SIEMENS

INSTALLATION & OPERATION

A53685 AIRLINK MARS

SOFTWARE DEFINED RADIO (SDR)

OCTOBER 2021

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VERSION A

Siemens Mobility, Inc.
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PROPRIETARY INFORMATION

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FCC RULES COMPLIANCE

The equipment covered in this manual 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 in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult Siemens Customer Service for help**.**

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

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 8 inches (20 cm) from the user and must not be co-located or operating in conjunction with any other antenna or transmitter.

All antenna installation and servicing are to be performed by qualified technical personnel only. When servicing or working at distances closer than 7 feet (2 meters), ensure the transmitter has been disabled. Depending upon the application and the gain of the antenna, the total composite power could exceed 100 watts EIRP. The antenna location should be such that only qualified technical personnel can access it, and under normal operating conditions no other person can come in contact or approach within 7 feet (2 meters) of the antenna.

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.

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 Airlink Mars 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 Airlink Mars 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

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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 Siemens versatile, high-performance A53685 Airlink Mars Radio Hardware Platform is capable of operating all Airlink Software Applications including the IEEE 802.16s and 802.16e air interface protocols and operation as a Base Station, Fixed Remote or Mobile Remote Radio.

The Airlink Mars radio, with transmit power up to 100 watts at the antenna port, offers the network operator many advantages including significantly greater range and capacity and improved performance. Mars can be especially useful in high noise environments.

Airlink Mars supports any frequency band from as low as 70 MHz up to 6 GHz. Furthermore, the Airlink Mars radio Hardware supports flexible channel sizes ranging from as narrow as 12.5 kHz up to 10 MHz.

Airlink Mars' ability to operate a variety of software applications combined with its frequency and channel size independence minimizes future obsolesce allowing the operator to plan for a minimum 15-year life cycle.

The Airlink Mars supports transmit power up to 100 Watts at the antenna port (before antenna gain) with industry-leading radio receiver sensitivity as low as -117 dBm. The combination of 100 Watt TX power, excellent receiver sensitivity, flexible channel sizes, and frequencies, leads to exceptional range in a point-to-multipoint wireless data system with 30+ mile non-line-of-sight of connectivity.

Mars uses front-to-back forced-air cooling to operate within a wide temperature range from -40°C to +70°C.

Figure 1-1 A53685 Airlink Mars Radio

1.1 Specifications

RADIO SPECIFICATIONS	
Frequency Range	70 MHz to 6 GHz
Channel Sizes	12.5 kHz to 30 MHz
Throughput	Up to 10 Mbps
TX Power	100 Watts (50 dBm) @ Antenna Port
RX Sensitivity	As low as -117 dBm
Waveform	OFDMA
Modulation	QPSK, 16-QAM, 64-QAM
FEC	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, Point to Point
Air Interface Protocol	IEEE 802.16-2017
Modulation Coding Scheme Selection	Dynamically Adjusted
QOS	Best Effort, Real-time polling service, Unsolicited Grant Service
CONNECTORS / INTERFACES	
DC Input	Phoenix 1778508
Grounding Terminal	10-32 Thread Screw
Serial Data	RJ-45 (RS232/RS449) 8/8 Jack
Console CLI	RJ-45 8/8 Jack – Cisco Serial
Ethernet (X2)	RJ-45 10/100 Mb 8/8 Jack
Antenna Port RF1	Type N Female Connector
GPS	SMA Jack Female Connector
LCD Display	16x2 Backlit

Specifications (continued)

PHYSICAL CHARACTERISTICS	
RF Antenna (2X)	50Ω
GPS	Active 5 VDC
Input Voltage	48 VDC +/- 25% (36 VDC – 60 VDC)
Data Interface	100 Base T, RS-232
Power Consumption	350 Watts
Indicators	LCD Panel, Power LED
Dimensions	19” x 3.5” x 16” (483 mm x 89mm x 407mm)
Weight	15 lbs. 14 oz (7.2 kg)
Enclosure Protection Rating	IP 50 Standard
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 Mars equipment.

Part Number	Description	FCC Certification ID
9000-53685-00 **XX**		
01	Base Station 100W, 160 MHZ, 802.16S	FCC Certification Pending
02	Base Station 100W, 217/218 MHZ, 802.16S	FCC Certification Pending
03	Base Station 100W, 450 MHZ, 802.16S	FCC Certification Pending
04	Base Station 100W, 757/787 MHZ, 802.16S	FCC Certification Pending
05	Base Station 100W, 896/935 MHZ, 802.16S	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 A53685 Airlink Mars Radio.

Siemens Mobility, Inc. will perform follow-up releases as radio bands achieve FCC certification.

SECTION 2
INTRODUCTION

2 INTRODUCTION

Mars is a radio hardware platform within the Airlink radio networks. The Mars radio can is a software defined radio that can be configured as a base station (BS) with BS5000 software.

The Airlink radio network can be made up of Mars 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 wideband or narrowband technology. Due to its design, the radio can be used through a wide range of frequencies 70 MHz to 6 GHz using channel sizes ranging from 12.5 kHz to 10 MHz.

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

Figure 2-1 A53685 Airlink Mars System

2.1 Summary of Operating Features

- 19” Rackmount active fan design
- Software Defined Radio (SDR) platform for future flexibility and new radio requirements
- Capable of Base Station operation
- Easily programmed or configured locally or remotely
- GPS connectivity for location and synchronization
- Frequency range from 70 MHz to 6 GHz
- Channel sizes from 12.5 kHz to 10 MHz
- Time Division Duplex (TDD) or FDD Half Duplex operation
- IEEE 802.16 – 2017[1] narrowband or wideband capability
- Wide operating temperature from -40°C to +70°C

[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.

2.2 Mechanical Design

The Mars radio is housed in a 19” rack mount enclosure. It is not an outdoor enclosure. If an outdoor installation is needed, it needs to be installed in a NEMA 4/4X enclosure.

