Horizon COMPACT™

Wireless Ethernet
Release 1.01.00

Product Manual - Volume 1
Version 1.2

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1.0 Introduction to Horizon Compact

DragonWave's Horizon Compact is a next-generation, high capacity, native Ethernet, microwave system offering improved economics and simplified operations. Featuring zero-footprint, the radio and the modem are integrated into one, single, compact, out-door-unit. Increased capacity (800Mbps); simplified installation and operation; and improved troubleshooting mean lower lifecycle costs. This highly integrated, carrier grade solution for Ethernet backhaul uses licensed or unlicensed spectrum.

Build your own network, easily and cost effectively. Connect fixed and mobile services to your network fast. Extend the reach of your network for Ethernet services and add on the additional capacity as you need it. Or, bring new Ethernet services to your high-capacity customers easily and cost effectively while optimizing your investment in legacy technology and facilities.

High Capacity Native Ethernet Wireless Gigabit Ethernet

Designed as an Ethernet platform from the ground up, the DragonWave Horizon Compact meets the critical needs demanded by carrier class customers delivering a wireless GigE/100bT connection of up to 800 Mbps full duplex over licensed or unlicensed frequency allocations. With a native Ethernet design and ultra-low latency, the Horizon Compact is optimized for next generation services.

Fixed and Scalable Bandwidth Operations

The Horizon Compact is a flexible bandwidth radio platform designed specifically for customers with rapid scalability requirements. The DragonWave Horizon Compact scales from 10 to 400 Mbps via a simple software configuration. For higher bandwidth needs, two radios can be polarization multiplexed on a single antenna using a Dual Polarity Radio Mount (DPRM) to provide up to 800 Mbps of capacity in a single link.

Zero-Footprint Option

The Horizon Compact is a single, outdoor, compact, weatherproof unit requiring no indoor space and is available with optical and electrical GigE interface options.

Enhanced Network Management

Horizon Compact fully supports remote management via in-band or out-of-band management, using SNMP (v3, V2c or V1), CLI and Web GUI. Security is a critical feature with SSH, SSL, and Radius.

Improved Reach

Horizon Compact enables bandwidth extensions over extended distances by providing up to 98 dB system gain in its standard power configuration, or up to 108dB in a high power configuration, both of which can support antennas sized up to six feet. This feature combination enables link lengths beyond 50 km/30 mi. In addition, DragonWave's dynamic modulation allows a link to be engineered to the highest availability, while maximizing throughput in good weather conditions.

Network Protection

Using DragonWave's Rapid Link Shutdown (RLS), Horizon Compact supports mesh and ring configurations with ~50 ms switching time, enabling 99.999% available carrier class services.

Product Features

11-38 GHz Frequency Support	High power variants
800 Mbps full duplex capacity	100ms Adaptive Modulation
Transparent Gigabit Ethernet solution	100ms Ring/Mesh Switching
Integrated RF Loopback	“Zero-footprint”, hardened outdoor unit

1.1 Applications

1.1.1 WiMax

DragonWave offers a high-capacity, carrier-grade, integrated solution for Ethernet backhaul using interference-free licensed spectrum. Horizon Compact enables rapid network expansion with remote scalability from 10 Mbps to 800 Mbps. With Horizon Compact the radio and modem are integrated into a single all-outdoor element attached directly to the antenna, allowing simple integration and eliminating any impact on the WiMAX base station footprint. Management integration into the base station EMS provides a single point of control for operations personal.

1.1.2 3G Cellular Backhaul / Ethernet Evolution

Meet the growing demand for increased capacity and data transport resulting from 3G cellular deployments. Horizon Compact provides Cost-effective, low capacity TDM services for base stations today. The DragonWave portfolio of products offers software controlled upgradeability to high-capacity native Ethernet and TDM services with ultra-low latency to enable 3G evolution with the minimum of network churn.

1.1.3 Leased Line Replacement

For many businesses, the only option for last mile access is the ILEC, provided on an aging copper infrastructure with long MTTR. Horizon Compact can replace leased services and eliminate recurring and expensive telecom Costs while at the same time improving service availability and enabling future growth and options for services with a scalable Ethernet network.

1.1.4 Last Mile Fibre Extension

The greatest demand for broadband services is within the core metro markets. Horizon Compact provides a superior complementary networking solution to rapidly extend high speed IP services from locations already attached to the service provider’s network. The DragonWave portfolio of products is ideal for network hardening, disaster recovery and applications that require legacy TDM services and carrier-grade, high capacity native Ethernet systems.

1.2 Technical Specifications

Frequencies

11 GHz	FCC/IC/ETSI/ITU
13 GHz	ETSI/AUS/NZ/ITU
15 GHz	IC/ETSI/AUS/NZ/MX/ITU
18 GHz	FCC/IC /ETSI/AUS/NZ/ITU
23 GHz	FCC/IC/ETSI/AUS/NZ/ITU/MX
24 GHz	UL FCC/IC/ETSI
24 GHz	DEMS FCC/IC
26 GHz	ETSI
28 GHz	FCC/ETSI
38 GHz	FCC/ETSI/AUS/NZ/MX

Mechanical

Radio/Modem (without antenna)
12 cm x 23.6 cm x 23.6 cm; 4.8kg
4.75 in x 9.3 in x 9.3in; 10.6 lbs
Antenna Wind Loading
112 kph (70 mph) Operational
200 kph (125 mph) Survival
Antenna Mount Adjustment
± 10° Az; ± 25° El

Payloads

Interface 1000/100/10 BaseT
Latency 100 BT
< 400μs, Typical < 200μs FastE
Latency GigE
< 200μs, Typical 120μs GigE
Frame Size
64 to 1600 Bytes, up to 9600 (GigE Mode)
Flow Control Yes (GigE mode only)
802.1p Yes – 8 levels served by 4 queues
802.1q Yes
Modulation Shifting
Current to Lowest ~100 mS

Power

Input -36 VDC to -60 VDC
Optional Adapter 110/240 VAC
Consumption (per link end)
20 Watts (LP) 47 Watts (HP)

Connections

Power -48V, PonE
Payload (+ Inband NMS) Shielded RJ-45 or optical LC
NMS (when out-of-band) Shielded RJ-45

Network Management (NMS)

Alarm Management
SNMP Traps, Enterprise MIB
NMS Compatibility
Any SNMP based network manager
SNMP v1, v2 and v3
Security 3 Level Authentication
EMS Web Based Management
System, SSL HTTP,SSH, Radius

Environmental

Operating Temperature
Standard Power (18-28 GHz) -40°C to + 50°C (-40°F to +122° F)
Humidity 100 % Condensing
Altitude 4500 m (14,760 ft)
Water Tightness: Nema4X, IP56 (directed hose test)
Operational Shock:
ETSI 300-019-1-4; 5g 11ms
Operational Vibration:
ETSI 300-019-1-4 Class 4m5, NEBS GR-63
Earthquake: NEBS GR-63

	Channel Bandwidth 50 MHz			Channel Bandwidth 40 MHz			Channel Bandwidth 30 MHz		
	Throughput Mbps	TX Power dB	RX Sensitivity dB	Throughput Mbps	TX Power dB	RX Sensitivity dB	Modulation scheme	TX Power dB	RX Sensitivity dB
QPSK	67	17/27	-81	54	17/27	-81	40	17/27	-82
16 QAM	110	14.5/24.5	-78	85	14.5/24.5	-78.5	64	14.5/24.5	-80
32 QAM	172	14/24	-73	132	14.5/24.5	-74	99	14.5/24.5	-75
64 QAM	216	12.5/22.5	-69	170	12.5/22.5	-70.5	128	12.522.5	-72
128 QAM	272	11/21	-66	218	11/21	-66.5	163	11/21	-68
256 QAM	323	11.5/21.5	-60						
256 QAM	372	9.5/19.5	-60	297	9.5/19.5	-60.5	223	9.5/19.5	-62

Modulation scheme	Channel Bandwidth 56/55 MHz			Channel Bandwidth 28 MHz			Channel Bandwidth 14 MHz		
	Throughput Mbps	TX Power dB	RX Sensitivity dB	Throughput Mbps	TX Power dB	RX Sensitivity dB	Throughput Mbps	TX Power dB	RX Sensitivity dB
QPSK				37	17/27	-83			
QPSK	65	17/27	-80	48	13.5/23.5	-82	24	13.5/23.5	-85
16 QAM	112	14.5/24.5	-77	72	13/23	-79	37	13/23	-82
32 QAM	217	11/21	-72	109	11/21	-75	47	13/23	-78
128 QAM	291	10.5/20.5	-66	144	10.5/20.5	-69	71	10.5/20.5	-72
256 QAM	386	9.5/19.5	-60	193	9.5/19.5	-63	95	9.5/19.5	-67

SP/HP shown for Tx Power
Throughput based on random frame size

Not all modes may be available in all channel sizes.
Preliminary data – may be subject to change

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2.0 Physical Description

Horizon Compact is an integrated Ethernet modem and microwave radio transceiver (11 through 38 GHz radio bands - see Appendix B - Frequency Tables for frequency bands supported in this release), housed in a rugged weatherproof housing. It is provided with two weatherproof connectors, Port 1 and Port 2. Port 1, copper 10/100/1000 Base-t, or optional optical interface, carries data and optional in-band management traffic. Port 2, copper 10/100/1000 Base-t, carries optional out-of-band management traffic only. When Port 2 is not in use, a weatherproof protective cap is used to seal the port.

A BNC style connector, with protective cap, is provided for obtaining field strength readings during the antenna alignment process. The output voltage is linear, giving 1 mV per dB values e.g. -30 mV = -30 dB. It is also used for providing a radio muting signal in system redundancy applications.

A high power variant is available, which requires a sun shield to meet temperature specifications.

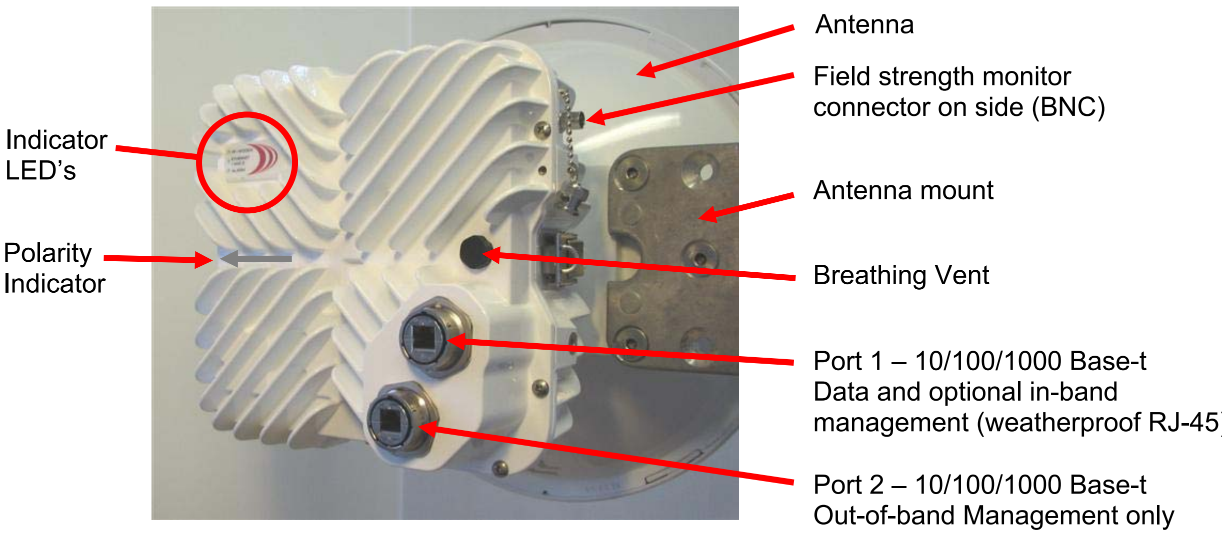

Figure 2-1 Horizon Compact - Copper Interface Variar

Figure 2-2 Horizon Compact LED indicators

Table 2-1
Horizon LED Operation

LED Status	Description
RF/Modem LED	
RED	Power ON, FPGA not ready.
Slow RED Blink	RF Transmitter OFF. Modem LOS
Steady GREEN/slow ORANGE blink	RF Transmitter ON. Modem LOS.
Steady GREEN	RF Transmitter ON. Modem OK.
Ethernet LED	
Copper Mode	
OFF	No link detected on either Ethernet port.
Slow Red Blink	Link detected on Out-of-band port (Port 2).
Steady Green	Link detected on Data port (Port 1).
Fast Green Blink	Link detected on both Out-of-band and Data ports.
Fiber Mode	
OFF	Transmit is disabled.
Steady Red	Transmit is enabled and no link is detected on either Ethernet port.
Slow Red Blink	Transmit is enabled and Link is detected on Out of band port (Port 2).
Steady Green	Transmit is enabled and a link is detected on Data port (Port 1).
Fast Green Blink	Transmit is enabled and link is detected on both Out of band and data ports.
Alarm LED	
Steady Green	No Alarms
Slow Red Blink	Alarm ON

2.1 Cabling

Both copper and optical interface cabling is supported.

2.1.1 Copper Interface

Two, weatherproof, RJ-45 Ethernet connectors provide data and management connections to the unit over CAT5E cabling. Ethernet cables **must** be wired for a straight through connection (see Section 3.0).

One connector (GigE – Port 1) is for data traffic and optional in-band management. Power (-36 to -60 V DC) is provided by an optional mains power adaptor and supplied to the Horizon Compact using Power on Ethernet (PonE) techniques, which incorporates both power and network transient suppression (See Section 7.1). CAT5E cable length is restricted to 90 metres.

The second connector (Port 2) is solely for an optional out-of-band management connection, using an overlay network. If Port 2 is not being used (e.g. in-band management being used), ensure that the vacant connector is sealed by fitting a weatherproof cap.

2.1.2 Optical Interface

A weatherproof, military specification, multi-pin, connector is provided for Port 2, which includes the power feed. Port 1 has a weatherproof optical fibre connector. Single mode and multimode fibre options are available. As with the copper variant, Port 1 supports data traffic and optional in-band management and Port 2 is for optional out-of-band management only.

In the optical variant, power (-36 to -60 V DC) is fed to Port 2 via a short ‘Y’ adapter cable, which also includes a weatherproof, in-line, RJ-45 connector for connecting to the optional out-of-band management overlay network. The power feed wires (see Table 2-2 for recommended gauge) are spliced into the adapter cable using weatherproof tap connectors. The power feed and Port 2 Ethernet cables (maximum length 100 m) are fed through a Transtector surge arrestor unit designed to protect power and network circuits from transients.

As an alternative, an existing AirPair ODU composite power and Ethernet cable assembly, which is compatible with the Horizon Port 2 connector, may be used, provided that the RJ-45 connector (grey CAT5) at the Transtector end is re-terminated to A T & T GigE standards. The same Transtector type used in an AirPair ODU installation may also be used.

Table 2-2 Port 2 Power Cable Wire Gauge

These values are true for all radio variants and based on a minimum voltage of 35 V DC at the Horizon.

Distance from Power Supply to Horizon Unit	50 m	100 m	200 m	300 m
Minimum wire gauge required (AWG)	20	16	14	12

Note that the power wires in the AirPair ODU modem composite cable are 16 AWG, which supports the maximum length (100 m) when out-of-band management is employed using the combined CAT5 cable.

2.2 Lightning Protection

The Horizon Compact is protected from cable transients and power surges caused by lightning, or other sources, by means of internal surge arrestor components and external housing grounding points (See Section 7.0). For the copper interface variant, protection of the connected network is provided by a proprietary DragonWave PonE power integrator/surge suppressor unit, into which the Ethernet cables are plugged. The power integrator/surge suppressor is located outside the network equipment enclosure, close to the network switch/router connection point.

The optical variant requires the power feed and the Port 2 management connection (if used) to be connected via a Transtector surge suppressor to protect power and network circuits.

2.3 Dual Polarity Radio Mount (DPRM)

The DPRM system allows two Horizon Compact units to be assembled to a single antenna. The antenna used is no different to that used for a single unit. One Horizon Compact unit is mounted for horizontal polarity and the other for vertical polarity. Both units can transmit and receive simultaneously. This allows a link to carry up to 800 Mbps of Ethernet traffic. Although both units can operate on the same frequency channels, with 30 dB isolation, it is recommended that different frequency channels be used for each unit.

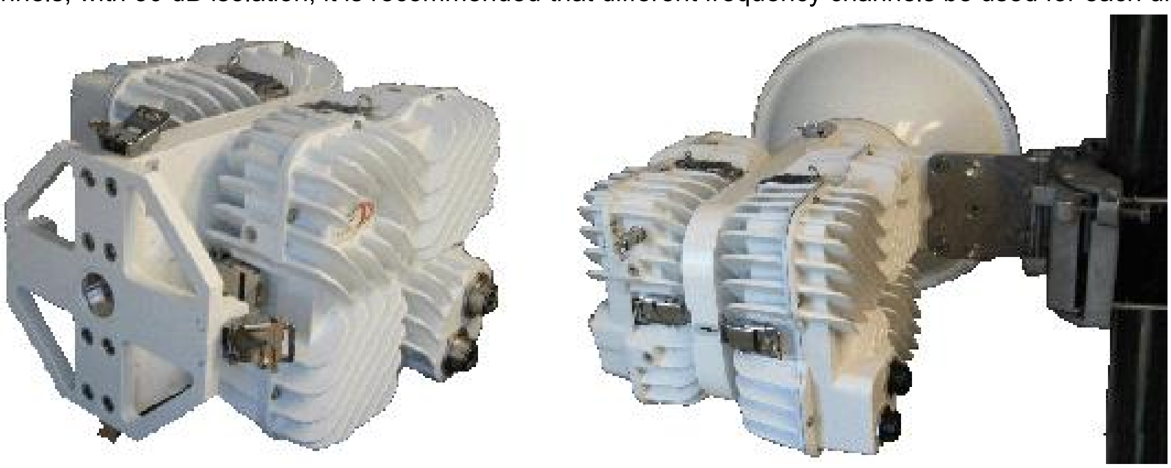

Figure 2-3 Dual Polarity Radio Mount

2.4 Power Switch Radio Mount (PSRM)

For redundancy purposes, the PSRM allows two Horizon units to be mounted to a single antenna. Both units must be oriented for the same polarity and only one unit can transmit/receive at any one time. The PSRM looks similar to the DPRM shown in Figure 2-3, but has internal components that only allow one unit to transmit/receive at a time.

Note that redundant systems do not have to use the PSRM. Each may be separately mounted to their own antennas if desired. See Section 10.13 for more details.

The benefits of the PSRM are that only one antenna is required, reducing tower real estate requirements, reducing weight and minimizing wind loading.

Disadvantages include a 4 dB loss in signal when operating on the primary systems at each end of the link and an 8.5 dB loss in signal when a secondary radio is activated (one end running on Primary and other end operating on secondary).

3.0 Installation Requirements

Various installation kits are available. Use the following key to build the desired kit part number:

CODE	DESCRIPTION
INK	Installation Kit
R1	Horizon Compact Release 1
CONNECTOR OPTIONS	
HCN	No Connectors or Cables
HCC	Copper Connectors, Out-of-Band Mgmt
HCI	Copper Connectors, In-band Mgmt
HCM	Military connector, Copper cables
HCF	Optical Fibre Interface
POWER OPTIONS	
AC	Alternating Current
DC	Direct Current
AD	½AC ½DC
LOCATION OPTIONS	
NA	North America
EU	Europe
GL	Global

Table 3-1 lists all the current ordering configurations, for various parts of the world

Table 3-1 Parts Required

Part Number	Kit Description
NORTH AMERICA	
A-INK-HCN-AC-NA-R1	Horizon Compact, No connectors, AC Install Kit
A-INK-HCN-AD-NA-R1	Horizon Compact, No Connectors Half AC, Half DC Install Kit
A-INK-HCC-AC-NA-R1	Horizon Compact, Copper Connectors AC Install Kit , 4 Glands and 8 Connectors
A-INK-HCC-AD-NA-R1	Horizon Compact, Copper Connectors Half AC, Half DC Install Kit , 4 Glands and 8 Connectors
A-INK-HCI-AC-NA-R1	Horizon Compact, Inband MGMT Copper Connectors AC Install Kit , 2 Glands and 4 Connectors
A-INK-HCI-AD-NA-R1	Horizon Compact, Inband MGMT Copper Connectors Half AC, Half DC Install Kit , 2 Glands and 4 Connectors
EUROPE	
A-INK-HCN-AC-EU-R1	Horizon Compact, No Connectors AC Install Kit
A-INK-HCN-AD-EU-R1	Horizon Compact, No Connectors Half AC, Half DC Install Kit
A-INK-HCC-AC-EU-R1	Horizon Compact, Copper Connectors AC Install Kit , 4 Glands and 8 Connectors
A-INK-HCC-AD-EU-R1	Horizon Compact, Copper Connectors Half AC, Half DC Install Kit , 4 Glands and 8 Connectors
A-INK-HCI-AC-EU-R1	Horizon Compact, Inband MGMT Copper Connectors AC Install Kit, 2 Glands and 4 Connectors
A-INK-HCI-AD-EU-R1	Horizon Compact, Inband MGMT Copper Connectors Half AC, Half DC Install Kit , 2 Glands and 4 Connectors
GLOBAL	
A-INK-HCN-DC-GL-R1	Horizon Compact, No Connectors DC Install Kit
A-INK-HCC-DC-GL-R1	Horizon Compact, Copper Connectors DC Install Kit , 4 Glands and 8 Connectors
A-INK-HCI-DC-GL-R1	Horizon Compact, Inband MGMT, Copper Connectors DC Install Kit, 2 Glands and 4 Connectors

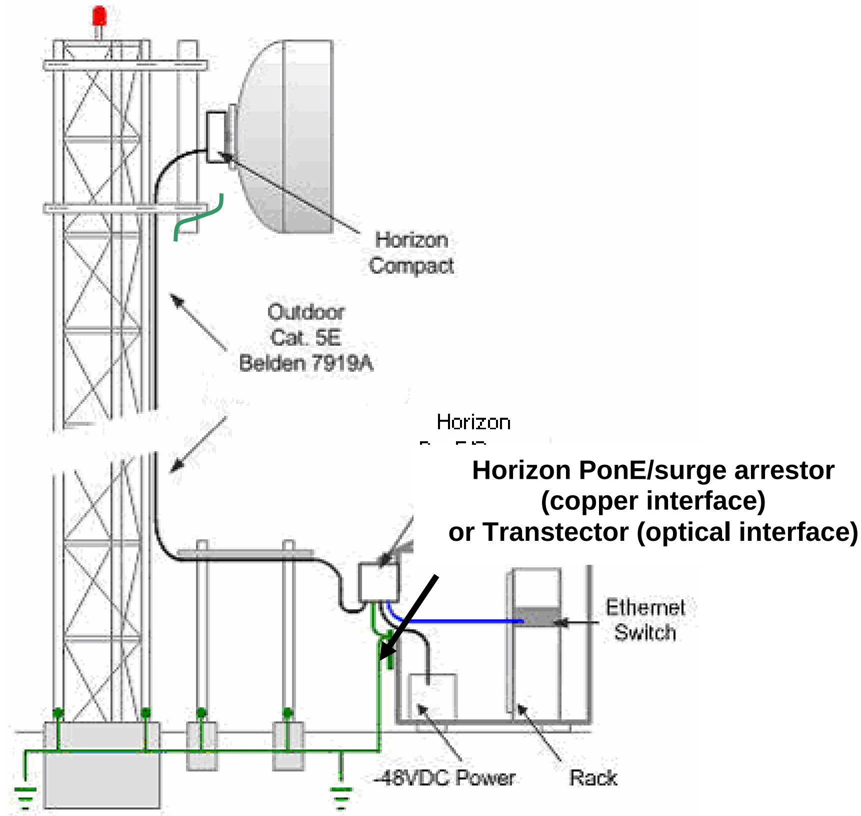

Figure 3-1 Horizon Compact Installation

3.1 Ethernet Cabling from Horizon to Ethernet Switch

For the copper interface, data cabling from the Horizon unit to the Ethernet switch consists of outdoor rated, shielded, Cat5E cables equivalent to Belden 7919A. The shielded cables require shielded RJ-45 connectors. Use of standard indoor unshielded RJ-45 connectors may result in poorly constructed cables, intermittent connections and data loss.

