122 dBm @ 50 kHz: -119 dBm
Waveform	OFDMA
Modulation	QPSK, 16-QAM, 64-QAM
FEC	Convolutional Coding (CC) with rates 1/2, 2/3, 3/4 Convolutional Turbo Coding (CTC) with rates 1/2, 2/3, 3/4, 5/6
Duplex Method	TDD or Half Duplex FDD
Topology	Point to MultiPoint
Air Interface Protocol	Band AMC 1x6 as per IEEE 802.16-2017 for channel bandwidth > 12.5 kHz
Modulation Coding Scheme Selection	Dynamically Adjusted
QOS	Best Effort, Real-time polling service
CONNECTORS / INTERFACES	
DC Input	Phoenix 1778508
Grounding Terminal	10-32 Electrical Grounding Screw – 3/8 inch
Serial Data/Console CLI	RJ-45 8/8 Jack
Ethernet	RJ-45 8/8 Jack
Antenna Port RF1	SMA Jack Female Connector
GPS	SMA Jack Female Connector

Specifications (continued)

PHYSICAL CHARACTERISTICS	
RF Antenna	50Ω
GPS	Active 5 VDC
Power Input	12 VDC to 24 VDC (12 to 13.3 VDC Nominal)
Data Interface	100 Base T, RS-232
Power Consumption	< 10 Watts
Indicators	Power On/Error, Link Status
Dimensions	6.6” x 4.8” x 1.6” (168mm x 122mm x 41mm)
Weight	2 lbs. 8 oz (1.14 kg)
Enclosure Protection Rating	IP 50 Standard, Optional IP65 Enclosure
Operating Temperature	-40ºC to +70ºC
SECURITY FEATURES	
AES-128, AES-256, Traffic Encryption	
Three-way Handshake Over the Air Re-keying (OTAR)	
EAP-TLS Based Authentication with X.509 Certificate and RSA-4096 Public Key Encryption	
Hardware-Based Secure Boot at the Root of the “Chain of Trust”	
NIST Certified Hardware Random Number Generator	
Memory Protection and Access Rights Limitation for Security Robustness	
Trusted Updates: Authenticated and Validated Upgrades and Configuration Changes	
Security Patch Management	
Secured SNMPv3 Remote Management	
SSHv2 Local Management	
Security Events Monitoring, Audit Ready	
COMPLIANCE	
IEEE 802.16-2017 – Standard for Air Interface for Broadband Wireless Access Systems	

1.2 Ordering Information

The following lists the ordering information for the Airlink Mercury equipment.

Part Number	Description	FCC Certificate ID
9000-53687-00 **XX**		
11	Fixed 160 MHZ	FCC Certification Pending
12	Fixed 217/218 MHZ	FCC Certification Pending
13	Fixed 450 MHZ	FCC Certification Pending
14	Fixed 757/787 MHZ	FCC Certification Pending
15	Fixed 896/935 MHZ	FCC Certification Pending

NOTE

NOTE

FCC certification of the radios in these bands is pending. Customers must have an FCC Special Temporary Authority (STA) license for the frequency band to deploy the A53687 Airlink Mercury Radio. Siemens Mobility, Inc. will perform follow-up releases as radio bands achieve FCC certification.

SECTION 2
INTRODUCTION

2 INTRODUCTION

The Airlink Mercury is a radio hardware platform within the Airlink radio network. The Airlink Mercury radio is a software defined radio that can be configured as a fixed or mobile Remote Station (RS).

The Airlink radio network can be made up of Mercury radios or used in conjunction with Siemens' other hardware platforms to build a multi-cell, point-to-multipoint (PtMP) networks using IEEE 802.16 – 2017[1] narrowband technology. Due to its design, the radio can be used through a wide range of frequencies 100 MHz to 1 GHz using channel sizes up to 50 kHz.

The radio can be configured locally or remotely using Airlink Graphical User Interface (GUI), Apollo or using SSH, or WinSCP. It is recommended for most customers to use Apollo.

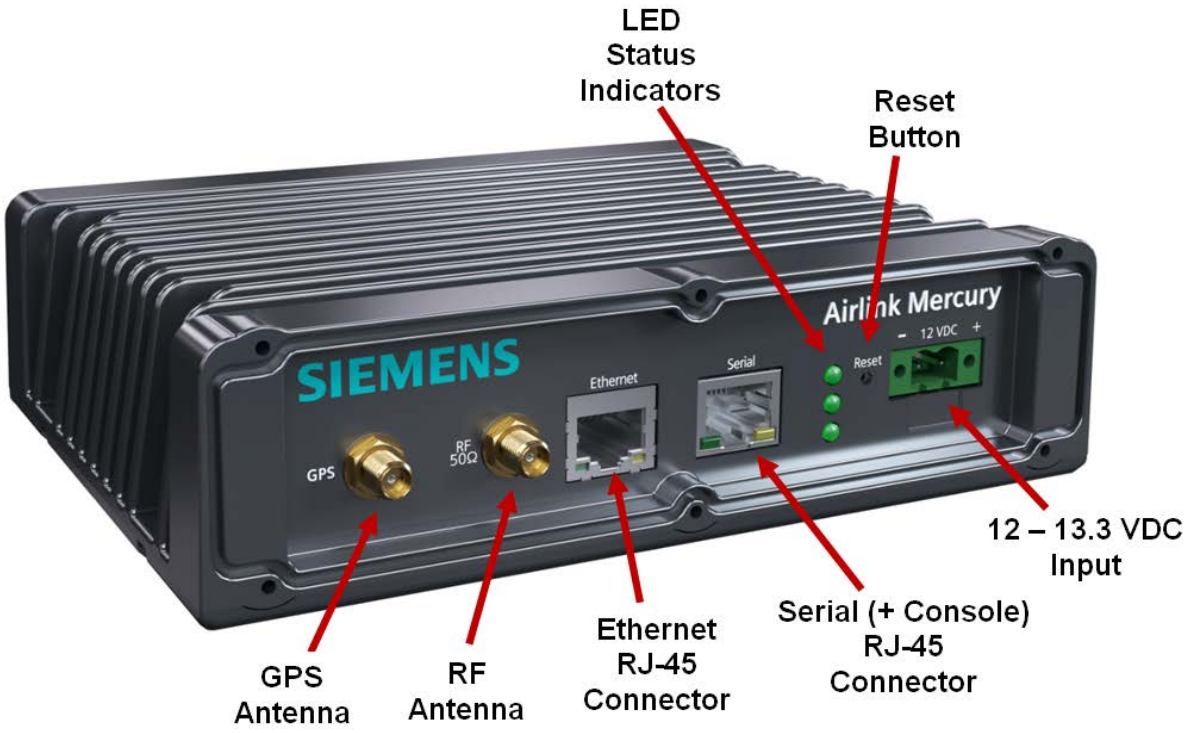


Figure 2-1 A53687 Airlink Mercury SDR Connectors, Indicators, and Controls

[1] IEEE 802.16 – 2017 uses channel sizes from 100 kHz to 10 MHz. A revision to the standard known as IEEE 802.16t is in development to address smaller channel sizes down to 12.5 kHz. However, at this time Siemens uses a modification of the IEEE 802.16 – 2017 for channel sizes less than 100 kHz.

2.1 Summary of Operating Features

The Airlink Mercury has the following operating features:

- Lightweight, compact, fan-less design for rugged environments
- Software Defined Radio (SDR) platform for future flexibility and new radio requirements
- Easily programmed or configured locally or remotely
- GPS connectivity for location and synchronization
- Frequency ranges from 100 MHz to 1 GHz
- Channel sizes up to 50 kHz
- Time Division Duplexing (TDD) or Half Duplex Frequency Division Duplexing (HD-FDD) operation
- IEEE 802.16 – 2017 narrowband capability
- Wide operating temperature from -40º F to +158º F (-40°C to +70°C)

2.2 Mechanical Design

The Airlink Mercury radio is housed in a compact enclosure that can be wall-mounted using screws. The enclosure is designed for rugged environments such as electrical substation control houses or switch cabinets, rail bungalows, trains, pump-off controller enclosures, or other SCADA or industrial enclosures. It is a fan-less design with heat sinks to dissipate heat.

In standard form, the Airlink Mercury enclosure is not suitable for outdoor applications. If an outdoor installation is required install the unit in a NEMA 4/4X enclosure.

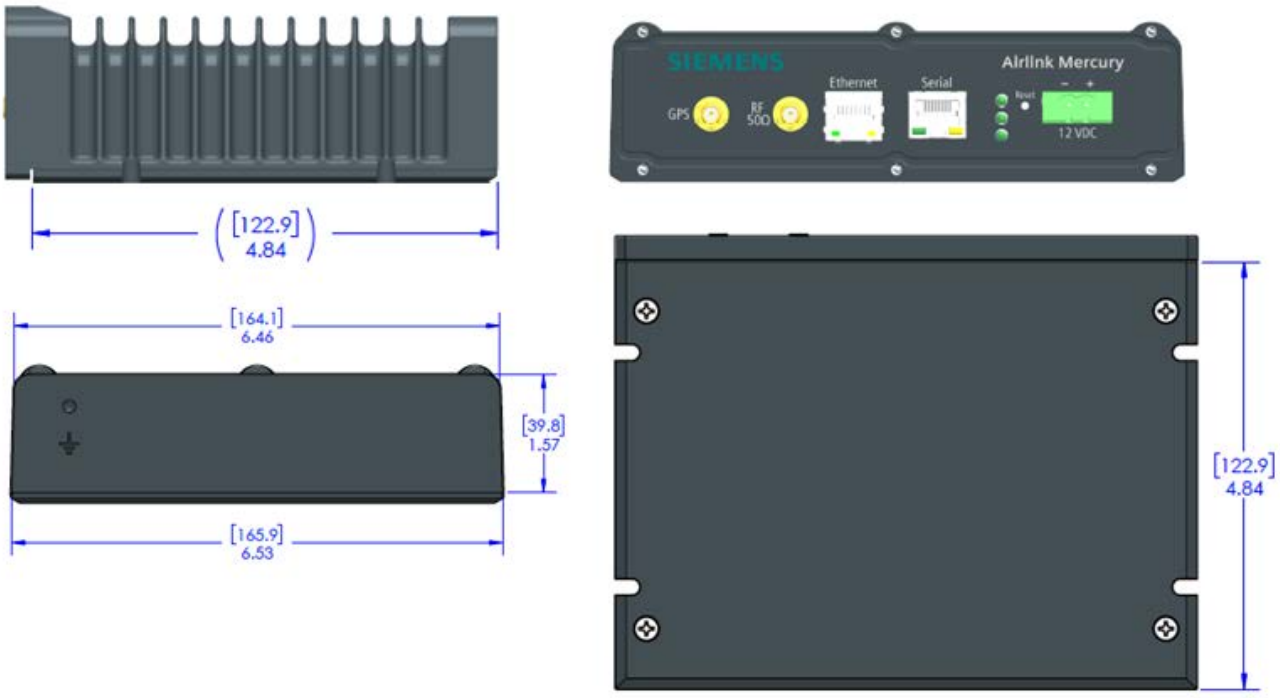


Figure 2-2 Mercury Radio Dimensions

2.3 Electrical Design

A block diagram of the Airlink Mercury radio is shown in Figure 2-3.