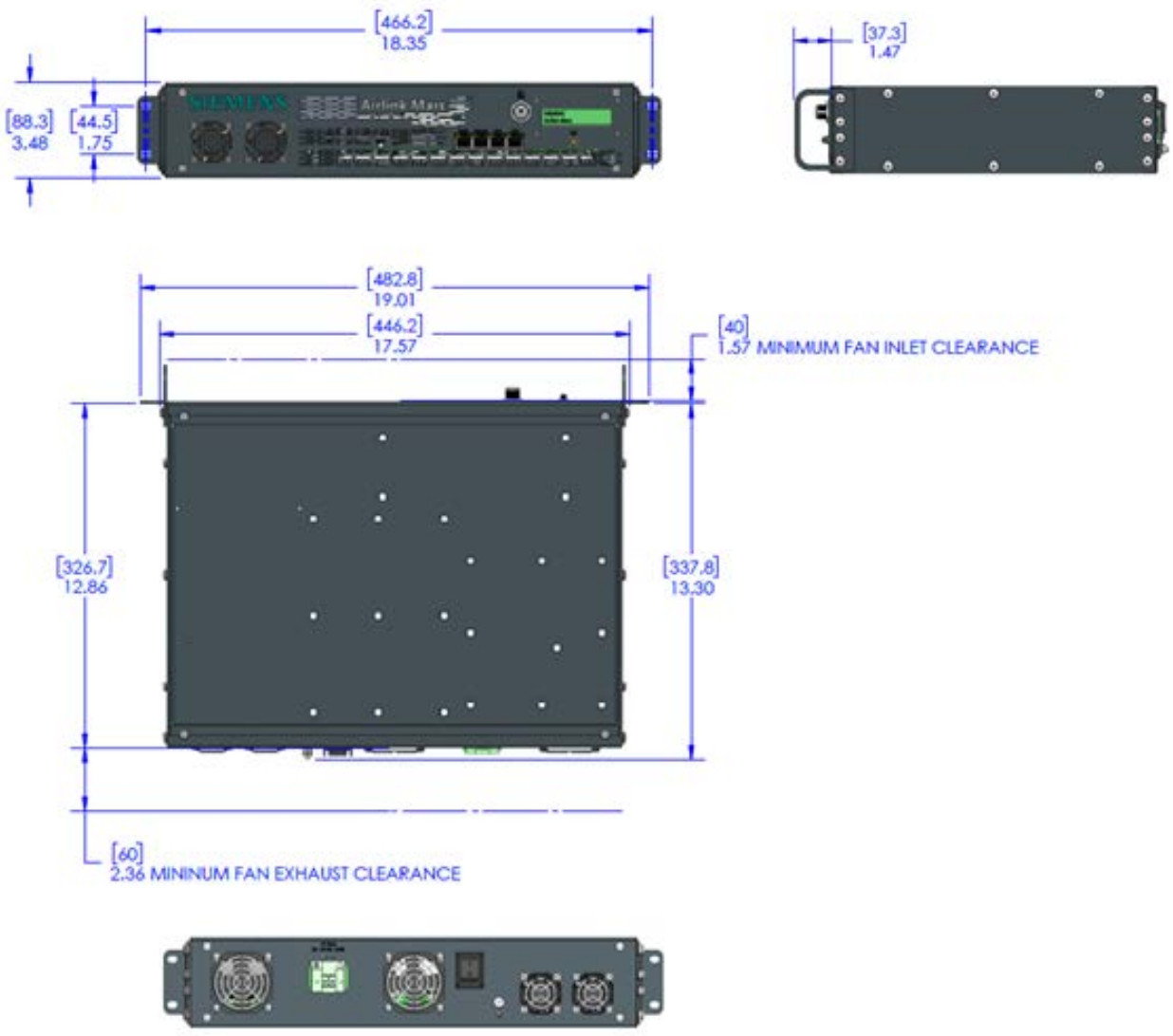


Figure 2-2 Airlink Mars Radio Dimensions

2.3 Electrical Design

The Mars radio is designed as shown in Figure 2-3.

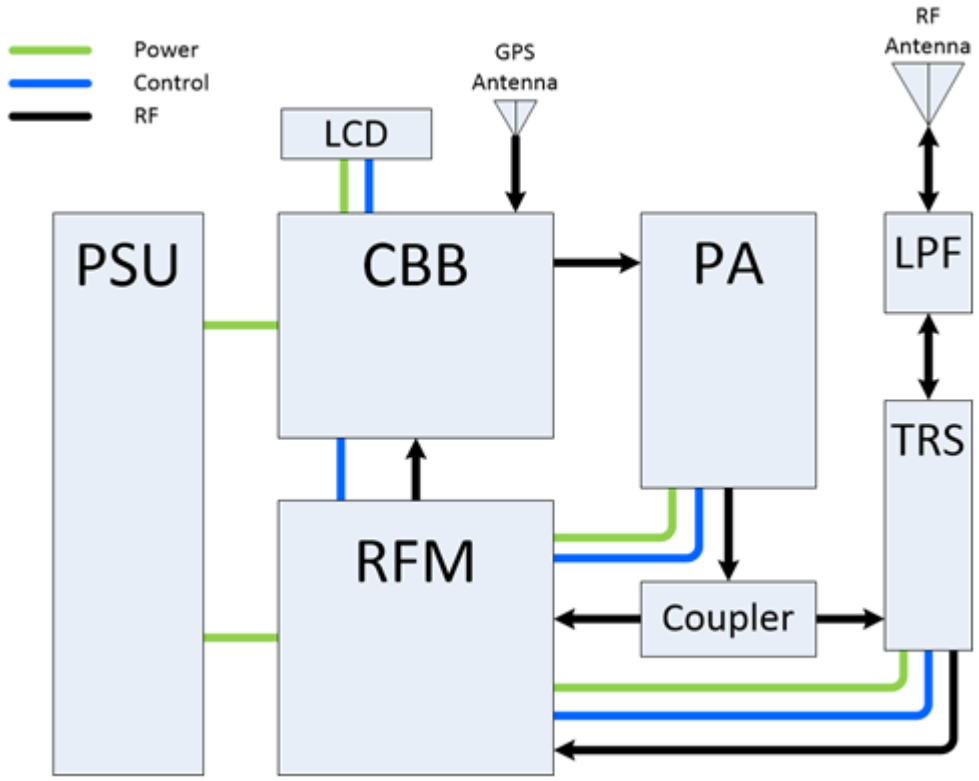


Figure 2-3 Airlink Mars Radio Block Diagram

Table 2-1 Airlink Mars Radio Subsystems

Subsystem	Description	Manufacturer
PSU	Power Supply Unit	Ondas Networks
CBB	Communications Base Board	Ondas Networks
RFM	Radio Frequency Module	Ondas Networks
PA	Power Amplifier	Empower RF Systems
Coupler	Transmit Coupler	Mini-Circuits
TRS	Transmit-Receive Switch	Ondas Networks
LPF	Low Pass Filter	Ondas Networks
SSD	System Status Display	Lumex
RF Antenna	Transmit Receive Signal	Various
GPS Antenna	GPS Signal	Various

2.3.1 Power Supply Unit (PSU)

The PSU requires an input voltage of 36 – 60 VDC capable of supplying a minimum of 10 amps. The PSU also provides power and speed control to the cooling fans.

2.3.2 Communications Base Board (CBB)

The CBB provides high flexibility in both frequency range and channel size. It uses GPS for location and synchronization and provides the inputs and outputs for the console, serial, and Ethernet ports. It also provides the connection to the outside LCD display that is visible on the outside of the radio.

The Mars Communications Base Board (CBB) acts as the main controller for the system. It provides general-purpose computing resources based on an embedded Linux operating system. The CBB includes logic implemented in FPGAs, DSPs, and a programmable RF Transceiver and supports the following user interfaces:

- Reset button with embedded power LED
- 2 x 10/100 MB Ethernet RJ45 sockets
- Serial Data through an RJ45 socket
- Serial Console interface through an RJ45 socket
- GPS antenna connection

The CBB includes a GPS receiver to provide a system and network synchronization using the 1-PPS signal and GPS data to provide the location, time of day, speed, and heading information.

The CBB provides the TX signal directly to Power Amplifier.

The CBB has a control and status interface with the Radio Frequency Module (RFM) and receives the RX signal as an Intermediate Frequency (IF) from the RFM. The CBB also provides the RFM with a 40 MHz reference clock signal.

The CBB provides status information to the System Status Display under software control.

2.3.3 Radio Frequency Module (RFM)

The Radio Frequency Module (RFM) provides the frequency specifics, filters, and power amplifiers to the radio and it uses a single RF path that is switched between TX and RX. The RFM supports a wide range of operational frequencies that are converted into an Intermediate Frequency (IF) for common filtering. The IF RX signal is routed to the CBB.

The RFM provides power, control, and status interface to the Power Amplifier.

The RFM uses the output of the Coupler to manage the TX signal level.

The RFM provides a power and control interface to the Transmit-Receive Switch (TRS) to switch the system between TX and RX modes for Time Division Duplexing (TDD) and Half-Duplex Frequency Division Duplexing (HD-FDD).

2.3.4 Power Amplifier (PA)

The Radio Frequency Module (RFM) provides the frequency specifics, filters, and power amplifiers to the radio and it uses a single RF path that is switched between TX and RX. The RFM supports a wide range of operational frequencies that are converted into an Intermediate Frequency (IF) for common filtering. The IF RX signal is routed to the CBB.

The RFM provides power, control, and status interface to the Power Amplifier.

The RFM uses the output of the Coupler to manage the TX signal level.

The RFM provides a power and control interface to the Transmit-Receive Switch (TRS) to switch the system between TX and RX modes for Time Division Duplexing (TDD) and Half-Duplex Frequency Division Duplexing (HD-FDD).

2.3.5 Transmit Coupler

The Mars radio platform uses the “ZARC-25-551+” High Power Signal Tap as a Coupler to monitor the TX signal and provide feedback to the RFM.

2.3.6 Transmit-Receive Switch

The Mars Transmit-Receive Switch (TRS) switches between TX and RX modes for Time Division Duplexing (TDD) and Half-Duplex Frequency Division Duplexing (HD-FDD). In TX mode the signal from the Coupler is routed to the Low-Pass Filter (LPF). In RX mode the signal from the LPF is routed to the RFM.

2.3.7 Low-Pass Filter (LPF)

The Mars Low-Pass Filter (LPF) provides an additional safeguard that guarantees that the level of harmonics emitted by Mars is well below the FCC requirements.

2.3.8 System Status Display (SSD)

The Airlink Mars uses the “LCR-U01602DSF/AWH” LCD module as a system status display. The display comprises a 2x16 character interface to provide the user with system status information under the control of the CBB.

2.3.9 RF Antenna

The Mars RF antenna is typically provided by the end-user based on operational requirements. The antenna should be matched to the operational frequency, with an impedance of 50 ohms.