If Port 2 is not being used, ensure that a protective weatherproof cap is fitted to the port receptacle.

The cables terminate in a Horizon Power on Ethernet (PonE) unit located outside of the building entry point.

Note: Straight through Ethernet cables must be used between the PonE adapter and the Horizon. The use of a cross-over type will result in damage to the Horizon Compact unit.

The PonE unit contains surge arrestors and must be grounded according to local or regional Electrical Codes. Ethernet cables are connected between the PonE unit and the Ethernet switch or router.

Power for the PonE unit is supplied by 2-wire 16 AWG electrical wiring, carrying 48 vDC (-48 v or +48v) with a maximum current draw of 2 amperes.

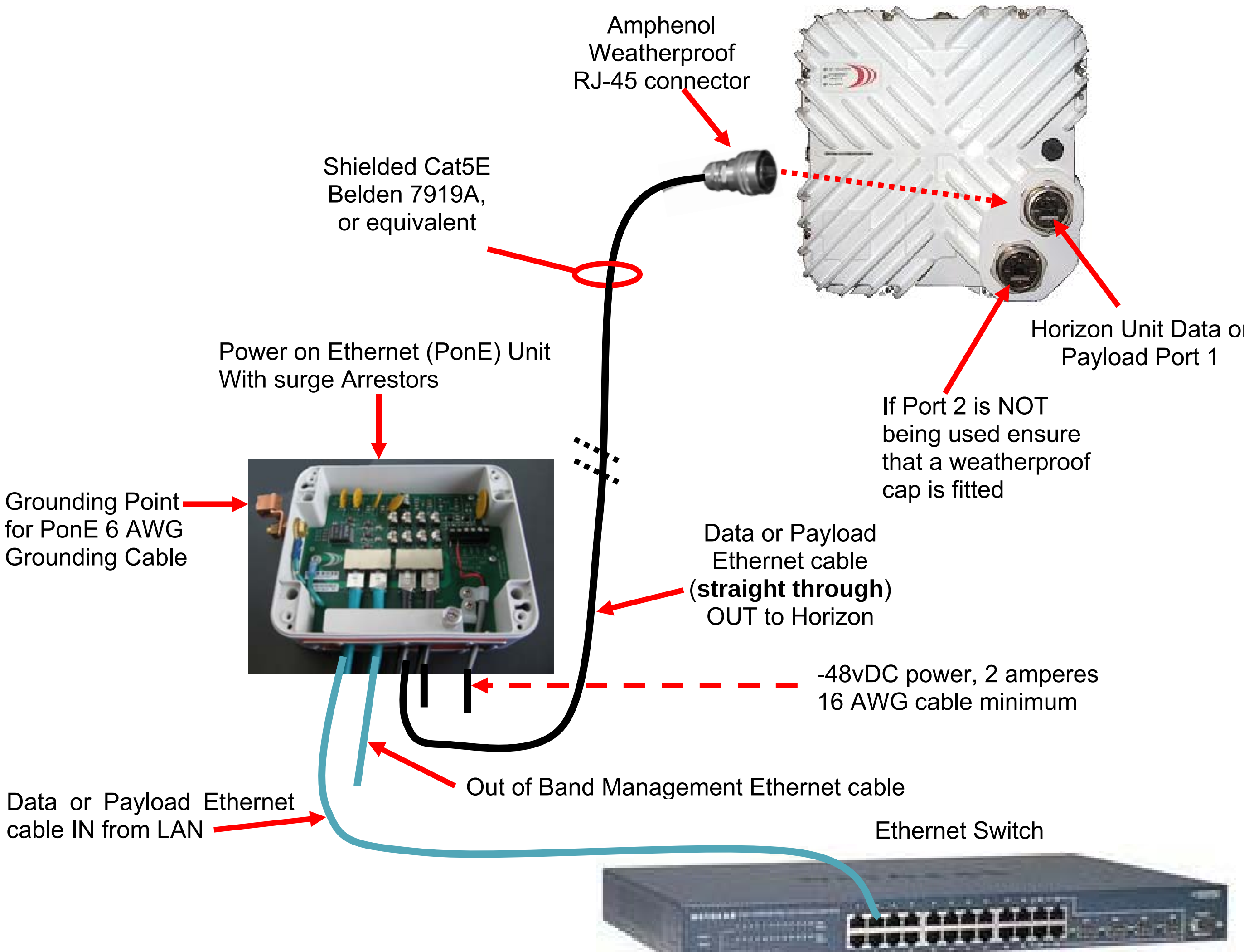

Figure 3-2 PonE and RJ-45 Connections for Horizon

3.2 Assembling the RJ-45 Connector

Weatherproof RJ-45 connector shells are used for connecting the CAT5E cable, leading from the power-on-Ethernet power supply and network connections, to the Horizon Compact. Cables and connectors may be purchased from DragonWave or may be constructed or supplied by the customer.

Two different styles of connector have been used in production. For Horizon serial numbers ending in “999” or less, an RJ45 “snap in” type in-line housing is used. For serial numbers ending in “1000” or higher a “push fit” style is used. Both styles are not compatible and do not mate with the respective female connector on the horizon chassis.

3.2.1 “Snap fit” style

The connector shell must be assembled in a specific manner for it to correctly connect to the Horizon Compact unit. The CAT5E cable is terminated as a **straight through** connection with a shielded RJ-45 connector. This RJ-45 connector has to be assembled into the weatherproof connector shell oriented as shown in Figure 3-3.

CAUTION
Using a cross-over connection will damage the Horizon Compact. Only use straight through cable connections.

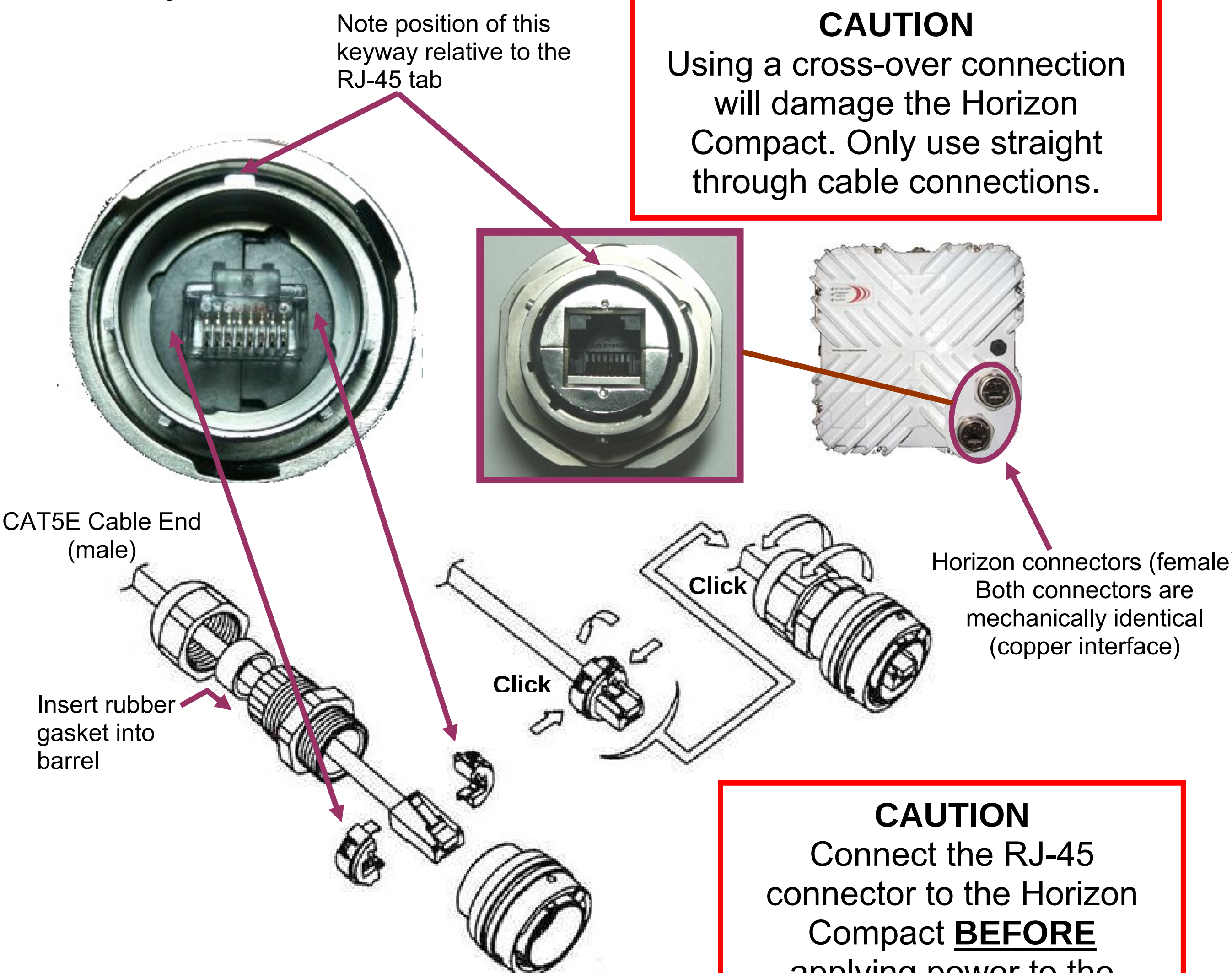

Figure 3-3 RJ-45 Cable connector “Snap fit” Style

CAUTION
Connect the RJ-45 connector to the Horizon Compact **BEFORE** applying power to the system at the PonE/surge unit. See 7.1 for more details.

3.2.2 “Push fit” style

This connector relies on a gland nut to hold the assembly firmly together. The CAT5E cable is threaded through all the components of the connector housing (see Figure 3-4) before the cable is terminated as a **straight through** connection with a shielded RJ-45 connector. Once terminated, the RJ-45 connector slides back into the connector housing which accepts the tab on the RJ-45 connector. Screw the ferrule into the connector housing as far as it will go, ensuring that the ‘O’ ring creates a tight seal with the connector housing. Slide the compression seal into the ferrule, noting that the keyways have to mate with channels in the ferrule. While ensuring that the RJ-45 connector is firmly seated in the connector housing, tighten up the gland nut to secure the complete connector assembly.

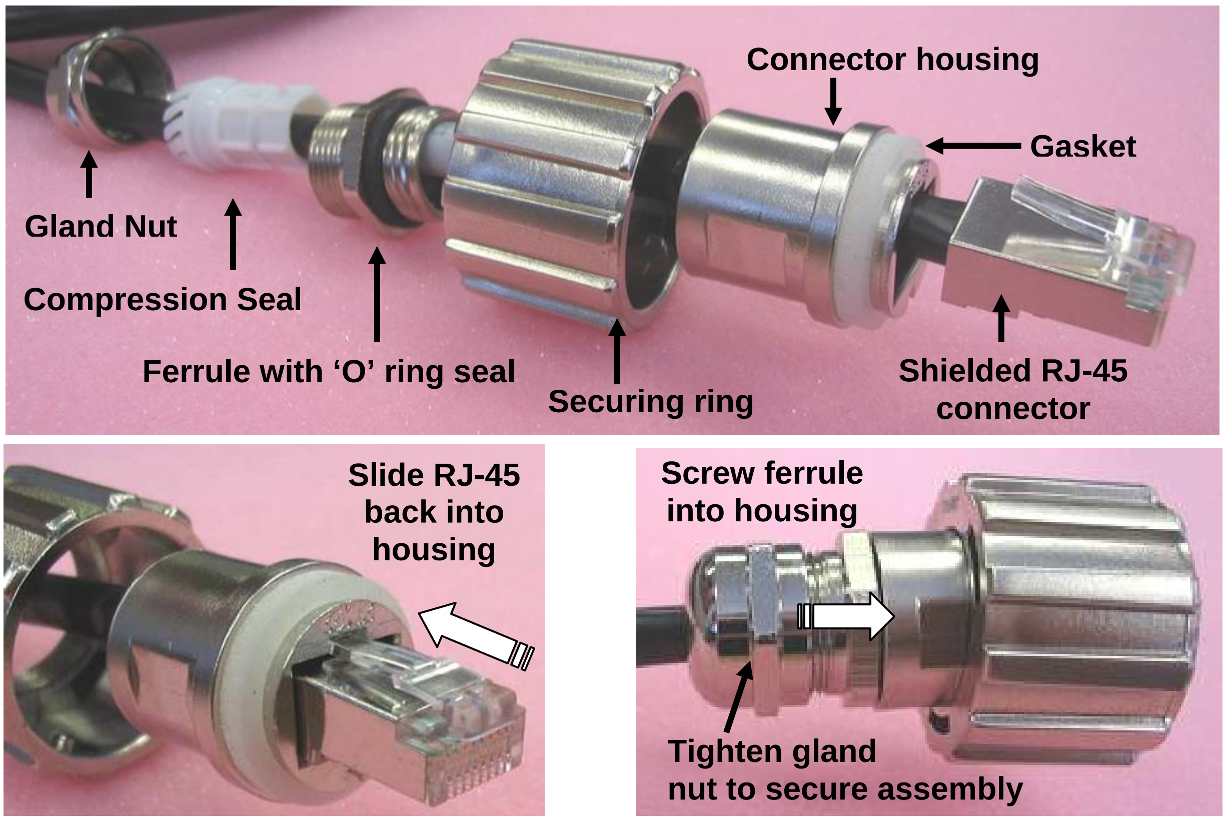

Figure 3-4 RJ-45 Cable connector “Push fit” Style

CAUTION
Using a cross-over connection will damage the Horizon Compact. Only use straight through cable connections.

CAUTION
Connect the RJ-45 connector to the Horizon Compact **BEFORE** applying power to the system at the PonE/surge unit. See 7.1 for more details.

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4.0 Powering the Horizon Compact

Before an active management session can be started on the Horizon Compact, power needs to be provided to the unit. **Read this section completely before applying power to the Horizon Compact.**

4.1 Copper Interface

The Horizon Compact with copper interface receives its power over the Ethernet connection to Port 1 using a DragonWave proprietary technique. To integrate the power onto the Ethernet cable requires the use of the DragonWave Power on Ethernet (PonE) adapter. The DragonWave PonE adapter also includes transient and surge suppression components to protect the power supply and network from lightning induced surges and transients.

Note: The Horizon PonE implementation is proprietary and does not follow IEEE standards.

CAUTION
Only use a straight-through Ethernet cable to connect the Horizon to the PonE/surge unit.
Do not use a cross-over Ethernet cable otherwise damage to the Horizon will result.

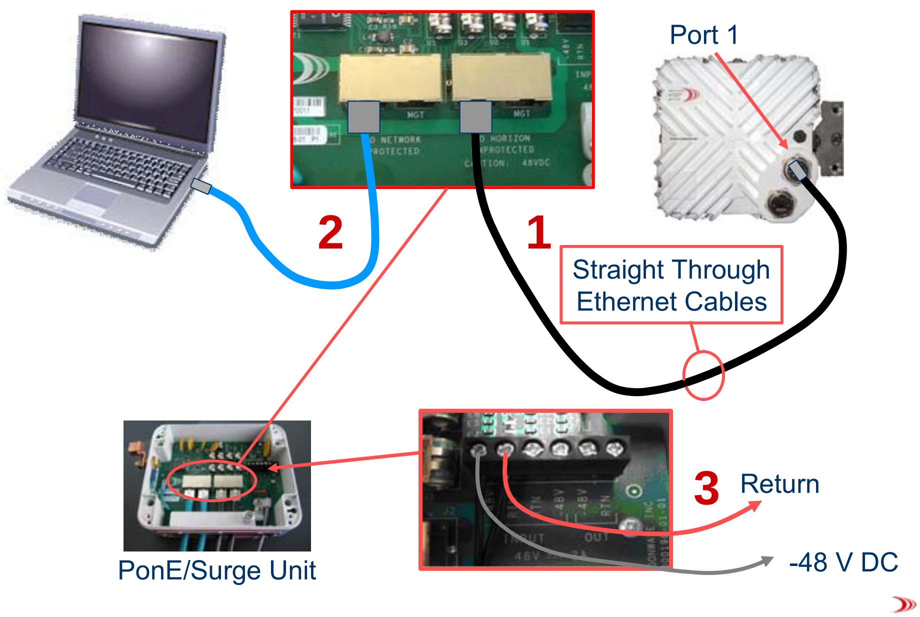


Figure 4-1 Connecting Power to the Horizon Compact – copper interface

CAUTION Connect the Horizon Compact unit to the PonE adapter correctly BEFORE turning on power.

1. Connect Port 1 of the Horizon Compact to the correct socket on the PonE adapter using a straight through Ethernet cable (see caution above).
2. Connect the Ethernet port on the PC to the network input socket on the PonE/surge unit, using a straight through Ethernet cable.

Ensure that you have connected the PC and Horizon to the correct RJ-45 sockets on the PonE/surge unit (see diagram above).

3. Once the PC and Horizon Compact are connected to the PonE/surge unit, you may connect power to the PonE/surge unit. This will supply power to the Horizon Compact unit.

CAUTION Do not connect a PC or other network device (e.g. network switch) to the right hand RJ-45 sockets on the PonE adapter. -48 V DC is present on these connectors which may destroy the connected device. Connect only a Horizon Compact unit to the right hand RJ-45 connectors.

4.2 Optical Interface

In the copper interface version, power is fed to the Horizon using PonE techniques via the Ethernet connection to Port 1. In the optical version, this is not possible, so power is fed via the connection to Port 2. Port 2 on the optical interface variant is equipped with a weatherproof MIL style multi-pin connector, which incorporates an Ethernet connection and a power feed (NOT PonE) connection. Connection to Port 2 is achieved using a short 'Y' adaptor cable, having an RJ-45 connector on one leg, and power tails on the other. The Ethernet connection to Port 2 provides for optional out-of-band management and the power tails allow a power feed to be spliced into circuit. Note that the Ethernet connection and power feed to Port 2 must be fed via a Transtector unit to protect the network and power systems from transients.

As an alternative, an existing AirPair ODU composite power and Ethernet cable assembly, which is compatible with the Horizon Port 2 connector, may be used, provided that the RJ-45 connector (grey CAT5) at the Transtector end is terminated as shown in Figure 4-3. The same Transtector type used in an AirPair ODU installation may also be used.

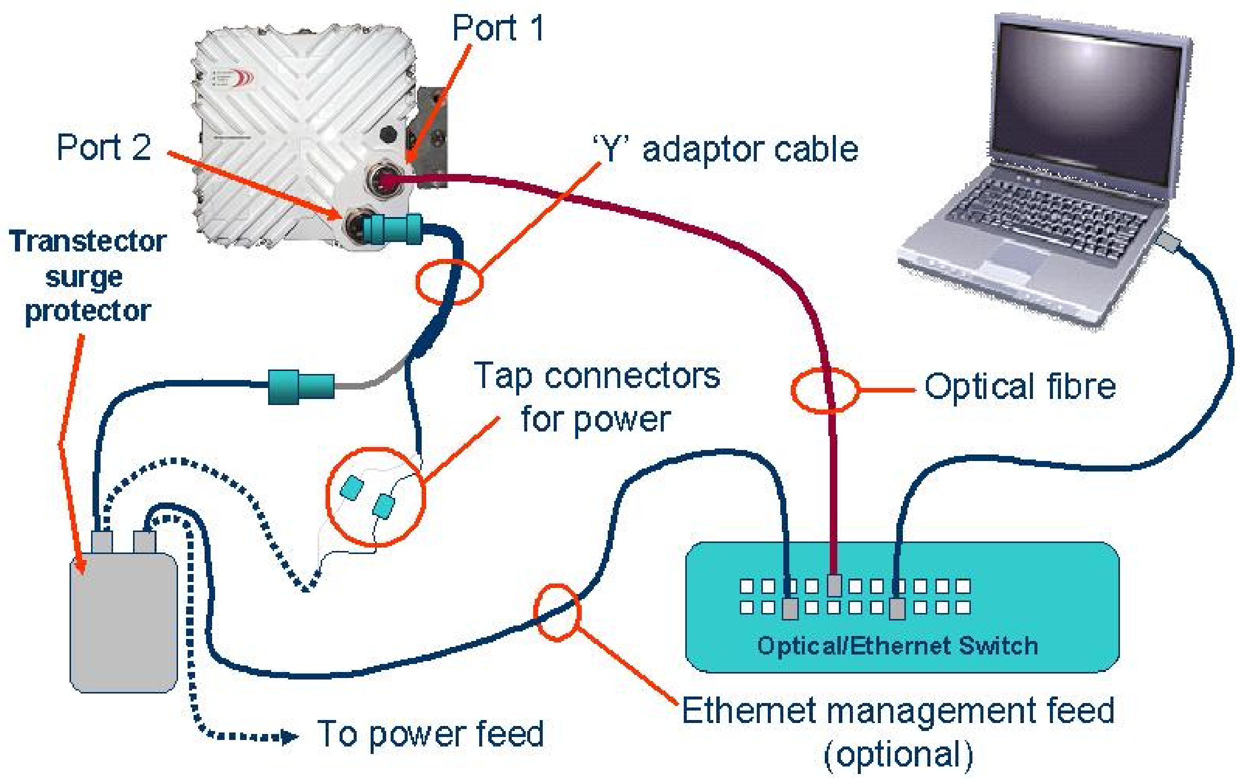
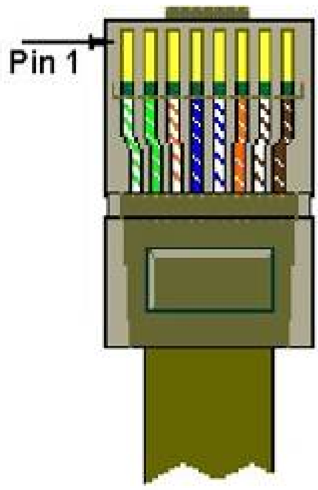


Figure 4-2 Connecting Power to the Horizon Compact – optical interface



1000BaseTx – RJ-45 pinout		
Pin	**Signal**	**Color**
1	TP0+	White/Green
2	TP0-	Green
3	TP1+	White/Orange
4	TP2+	Blue
5	TP2-	White/ Blue
6	TP1-	Orange
7	TP3+	White/Brown
8	TP3-	Brown

Figure 4-3 RJ-45 connector pinout – Port 2 management

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5.0 Initial Configuration

There are a number of configuration steps that need to be carried out before the Horizon Compact can become operational. It is recommended that these steps be performed prior to mounting the system on the tower. These steps relate to:

- radio bands
- frequency channels
- IP address information

Once this information has been correctly entered, the Horizon Compact system is ready for installation and system alignment.

