

# WRH

## WIDEBAND RADIO HEAD

INSTALLATION AND SERVICE MANUAL

### HIGH POWER VERSION



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This Powerwave product is designed to operate within the Normal Operating (typical operating) ranges or conditions specified in this document. Operation of this equipment beyond the specified ranges in this document may cause (1) spurious emissions that violate regulatory requirements; (2) the equipment to be automatically removed from service when maximum thresholds are exceeded; or (3) the equipment to not perform in accordance with its specifications. It is the Operator's responsibility to ensure this equipment is properly installed and operated within Powerwave operating specifications to obtain proper performance from the equipment and to comply with regulatory requirements.

The rated output power of a WRH-V is for multiple carriers. As long as the composite power does not exceed the rated power (20W for North America), derating is not required for multiple carriers. For situations where regulatory requirements require reduced interference to adjacent band users, the rating would have to be reduced by 3 dB. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device. Input power is rated at 115/230VAC, 50/60Hz, and should be protected based on the power and fuse specifications in Chapter 5 of this manual. Power strips should, at a minimum, conform to this requirement to prevent equipment damage and possible overload.

#### Federal Communications Commission (FCC)

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to CRF47 part 15 of the FCC rules. This equipment is also certified to CRF47 part 22 (cellular), part 24 (PCS) and part 90 (iDEN800 and iDEN900) of the FCC Rules depending on the band of operation. Changes or modifications not expressly approved by Powerwave Technologies, Inc. for compliance could void the user's authority to operate this equipment. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

#### Industry Canadian Requirements

All Powerwave apparatus introduced in the Canadian market meet all requirements of the Canadian Interference-Causing Equipment Regulations. The -20dB bandwidth at 1900 MHz band is 80 MHz. The -20dB bandwidth at IDEN 900 MHz band is 20 MHz. The -20dB bandwidth at the 850 MHz is 34 MHz. The output impedance of the unit referenced in this document is 50 Ohms. The -20dB bandwidth at IDEN 800MHz band is 26 MHz. The Manufacturer's rated output power of this equipment is for single carrier operation. For situations when multiple carrier signals are present, the rating would have to be reduced. For example, at IDEN 800MHz band, the rating would have to be reduced by 3.5 dB, especially where the output signal is re-radiated and can cause interference to adjacent band users. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device. The input signal is optical so input impedance requirements are not applicable.

#### European Requirements

The Powerwave WRH-V apparatus introduced in EU markets are certified to ESTI EN 300 609-4 (GSM900 and DCS1800) and ESTI EN 301 908-11 (WCDMA).

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## Warnings, Cautions, and Notes

Warnings, Cautions, and Notes are found throughout this manual where applicable. The associated icons in warnings and cautions are used to quickly identify a potential condition that could result in the consequences described below if precautions are not taken. Notes clarify and provide additional information to assist the user.



**WARNING:** The warning symbol means danger. You are in a situation that could cause bodily injury or death. Before you work on any equipment, be aware of the hazards involved with electrical and RF circuitry and be familiar with standard practices for preventing accidents.



**CAUTION:** The caution symbol means the potential exists for equipment damage or loss of data.

**NOTE** Notes contain helpful suggestions or references to material not covered in the document.

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**Revision Record**

| <b>Revision Letter</b> | <b>Date of Change</b> | <b>Reason for Change</b>   |
|------------------------|-----------------------|--|
| A                      | November 2007         | New (original)   |
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## Abbreviations

The following list of abbreviations are used throughout this manual, the software, and the repeater:

|        |  |
|--------|--|
| AGC    | Automatic Gain Control   |
| ALI    | Alarm Interface  |
| AMPS   | Advanced Mobile Phone Service  |
| BA     | Booster Amplifier  |
| BeO    | Beryllium Oxide  |
| BMU    | Base Station Master Unit   |
| BS     | Base Station, BS antenna = towards the base station                          |
| BSA    | Band Selective Amplifier   |
| BSel   | Band Selective   |
| BTS    | Base Transceiver Station   |
| CDMA   | Code Division Multiple Access  |
| CHE    | Channel Amplifier for GSM and EDGE   |
| CMB    | Combiner   |
| CSA    | Channel Selective Amplifier  |
| CSel   | Channel Selective  |
| CU     | Control Unit   |
| CW     | Continuous Wave  |
| DAMPS  | Digital Advanced Mobile Phone Service  |
| DC     | Directional Coupler  |
| DCS    | Digital Communication System (same as PCN)                                   |
| DIA    | Distribution Interface   |
| DL     | Downlink signal direction (from base station via repeater to mobile station) |
| DPX    | Duplex filter  |
| EDGE   | Enhanced Data rates for GSM Evolution  |
| EEPROM | Electrical Erasable Programmable Read Only Memory                            |
| EGSM   | Extended Global System for Mobile communication                              |
| ESD    | Electrostatic Discharge  |
| ETACS  | Extended Total Access Communication System                                   |
| ETSI   | European Telecommunications Standard Institute                               |
| FLI    | Fiber Link Interface   |
| FON    | Fiber Optic Node   |
| FOR    | Fiber Optic Repeater   |
| FOU    | Fiber Optic Unit   |
| GSM    | Global System for Mobile communication                                       |
| HW     | Hardware   |
| ICNIRP | International Commission on Non-Ionizing Radiation Protection                |
| LED    | Light Emitting Diode   |
| LNA    | Low Noise Amplifier  |
| MCPA   | Multi-Carrier Power Amplifier  |
| MS     | Mobile Station, MS antenna = towards the mobile station                      |

|      |  |
|------|--|
| MSC  | Mobile Switching Center  |
| NEMA | National Electrical Manufacturers Association                              |
| NiCd | Nickel Cadmium   |
| NMT  | Nordic Mobile Telephone system   |
| NOC  | Network Operations Center  |
| OCM  | Optical Converter Module   |
| OMS  | Operation and Maintenance System   |
| PCN  | Personal Communication Network (same as DCS)                               |
| PCS  | Personal Communication System  |
| POI  | Point of Interconnect  |
| PSM  | Power Supply Module  |
| PTFE | Polytetrafluoro Ethylene (Teflon)  |
| R2R  | Repeater-to-Repeater   |
| RCI  | Remote Control Interface   |
| RCU  | Remote Control Unit  |
| RCM  | RF Converter Module  |
| RF   | Radio Frequency  |
| RIA  | Repeater-to-Repeater Adapter   |
| RMU  | Remote Master Unit   |
| RSSI | Received Signal Strength Indication  |
| RTC  | Real Time Clock  |
| SW   | Software   |
| TACS | Total Access Communication System  |
| TDMA | Time Division Multiple Access  |
| UL   | Uplink signal direction (from mobile station via repeater to base station) |
| UPS  | Uninterruptible Power Supply   |
| WHO  | World Health Organization  |
| WLI  | Wire Link Interface  |
| WRH  | Wideband Radio Head  |

# Chapter 1

## Product Description

### Introduction

This manual contains information and procedures for installation, operation, and maintenance of a High Power Wideband Radio Head (WRH-V). The manual is organized into chapters as follows:

- ❑ Chapter 1 - Product Description
- ❑ Chapter 2 - Controls and Indicators
- ❑ Chapter 3 - Installation
- ❑ Chapter 4 - Maintenance
- ❑ Chapter 5 - Specifications

### Scope of Manual

This manual is intended for use by service technicians familiar with similar types of equipment. It contains service information required for the equipment described and is current as of the printing date. Changes which occur after the printing date may be incorporated by a complete manual revision or alternatively as additions.

### Safety

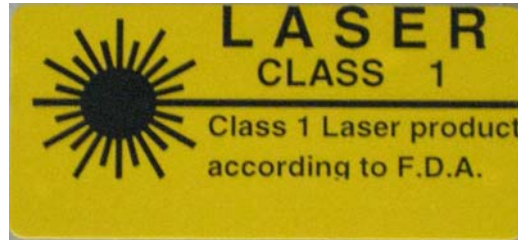
It is necessary that any personnel involved in installation, operation, or service of units included in a Powerwave Distributed Antenna System (DAS) understand and follow the below points.



- ❑ Powerwave WRH-Vs are designed to receive and amplify signals from one or more base stations and retransmit the signals to one or more mobile stations. And, also to act the other way round, that is to receive signals from one or more mobile stations, amplify and retransmit the signals to the base stations. Powerwave WRH-V systems must be used exclusively for this purpose and nothing else.
- ❑ Units supplied from the mains must be connected to grounded outlets and in conformity with the local prescriptions.
- ❑ Power supply units supplied from the mains contain dangerous voltage that can cause electric shock. Disconnect the mains prior to any work in such a unit. Local regulations are to be followed when servicing such units. Authorized service personnel only are allowed to service units while the mains is connected.
- ❑ The WRH-V cover must be secured in opened position, for instance by tying it up. Otherwise, the cover can be closed by the wind and cause your fingers getting pinched or your head being hit.
- ❑ When working on a WRH-V on high ground, for instance on a mast or pole, be careful not to drop parts or the entire WRH. Falling parts can cause serious personal injury.
- ❑ All RF transmitting units, including WRHs, will generate radio signals and thereby give rise to electromagnetic fields that may be hazardous to the health of any person who is extensively exposed close to an antenna.
- ❑ A lithium battery is permanently mounted on the CU and FON PCBAs. Due to the risk of explosion, this battery must only be removed from the board by a Powerwave authorized service technician.
- ❑ NiCd batteries are mounted on the FON PCBA. These batteries contain environmental poisonous substances. If replaced, the old batteries should be disposed of as stated in the local prescriptions.



- ❑ The FON unit contains a Class 1M laser transmitter that emits 2—4 mW of invisible laser radiation at 1550 nm during operation and is intended for a restricted location. Avoid direct exposure from a disconnected laser transmitter or fiber cord. For example, do not view directly with optical instruments (magnifiers) and do not view directly with non-attenuating optical instruments.
- ❑ The FON unit has this warning label attached:



- ❑ See page 3-5, Fig. 3-6 for the location of laser apertures on the FON.
- ❑ Do not power up the FON unit if a fiber cable is not connected to the fiber output UL port, or if a fiber cable is connected to the port but disconnected at the other end.
- ❑ **Never look at the end of a fiber cable.** The 1310nm and 1550nm laser light is not visible. Always use an instrument, such as a power meter, to detect signaling.

### Human Exposure of RF Radiation

Safe distances must be kept when working around antennas. The following paragraphs describe the cautions to be aware of during the installation and maintenance of antenna systems and how to calculate safety distances needed for RF radiation at different antenna power and frequencies.

#### Antennas

To be able to receive and transmit signals, a WRH-V is connected to a donor antenna directed towards the base station and a service antenna directed towards the coverage area. A fiber optic cable from the base station might, however, be substituted for the donor antenna.

#### Installation and Maintenance of Antenna Systems

Installation and maintenance of all antenna systems must be performed with respect to the radiation exposure limits for public areas. The antenna radiation level is affected by WRH-V output power, antenna gain, and transmission devices such as cables, connectors, splitters and feeders. Also have in mind the system minimum coupling loss, typically between 25dB and 35dB, is determined by a standard with the purpose to protect base stations from noise and other performance dropping effects.

#### Radiation Exposure

The World Health Organization (WHO) and International Commission on Non-Ionising Radiation Protection (ICNIRP) have determined recommendations for radiation exposure. ICNIRP recommends not to exceed the following radiation power for public exposure:

##### Frequency Radiation power

|               |                      |
|---------------|----------------------|
| 800/900 MHz   | 4.5W/m <sup>2</sup>  |
| 1800/1900 MHz | 9.0W/m <sup>2</sup>  |
| 2100 MHz      | 10.0W/m <sup>2</sup> |

For antennas larger than 20cm the maximum radiation power can be calculated by using the following formula:

$$S = P / (4\pi r^2)$$

S = Radiation power in W/m<sup>2</sup>  
 P = Output power in W  
 r = Distance between antenna and human in meters

## Electrostatic Discharge (ESD)



ESD can severely damage essential parts of the equipment if not handled carefully. Parts on printed circuit board assemblies (PCBA) as well as other parts in the equipment are sensitive to ESD. Never touch the PCBA or uninsulated conductor surfaces unless absolutely necessary.

If you must handle the PCBAs or uninsulated conductor surfaces, use ESD protective equipment or first touch the chassis with your hand. Never let your clothes touch PCBAs or uninsulated conductor surfaces and always store PCBAs in ESD-safe bags.

## Overview



Figure 1-1 Powerwave Wideband Radio Head (WRH)

Powerwave WRH-Vs work as bi-directional on-frequency amplifiers used to extend coverage into uncovered areas in wireless mobile systems such as base station fringe areas, tunnels, convention centers, airports and buildings. It receives, amplifies, and transmits signals to/from a base transceiver station (BTS) to/from mobile stations (MS) with both directions being served simultaneously. Connections to the WRH-V are made with N-type or 7/16" male connectors.

WRH-Vs are microprocessor controlled with alarm and operational status LEDs visible on the front cover. Cooling is provided through convection heat dissipation. Operational parameters, such as gain and power levels are set using a PC running Powerwave OM-Online software which communicates with the WRH-Vs either locally or remotely via modem. Remote operation can be performed via PSTN or a GSM net. The Operation and Maintenance System (OMS) provides for Network Operations Center (NOC) configuration and alarm monitoring.

WRH-Vs can be configured in many combinations depending on the wireless system, single or double system operation, and output power. The following paragraphs provide a description of the different models of WRH-Vs available.

The WRH-V is a fiber fed system designed to provide a high output power level and comes equipped with a MCPA in the downlink path. The MCPA restricts the number of bands to one in the cabinet and one additional band if a high cover is used. The MCPA is located in the cabinet and is supplied from the existing PSU.