2.3.10 GPS Antenna

The Mars GPS antenna is used to provide the GPS signal to the CBB. The antenna should be an active device to support the 5 VDC provided by the CBB.

2.4 Functional Theory of Operation

Airlink can use Time Division Duplex (TDD), meaning the downlink and uplink communication uses the same frequency, but at different times or Half Duplex 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 5 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 transmit 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 BSs in the system transmit at the same time. A BS and 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 Mars radio is designed to operate over a wide range of frequencies and channel configurations while minimizing interference. The radio can operate from 70 MHz to 6 GHz using channel sizes from 12.5 kHz to 10 MHz. At QPSK using convolution turbo coding (CTC) rate of ½, the receiver sensitivity ranges from -127 dBm for a 12.5 kHz channel to -98 dBm for a 10 MHz channel.

The radio incorporates filtering at the following stages:

- RFM
  - RF (Image) Filter which is centered at the RF frequency of operation
  - Intermediate Frequency (IF) Filter which is centered at the IF frequency of operation
- Configurable analog filter which is embedded in the AD9364 analog front-end chip
- Digital filter

The configurable analog filter and the digital filter are software configurable filters embedded on the CBB. These filters are very specific, narrow filters. The filter in the RFM receive path is a broad filter meant to eliminate distant, noisy RF neighbors and is used to attenuate interference to avoid saturating the receiver before the analog to digital conversion. 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.

The RFM filter consists of components within the RFM and the IRF, as shown in the figure below. The receive signal comes into the TX/RX switch on the RF frequency, goes through an LNA, and into the RF SAW filter. From the RF SAW filter, it goes into a mixer where it is transformed to the IF frequency, goes into an amplifier, and the CBB. The low bandpass filter and the RF SAW filter are at the RF frequency whereas the IF SAW (surface acoustic wave) filter is at the IF frequency.

The RF SAW filter and the IF SAW filter are located on a separate daughter board and are not physically part of the RFM.

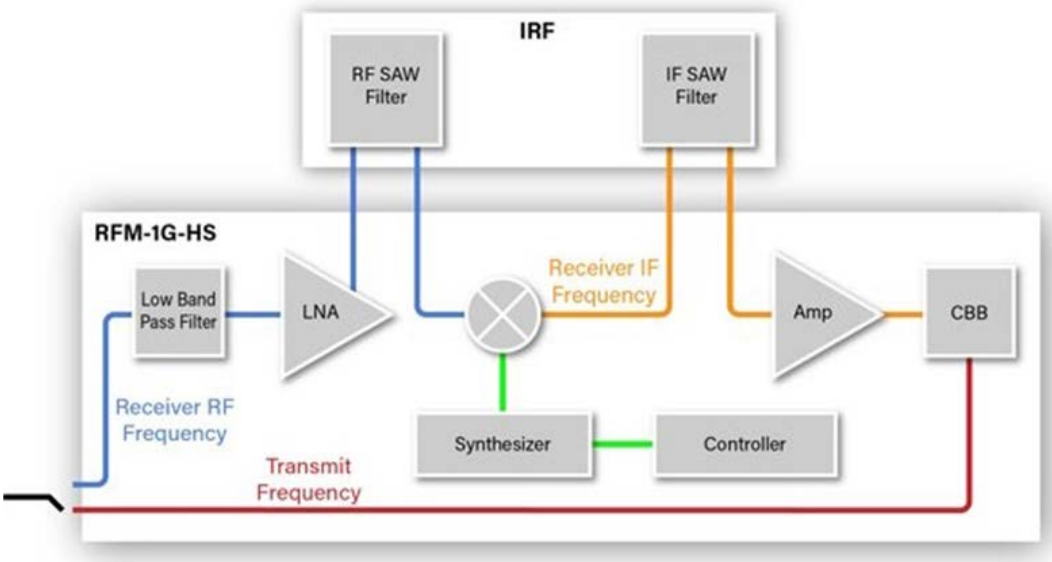


Figure 2-4 RF and IF SAW Filters

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. The 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.

SECTION 3
INSTALLATION

3 INSTALLATION

3.1 Installation Overview

Pre-installation planning is key 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 Mars 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.

3.2 Environmental Considerations

The Mars hardware platform supports Airlink base station radio software, BS5000, or Airlink remote radio software, Cobalt. 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 the ambient environment is within -40º C (40º F) - 70° C (158° F). Humidity should not exceed 95% for more than 96 hours with the average humidity at 55%.

3.2.1 Equipment Ventilation

The cooling airflow from the fans is from the front of the radio to the back and the radio should be mounted in an area that allows for adequate air flow. The radio should be mounted without obstructions to the fans. For maximum cooling, the fans require a minimum 2” clearance.

3.3 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.

3.4 Input Power Requirements

The Mars radio requires a 36 to 60 VDC power input. The DC source must be capable of supplying 10 amps and should be on a dedicated circuit protected with a fuse or circuit breaker rated at 10 amps. Ensure wire of appropriate size is used.

3.5 Equipment Installation

3.5.1 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.

3.5.2 Equipment Mounting

Mounting brackets are provided for attaching the Mars radio in a 19” rack mount enclosure.

Figure 3-1 Physical Dimensions

3.5.3 Radio Grounding Guidelines

The Mars Radio is equipped with a single ground lug located on the rear of the radio. The ground post must be connected to earth ground. Install at least a 12 AWG protective ground wire with #10 size ring-lug to a safe grounding position.

3.5.4 Mechanical Installation

3.5.4.1 Mounting Procedure

Mounting brackets are provided for attaching the radio into a 19” rack mount cabinet. Note that the Mars has an active fan cooling system and as such, the fans require a minimum 2” clearance on the front and back.

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

3.6 Electrical Connection

3.6.1 DC Power Supply Connection

The Radio is supplied with a mating screw terminal plug, Phoenix P/N: 1777989 that needs to be wired on the back. There is no DC power cable supplied with the radio. The radio should be connected to a 36 to 60 VDC power supply. The DC source must be capable of supplying 10 amps and is recommended to be on a dedicated circuit that is protected by a fuse or circuit breaker capable of 10 amps. Ensure wire of appropriate size is used. Tighten screw terminal locking screws with a screwdriver to prevent disconnection of plug from the socket.

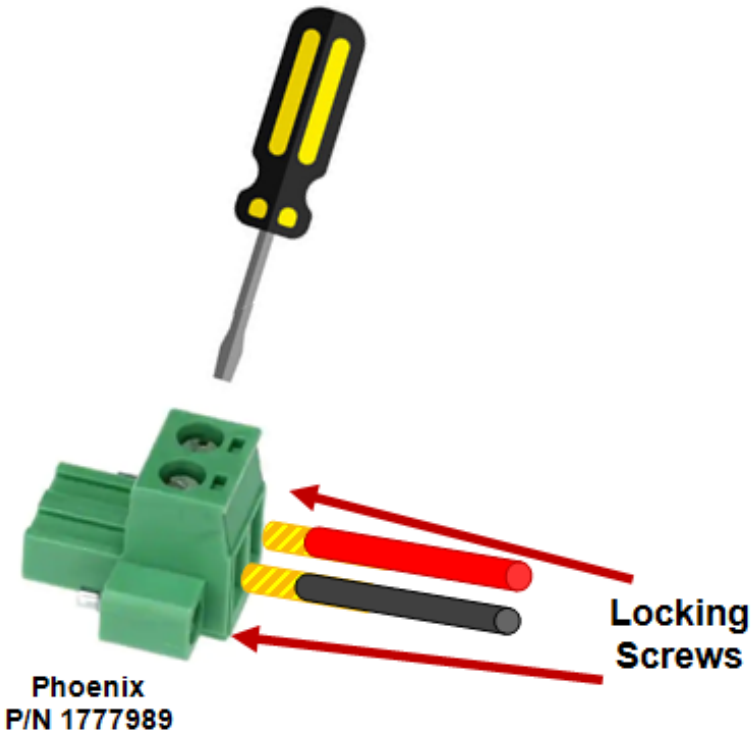


Figure 3-2 Phoenix 1777989 DC Input Connector Wiring and Installation

⚠ WARNING

WARNING

ENSURE CORRECT POLARITY WHEN WIRING THE DC POWER SUPPLY TO THE SCREW TERMINAL PLUG.