The Horizon Compact can be configured using Telnet or the Web interface.

Before attempting to log on you must configure the network parameters of your laptop, or PC, so that they are in the same domain as the Horizon Compact default IP address and subnet mask values.

By default, the IP address of a Horizon Compact system is 192.168.10.100 and the subnet mask is set to 255.255.0.0. Use this IP address to communicate with the unit, using either Telnet or the Web browser. A complete set of CLI commands is available for use with Telnet (See Appendix A).

For the copper interface, connect your laptop or PC Ethernet port to Port 1 (GigE port) on the Horizon Compact using a straight through Ethernet cable. For the optical interface, you will need to connect your PC to Port 1 of the Horizon via an optical switch. By default the management option is set to “inband”, which will allow management through the Port 1 data port.

Note: If the management interface type happens to be set to “out-of-band”, management through Port 1 (GigE port) will not be possible. In this case connect your laptop or PC to the Horizon Compact via Port 2. In both copper and optical Horizon variants, Port 2 has a copper interface.

5.1 Logging On

Secure management access to the Horizon Compact is controlled by a user name and password. The default Super User name is “**energetic**” and the default password is “**wireless**”.

Note: The Super User name (and other users) and password can be changed, but it is recommended that they are not changed until the radio link is properly configured, aligned and capable of carrying traffic. User accounts can only be changed using Telnet access.

5.1.1 Using Telnet

From the DOS Command Prompt, or from the Windows Run option, type:

telnet 192.168.10.100 and press Enter.

When the Telnet window appears press Enter again to reveal the logon prompt.

When prompted, enter the Super User name “energetic” and password “wireless”.

Successful logging on is indicated by the CLI cursor (->) being displayed.

Note that after 10 minutes of inactivity, you will be automatically logged off the system.

5.1.2 Context Sensitive Help

Full context sensitive help is available for all CLI commands. Type ***?*** followed by a partial command to return a list of all commands that match the entry, with an explanation as to how each command is used. Type a command followed by ***?*** to return a list of all variants of that command. See Appendix A – List of CLI Commands for an alphabetical list of CLI commands.

5.1.3 Using the Web interface

The Horizon Compact Web interface is disabled by default. You must use Telnet to enable the Web interface by issuing the CLI command ***set web server on*** press Enter.

Open a Web browser and, in the “Address” or URL field at the top of the page, enter the IP address of the Horizon unit (default is 192.168.10.100) and press Enter. If your laptop or PC has been correctly set up, you will be prompted for the user name and password. Type in the default Super User name “energetic” and password “wireless”. The Horizon Compact Home Web page will be displayed.

5.2 Configuring Radio Band and Frequency Channels

Both Horizon Compact units in a system (near and far end) have to be configured with the same radio band. The radio band selected must match that for which the Horizon Compact units have been manufactured. Only those radio bands for which the radio can be configured are available for selection. The radio band will also be dictated in the wireless licensing documents.

Typical radio band configuration selections have the format “fcc18b”, “ic23a” etc.

The Horizon Compact units at each end of the link have different frequency banks allocated to them. One unit will be allocated the “LOW” bank and the other the “HIGH” bank. This is indicated on the label attached to each unit (LOW or HIGH). Wireless licensing documents will indicate at which end of the link each should be located. The radio part number, that is stored in the system, determines if it is a LOW or HIGH unit and automatically configures the correct frequency bank for each unit.

Note that Horizon Compact units designed to operate at unlicensed frequencies have the same type of radio at each end of the link and do not have a LOW or HIGH indication on their labels.

Each bank contains a number of frequency channels, of which only one will be selected. Once again the actual frequency channel will be dictated in the wireless licensing documents.

You also need to configure the system mode (determines bandwidth and throughput parameters).

Use the following procedures to configure the radio parameters:

5.2.1 Using Telnet

1. Type the CLI command: ***get radio band*** and press Enter. The system will respond with the currently configured radio band and a list of all supported radio bands
2. Type the CLI command: ***set radio band <radio band>*** and press Enter, where ***<radio band>*** is the required radio band
3. Type the CLI command ***get system mode*** and press Enter. The system will respond with the current mode plus a list of allowable modes for the selected radio band.
4. Type the CLI command ***set system mode <Horizon mode>*** and press Enter. The mode follows the format of hc< channel bandwidth >_< speed >_<modulation>. For example, for a 50 MHz channel bandwidth with average Horizon speed of 110 Mbps using 16QAM modulation, enter ***set system mode hc50_110_16qam***
5. Type the CLI command ***get system speed*** and press Enter. The current system speed will be displayed. This, by default, will be the maximum speed supported by your purchased licensed speed key. Note that the mode configured in step 4 will determine the speed available to the system and cannot exceed the licensed speed, regardless of the mode selected.
6. To reduce the throughput speed to a figure less than the licensed speed, use the CLI command ***set system speed <speed>,*** where<speed> is in Mbps and can be adjusted in 1 Mbps increments.
7. Type the CLI command ***get frequency bank*** and press Enter. A list of frequencies is displayed.

8. Locate the frequencies on the displayed list that match those found on the wireless license documents, and note the index number/letter on the left of the list (case sensitive)
9. Type the CLI command ***set programmed frequency <index number/letter>*** and press Enter, where ***<index number/letter>*** is the same as that found in step 8
10. Type the CLI command ***save mib*** and press Enter. This command saves the entered information to memory, but does not yet apply it.

Note: You will need to issue the CLI command ***reset system*** to apply the changes and make them effective. Optionally, this can be left until all the initial configuration parameters have been entered before issuing the command (See 5.3.1 step 5).

5.2.2 Using the Web interface

1. From the Home page select the "Configuration" menu option and then select the "Frequency and port configuration" option
2. Use the drop down menus on the Web page for entering or changing the radio band and the programmed frequency. The frequency bank "txLow" or "txHigh" will be pre-determined (HIGH or LOW Horizon label)
3. Return to the "Configuration" menu and select the "System Configuration" option
4. Use the drop down menu to select the desired system mode
5. click on the "Save settings" button

Note: You will also need to click on the "Reset system" button to make these entries effective. Optionally, this can be left until **all** the initial configuration parameters have been entered before issuing the command (See 5.3.2 step 6).

5.3 Configuring IP Address Values

When shipped from DragonWave, the Horizon Compact is configured with a default IP address (192.168.10.100) and subnet mask (255.255.0.0). The default address is used to communicate with the Horizon Compact for initial configuration purposes, such as entering the IP address that the unit will have in the network to which it is to be connected. IP address information is entered in the following manner:

5.3.1 Using Telnet

1. Type the CLI command ***set ip address <nnn.nnn.nnn.nnn>*** and press Enter, where ***<nnn.nnn.nnn.nnn>*** is the desired IP address in standard format
2. Type the CLI command ***set subnet mask <nnn.nnn.nnn.nnn>*** and press Enter, where ***<nnn.nnn.nnn.nnn>*** is the desired subnet mask in standard format
3. Type the CLI command ***set default gateway <nnn.nnn.nnn.nnn>*** and press Enter, where ***<nnn.nnn.nnn.nnn>*** is the IP address of the default gateway in standard format
4. Type the CLI command ***save mib*** and press Enter. This command saves the entered information to memory, but does not yet apply them.
5. Type the CLI command ***reset system*** and press Enter, followed by "Y". This command resets the system and applies all the radio and IP changes just made. **Note that resetting the system disrupts traffic.**

Once the system has reset, you may not be able to communicate with it without changing your laptop or PC networking parameters to match the new IP address values programmed into the Horizon Compact.

Note that the ***reset system*** command is not always required when making configuration changes, but the ***save mib*** command is always required. Commands that require a reset system will be indicated on the screen.

5.3.2 Using the Web Interface

1. From the Home page select the “Configuration” menu option and then select the “IP configuration” option
2. Enter the IP address, subnet mask and default gateway values, using standard format, in their respective fields
3. Click on the “Submit” button
4. Click on the “Save settings” button
5. Click on the “Reset system” button

Once the system has reset, you may not be able to communicate with it without changing your laptop or PC networking parameters to match the new IP address values programmed into the Horizon Compact.

The system is now configured and capable of passing traffic once the Horizon Compact units are attached to antennas, mounted at each end of the link and aligned.

5.4 Recovery of IP Address and Serial Numbers

In the event that the Horizon Super User name and password, or IP address has been lost, forgotten, or misconfigured, you will need to contact DragonWave. DragonWave Technical Support will provide the Merlin recovery utility that, using a proprietary protocol, can recover the configured IP address parameters and/or reset the Super User name, Super User password and IP address parameters to the factory default values (energetic, wireless; 192.168.10.100, 255.255.0.0). In addition it reports the system serial number.

The Merlin utility runs on a PC running the Windows operating system and requires a one-time-use recovery key provided by DragonWave. Proof of ownership and proof of authority must be provided before the key will be issued. When Merlin is invoked, the Horizon unit responds with the required information, which is saved in a text file, located in the same directory as the Merlin application.

5.5 Changing and Adding User Names and Passwords

User account names and passwords can only be configured using a Telnet session. Only the Super User can change or add user account names or passwords. There are three user account levels as shown in Table 5-1

Table 5-1 User Account Levels

Account Level	Number of Accounts Available	Functionality
Super User	1	Super User account has control over the usernames and passwords for both the NOC and Admin accounts. Can create backup file of NOC and Admin accounts onto an FTP server, restore system settings and load new software
noc	5	NOC accounts allow full control over the configuration of the Horizon Compact system, including setting the frequency and IP address. NOC accounts may also backup the Horizon Compact system settings to an FTP server and restore the system settings from an FTP server. NOC accounts cannot create or change user accounts, or issue any security related commands (ex: set http secure access)
admin	50	Admin accounts allow operational management of the Horizon Compact system but have some restrictions for changes to configuration

No default noc or admin user accounts are configured when the Horizon Compact leaves the factory. Account names and passwords are case sensitive. There can be no duplication of names or passwords across all user levels. A password cannot be the same as a user name.

5.5.1 Changing the Super User Name and Password

It is recommended that the default Super User name and password be changed as soon as the Horizon Compact system is aligned and operational.

Note: When you change the Super User name and/or password, record the new values in a safe place. If you forget the new values, there is no way of retrieving them from the system. You will have to contact DragonWave to arrange a Super User reset (24 hour support number 613-271-7010, or support@dragonwaveinc.com).

To change the super user use the CLI command ***set super user*** and press Enter. Follow the prompts. When the new name and password have been accepted enter the CLI command ***save mib*** and press Enter. This will save the changes in non volatile memory. Failing to save the mib will result in changes being lost in the event of a power failure, or system reset.

5.5.2 Adding or Changing noc User Accounts

Up to five noc user accounts can be configured. Use the CLI command ***set noc user*** as shown in the following procedure:

Required Action	Steps
Create noc Login Accounts	Five noc (network operations center) accounts are available. The username and password cannot be the same value. Log in as the super user. View current account settings. Sequence: **get user accounts** press Enter The system responds: ** *ADMIN ACCOUNTS* ** *Index UserName Password* *1* *2* *3* ‘ ‘ *48* *49* *50* ** *NOC ACCOUNTS* ** *Index UserName Password* *1* *2* *3* *4* *5* *->* Create a new noc account: Sequence: **set noc user** press Enter The system responds: *Index:* Enter the <index #> where <index #> is from 1 to 5 and represents one of the 5 available accounts. The system responds: *UserName:*

Required Action	Steps
	Enter the desired username for this account. The system responds: *Verify UserName:* Re-enter the desired username for this account. The system responds: *Password:* Enter the desired password for this account. The system responds: *Verify Password:* Re-enter the desired password for this account. The system responds: *User Accepted:* If the usernames or passwords do not match the system will respond: *nak* Repeat for as many noc accounts as required. Save the settings. **save mib** press Enter The system responds: *MIB saved.* Note: the new account settings must be saved, otherwise they will be lost after the next system reset. The user must perform the save mib command in order to save the changes.

5.5.3 Adding or Changing Admin User Accounts

Up to 50 admin accounts can be configured. Use the CLI command ***set admin user*** as shown in the following procedure:

Required Action	**Steps**
Create Administrator Login Accounts	50 Administrator accounts are available. The username and password cannot be the same value. Log in as the Super User View current user account settings. Sequence: **get user accounts** press Enter The system responds: ** *ADMIN ACCOUNTS* ** *Index UserName Password* *1* *2* *3* ‘ ‘ *48* *49* *50* ** *NOC ACCOUNTS* ** *Index UserName Password* *1* *2* *3* *4* *5* *->* Create a new Administrator account: Sequence: **set admin user** press Enter The system responds: *Index:* Enter the <index #> where <index #> is from 1 to 50 and represents one of the 50 available accounts. The system responds: *UserName:* Enter the desired username for this account. The system responds: *Verify UserName:*

Required Action	Steps
	Re-enter the desired username for this account. The system responds: *Password:* Enter the desired password for this account. The system responds: *Verify Password:* Re-enter the desired password for this account. The system responds: *User Accepted:* If the usernames or passwords do not match the system will respond: *nak* Repeat for as many admin accounts as required. Save the settings. **save mib** press Enter The system responds: *MIB saved.* Note: the new account settings must be saved, otherwise they will be lost after the next system reset. The user must perform the save mib command in order to save the changes.

5.6 Logging Out

When accessing the system via Telnet, log out of the system by using the CLI command ***lo***.

When accessing using the Web browser, closing the browser will log you out of the system.

5.6.1 Session Time Out

After 10 minutes of inactivity, Horizon Compact units will automatically terminate the login session.

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6.0 Antenna Mounting and Tower Specifications

The Horizon Compact unit clip mounts onto a range of antennas, providing a variety of gain and range options. The same mounting system is used for all sizes of antenna.

The Horizon Compact has four, integral, spring loaded, mounting clips. The antennas are provided with four mounting lugs, onto which the mounting clips attach. The antenna port and the waveguide adaptor of the Horizon Compact, push fit together before the clips are set, and are weather-sealed with a lubricated ‘O’ ring located on the outside surface of the antenna port (lubricate with provided lubricant before assembling).

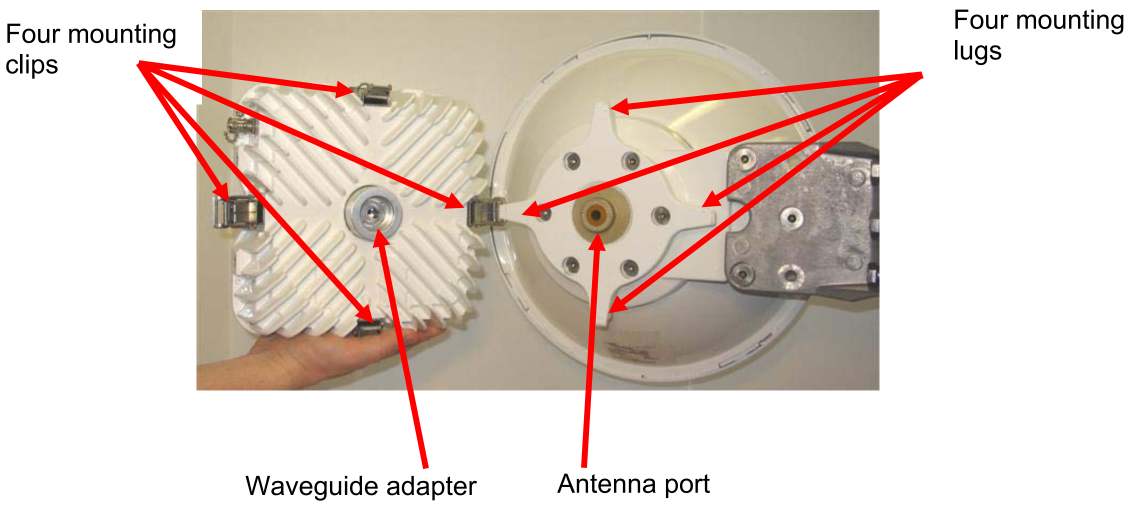

Figure 6-1 Horizon Compact showing clip mount features

6.1 Polarity

The radio frequency polarity is indicated by an arrow molded into the Horizon Compact housing. Attach the Horizon Compact to the antenna so that the arrow points either vertically or horizontally, as required, when the assembly is attached to the mounting post or tower. With the arrow horizontal (pointing to the left) – horizontal polarity; with the arrow vertical (pointing upwards) – vertical polarity. The required radio polarity is defined in your licensing documentation.

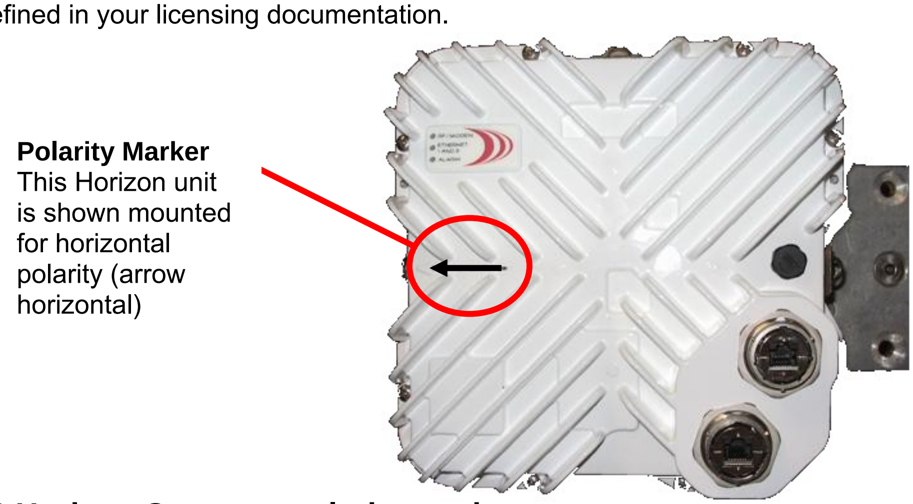

Figure 6-2 Horizon Compact polarity marker

6.2 Pole and Tower Specifications

It is important that mounting posts or towers used meet the DragonWave specifications for rigidity to minimize the effects of twist and sway on the alignment of the link. Note that the maximum twist and sway angle allowable is equal to half of the antenna beam width.

Table 6-1
Twist and Sway Specifications – Selected Frequencies

Frequency	Antenna Diameter	3 dB Beamwidth (degrees)	Maximum Twist and Sway (degrees)
18 GHz	30 cm/12"	3	+/- 1.5
	60 cm/24"	2	+/-1
	90 cm/36"	1.3	+/- 0.65
	120 cm/48"	1	+/- 0.5
23 GHz	30 cm/12"	2.7	+/- 1.35
	60 cm/24"	1.7	+/- 0.85
	90 cm/36"	1.1	+/- 0.55
	120 cm/48"	0.8	+/- 0.4

Table 6-2
Mounting pole specifications

Antenna Diameter	Steel Pipe Nominal Outside Diameter	Max. Distance Above Last Rigid Attachment Point
30 cm/12"	7.5 cm/3 "	90 cm/36"
30 cm/12"	10 cm/4"	120 cm/48"
60 cm/24"	7.5 cm/3"	75 cm/30"
60 cm/24"	10 cm/4"	90 cm/36"
75 cm/30"	10 cm/4"	75 cm/30"
90 cm/36"	10 cm/4"	(tower mount recommended)
120 cm/48"	10 cm/4"	(tower mount recommended)
180 cm/72"	11.5 cm/4.5"	(tower mount recommended)

Twist and sway caused by wind or human activity can cause a link to fail. Using poles with specifications shown in Table 6-2 will result in a stable mounting system. Systems with antenna sizes of 90 cm/36" in diameter and greater, are recommended to be mounted on towers.

7.0 Grounding, Power and Surge Arrestors

The Horizon unit must be grounded using a minimum of 6 AWG copper wire attached to any of the eight ground points available on the Horizon case, as shown in Figure 7-1.

Surge arrestors and lightning protection is built into the Horizon unit.

The Ethernet and PonE cables must be properly protected at the end of their run as they enter the building. Before Ethernet cables enter buildings, voltages shall be clamped down to SELV by approved type primary protectors.

For the copper interface option, proper use of the Horizon PonE unit provides lightning and surge protection for the connected network. The PonE unit shall be installed according to local Electrical Safety Codes.

For the optical interface, proper use of the Transtector unit protects the optional management Ethernet connection (if used) and the power supply.

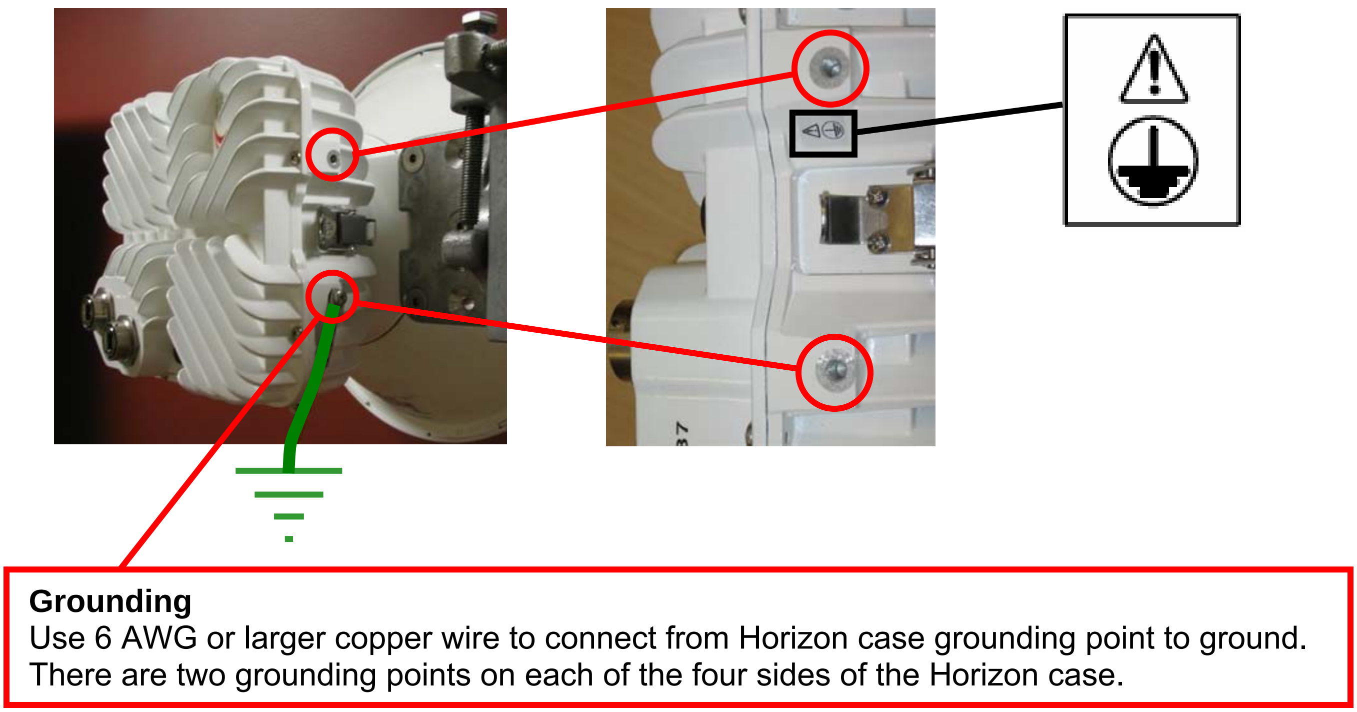

Figure 7-1 Horizon Compact case grounding point

7.1 Power on Ethernet (PonE)

The copper interface variant of Horizon operates on -48 VDC and employs a proprietary Power on Ethernet solution. The Horizon Power on Ethernet surge arrestor unit provides integration of -48 VDC and the two **straight through** Ethernet cables.