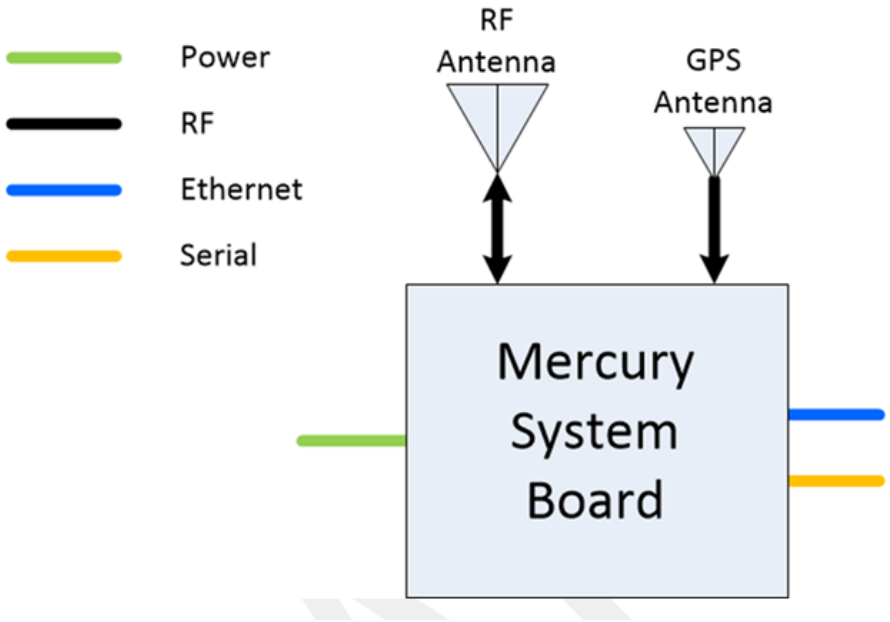


Figure 2-3 Mercury Radio Block Diagram

2.4 Functional Theory of Operation

Airlink can use Time Division Duplexing (TDD), meaning the downlink and uplink communication uses the same frequency, but at different times or Half Duplex Frequency Division Duplexing (FDD) where the downlink and the uplink use different frequencies (still at different times - simultaneous transmission is not supported currently). Time separation between the downlink and uplink messages is done with TDD framing. A TDD radio is constantly toggling between transmit and receive states. The Base Station transmits during the downlink subframe (DLSF) and receives during the uplink subframe (ULSF) while the remote station transmits during the ULSF and receives during the DLSF.

The Airlink TDD radio uses a fast-switching power amplifier (PA) and transmit/receive (TX/RX) switch. The PA gate voltage is used to switch the PA in less than 2 µs between transmit and receive states. The TX/RX switch switches the antenna to the PA during the transmit phase and to the low noise amplifier (LNA) during the receive phase. The PA does not transmit during the receive state and the PA is maintained in the off state during the receive phase if transmission is not needed to minimize power consumption.

To avoid self-interference, the TDD frame structure (i.e. the duration of the DLSF, ULSF, and the total gap), is identical across the entire system. Additionally, the beginning of the TDD frame is synchronized to a 1 pulse per second (PPS) generated by a GPS receiver. All Base Stations in the system transmit at the same time. A Base Station (BS) and Remote Station (RS) never transmit at the same time, so they never interfere with each other.

The DLSF and ULSF may be further divided into zones that are identical across the entire system. Zones may be able to make the network more efficient during certain conditions. For example, an RS in the middle of the sector serving area is less susceptible to interference from other sectors and generates less interference to the remotes of other sectors. Therefore, these remotes may use a more aggressive frequency reuse scheme than remotes in the sector that are located closer to the sector boundaries. The DLSF and ULSF can be partitioned into two zones. One zone will be used for remotes at the boundaries of the sector with a less aggressive frequency reuse scheme and the other zone will be used for remotes near the center of the sector with a more aggressive frequency reuse scheme. This is known as fractional frequency reuse (FFR)

2.4.1 Filtering Architecture

The Airlink Mercury radio is designed to operate over a wide range of frequencies and channel configurations while minimizing interference. The Airlink Mercury radio can operate from 100 MHz to 1 GHz using channel sizes from 12.5 kHz to 50 KHz. At QPSK using convolution coding (CC) rate of ½, the receiver sensitivity ranges from -114 dBm for a 12.5 kHz channel.

The Airlink Mercury radio incorporates filtering at the following stages:

- Configurable digital filter which is embedded in the CMX 983 front-end chip
- Base band Analog Filter which is embedded in the CMX 994 front-end chip.

The configurable digital filters are software configurable filters embedded on the Airlink Mercury. These filters are very specific, narrow filters. When the adjacent channel interferer's power is greater than the Airlink signal, the gain in the receive chain needs to be reduced to avoid saturation. The stronger the interferer, the lower the receive gain. As the receive gain is reduced, the Airlink signal occupies a smaller portion of the analog to digital converter (ADC) amplitude range which reduces the resolution and increases the quantization noise until a level at which the signal can no longer be decoded.

2.5 Security Architecture Authentication and Authorization

Authentication is the act of verifying the user is who they claim to be. Authorization is the process of giving the user permission to access a specific resource or function. Both functions are handled by the Authentication, Authorization, and Accounting (AAA) server using multi-factor authentication.

Airlink device authentication uses Extensible Authorization Protocol – Transport Layer Security (EAP-TLS) with X.509 authentication. Local access to the Airlink Base Station and Remote device is authenticated by role-based usernames and passwords. Access to a device's memory is read/write restricted according to roles.

Remote access to these devices is controlled via Airlink NMS and Airlink Apollo with secured authentication SNMPv3, SFTP, and SSHv2. The Airlink NMS and Airlink Apollo (when accessible remotely) are HTTPS and authenticated through the AAA server. The Airlink system authenticates devices before establishing network connections. Certification is handled by the

customer, who may configure the AAA server authentication process. The Base Station and Remote device use role-based authentication when based locally.

There are different levels of authentication within the NMS:

- **Viewer** – can view information about the radio equipment.
- **Technician** – can view, configure, upgrade, and run diagnostics of radio equipment; can acknowledge and clear radio equipment-related events; has no access to radio equipment secured memory or security-related configuration.
- **Technical Manager** – can view, configure, upgrade, and run diagnostics of radio equipment; can acknowledge and clear radio equipment-related events; has local access to radio equipment secured memory or security-related configuration.
- **Administrator** – can edit users and roles.

NMS users can be restricted by geographic regions.

All Airlink network elements (base stations, remote stations, management software) are initially configured with a default administrator user and password. Upon initial detection of the administrator, a new password is enforced. No action is available until the password has been changed. A strong password is enforced, meaning the password is a minimum of eight characters and has one or more of the following types:

- Lower case alphabetic
- Upper case alphabetic
- Numeric
- Special characters (e.g. #, $, @, &)

The Airlink base stations and remote stations support remote digital certification revocation, renewal, and change using the Apollo toolkit as an operation that is enabled to the administrator only. Airlink currently uses a single default username and password for all base stations and remote stations.

2.5.1 Encryption

The Airlink system uses traffic key encryption AES-128 or AES-256 and Counter with Cipher Block Chaining-Message Authentication Code (CBC-MAC). Airlink uses the IEEE-802.16 key derivation function Dot16KDF.

Cryptographic keys and security data are stored in secured storage within the system memory in locations that are impervious to unwanted access. Secure storage includes an encrypted blob of keys, anti-tamper protection that can only be unlocked by a master key, a private key bus between non-volatile memory and cryptographic engines.

Airlink uses the Privacy and Key Management Protocol version 2 (PKMv2) for secure key management transfer and exchange. The authorization key is generated and is used to secure the 3-way handshake of the traffic key distribution. The process is secured, encrypted, and authenticated through all stages using RSA-4096, Cipher-based Message Authentication Code (CMAC), Hash-based Message Authentication Code (HMAC), and AES-256 – CCM.

Passwords are encrypted with the device public key. Private key is stored in secured storage provided by the chip. All keys in the system, except the private-public keys, are randomly generated and with a configurable lifecycle. Hardware-generated random number generator is used by all cryptographic algorithms and hashing functions.

2.6 Detection and Monitoring

Airlink devices include several security mechanisms such as secure boot (hardware-enforced root-of-trust, customer programmable keys, and OTP data, support for takeover protection, IP protection, and anti-rollback protection), strong cryptography algorithms, trusted execution environment support (firewall support for isolation, secure DMA path and interconnect and secure watchdog/timer/IPC) and more.

This Page Intentionally Left Blank

SECTION 3
INSTALLATION

3 INSTALLATION

3.1 Installation Overview

Pre-installation planning is essential to a good installation. This includes careful consideration of mounting location in relation to input power, antenna(s), and backhaul connectivity (for base stations). Before installation, ensuring the site is well-grounded and prepped for lightning mitigation, power surges, etc. is imperative. Refer to Motorola R56[2] "Standards and Guidelines for Communication Sites" for recommended best practices for site preparation. Additionally, environmental conditions, the mounting method, required tools, and equipment should also be considered.

NOTE

NOTE

Completely read the entire Installation section before beginning the actual installation.

NOTE

NOTE

For first time installers, it is recommended to set up a base station and remote station in a lab environment connected to dummy loads to understand setup and configuration prior to installing radios in a remote environment.

This information is intended to serve as an overview for installing the Airlink Mercury radio and its associated equipment. Instructions for each task are provided in the following sections.

- Plan the installation, paying particular attention to environmental conditions at the site, ventilation requirements, surge protection, grounding, and lightning protection.
- Unpack and inspect the equipment
- Physically install the equipment at the site
- Connect the radio to the following equipment:
  - Antenna(s)
  - Backhaul
  - System equipment
  - DC power
- Verify proper installation of equipment following installation
- Optimize equipment and site using optimization checklist

[2] Motorola Standards and Guidelines for Communication Sites, Motorola Solutions, Inc.

3.1.1 Environmental Considerations

The Airlink Mercury hardware platform supports Airlink remote radio software. Currently, the compact enclosure is designed for indoor operation only. For outdoor use it must be installed in a ventilated NEMA 4/4X enclosure of adequate size and airflow to ensure an ambient environment of -40º F to +158º F (-40ºC to 70° C). Humidity should not exceed 95% non-condensing for more than 96 hours with the average humidity at 55%.