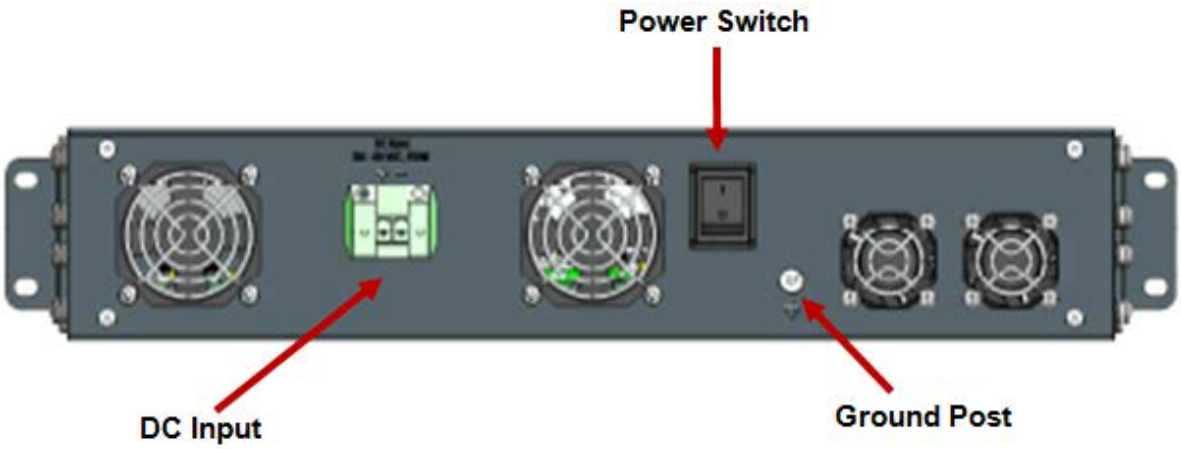


Figure 3-3 DC Input Connector Wiring and Mounting

There is a combination Power LED/Reset switch and a two-position terminal socket on the front panel as shown in Figure 3-4.

Figure 3-4 Power LED and Reset Button

- 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.

3.6.2 Antenna System Connections

One Type N Female connector, for both transmit and receive, is located on the front of the radio. Flexible coaxial cable with a Type N Male connector should be connected between the main RF transmission cable and the radio. Ensure the coaxial cable is properly grounded and properly connected to a lightning protector (e.g. Polyphaser).

Figure 3-5 Antenna Connections

3.7 GPS Synchronization

3.7.1 Overview

The radio employs optional GPS-based timing to synchronize the operation of the network if necessary. An optional L1 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.

3.7.2 GPS System

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

3.7.3 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 noted in the following section.

3.7.4 GPS Antenna

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

The Trimble antenna has a TNC female connector. The cable from the Airlink Mars 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 3-6 Trimble Bullet III GPS Antenna

NOTE

NOTE

RF cabling should be installed by properly trained and qualified personnel.

3.7.5 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 3-7.

- Serial - RJ45 8-pin socket wired using the Cisco interface specification for RS232 serial data.
- Console - RJ45 8-pin socket wired using the Cisco RS232 serial interface specification for console access.
- Eth1 - RJ45 8-pin socket for CAT5/6e Ethernet 10/100 Base-T cable interface.
- Eth2 - RJ45 8-pin socket for CAT5/6e Ethernet 10/100 Base-T cable interface.

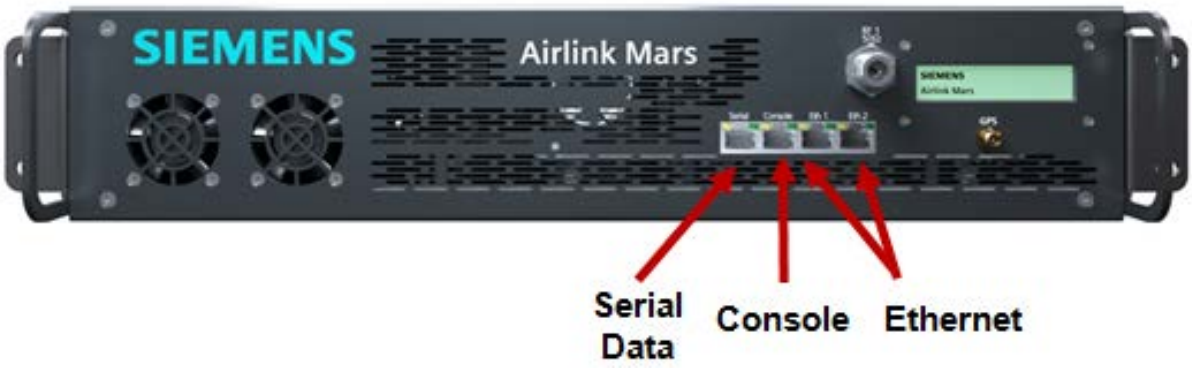


Figure 3-7 Network Connectors

3.7.6 Connection Summary

Table 3-1 Connection Summary

Connection/Switch	Application
LCD	LCD screen shows system status
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 18-60 VDC, 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.**
Reset DC/LED Power Indicator	This is a dual-purpose DC power reset switch with a built-in LED power indicator.
GPS	SMA female connector torqued down to 5 inch-pounds with 5/16” open-end wrench for an optional GPS antenna.
RF1 50 Ω	50Ω N-Type 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 Airlink Mars radio without a 50 Ohm (4 Watt min) load (or antenna) on the RF connector.**
Serial	RJ45 8-pin socket wired using the Cisco interface specification for RS232 serial data.
Console	RJ45 8-pin socket wired using the Cisco RS232 serial interface specification for console access.
Eth1	RJ45 8-pin socket for CAT5/6e Ethernet 10/100 Base-T cable interface.
Eth2	RJ45 8-pin socket for CAT5/6e Ethernet 10/100 Base-T cable interface.

3.8 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 5 for configuration information.

3.8.1 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.

3.8.2 Verifying Proper Operation

When the station is starting up, initially there will be this message on the screen:

While this screen appears, the radio is going through its startup menu and launching the configuration file. After approximately 30 seconds, the following screens appear:

After 60 to 70 additional seconds, the radios will connect and begin scrolling through the following screens:

If the base station does not start properly, the original screen will stay up, and no other screens will scroll on the LED screen:

SECTION 4
TROUBLESHOOTING

4 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 4-1 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.) 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 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 in most installations, the BS site is normally installed on a high tower and as such, the antenna is more susceptible to
interference which could obscure the reception of the RS signal. Given this, a highly directional Yagi antenna, aligned properly is always preferred.
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, then that is an indication that the signal level is too low at the BS. In this case, there is either interference obscuring the signal, the antennas are misaligned (which reduces the signal level), the RF cabling or lightning protector are damaged, or possibly 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>QAM 16 1/2</td></tr><tr><td>3</td><td>13-17</td><td>QAM 16 3/4</td></tr><tr><td>4</td><td>N/A</td><td>QAM 64 ½*</td></tr><tr><td>5</td><td>18-19</td><td>QAM 64 2/3</td></tr><tr><td>6</td><td>20-21</td><td>QAM 64 3/4</td></tr><tr><td>7</td><td>22+</td><td>QAM 64 5/6</td></tr></table>
To increase throughput, the CINR needs to increase to support the higher modulation techniques as shown.

*QAM 64 ½ is not implemented</td></tr>
<tr><td>Console Messages are Slow or Garbled</td><td>Verify correct interface settings for console</td></tr>
</table>

SECTION 5
CONFIGURATION

5 CONFIGURATION

5.1 Description

This section provides an overview of the setup, configuration, and operational aspects of the Airlink network, consisting of base stations running BS5000 software and remote radios running Cobalt software based on the Airlink Mars 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 Mars 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.

5.2 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.

5.3 Serial Port Console Access

Console access to the radio is provided by the RJ45 8 pin Console port using a Cisco standard console (USB to RJ45) cable as shown in Figure 5-1.

RJ45 8P8C Pinout

Pin #1 - CTS	Pin #5 - GND
Pin #2 - DSR	Pin #6 - TXD
Pin #3 - RXD	Pin #7 - DTR
Pin #4 - GND	Pin #8 - RTS

Figure 5-1 Console Port Cable (USB to RJ-45)

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

Table 5-1 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.