### Chassis Design

The WRH-V is housed in a cast aluminium waterproof chassis, class NEMA4 / IP65, approved for outdoor use but is also suited for indoor installations. The chassis consists of a cabinet and a cover attached with hinges. The cabinet contains the WRH-V circuitry. The cover comes as either a low or high version. The high cover can be used as an empty cover or be equipped as a part of the WRH-V or an independent WRH-V unit. A WRH-V with a high cover that is equipped as two independent units can, for example, be equipped for channel selective operation in the cabinet and band selective operation in the cover.

Inside the WRH, a number of amplifier PCBAs are individually shielded and located under a metal cover that can be opened outward. These PCBAs are of different types depending on the supported system.

### Sub Unit Overview

A number of amplifier PCBAs are individually shielded and located under a metal cover inside the WRH-V. This cover can be opened outward for access. These amplifier PCBAs are of different types depending on the supported system. All of the WRH-Vs are built up with a number of sub units which are described in the following sections.

#### Wideband Amplifier PCBA (WBA)

WRH-Vs can handle multiple carriers over a wide band. Each band requires one WBA for the uplink and downlink, and one associated PA or MCPA for the downlink. The cabinet can be equipped with up to two WBAs along with two PAs supporting two bands or one MCPA supporting one band. Positions 1 and 3, shown in Figure 1-6, are assigned for a WBA.

#### Multi-Carrier Power Amplifier PCBA (MCPA)

The MCPA is used to amplify the output signal from the WBA. Each MCPA can handle one band in the downlink direction. It requires an extra heat sink element on the outside of the cabinet or high cover to dissipate the heat generated. The MCPA occupies positions 2 through 4 in the cabinet and 6 through 8 in a high cover, as shown in Figure 1-6.

#### Distribution PCBA (DIA)

The DIA is the core distribution PCBA to which all other PCBAs and units connect in the cabinet with the exception of the PA. Figure 1-2 shows a DIA PCBA. A shielded metal frame on the DIA provides the mounting location for the CU, ALI and RCIs, if used.

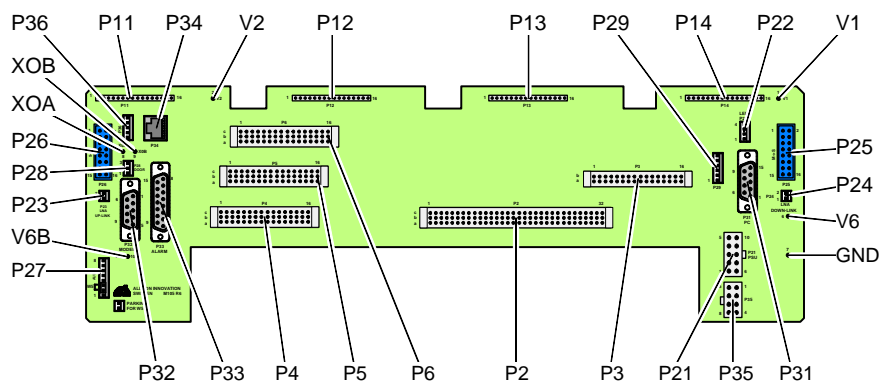


Figure 1-2 DIA PCBA

### Control Unit PCBA (CU)

Figure 1-3 shows the CU, which is the core microprocessor controller in the WRH-V and is connected to P2 on the DIA. The CU contains a microprocessor, main memory, flash memory for the CU software, EEPROM memory for parameters, memory for the event log and statistics, a REFO reference oscillator, ports for local and remote communication, a battery powered real-time clock, and a MAC identity circuit. It supervises and controls operational parameters such as gain control and channel handling, alarms, the event log, the password and the logon. The CU is also a control interface for OM-Online and OMS. Software for the CU can be downloaded from OM-Online, either locally or remotely. It is located in the lower right part of the shielded DIA frame.

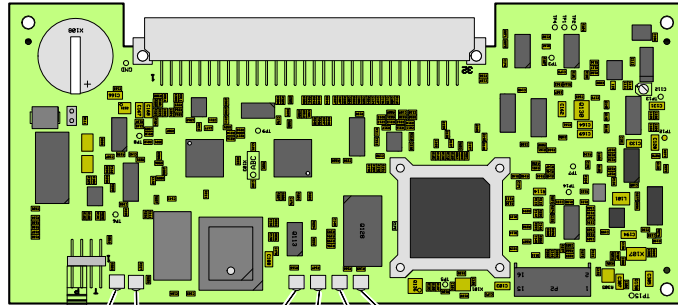


Figure 1-3 CU PCBA

### Low Noise Amplifier (LNA)

LNAs are used on the uplink and are located at the top of the cabinet and the high cover, if equipped. An example of an LNA is illustrated in Figure 1-4. All of the coaxial connectors are SMA-type. Signals from the DPX output are fed to the LNA input connector (IN). The OUT1 and OUT2 outputs feed the WBAs in the UL direction. The signal level at these connectors is +20dB referenced to the antenna input. The other output, OUT LOW, is an expansion output for an additional LNA if the WRH-V is equipped with a unit in the cover part of the chassis. The gain to this connector is +2dB. The +7V input is used for +7V supply from the DIA PCBA and the ATT connection is for the control signal for a controllable attenuator in the LNA.



Figure 1-4 LNA

### Duplex Filter (DPX)

DPXs are located on the metal cover sheet in the upper part of the cabinet.

### Fiber Optic Unit (FOU)

The FOU is a metal plate mounted on top of the cover plate in the upper part of the WRH. The FON and fiber optic connectors are mounted on the FOU. Figure 1-5 illustrates an FOU with the FON and fiber optic connectors mounted on the plate. It can also be configured with combiners, splitters, and Wave Division Multiplexers (WDMs) to obtain a desired combination of several branches with double or single fiber.

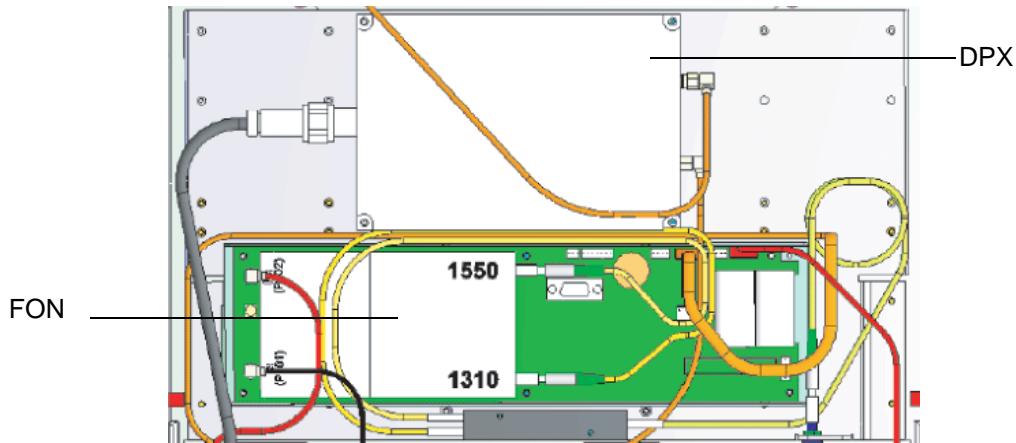


Figure 1-5 FOU in WRH-V

### Fiber Optic Node (FON)

The FON is the main part of the FOU. It is a bi-directional electrical/optical signal converter and a node in a fiber network. In addition, the FON has all the functionality included in the CU PCBA and contains battery backup. It has also functionality for:

- Electrical and optical signal supervision
- Internal and external alarm handling
- RS232 interface for local PC control via an O&M software (OM-Online)
- Remote control via an O&M software (OM-Online or OMS)
- Interfaces for RCU and FLI
- Battery backup with charger

There are two versions of the FON; one with three SMA ports (UL, DL and RX Mon) and the other with four SMA ports (UL, DL, RX Mon and TX Mon). The FON also has two optical ports for DL and UL fiber connections.

### Power Supply Unit (PSU)

The PSU supplies DC power to all of the components in the WRH-V.

### Remote Control Unit (RCU)

The RCU is an optional communication unit for remote control of WRH-Vs via PSTN or RF modems. RCU types and details are described in Chapter 4.

### Alarm Interface PCBA (ALI) and Remote Control Interface PCBA (RCI)

The ALI handles alarms and alarm communication. It is replaced with an RCI if an RCU is used and provides an interface between the CU and an RCU for remote communication via modem. The RCI also handles alarms and alarm communication. Either unit is located in the lower left part of the shielded DIA frame.



### Sub Unit Locations

The MCPA is located at positions 3 and 4 in the cabinet. A WRH-V is equipped for one band in the cabinet and, if required, an additional band in a high cover. PCBA positions are illustrated in Figure 1-6 and a block diagram is located in Appendix A.

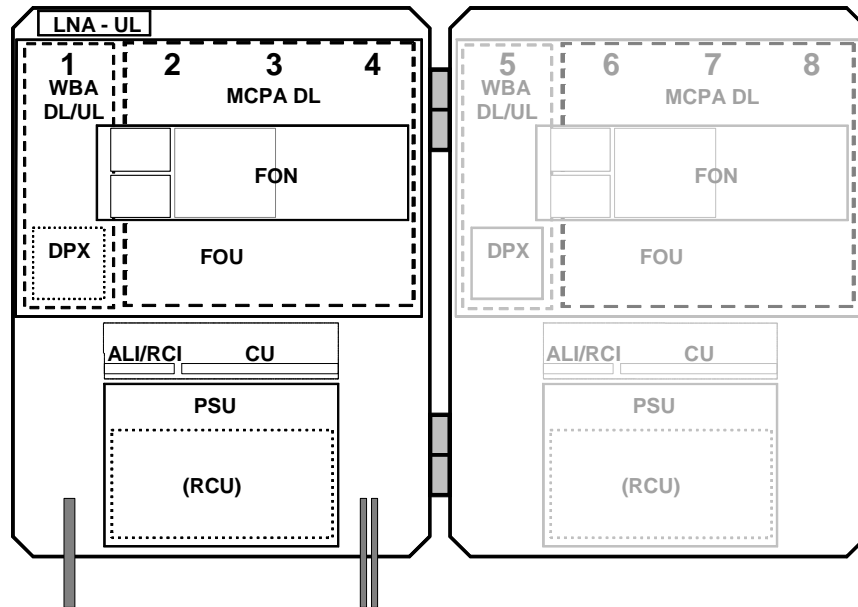


Figure 1-6 WRH-V Sub Unit Locations

### Fiber Optic Distribution Networks

Fiber optic networks are setup identically to data networks. WRH-Vs are connected in a star configuration as illustrated in Figure 1-7. In this example, a Base Station Master Unit (BMU) is fed by a BTS via an RF cable. An Optical Converter Module (OCM) could also be used depending on the system configuration. The BMU or OCM contain three FONs and provide continuity to the FONs in the four WRHs. By using WDMs and Optical Splitters (OSPs) in the WRHs, the distribution net can be built up with a combination of star and daisy-chain connections using double or single fiber.

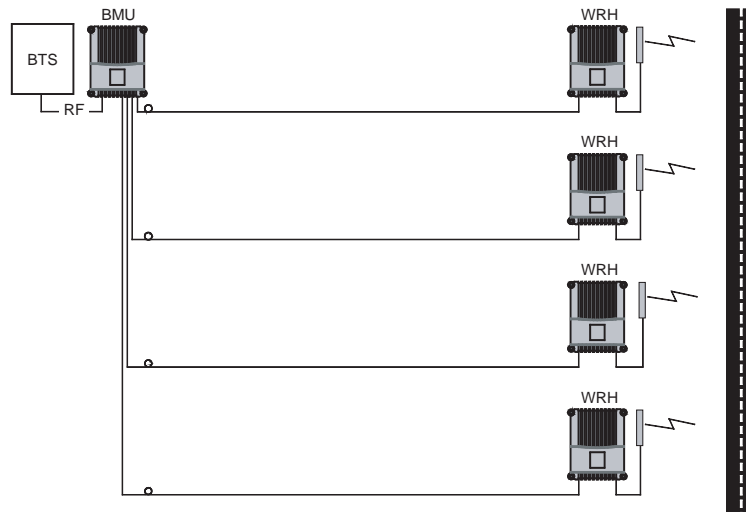


Figure 1-7 Fiber Optic Star Configuration

### Multi-Operator Configurations

Multi-operator systems require the use of Point of Interconnect (POI) units and OCMs as illustrated in Figure 1-8. In this simple example, two operators have two sectors each. Each sector is connected to a POI and then to a RCM. The RCM is interconnected with an OCM via coaxial cables. The combined DL and UL signals are converted to optical signals in the OCM and then distributed to the WRHs-V.

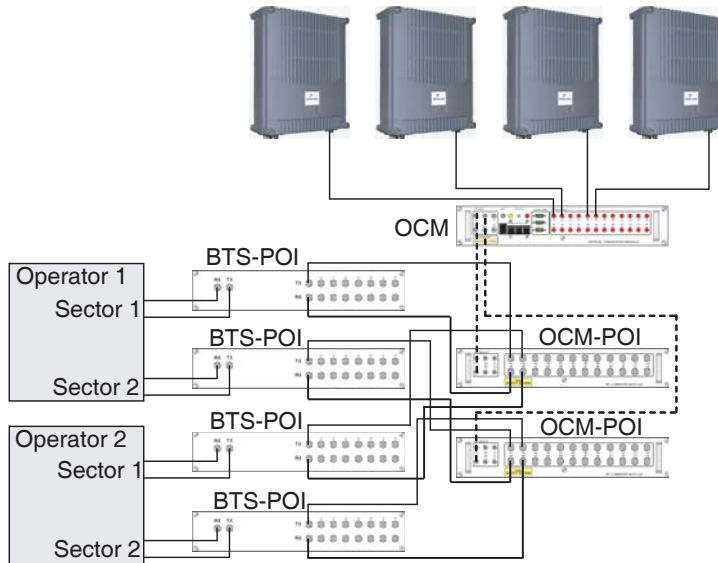


Figure 1-8 Multi-operator System

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# Chapter 2 Controls, Indicators and Connectors

## Introduction

This chapter contains descriptions of the controls, indicators and connectors for the WRH.