3.1.2 Equipment Ventilation

The Mercury radio should be mounted in an area that allows for adequate air flow. The radio should be mounted to maximize air flow around the heat sinks. For maximum cooling, the radio should be mounted vertically to promote airflow over the fins. Provide adequate airflow around the radio enclosure, maintaining a minimum 2” clearance from the front, sides, and top surfaces.

3.1.3 Site Grounding

Motorola’s R56 site preparation practices provide the best source for grounding and lightning preparation and should be consulted before equipment installation. It should be referred to for grounding and lightning
mitigation during this installation. Grounding and lightning protection are important during equipment installation as grounding issues and damage to equipment from lightning can cause significant issues if not done properly. Grounding and lightning protection can be divided into the following categories:

- **Electrical Ground** - Ground wires carrying current from equipment or circuitry at the site ground. This includes AC or DC electrical power used to power equipment at the site, backhaul connectivity, or alarm wiring.
- **Lightning Protection** - Lightning protection and mitigation are crucial for safe and reliable communications. This includes radio equipment, backhaul, coaxial cables, networking cables, AC/DC cabling, etc. This is not only for equipment that is directly onsite, but equipment where there’s an electrical path from elsewhere to the site.
- **Surge Protection** – It is critical to protect the equipment from electrical surges that can occur from the power supply or source.

3.1.4 Input Power Requirements

The Mercury radio will accept 12 to 24 VDC (12 to 13.3 VDC nominal) power input. The DC source must be capable of supplying 2 amps and should be on a dedicated circuit protected with a fuse or circuit breaker rated at 5 amps. Ensure wire of appropriate size is used.

3.2 Equipment Installation

3.2.1 Equipment Unpacking and Inspection

Inspect the equipment as soon as possible after delivery. If any part of the equipment has been damaged in transit, immediately report the extent of the damage to Siemens Customer Service.

3.2.2 Equipment Mounting

Slots are incorporated into the Mercury enclosure to facilitate mounting the unit to a flat surface.

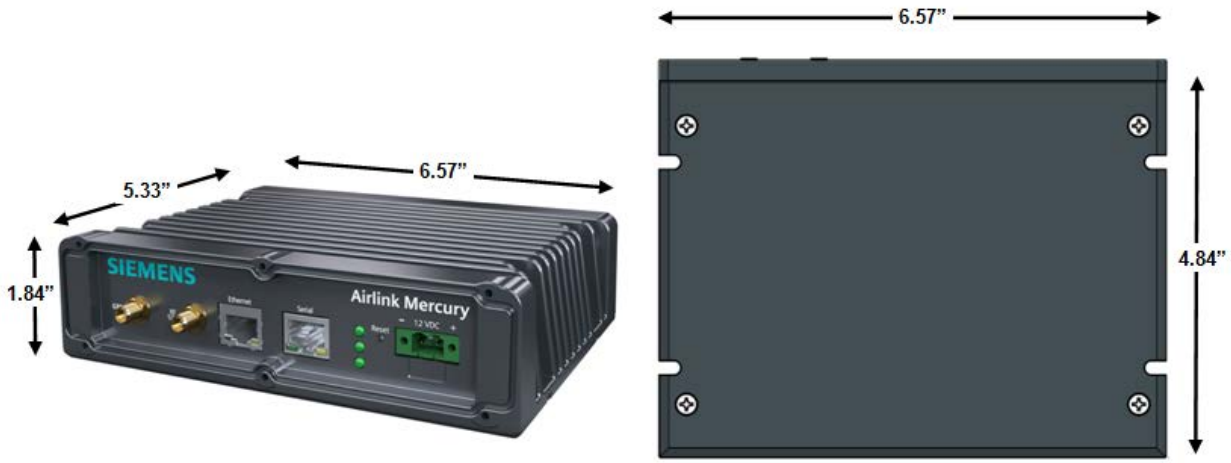


Figure 3-1 Mounting Dimensions

3.2.3 Radio Grounding Guidelines

The Airlink Mercury Radio is equipped with a single grounding point on the rear of the radio. The ground point must be connected using a 10-32 electrical grounding screw of 3/8" length with a #10 size ring-lug. This should be connected to a safe earth ground using at least a 12 AWG protective ground wire.

Figure 3-2 Grounding Point

3.2.4 Mechanical Installation

3.2.4.1 Mounting Procedure

Slots are incorporated into the Mercury enclosure to facilitate mounting the unit to a flat surface. Note that the Mercury has a passive cooling system and as such, the external cooling fins should not be blocked. Provide adequate airflow around the radio enclosure, maintaining a minimum 2” clearance from the front, sides, top, and rear surfaces.

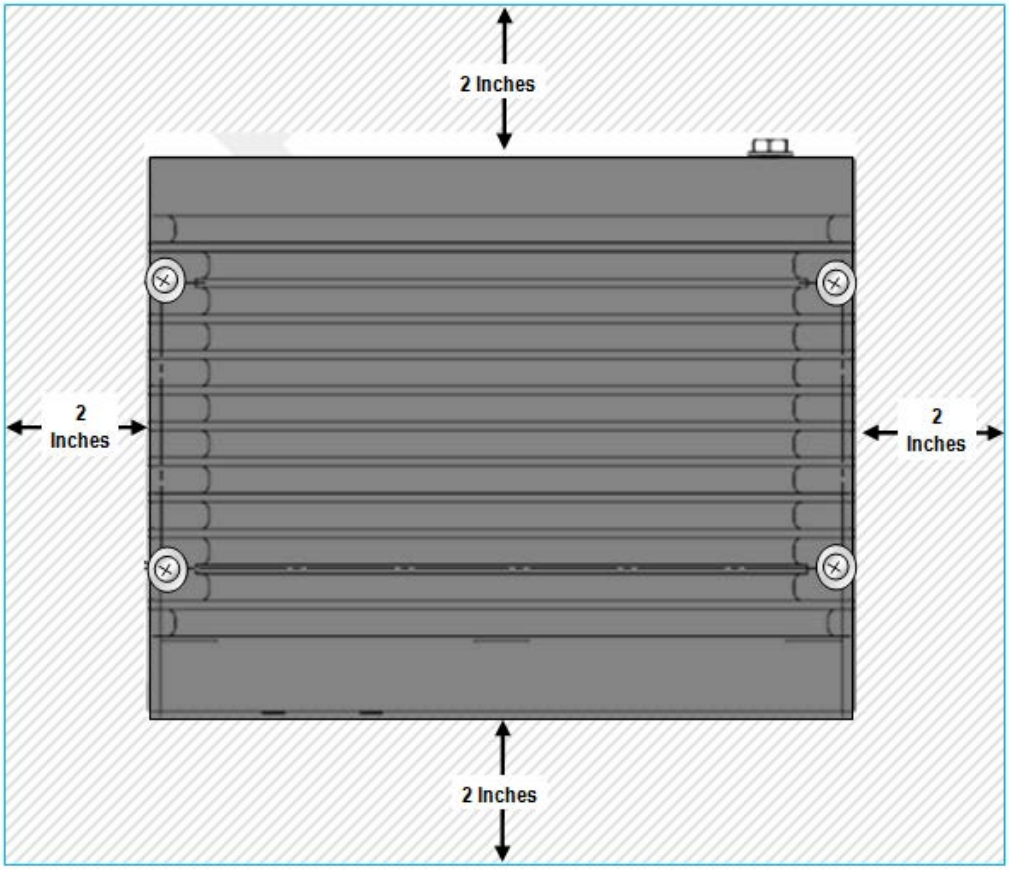


Figure 3-3 Airflow Clearance

The Mercury radio can be mounted with either the connectors facing right, left, or down. (Up is possible, but not recommended to avoid ingress of dust and other foreign matter).

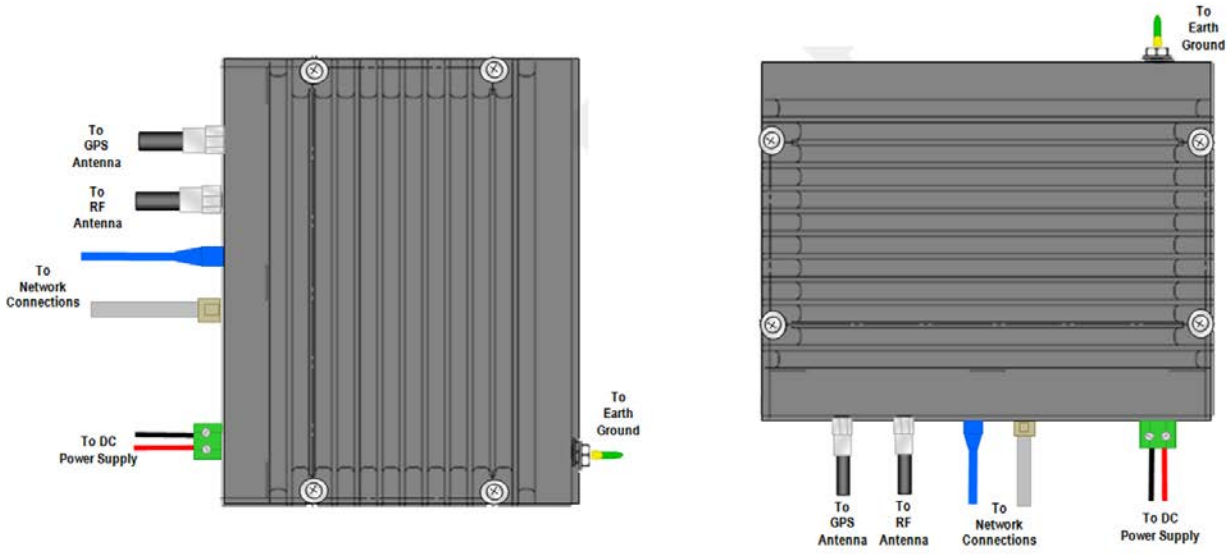


Figure 3-4 Mounting Options

Fasten the radio using four #8 (M4) screws with washer and lock-washer to a flat and level surface using the mounting brackets provided.

