ONDAS NETWORKS

Venus-900

User and Installation Guide

Document Version 1.3

February 2022

Warning: Never power on a Venus-900 radio without a load on the RF connector.

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1 FCC 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 Ondas Networks could void the user's authority to operate the equipment.

2 FCC Exposure Statement

This equipment complies with the FCC RF radiation exposure limits set forth for a controlled environment. This transmitter must follow the specific operating instructions for satisfying RF exposure compliance.

This transmitter must be at least 20 centimeters from the user and must not be co-located or operating in conjunction with any other antenna or transmitter.

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 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 the dealer or an experienced radio/TV technician for help.

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Ondas Networks may void the user's authority to operate the equipment.

3 System Overview

The Venus-900 platform employs Ondas Networks' FullMAX technology

FullMAX is a multi-cell, Point-to-Multipoint (PtMP) broadband wireless system based on the IEEE 802.16 standard with modifications to enable its operation in a wide range of frequencies and a wide range of channel sizes. The system is used to establish a private, broadband wireless service for mission critical industries. FullMAX supports both fixed and mobile applications.

The main characteristics of the FullMAX System include the following:

FullMAX employs HD-FDD or TDD framing to provide greater flexibility and to maximize spectrum utilization.

FullMAX is capable of operating in any frequency band between 40 MHz and 6 GHz and in any channel size between 12.5 kHz and 5 MHz. FullMAX can be configured to operate in a downlink to uplink ratio to support symmetrical, asymmetrical and reverse asymmetrical applications.

The FullMAX system offers the private system operator wide area coverage by leveraging the following:

- High transmit power from both the Base Station and Remote Stations
- Exceptional receiver sensitivity
- Superior propagation due to the operation in narrower channel sizes and low band frequencies

The FullMAX system offers excellent frequency utilization through the following capabilities:

- Adaptive Modulation and Coding per link in both the downlink and uplink
- Optimization of the downlink and uplink ratio for the user's main applications. For example, in the case of SCADA applications, the FullMAX frame is configured as reverse asymmetrical, i.e., more bandwidth is allocated to the uplink than to the downlink.
- Modifications to the standard air interface protocol to minimize MAC layer overhead.
- Employ Band-AMC subcarrier allocation scheme in both uplink and downlink direction to maximize the percentage of data transport subcarriers.
- Packet Header Suppression (PHS) with the following characteristics:
    - Compressible header field values are learned automatically with no need for manual configurations.
    - Support for multiple compressible values for the same header fields. As a result, PHS can be used even when the header fields are not constant.

FullMAX includes a versatile set of Quality of Service (QoS) tools that can optimize traffic performance for each application and prioritize access to the available bandwidth according to the operator's requirements. QoS tools include various scheduling methods (e.g., Best Efforts and Unsolicited Grant

Service), service flows with various QoS parameters such as priority level, minimum and maximum traffic rates, guaranteed delay, jitter, etc.

FullMAX provides secure connections with strong encryption (AES-128 or AES-256), strong authentication (EAP after RSA with X.509 certificates) and advanced key management protocol (PKMv2).

FullMAX supports various frequency reuse methods including:

- Traditional full channel based frequency reuse
- OFDMA based Band-AMC sub-channel reuse with up to 12 sub-channels in both uplink and downlink. Any combination of sub-channels can be used in each sector in both downlink and uplink.

FullMAX Remote Stations support a pre-configured channel acquisition plan, i.e., a preconfigured list of channel alternatives, characterized by center frequency, bandwidth, sub-channels and other parameters. During channel acquisition, the Remote Station goes through the list and evaluates the best alternative.

FullMAX has an advanced remote management system that enables the system operator to monitor, configure, manage, detect failures and diagnose problems. The FullMAX system configuration and FullMAX system provisioning support centralized management profiles.

The FullMAX system architecture consists of Base Stations, Fixed Remote Stations and Mobile Stations. Backhaul networking equipment connects the Base Stations to the customer's Network Operations Center (NOC) and the FullMAX Network Management System (NMS).

FullMAX Base Stations are typically installed in the existing Private Land Mobile Radio (PLMR) towers serving their respective cells.

The FullMAX Base Station is designed as a single sector device. Any number of sectors can be designed per tower, however the most common configuration is a three sector design with one Base Station unit per sector.

The sector configuration dictates the type of antenna that should be used. Typically a router is used at the tower to connect all Base Stations to the NOC via backhaul facilities. FullMAX Fixed Remote and Mobile Stations are deployed throughout the tower's serving area.