## Front Cover Indicators



Figure 2-1 External Indicators

Two LEDs, shown in Figure 2-1, are located on the front cover to provide easy identification of a fault in the system. The amber operation LED lights up approximately 15 seconds after the main power is switched on. When the LED is steady, the WRH-V is ready for operation. The red alarm LED indicates a system error alarm when flashing and a critical alarm when steady.

## Cabinet Indicators

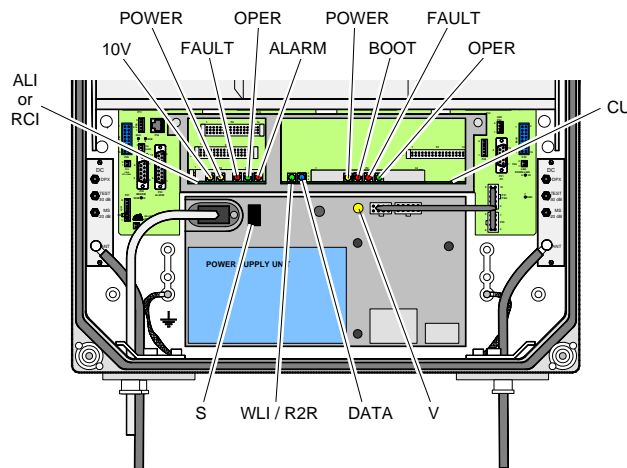


Figure 2-2 Cabinet Internal Indicators

Figure 2-2 shows the LED indicators located on the ALI or RCI, the CU PCBAs, the 115/220V main power switch (S) in the cabinet, and the voltage indicator (V). These indicators are described in further detail in the following sections.

## PCBA Indicators

This following paragraphs describe the LED indicators on the main PCBAs inside the WRH.

### CU PCBA

Figure 2-3 shows the location of the LEDs on the CU and Table 2-1 lists their indications.

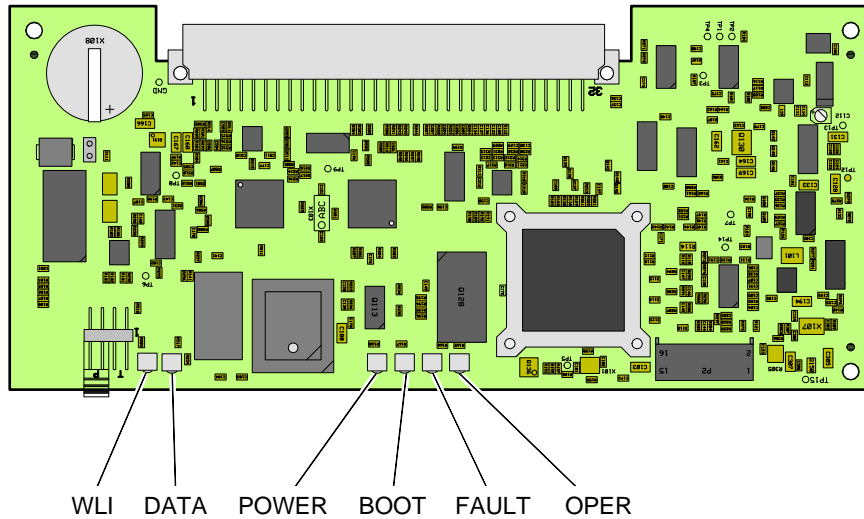


Figure 2-3 CU PCBA Indicators

Table 2-1 CU PCBA LED Indicators

| LED   | Description   |
|-------|---|
| WLI   | Wire Link Interface. A flashing green LED indicates the unit is receiving data over the subcarrier. A steady green LED indicates: the unit is currently not receiving any data, is currently not a control station or there is no other node in the network |
| DATA  | Blue LED indicating data transmission in the W-net  |
| POWER | Yellow LED indicating present power and remains steady after power is switched on   |
| BOOT  | Steady red LED when the CU boots (10 – 15 seconds after main power is switched on), then flashing red (5 – 10 seconds), then off if no error is detected. If an error is detected LED will stay on  |
| FAULT | Flashing red LED for 15 – 20 seconds after main power is switched on. Flashes for less serious alarms (Error) and is on solid for fatal alarms (Critical)   |
| OPER  | Steady green LED indicates WRH-V is ready for operation   |



**WARNING: A lithium battery is permanently mounted on the CU PCBA. Due to risk of explosion, this battery must not be removed. In case of battery malfunction, replace the CU PCB.**

### FON PCBA

The FON is shown in Figure 2-4 and the LED indicators are listed in Table 2-2.

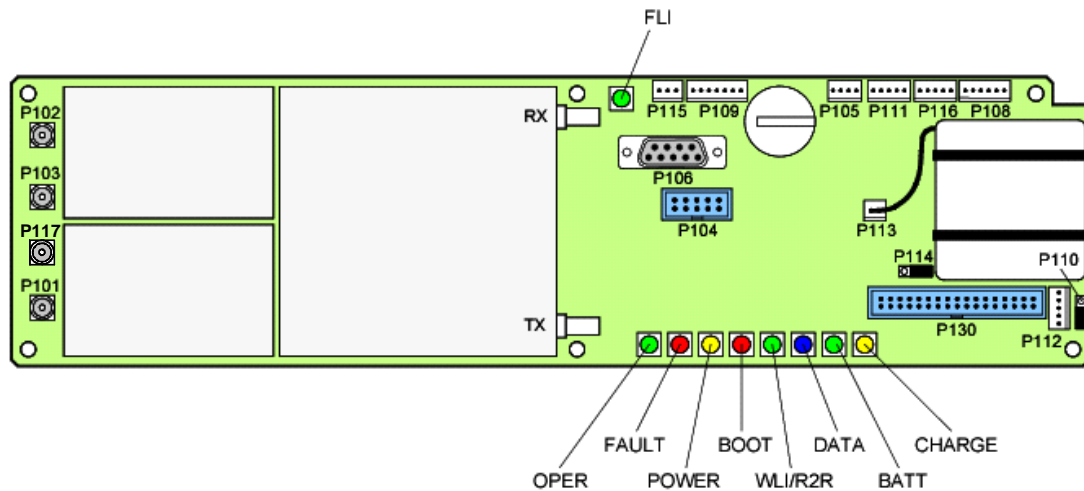


Figure 2-4 FON LED Indicators

Table 2-2 FON LED Indications

| LED        | Description  |
|------------|--|
| FLI or F2F | Green LED. Fiber Line Interface (FLI). Flashing LED indicates the unit is receiving data over the sub carrier. A steady LED indicates the unit has detected an FLI sub-carrier, but is not carrying any data   |
| OPER       | Green LED. Lights up for approximately 5 seconds after the power is switched on. The LED is dark during the boot process and when it is steadily lit again, it indicates the unit is ready for operation   |
| FAULT      | Red LED. Flashes for 15 – 20 seconds after the mains is switched on. Will flash for less serious alarms and be steady for fatal alarms   |
| POWER      | Yellow LED. Indicates power is present   |
| BOOT       | Red LED. Steady LED when the control unit boots up (10 – 15 seconds after the mains is switched on). Next enters a flashing state for 5 – 10 seconds. If no error is detected, the LED turns off. If an error occurs, the LED remains on   |
| WLI        | Green LED. Wire Link Interface. Flashing LED indicates unit is receiving data over the subcarrier. A steady LED indicates one of the following: The unit is not currently receiving any data, the unit is not currently a control station or there is no other node in the network |
| DATA       | Blue LED. Indicates data transmission in the W-net   |
| BATT       | Green LED. Steady LED indicates battery pack is currently used as power source   |
| CHARGE     | Yellow LED. Steady LED indicates battery charging  |

### PCBA Connections

The following tables list the connections from the main PCBAs to replaceable units inside the WRH-V. Table 2-3 lists the connections for a WRH-V configured for PCS both with and without diversity and Table 2-4 lists the connections for Cellular with and without diversity.

Table 2-3 WRH-V Base Unit Connections

| From       | To           | Cable Number  | Non-Diversity | Diversity |
|------------|--------------|---------------|---------------|-----------|
| WBA P2401  | M FON P101   | VE007 06/3    | Used          | Used      |
| WBA P3401  | D FON P101   | 700-16639-001 | Not Used      | Used      |
| WBA P1101  | M FON P102   | VE007 20/2    | Used          | Used      |
| PSU        | DIA P21, P35 | VE007 98/1    | Used          | Used      |
| M FON P108 | DIA P29      | VE007 66/1    | Used          | Used      |
| D FON P108 | M FON P116   | VE007 66/1    | Not Used      | Used      |
| M FON P111 | DIA P36      | VE008 05/1    | Used          | Used      |
| D FON P111 | DIA P112     | VE008 05/1    | Not Used      | Used      |

Table 2-4 WRH-V Cover Unit Connections

| From          | To           | Cable Number  | Non-Diversity | Diversity |
|---------------|--------------|---------------|---------------|-----------|
| Cover DIA P36 | M FON P112   | VE008 05/1    | Used          | Not Used  |
| Cover DIA P36 | D FON P112   | VE008 05/1    | Not Used      | Used      |
| PSU           | DIA P21, P35 | VE007 98/1    | Used          | Used      |
| DX DL C       | M FON P102   | 700-14508-401 | Used          | Used      |
| DX UL1 C (M)  | M FON P101   | 700-14508-401 | Used          | Used      |
| DX UL2 C (D)  | M FON P101   | VE007 52/2    | Not Used      | Used      |

**DIA PCBA**

Figure 2-5 shows and Table 2-5 lists the connections on the DIA PCBA. The DIA provides most of the internal connection between the sub units and external ports. Connectors involved are also located on the DIA.

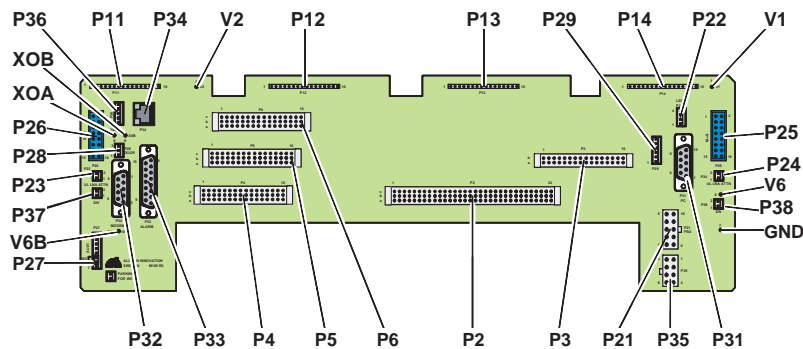


Figure 2-5 DIA PCBA Connectors and Testpoints

The External Alarm Port P33 is used for external alarm sensors and alarm equipment. The four alarm inputs are low-level inputs with common ground (AIC). Use an insulated switch or relay to initiate alarms (open switches in normal operating mode, closed switches cause alarm). The alarm switch connection can be toggled between active open and active closed. The alarm input voltage ratings, related to ground (AIC), are:  $V_{inmax} = 5.5V$ ,  $V_{inmin} = -0.5V$ .

The four alarm inputs are connected to the following pins:

- Pin 14 AI1 External alarm input 1 - EAL1
- Pin 15 AI2 External alarm input 2 - EAL2
- Pin 7 AI3 External alarm input 3 - EAL3
- Pin 8 AI4 External alarm input 4 - EAL4

Pin 6 AIC Ground.

Two alarm outputs are 1 pole closing and 1 pole opening relay outputs insulated from each other. Maximum ratings, related to ground or any other alarm terminal, are 50 VAC / 60 VDC. The alarm outputs are defined as follows:

Pin 9 and 1 AO1 and AO8 Closed when operating, otherwise open.

Pin 10 and 2 AO6 and AO7 Open when operating, otherwise closed.

Pin 11 and 3 AO2 and AO5 Closed at alarm state, otherwise open.

Pin 12 and 4 AO3 and AO4 Open at alarm state, otherwise closed.

Table 2-5 DIA PCBA Connections

| Port     | Connected to  |
|----------|---|
| P2       | CU PCBA   |
| P3, 5, 6 | Not Used  |
| P4       | ALI or RCI PCBA   |
| P11 - 14 | Channel PCBA positions 1 through 4  |
| P21      | PSU, connector 1  |
| P22      | LED PCBA in cover   |
| P23      | LNA/UL  |
| P24      | LNA/DL  |
| P25      | Expansion output port to cover circuitry. Only in cabinets  |
| P26      | Expansion input port to cover circuitry. Used in equipped high covers   |
| P27      | Auxiliary Port (8-pin male) - Pins 2 and 3 must always be interconnected to provide the CU and ALI/RCI PCBAs with voltage. If there is no cable connected, pins 2 and 3 must be interconnected with a jumper  |
| P28      | Door switch port - Normally, alarm input AI4 is used for door opening alarm EAL4 which is arranged using an optional door switch. Signal AI4 and AIC are thus available also in the P28 connector, to which the door switch is connected. The EAL4 door switch alarm is activated 10 – 30 seconds after the cover has been opened |
| P29      | Power to FON  |
| P31      | RS-232 PC Port (9-pin D-sub female) - Used for local PC communication   |
| P32      | RS-232 Modem port (9-pin D-sub male)  |
| P33      | External Alarm Port (15-pin D-sub female) - Used for external alarm sensors and alarm equipment. Four alarm inputs, EAL1 – EAL4, and two alarm outputs  |
| P34      | Not used  |
| P35      | PSU, connector 2  |
| P36      | IP or R2R connection between CU and FON   |
| P37      | LNA Diversity DL  |
| P38      | LNA Diversity UL  |

## LNA

Figure 2-6 shows the front of the LNA and Table 2-6 lists the connections.