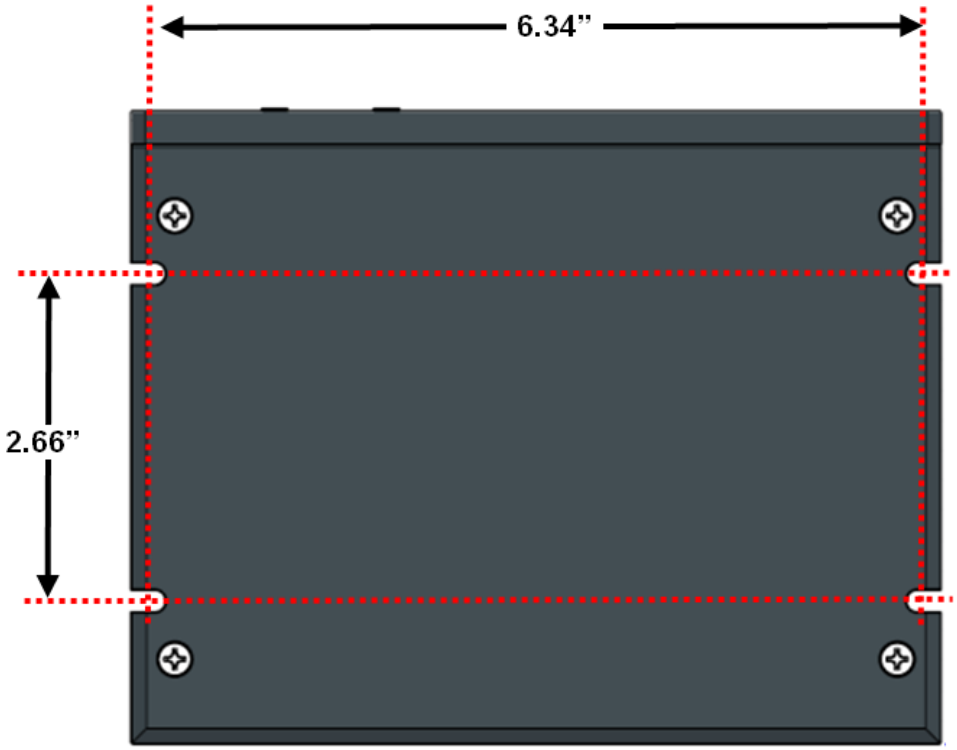


Figure 3-5 Mounting Tabs

3.3 Electrical Connection

3.3.1 DC Power Supply Connection

The Radio is supplied with a mating screw terminal plug, Phoenix P/N: 1777989 that needs to be wired. There is no DC power cable supplied with the Airlink Mercury radio.

Figure 3-6 Power Input

The radio should be connected to a 12 to 24 VDC (12 to 13.3 VDC nominal) power supply. The DC source must be capable of supplying 2 amps and is recommended to be on a dedicated circuit that is protected by a fuse or circuit breaker capable of 5 amps. Ensure wire of appropriate size is used. Tighten screw terminal locking screws with a screwdriver to prevent disconnection of plug from the socket.

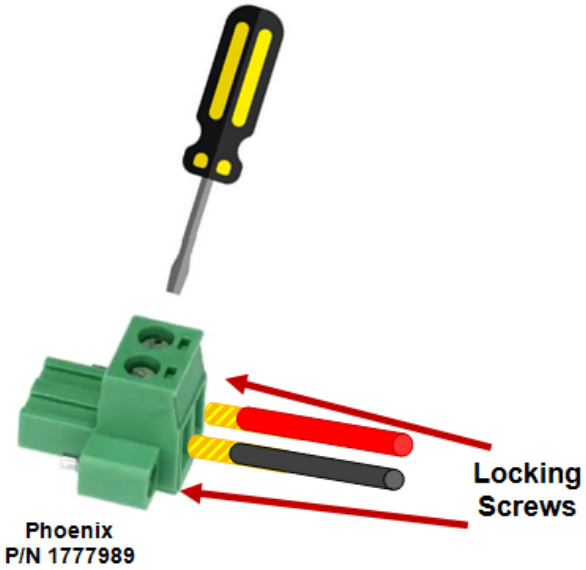


Figure 3-7 DC Input Connector Wiring

WARNING

ENSURE CORRECT POLARITY WHEN WIRING THE DC POWER SUPPLY TO THE SCREW TERMINAL PLUG. THE POWER SUPPLY (NOT SUPPLIED) MUST MEET ELECTRICAL REQUIREMENTS AND STATE AND LOCAL CODE REQUIREMENTS FOR THE USE APPLICATION. INSTALLATION MUST BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

- For PERMANENTLY CONNECTED EQUIPMENT, a readily accessible power disconnect device should be incorporated external to the equipment.
- For PLUGGABLE EQUIPMENT, the power socket-outlet should be installed near the equipment and should be easily accessible.

3.3.2 Antenna System Connections

Two female SMA connectors are provided for the RF and GPS antenna connections.

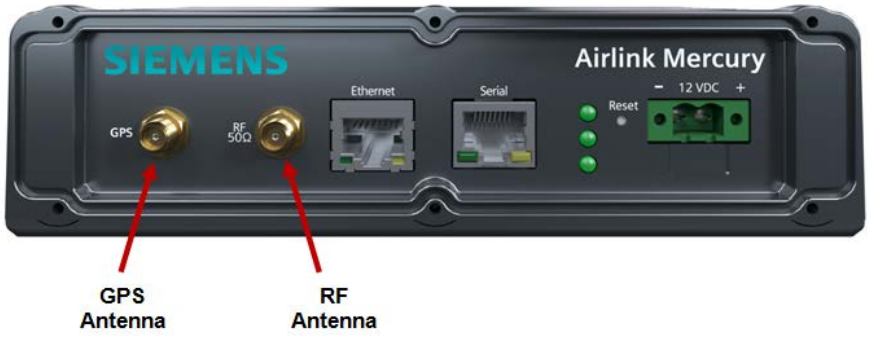


Figure 3-8 Antenna Connections

RF antenna and GPS antenna are sold separately and not included with the Mercury radio. Antennas should be installed by qualified personnel and care should be taken with its grounding and connection to coaxial cable.

This Page Intentionally Left Blank

SECTION 4
GPS SYNCHRONIZATION

4 GPS SYNCHRONIZATION

4.1 GPS Synchronization Overview

Mercury employs optional GPS-based timing to synchronize the operation of the network if necessary. An optional GPS antenna such as the Trimble Bullet III antenna or equivalent as noted in the following section can be ordered. When used, GPS information can be retrieved by the Command Line Interface (CLI) or SNMP interface.

4.2 GPS System

The GPS system consists of a Mercury internal GPS module connected to an external active GPS antenna connected to the female GPS antenna port.

Figure 4-1 GPS Antenna Connection

4.2.1 Internal GPS Module

The internal GPS module includes an oscillator that may be synchronized by the GPS satellite network via the external active (+5V) antenna. A female SMA connector is provided for the GPS antenna connection. The recommended antenna is the Trimble GPS antenna as shown in Figure 4-2.

4.2.2 GPS Antenna

The optional antenna supplied for use with the Mercury is a Trimble Bullet III GPS antenna (or equivalent) as shown below. This antenna requires 5 VDC which is supplied through the Mercury GPS connector.

The Trimble antenna has a TNC female connector. The cable from the Mercury should be a single run TNC-Male to SMA-Male RG-8X cable (without additional connectors or adapters) and no longer than 75 feet as the antenna is an active 5 VDC device with power supplied over this interface. Lower loss cable such as RG-8 can be used for extended length if needed.

The antenna should be installed with a clear view of the sky. The base of the unit is threaded to allow it to be mounted on a hollow conduit.

Feature	3.3V	5.0V
Prime Power	3.3V DV (±10%)	5.0V DV (±10%)
Power Consumption	<20mA	<30mA
Gain	28dB ± 3dB	30dB ± 3dB
Output Impedance	50Ω	
Frequency	GPS L1 1575.42 ±1.023MHz	
VSWR	2.0 maximum	
Axial ratio	90°: 4dB maximum; 10°: 6 dB maximum	
Noise	3.0dB (typical)	
Bandwidth (10dB RL)	50MHz (min)	
Out of Band rejection	fo=1575.42MHz fo ±20 MHz: 7dB min fo ±30 MHz: 12dB min fo ±50 MHz: 20 dB min fo ±100MHz: 30dB min	
Azimuth coverage	360° (omnidirectional)	
Elevation coverage	0°-90° elevation (hemispherical)	0°-90° elevation (hemispherical)
ESD	IEC 61000-4-2	

Figure 4-2 Trimble Bullet III GPS Antenna

NOTE

NOTE

RF cabling should be installed by properly trained and qualified personnel in compliance with all State and Local codes.

4.3 System Cable Connections

Depending on the type of system the radio is connected to, various connections will be needed. The connections are shown in Figure 4-3.

- Serial - RJ45 8-pin socket wired using the Cisco interface specification for RS232 serial data and incorporating embedded Console interface as described in the Remote Access section of this manual.
- Eth - RJ45 8-pin socket for CAT5/6e Ethernet 10/100 Base-T cable interface.