4 Physical Installation

4.1 Introduction

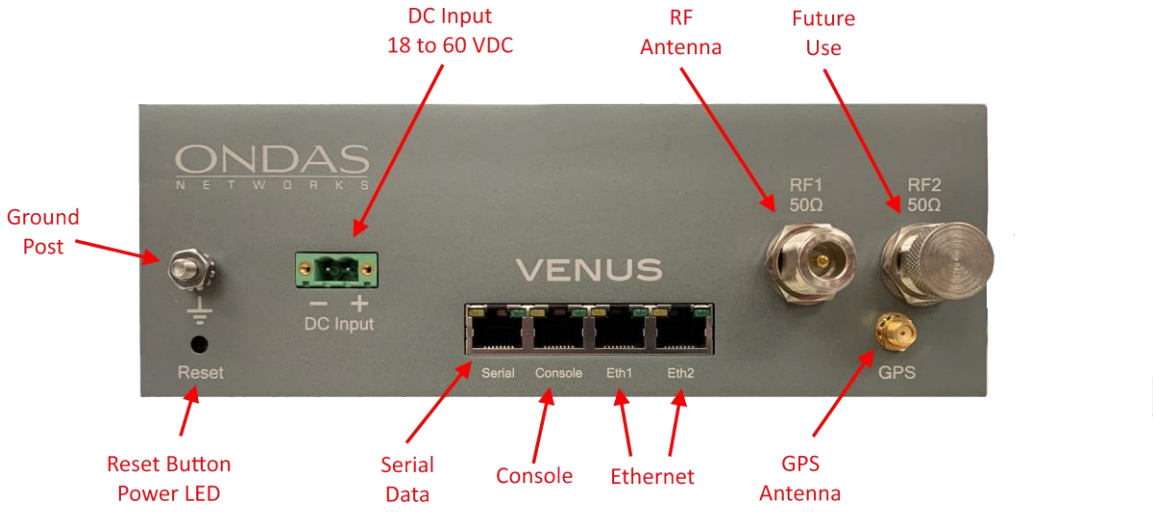
A Venus-900 radio is comprised of software and hardware which is packaged in an indoor enclosure intended for mounting vertically on a flat surface.

4.2 Venus-900 Enclosure

4.2.1 Specifications

Enclosure Material	Aluminum Alloy
Dimensions (W x D x H)	8.5" x 4.85" x 2.95" (252mm x 123mm x 84mm)
Operating Temperature	-40° F to 158° F (-40° C to 70° C)
DC Input Power Range	18 to 60 VDC
Power Consumption	No load : 13.1 watts @ 48 VDC Peak load : 23.4 watts @ 48 VDC

4.2.2 Product Overview

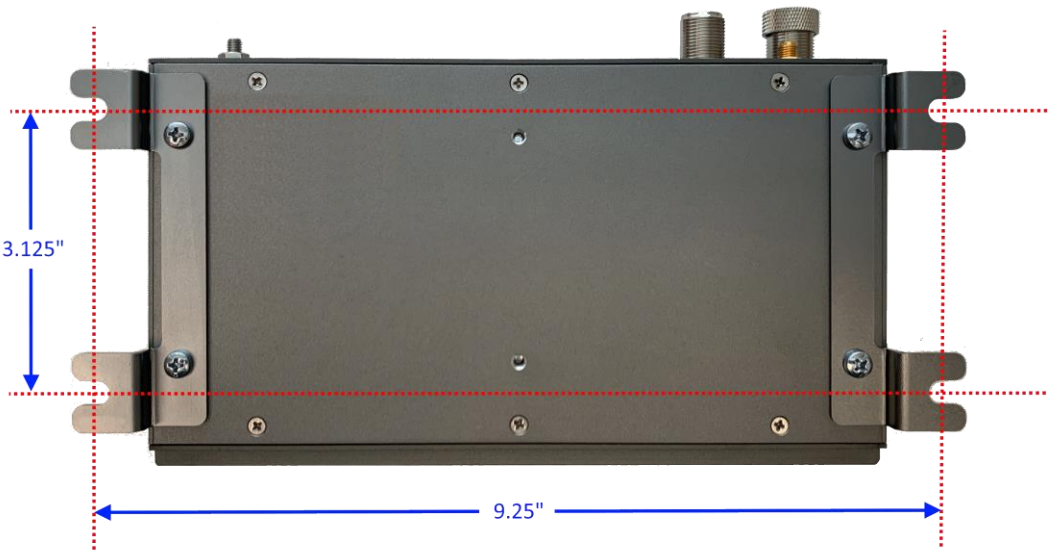


4.2.3 Connection Descriptions

Connector	Application
GPS Antenna	SMA female connector for optional GPS antenna.
RF Out	50Ω N-Type female connector for RF input from antenna
DC Input	DC power input 18 to 60 volts. Warning: Ensure Correct Polarity
Ethernet	2 x RJ45 connector for Ethernet 10/100 Base-T interface
Console (Serial)	RJ45 8-pin connector wired using the Cisco interface specification for console access
Serial Data	RJ45 8-pin connector wired using the Cisco interface specification for serial data
Ground Post	Connection to building ground

4.2.4 Mounting Guidelines

A mounting bracket is provided for attaching the Venus-900 enclosure to a vertical flat surface..