Figure 2-6 LNA

Table 2-6 LNA Connections

| LNA Port | Connected to                                 |
|----------|--|
| OUT LOW  | IN on the LNA/UL in the cover, if equipped   |
| IN       | LO on the service DPX duplex filter          |
| ATT +7V  | P23 on the DIA PCBA                          |
| OUT1     | P2101 on the WBA PCBA                        |
| OUT2     | Diversity LNA connected to P3101 on WBA PCBA |

**FON**

Figure 2-7 shows the locations of the connectors on the FON and Table 2-7 lists the port numbers, connector types, and port usage.

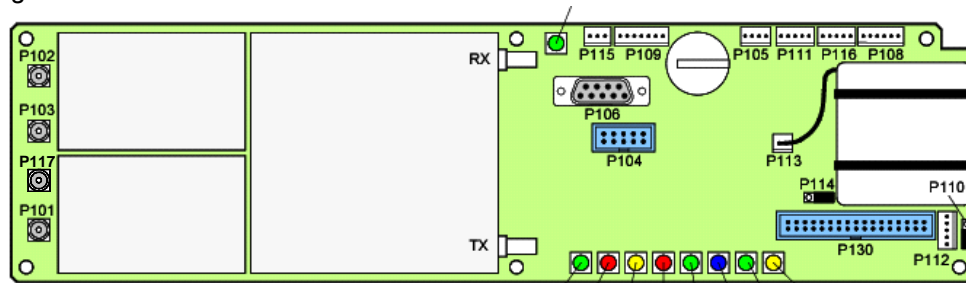


Figure 2-7 FON Connector Locations

Table 2-7 FON Connectors

| Port     | Description   |
|----------|---|
| P101     | SMA, electrical RF input port (to the optical TX port)  |
| P102     | SMA, electrical RF output port (from the optical RX port)   |
| P103     | SMA, electrical RF output port (15dB below the P102 port)   |
| RX       | DIN/APC, optical input port (to the P102 and P103 RF ports)   |
| TX       | DIN/APC, optical output port (from the P101 RF port)  |
| P104     | Used only for development and debugging   |
| P105     | 4-pin male, door LED indicators. Used for the yellow and red LED indicators located on the front cabinet door |
| P106     | 9-pin D-sub female, RS-232 used for local PC communication  |
| P108/116 | 6-pin male, parallel connected power ports for the FON  |
| P109     | 7-pin male, used for external alarm sensors   |



Table 2-7 FON Connectors (Continued)

| Port     | Description   |
|----------|---|
| P110     | W-link jumper, used to terminate units in a W-link. It has to be set in the parking state for all units except for the first and last units in a W-link. The Parking state (P) has the jumper between the center and bottom pins. The opposite state, with the jumper between the tip and center pins, terminates(T) the W-link       |
| P111/112 | 5-pin male, WLI ports used for interconnecting nodes in WLI-nets (IP or R2R networks). They are identical and connected in parallel. One of the connectors is intended to be used from the previous node and the other connector to the next node in the network. Either can be used for the first and the last unit in the net chain |
| P113     | 2-pin male, used for the on-PCBA backup batteries   |
| P114     | Backup power output jumper, sets the backup power output state. The OFF state has jumper between the center and left pins. This jumper has to be in the OFF state when used in an OCM. Otherwise, it shall be in the ON state   |
| P115     | 3-pin male, intended for future use   |
| P117     | SMA, electrical RF output port (15dB below the P101 port)   |
| P130     | 34-pin, 2-line male, RCU port used for connecting an RCU. The connector contains both the modem connection and RCU power supply   |

## PSU

The PSU is located in the bottom middle of the cabinet or in an equipped high cover. The PSU has all the voltages required for the WRH. It has capacity for the radio circuitry, fiber optics, and modem. Multi-band WRH-Vs always require a second PSU. There are two PSU types with different input voltages:

1. 115/230V 50/60Hz, 300W input max.
2. 21- 60V DC, 300W input max.

The PSU is connected to the DIA at P21 and P35, and voltage is tested at V1 (test point for P35) and V2 (test point for P21).

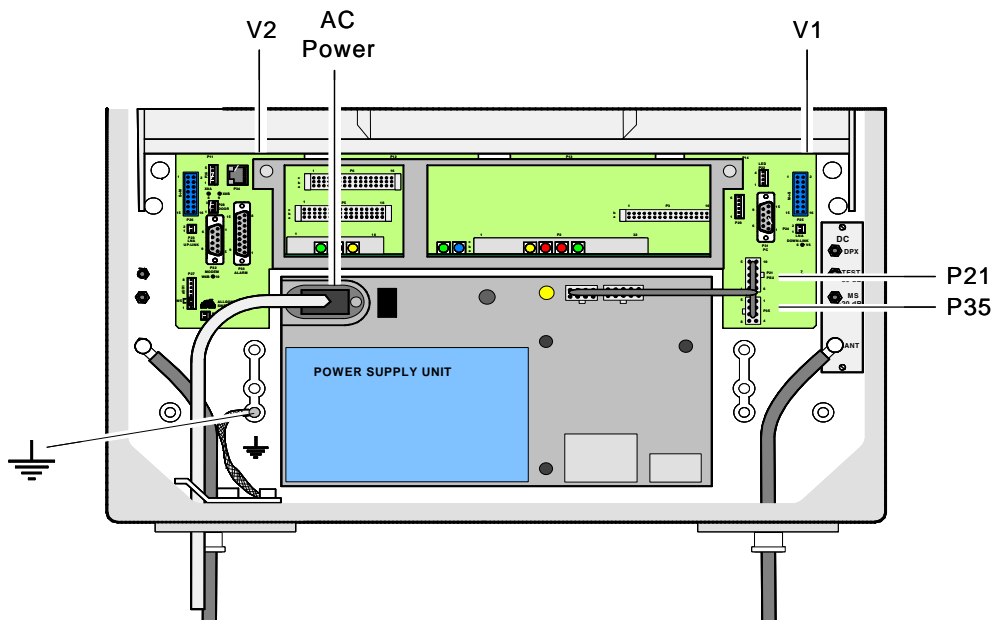


Figure 2-8 PSU Location

## Software and Hardware Compatibility

There are different versions of CU PCBA software which can be combined with PCBAs of various revisions. These have unique part numbers and revision information. Table 2-8 lists the software currently available in combination with CU PCBA revisions.

Table 2-8 Hardware / Software Compatibility

| CU PCBA part number               | CU Software part number          |
|-----------------------------------|----------------------------------|
| 500-13817-001 (previously K103/3) | D631-18072-001<br>D631-18072-003 |

This information is accurate as of 06/31/2007. As new versions of hardware and software are released without prior notice, contact your Powerwave sales representative for information on the latest revision.

For detailed information, refer to the release notes for the CU software to be downloaded (normally found in the readme.txt file provided with the program files).

# Chapter 3

## Installation

### Introduction

This chapter contains unpacking, inspection and installation instructions for installing and powering up the WRH.

### Site Survey

Powerwave recommends that a site survey be performed prior to equipment ordering or installation. Performing a detailed site survey reduces or eliminates installation and turn-up delays. Pay particular attention to power plant capacity, cooling needs, floor space, and RF/DC cabling/breaker requirements. Cabinet dimensions and weights are listed in Chapter 5.

### Unpacking and Inspection

This equipment has been operated, tested, and calibrated at the factory. Carefully open containers to remove equipment. Retain all packing material that can be reassembled in the event unit must be returned to the factory. Perform the following steps:

- Visually inspect equipment for damage that may have occurred during shipment. If possible, in the presence of the delivery person.
- Check for evidence of water damage, bent or warped chassis, loose screws or nuts, or extraneous packing material in connectors.

If equipment is damaged, file a claim with the carrier once the extent of any damage is assessed.

If equipment must be returned to factory, please contact factory for a Return Material Authorization (RMA), see Chapter 4.

### WRH-V Location

The WRH-V is designed with a weather proof outdoor cabinet that can be mounted without any kind of shelter from rain, snow or hail. The same unit can be installed indoors. A preferable site for the WRH-V is a location free of obstructions, easily accessible and allows for proper air-flow and ventilation.

If a WRH-V is installed outdoors and can be exposed to direct sunshine, it is essential that air circulates around the WRH-V with no obstacles. The operating temperature must not exceed 131°F (55°C). A shelter can be used to shade the WRH-V from direct sunshine.

Never open a WRH-V when rain, snow, hail, high humidity or high winds are present unless some kind of temporary shelter can be erected.

### Mounting

The WRH-V is easy to mount using the provided mounting bracket, which has 9/16-inch (14mm) holes for 3/8-inch (10mm) or 1/2-inch (12mm) fixing screws. Clamps with C-C measurements of 3.5-inch (90mm), 5.3-inch (135mm), 5.7-inch (144mm), 8.1-inch (205mm), 9.8-inch (250mm), and 11.8-inch (300mm) can be used as well. The vertical C-C measurement for these is 16.2-inch (411mm). There is a 9/16-inch (14mm) single hole in the middle of the mounting bracket, marked 'A' in the figure, which is intended for a locking screw to lock the bracket into place.

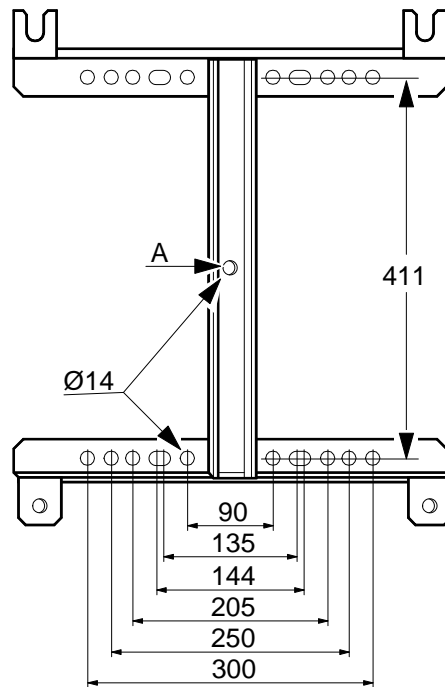


Figure 3-1 Mounting Bracket

Normally, the WRH-V is mounted on a wall, pole, or mast. Figure 3-2 illustrates the installation of the mounting bracket on a wall using four fixing screws and a locking screw.

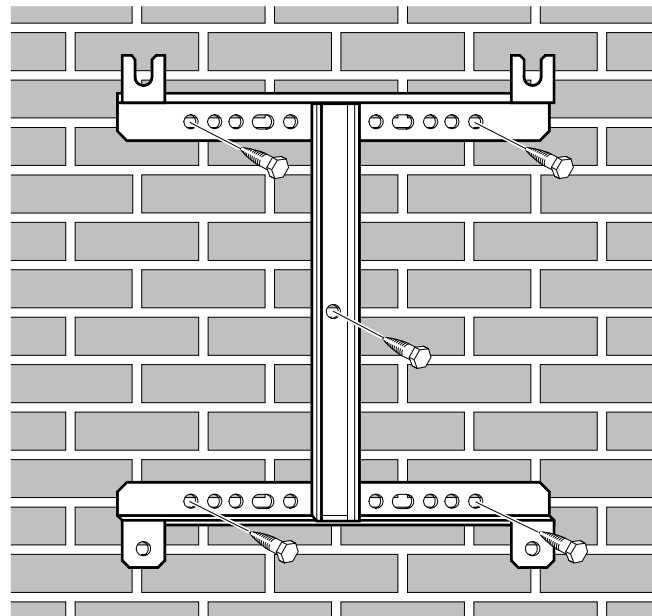


Figure 3-2 Mounting Bracket Installation on Wall

Figure 3-3 illustrates the installation of the mounting bracket on a pole using two 5.7-inch (144mm) U-shaped clamps and a locking screw.

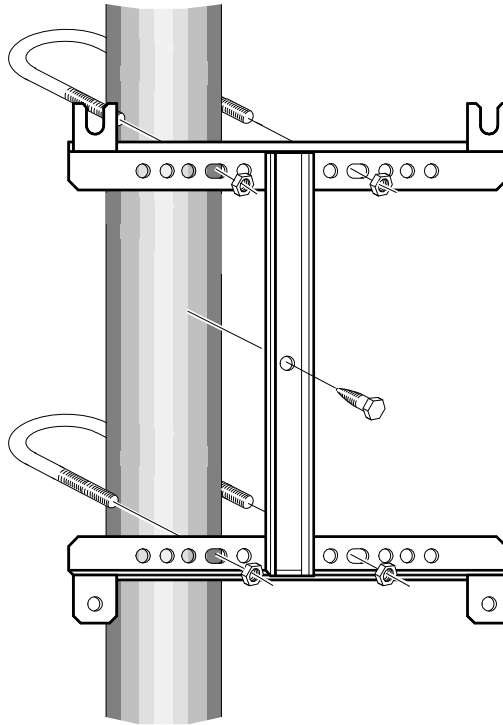


Figure 3-3 Attaching the Bracket to a Pole

Figure 3-4 illustrates a mast installation using two 11.8-inch (300mm) bar-shaped clamps and no locking screw.

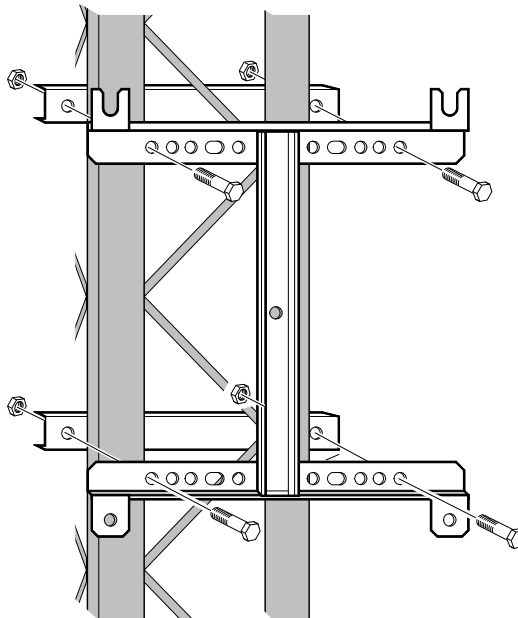


Figure 3-4 Attaching the Bracket to a Mast

After installing the mounting bracket, hang the WRH-V on the upper supports, as illustrated in Figure 3-5. Tighten the upper and lower mounting screws to secure it into place using the 6mm hex socket wrench. Locking cylinders, used to prevent unauthorized removal of the repeater, can be inserted and locked with a

key after the lower screws have been tightened. Make sure the donor antenna, directed towards the BTS antenna, and the service antenna, directed towards the area to be covered by the WRH, are mounted and installed properly.