5.4 Default Passwords and Change

The default passwords are as follows:

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

Default passwords are changed as done in Linux. To change any default password, log in to the root user account and use the following command:

$ passwd operator “new password”

$ passwd admin “new password”

$ passwd root “new password”

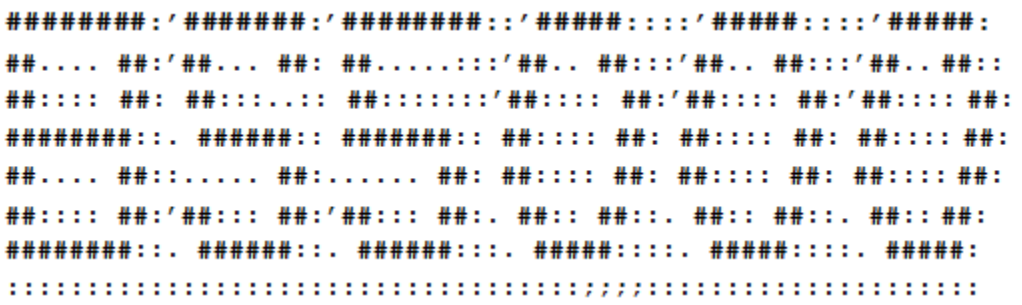
Where “new password” is your new required password.

NOTE

NOTE

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

5.5 Base Station Console Display



Console access to a base station radio is password protected. The username “operator” is limited to performance commands without access to configuration commands, “admin” is limited to the CLI performance AND configuration commands, while “root” provides unrestricted use.

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.

5.6 SSH Ethernet Access

The base station radios support SSH and telnet for Ethernet access that is also password protected. The user “operator” is limited to performance commands without access to configuration commands, “admin” is limited to the CLI performance AND configuration commands, while “root” provides unrestricted use.

Remote radios support SSH for Ethernet access which is password protected. The user “operator” is limited to performance commands without access to configuration commands, “admin” is limited to the CLI performance AND configuration commands, while “root” provides unrestricted use.

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.

5.7 WinSCP

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

5.7.1 WinSCP Startup Dialog

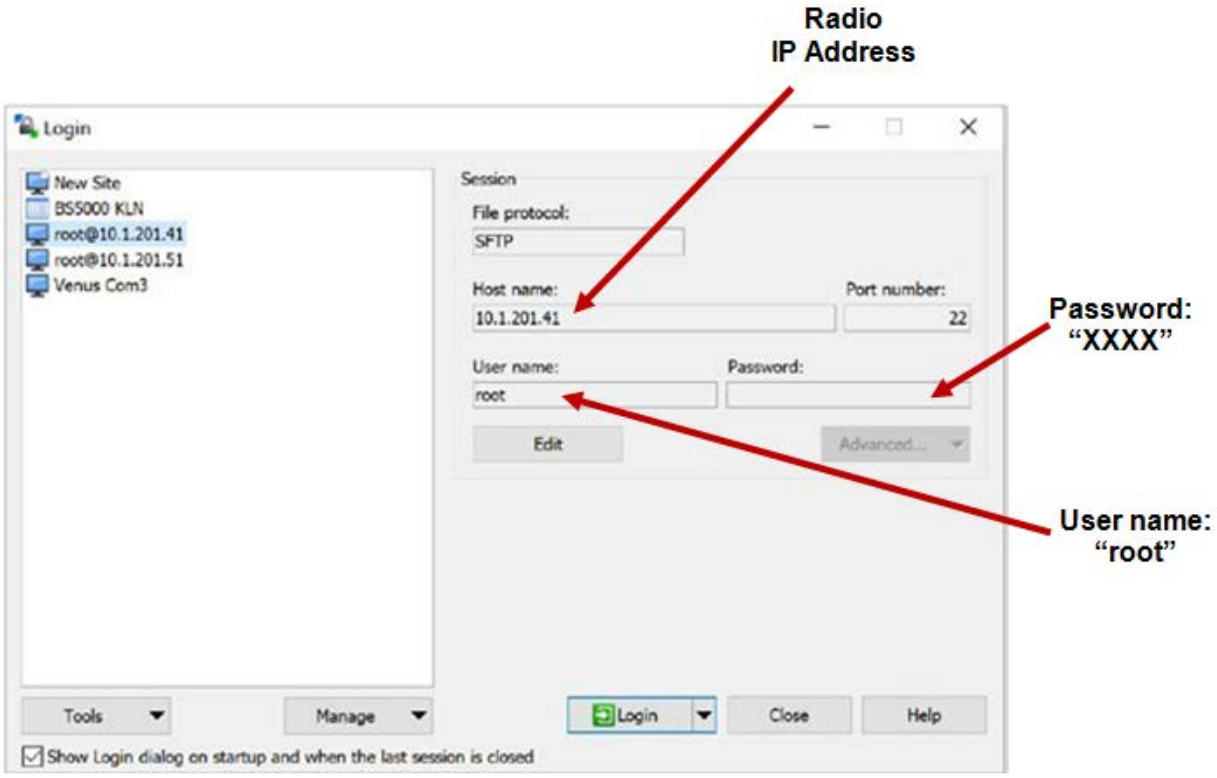


Figure 5-2 Startup Dialog – User Name and Password

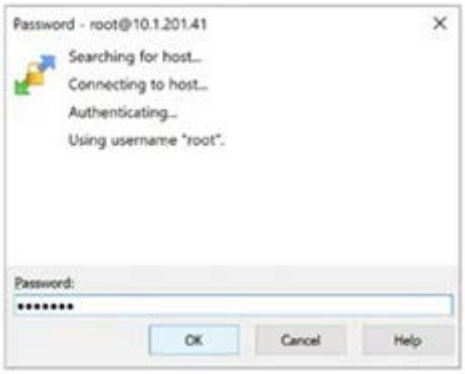


Figure 5-3 Entering Password

5.7.2 BS50000 File Structure

The right side of the WinSCP screen shows the BS5000 files. Within the root directory, the following subdirectories are shown.

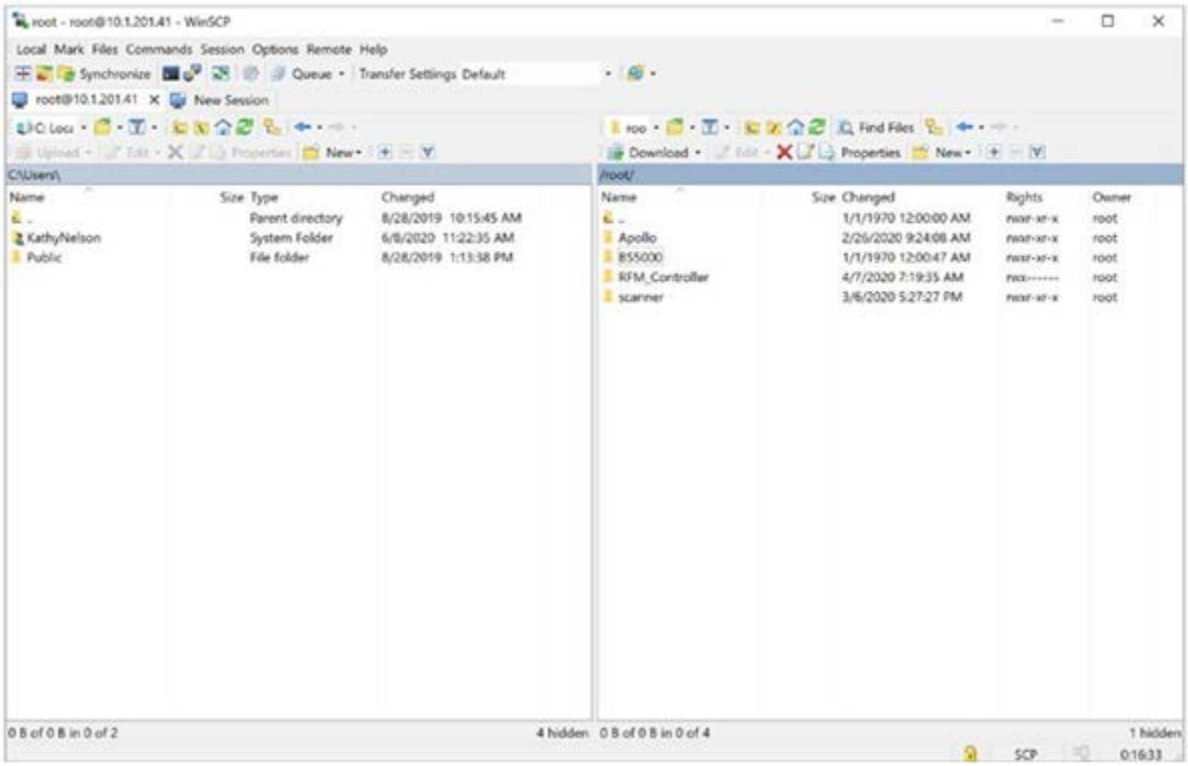


Figure 5-4 Main Session Window

Because this is a windows environment, double-clicking on the directory you want to move to will bring you to the subdirectory. The BS5000 config files can be found in the BS5000 subdirectory.