5 System Operation

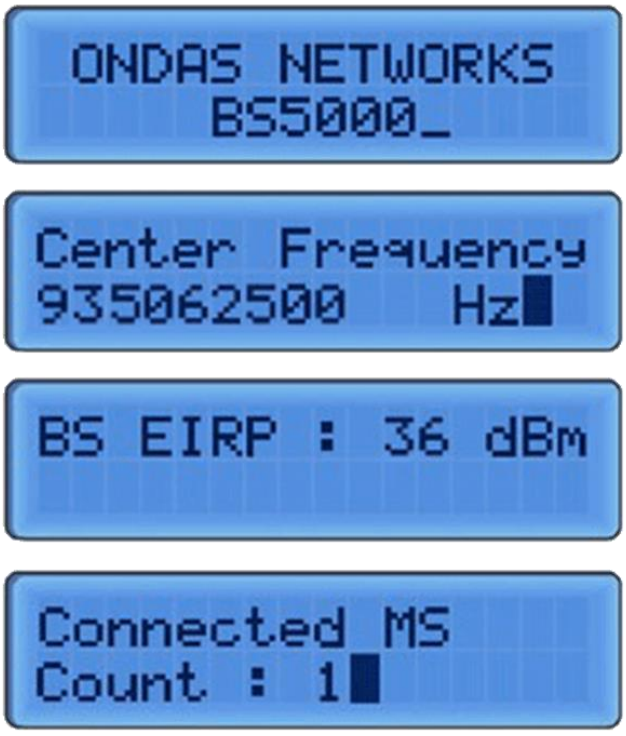
Warning: Never power on a Venus-900 radio without a load on the RF connector.

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

The Venus-900 radio platform may operate as a Base Station, Control Station or Mobile Station.

5.1 Base Station Operation

Basic functionality of a Venus-900 base station can be determined from the LCD screen. If a mobile station is connected, the following screens will be cycled through:



5.1.1 Base Station CLI

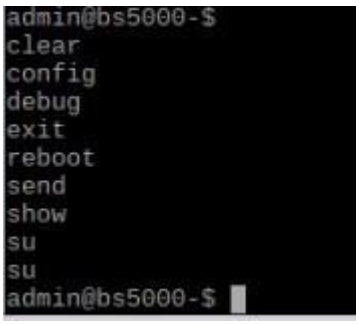
The base station CLI includes many features for manipulating key configuration parameters, however it is recommended that it be used primarily for obtaining measurement and status information as described below.

5.1.2 Basic CLI Use

Use SSH to login to a base station with user “admin” and the appropriate password. After successful login, the following prompt will be displayed:

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:



To see (or show) system performance, type “show then space” and return:

Now type tab for more options:

```
admin@bs5000-$ show bs
show bs>
con
connected
decoded
encoded
gps
ipconfig
l1If
l3If
mcs
measurement
phyconfig
read
rfmType
sdu
statistics
sysconfig
tce
temperature
timing
transmitted
ul
uptime
version
show bs>
```

To see current system performance, type “measurement all”:

```
show bs measurement report> all
all
00:21:ee:00:04:ea--|--DL RSSI: -78 dBm  DL CINR:26 dB  DL FEC: 7
                   |--UL RSSI: -79 dBm  UL CINR:28 dB  UL FEC: 7 MS TxPwr: 25.0 dBm

show bs measurement report>
```

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

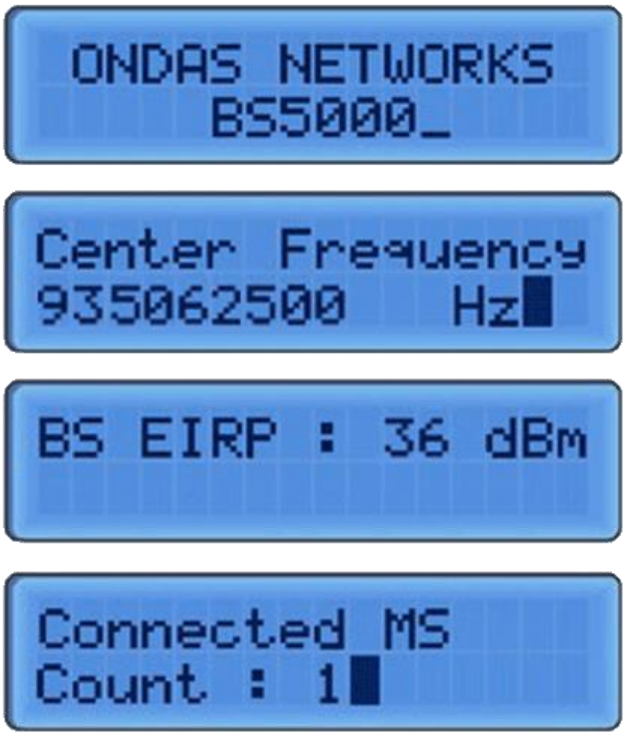
```
admin@bs5000-$ show bs measurement report all
show bs measurement report all
00:21:ee:00:04:ea--|--DL RSSI: -78 dBm  DL CINR:25 dB  DL FEC: 7
                   |--UL RSSI: -80 dBm  UL CINR:28 dB  UL FEC: 7 MS TxPwr: 25.0 dBm

admin@bs5000-$
```