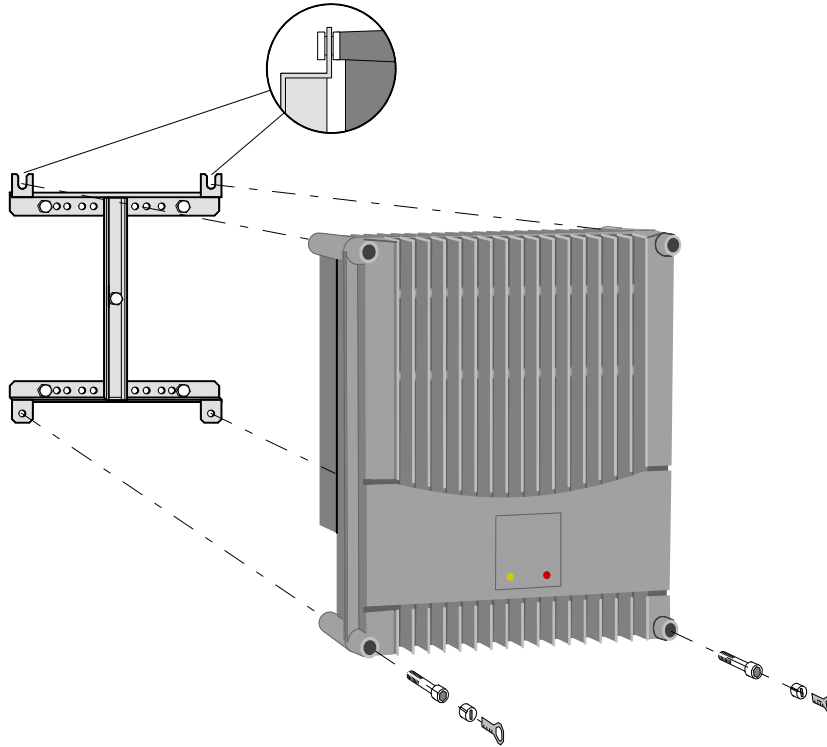


Figure 3-5 Attaching the WRH-V to the Bracket

## Connections

This section describes general examples of how to connect the input and output ports on the WRH.

### Main Power and Grounding

Local regulations need to be followed for the main power connection. WRH-Vs are approved in accordance with EN and UL/cUL regulations. This is, however, only valid if a classified power cord is used. For the WRH-V to meet these regulations you must select one of the following classified and approved cord types:

- EN – H 05 W5 - F HMR
- UL – AWM Style 2587
- CSA– AWM 1 A/B 11 A/B

For outdoor use, the power cord should meet at least IP65 encapsulation requirements. Do not turn the main power on until you are ready to commission the WRH.



**WARNING: For WRH-Vs supplied from the main power source, the main outlet must be grounded.**

### Fiber Optic and RF Connections

Fiber optic and RF cable connections should be verified both internally and externally before powering up the equipment. This section illustrates the general internal connections of the WRH-V. Verify these connections with the as-built drawings and documents for your specific system configuration. Table 3-1 lists the steps to add the external connections to the WRH-V.

Table 3-1 Cable Connection Procedure

| Step | Action  |
|------|---|
| 1    | Connect service antenna coaxial cable to left-outside DIN connection on cabinet |
| 2    | Connect fiber optic cable from OCM or BMU to fiber optic cable demark on FOU    |
| 3    | Connect station ground to appropriate ground point in cabinet                   |
| 4    | Mount main power plug to main power cord and insert into PSU                    |

**WRH-V**

Figure 3-6 illustrates the cables and connections for the WRH-V.

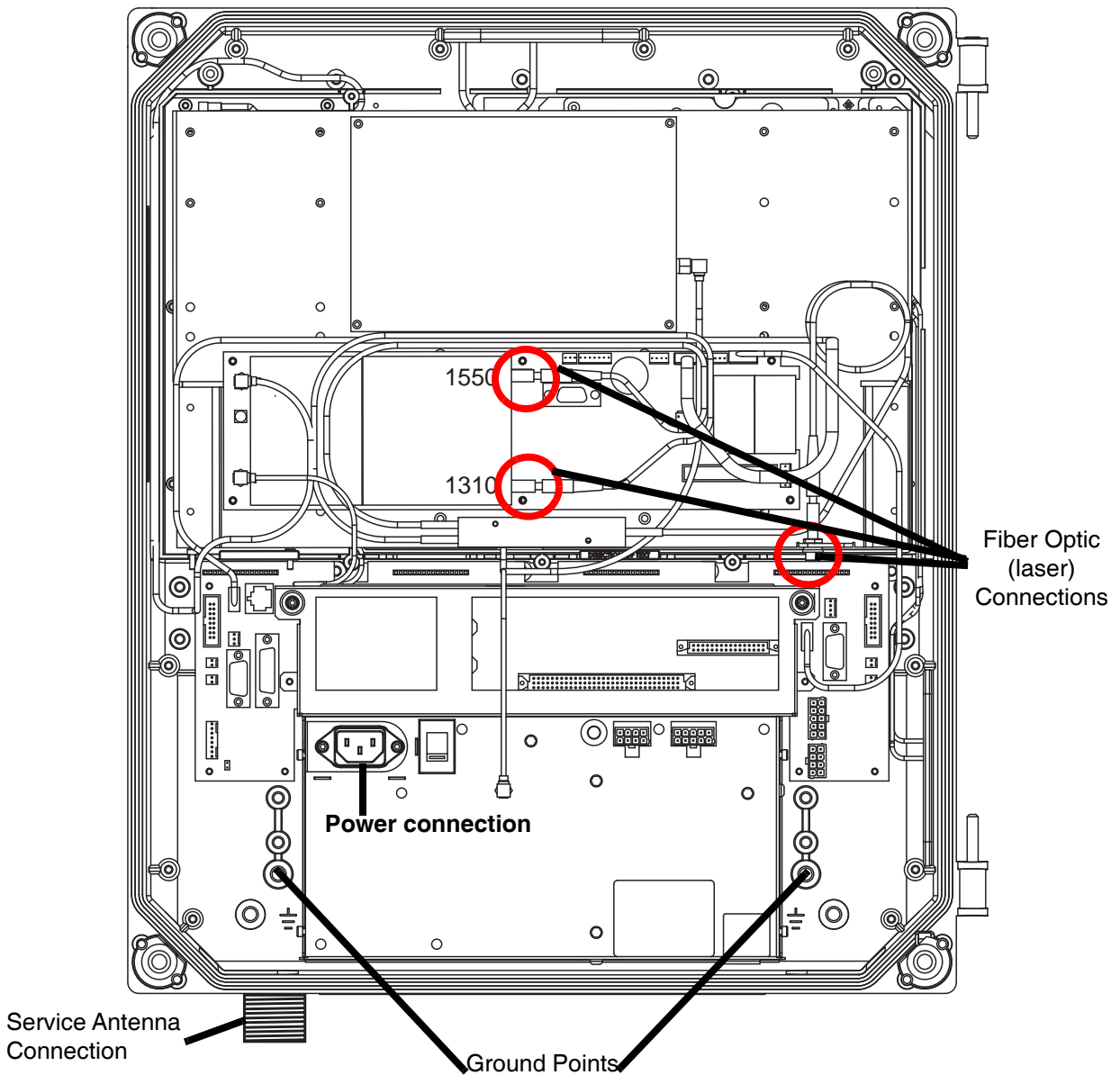


Figure 3-6 WRH-V Cable Connections

## Optional Connections

### Alarms

Alarm signals from external sensors are received by an ALI or RCI which forwards them to the CU. The RCI is used if the WRH-V has an RCU, otherwise the ALI is used. The software on the CU can activate acoustic or visual alarms or direct the alarm to the P33 alarm port for forwarding via an RCU through OM-Online. Alarms can also be handled by the FON. Alarms are configured through OM-Online.

### External Alarm

Burglary, fire or other external alarms can be handled by the WRH-V. External alarm sensors and alarm signals are connected to the P33 alarm port located to the left in the cabinet, as illustrated in Figure 3-7. The P33 alarm port is described in Chapter 2. The cable for this installation is taken through a strain relief bushing at the bottom of the WRH-V cabinet.

### Door Open Alarm

A door open alarm can be configured and installed in the WRH. This is arranged with a door switch connected to pin 8 (AI4) on P28, as described in chapter 2. The location of P28 is shown in Figure 3-7.

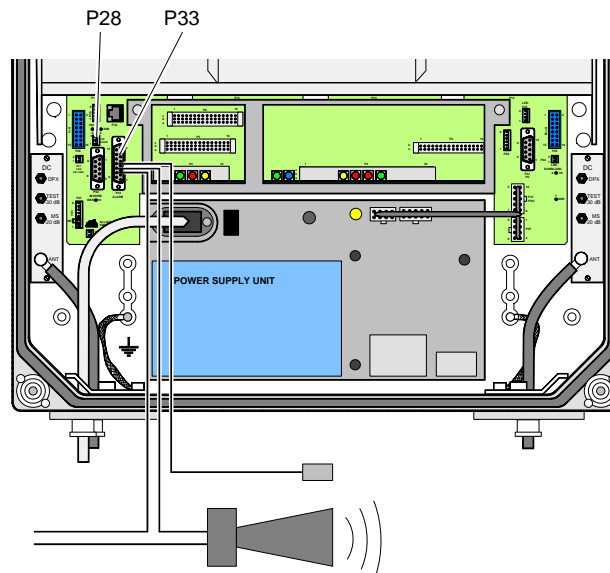


Figure 3-7 External Alarm Connection

### Main Power Breakdown Relay

To be able to distinguish PSU faults from power failures, a main power breakdown relay can be used. This relay is not included in the WRH. It has to be mounted outside the WRH-V cabinet. The relay intended for this purpose must fulfil the following specifications:

|                          |                      |
|--------------------------|----------------------|
| Closing time:            | Max. 30 milliseconds |
| Insulation coil/contact: | Min. 4KV             |

A main power connected relay must also be in compliance with valid local regulations. To install a main power breakdown relay connection, follow the steps listed in Table 3-2.



Table 3-2 Main Power Breakdown Relay Connection

| Step | Action   |
|------|--|
| 1    | Connect a currentless closed relay contact to pin AI1 and AIC on P33 alarm connector, as shown in Figure 3-8. Alarm is initiated when pins AI1 and AIC are shorted |
| 2    | Connect relay coil. Coil must be supplied from same fuse as WRH  |
| 3    | After commissioning, select Mains Breakdown in alarm configuration window in OM-Online. For details on setting alarm configuration see OM-Online User Manual.      |

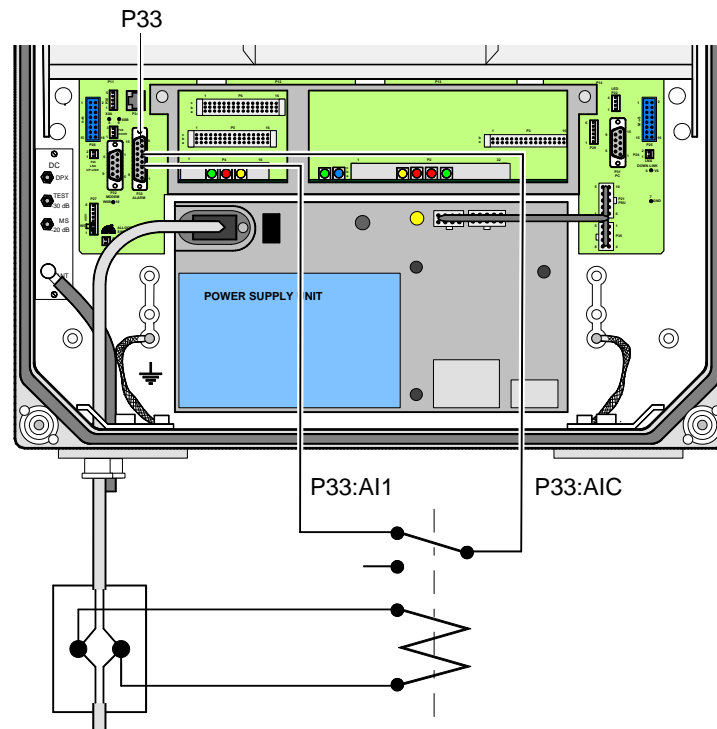


Figure 3-8 Main Power Breakdown Relay Connection

## 21-60 Volt DC PSU Installation

See the Field Replaceable Units, PSU section in Chapter 4 for details on replacing a 115/230 VAC PSU with a 21 to 60 Volt DC PSU.

## Commissioning

Before proceeding, carefully read the Safety section and check all connections made during the installation. To fulfill the IP65 weather protective requirements, ensure cable strain relief bushings are properly tightened. Also, ensure gaskets at cable inlets and on the cabinet are properly fitted and not damaged.

A WRH-V can be configured locally with OM-Online by connecting a standard serial cable from the COM port on the PC to the P31 PC port (RS-232) located to the right in the cabinet as shown in Figure 3-9. The P31 PC port is described in Chapter 2. Details on using OM-Online are described in the OM-Online User Manual.