Note: The Horizon PonE implementation is proprietary and does not follow IEEE standards.

The surge arrestor uses RJ-45 connectors for the Ethernet cables and screw-terminals for the -48 VDC power connections. Dual -48 VDC power connectors are provided, allowing for the connection of redundant power supplies.

The surge arrestor unit contains protection against cable transients and power surges caused by lightning or other sources. The surge arrestor is installed at the opposite end of the Cat5E/PonE cables to that of the Horizon unit and protects the network.

To ensure adequate lightning protection, the PonE surge arrestor unit must be properly grounded.

CAUTION

Serious damage to network switches or routers can occur if the network is plugged into the connectors marked "TO HORIZON UNPROTECTED". Power is fed to the Horizon unit along the same wires that carry Ethernet traffic to the Horizon unit. Do not, under any circumstances, plug cables connected to the network into the RJ-45 connectors marked "TO HORIZON UNPROTECTED".

CAUTION

Only use straight through Ethernet cables to connect the PonE adapter to the Horizon Compact. Using cross-over cables will result in damage to the Horizon Compact unit.

CAUTION

Connect the Cat5E cables to the Horizon Compact BEFORE applying power to the PonE surge arrestor unit.

Horizon consumes a nominal 20 Watts (standard power), or 40 Watts (high power variant) from the -48 VDC supply. All eight of the wires in the Ethernet cable are used to carry power to the Horizon Compact unit. The Power on Ethernet surge arrestor unit is rated at 2 amps.

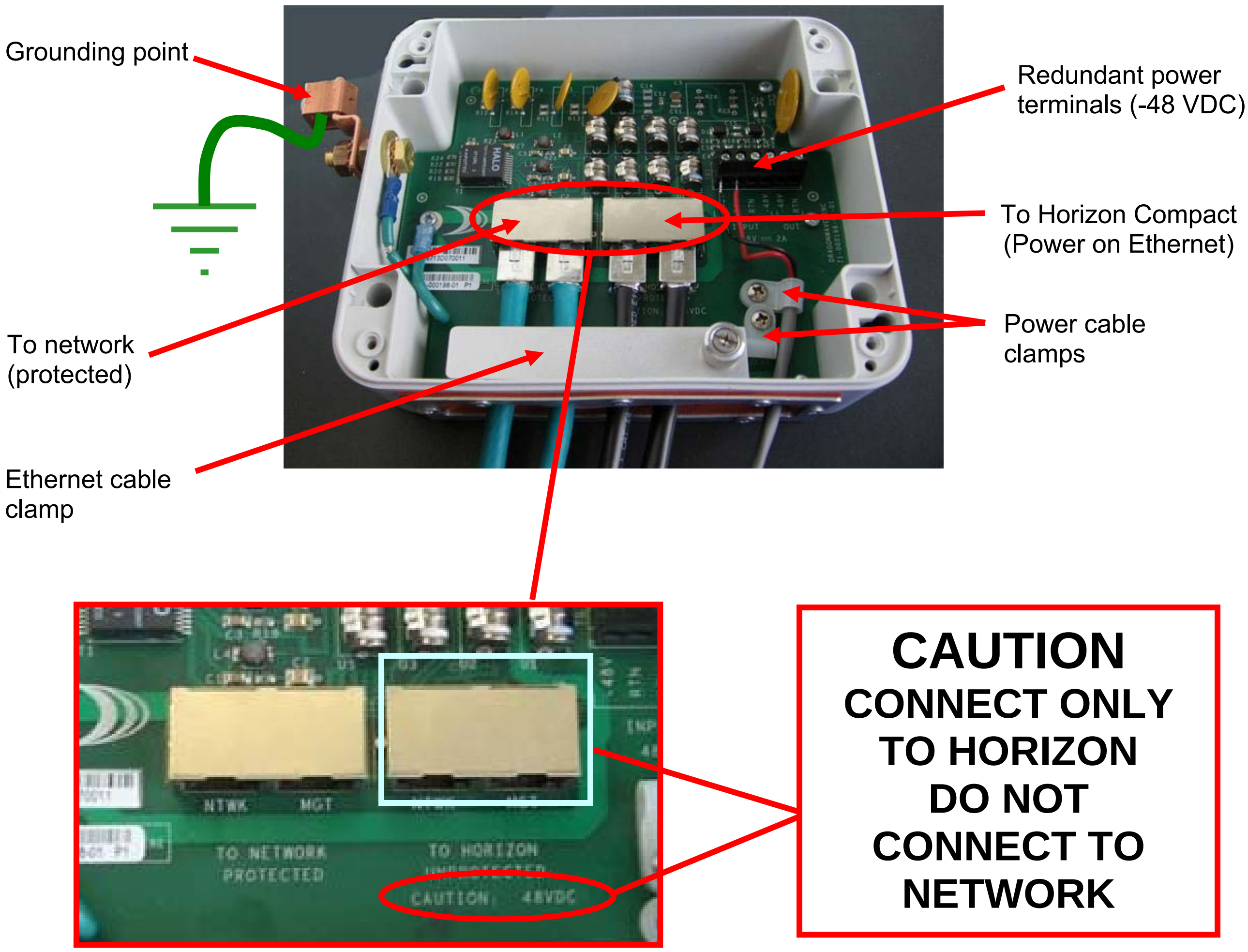

Figure 7-2 Surge arrestor and power integrator

Two different sized cable clamps are provided for the power cable. Select the one that best suits the size of cable being used.

The Ethernet cables are secured with a "bar" type clamp which is locked down using a single screw. Additional cable security can be added by applying cable clips to the cables, as close to the clamp bar as possible, as shown in Figure 7-3.

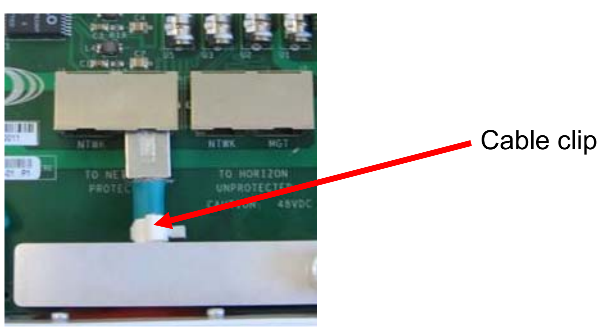

Figure 7-3 Ethernet cable clip

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8.0 Preparing for Alignment

The Horizon Compact and antenna assembly is attached to the mounting post, or tower, with a specialized mounting bracket that allows fine orientation adjustment of the Horizon/antenna assembly. The same mounting bracket is used for all antenna sizes.

Visual alignment is achieved by rotating the assembly on the post, or tower, and positioning the assembly so that the antenna is visually aligned with the target system before tightening the mounting bracket clamp. Final alignment is achieved using the azimuth and elevation adjustment bolts. Once alignment is achieved, the adjustment mechanisms are locked in place with lock nuts.

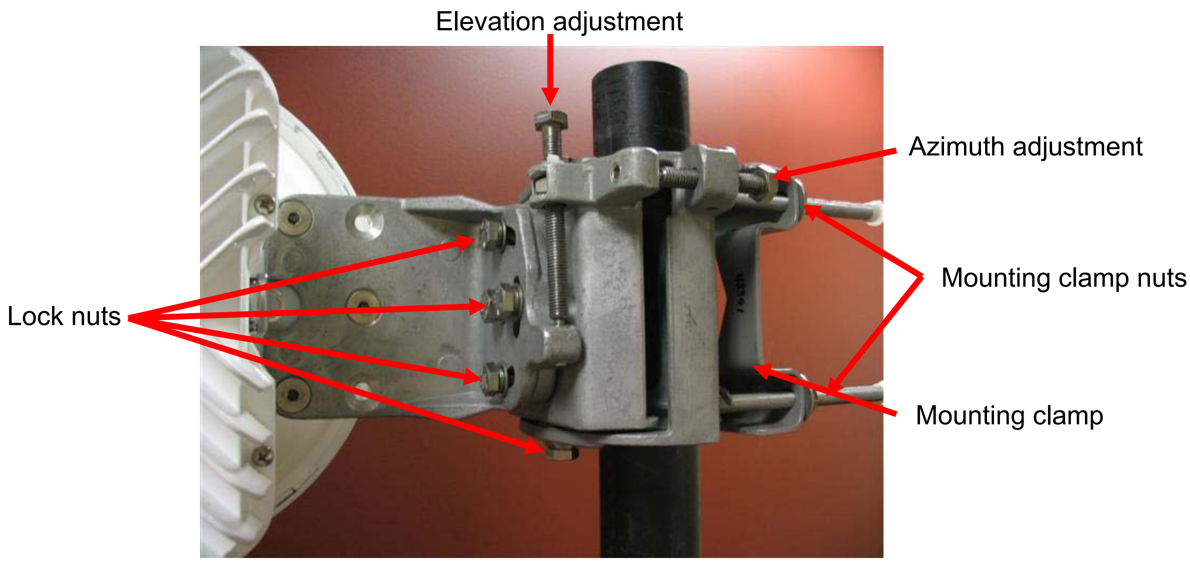


Figure 8-1 Mounting bracket with fine adjustment bolts

Final alignment is achieved by monitoring the received signal level (RSL) values as the system is adjusted for azimuth and elevation. The BNC Field Strength Monitor connection is used in conjunction with a voltmeter for RSL monitoring. See Section 8.1. Adjustments are made until the RSL value is at a maximum, which should be within ± 3 dB of the expected value (link budget figure).

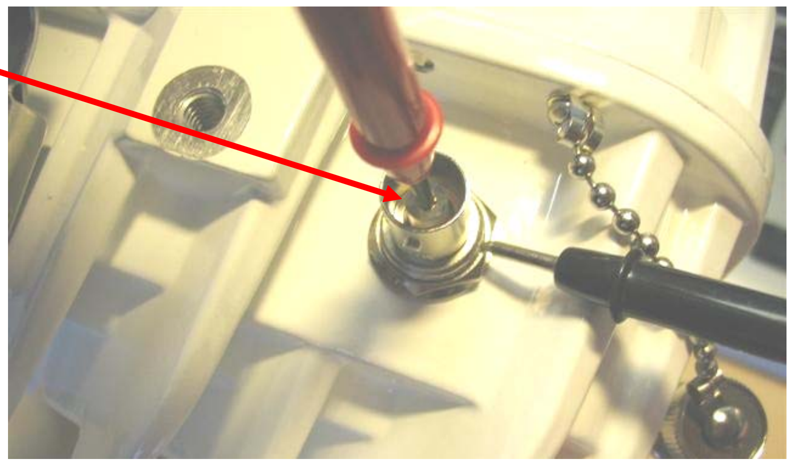
8.1 Received Signal Level (RSL) Measurements

To accurately align the Horizon Compact to its far end peer, you need to monitor the received signal level (RSL). There are two recommended methods for monitoring RSL. These are:

1. Use the CLI command ***set alignment on*** to activate the alignment feature at the BNC connector located on the side of the unit. Connect a voltmeter to the BNC connector. The voltage at this connector is linearly related to RSL and is 1 mV per dB e.g. -45 mV = -45 dB. Note that the centre connection on the BNC connector is positive, so to read negative values (to correlate with the negative RSL values) connect the negative pole of the voltmeter to the centre connection.

BNC field strength connector

Voltmeter probes connected to BNC connector



BNC to banana jacks cables are available from your voltmeter dealer, or can be constructed by the user.

Figure 8-2 Voltmeter connections to BNC field strength monitoring connector

2. Alternatively, readings can be made remotely via the Web interface, using the Tools – Link Alignment menu option. An operator would then have to continually relay RSL readings, via a radio or cell telephone, to the rigger adjusting the positioning of the system.

8.2 Three Important Factors

When you prepare to align the radio antennas, you must consider three important factors:

1. the radiation patterns of dish antennas (main lobe and side lobes)
2. the need for a Clear Line of Sight (LoS)
3. the sensitivity of the alignment adjustment

8.2.1 Antenna Radiation Patterns

The dish antennas used for the DragonWave Horizon Compact have high gains and very narrow beam widths, making antenna alignment a critical element of a successful installation. In addition to the main antenna beam, or lobe, there are often side lobes. Care must be taken to ensure that alignment is made to the main lobe and not onto a side lobe. If you align onto a side lobe, the RSL will be at least 20dB less than expected.

Table 8-1 Antenna Gains and Beam Widths – Selected Frequencies

Antenna Size	18 GHz Horizon		23 GHz Horizon	
	Beamwidth of main lobe (degrees, 3 dB)	Gain dBi	Beamwidth of main lobe (degrees, 3 dB)	Gain dBi
30 cm/12”	3.0 degrees	34	2.7 degrees	35.1
60 cm/24”	2.0 degrees	38.6	1.7 degrees	40.2
90 cm/36"	1.3 degrees	42.0	1.1 degrees	43.7
120 cm/48”	1.0 degrees	44.5	0.8 degrees	46.2

8.2.2 Clear Line of Sight (LoS)

The DragonWave Horizon Compact requires a clear LoS between the units at each end of the link. You must be able to see an unobstructed view of the antennas from each end. Avoid obstacles that are close to the LoS mid-way between antennas, but not blocking it, as this can have a negative impact on signal quality (Fresnel zone clearance). Also, ensure that antennas are mounted with adequate clearance from roof tops, roof edges, walls and other obstacles (e.g. air conditioning plant) to avoid problematic near field effects.

8.2.3 Alignment Adjustment Sensitivity

When aiming the antenna it cannot be over emphasized that you must rotate the adjustment nut(s) 1/10th of a turn at a time between taking RSL readings (allow time for the RSL reading to update). One full turn of the adjustment mechanism can move the antenna through 1.6 degrees azimuth or 2.2 degrees of elevation. Table 8-1 shows that the beam width of the typical antenna is often less than the amount of movement available with one full turn of the aiming adjustment.

9.0 Aligning the Antennas

Follow the steps of the alignment procedure shown below. **Note:** ensure that the CLI command ***set alignment on*** has been entered at both ends of the link if you are using the BNC connector to measure field strength.

At the first end:

1. Loosen the pan mechanism lock nuts
2. Pan or move the antenna horizontally across the entire range of adjustment to identify the main lobe and the side lobes. The main lobe is approximately 2 degrees in width (depends on frequency and antenna size). The two major side lobes are approximately 5 degrees apart. Adjust the antenna to the main lobe (approximately).
3. Tighten the pan mechanism lock nuts and loosen the tilt mechanism lock nuts.
4. Tilt or move the antenna vertically until you receive the strongest RSL reading.
5. Tighten the tilt mechanism lock nuts and loosen the pan mechanism lock nuts.
6. Pan or move the antenna horizontally to locate each of the lobes. Record the RSL values of each. Select the strongest RSL recorded and readjust the antenna to this strongest RSL reading.
7. Re-tighten the pan/tilt mechanism lock nuts to lock the antenna in place.

At the other end:

8. Repeat steps 1 through 7

Return to the first end:

9. Loosen the pan mechanism lock nuts.
10. Pan or move the antenna horizontally across the entire range of adjustment to identify the main lobe and the two major side lobes. Adjust the antenna to the main lobe (approximately).
11. Tighten the pan mechanism lock nuts and loosen the tilt mechanism lock nuts.
12. Tilt or move the antenna vertically until you receive the strongest RSL reading.
13. Tighten the tilt mechanism lock nuts and loosen the pan mechanism lock nuts.
14. Pan or move the antenna horizontally and locate the strongest RSL reading.
15. Re-tighten the pan/tilt mechanism lock nuts to lock the antenna in place.
16. Repeat steps 1 through 15 as necessary to obtain maximum RSL reading.

Notes:

The RSL level should be within ±3 dB of predicted levels. Factors that contribute to low RSL levels are:

- incorrect antenna alignment - aligned to a side lobe and not main lobe
- improper polarization of antennas – one end horizontal and the other vertical
- path issues - obstructions such as trees, hills, or buildings within the beamwidth
- path clearance issues such as diffraction, partial obstruction, Fresnel zone issues

9.1 Signs of a Healthy Link

You can be confident that a link is properly aligned and free of problems if the following readings are obtained during a Telnet or Web interface session with each end of the link :

- No alarms – use the CLI command ***get alarms*** and press Enter to return a list of current alarms – should be none that cannot be explained by network status
- Received signal level (RSL) within ±3 dB of link budget figure in clear weather. Use the CLI command ***get modem statistics*** and press Enter to obtain the RSL reading. The Unchannelized power reading should be within 6 dB of the RSL reading. If the Unchannelized power drops below -75 dB, then it is likely that there is no signal being presented at the radio portion of Horizon Compact. Check alarms.
- Eb/No of 19 dB or higher – use the CLI command ***get modem statistics*** and press Enter to display the Eb/No value
- Signal to Noise Ratio (SNR) of 24 dB or higher – use the CLI command ***get modem statistics*** and press Enter to display the SNR value
- Equalizer Stress typically between 20 and 30, but never more than 150 - use the CLI command ***get modem statistics*** and press Enter to display the Equalizer stress value
- Modem Block Error Rate 0.00e+00 – use the CLI command ***get traffic statistics*** and press Enter to display the Modem Block Error Rate. Modem block errors are an indication of loss of data frames. Note that there are residual modem block errors as a result of the alignment process.
- Transmit power typically set at the maximum for the radio band used – use the CLI command ***get transmit power*** and press Enter to return the configured transmit power
- All sections operational – use the CLI command ***get health*** and press Enter to return the health status of all three sections of the system

The readings obtained using the CLI commands during a Telnet session can also be retrieved using the Web interface. All items listed here are available on the left-hand pane of the Web interface and appear on each Horizon web page.

10.0 Advanced Configuration Features

DragonWave Horizon Compact has a number of optional advanced configuration features that may be applied if desired. It is recommended that they only be applied once the Horizon Compact is satisfactorily aligned and successfully carrying traffic. The following lists the features available:

- Radius Server User Authentication
- VLAN Tagging
- 802.1P Priority Tagging
- Horizon Throughput Speed
- Adaptive Transmit Power Control (ATPC)
- Modem Authentication
- Threshold Alarms
- Rapid Link Shutdown (RLS)
- Simple Network Timing Protocol (SNTP)
- Adaptive Modulation
- Radio Redundancy

Each feature is described in this manual, but detailed configuration information for each can be found in the Horizon Product Manual Volume 2 - Advanced Features.

10.1 RADIUS Server User Authentication

The DragonWave Remote Authentication Dial In User Service (RADIUS) server option enables users to be centrally authenticated before being allowed access to a Horizon Compact unit. This adds another layer of security by removing user access control away from individual units and moving it to a central server. However, all Horizon Compact units must have all approved users entered in the user authentication list before the system will grant access at the appropriate user levels (admin, NOC, Super).

Up to five (5) RADIUS servers can be configured.

When one, or more, RADIUS server is configured, the username and password authentication system on the Horizon Compact is bypassed, in favour of the RADIUS system. Access levels are still retained in the local Horizon Compact memory, so once a user is verified by the RADIUS server the access level is assigned by the Horizon Compact (provided that that user is a valid user on that unit). Any user that is validated by the RADIUS server, but is not found in the Horizon Compact user authentication list, can gain access to the unit but only at an admin user level.

If, on attempting to log in, a user does not receive a response from a configured RADIUS server, the user will not be allowed to log in.

Only the Super User can issue any of the RADIUS "set" commands and view any of the security related entries returned with "get" commands (passwords, shared key etc..)

10.2 Management VLAN Tagging

Note: The configuration of Horizon Compact VLAN tagging is only necessary if you wish to restrict Horizon Compact management communications to a specific management VLAN.

The Horizon Compact system will pass user VLAN traffic transparently, independent of the Horizon Compact VLAN settings. The VLAN settings are for Horizon Compact management purposes and do not affect user data or traffic. VLAN Standard IEEE 802.1Q is supported for Horizon Compact VLAN tagging and it accommodates up to 4096 VLANs within the "8100" VLAN range. Note that the Horizon Compact system handles Ethernet frame sizes up to 9600 bytes.

There are three parameters associated with Horizon Compact VLAN tagging:

1. Enable or disable VLAN tagging (set VLAN tagging [on/off])
2. Identify the VLAN tag id to be used with Horizon Compact (set VLAN tag [tag id])
3. Determine whether to allow Horizon Compact to match the VLAN settings in response to incoming frames, or whether to restrict responses to those incoming frames containing the programmed VLAN tag. There are two modes (set network protocol strict [off/on]) which are commonly known as "friendly" and "strict" mode.
    i. **"Friendly" mode.** In this mode, Horizon Compact matches the VLAN format of the incoming frame. If an incoming frame contains a VLAN tag, then Horizon Compact responds with a VLAN tag matching the incoming frame. If the incoming frame does not contain a VLAN tag then Horizon Compact does not insert a VLAN tag in the response. Frames generated by Horizon Compact (e.g. SNMP traps) will contain the programmed VLAN tag.
    ii. **"Strict" mode.** Horizon Compact will only respond to frames containing the programmed VLAN tag. All other frames will be ignored. Frames generated by Horizon Compact (e.g. SNMP traps) will always contain the programmed VLAN tag.

10.3 802.1P Priority Queuing Implementation in Horizon Compact

QoS implementation is best done on the ingress and egress portions of the transport network. As such, QoS should be implemented on the Ethernet switches. Once that implementation is in place, the Horizon Compact can be configured for QoS, should the potential for congestion exist. Enabling CoS/QoS (802.1P) on Horizon Compact ensures that the high priority traffic is delivered at the expense of lower priority traffic.

Horizon Compact supports the eight Classes of Service (CoS) levels (0-7) defined within 802.1P. There are four CoS Queues within Horizon Compact, numbered 1 to 4. Any of the eight CoS levels can be assigned to any of the four Horizon Compact CoS Queues. Horizon can also be configured to use the priority bits found in the DSCP field of IP headers. Any frames not having an IP header can be classified based on the default class of service value (**set cos default value [0 though 7]**).

There are three additional Horizon Compact settings that can be used to customize the data flow to match network requirements:

1. CoS Committed Information Rate (CIR), which determines the guaranteed bandwidth allocated to a particular Queue.
2. CoS Committed Burst Size, which determines the amount of burst data the Queue can manage.
3. Expedite Queuing (see Section 10.3.3), which allows a Queue to be set as a priority Queue whereby it delivers its data at the expense of other non-Expedite Queues.