4.4 Connection Summary

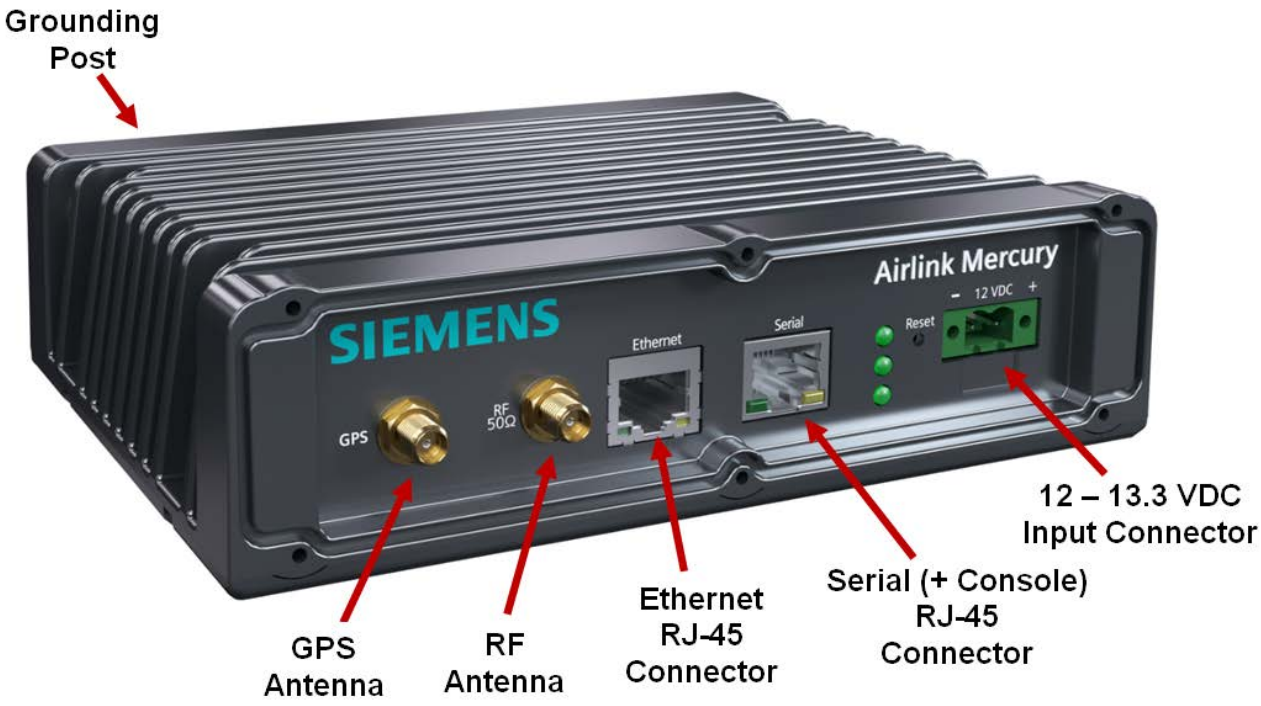


Figure 4-3 Airlink Mercury Connections

Table 4-1 Connection Summary

Connection/Switch	Application
Ground Post	Connection to protective earth ground. Use a #10-32 thread locking nut torque to 8 inch-pounds with a 3/8” wrench.
Input - / +	The Radio is supplied with a mating screw terminal plug, Phoenix P/N: 1777989, that needs to be wired. DC power input 12 to 24 VDC (12 - 13.3 VDC nominal), 2A maximum. Tighten screw terminal locking screws using a screwdriver to prevent disconnection of plug from the socket. **⚠ WARNING** **Ensure correct polarity when wiring DC power supply to screw terminal plug. Power supply (not provided) must meet electrical requirements and State and local code requirements for use application. Installation by qualified personnel only.**
LED Power Indicator	LED power indicator indicates the power and the connection status.
GPS	SMA female connector torqued down to 5 inch-pounds with 5/16” open-end wrench for an optional GPS antenna.
RF	SMA female connector for RF input/output from the antenna. Torque hex connector to 15 inch-pounds with 5/8” open-end wrench. **⚠ WARNING** **Never energize the Mercury radio without a 50 Ohm (4 Watt min) load (or antenna) on the RF connector.**
Serial (+Console)	RJ45 8-pin socket wired using the Cisco interface specification for RS232 serial data. The embedded Console interface is provided by the adapter cable described.
Eth	RJ45 8-pin socket for CAT5/6e Ethernet 10/100 Base-T cable interface.

4.5 Mandatory Product Labels

Mandatory product labels can be found on the rear of the unit as shown in Figure 4-4.

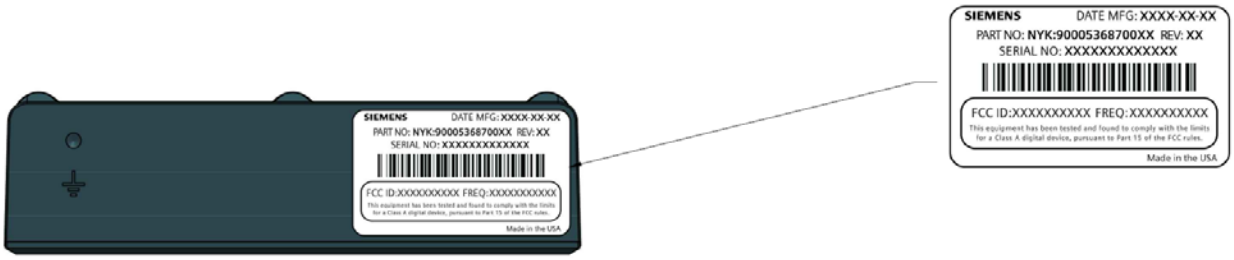


Figure 4-4 Mandatory Product Labels

4.6 Post Installation Checklist

The radios should come from the factory with configurations predetermined upon ordering. This section applies to powering the radios on with proper configuration files. If changes need to be made to radio configurations, refer to Section 6 for configuration information.

4.6.1 Applying Power

Before applying power to the station, make sure all cables are securely connected. Turn on the DC circuit breaker or fuse that is supplying power to the radio.

4.6.2 Verifying Proper Operation

The Mercury front panel includes three LEDs as shown in Figure 4-5.

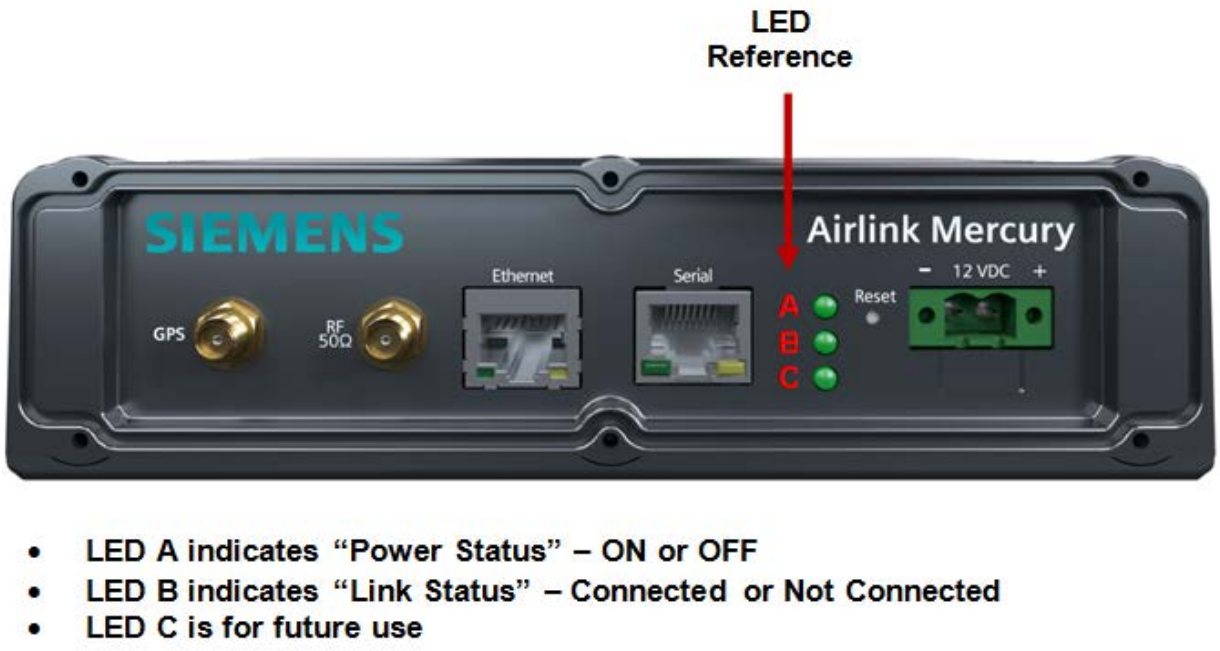


Figure 4-5 Reference LEDs

This Page Intentionally Left Blank

SECTION 5
TROUBLESHOOTING

5 TROUBLESHOOTING

If properly configured, the Remote Station (RS) and the Base Station (BS) should connect within one minute after being turned on. If the connection is not established, then the following needs to be investigated.

Table 5-1 Troubleshooting Matrix

PROBLEM	TROUBLESHOOTING PROCEDURE
Configuration Mismatch	Verify that both the BS and the RS are configured for the same configuration. (Note that if the configuration is to be changed over the radio link, then it is essential to configure all RS units before configuring the BS unit as connectivity to the RS unit will be lost after the new configuration is implemented on the BS.) Symbolic Link: It is important to note that the system relies on symbolic links to the desired configuration file. Multiple configurations can be stored on each radio, but only the one linked is active. If the symbolic link is to the wrong configuration file, then the unit will not connect.
Excessive Pathloss	In a lab setup, verify that the attenuation between the BS and the RS is set properly and does not exceed 90 dB. (Do not power on the radios without the proper attenuation between the units). In an operational environment, verify that the path loss is acceptable and that the connections to the antennas are secure and proper. Verify that the antennas are correctly installed per the RF plan.
Cabling & Antennas	Verify that both the BS and RS along with their associated RF cabling and antennas are properly grounded.
Interference	Perform an RF scan using Apollo to verify that the channel is clear of RF interference. Note that the radio has a very large RF range and as such, out of TX/RX band RF energy can affect the radio's sensitivity. Proper use of external filters can reduce this interference.

<table>
<tr><th>PROBLEM</th><th>TROUBLESHOOTING PROCEDURE</th></tr>
<tr><td>BS Detected & No Connection</td><td>If the BS signal is detected (DL ACQUIRED) but a connection is not established, then the following needs to be determined:

An RF scan using Apollo should be performed to verify that there is no interference in the channel. This needs to be performed at both the RS site and the BS site. Note that often the BS site is installed on a high tower and as such, the antenna is more susceptible to interference which could obscure the reception of the signal from the RS. Omnidirectional antennas will tend to experience greater interference than sectorized or directional (Yagi) antennas.

Verify the orientation (both horizontal and vertical) of the antennas.

Check the TX power of each unit. If both units are transmitting at maximum power, then there is most likely an issue with the RF path. Note that the BS actively controls the TX power of the RS, so if the RS is transmitting at maximum power, it is an indication that the signal level is too low at the BS. In this case, interference may be obscuring the signal, the antennas are misaligned (which reduces the signal level), the RF cabling or lightning protector is damaged, or water has entered the connectors or cables.</td></tr>
<tr><td>Low Throughput</td><td>The throughput is dynamically determined based on the RF environment and the default configuration for this is shown in the following table:

<table>
<tr><th>FEC</th><th>CINR</th><th>Modulation</th></tr>
<tr><td>0</td><td>0-5</td><td>QPSK 1/2</td></tr>
<tr><td>1</td><td>6-8</td><td>QPSK 3/4</td></tr>
<tr><td>2</td><td>9-12</td><td>16 QAM 1/2</td></tr>
<tr><td>3</td><td>13-17</td><td>16 QAM 3/4</td></tr>
<tr><td>4</td><td>N/A</td><td>64 QAM ½*</td></tr>
<tr><td>5</td><td>18-19</td><td>64 QAM 2/3</td></tr>
<tr><td>6</td><td>20-21</td><td>64 QAM 3/4</td></tr>
<tr><td>7</td><td>22+</td><td>64 QAM 5/6 **</td></tr>
</table>

To increase throughput, the CINR needs to increase to support the higher modulation techniques as shown.

* 64 QAM 1/2 is not implemented as it provides the same performance as 16 QAM 13/4

** Note that FEC 7 (64 QAM 5/6) is only implemented in Uplink by Mercury</td></tr>
<tr><td>Console Messages are Slow or Garbled</td><td>Verify correct interface settings for console</td></tr>
</table>

SECTION 5
CONFIGURATION

6 CONFIGURATION

6.1 Description

This section provides an overview of the setup, configuration, and operational aspects of the Airlink network, consisting of remote radios running Airlink Mercury software based on the Mercury hardware platform.

The radio will ship from the factory with preset configurations.

⚠ CAUTION

CAUTION

CAUTION IS ADVISED WHEN MAKING CONFIGURATION CHANGES.