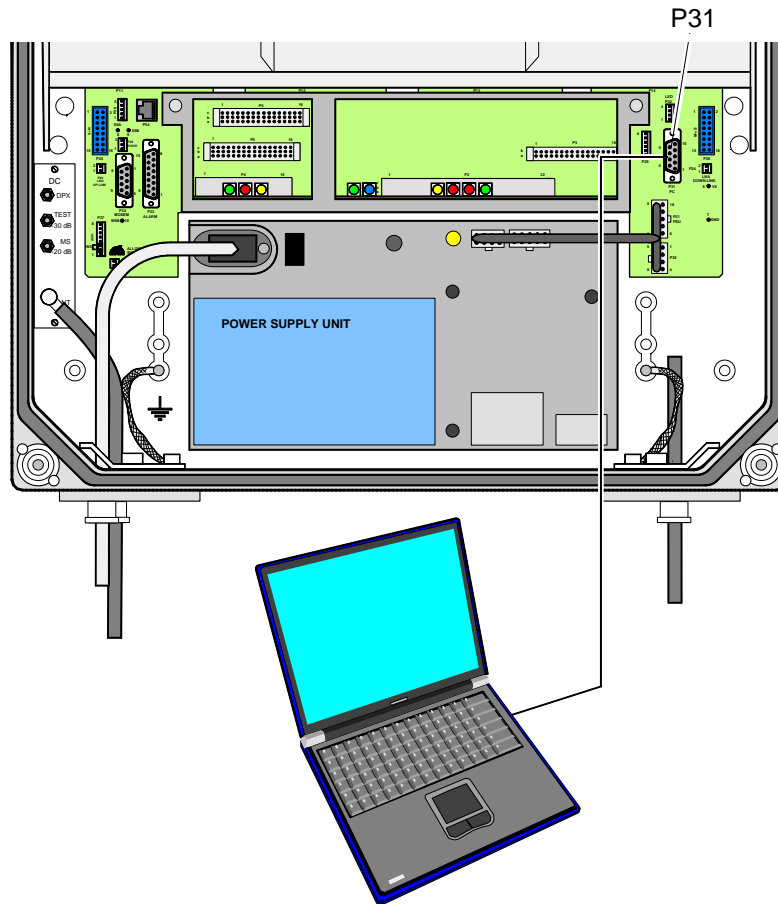


Figure 3-9 Connecting a PC for Local Access

**Initial Startup**

To complete the initial start-up of the WRH-V, follow the steps listed in Table 3-3.

Table 3-3 Initial Startup Procedure

| Step | Action  |
|------|---|
| 1    | Turn main power on  |
| 2    | Check Yellow LED on power supply unit. Steadily lit = functioning correctly   |
| 3    | Check the four CU PCBA LEDs. Refer to CU PCBA section in Chapter 2 for correct power up indications   |
| 4    | Check the three ALI PCBA LEDs or corresponding LEDs on RCI PCBA. Refer to ALI or RCI PCBA section in Chapter 2 for correct power up indications |

## Passive Intermodulation (PIM) Testing

PIM is the non-linear effect of passive RF components in a desired RF transmission band. As higher per-carrier transmit power levels are applied to duplexed passive RF networks, PIM becomes an increasingly significant factor in potential receiver desensitization. A PIM tester may be used on the RF network prior to turn-on and commissioning of the unit, but if a PIM tester is not available, the following may be used:

The following equipment is required to test for PIM:

- Anritsu Site eMaster or equivalent RF Spectrum Analyzer
- Agilent ESG4432B or equivalent Multi-Signal Generator (or commissioned BTS)
- Guaranteed/calibrated PIM load capable of handling 20W composite power
- Low-PIM RF cable adaptors such as N-N female, Din male to N female, DIN-DIN, SMA-SMA female, and N male to SMA female
- Installed and operational WRH-V unit
- Installed passive RF network under test
- Torque wrenches for DIN and N connectors

Two different types of setup are available, depending on equipment availability and testing methods.

Figure 3-10 shows PIM testing with two carriers over one WRH-V, and Figure 3-11 shows PIM testing with one carrier over each of two WRH-Vs.

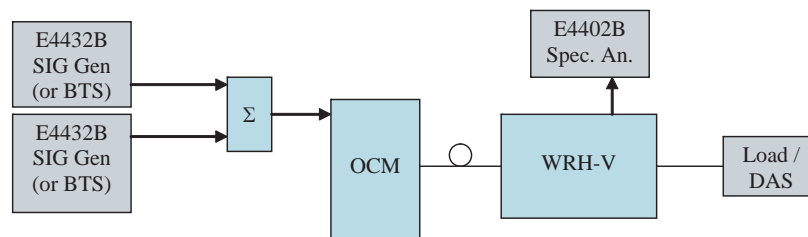


Figure 3-10 PIM testing two carriers and one WRH-V

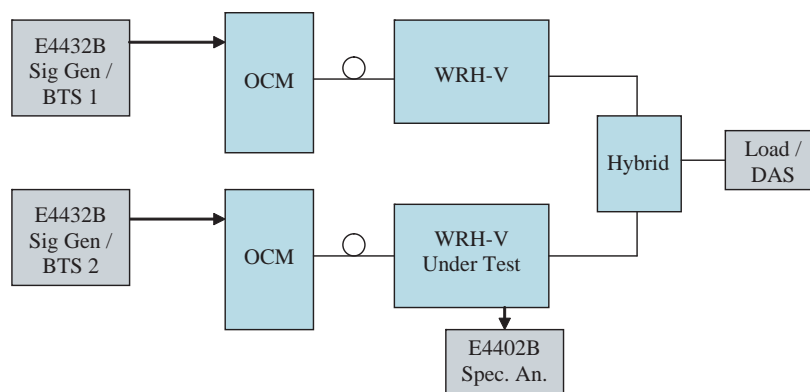


Figure 3-11 PIM testing one carrier over each of two WRH-Vs

The following PIM test uses the receive sensitivity and gain of the WRH-V under test to verify that the receive path is free of PIM noise. For PIM to be a problem at a particular site, TX signals must exist such that their products fall into the RX band using the formulae:

$$3^{\text{rd}} \text{ order product} = (2 * f_1) - f_2$$

and

$$3^{\text{rd}} \text{ order product} = (2 * f_2) - f_1$$

Where  $f_1$  and  $f_2$  are two TX signals entering a WRH-V. The specification for the maximum allowed PIM is -115 dBm per 100 kHz resolution bandwidth at rated output power. To test for PIM follow the steps listed in Table 3-4.

Table 3-4 PIM Testing Procedure

| Step | Action  |
|------|---|
| 1    | If BTS signals are present, continue with step 2. Otherwise, connect two signal generators to OCM and set frequencies such that products are in relevant receive band (see equations above)   |
| 2    | Set WRH-V UL gain to 60 dB and DL gain such that desired per carrier power is presented at output port  |
| 3    | Set Spectrum Analyzer to 100 kHz resolution bandwidth and view RX band at 3 <sup>rd</sup> order product frequency calculated in step 1  |
| 4    | Loosen fastening screw in each corner on front cover of WRH-V under test, and open cover  |
| 5    | Verify the noise floor specification for the Spectrum Analyzer. If the noise floor is higher than or equal to -85 dBm/100 kHz, locate FON, disconnect UL cable from port P101 and connect Spectrum Analyzer to the cable using an SMA female - female connector (noise limit becomes -115 dBm + 60 dB = -55 dBm). Continue with step 7. |
| 6    | If noise floor is lower than -85 dBm/100 kHz, locate the FON card and connect the Spectrum Analyzer to P117 (noise limit becomes -115 dBm + 60 dB - 30 dB = -85 dBm). If the FON only has three RF ports on the left side, port P117 will not be available, so follow instructions listed in step 5.                                    |
| 7    | Enable WRH-V TX signal. For details on using OM-Online, see OM-Online user manual   |
| 8    | Using Spectrum Analyzer, measure noise level. If no noise exists above calculated limit in step 5 (-55 dBm) or step 6 (-85 dBm) above, as appropriate, then test is passed and no other action is necessary   |
| 9    | If a higher level of noise exists, disable the WRH-V TX signal and disconnect cable to DAS at bottom-left outside corner  |
| 10   | Connect low PIM load onto WRH-V Service antenna connector at bottom-left outside corner. Tighten connectors securely  |
| 11   | Remeasure noise level. If no noise exists above calculated limit in step 5 (-55 dBm) or step 6 (-85 dBm) as appropriate, then DAS has a PIM issue. Tighten all connections in DAS with torque wrenches, replace any crimped or severely bent cables, and retest. Repeat until all issues are solved                                     |
| 12   | Otherwise, if noise is higher than limit, WRH-V is defective and must be replaced. See Chapter 4 for Replacement procedures   |

# Chapter 4 Maintenance

## Introduction

This chapter contains periodic maintenance and performance test procedures for the WRH.

## Periodic Maintenance

Periodic maintenance requirements are listed in Table 4-1, as well as the intervals at which the tasks should be performed.

Table 4-1 Recommended Periodic Maintenance

| Task                                | Interval   | Action  |
|-------------------------------------|--|---|
| Inspection of cables and connectors | 12 months  | Inspect power, RF and Fiber cables for signs of damage or wear (frayed insulation, cracks, punctures, etc.) Check connections to be sure they are tight |
|                                     | Optional   | Perform cable sweeps  |
| Clean equipment                     | Clean as required depending on operating environment |   |

## Troubleshooting

The sections that follow contain a list of problems that could occur and a few suggested actions that might correct each problem. If the suggested corrective action does not eliminate the problem, please contact your Powerwave field representative or help line for further instruction.

## Clearing Alarm Faults

Table 4-2 lists the alarms that can be generated in the WRH. Critical, Error and Warning alarms are sent automatically from a WRH-V to OM-Online, stored and then viewed in the Alarm window.

Table 4-2 Alarm Troubleshooting

| ID | Alarm Text | Alarm Unit | Alarm    | Description   |
|----|------------|------------|----------|---|
| 1  | Power      | PSU        | Critical | PSU1 in the cabinet does not work properly. A sum signal from the PSU1 indicates that at least one voltage output has dropped. If no mains breakdown relay is used, then the alarm will also be sent at mains breakdown                       |
|    |            |            | Ceasing  | PSU1 in the cabinet works properly again. Ceasing is sent if the PSU1 works at start-up, and there is a corresponding critical PSU1 alarm logged in the Events log. The WRH-V will restart when the power is back and this alarm will be sent |
|    |            | PSU        | Critical | PSU2 in the cover does not work properly. A sum signal from the PSU2 indicates that at least one voltage output has dropped. If no mains breakdown relay is used, then the alarm will also be sent at mains breakdown                         |

Table 4-2 Alarm Troubleshooting (Continued)

| ID | Alarm Text          | Alarm Unit   | Alarm    | Description   |
|----|---------------------|--------------|----------|---|
|    |                     |              | Ceasing  | PSU2 in the cover works properly again. Ceasing is sent if the PSU2 works at start-up, and there is a corresponding critical PSU2 alarm logged in the Events Log. The WRH-V will restart when the power is back and this alarm will be sent                         |
|    | Power               | FON          | Error    | The FON 10 Volt charger voltage is below limit. Suggested remedy: Replace the FON   |
|    |                     |              | Ceasing  | The cause of the alarm has ceased   |
| 2  | WRH-V restart       | CU           | None     | Power on start, or user ordered reboot. Logged to indicate a normal power up, or a restart ordered by the operator  |
|    |                     |              | Warning  | Software error restart, 1st – 7th time. Restart 1st to 7th time during a 14 day period. The counter is reset every 14th day, counted from power up  |
|    |                     |              | Error    | Software error restart 8th – 10th time. Restart 8th to 10th time during the 14 day period. At the 11th time, the SW bank will be blocked and not used anymore until a user ordered reset is performed, or power is switched off/on                                  |
| 3  | Mains breakdown     | External     | Critical | The mains power is gone. Used with an external relay indicating mains breakdown. The external relay should be connected to External Alarm 1 and the WRH-V configured to indicate this alarm. If no relay is used, a mains breakdown will be reported as a PSU fault |
|    |                     |              | Ceasing  | The mains power is back. Sent if there is a corresponding critical mains breakdown alarm logged in the Events Log. The WRH-V will restart when the power is back  |
| 4  | Alarm reset         | CU           | None     | Alarm reset by the user. All alarms are reset. The cause of the alarm will be re-evaluated and reported, if still active  |
| 5  | Local bus error     | WBA #, MCPA# | Error    | Error when communicating on the bus. The CU has no contact with the WBA, or MCPA PCBA, which is taken out of service  |
| 6  | Main bkd w backup   | External     | Error    | Used to indicate that the mains is no longer available. WRH-V is powered by external battery backup unit. Suggested remedy: Check the mains power   |
|    |                     |              | Ceasing  | The cause of the alarm has ceased   |
| 7  | Err in AD-converter |              | Warning  | The analog-to-digital converter on the CU PCBA does not give reliable values  |
| 8  | New unit detected   |              | None     | Compared to the last power on, the CU has recognized at least one additional hardware unit  |
| 9  | Inst. unit lost     |              | Error    | Compared to the last power on, the CU lacks at least one hardware unit  |
| 10 | EEPROM error        | CU           | Error    | EER read or write fail. Data cannot be written or read from the EEPROM on the CU PCBA. User parameters are stored in the EEPROM   |
| 11 | Log memory fault    |              | Error    | Log memory fault. Indicates that the log memory on the CU PCBA is faulty. The WRH-V will not work. Not available in all CU software versions  |