10.3.1 Operation with 802.1P Priority Queuing Disabled

If 802.1P filtering is disabled in the Horizon Compact system, all incoming frames are treated equally and are forwarded on a first-come first-served basis. The system operates in a FIFO (First In First Out) basis.

If the Pause Frames feature (see Section 10.4) is enabled, pause frames will be sent to the connected switch when the input buffer is close to being full (internally set threshold). This allows time for the queue to empty prior to more frames being received and thus avoids congestion.

10.3.2 Operation with 802.1P Priority Queuing Enabled

If 802.1P filtering is enabled in the Horizon Compact system, the scheduling mechanism can be described as follows:

1. Select the highest priority queue which has a frame in it
2. Send that frame

If COS CIRs are set for the queues, then the scheduling mechanism can be described as follows:

1. Select the highest priority queue which has a frame in it, and hasn't used up its CIR budget
2. Send that frame

The operation of the Scheduler is affected by both the user-configurable CIR and CoS Queue PBS settings.

If the Pause Frames feature (see Section 10.4) is enabled, pause frames will be sent to the connected switch when the input buffer is close to being full (internally set threshold).

The Horizon Compact system also allows any frames without a VLAN tag to be allocated an 802.1P CoS level ("set untagged frame priority"). If the "set untagged frame priority" is not configured, then all untagged frames will be forwarded through Queue 1.

Horizon Compact is also able to manage Q-in-Q or Super VLAN traffic. The system can be configured to use either an encapsulated frame's priority tag or the encapsulating frame's priority tag, in determining priority handling.

10.3.3 Expedite Queues

Expedite Queuing is a mechanism that allows one or more of the four Queues to transmit its data as priority traffic, at the expense of the remaining Queues. When Expedite Queue is enabled, then as long as there is data in the Expedite Queue, or Queues, that data will be transmitted first. This allows time critical or error-sensitive traffic to have priority data delivery.

As network services increase, the need for multiple Expedite Queues becomes evident. A network administrator may require three Expedite Queues and decide to send all network routing protocols through the highest Expedite Queue; send IP Voice through the next highest Expedite Queue; send Video over IP through the next highest Expedite Queue and send all other traffic to the remaining Queue, which is not configured as an Expedite Queue. To do this, the administrator would configure Queues 4, 3 and 2 as Expedite Queues and configure Queue 1 as a standard Queue with a particular CIR. Configuring the CIR for a particular queue to 100% enables the expedite function for that queue.

10.3.4 Management Traffic

Slow Ethernet services and multicast frames are handled by a special Queue inside the Horizon Compact. The Queue is not user-accessible. It works similar to an Expedite Queue in that it ensures management traffic is passed through in an "expedited" fashion. It does not affect, nor is related to the 4 Queues within Horizon Compact. This Queue does not impact the operation of the 4 user-configurable 802.1P Queues.

Frames destined for the **01-80-C2-00-00-xx** MAC addresses are sent to the internal Queue. Examples: STP, RSTP, MSTP LACP, Pause Frames, GARP (GMRP,GVRP), bridge broadcasts, OAM, LLDP, Port based authentication are all sent to the internal Queue and are transmitted in an expedited fashion. Other frames that the user determines must be treated in an expedited fashion, such as “keep-alive” frames and MRP frames, must be assigned a CoS within the switch, then assigned to the appropriate Queue within Horizon Compact.

10.4 Pause Frames

Pause frames are generated by the weaker (slower) link when its forward pipe gets full. Pause frames inform the upstream device to “pause and stop sending traffic for a period of 5 msec”. When the Pause Frame feature is enabled, Horizon Compact generates pause frames to the Ethernet switch when the Horizon Compact receiving buffer hits the internally set threshold. The receiving buffer threshold is close to 100 msec at GigE rate. At data rates lower than GigE, the data buffer will accommodate a lesser amount of data. The Pause Frame feature can be used when CoS/QoS is enabled or disabled.

10.5 Horizon Compact Throughput Speed

When you purchase a Horizon Compact system you receive a unit capable of giving a throughput speed of up to 400 Mbps. However, the actual throughput speed achievable for any given system depends on the specific throughput speed key that you purchased with the system

You can upgrade your system to a higher licensed throughput speed (up to 400 Mbps) by purchasing an upgrade key and reprogramming your system. Any upgraded system can be reconfigured to a lower throughput speed as required, without losing the ability to return to the upgraded speed.

You may also downgrade a system to a lower licensed speed. A downgraded system may warrant a refund of licensing fees. A downgraded system cannot be returned to its former higher licensed speed without purchasing another licensed upgrade key.

10.5.1 Maximum Throughput Speed

The maximum throughput speed is determined by the Horizon Compact throughput speed key you purchase, however, it is important to note that this is also determined by the Channel bandwidth associated with the configured radio band, and the modulation scheme used. The channel bandwidth is a function of the radio band, and the modulation scheme is automatically selected depending on the desired maximum throughput. Configuring the Radio Band and System Mode of the system determines the maximum throughput and hence determines the modulation scheme applied.

Note: if you set a System mode of hc50_110_16QAM, the 110 figure indicates the maximum throughput speed capability of that mode. However, if your licensed throughput speed key purchased from DragonWave is less than this figure, your system throughput will be limited to the purchased licensed throughput speed. Table 10-1 shows the modulation schemes that are selected for various Operating Modes when 23 GHz radio band with 50 MHz channel spacing is configured.

Table 10-1 Bandwidth Operating Mode and Modulation Scheme (50 MHz Channel bandwidth)

Operating Mode	Modem Mode	Average Packet Throughput (Mbps)	Max Tx Power SP/HP	Threshold (dBm) BER 10-6 SP/HP	Saturation (dBm) BER 10-6
HC50_67	QPSK	67	17/27	-81	-18
HC50_110	16QAM	110	14.5/24.5	-77/-75	-20.5
HC50_171	32QAM	172	14/24	-72/-70	-21
HC50_215	64QAM	216	12.5/22.5	-68	-22.5
HC50_271	128QAM	272	11/21	-62	-24
HC50_322	256QAM	323	11.5/21.5	-59	-24.5
HC50_371	256 QAM	372	9.5/NA	-59	-25.5
HC50_364	256 QAM	364 **	NA/19.5	-59	-25.5

Note: The average packet throughput is calculated using 64, 128, 256, 512, 1024, 1280, and 1518bytes Ethernet frames.
** Throughput optimized to fit within required spectral mask limits.

10.6 Adaptive Transmit Power Control (ATPC)

Adaptive Transmit Power Control (ATPC) allows a Horizon Compact system to adjust its transmit power to compensate for far end signal loss caused by changes in atmospheric conditions e.g. heavy rain. ATPC maintains the RSL at -50 dB and adjusts the transmit power by up to 20dB as necessary in order to maintain -50 dB during fade conditions.

RSL threshold levels that trigger power changes, the maximum power change allowed, and a hysteresis factor are preset at values which optimize the operation of the Horizon Compact system. A fade factor of 5dB/second can be handled.

The Horizon Compact system is able to discriminate between RSL levels that are reduced as a result of interference and those as a result of genuine path loss, so that ATPC is not invoked unnecessarily.

Some jurisdictions require the use of ATPC so that power levels are kept as low as possible when wireless communication conditions are good. When ATPC is to be used, if it can be shown that the maximum power of the system would be used only on infrequent occasions, some jurisdictions will allow a lower power level to be used in the calculations that determine interference criteria. This offers some advantage to the installation. This lower power is termed the “coordinated power”. The DragonWave ATPC feature supports a coordinated power parameter.

ATPC is enabled or disabled by issuing the CLI command ***set atpc [on/off][coordinated power]***

The current status of ATPC can be determined by using the CLI command ***get atpc status***.

Note: If ATPC and Advanced Adaptive Modulation (AAM) are both enabled, when AAM is invoked i.e. modulation scheme switched to a lower level, ATPC is automatically disabled until AAM restores the original modulation scheme.

10.7 Horizon Compact Authentication

This feature is only necessary if you wish to restrict communication from a Horizon Compact unit to a specific peer or to a group of Horizon Compact units. Authentication is generally used as a security measure. It is not recommended to enable Authentication prior to alignment of the radios.

Authentication restricts a Horizon Compact unit from communicating with other Horizon Compact units unless the other units match an authentication string. There are three types of authentication:

1. No Authentication
2. Unique Authentication
3. Group Authentication

A new Horizon Compact system in line with the signal cannot authenticate and receive data if another Horizon Compact system is already authenticated. The system authenticates its peer(s) at an interval of approximately five seconds.

The Horizon Compact node does not accept data from other manufacturers' systems.

10.8 Threshold Alarms

Horizon Compact provides Threshold Alarms to assist in managing the performance of the system. Threshold alarms are available for the following parameters:

1. RSL (Receive Signal Level)
2. Bandwidth Utilization
3. Dropped Frames
4. Signal To Noise (SNR) *

With the exception of SNR, each Threshold Alarm has two associated parameters:

1. Threshold value
2. A time limit over which the Threshold value must be exceeded before the alarm is reported.

The combination of the value and the time limit is user defined. The proper combination of the two parameters will prevent false alarms from occurring.

* For the SNR parameter, only the threshold level can be set, the time limit, or hysteresis, being a preset value.

10.9 Rapid Link Shutdown

It is often desirable to signal or detect network link issues in the quickest manner possible. This is especially true when running Layer 2 redundancy protocols, such as Spanning Tree and Metro Ring protocols. Signalling to the network is done by shutting down the Ethernet data port(s) connecting the Horizon Compact to the network. The Rapid Link Shutdown (RLS) feature provides this functionality.

Some situations that would result in Rapid Link Shutdown include:

- Link outage. Should a power failure or a complete loss of link occur then Ethernet ports at both ends of the link can be shut down
- Far-end Ethernet connection problems. If the remote unit data Ethernet port is disconnected or disabled, the near-end unit will also shutdown it's Ethernet port
- Link quality problems. If the link quality (error rate) reaches user programmable thresholds the Horizon Compact Ethernet ports can be shut down
- Horizon Compact configuration or hardware failure. If hard faults, such as a hardware failure, interrupt the link, both Horizon Compact Ethernet ports can be shut down.

10.10 Configuring the Time Source (SNTP)

Date and time information can be entered into the system using CLI command ***set date time [dd/dd/yyyy hh:mm:ss:ms]*** press Enter.

The date and time settings in Horizon Compact are not maintained if a power outage is experienced. To ensure that set system date and time are always accurate, the system can poll known time sources and update time information on an ongoing basis.

Up to five time sources can be configured, which can provide accurate time and date information to the system. Simple Network Time Protocol (sntp) is used. Either an Internet time source or an NTP server on your network may be used.

Five time sources are configured by default (see Table 10-2). Each time source is indexed 1 to 5. Indices 1 and 2 are from Industry Canada servers, 3 and 4 are from U.S. Navy servers and 5 is from a Swiss server. Any other time sources can be configured. The timing information is polled every 60 minutes.

Table 10-2 Time Sources

Index	Stratum	Source IP Address	Source
1	2	199.212.17.15	Industry Canada
2	2	199.212.17.20	Industry Canada
3	1	192.5.41.40	U.S. Navy
4	1	192.5.41.209	U.S. Navy
5	2	129.132.2.21	Switzerland

10.11 Automatic Adaptive Modulation (AAM)

The two principal modulation schemes used on the Horizon Compact system are QPSK and QAM. QPSK (the lowest modulation scheme) is ideal for long distance, but has the lowest throughput capability.

Higher throughputs are achieved by using more complex modulation schemes e.g. 16-QAM, 32-QAM, 64-QAM, 128-QAM, 256-QAM. The higher numbers indicate a progressively more complex scheme and a higher bandwidth (throughput) capability e.g. 256-QAM is more complex than 128-QAM and provides a higher throughput. More complex modulation schemes are susceptible to noise and thus require a stronger signal for the demodulator to accurately decode the data stream. Consequently, the more complex the modulation scheme used, the shorter the distance limitation of the radio link.

If a system is using a given modulation scheme and weather conditions cause signal levels to deteriorate below acceptable levels (risking a link failure), changing the modulation scheme to a less complex scheme, will allow the link to remain functional, although the throughput will be lower, until weather conditions improve. The modulation scheme can then be returned to the original scheme and the throughput returned to normal levels.
The Horizon Compact system can be configured to automatically change modulation schemes if environmental conditions deteriorate to the point where a wireless link may otherwise fail. This feature is called Automatic Adaptive Modulation (AAM). Note that AAM cannot be invoked if RLS is enabled.

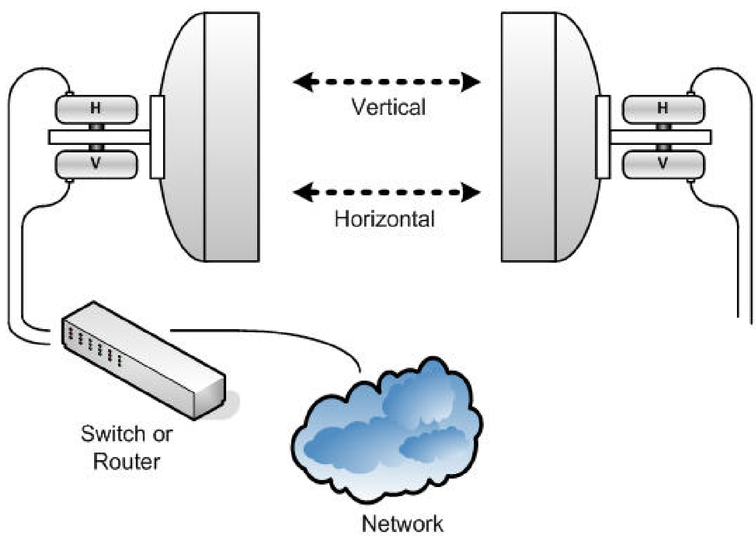
The current modulation scheme (determined by the configured system mode parameter) will switch to the lowest modulation scheme available (a number of system modes, which includes the modulation scheme, are available for any given radio band, see Section 5.2), if the Horizon Compact units detect errored, but corrected, frames (caused by reduced RSL levels). The original modulation scheme will be restored once preset parameters indicate that conditions are suitable for returning to the original modulation scheme (and return to the original bandwidth). The total outage time due to modulation downshift is approximately 50 to 100 mS on average, with upshift down time at approximately 75 mS.

All radio bands available with the Horizon Compact support AAM.

10.12 Horizon Compact Throughput Doubling

Horizon units are capable of transmitting up to 400 Mbps. For higher data rates, an Ethernet switch that supports link aggregation is required. Horizon can be configured as 2 units, each with their own separate antenna, or the Dual Polarity Radio Mount (DPRM) can also be used to mount two systems to a single antenna (see Figure 2-3). The DPRM allows both systems to transmit/receive simultaneously, one with horizontal polarization and the other with vertical polarization, supporting load sharing or throughput doubling (up to 800 Mbps) (see Figure 10-1)

Figure 10-1 DPRM and Throughput Doubling



10.13 Horizon Redundancy

The Horizon system can be configured for redundancy using two physical options. One option allows for two separate Horizon units, each with its own antenna, and connected to an Ethernet switch configured with a re-routing protocol. The switch is responsible for re-routing the data to the redundant stand-by unit when a failure occurs. This option is termed the “two wire” option.

The second option has two Horizon units mounted on a Power Switch Radio Mount (PSRM) with the data feed from a single connection to a switch. Switching traffic to the redundant stand-by unit is determined and performed by the Horizon Compact system and not the connected switch. This option is termed the “single wire” option.

The configuration steps for each option are different (see Volume 2 for more details).

10.13.1 BNC Connector

The BNC connector on the side of the Horizon Compact serves a dual purpose. It can be configured as a source for field strength measurements during antenna alignment, or configured to provide a redundancy switch signal to a second Horizon Compact system mounted close by. For redundancy, the BNC connectors on both units are interconnected with a coaxial cable. Note that for redundancy to work, you must ensure that the field strength option for the BNC connector is turned off (***set alignment off***).

When the Horizon system is configured for redundancy, a DC signal is presented at the BNC connector of the unit normally carrying traffic. Since the BNC connectors on both units are interconnected, the DC signal is passed to the stand-by unit. As long as the DC signal is present, then the stand-by radio is held in a hot stand-by state. When the DC signal is removed (as a result of the unit normally carrying traffic failing), then the stand-by radio becomes active, and takes over the traffic. After a redundancy switch, once the first system is able to return to carrying traffic, a manual switch is required, via a CLI command, to return the system to its original state.

10.13.2 Two Wire Option

The “two wire” option is so named because two separate data feeds are required; one to each Horizon system. One Horizon system is configured as the primary and the other as the secondary. Note that the terms “primary” and “secondary” relate solely to the internal functions of the units and has no relationship to which radio is in stand-by or which is carrying traffic. Management has to be via Port 2, so each Horizon will be configured for out-of-band management and have its Port 2 connected to the overlay management network.

Data re-routing, between the Horizon systems, is dependant upon a connected Ethernet switch. Ethernet switch settings are used to reroute the traffic from one Horizon unit to the other, when a failure occurs. Protocols such as RSTP, LACP and routing protocols are able to determine that the Horizon units have switched from active to stand-by units, or vice-versa, and will reroute the data traffic through the active link.

Figure 10-2 Redundancy Connections – 2 wire option – copper interface

NOTE: For clarity, the PonE power adapter and surge arrestor have been omitted from the diagram. Both the Port 1 and Port 2 Ethernet connections and the power feed via Port 1 must be protected from transients.

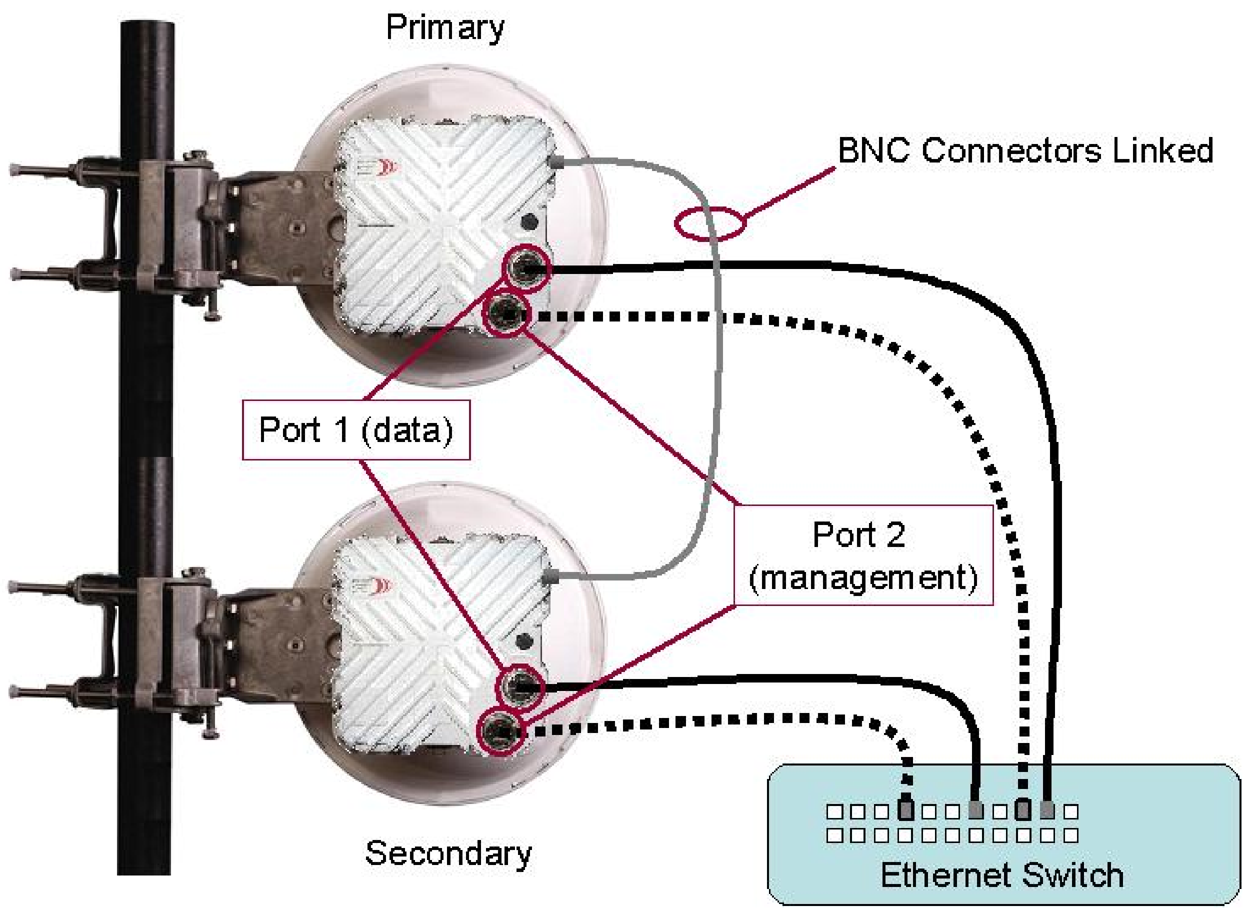
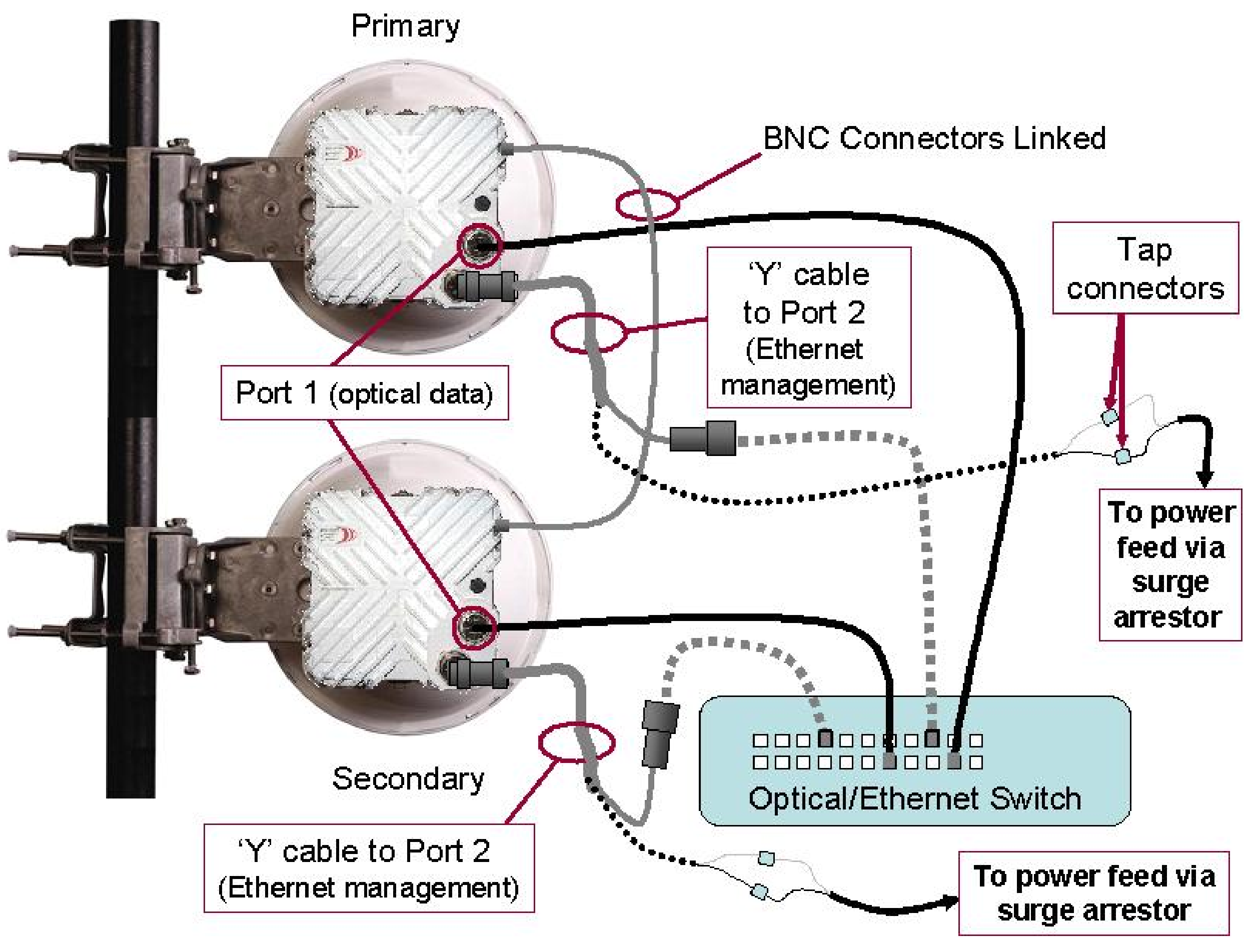


Figure 10-3 Redundancy Connections – 2 wire option – optical interface

NOTE: For clarity, the Transtector surge arrestor has been omitted from the diagram. Both the Ethernet management feed to Port 2 and the power feed, via Port 2, must be protected from transients.