Double-clicking on **..** will bring you to a higher directory.

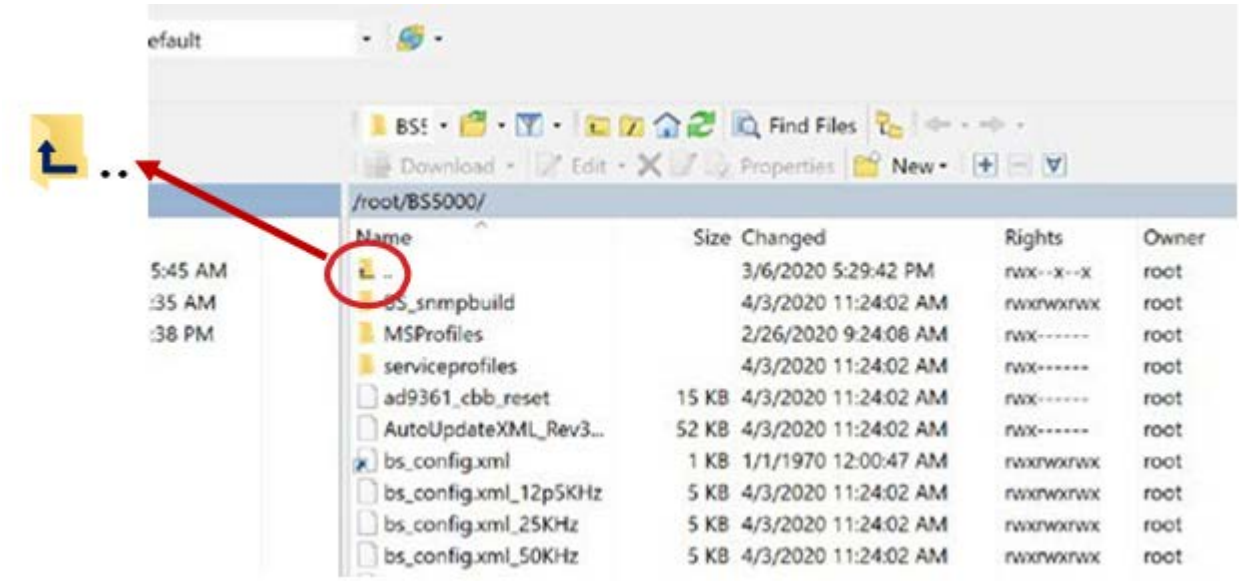


Figure 5-5 Selecting a Higher Directory

Double-clicking on a file name will open the file which can then be edited. Figure 5-6 shows an example of a configuration file.

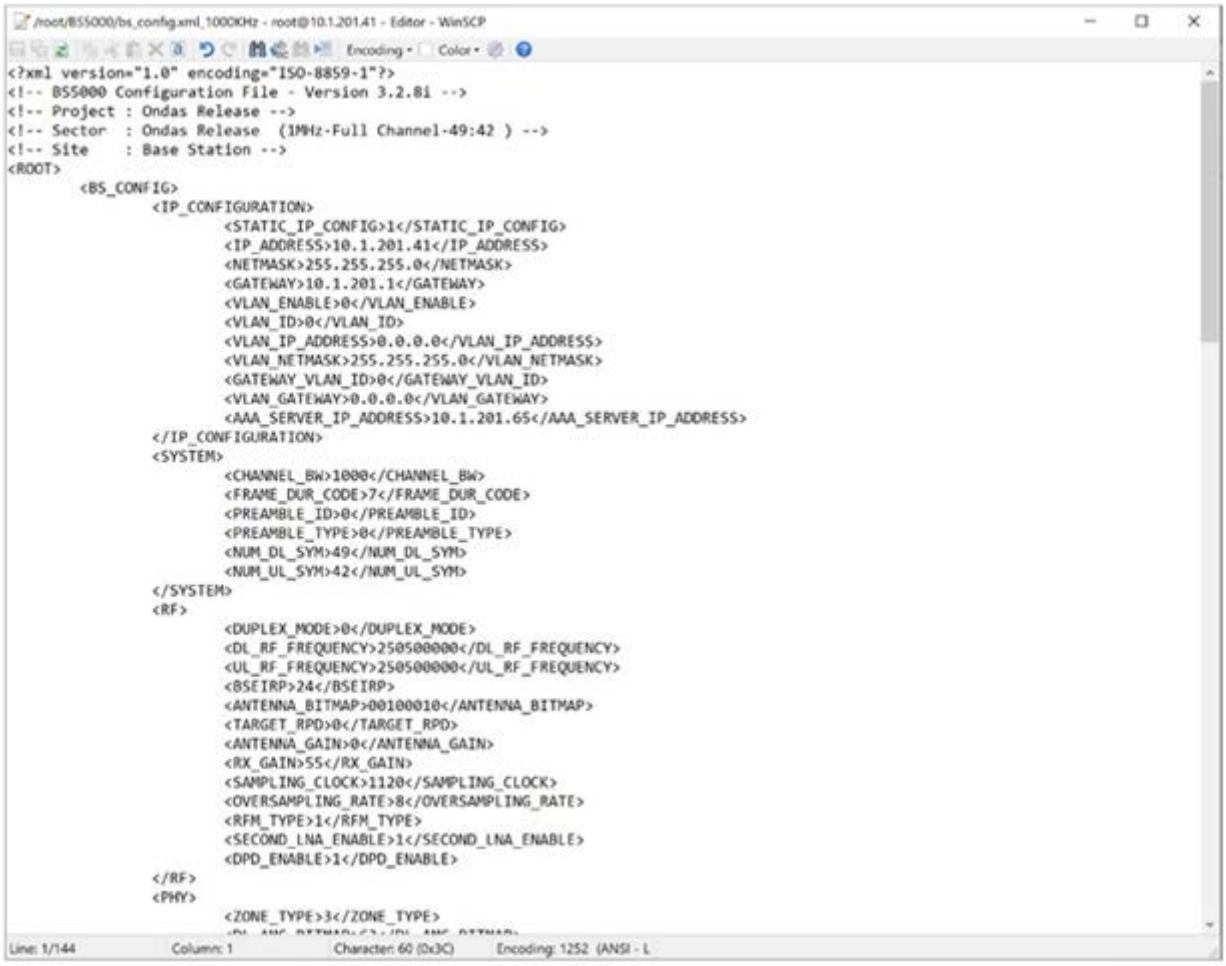


Figure 5-6 Configuration File Example

5.7.3 WinSCP Actions

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)

5.8 Base Station Configuration Files

The radio will ship from the factory with preset configuration files.

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

⚠ CAUTION

CAUTION

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

This section describes the key configuration elements for the BS5000 base station on a per file basis. Be aware the configuration files contain many other parameters which should not be modified.

Detailed configuration information for BS5000 can be found in the “Airlink Configuration Release Manual” for your software version.

The following tables describe the key files in the Base Station (BS5000) radio:

Table 5-2 Base Station Configuration Overview

Filename	Function
/root/BS5000/start_bs.sh	Base Station Start-up Script
/root/BS5000/bs_config.xml	Application Configuration File or Link
/root/BS5000/BS_snmpbuild/snmpd.conf	SNMP Configuration file
/root/BS5000/MSProfiles	Service Flow (Traffic) Definitions
/root/BS5000/serviceprofiles	Quality of Service Definitions

- start_bs.sh – This is the base station configuration file. It can be a single file or a file the base station uses when it’s initially booted up. This file will be custom tailored by Siemens based on each customer's requirements. Changes should be coordinated with Siemens.