Table 4-2 Alarm Troubleshooting (Continued)

| ID | Alarm Text       | Alarm Unit | Alarm   | Description  |
|----|------------------|------------|---------|--|
| 12 | High temp        | CU         | Warning | The CU PCBA temperature is higher than 90°C  |
|    |                  |            | Ceasing | The CU PCBA temperature has fallen below 90°C  |
| 13 | REFO error       |            | Error   | Significant REFO drift or error detected by CU   |
| 14 | Ext REFO error   |            | Warning | Suggested remedy: Check the reference source and the cables  |
| 15 | CU battery fault | CU         | Warning | CU RAM battery fault. The battery for the RAM on the CU PCBA has a voltage outside the normal 2.7 to 3.5 Volt. An alarm may be initiated at start-up if the WRH-V has been stored out of power for a long time. Suggested remedy: Ensure jumper P3 on the CU PCBA is mounted to charge the battery |
|    |                  |            | Ceasing | The cause of the alarm has ceased  |
| 16 | SW load error    | CU         | Error   | Software load error. An error has occurred during a software load process. The flash memory does not contain a proper software. Suggested remedy: Check the CU software using the OM-Online SW Manager. Do NOT restart the WRH   |
| 17 | Log cleared      | CU         | None    | Log memory has been cleared. The check sum in the Events Log memory is faulty. The log is cleared. Can be caused of a bad RAM battery backup or low voltage to the RAM   |
| 18 | RTC restarted    | CU         | None    | The time is changed by the operator (logged to keep track of changes made to the RTC)  |
|    |                  |            | Warning | Time reset to 1994-01-01. The RTC was unable to keep track of the time and did a reset. Suggested remedy: Ensure jumper P3 on the CU PCBA is mounted to charge the battery   |
| 19 | RTC error        |            | Error   | RTC does not operate. The CU has detected an error in the RTC operation which makes the time unreliable. Suggested remedy: Replace the CU PCBA   |
| 20 | Door open alarm  | External   | Config  | The door has been open 30 seconds without disabling the alarm  |
|    |                  |            | Ceasing | The door has been closed 30 seconds, or the alarm is disabled  |
| 21 | External alarm 1 | External   | Config  | External alarm input EA1 active more than 1 second   |
|    |                  |            | Ceasing | External alarm input EA1 no longer active  |
| 22 | External alarm 2 | External   | Config  | External alarm input EA2 active more than 1 second   |
|    |                  |            | Ceasing | External alarm input EA2 no longer active  |
| 23 | External alarm 3 | External   | Config  | External alarm input EA3 active more than 1 second   |
|    |                  |            | Ceasing | External alarm input EA3 no longer active  |
| 24 | External alarm 4 | External   | Config  | External alarm input EA4 active more than 1 second   |
|    |                  |            | Ceasing | External alarm input EA4 no longer active  |

Table 4-2 Alarm Troubleshooting (Continued)

| ID | Alarm Text           | Alarm Unit                    | Alarm   | Description   |
|----|----------------------|-------------------------------|---------|---|
| 30 | No modem found       | Remote ctrl                   | None    | No modem found, that is no answer is returned on a poll string to the modem   |
| 33 | No connection        | Remote ctrl                   | None    | No connection at callback. The WRH-V has tried to call as many times as stated in the alarm call settings. No connection was established.   |
|    |                      |                               | Warning | No connection at alarm call. The WRH-V has tried to call as many times as stated in the alarm call settings. No connection was established. This alarm does not generate a new attempt to report alarm by alarm call.   |
| 34 | Login failed         |                               | None    | Invalid WRH-V password  |
| 35 | Remote connection    | Remote ctrl                   | None    | Modem connection to OM-Online opened. Not logged on CU2. Login Registry gives the same function and more information about CU2  |
| 36 | Modem init failed    | Remote ctrl                   | None    | Initiation string to modem not OK. The initiation string sent to the modem is not OK. The string may contain commands not recognized by the modem. An alarm might be sent anyway. Suggested remedy: Check the modem using the OM-Online or OMS modem debugger |
| 37 | Remote timeout       | Remote ctrl                   | Warning | The time limit of 20 minutes is exceeded without extending the timer. The modem connection is terminated by the WRH   |
| 38 | PIN code failed      | Remote ctrl                   | Warning | The PIN code sent to MS is incorrect. To unlock the MS/SIM card, the PUK code will probably be needed   |
|    |                      |                               | Ceasing | The cause of the alarm has ceased   |
| 39 | No phone detected    | Remote ctrl                   | Warning | When using a PC-card together with the MS, the alarm indicates contact with the PC-card, but MS is not present or turned off. <b>Note:</b> A Nokia MS does not power-up after power failure. Suggested remedy: Ensure the cellular phone is connected         |
|    |                      |                               | Ceasing | The cause of the alarm has ceased   |
| 40 | Battery fault        | RCU, FON charger              | Error   | The backup battery on the RCU or the FON PCBA does not work properly. Suggested remedy: Check cables or replace battery   |
|    |                      |                               | Ceasing | The cause of the alarm has ceased   |
| 42 | Antenna isolation    | WBA #,<br>Channel #,<br>UL/DL | Warning | Low antenna isolation. The antenna isolation is lower than the gain set. Gain is reduced by 10dB – 13dB below the oscillation point. Suggested remedy: Decrease gain or increase antenna isolation  |
|    |                      |                               | Error   | Low antenna isolation at lowest gain. The gain has been reduced as much as possible but the oscillation still remains. The amplifier is turned off. Suggested remedy: Decrease gain or increase antenna isolation   |
|    |                      |                               | Ceasing | Normal operation again, that is no oscillation can be detected 13dB above the gain set  |
| 48 | Battery backup fault | External                      | Error   | If a battery backup unit alarm is connected to external alarm 2, then the operator can configure the WRH-V to display this alarm when the battery backup unit indicates alarm   |



Table 4-2 Alarm Troubleshooting (Continued)

| ID  | Alarm Text           | Alarm Unit                    | Alarm        | Description   |
|-----|----------------------|-------------------------------|--------------|---|
|     |                      |                               |              |   |
|     |                      |                               | Ceasing      | The cause of the alarm has ceased   |
| 50  | Fiberoptical error   | FOT fiber optics              | Configurable | If a fiber unit alarm is connected to external alarm 3, then the operator can configure the WRH-V to display this alarm when the fiber optical unit indicates alarm |
|     |                      |                               | Ceasing      | The cause of the alarm has ceased   |
| 70  | Bad table alarm      | CU                            | Error        | Requested table contains incorrect information (SW error)   |
| 71  | Table not found      | CU                            | Error        | Requested table not found in the database (SW or calibration error)   |
| 72  | Table database error | CU                            | Error        | Table database not found (calibration error)  |
| 80  | Antenna SWR alarm    | Donor antenna service antenna | Error        | Too low antenna return loss, caused either by cables, connectors, or antenna problems.<br><br>Suggested remedy: Check antenna and cables                            |
|     |                      |                               | Ceasing      | The cause of the alarm has ceased   |
| 90  | FON power alarm      | FON RF                        | Error        | A DC voltage on a FON PCBA is out of range. Suggested remedy: Replace the FON PCBA.   |
|     |                      |                               | Ceasing      | The cause of the alarm has ceased   |
| 91  | FON TxStable alarm   | FON RF                        | Error        | Laser transmitter control loop voltage out of range. Suggested remedy: Replace the FON PCBA   |
|     |                      |                               | Ceasing      | The cause of the alarm has ceased   |
| 92  | FON RxLevel alarm    | FON                           | Warning      | Received optical level is below any of the two limits (one for Warning and one for Error). Suggested remedy: Check optical cables                                   |
|     |                      |                               | Error        | Received optical level is below any of the two limits (one for Warning and one for Error). Suggested remedy: Check optical cables                                   |
|     |                      |                               | Ceasing      | The cause of the alarm has ceased   |
| 93  | FON SPI alarm        | FON F2F                       | Error        | The SPI bus connection to the RF modem does not work properly. Suggested remedy: Replace the FON PCBA   |
| 245 | Not In Allowed Area  | CU                            | None         | WRH-V is moved from the operating area and the RF HW is switched on or off  |

## Remarks:

The Door Open alarm requires an optional door switch described in the Door Open Alarm section of Chapter 3.

The Main power breakdown alarm requires an optional relay described in the Main Power Breakdown Relay section of Chapter 3.

## Field Replaceable Units

The following units can be replaced in the field on-site by a qualified technician with experience maintaining RF equipment:

- FON
- PSU
- WRH

### FON

To replace a FON PCBA, follow the steps listed in Table 4-3. For details on cables and connectors, see Chapter 2.



**CAUTION: Do not look into the end of any fiber optic cable. Be sure to cap fiber optic cables to protect the connecting end from damage**



**CAUTION: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure"**

**NOTE** Verify 'Fiberoptical' classmark in the FON Status window is checked, otherwise FON will not be operational. Classmarks are described in the OM-Online User Manual.

Table 4-3 FON Replacement Procedure

| Step | Action   |
|------|--|
| 1    | Loosen all four locking screws on front of cabinet                                     |
| 2    | Open WRH-V door and secure   |
| 3    | Locate power connector on FON and remove connector from PCBA                           |
| 4    | Verify all cables on FON are labeled before disconnecting, then disconnect all cables. |
| 5    | Remove screws securing FON PCBA to FOU and remove PCBA                                 |
| 6    | Replace FON PCBA in reverse order and apply power                                      |
| 7    | Connect PC to OM Online port, login to FON and verify configuration and IP address.    |
| 8    | Close WRH-V door and secure  |

## PSU

To replace a PSU, follow the steps listed in Table 4-4. For details on cables and connectors, see Chapter 2.

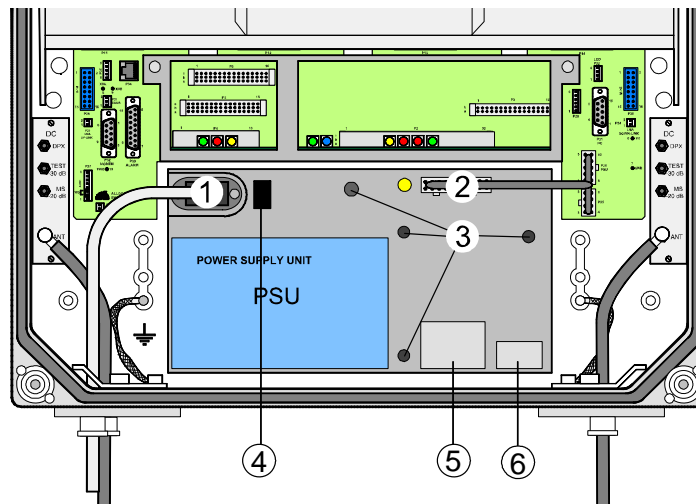


Figure 4-1 PSU Cable, Switch and Label locations

Table 4-4 PSU Replacement Procedure

| Step | Action  |
|------|---|
| 1    | Loosen all four locking screws on front of cabinet  |
| 2    | Open WRH-V door and secure  |
| 3    | Disconnect main power plug from PSU (Location 1 shown in Figure 4-1)  |
| 4    | Disconnect power cable bundle from PSU (Location 2 shown in Figure 4-1)   |
| 5    | Loosen but do not remove screws securing PSU using a 5mm Allen key and remove PSU (Location 3 shown in Figure 4-1)  |
| 6    | On new AC power supply, if used, set input voltage switch on PSU to correct input voltage -- 115 VAC or 230 VAC (Location 4 shown in Figure 4-1)  |
| 7    | On new DC power supply, if used, verify that the supply voltage is 24 VDC or 48 VDC as stated on label on PSU (Location 5 shown in Figure 4-1)  |
| 8    | Set new PSU to correct output supply voltage (27 VDC) by moving wire connection plug as illustrated on label on PSU (Location 6 shown in Figure 4-1)  |
| 9    | Mount new PSU with all four fixing screws (Location 3 shown in Figure 4-1)  |
| 10   | Connect PSU to DIA PCBA (Location 2 shown in Figure 3-9) with cable marked VE007 98/1. This cable must be used in all situations. If only one connection is available on DIA PCBA, the second connector may be tied out of the way with a cable tie |
| 11   | Insert power cord (AC power supply) or connect DC power cable brown wire (Europe) or black wire (US) to positive (+) pole and blue wire (Europe) or white wire (US) to negative (-) pole (DC power supply)  |
| 12   | Close WRH-V door and secure with four locking screws on front of cabinet  |

## WRH-V

To replace a WRH-V, follow the steps listed in the Table 4-5.



**WARNING: A fully loaded WRH-V can weigh 96lbs. Lifting of the WRH-V should be done by two people. Do not attempt to carry the WRH-V up a ladder.**

Table 4-5 WRH-V Replacement Procedure

| Step | Action  |
|------|---|
| 1    | Loosen all four locking screws on front of cabinet  |
| 2    | Open WRH-V door and secure  |
| 3    | Disconnect main power plug from PSU   |
| 4    | Verify all external cables connected to WRH-V are labeled before disconnecting, then disconnect all external cables |
| 5    | Remove mounting screws from bottom legs of WRH-V and loosen mounting screws in top legs                             |
| 6    | Close and secure door   |
| 7    | Lift the WRH-V off of mount hinges  |
| 8    | Replace WRH-V in reverse order  |
| 9    | Connect PC to OM Online port and verify configuration. For Fiber Optic installations, verify IP address             |
| 10   | Close WRH-V door and secure   |

## Remote Control Unit (RCU)

The RCU provides remote control of Powerwave WRHs. It contains an integrated mobile phone, modem and power supply backup. The RCU is installed in the bottom front of the cabinet, on top of the PSU as illustrated in Figure 4-2.

The RCU is connected to P130 on either an RCI or FON. A jumper is required between pins 1 and 2 on the RCI if the P130 cable connector is disconnected. If a main power failure occurs, the unit has a battery with enough capacity for sending a number of alarms.