10.13.3 Single Wire Option with the PSRM

The “single wire” option is so named because only one data feed is required to be connected to the two interconnected Horizon systems mounted on the PSRM.

The PSRM supports system redundancy by connecting two Horizon units to a single antenna. Only one of the radios of the mounted systems may operate at any one time. Both systems have the identical polarity, either both vertically or both horizontally polarized. One system is configured as the Primary and the other as the Secondary. Note that the terms “primary” and “secondary” relate solely to the internal functions of the units and has no relationship to which radio is in stand-by or which is carrying traffic.

Port 1 of the primary unit carries the data feed, with Port 2 of both units interconnected. Port 1 of the secondary unit handles management traffic. The secondary unit has to be configured for in-band management and the primary unit configured for out-of-band management.

Switching from the active unit to the stand-by unit is determined by the configuration of the Horizon Compact units and does not depend on connected Ethernet switches.

After a redundancy switch, once the first unit is able to return to carrying traffic, a manual switch is required, via a CLI command, to return traffic to the first unit.

Figure 10-4 Redundancy Connections – Single wire option – copper interface

NOTE: For clarity, the PonE power adapter and surge arrestor have been omitted from the diagrams. Both Port 1 Ethernet connections and the power feed via Port 1 must be protected from transients.

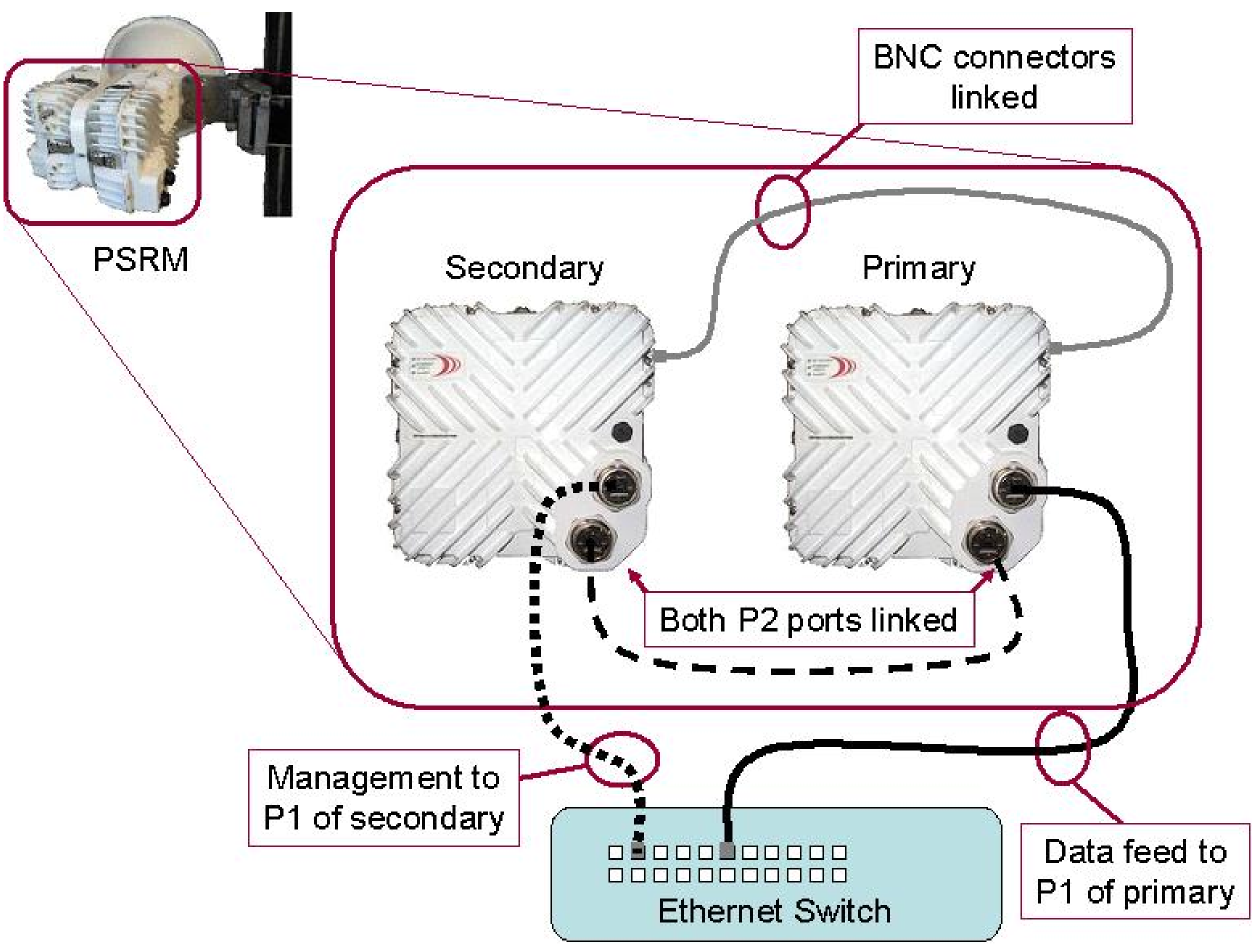
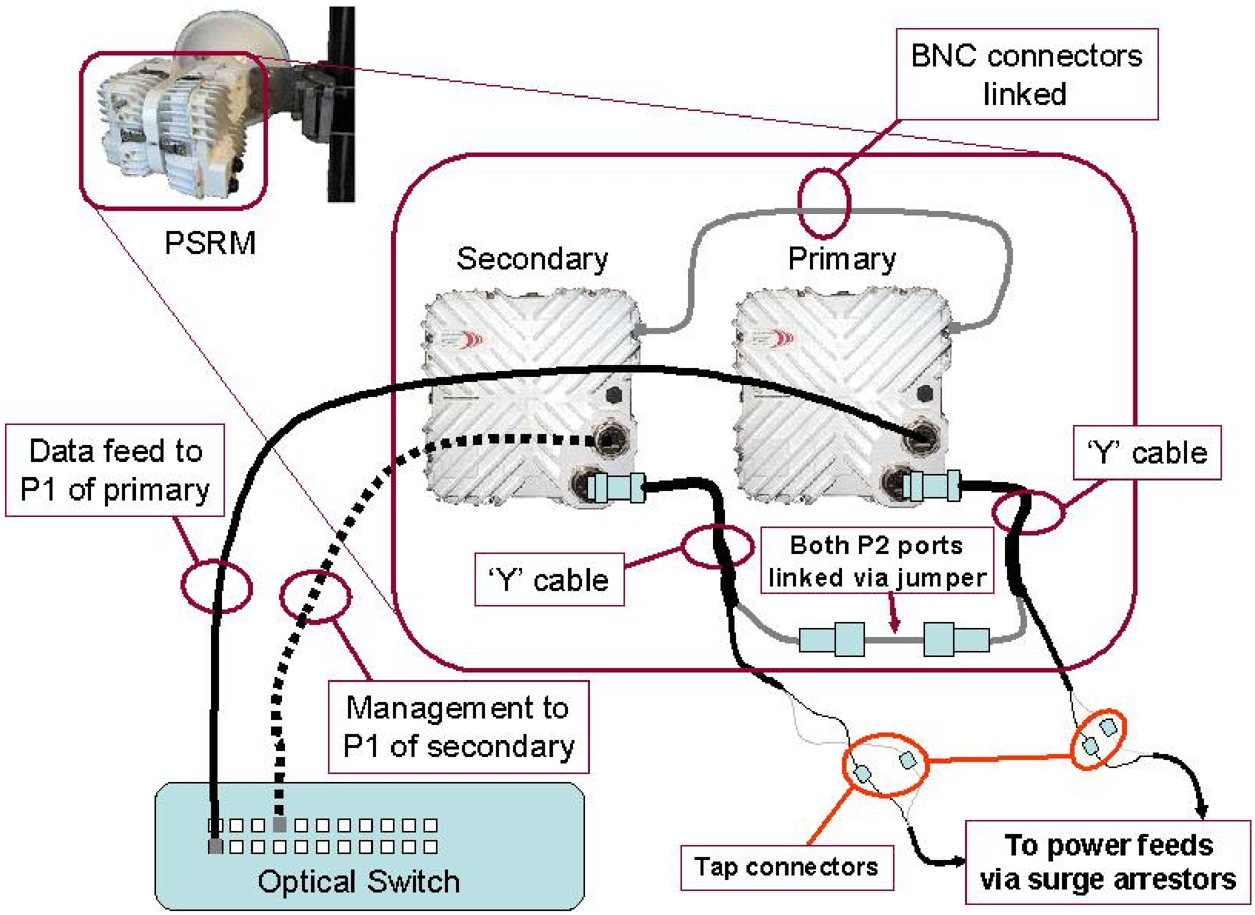


Figure 10-5 Redundancy Connections – Single wire option – optical interface

NOTE: For clarity, the Transtector surge arrestor has been omitted from the diagram. The power feed must be protected from transients.



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11.0 Horizon Management

The Horizon Compact system can be fully managed locally or remotely. Horizon Compact supports Telnet access, SNMP management and a Web interface accessible through the IP network. The entire Command Line Interface (CLI) command set is available through Telnet. The entire list of system parameters is available through SNMP access. The Web interface provides access to system configuration and performance parameters. In-band and out-of-band management options are available.

11.1 In-band and Out-of-band Management

The Horizon Compact contains a dual NIC which has two 10/100/1000 Base-t Ethernet ports. These are labelled Port 1 and Port 2. The system may be configured to use EITHER Port 1 (in-band), OR Port 2 (out-of-band) for management traffic. Management traffic includes:

1. Telnet traffic and associated CLI commands
2. SNMP management
3. ping
4. FTP, used for configuration backup and restore and software upgrades.

All management functions that are available on Port 1 are also available on Port 2. Both ports may be configured to operate with or without management VLANs (see Section 10.2).

The key points to consider when choosing the network management configuration are as follows:

- Port 1 is always used for customer data traffic. It is not possible to send customer data traffic over Port 2.
- Port 1 can be configured to support management traffic in addition to customer data traffic. Use the CLI command ***set network management interface port1*** then press Enter. The default configuration is for management data traffic to be carried over Port 1. Both ends of the link can be managed when Port 1 is set as the management interface.
- Port 2 can only be used for management. Port 2 does not carry any customer data traffic. Port 2 is disabled by default and can be enabled by using the CLI command ***set network management interface port2***.

11.1.1 Management through Port 1 (in-band)

Port 1 is always used to carry customer data traffic and operates at rates of up to 400 Mbps over the radio link, from the local Horizon Compact system through to the far end Horizon Compact system.

Management is set to Port 1 (in-band) by default and management using Telnet, SNMP and Web interface are supported. To enable in-band management on a system that has been set to out-of-band management (Port 2), use the CLI command ***set network management interface port1*** then press Enter.

When the network management interface is set to "port1" all management traffic must arrive on Port 1, or it will be ignored by the system. Configuration and management of the Horizon Compact system can be accomplished through a Telnet, or SSH, session, and although the Telnet session is intermixed with user traffic, the Telnet session occupies very little bandwidth (in the order of kbps) and therefore has almost no effect on user traffic throughput.

A Telnet, or SSH, session can be established through one Horizon Compact system, over the radio link to the far end Horizon Compact system, allowing management of both ends of the link.

Management of the Horizon Compact system can also be performed through a VLAN using 802.1Q VLAN tagging. Management through VLAN offers increased access security. Refer to Section 10.2 for more information.

11.1.2 Management through Port 2 (out-of-band)

Port 2 is available for out-of-band management purposes only. It does not carry customer data traffic. It has been designed to be used in conjunction with a management overlay network that is separate from the customer data network. The management overlay network is typically extended back to the Network Operations Center.

To select out-of-band management use the CLI command ***set network management interface port2*** and press Enter. This allows management of the near end unit only. To gain access to the far end unit use the CLI command ***set network management interface port2 extended*** and press Enter. **Note:** With this "extended" command**,** an Ethernet connection must NOT be present on Port 2 of the far end system otherwise a network loop will be created.

Port 2 supports management of the Horizon Compact system through Telnet sessions, SNMP and the Web interface. When the management interface has been set to "port2", all management traffic must arrive on Port 2, otherwise it is ignored by the system. Customer data traffic continues to be carried over Port 1.

11.2 Telnet Access

Once correctly configured, the Horizon Compact is accessible through a Telnet session using Super User, NOC and Admin level user accounts. Refer to Appendix A for details of CLI commands. The Horizon Compact system can be completely configured, tested and managed through a Telnet session. The Telnet function is enabled by default but can be disabled within the Horizon Compact system. Use the CLI command ***set telnet [on/off]*** to enable or disable Telnet access.

11.3 Secure Shell Access Security

Telnet sessions over a network, such as the Internet, are not secure. User names and passwords, as well as commands and system responses, are transmitted in clear text during a Telnet session. A secure shell (SSH) protocol can be enabled in the Horizon Compact system to ensure that access to the units is restricted to authorized clients. Horizon Compact uses the Secure Shell SSH2 server programme to create the secure environment for Telnet sessions. SSH2 is a recognised industry standard, encrypting, security programme. When enabled, SSH encrypts the entire Telnet session, including all usernames, passwords, commands and responses from the system. SSH also verifies that you are talking to the desired server by means of an authentication process using a "fingerprint". The "fingerprint" is a unique identifier found only on the desired server.

Enable/disable SSH by issuing the CLI command ***set ssh server [on/off]*** then press Enter.

The server "fingerprint" can be returned by issuing the CLI command ***get ssh server fingerprint*** then press Enter.

A Secure Shell client programme needs to be installed on any computer which is to be used to manage a Horizon Compact system with SSH enabled. A free SSH client programme (PuTTY) is available on the Web.

Note that both SSH and Telnet can be enabled at the same time. To ensure security, once SSH has been enabled, disable Telnet.

11.4 Supported SNMP Versions

DragonWave Horizon Compact systems support three versions of SNMP.

- Version 1 (SNMP v1) is the initial implementation of SNMP.
- Version 2 (SNMPv2c) is the second release of SNMP, which has additions and enhancements to data types, counter size and protocol operations.
- Version 3 (SNMPv3) is the most recent version of SNMP. The functionality of SNMPv1 and SNMPv2c remain intact, but SNMPv3 has significant enhancements to administration and security.

SNMPv3 is an interoperable standards-based protocol that provides secure access to devices by authenticating and encrypting packets over the network. The security features provided in SNMPv3 are as follows:

- Message integrity
- Authentication
- Encryption

SNMP configuration is covered in detail in Volume 2.

11.5 Web Interface

The Horizon Compact Web interface runs in a standard browser. To log on see Section 5.1.3.

11.5.1 Home Screen

The Home Screen (window) is divided into 3 sections (panes). The navigation bar displays seven menu options. The status pane on the left is used to monitor the system health and link performance. The system information pane on the right displays system parameters and allows configuration changes.

Figure 11-1 Web Interface - Home Screen

System Status Pane

The main screen displays system status in the left hand pane. The information can be continually refreshed. The default is no self-refresh (set to 0 seconds). Click on the “Set” button to manually refresh. The maximum refresh rate is 99999 seconds. The minimum refresh rate is 3 seconds. Setting the self-refresh rate also causes the Performance and Alarms screens to be refreshed at that rate.

System Information Pane

The system information pane contains information on the Horizon Compact type, management settings, IP address information, and frequency settings. This pane is not updated automatically. The user must refresh the screen either by using the browser's refresh button or by clicking on the Home button within the navigation bar in order to update the system information pane.

Sub-menu Options

The main screen has four Sub-menu options :

- **More Information** - opens a window and displays a summary of the system configuration.
- **System Name** - link to the System Configuration page. If this field has been previously configured then the value is displayed
- **System Location** - link to the System Configuration page. If this field has been previously configured then the value is displayed
- **Manage your Peer Horizon system : [IP address]** - links to the login screen of the peer node (provided the peer node has had its IP address configured). This provides the user with a web browser interface to each end of the Horizon Compact link.
- **Navigation Bar -** Click on the navigation bar across the top of the page to navigate to different screens. Each menu option displays a single screen.

11.5.2 Performance Screen

The performance screen displays the traffic statistics for the Horizon Compact link. There are three groups of statistics reported:

1. Ethernet traffic statistics from the point of view of the modem NIC in and out from the local Ethernet cable (payload) and 802.1P priority Queues
2. Modem-to-modem communication for Port 2
3. Modem-to-modem communication for Port 1

This screen is updated at the rate specified in the refresh rate text box in the System Status Pane.

11.5.3 Configuration Screen

The main configuration screen provides hypertext links to each of the configuration sections within the Horizon Compact system. To navigate to the individual sections, click on the hypertext link. The Configuration screen allows the user to access the following sections :

System Configuration	Automatic Transmit Power Control (ATPC) Configuration
IP Configuration	Automatic Adaptive Modulation (AAM) Configuration
Frequency and Port configuration	SNTP Configuration
SNMP Trap Hosts Configuration	Logs Configuration
SNMP Managers Configuration	RADIUS Client Configuration
SNMP V3 Managers Configuration	Ethernet Quality of Service
SNMP Traps Configuration	

11.5.4 Diagnostics Screen

The diagnostics screen has a link that directs you to the DragonWave support Web page, where you can download diagnostics programmes.

11.5.5 Alarms Screen

The Alarms screen displays the current status of the alarms within the Horizon Compact system and the total accumulated time the alarm has been present (in seconds). The total accumulated time may indicate the current alarm has been active for the timeframe indicated, or may indicate the alarm has occurred multiple times for a total time equaling the displayed value (See 11.9 for a list of alarms). This screen is updated at the rate specified in the refresh rate text box on the left hand side of the page. The default is no self-refresh (set to 0 seconds).

11.5.6 Tools Screen

This screen provides you access to the Link Alignment Tool and Link Planning Tool. The Link Alignment Tool provides a continuously updated RSL reading for link alignment operations as an alternative to using a DVM connected to the BNC field strength monitor connector (see Section 8.1).

11.5.7 Contacts Screen

If you need to contact DragonWave all the information you need is shown on this screen.

11.6 Horizon Compact SSL Web Server

The Horizon Compact Web server can be configured for Secure Sockets Layer (SSL). The Web server may be configured to operate in standard mode or in SSL mode. The Horizon Compact SSL Web server is HTTP 1.0/1.1 compliant, features full support of HTML 2.0, 3.2, 4.0 and supports SSL 3.0.

Secure Sockets Layer, SSL, is the standard security technology for creating an encrypted link between a Web server and a browser. This link ensures that all data passed between the Web server and browser remain private and integral. In order to be able to generate an SSL link, a Web server requires an SSL Certificate.

In order to invoke SSL on the Horizon Compact Web server, an SSL certificate must be generated on the Horizon Compact. Horizon Compact uses an embedded SSL Web server from Allegro Software Development Corporation. Once generated, the certificate may be held as a private certificate or it may be registered with a Trusted Certificate Authority such as:

- Allegro Software Development Corporation
- Microsoft Root Authority
- Thawte Server
- GTE Cybertrust Root
- VeriSign RSA Secure Server

SSL access can be enabled on a per-user group basis. SSL access can be invoked for the Super User, for all NOC accounts, for all Admin accounts, or any combination of the three. Once SSL access has been enabled for the user group then all members of that user group must use SSL to connect to the Horizon Compact Web browser. Even if SSL access is not required for the user group, those users may access the Horizon Compact Web browser through HTTPS (SSL) as a security measure.

11.6.1 Generating a Certificate on Horizon Compact

In order to generate an SSL certificate on Horizon Compact, the user must be logged in as either a NOC or Super User access level. The SSL certificate is tied to the Horizon Compact IP address. If the Horizon Compact IP address is changed, then the SSL certificate should be regenerated. Otherwise the browser SSL session will allow access but it will report that the certificate is invalid. In this situation, it is the browser user's responsibility to verify that the proper Horizon Compact is being accessed and that the invalid certificate is due to an IP address change.

11.7 Event and Performance Logs

The Horizon Compact system supports two logs, the Events Log and the Performance Log. Each can be used to trace the behaviour of the system over time.

The Events Log is invoked or disabled by issuing the CLI command ***set logging [on/off].*** This log records alarm and reset events. Approximately 17,500 events can be captured by the Events log. Once the log is full the oldest entries are overwritten. Use the CLI command ***get log entries*** and press Enter, to display log entries. Use Ctrl C to abort the listing.

Issuing the CLI command ***set performance logging [on/off]*** enables or disables the Performance Log. This log collects system performance information at time intervals that are configured using the CLI command ***set performance log interval [hh:mm:ss].***

Use the CLI command ***get performance log*** and press Enter, to display a list of Performance Log entries. Use Ctrl C to abort the listing.

Between 6000 and 8000 entries can be logged before the Performance Log memory is full. Once the memory is full, new entries will overwrite the oldest entries. The following table assumes that an average of 7000 entries will occur before memory overflow. If the memory accepts more entries, then the log duration before overflow will be extended.