- bs_config.xml – This is the symbolic link file (pointer file) that points to the file that contains the majority of the configuration information for the base 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 “BS5000 and Cobalt-Plus 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
  - BSIRP
  - RX_Gain
  - Sub-channel bitmap

- snmpd.conf – snmpd configuration information
- MSProfiles – Remote profile information
- Serviceprofiles – Service profile information

5.9 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 “bs_config.xml” or “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 Base Station Configuration Directory:

```
root@BS5000:/root/BS5000# ls -l bs_config.xml
lrwxrwxrwx 1 root root16 Jan2 05:43 bs_config.xml -> bs_config.xml_1M
```

This command shows that the symbolic link file “bs_config.xml” is linked to the configuration file “bs_config.xml_1M”. 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 “1M” configuration above to “1M_asym” is as follows. (Note that a symbolic link can be overwritten using the force “-f” option (e.g. -sf bs_config.xml_1M bs_config.xml.)

```
(Show Symbolic link):
    root@BS5000:/root# cd BS5000/
    root@BS5000:/root/BS5000# ls -l bs_config.xml

lrwxrwxrwx 1 root root 16 Jan              2 05:43 bs_config.xml -> bs_config.xml_1M
(Remove symbolic link and create new symbolic link):
    root@BS5000:/root/BS5000# rm bs_config.xml
    root@BS5000:/root/BS5000# ln -s bs_config.xml_1M_asym  bs_config.xml
    root@BS5000:/root/BS5000# ls –l  bs_config.xml
(Show new Symbolic link):
          root@BS5000:/root/BS5000# ls -l      bs_config.xml
   lrwxrwxrwx 1 root root 21 Jan 2 05:50 bs_config.xml  -> bs_config.xml_1M_asym
```

5.10 Coordinated Configuration File Changes

The recommended process is to first make changes in the base station, but to delay rebooting the radio until the equivalent changes have been made in the remote radio(s). 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 base station will go through a sanity reboot every 300 seconds if no remote is connected, although this interval may be configured to a different value or disabled entirely. Similarly, 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 the base station and remote radios, reboot the radio to which you do NOT have local access. 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.

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SECTION 6
OPERATION

6 OPERATION

6.1 Description

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

6.2 Base Station Operation

The basic functionality of the base station can be determined from the LCD screen. If a remote station is connected to the base station, a series of LCD screens will be cycled in succession as shown in Figure 6-1.

Figure 6-1 Base Station LCD Screen – Remote Station Connection

6.2.1 Base Station CLI

The base 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 as described in the following sections.

6.2.1.1 Basic CLI Use

Use SSH to login to a base station radio with user “admin” and password. After successful login, the following prompt will be displayed as shown in Figure 6-2.

Figure 6-2 Successful “admin” Login

To avoid a conflict between simultaneous updates, only a single CLI instance is supported per radio. Consequently, it is important to exit any session gracefully using the exit command. If a session is abruptly closed, further CLI access may not be possible until the system is restarted.

CLI commands can be shown by typing a “tab” at the prompt as shown here

Figure 6-3 CLI Commands

To view system performance, type “show”, then space bar, and return.

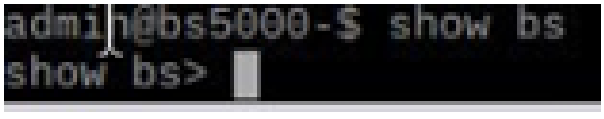


Figure 6-4 View System Performance

Press the tab key for more options.

Figure 6-5 Additional Options

To view current system performance, type “measurement report all”.

Figure 6-6 View Current System Performance

If known, all of the CLI commands can be typed together on a single line

Figure 6-7 Show All BS Measurement Report

This is a small sample of the many CLI capabilities and their use. For further detail, please reference the BS5000 and Cobalt-Plus CLI Operations and Configuration Manual for your software version.

6.3 Remote Station (Cobalt) CLI Operation

The basic functionality of Cobalt software operating on a remote radio can be determined from the LCD screen. The LCD displays the state of the remote station by cycled through its status screens. It shows “scanning“ when it is searching for a base station and “connected” with operational details when it is connected to the base station shown in Figure 6-8.

Figure 6-8 Remote Station Connection Process LCD Screens

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

6.3.1 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 as described below.

6.3.1.1 Basic CLI Use

Use SSH to login to the Cobalt admin user with the password. After successful login, the following prompt will be displayed.

```
admin@cobalt-$
```

Figure 6-9 Remote Station Logon Screen

This is the admin CLI. All commands are nested and can be listed by typing a “tab”. The first level is shown in Figure 6-10.

Figure 6-10 All Commands List

As an example, to see a connected measurement report for the ms, type show and tab as shown in Figure 6-11.

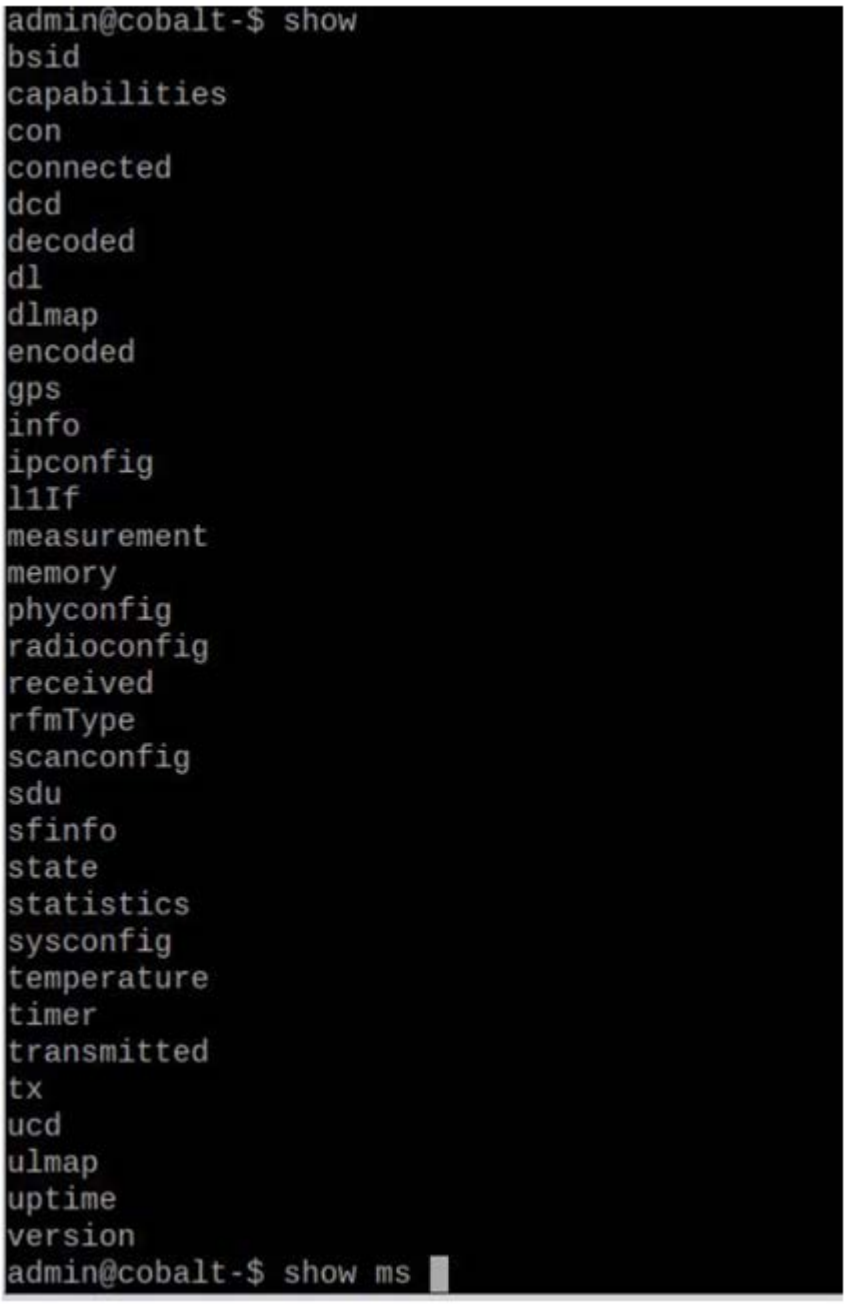


Figure 6-11 View Connected Measurement Report

These are the CLI commands available for the RS. If the command “show ms measurement report” is typed, then the measurement report is displayed as shown in Figure 6-12.