CONFIGURATIONS TO THE RADIO SOFTWARE ARE VERY COMPLEX AND SHOULD BE PERFORMED IN APOLLO WHICH ALLOWS ACCESS TO A SUBSET OF CONFIGURATIONS OR BY SIEMENS CUSTOMER SUPPORT TO PREVENT ACCIDENTAL CONFIGURATION CHANGES THAT CAN RENDER THE RADIOS UNUSABLE.

While many aspects of a link are determined by the base station and learned by the remote radio during network entry and regular operation (e.g. provisioning and Quality of Service), certain elements are preconfigured in the remote radio.

There are two recommended methods of changing the configuration of the Airlink Mercury radios:

- Apollo (preferred) – Siemens' Graphic User Interface (GUI) – Information on this is provided in a separate manual
- WinSCP: Manually uploading or editing configuration files using Win SCP and creating a new symbolic link (for advanced users):
  - WinSCP can be used as follows:
    - Upload and relink: Upload a new configuration file and relink the file (preferred)
    - Edit & relink: Carefully edit another preexisting configuration file and relink the file
    - Edit: the symbolic link file (which edits the linked file by default)

NOTE

NOTE

Temporary Non-permanent Configuration Changes (no reboot required) can be made using the CLI. This is described in the Operations section of this document. Information provided in this section is for non-permanent changes to a limited number of system parameters (i.e. system reboot reverts to the original parameters) and is intended for test purposes only.

6.2 Remote Access

Airlink radios may be accessed locally using the serial port as a console or remotely using SSH or WinSCP over an Ethernet connection as described in the following sections.

6.2.1 Radio Console Access

The Mercury Serial connector includes an embedded Console interface. The Console is accessible using a Console Adapter cable as shown in Figure 6-1.

Figure 6-1 Console Port Cable (USB to RJ-45)

The pin-out of the Mercury Serial connector is described in Table 6-1.

Table 6-1 Mercury Serial Cable Pin-out

PIN	Function
1	Ground
2	Ground
3	Serial Data Tx
4	Ground
5	Ground
6	Serial data Rx
7	Console Tx
8	Console Rx

The Console interface may be accessed using a serial application (Putty, HyperTerminal, minicom, MobaXterm, etc.) configured with the following characteristics:

Table 6-2 Console Configuration

Parameter	Value
Speed	115,200
Data Bits	8
Stop Bits	1
Parity	None
Flow Control	None

NOTE

NOTE

The console interface is also used for status reporting which can make CLI use a challenge. Wherever possible, it is recommended that Ethernet access (described later) is used.

6.3 Passwords

6.3.1 Default Passwords

The default passwords are as follows:

user/password: operator/operator100
user/password: admin/admin100
user/password: root/root100

6.3.2 Changing Passwords

Default passwords are changed using the standard Linux tools. To change any default password, login to the root user account and use the following command:

$ passwd operator “new password”

$ passwd admin “new password”

$ passwd root “new password”

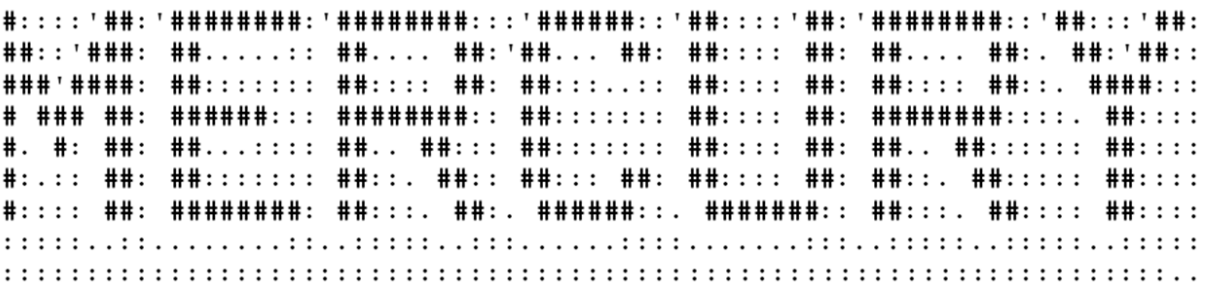
Where “new password” = new required password.

NOTE

NOTE

Quotes are not required and Linux will not ask you to repeat your password.

6.4 Remote Station Display



Console access to a remote radio is password protected. The username “operator” is limited to status commands without access to configuration commands, “admin” provides access to the CLI status and configuration commands, while “root” provides unrestricted file system access and Linux OS commands.

In a live network, commentary and progress reports are sent to the console port as status information. For this reason, local console access can often appear cluttered and confusing. Wherever possible, it is recommended that Ethernet access, either remotely or locally via the Ethernet port is used.

6.5 Radio Ethernet Access

Remote radios support SSH for Ethernet access which is password protected. The user “operator” is limited to status commands without access to configuration commands, “admin” provides access to the CLI status AND configuration commands, while “root” provides unrestricted file system access and Linux OS commands.

More advanced users familiar with the Linux Operating System will find a subset of standard commands, some with limited functionality that may be used for system navigation and file manipulation in the online application partition.

The open-source tool WinSCP as described in the following section may provide a more familiar environment for Windows users.

6.6 WinSCP

WinSCP (http://www.winscp.net) is an open-source tool that provides powerful remote file management tools from a Windows environment.

6.6.1 WinSCP Startup Dialog

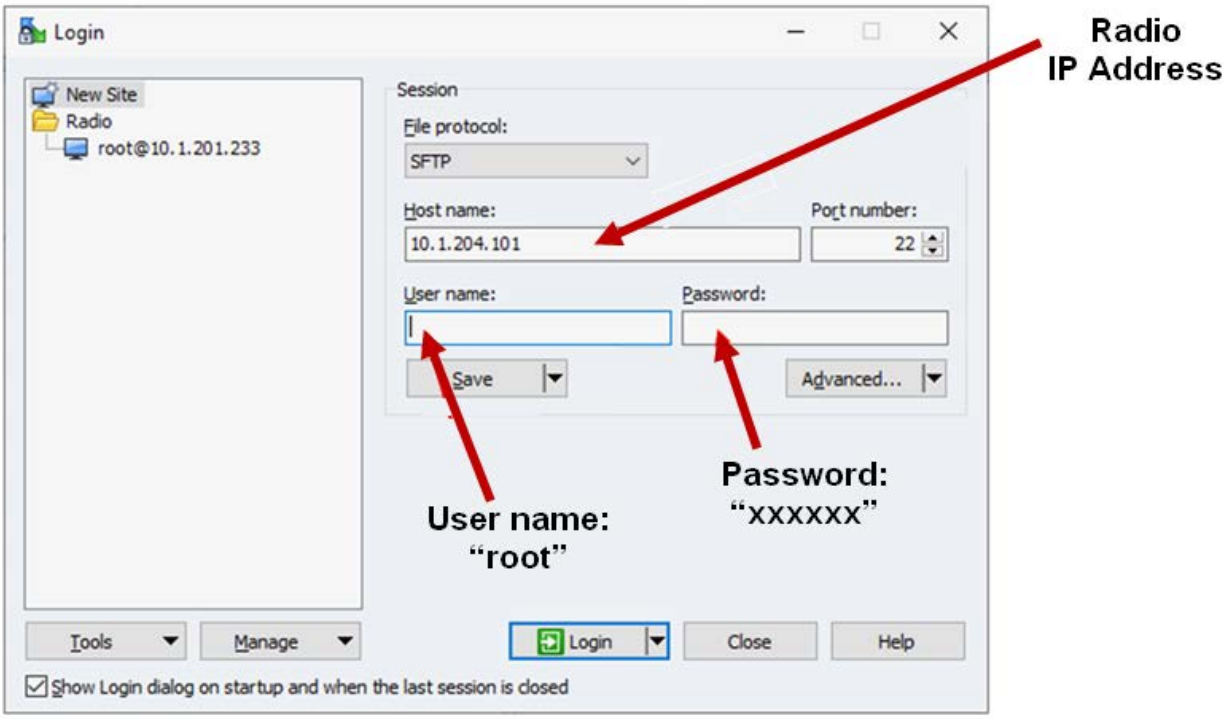


Figure 6-2 Startup Dialog – User Name and Password

6.6.2 WinSCP Configuration of Mercury

There are three methods used to change the configuration using WinSCP:

1. Upload and relink: Upload a new configuration file and relink the file (preferred)
2. Carefully edit another preexisting configuration file and relink the file
3. Edit the symbolic link file (which edits the linked file by default)

6.6.3 Mercury File Structure

The right side of the WinSCP screen shows the Mercury files. Within the root directory, the following subdirectories are shown in Figure 6-3.

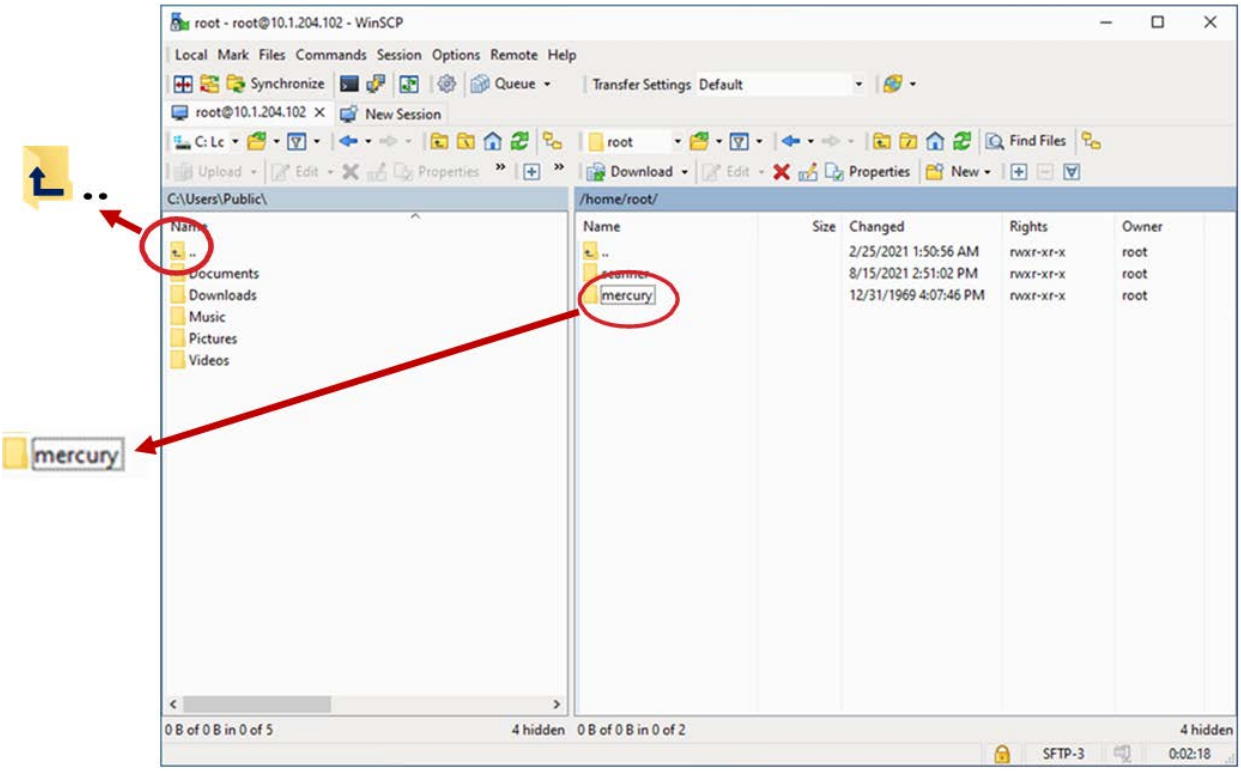


Figure 6-3 Mercury File Structure

Because this is a windows environment, double-clicking on the directory you want to move to will bring you to the subdirectory. The mercury config files can be found in the mercury subdirectory.