Logging Interval	Log Duration
15 secs (minimum)	~ 29 hours
1 minute	~ 116 hours (~ 4.8 days)
15 minutes (default)	~ 73 days (~ 2.4 months)
1 hour	~ 292 days (~ 9.7 months)
24 hours (maximum)	7000 days (~ 19.2 years)

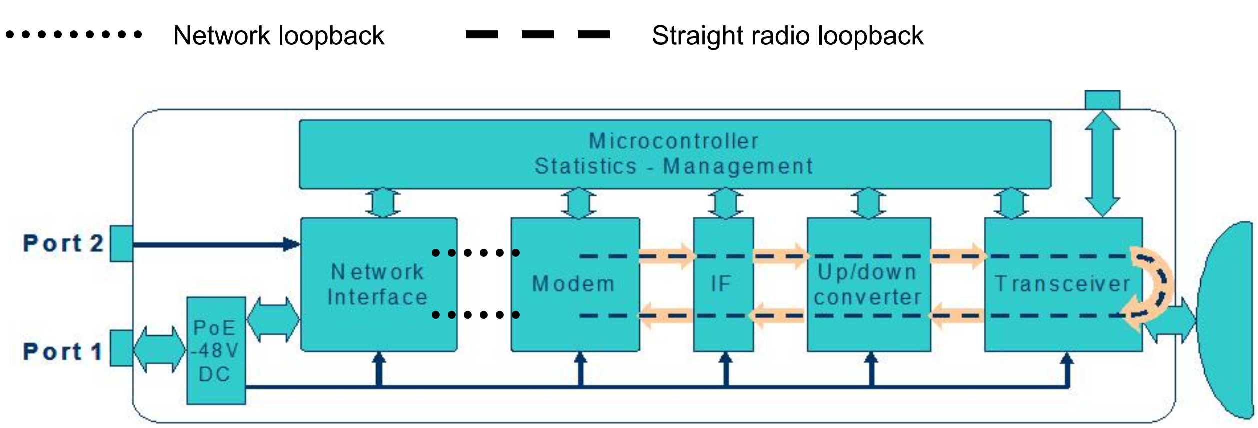
11.8 Radio Loopback

Horizon provides a radio loopback facility for analysis of transmit or receive path issues. Invoking a radio loopback is service affecting and will stop all data transfer. There are two options:

- Straight radio loopback - Ethernet traffic is not looped back to the network, Ethernet traffic is discarded and the RF portion of the Horizon unit is placed in loopback (see Figure 11-2).
- Radio loopback plus network loopback – Ethernet traffic and the radio are placed in loopback

During the loopback, if the modem transmitter loss of sync alarm is not active, then both the transmitter and receiver of the Horizon unit under test are functioning correctly. A user configurable time limit can be applied to the loopback feature (default is 30 seconds). Once the time limit has expired the loopback will be automatically removed. Note that the far end transmitter should be muted when analysing the near end system using the radio loopback feature. The radio loopback is invoked or disabled by issuing the CLI command ***set radio loopback [on/off] [time][network].***

Figure 11-2 Radio Loopback



11.9 Alarms List

Use the CLI command ***get alarms*** to display a list of active alarms. Alternatively, alarms are listed on the Alarms page of the Web interface. Active alarms are clearly indicated.

The following list shows the various alarms available:

- Explicit Authentication Failed
- Ethernet Link Down
- Dropped Ethernet Frame Threshold Exceeded
- Bandwidth Utilization Threshold Exceeded
- Modem hardware fault
- Modem receiver loss of signal
- Modem SNR below threshold
- Modem programming error
- Modem transmitter loss of sync
- Modem equalizer stress above threshold
- Radio RSL Below Threshold
- SNTP Servers Unreachable
- RLS Shutdown Activated
- AAM Config mismatch
- Tx power detector below threshold
- Radio current out of limits
- TempComp cal table not available
- Radio temperature out of limits
- Radio Power Amplifier
- ATPC Config Mismatch
- RLS Mismatch
- Frequency File invalid
- AAM running on QPSK modulation
- Synthesizer Unlock

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12.0 Configuration Backup and Restore

Horizon Compact provides a backup and restore facility for system configuration data and user account data. The backup and restore uses an FTP server to transfer files. It is recommended to have an FTP server at your network management site for use with the Horizon Compact backup and restore facilities. Note that the Super User or a noc user level can perform backup and restore functions.

12.1 System Configuration Backup

The Horizon Compact system configuration can be saved to an FTP server. All system configuration parameters are backed up, allowing the exact configuration to be replicated.

Use the CLI command: ***save config ftp:<filename>*** press Enter

where ***<filename>*** is the name of the file to be created on the FTP server. Follow the prompts.

Note that the above command will save the file in the root directory of the ftp server. Adding the path information to the file name will allow you to save it in a specific directory on the ftp server.

12.2 System Configuration Restore

The Horizon Compact system configuration can be retrieved from the FTP server on which it was backed up. All system configuration parameters are restored, allowing the exact configuration to be replicated.

Use the CLI command: ***copy ftp: <filename>*** press Enter

where ***<filename>*** is the name of the file to restore to the Horizon Compact . Follow the prompts.

Note that the above command will retrieve the file from the root directory of the ftp server. Adding the path information to the file name will allow you to retrieve it from a specific directory on the ftp server.

12.3 User Account Configuration Backup

The Horizon Compact system user account configuration can be saved to an FTP server. All user account parameters are backed up, allowing the exact configuration to be replicated.

Use the CLI command: ***save users ftp:<filename>*** press Enter

where ***<filename>*** is the name of the file to be created on the FTP server. Follow the prompts.

Note that the above command will save the file in the root directory of the ftp server. Adding the path information to the file name will allow you to save it in a specific directory on the ftp server.

12.4 User Account Configuration Restore

The Horizon Compact system user account configuration can be retrieved from an FTP server. All user account configuration parameters are restored, allowing the exact configuration to be replicated.

Use the CLI command: ***copy ftp: <filename>*** press Enter

where ***<filename>*** is the name of the file to restore to the Horizon Compact.

Note that the above command will retrieve the file from the root directory of the ftp server. Adding the path information to the file name will allow you to retrieve it from a specific directory on the ftp server.

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13.0 Software Upgrades

From time to time new software loads are made available that may add new features to the Horizon Compact system. You can download new software remotely using File Transfer Protocol (FTP).

Use the Command Line Interface (CLI) via Telnet and invoke the FTP with either a local FTP server that is on the same network as the Horizon Compact system, or use DragonWave's FTP server site available through the Internet. The Horizon Compact can interact with the most popular FTP servers on a variety of operating systems. Anonymous FTP, as well as a user–supplied username and password are supported.

13.1 Single System

Log into the system via Telnet and use the CLI command ***copy ftp: <filename>*** and press Enter. Where ***<filename>*** is the name of the software load file in the format *omni_x.y.z.hex* and includes any path information.

You will be prompted for the IP address of the FTP server. The FTP server will then prompt you for user name and password.

Once the download is complete you will need to use the CLI command ***save mib*** and press Enter.
The new software is now saved in non volatile memory, but not yet in use.

Note that traffic is not affected during the software download process.

To make the new software load active requires the system to be reset. **This is traffic affecting.**

To activate the new software load use the CLI command ***reset system*** and press Enter. Then press Y. The system will reset and load the new software.

13.2 Multiple Systems

A batch mode software upgrade programme is available from DragonWave on request. This Unix based programme uses a flat file listing of all IP addresses of units on a network. It will perform simultaneous upgrades of multiple units. The number capable of being upgraded simultaneously is limited only by the number of active FTP sessions allowed by the on-net FTP server.

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Appendix A – List of CLI Commands

Command Syntax Summary (alpha order)

? (help)
copy [ftp:filename]
create ssl certificate
delete mib [newest|both]
delete radius server [index]
diagnose aam
downgrade system licensed speed [speed]
erase log
erase performance log
exit
get aam status
get alarms
get alarms counter
get alignment
get air interface authentication type
get antenna diameter
get atpc status
get authentication failure action
get authenticated peer
get authentication status
get backup ipconfig
get bandwidth utilization threshold
get bandwidth utilization status
get config commands
get cos default value
get cos expedite queue
get cos qinq itag
get cos qinq otag
get cos queue cir
get cos queue mapping
get cos queue cbs
get cos type
get date time
get default ipconfig
get default gateway
get dropped frames threshold
get enet address
get enet config
get enet speed
get enet status
get frequency bank
get frequency file crc
get frequency file status
get group authentication key
get health
get http secure access [Admin|Noc|Super]
get hw inventory
get ip address
get install type
get leds
get licensed speed count
get logging
get log entries
get maximum frame size
get modem modulation
get modem statistics
get network management interface
get network protocol strict
get omni file crc
get optical transmitter state
get pause state
get performance log
get performance logging
get performance log interval
get programmed frequency
get qos
get radio band
get radio loopback
get radio statistics
get radio status
get radio transmitter state
get radius servers
get radius server retransmit
get radius server timeout
get radius server deadtime
get radius super user authentication
get redundancy link monitor parameters
get redundancy mode
get redundancy override
get redundancy partner information
get redundancy secondary enet state
get redundancy status
get rls
get rls link enable
get rls link monitor parameters
get rls link control
get rls make rsl
get rls signal fault parameters
get rls status
get rsl threshold
get sessions
get snmp access mode
get snmp managers
get snmp set request
get snmp traps
get snmp trap hosts
get snmpv3 managers
get snmpv3 trap hosts
get snr threshold
get sntp
get sntp offset
get ssh server
get ssh server fingerprint
get ssl certificate status
get subnet mask
get super user
get sw inventory
get sw version
get system licensed speed downgrade information
get system mode
get system speed
get system summary

get system redundancy
get telnet access
get traffic statistics
get transmit power
get unique peer authentication key
get user accounts
get user session
get vlan tag
get vlan tagging
get web server
kill ssh sessions
list [ftp:file/directory/]
lo
ping [-w timeout][-n count][-t][ip address]
reset [system / modem]
save config [ftp:filename]
save log [ftp:filename]
save mib
save performance log [ftp:filename]
save users [ftp:filename]
set aam [on/off]
set admin user
set air interface authentication type [type]
set authentication failure [action]
set alarms counter [0]
set alignment [on/off]
set antenna diameter [index of diameter]
set atpc [on|off][coordinated power]
set bandwidth utilization threshold [threshold][time]
set cos default value [0-7]
set cos expedite queue [on|off]
set cos qinq itag [protocol id]
set cos qinq otag [protocol id]
set cos queue cir [0-100,0-100,0-100,1-100]
set cos queue mapping [mapping]
set cos queue cbs
set cos type [cos_vlan][cos_qinq_itag][cos_qinq_otag]
set current channel index
set date time [dd/mm/yyyy hh:mm:ss:ms]
set default gateway [ip address]
set dropped frames threshold [threshold][time]
set enet config [port1|port2]
set enet speed [port1|port2] speed[10|100|1000|auto]
AutoNeg[auto]
set frequency bank
set group authentication key [key]
set http secure access [Admin|Noc|Super] [on|off]
set ip address [address]
set logging [on|off]
set maximum frame size [1600-9600]
set network management interface [port1|port2|port2 extended]
set network protocol strict [on|off]
set noc user
set optical transmitter state [on|off]
set pause state [on|off]
set performance logging [on|off]
set performance log interval [hr:min:sec]
set programmed frequency [index]
set qos [on|off]
set radio transmitter state [enable|disable]
set radio band [band]
set radio loopback [on|off]
set radio rxgain
set radio txgain
set radius server key [index] [key]
set radius server host [index] [ip address]
set radius super user authentication strict [on|off]
set redundancy link monitor parameters
set redundancy mode
set redundancy override [primary|secondary|
manual|auto]
set redundancy standby enet state [on/off/pulse]
set redundancy state switch [on]
set rls [on|off]
set rls link enable [on|off]
set rls link monitor parameters [dn2up frame error] [up2dn frame error] [dn2up samples] [up2dn samples] [sample time]
set rls link control [on|off]
set rls make rsl [rsl value][time]
set rls signal fault parameters [time][% error]
set rsl threshold [threshold][time]
set snmp access mode [v1|v2c|off]
set snmp manager [mgr index] [ip address]
[enable|disable] [community string]
set snmp set request [on|off]
set snmp trap [trap#] [enable|disable]
set snmp trap host [host#] [ip address]
[enable|disable] [community string]
set snr threshold [threshold]
set snmpv3 trap host enable [index]
set snmpv3 trap host disable [index]
set snmpv3 trap host ip [index] [ip address]
set snmpv3 trap host user [index] [none|des]
set snmpv3 trap host authentication [indes]
[none|md5|sha] [passwd]
set snmpv3 trap host privacy [index] [none|des]
set sntp [on|off]
set sntp default
set sntp offset [hrs]
set sntp server [index] [ip address]
set ssh server
set super user [username] [password]
set system current speed [speed]
set system mode [mode]
set system redundancy [on|off]
set telnet [on|off]
set traffic statistics [0]
set transmit power [power in dB]
set unique peer authentication key [key]
set subnet mask [mask]
set vlan tag [vlan ID (0-4095)] [vlan priority (0-7)]
set vlan tagging [on|off]
set web server [on|off]
upgrade system licensed speed [speed] [key]

Appendix B - Frequency Tables

The following tables show the frequencies supported in Release 1.2 :

Table B-1 11 GHz FCC/ETSI a 40 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	10735	11225	1'	11225	10735
2	10775	11265	2'	11265	10775
3	10815	11305	3'	11305	10815
4	10855	11345	4'	11345	10855
5	10895	11385	5'	11385	10895
6	10935	11425	6'	11425	10935

Table B-2 11 GHz NZ a 40 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	10735	11265	1'	11265	10735
2	10775	11305	2'	11305	10775
3	10815	11345	3'	11345	10815
4	10855	11385	4'	11385	10855
5	10895	11425	5'	11425	10895

Table B-3 11 GHz FCC a 30 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	10715	11215	1'	11215	10715
2	10755	11245	2'	11245	10755
3	10795	11285	3'	11285	10795
4	10835	11325	4'	11325	10835
5	10875	11365	5'	11365	10875
6	10915	11405	6'	11405	10915

Table B-4 11 GHz IC a 30 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	10725	11225	1'	11225	10725
2	10755	11255	2'	11255	10755
3	10785	11285	3'	11285	10785
4	10815	11315	4'	11315	10815
5	10845	11345	5'	11345	10845
6	10875	11375	6'	11375	10875
7	10905	11405	7'	11405	10905
8	10935	11435	8'	11435	10935

Table B-5 11 GHz ITU a 40 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	10715	11245	1	11245	10715
2	10755	11285	2	11285	10755
3	10795	11325	3	11325	10795
4	10835	11365	4	11365	10835
5	10875	11405	5	11405	10875
6	10915	11445	6	11445	10915

Table B-6 11 GHz FCC/ETSI b 40 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
7	10975	11465	7'	11465	10975
8	11015	11505	8'	11505	11015
9	11055	11545	9'	11545	11055
10	11095	11585	10'	11585	11095
11	11135	11625	11'	11625	11135
12	11175	11665	12'	11665	11175

Table B-7 11 GHz NZ/ETSI b 40 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
6	10935	11465	6'	11465	10935
7	10975	11505	7'	11505	10975
8	11015	11545	8'	11545	11015
9	11055	11585	9'	11585	11055
10	11095	11625	10'	11625	11095
11	11135	11665	11'	11665	11135

Table B-8 11 GHz FCC b 30 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
7	10955	11445	7'	11445	10955
8	10995	11485	8'	11485	10995
9	11035	11525	9'	11525	11035
10	11075	11565	10'	11565	11075
11	11115	11605	11'	11605	11115
12	11155	11645	12'	11645	11155
13	11185	11685	13'	11685	11185

Table B-9 11 GHz IC b 30 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
9	10965	11465	9'	11465	10965
10	10995	11495	10'	11495	10995
11	11025	11525	11'	11525	11025
12	11055	11555	12'	11555	11055
13	11085	11585	13'	11585	11085
14	11115	11615	14'	11615	11115
15	11145	11645	15'	11645	11145
16	11175	11675	16'	11675	11175

Table B-10 11 GHz ITU b 40 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
7	10955	11485	7'	11485	10955
8	10995	11525	8'	11525	10995
9	11035	11565	9'	11565	11035
10	11075	11605	10'	11605	11075
11	11115	11645	11'	11645	11115
12	11155	11685	12'	11685	11155

Table B-11 13 GHz NZ/AUS/ETSI/ITU a 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	12765	13031	1'	13031	12765
2	12793	13059	2'	13059	12793
3	12821	13087	3'	13087	12821
4	12849	13115	4'	13115	12849

Table B-12 13 GHz NZ/AUS/ETSI/ITU a 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	12758	13024	1'	13024	12758
2	12772	13038	2'	13038	12772
3	12786	13052	3'	13052	12786
4	12800	13066	4'	13066	12800
5	12814	13080	5'	13080	12814
6	12828	13094	6'	13094	12828
7	12842	13108	7'	13108	12842
8	12856	13122	8'	13122	12856

Table B-13 13 GHz NZ/AUS/ETSI/ITU b 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
5	12877	13143	5'	13143	12877
6	12905	13171	6'	13171	12905
7	12933	13199	7'	13199	12933
8	12961	13227	8'	13227	12961

Table B-14 13 GHz NZ/AUS/ETSI/ITU b 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
9	12870	13136	9'	13136	12870
10	12884	13150	10'	13150	12884
11	12898	13164	11'	13164	12898
12	12912	13178	12'	13178	12912
13	12926	13192	13'	13192	12926
14	12940	13206	14'	13206	12940
15	12954	13220	15'	13220	12954
16	12968	13234	16'	13234	12968

Table B-15 15 GHz ITU a 28 MHz Channels (490 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14417	14907	1'	14907	14417
2	14445	14935	2'	14935	14445
3	14473	14963	3'	14963	14473
4	14501	14991	4'	14991	14501
5	14529	15019	5'	15019	14529
6	14557	15047	6'	15047	14557

Table B-16 15 GHz ITU a 14 MHz Channels (490 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14417	14907	1'	14907	14417
2	14431	14921	2'	14921	14431
3	14445	14935	3'	14935	14445
4	14459	14949	4'	14949	14459
5	14473	14963	5'	14963	14473
6	14487	14977	6'	14977	14487
7	14501	14991	7'	14991	14501
8	14515	15005	8'	15005	14515
9	14529	15019	9'	15019	14529
10	14543	15033	10'	15033	14543
11	14557	15047	11'	15047	14557
12	14571	15061	12'	15061	14571

Table B-17 15 GHz ITU a2 28 MHz Channels (420 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14515	14935	1'	14935	14515
2	14543	14963	2'	14963	14543
3	14571	14991	3'	14991	14571
4	14599	15019	4'	15019	14599

Table B-18 15 GHz ITU a2 14 MHz Channels (420 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14515	14935	1'	14935	14515
2	14529	14949	2'	14949	14529
3	14543	14963	3'	14963	14543
4	14557	14977	4'	14977	14557
5	14571	14991	5'	14991	14571
6	14585	15005	6'	15005	14585
7	14599	15019	7'	15019	14599

Table B-19 15 GHz IC a 40 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
D1	14520	14995	D1'	14995	14520
D2	14560	15035	D2'	15035	14560

Table B-20 15 GHz ITU b 28 MHz Channels (490 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
7	14585	15075	7'	15075	14585
8	14613	15103	8'	15103	14613
9	14641	15131	9'	15131	14641
10	14669	15159	10'	15159	14669
11	14697	15187	11'	15187	14697
12	14725	15215	12'	15215	14725

Table B-21 15 GHz ITU b 14 MHz Channels (490 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
13	14585	15075	13'	15075	14585
14	14599	15089	14'	15089	14599
15	14613	15103	15'	15103	14613
16	14627	15117	16'	15117	14627
17	14641	15131	17'	15131	14641
18	14655	15145	18'	15145	14655
19	14669	15159	19'	15159	14669
20	14683	15173	20'	15173	14683
21	14697	15187	21'	15187	14697
22	14711	15201	22'	15201	14711
23	14725	15215	23'	15215	14725
24	14739	15229	24'	15229	14739

Table B-22 15 GHz ITU b2 28 MHz Channels (420 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
5	14627	15047	5'	15047	14627
6	14655	15075	6'	15075	14655
7	14683	15103	7'	15103	14683
8	14711	15131	8'	15131	14711
9	14739	15159	9'	15159	14739

Table B-23 15 GHz ITU b2 14 MHz Channels (420 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
8	14613	15033	8'	15033	14613
9	14627	15047	9'	15047	14627
10	14641	15061	10'	15061	14641
11	14655	15075	11'	15075	14655
12	14669	15089	12'	15089	14669
13	14683	15103	13'	15103	14683
14	14697	15117	14'	15117	14697
15	14711	15131	15'	15131	14711
16	14725	15145	16'	15145	14725
17	14739	15159	17'	15159	14739
18	14753	15173	18'	15173	14753

Table B-24 15 GHz IC b 40 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
D3	14600	15075	D3'	15075	14600
D4	14640	15115	D4'	15115	14640
D5	14680	15155	D5'	15155	14680
D6	14720	15195	D6'	15195	14720

Table B-25 15 GHz MEX b 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
32	14746	15061	32'	15061	14746

Table B-26 15 GHz MEX b 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
32A	14739	15054	32A'	15054	14739
32B	14753	15068	32B'	15068	14753

Table B-27 15 GHz ITU c 28 MHz Channels (490 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
13	14753	15243	13'	15243	14753
14	14781	15271	14'	15271	14781
15	14809	15299	15'	15299	14809
16	14837	15327	16'	15327	14837

Table B-28 15 GHz ITU c 14 MHz Channels (490 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
25	14753	15243	25'	15243	14753
26	14767	15257	26'	15257	14767
27	14781	15271	27'	15271	14781
28	14795	15285	28'	15285	14795
29	14809	15299	29'	15299	14809
30	14823	15313	30'	15313	14823
31	14837	15327	31'	15327	14837
32	14851	15341	32'	15341	14851

Table B-29 15 GHz ITU c2 28 MHz Channels (420 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
10	14767	15187	10'	15187	14767
11	14795	15215	11'	15215	14795
12	14823	15243	12'	15243	14823
13	14851	15271	13'	15271	14851
14	14879	15299	14'	15299	14879
15	14907	15327	15'	15327	14907

Table B-30 15 GHz ITU c2 14 MHz Channels (420 MHz T/R)

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
19	14767	15187	19'	15187	14767
20	14781	15201	20'	15201	14781
21	14795	15215	21'	15215	14795
22	14809	15229	22'	15229	14809
23	14823	15243	23'	15243	14823
24	14837	15257	24'	15257	14837
25	14851	15271	25'	15271	14851
26	14865	15285	26'	15285	14865
27	14879	15299	27'	15299	14879
28	14893	15313	28'	15313	14893
29	14907	15327	29'	15327	14907
30	14921	15341	30'	15341	14921

Table B-31 15 GHz IC c 40 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
D7	14760	15235	D7'	15235	14760
D8	14800	15275	D8'	15275	14800

Table B-32 15 GHz AUS d 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
6	14655	15299	6'	15299	14655
7	14683	15327	7'	15327	14683
8	14711	15355	8'	15355	14711

Table B-33 15 GHz NZ d 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14515	15159	1'	15159	14515
2	14543	15187	2'	15187	14543
3	14571	15215	3'	15215	14571
4	14599	15243	4'	15243	14599
5	14627	15271	5'	15271	14627
6	14655	15299	6'	15299	14655
7	14683	15327	7'	15327	14683
8	14711	15355	8'	15355	14711

Table B-34 15 GHz AUS d 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
2	14550	15194	2'	15194	14550
3	14564	15208	3'	15208	14564
4	14578	15222	4'	15222	14578
5	14592	15236	5'	15236	14592
6	14606	15250	6'	15250	14606