There are many CLI capabilities and this is only a brief example of its use. For further detail, please reference the CLI Operations and Configuration Manual for your software version.

5.2 Control Station Operation

Basic functionality of a Venus-900 control station can be determined from the LCD screen. If a mobile station is connected, the following screens will be cycled through:



5.2.1 Control Station CLI

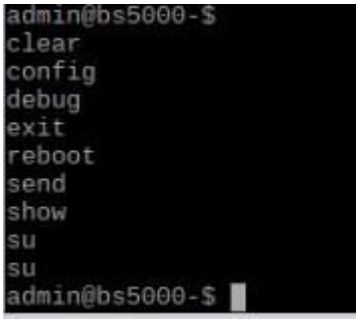
The control station CLI includes many features for manipulating key configuration parameters, however it is recommended that it be used primarily for obtaining measurement and status information as described below.

5.2.2 Basic CLI Use

Use SSH to login to a base station with user “admin” and the appropriate password. After successful login, the following prompt will be displayed:

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:



To see (or show) system performance, type “show then space” and return:

Now type tab for more options:

```
admin@bs5000-$ show bs
show bs>
con
connected
decoded
encoded
gps
ipconfig
l1If
l3If
mcs
measurement
phyconfig
read
rfmType
sdu
statistics
sysconfig
tce
temperature
timing
transmitted
ul
uptime
version
show bs>
```

To see current system performance, type “measurement all”:

```
show bs measurement report> all
all
00:21:ee:00:04:ea--|--DL RSSI: -78 dBm  DL CINR:26 dB  DL FEC: 7
                   |--UL RSSI: -79 dBm  UL CINR:28 dB  UL FEC: 7 MS TxPwr: 25.0 dBm

show bs measurement report>
```

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

```
admin@bs5000-$ show bs measurement report all
show bs measurement report all
00:21:ee:00:04:ea--|--DL RSSI: -78 dBm  DL CINR:25 dB  DL FEC: 7
                   |--UL RSSI: -80 dBm  UL CINR:28 dB  UL FEC: 7 MS TxPwr: 25.0 dBm

admin@bs5000-$
```

There are many CLI capabilities and this is only a brief example of its use. For further detail, please reference the CLI Operations and Configuration Manual for your software version.

5.3 Mobile Station Operation

Basic functionality of Venus-900 mobile station can be determined from the LCD screen. The LCD displays the state of the mobile station by cycling through status screens. It shows “scanning“ when it is searching for a connection and “connected” with operational details when it is connected as shown below.

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

5.3.1 Mobile Station CLI

The mobile 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.

5.3.2 Basic CLI Use

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

```
admin@cobalt-$
```

This is the admin CLI. All commands are nested and can be listed by typing a “tab”. The first level is shown here:

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

These are the CLI commands available. If the command “show ms measurement report” is typed, then the measurement report is shown:

```
admin@cobalt-$ show ms measurement report
show ms measurement report
DL Preamble  CINR Reuse 1      :  30 (dB)
DL Preamble  CINR Reuse 3      :  26 (dB)
Rx Gain                        :  52 (dB)
FreqErr                        : -64 (Hz)
DL Preamble  RSSI              : -78 (dBm)
DL RPD                         : -26 (dBm)
DL Path loss                   : 102 (dB)
Mean Preamble CINR Reuse 1     :  30 (dB)
Mean Preamble CINR Reuse 3     :  25 (dB)
Mean Preamble RSSI             : -78 (dBm)
MS Tx Power                    :  25 (dBm)
Current UL FEC Code            :   7
Current DL FEC Code            :   7
Power Control mode             : Closed loop power control mode

AMC Bands            Effective CINR     Physical CINR
Band [ 0]                30 dB              30 dB
Band [ 1]                27 dB              27 dB
Band [ 2]                25 dB              25 dB
Band [ 3]                28 dB              28 dB
Band [ 4]                26 dB              26 dB

admin@cobalt-$
```

The results displayed are to be interpreted as follows.

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 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