Double-clicking on the **..** icon will bring up a higher directory.

The mercury configuration file is located under the “mercury” directory

Double-clicking on a file name will open the file which can then be edited. The figure below shows an example of a mercury configuration file:

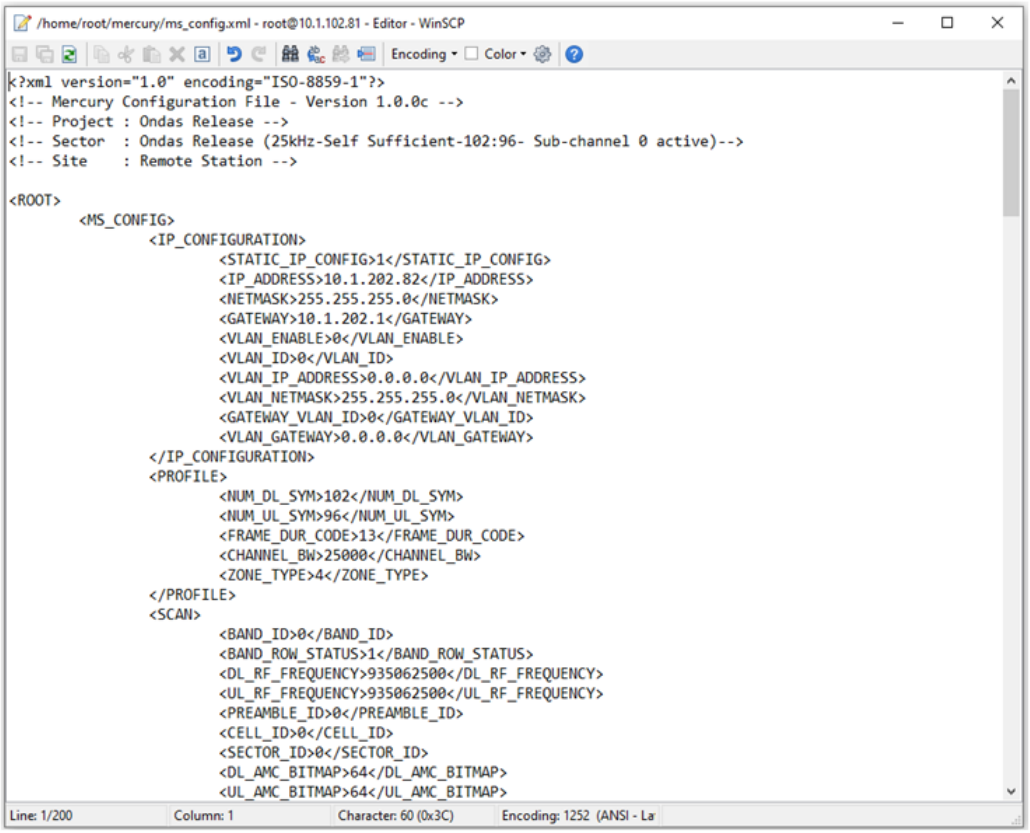


Figure 6-4 Mercury Configuration File

6.7 Remote Radio Station

The operation of a remote station is determined by a set of configuration parameters organized into a series of files in the application partition. The radio will ship from the factory with preset configuration files.

The operation of a remote station is determined by a set of configuration parameters organized into the following files in the application partition.

Table 6-3 Remote Station Configuration Files and Functions

Filename	Function
/home/root/mercury/start_mercury.sh	Remote Start-up Script
/home/root/mercury/ms_config.xml	Application Configuration File or Link
/home/root/mercury/MS_snmpbuild/snmpd.conf	SNMP Configuration file

CAUTION

WITHIN THE ROOT DIRECTORY OF THE RS, THERE ARE SEVERAL IMPORTANT FILES. IT IS IMPORTANT TO BE CAREFUL WHEN MAKING CHANGES TO THE DIRECTORY. CHANGES TO THESE IMPORTANT FILES CAN CAUSE THE RADIOS TO NOT CONNECT. PLEASE PROCEED WITH CAUTION.

This section describes the key configuration elements for the Mercury Remote station on a per file basis. Be aware the configuration files contain many other parameters which should not be modified

- start_mercury.sh – This is the file the remote station uses when it's initially turned on. This will be custom tailored by Siemens based on each customer's requirements. Changes should be coordinated with Siemens.
- ms_config.xml – This is the configuration file for the RS. This can be a single file or a symbolic link file (pointer file) that points to the file that contains the configuration information for the remote station. It contains the IP configuration, system information which includes the channel bandwidth, the RF information which includes TX/RX frequency, and many other configuration parameters. These configuration parameters, their definitions, and possible values can be found in the "Airlink Mercury Parameter Configuration Manual" for your software version. As a note, many parameters in this file are interrelated and should not be changed without advanced knowledge of the system. Parameters that can be changed are listed below:
  - IP CONFIGURATION (IP address, Netmask, Gateway, etc.)
  - UL/DL Frequency
  - RX_Gain
  - Sub-channel bitmap
- snmpd.conf – SNMP configuration information

6.8 Maintaining Multiple Configuration File Versions

As previously mentioned, there are three methods used to change the configuration using WinSCP:

1. Upload and relink: Upload a new configuration file and relink the file (preferred) – This method uses WinSCP to transfer a new configuration file to the radio. The old symbolic link will then need to be deleted and a new symbolic link will need to be created to this new file as noted below.

2. Carefully edit a preexisting configuration file and relink the file – This method is a little more involved as it will require the user to selectively edit an existing configuration file and then delete the old symbolic link and create a new link to the modified file. (It should be noted that syntax errors and incorrect parameter selection and range can disable a radio.)

3. Edit the symbolic link file (which edits the linked file by default) – This method edits the symbolic link file "ms_config.xml" which edits the linked file therefore a new symbolic link does not need to be created.

The recommended process for managing configuration file changes is to create multiple copies of the appropriate configuration file, giving each version a meaningful filename. A symbolic link is then used to make the association with the standard filename and the version to be used, as shown in the example below.

Command to show Symbolic link in Remote Station Configuration Directory:

```
root@Mercury:~/mercury# ls -l ms_config.xml
lrwxrwxrwx  1 root root  19 Jan  6 00:28 ms_config.xml -> ms_config.xml_25k
```

This command shows that the symbolic link file "ms_config.xml" is linked to the configuration file "ms_config.xml_25k". Note that changes to bs_config.xml will change the linked file as well. If a different config file is required, then the symbolic link needs to be changed to the new file.

Before you can change a symbolic link you must delete (or overwrite) the existing one. Thus, the process to change from the "25k" configuration above to "25k_asym" is as follows.

NOTE

NOTE

A symbolic link can be overwritten using the force "-f" option (e.g. -sf ms_config.xml_25k ms_config.xml

Show Symbolic link:

```
root@Mercury:~# cd mercury
root@Mercury:~/mercury# ls -l ms_config.xml
lrwxrwxrwx 1 root root   19 Jan  6 00:28 ms_config.xml -> ms_config.xml_25k
```

Remove symbolic link and create new symbolic link:

```
root@Mercury:~/mercury# rm ms_config.xml
root@Mercury:~/mercury# ln -s ms_config.xml_25k_asym ms_config.xml
```

Show new Symbolic link:

```
root@Mercury:~/mercury# ls -l ms_config.xml
lrwxrwxrwx 1 root root 19 Jan 6 00:28 ms_config.xml -> ms_config.xml_25k_asym
```

6.9 Coordinated Configuration File Changes

The configuration file is only read at boot time, so any changes will not take effect until the radio reboots. However, be aware that a disconnected remote radio will go through a sanity reboot if it fails to connect to a Base Station within a defined time, typically configured as 300 seconds.

Once configuration changes have been made in remote radios, reboot the radios to which you do NOT have local access first. This is usually the remote radio(s) since typically backhaul exists to the base stations at the tower site(s). However, if experiments are being conducted from remote sites in the field, then the base station would be rebooted first.

SECTION 7
OPERATION

7 OPERATION

7.1 Description

After the radio and antenna system has been installed and the radio properly configured, the radio can be placed into operation.

7.2 Remote Station (Airlink Mercury) CLI Operation

The basic functionality of the Airlink Mercury software operating on a remote radio can be determined from the LEDs.

Further operational information can be obtained via the CLI as described in this section.

7.2.1 Remote Station CLI

The remote station CLI includes many features for manipulating key configuration parameters however it is recommended that it be used primarily for obtaining measurement and status information described as follows.

7.2.2 Basic CLI Use

Use SSH to login to Mercury admin user with the password. After a successful login, a banner will be displayed as shown in Figure 7-1.

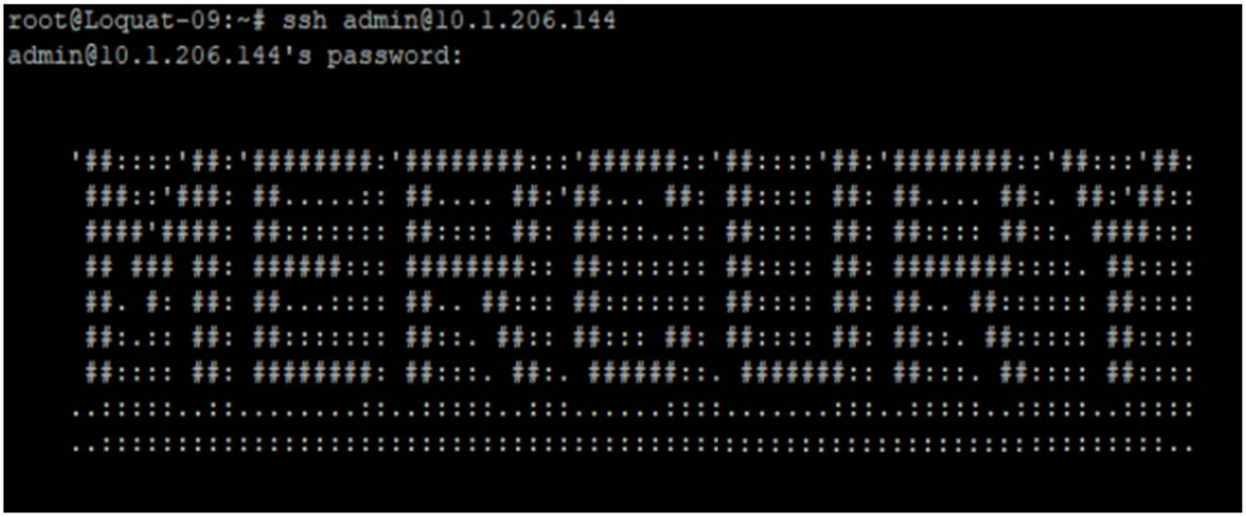


Figure 7-1 CLI Basic Opening Screen Banner

This is the admin CLI. All commands are nested and can be listed by typing a “tab”. The first level is shown in Figure 7-2.