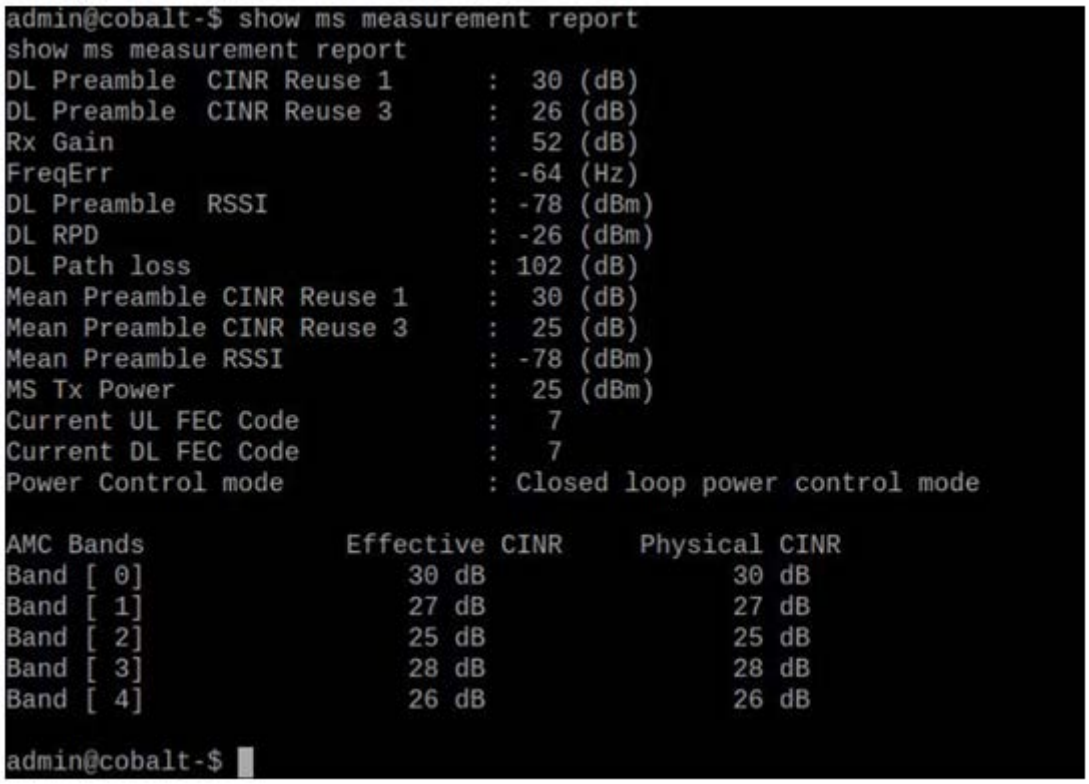


Figure 6-12 Measurement Report Screen

The results displayed are to be interpreted as follows:

Table 6-1 Measurement Results Interpretation

Parameter			Interpretation
DL Preamble CINR Reuse 1 : 29			CINR when we consider all the tones
DL Preamble CINR Reuse 3 : 28			CINR when we consider only modulated tones
Rx Gain : 9			MS Rx AD9361 gain
Frequency Error : 660			Frequency offset of the received signal
DL Preamble RSSI : -37			Received Signa Strength Indication
DL RPD : -28			Received power density
DL Path loss : 57			Total downlink path signal attenuation
Mean Preamble CINR Reuse 1 : 28			Average CINR over 16 frames
Mean Preamble CINR Reuse 3 : 27			Average CINR over 16 frames
Mean Preamble RSSI : -37			Average RSSI over 16 frames
MS Tx PowerPerSubcarrier(BPSK) : 36			MS Tx power in dbm
Current UL FEC Code : 2			Uplink modulation
Current DL FEC Code : 6			Downlink modulation
Power Control mode : Closed Loop			Power control mode (open loop/closed loop)
AMC Bands	Effective CINR	Physical CINR	
Band [0]	28 dB	28 dB	Sub channel 0 carrier to noise ratio
Band [1]	28 dB	28 dB	Sub channel 1 carrier to noise ratio
Band [2]	28 dB	28 dB	Sub channel 2 carrier to noise ratio

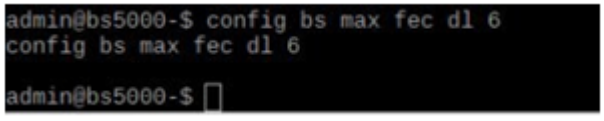
6.4 Temporary Operational Non-Permanent Changes (No Reboot Required)

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. 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.

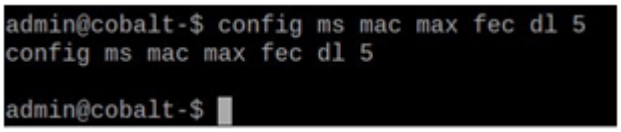
1. Set Maximum DL or UL FEC code

   For Base Station (bs) or type “config bs max fec dl 6” as shown:



For Remote Station (ms) type:

"config ms max fec dl 5" as shown

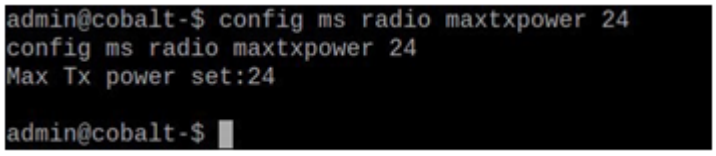


Where bs = base station

ms = remote station dl =
downlink
ul=uplink
fec=fec modulation code which can be 0, 1, 2, 3, 5, 6, 7*
(*Note: The FEC code 4 can be set but the max fec code will be 3)

2. Set Base Station (bs) Transmit Power
   Type "config bs rf eirp 24" as shown:

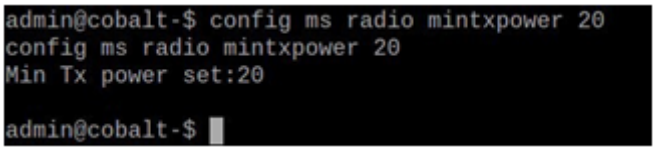
Where bs = base station
24 = max transmit power (-39 to +36)
Set Maximum Remote Station Transmit Power,
Type "Config ms radio maxtxpower 24" as shown:



Where ms = remote station
24 = the maximum transmit power for the remote (range is -39 to 43 dBm).

Note: Transmit power can be less if the RF conditions support a lower transmit power level.

Set Minimum Remote Station transmit power,
Type: “Config ms radio mintxpower 20” as shown:

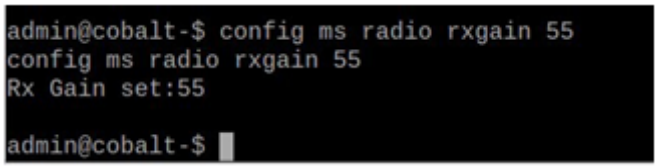


Where ms = remote station
20 = min transmit power (range is -39 to 43 dBm)

3. Change Receive Gain for the Base Station,
Type “config bs rf rxgain 60” as shown:

Where bs = base station
60 = receive gain (0 to 76)

For the Remote Station,
Type “config ms radio rxgain 55” as shown:



Where ms = remote station
55 = receive gain (0 to 78)

SECTION 7
SOFTWARE UPDATES

7 SOFTWARE UPDATES

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

- Apollo is recommended to 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:
        - Copy the new flash configuration file (example: MS-FM_3.2.8-Mars-MS.jffs2) to the /tmp directory in the radio (Must be copied to the /tmp directory -note that /tmp directory is erased on a reboot)
            - Note that there are different versions for the base station and the remote station. The base station begins with BS-FM and the remote station begins with MS-FM
            - Each customer will have software tailored to their requirements and as such the software will have a customer ID embedded in the name
            - Software version number will follow the customer ID field
        - run the flashoff script: flashoff/tmp/ MS-FM_3.2.8-Mars-MS.jffs2 (overwrites the non-active partition and takes about 2 minutes)

          Here is an example of the reflash:

```
root@BS5000:/root# flashoff /tmp/MS-FM_3.2.8-Mars-MS.jffs2 Erasing offline
partition 2...
Erasing 256 Kibyte @ 3200000 -- 100 % complete. Cleanmarker written at
31c0000.
Flashing /tmp/MS-FM_3.2.8-Mars-MS.jffs2 to offline partition 2...
Erasing blocks: 116/116 (100%)
Writing data: 29540k/29540k (100%)
Verifying data: 29540k/29540k (100%)
root@BS5000:/root#
```

        - run the reboot and change partition script: newboot -r -Y (reboots the radio to the reflashed partition)

- Over the Air Update – This is a delta package that contains only the changes to the software and can be done remotely over the air
- 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.