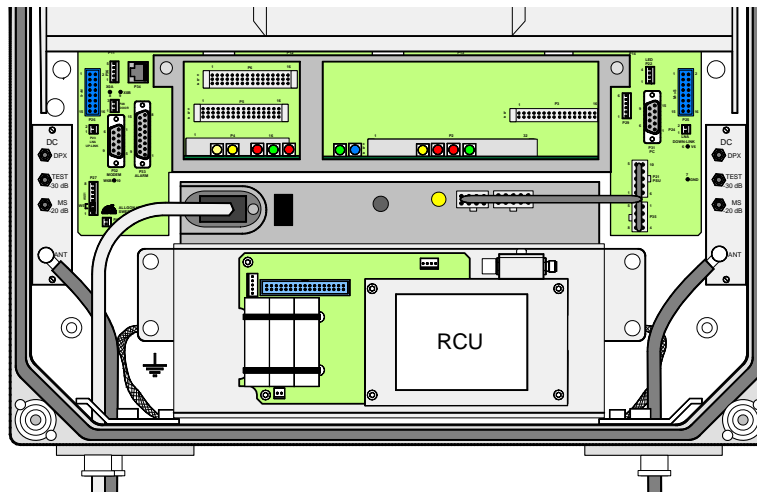


Figure 4-2 RCU in the WRH-V cabinet

**RCU for Radio Communication**

The RCU antenna for a radio modem is connected to the BS antenna via the uplink DC, provided the RCU and the WRH-V operate in the same cell system. Otherwise, the modem must have a separate antenna. Data is transferred between the WRH-V and the RCU via the P130 modem port on the RCI or FON. The RCU is also powered via the same port and has a battery with enough capacity to send a number of alarms if a main power failure occurs.

**RCU for Telephone Line Communication**

The land line version uses a telephone line connected to a terminal block on the RCU. A free strain relief bushing at the bottom of the WRH-V is used for the external telephone line cable.

**Return For Service Procedures**

When returning products to Powerwave, the following procedures will ensure optimum response.

**Obtaining an RMA**

A Return Material Authorization (RMA) number must be obtained prior to returning equipment to the factory for service. Please contact our Repair Department at +1-714-466-1000 to obtain this number, or FAX your request to +1-714-466-5800. Failure to obtain this RMA number may result in delays in receiving repair service.

**Repackaging for Shipment**

To ensure safe shipment of the unit, it is recommended that the original package designed for shipping the unit be reused. If it is not available, contact Powerwave's Customer Service Department at 1-800-797-9283, +1-714-466-100 or by e-mail at support@pwav.com for packing material.

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# Chapter 5 Specifications

## Introduction

This chapter provides specifications for the WRH-V.

Table 5-1 WRH-V Specifications

| <b>Electrical</b>                              |  |
|--|--|
| Frequency band UL                              | 824 to 849 MHz (Cellular)<br>806 to 824 MHz (800 iDEN)<br>880 to 915 MHz (GSM 900)<br>896 to 901 MHz (900 iDEN)<br>1710 to 1785 MHz (GSM 1800)<br>1850 to 1910 MHz (PCS)<br>1920 to 1980 MHz (UMTS)<br>1710 to 1755 MHz (AWS 2100)   |
| Frequency band DL                              | 869 to 894 MHz (Cellular)<br>851 to 869 MHz (800 iDEN)<br>935 to 940 MHz (GSM 900)<br>925 to 960 MHz (900 iDEN)<br>1805 to 1880 MHz (GSM 1800)<br>1930 to 1990 MHz (PCS)<br>2110to 2170 MHz (UMTS)<br>2110 to 2155 MHz (AWS 2100)  |
| Max absolute delay                             | <300 ns  |
| Gain adjustment range (in 1 dB steps)          | 30 dB  |
| <b>Gain</b><br>Uplink<br>Downlink<br>Variation | 35 to 60 dB typical - Excluding fiber link<br>45 to 70 dB typical - Excluding fiber link<br>± 1.5 dB versus temperature including fiber link<br>± 1.5 dB versus DL frequency including fiber link<br>± 0.5 dB versus DL output power including fiber link<br>± 0.5 dB versus input voltage including fiber link<br>± 2.0 dB versus UL frequency including fiber link |
| Instantaneous bandwidth                        | 25 MHz (Cellular)<br>18 MHz (800 iDEN)<br>35 MHz (GSM 900)<br>5 MHz (900 iDEN)<br>75 MHz (GSM 1800)<br>60 MHz (PCS)<br>60 MHz (UMTS)<br>45 MHz (AWS)   |
| Uplink AGC limit                               | 0 dBm at FON input   |
| Downlink AGC limit                             | 43 dBm at antenna port   |
| Return Loss                                    | 11 dB  |

Table 5-1 WRH-V Specifications (Continued)

|   |  |
|---|--|
| Downlink, Spurious and Emissions level  | -13 dBm/1 MHz (FCC)<br>-36 dBm (below 1 GHz, per ETSI EN 300 609-4)<br>-30 dBm (above 1 GHz, per ETSI EN 300 609-4)                        |
| Downlink power                          | +43 dBm RMS (20 Watts) (for FCC - UMTS)<br>+40 dBm RMS (10 Watts) (for ETSI - GMS/EDGE)  |
| Noise figure excluding fiber optic link | 4 dB   |
| Fiber-Optic Link Budget                 | 10 dBo   |
| Receiver input port return loss         | 14 dB  |
| Power supply voltage                    | 115/230 VAC<br>21-60 VDC   |
| Maximum Current Draw (Single Band)      | 6 A @ 115 VAC<br>3 A @ 230 VAC<br>15A @ 21-60 VDC  |
| Maximum Current Draw (Dual Band)        | 6 A @ 115 VAC<br>3 A @ 230 VAC<br>15A @ 21-60 VDC  |
| Recommended Fuse size<br>Single Band    | 10 A for AC voltage<br>20 A for DC voltage   |
| Dual Band                               | 20 A for AC voltage<br>40 A for DC voltage   |
| Power consumption                       | 210 W typical, 300 W max (Single band)<br>420 W typical, 600 W max (Dual band)   |
| <b>Impedance</b><br>Input<br>Output     | Not Applicable - Optical input<br>50 $\Omega$  |
| <b>Mechanical</b>                       |  |
| Dimensions (W x H x D in inches)        | 465 x 530 x 195 mm (18.3 x 20.9 x 8.3 in) incl. hinges (low cover)<br>465 x 530 x 310 mm (18.3 x 20.9 x 12.3 in) incl. hinges (high cover) |
| Weight                                  | <25 kg (55 lbs) low cover<br><44 kg (96 lbs) high cover  |
| Service Antenna port connector          | 7/16 DIN Female  |
| Donor Optical port connector            | FC/APC   |
| <b>Environmental</b>                    |  |
| Operating Temperature Range             | -25 °C to +55 °C (-13°F to +131°F)   |
| Altitude                                | -142 m to 4000 m (-466 ft. to 13100 ft.)   |
| Casing class                            | NEMA4/IP65   |
| <b>Fiber Optic Node (FON)</b>           |  |
| Bandwidth @ 3dB                         | 800 – 2200 MHz   |
| Power Consumption, total                | <5 W   |



Table 5-1 WRH-V Specifications (Continued)

|   |   |
|---|---|
| Wavelength  | TX: DFB 1310 or 1550 nm<br>RX: 1250 – 1600 nm |
| <i>Transmit</i><br>Max continuous RF input<br>Optical output power, two levels<br>RF attenuation settable by SW in 1dB steps<br>Max power at 1550 nm                      | +36dBm<br>+3 or 0dBm<br>0-20dB<br>3.46 mW     |
| <i>Receive</i><br>Max optic power input<br>RF attenuation settable by SW in 1dB steps<br>Alarm threshold level, settable warning<br>Alarm threshold level, settable error | +5dBm<br>4-24dB<br>0-40dBm<br>0-40dBm         |

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# Appendix A Block Diagrams

## Introduction

This appendix describes the main signals paths for the WRH.

## Non-Diversity

Figure A-2 shows the non-diversity block diagram configuration of the WRH-V. The WRH-V is always fed by a BTS via either a BMU or an OCM. The TX signal from the BTS is converted to an optical signal in a BMU or OCM and fed to the WRH-V via a fiber optic cable. The optical signal is then received by the FON and converted to an RF signal. The FON supervises the signaling and reports errors via the RCU connected to the CU.

The RF signal enters the WBA, is amplified, and further amplified in amplifier stages followed by controllable attenuators. The signal exits the WBA and enters the MCPA where it is amplified and fed to the DPX. The amplified output signal passes the DPX before it is fed to the service antenna.

The uplink signal path is located on the same WBA but goes through an LNA before entering the WBA.

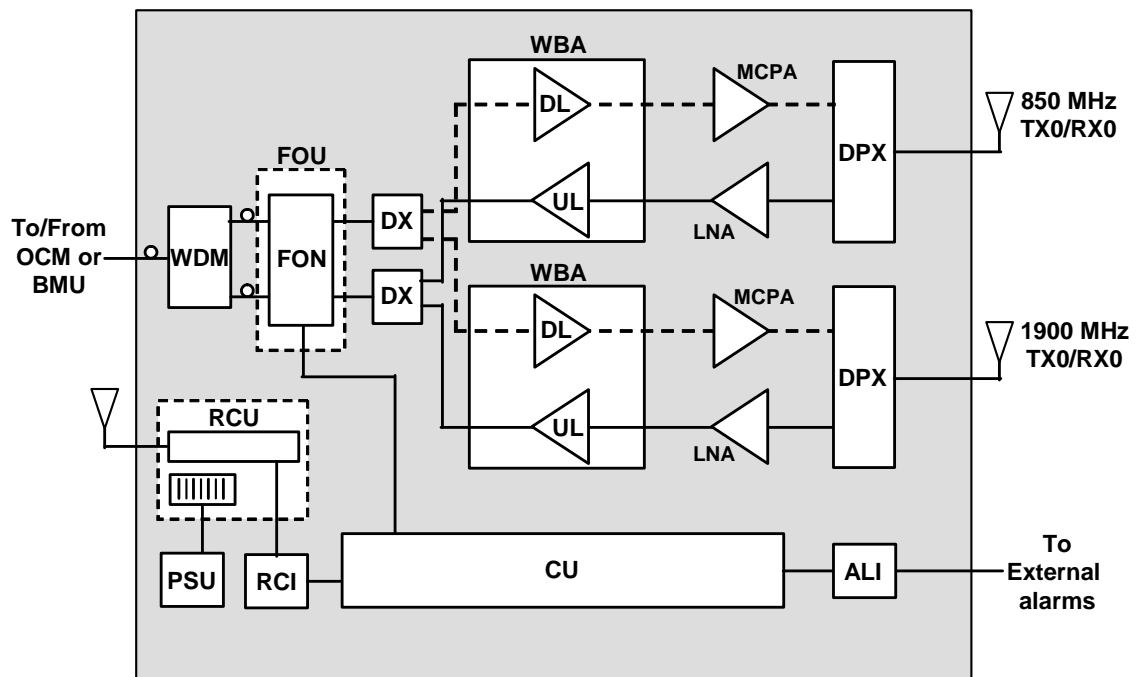


Figure A-1 WRH-V Block Diagram - Non-Diversity

### Diversity

Figure A-2 illustrates the diversity block diagram configuration of the WRH-V. With diversity installed, there are two paths on the UL instead of one. This requires an additional FON for the added receive path signal. Signal flow is identical to the non-diversity version with the MCPA on the DL and LNAs on the UL providing the additional amplification out of and into the WBA.

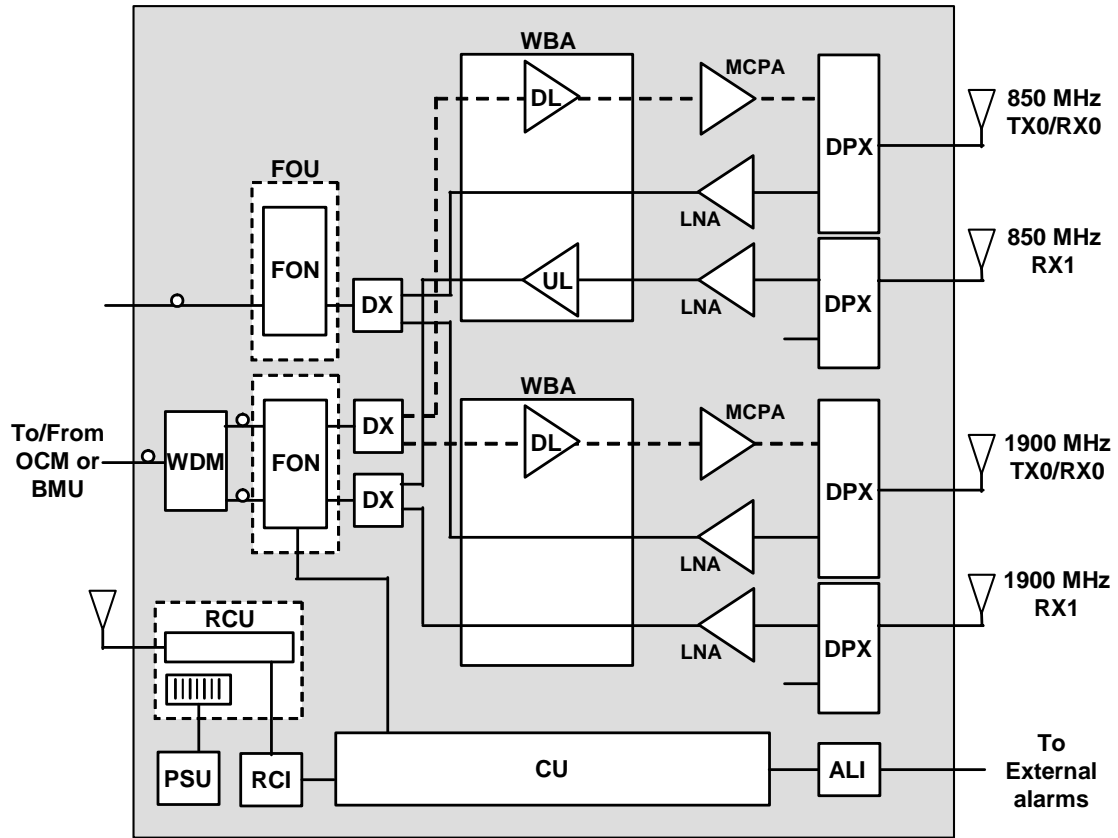


Figure A-2 WRH-V Block Diagram - Diversity