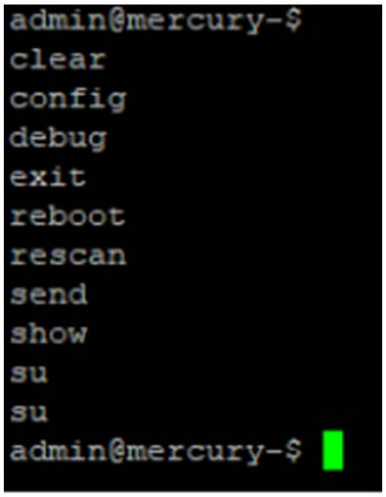


Figure 7-2 First Level Commands

As an example, to see a connected measurement report for the ms, type show and tab:

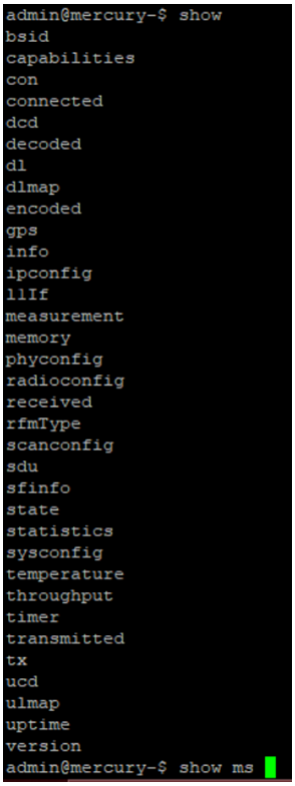


Figure 7-3 View a Connected Measurement Report Example

These are the CLI commands available for the RS. If the command “show ms measurement report” is typed, then the measurement report is shown in Figure 7-4

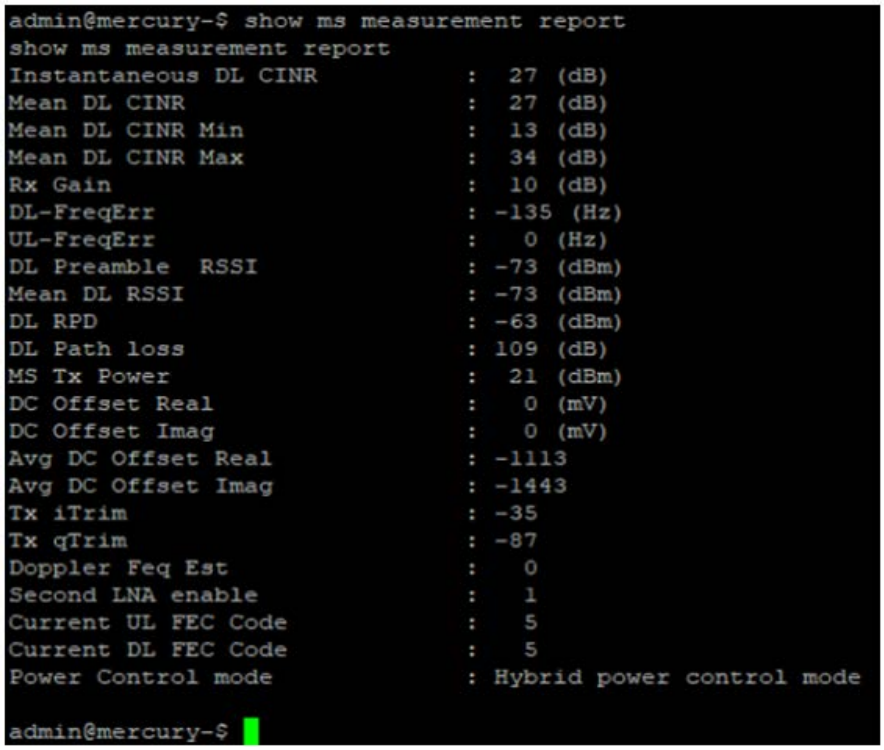


Figure 7-4 MS Measurement Report

Mean DL CINR :	:	27 (dB)	Average DL CINR
Mean DL CINR Min :	:	13 (dB)	Minimum CINR
Mean DL CINR Max:	:	34 (dB)	Maximum CINR
Rx Gain:	:	10 (dB)	RX Gain configured
DL-FreqErr:	:	-135 (Hz)	Down-link frequency error
UL-FreqErr:	:	0 (dB)	Up-link frequency error
DL Preamble RSSI :	:	-73 (dBm)	Down-link preamble RSSI of current frame
Mean DL RSSI :	:	-73 (dBm)	Average preamble RSSI
DL RPD :	:	-63 (dBm)	Down-link Receive Power Density
DL Path loss :	:	109 (dB)	Down-link path loss
MS Tx Power :	:	21 (dBm)	Up-link power configured
DC Offset Real :	:	0 (mV)	Down-link Hardware DC offset real in mv
DC Offset Imag :	:	0 (mV)	Down-link Hardware DC offset imag in mv
Avg DC Offset Real :	:	-1113	Down-link software DC offset real
Avg DC Offset Imag :	:	-1443	Down-link Hardware DC offset imag

Tx iTrim :	:	-35	Up-link DC offset real
Tx qTrim :	:	-87	Up-link DC offset imag
Doppler Feq Est :	:	0	Doppler frequency offset
Second LNA enable :	:	1	Second LNA Parameter
Current UL FEC Code:	:	5	Uplink modulation
Current DL FEC Code:	:	5	Downlink modulation
Power Control Mode:	:	Hybrid power control mode	Uplink Power control mode

For a full description of the CLI commands, refer to the Mercury Command Line Interface (CLI) Manual.

7.2.3 Temporary Operational Non-Permanent Changes (No Reboot Required)

This section describes the recommended techniques for managing temporary non-permanent configuration changes in an experimental test environment.

CLI commands can be used to change certain parameters for test purposes. These changes are not permanent and are undone whenever the system is rebooted. Any changes to the configuration files that are intended to be permanent need to be made by editing the configuration files directly in WinSCP or through Apollo.

The following parameters can be changed temporarily:

1. Change the maximum and minimum transmit power for Mercury.

   Set Minimum Remote Station transmit power type as shown in Figure 7-5. The Minimum transmit power range is 0 to 25 dBm

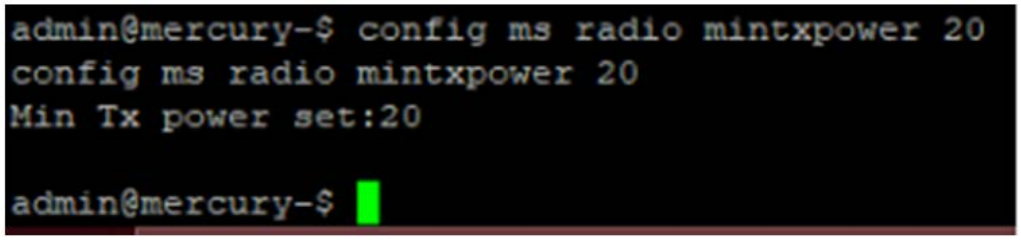


Figure 7-5 Set Minimum Remote Station Power

   Set Minimum Remote Station transmit power type as shown in Figure 7-6. The Maximum transmit power range is 0 to 25 dBm.

```
admin@mercury-$ config ms radio mintxpower 20
config ms radio mintxpower 20
Min Tx power set:20

admin@mercury-$
```

Figure 7-6 Maximum Transmit Power

2. Change the MS RX gain for Mercury as shown in Figure 7-7.

   The range for Receive Gain is 0 to 62 dB.

```
admin@mercury-$ config ms radio rxgain 55
config ms radio rxgain 55
Rx Gain set:55

admin@mercury-$
```

Figure 7-7 Adjust Receive Gain

This Page Intentionally Left Blank

SECTION 8
SOFTWARE UPDATES

8 SOFTWARE UPDATES

Software updates to the radio are made using the following methods:

- Apollo can upgrade the software and should be used whenever possible.
- Complete reflash of the radio – this is a 25 – 30 Mbyte file and should be done locally at the radio. There are two partitions in the radio, a primary and a backup partition. Each partition needs to be separately reflashed depending on the customer's requirements. After reflashing a partition, the configuration files will need to be updated.
- To reflash a partition, use the following procedure:
  - Before flashing the image check for the active partition using “activepart” command.
    # activepart
    The active file system is in mtdblock6
    The offline file system is in mtdblock5
  - Copy the new flash image file (e.g.: Mercury_Release_1.0.0c.ubi) to the /tmp directory in the radio using WinSCP or scp.

NOTE

NOTE

The /tmp directory is erased on a reboot

  - Erase the inactive partition (in this example the inactive partition is mtdblock5)
    # flash_eraseall /dev/mtd5
  - Flash the release image to the inactive partition
    # ubiformat /dev/mtd5 -f Mercury_Release_1.0.0c.ubi -s 512 -O 512
    # sync
  - flashoff <filename> (e.g. flashoff /tmp/Mercury_Release_1.0.0c.ubi
- To reboot the radio to use the newly installed image, enter the following commands
  # boot1
  # reboot

  Radio will reboot and switch the active partition to mtdblock5.

  # activepart
  The active file system is in mtdblock5
  The offline file system is in mtdblock6

- If the active partition is mtdblock5, the commands are as follows:

  ```
  # flash_eraseall /dev/mtd6
  # ubiformat /dev/mtd6 -f Mercury_Release_1.0.0c.ubi -s 512 -O 512
  # boot2
  # reboot
  ```

  Radio will reboot and switch the active partition to mtdblock6.

  - newboot –r

- New configuration files – This is a change to configuration files and can be done locally or remotely as described in this document using Apollo or WinSCP

Specific details of software upgrades will be provided in the release package