Table B-35 15 GHz NZ d 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14536	15180	1'	15180	14536
2	14550	15194	2'	15194	14550
3	14564	15208	3'	15208	14564
4	14578	15222	4'	15222	14578
5	14592	15236	5'	15236	14592
6	14606	15250	6'	15250	14606

Table B-36 15 GHz ETSI d 56 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14529	15257	1'	15257	14529
2	14585	15313	2'	15313	14585

Table B-37 15 GHz MEX d 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14515	15243	1'	15243	14515
2	14543	15271	2'	15271	14543
5	14571	15299	5'	15299	14571

Table B-38 15 GHz ETSI d 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14515	15243	1'	15243	14515
2	14543	15271	2'	15271	14543
5	14571	15299	5'	15299	14571
6	14599	15327	6'	15327	14599

Table B-39 15 GHz ETSI d 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	14515	15243	1'	15243	14515
2	14529	15257	2'	15257	14529
3	14543	15271	3'	15271	14543
4	14557	15285	4'	15285	14557
5	14571	15299	5'	15299	14571
6	14585	15313	6'	15313	14585
7	14599	15327	7'	15327	14599
8	14613	15341	8'	15341	14613

Table B-40 15 GHz MEX d 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
A1A	14508	15236	A1A'	15236	14508
A1B	14522	15250	A1B'	15250	14522
A2A	14536	15264	A2A'	15264	14536
A2B	14550	15278	A2B'	15278	14550
A3A	14564	15292	A3A'	15292	14564
A3B	14578	15306	A3B'	15306	14578

Table B-41 18 GHz FCC/IC 50 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	17765	19325	1'	19325	17765
2	17815	19375	2'	19375	17815
3	17865	19425	3'	19425	17865
4	17915	19475	4'	19475	17915
5	17965	19525	5'	19525	17965
6	18015	19575	6'	19575	18015
7	18065	19625	7'	19625	18065
8	18115	19645	8'	19645	18115

Table B-42 18 GHz IC 50 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
B1	18165	19325	B1'	19325	18165
B2	18215	19375	B2'	19375	18215

Table B-43 18 GHz Brazil 27.5 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	17727.5	19287.5	1'	19287.5	17727.5
2	17755	19315	2'	19315	17755
3	17782.5	19342.5	3'	19342.5	17782.5
4	17810	19370	4'	19370	17810
5	17837.5	19397.5	5'	19397.5	17837.5
6	17865	19425	6'	19425	17865
7	17892.5	19452.5	7'	19452.5	17892.5
8	17920	19480	8'	19480	17920
9	17947.5	19507.5	9'	19507.5	17947.5
10	17975	19535	10'[	19535	17975
11	18002.5	19582.5	11'	19582.5	18002.5
12	18030	19590	12'	19590	18030
13	18057.5	19617.5	13'	19617.5	18057.5
14	18085	19645	14'	19645	18085
15	18112.5	19672.5	15'	19672.5	18112.5

Table B-44 18 GHz Brazil 55 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	17727.5	19287.5	1'	19287.5	17727.5
2	17782.5	19342.5	2'	19342.5	17782.5
3	17837.5	19397.5	3'	19397.5	17837.5
4	17892.5	19452.5	4'	19452.5	17892.5
5	17947.5	19507.5	5'	19507.5	17947.5
6	18002.5	19562.5	6'	19562.5	18002.5
7	18057.5	19617.5	7'	19617.5	18057.5
8	18112.5	19672.5	8'	19672.5	18112.5

Table B-45 18 GHz Brazil 13.75 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	17713.75	18723.75	1'	18723.75	17713.75
2	17727.5	18737.5	2'	18737.5	17727.5
3	17741.25	18751.25	3'	18751.25	17741.25
4	17755	18765	4'	18765	17755
5	17768.75	18778.75	5'	18778.75	17768.75
6	17782.5	18792.5	6'	18792.5	17782.5
7	17796.25	18806.25	7'	18806.25	17796.25
8	17810	18820	8'	18820	17810
9	17823.75	18833.75	9'	18833.75	17823.75
10	17837.5	18847.5	10'[	18847.5	17837.5
11	17851.25	18861.25	11'	18861.25	17851.25
12	17865	18875	12'	18875	17865
13	17878.75	18888.75	13'	18888.75	17878.75
14	17892.5	18902.5	14'	18902.5	17892.5
15	17906.25	18916.25	15'	18916.25	17906.25
16	17920	18930	16'	18930	17920
17	17933.75	18943.75	17'	18943.75	17933.75
18	17947.5	18957.5	18'	18957.5	17947.5
19	17961.25	18971.25	19'	18971.25	17961.25
20	17975	18985	20'	18985	17975
21	17988.75	18998.75	21'	18998.75	17988.75
22	18002.5	19012.5	22'	19012.5	18002.5
23	18016.25	19026.25	23'	19026.25	18016.25
24	18030	19040	24'	19040	18030
25	18043.75	19053.75	25'	19053.75	18043.75
26	18057.5	19067.5	26'	19067.5	18057.5
27	18071.25	19081.25	27'	19081.25	18071.25
28	18085	19095	28'	19095	18085
29	18098.75	19108.75	29'	19108.75	18098.75
30	18112.5	19122.5	30'	19122.5	18112.5
31	18126.25	19136.25	31'	19136.25	18126.25
32	18140	19150	32'	19150	18140
33	18153.75	19163.75	33'	19163.75	18153.75
34	18167.5	19177.5	34'	19177.5	18167.5
35	18181.25	19191.25	35'	19191.25	18181.25
36	18195	19205	36'	19205	18195
37	18208.75	19218.75	37'	19218.75	18208.75

Table B-46 18 GHz ETSI/ITU 27.5 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	17727.5	18737.5	1'	18737.5	17727.5
2	17755	18765	2'	18765	17755
3	17782.5	18792.5	3'	18792.5	17782.5
4	17810	18820	4'	18820	17810
5	17837.5	18847.5	5'	18847.5	17837.5
6	17865	18875	6'	18875	17865
7	17892.5	18902.5	7'	18902.5	17892.5
8	17920	18930	8'	18930	17920
9	17947.5	18957.5	9'	18957.5	17947.5
10	17975	18985	10'[	18985	17975
11	18002.5	19012.5	11'	19012.5	18002.5
12	18030	19040	12'	19040	18030
13	18057.5	19067.5	13'	19067.5	18057.5
14	18085	19095	14'	19095	18085
15	18112.5	19122.5	15'	19122.5	18112.5
16	18140	19150	16'	19150	18140
17	18167.5	19177.5	17'	19177.5	18167.5
18	18195	19205	18'	19205	18195

Table B-47 18 GHz ETSI/ITU/French 55 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	17755	18765	1'	18765	17755
2	17810	18820	2’	18820	17810
3	17865	18875	3’	18875	17865
4	17920	18930	4’	18930	17920
5	17975	18985	5’	18985	17975
6	18030	19040	6’	19040	18030
7	18085	19095	7’	19095	18085
8	18140	19150	8’	19150	18140
9	18195	19205	9’	19205	18195

Table B-48 18 GHz ETSI/ITU/French 13.75 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	17734.375	18744.375	1'	18744.375	17734.375
2	17748.125	18758.125	2’	18758.125	17748.125
3	17761.875	18771.875	3’	18771.875	17761.875
4	17775.625	18785.625	4’	18785.625	17775.625
5	17789.375	18799.375	5’	18799.375	17789.375
6	17803.125	18813.125	6’	18813.125	17803.125
7	17816.875	18826.875	7’	18826.875	17816.875
8	17830.625	18840.625	8’	18840.625	17830.625
9	17844.375	18854.375	9’	18854.375	17844.375
10	17858.125	18868.125	10’	18868.125	17858.125
11	17871.875	18881.875	11’	18881.875	17871.875
12	17885.625	18895.625	12’	18895.625	17885.625
13	17899.375	18909.375	13’	18909.375	17899.375
14	17913.125	18923.125	14’	18923.125	17913.125
15	17926.875	18936.875	15’	18936.875	17926.875
16	17940.625	18950.625	16’	18950.625	17940.625
17	17954.375	18964.375	17’	18964.375	17954.375
18	17968.125	18978.125	18’	18978.125	17968.125
19	17981.875	18991.875	19’	18991.875	17981.875
20	17995.625	19005.625	20’	19005.625	17995.625
21	18009.375	19019.375	21’	19019.375	18009.375
22	18023.125	19033.125	22’	19033.125	18023.125
23	18036.875	19046.875	23’	19046.875	18036.875
24	18050.625	19060.625	24’	19060.625	18050.625
25	18064.375	19074.375	25’	19074.375	18064.375
26	18078.125	19088.125	26’	19088.125	18078.125
27	18091.875	19101.875	27’	19101.875	18091.875
28	18105.625	19115.625	28’	19115.625	18105.625
29	18119.375	19129.375	29’	19129.375	18119.375
30	18133.125	19143.125	30’	19143.125	18133.125
31	18146.875	19156.875	31’	19156.875	18146.875
32	18160.625	19170.625	32’	19170.625	18160.625
33	18174.375	19184.375	33’	19184.375	18174.375
34	18188.125	19198.125	34’	19198.125	18188.125
35	18201.875	19211.875	35’	19211.875	18201.875
36	18215.625	19225.625	36’	19225.625	18215.625

Table B-49 18 GHz ETSI/ITU/French 27.5 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	17741.25	18751.25	1'	18751.25	17741.25
2	17768.75	18778.75	2’	18778.75	17768.75
3	17796.25	18806.25	3’	18806.25	17796.25
4	17823.75	18833.75	4’	18833.75	17823.75
5	17851.25	18861.25	5’	18861.25	17851.25
6	17878.75	18888.75	6’	18888.75	17878.75
7	17906.25	18916.25	7’	18916.25	17906.25
8	17933.75	18943.75	8’	18943.75	17933.75
9	17961.25	18971.25	9’	18971.25	17961.25
10	17988.75	18998.75	10’	18998.75	17988.75
11	18016.25	19026.25	11’	19026.25	18016.25
12	18043.75	19053.75	12’	19053.75	18043.75
13	18071.25	19081.25	13’	19081.25	18071.25
14	18098.75	19108.75	14’	19108.75	18098.75
15	18126.25	19136.25	15’	19136.25	18126.25
16	18153.75	19163.75	16’	19163.75	18153.75
17	18181.25	19191.25	17’	19191.25	18181.25
18	18208.75	19218.75	18’	19218.75	18208.75

Table B-50 18 GHz ETSI/ITU 13.75 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
35	18181.25	19191.25	35'	19191.25	18181.25
36	18195	19205	36'	19205	18195
37	18208.75	19218.75	37'	19218.75	18208.75
38	18222.5	19232.5	38'	19232.5	18222.5
39	18236.25	19246.25	39'	19246.25	18236.25
40	18250	19260	40'	19260	18250
41	18263.75	19273.75	41'	19273.75	18263.75
42	18277.5	19287.5	42'	19287.5	18277.5
43	18291.25	19301.25	43'	19301.25	18291.25
44	18305	19315	44'	19315	18305
45	18318.75	19328.75	45'	19328.75	18318.75
46	18332.5	19342.5	46'	19342.5	18332.5
47	18346.25	19356.25	47'	19356.25	18346.25
48	18360	19370	48'	19370	18360
49	18373.75	19383.75	49'	19383.75	18373.75
50	18387.5	19397.5	50'	19397.5	18387.5
51	18401.25	19411.25	51'	19411.25	18401.25
52	18415	19425	52'	19425	18415
53	18428.75	19438.75	53'	19438.75	18428.75
54	18442.5	19452.5	54'	19452.5	18442.5
55	18456.25	19466.25	55'	19466.25	18456.25
56	18470	19480	56'	19480	18470
57	18483.75	19493.75	57'	19493.75	18483.75
58	18497.5	19507.5	58'	19507.5	18497.5
59	18511.25	19521.25	59'	19521.25	18511.25
60	18525	19535	60'	19535	18525
61	18538.75	19548.75	61'	19548.75	18538.75
62	18552.5	19562.5	62'	19562.5	18552.5
63	18566.25	19576.25	63'	19576.25	18566.25
64	18580	19590	64'	19590	18580
65	18593.75	19603.75	65'	19603.75	18593.75
66	18607.5	19617.5	66'	19617.5	18607.5
67	18621.25	19631.25	67'	19631.25	18621.25
68	18635	19645	68'	19645	18635
69	18648.75	19658.75	69'	19658.75	18648.75

Table B-51 18 GHz ETSI/ITU 27.5 MHz Channels

TxLow			TxHigh		
Channel index	**Tx RF (MHz)**	**Rx RF (MHz)**	**Channel index**	**Tx RF (MHz)**	**Rx RF (MHz)**
18	18195	19205	18'	19205	18195
19	18222.5	19232.5	19'	19232.5	18222.5
20	18250	19260	20'	19260	18250
21	18277.5	19287.5	21'	19287.5	18277.5
22	18305	19315	22'	19315	18305
23	18332.5	19342.5	23'	19342.5	18332.5
24	18360	19370	24'	19370	18360
25	18387.5	19397.5	25'	19397.5	18387.5
26	18415	19425	26'	19425	18415
27	18442.5	19452.5	27'	19452.5	18442.5
28	18470	19480	28'	19480	18470
29	18497.5	19507.5	29'	19507.5	18497.5
30	18525	19535	30'	19535	18525
31	18552.5	19562.5	31'	19562.5	18552.5
32	18580	19590	32'	19590	18580
33	18607.5	19617.5	33'	19617.5	18607.5
34	18635	19645	34'	19645	18635
35	18662.5	19672.5	35'	19672.5	18662.5

Table B-52 18 GHz ETSI/ITU/French 55 MHz Channels

TxLow			TxHigh		
Channel index	**Tx RF (MHz)**	**Rx RF (MHz)**	**Channel index**	**Tx RF (MHz)**	**Rx RF (MHz)**
9	18195	19205	9'	19205	18195
10	18250	19260	10'	19260	18250
11	18305	19315	11'	19315	18305
12	18360	19370	12'	19370	18360
13	18415	19425	13'	19425	18415
14	18470	19480	14'	19480	18470
15	18525	19535	15'	19535	18525
16	18580	19590	16'	19590	18580
17	18635	19645	17'	19645	18635

Table B-53 18 GHz French 13.75 MHz Channels

TxLow			TxHigh		
Channel index	**Tx RF (MHz)**	**Rx RF (MHz)**	**Channel index**	**Tx RF (MHz)**	**Rx RF (MHz)**
33	18174.375	19184.375	33'	19184.375	18174.375
34	18188.125	19198.125	34'	19198.125	18188.125
35	18201.875	19211.875	35'	19211.875	18201.875
36	18215.625	19225.625	36'	19225.625	18215.625
37	18229.375	19239.375	37'	19239.375	18229.375
38	18243.125	19253.125	38'	19253.125	18243.125
39	18256.875	19266.875	39'	19266.875	18256.875
40	18270.625	19280.625	40'	19280.625	18270.625
41	18284.375	19294.375	41'	19294.375	18284.375
42	18298.125	19308.125	42'	19308.125	18298.125
43	18311.875	19321.875	43'	19321.875	18311.875
44	18325.625	19335.625	44'	19335.625	18325.625
45	18339.375	19349.375	45'	19349.375	18339.375
46	18353.125	19363.125	46'	19363.125	18353.125
47	18366.875	19376.875	47'	19376.875	18366.875
48	18380.625	19390.625	48'	19390.625	18380.625
49	18394.375	19404.375	49'	19404.375	18394.375
50	18408.125	19418.125	50'	19418.125	18408.125
51	18421.875	19431.875	51'	19431.875	18421.875
52	18435.625	19445.625	52'	19445.625	18435.625
53	18449.375	19459.375	53'	19459.375	18449.375
54	18463.125	19473.125	54'	19473.125	18463.125
55	18476.875	19486.875	55'	19486.875	18476.875
56	18490.625	19500.625	56'	19500.625	18490.625
57	18504.375	19514.375	57'	19514.375	18504.375
58	18518.125	19528.125	58'	19528.125	18518.125
59	18531.875	19541.875	59'	19541.875	18531.875
60	18545.625	19555.625	60'	19555.625	18545.625
61	18559.375	19569.375	61'	19569.375	18559.375
62	18573.125	19583.125	62'	19583.125	18573.125
63	18586.875	19596.875	63'	19596.875	18586.875
64	18600.625	19610.625	64'	19610.625	18600.625
65	18614.375	19624.375	65'	19624.375	18614.375
66	18628.125	19638.125	66'	19638.125	18628.125
67	18641.875	19651.875	67'	19651.875	18641.875
68	18655.625	19665.625	68'	19665.625	18655.625
69	18669.375	19679.375	69'	19679.375	18669.375
70	18683.125	19693.125	70'	19693.125	18683.125

Table B-54 18 GHz French 27.5 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
17	18181.25	19191.25	17'	19191.25	18181.25
18	18208.75	19218.75	18'	19218.75	18208.75
19	18236.25	19246.25	19'	19246.25	18236.25
20	18263.75	19273.75	20'	19273.75	18263.75
21	18291.25	19301.25	21'	19301.25	18291.25
22	18318.75	19328.75	22'	19328.75	18318.75
23	18346.25	19356.25	23'	19356.25	18346.25
24	18373.75	19383.75	24'	19383.75	18373.75
25	18401.25	19411.25	25'	19411.25	18401.25
26	18428.75	19438.75	26'	19438.75	18428.75
27	18456.25	19466.25	27'	19466.25	18456.25
28	18483.75	19493.75	28'	19493.75	18483.75
29	18511.25	19521.25	29'	19521.25	18511.25
30	18538.75	19548.75	30'	19548.75	18538.75
31	18566.25	19576.25	31'	19576.25	18566.25
32	18593.75	19603.75	32'	19603.75	18593.75
33	18621.25	19631.25	33'	19631.25	18621.25
34	18648.75	19658.75	34'	19658.75	18648.75
35	18676.25	19686.25	35'	19686.25	18676.25

Table B-55 18 GHz Australian 13.75 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	18305	19315	1’	19315	18305
2	18318.75	19328.75	2’	19328.75	18318.75
3	18332.5	19342.5	3’	19342.5	18332.5
4	18346.25	19356.25	4’	19356.25	18346.25
5	18360	19370	5’	19370	18360
6	18373.75	19383.75	6’	19383.75	18373.75
7	18387.5	19397.5	7’	19397.5	18387.5
8	18401.25	19411.25	8’	19411.25	18401.25
9	18415	19425	9’	19425	18415
10	18428.75	19438.75	10’	19438.75	18428.75
11	18442.5	19452.5	11’	19452.5	18442.5
12	18456.25	19466.25	12’	19466.25	18456.25
13	18470	19480	13’	19480	18470
14	18483.75	19493.75	14’	19493.75	18483.75
15	18497.5	19507.5	15’	19507.5	18497.5
16	18511.25	19521.25	16’	19521.25	18511.25
17	18525	19535	17’	19535	18525
18	18538.75	19548.75	18’	19548.75	18538.75
19	18552.5	19562.5	19’	19562.5	18552.5
20	18566.25	19576.25	20’	19576.25	18566.25

Table B-56 18 GHz Australian 27.5 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	18305	19315	1’	19315	18305
2	18332.5	19342.5	2’	19342.5	18332.5
3	18360	19370	3’	19370	18360
4	18387.5	19397.5	4’	19397.5	18387.5
5	18415	19425	5’	19425	18415
6	18442.5	19452.5	6’	19452.5	18442.5
7	18470	19480	7’	19480	18470
8	18497.5	19507.5	8’	19507.5	18497.5
9	18525	19535	9’	19535	18525
10	18552.5	19562.5	10’	19562.5	18552.5

Table B-57 18 GHz Australian 55 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
1	18360	19370	1’	19370	18360
2	18415	19425	2’	19425	18415
3	18470	19480	3’	19480	18470
4	18525	19535	4’	19535	18525
5	18580	19590	5’	19590	18580

Table B-58 23 GHz FCC 50 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
19	22125	23325	19'	23325	22125
20	22175	23375	20'	23375	22175
21	22225	23425	21'	23425	22225
22	22275	23475	22'	23475	22275
23	22325	23525	23'	23525	22325
24	22375	23575	24'	23575	22375

Table B-59 23 GHz IC 50 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
A7	22125	23325	A7’	23325	22125
A8	22175	23375	A8’	23375	22175
A9	22225	23425	A9’	23425	22225
A10	22275	23475	A10’	23475	22275
A11	22325	23525	A11’	23525	22325
A12	22375	23575	A12’	23575	22375

Table B-60 23 GHz Mexico 50 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
A7	22125	23325	A7’	23325	22125
A8	22175	23375	A8’	23375	22175
A9	22225	23425	A9’	23425	22225
A10	22275	23475	A10’	23475	22275

Table B-61 23 GHz Australia 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
5	22071	23303	5’	23303	22071
6	22085	23317	6’	23317	22085
7	22099	23331	7’	23331	22099
8	22113	23345	8’	23345	22113

Table B-62 23 GHz ITU 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
61	22071	23303	61'	23303	22071
62	22085	23317	62'	23317	22085
63	22099	23331	63'	23331	22099
64	22113	23345	64'	23345	22113
65	22127	23359	65'	23359	22127
66	22141	23373	66'	23373	22141
67	22155	23387	67'	23387	22155
68	22169	23401	68'	23401	22169
69	22183	23415	69'	23415	22183
70	22197	23429	70'	23429	22197
71	22211	23443	71'	23443	22211
72	22225	23457	72'	23457	22225
73	22239	23471	73'	23471	22239
74	22253	23485	74'	23485	22253
75	22267	23499	75'	23499	22267
76	22281	23513	76'	23513	22281
77	22295	23527	77'	23527	22295
78	22309	23541	78'	23541	22309
79	22323	23555	79'	23555	22323
80	22337	23569	80'	23569	22337

Table B-63 23 GHz ITU 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
31	22078	23310	31'	23310	22078
32	22106	23338	32'	23338	22106
33	22134	23366	33'	23366	22134
34	22162	23394	34'	23394	22162
35	22190	23422	35'	23422	22190
36	22218	23450	36'	23450	22218
37	22246	23478	37'	23478	22246
38	22274	23506	38'	23506	22274
39	22302	23534	39'	23534	22302
40	22330	23562	40'	23562	22330

Table B-64 23 GHz Australia 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
3	22078	23310	3’	23310	22078
4	22106	23338	4’	23338	22106

Table B-65 23 GHz ETSI 14 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
5	22071	23079	05'	23079	22071
6	22085	23093	06'	23093	22085
7	22099	23107	07'	23107	22099
8	22113	23121	08'	23121	22113
9	22127	23135	09'	23135	22127
10	22141	23149	10'	23149	22141
11	22155	23163	11'	23163	22155
12	22169	23177	12'	23177	22169
13	22183	23191	13'	23191	22183
14	22197	23205	14'	23205	22197
15	22211	23219	15'	23219	22211
16	22225	23233	16'	23233	22225
17	22239	23247	17'	23247	22239
18	22253	23261	18'	23261	22253
19	22267	23275	19'	23275	22267
20	22281	23289	20'	23289	22281
21	22295	23303	21'	23303	22295
22	22309	23317	22'	23317	22309
23	22323	23331	23'	23331	22323
24	22337	23345	24'	23345	22337
25	22351	23359	25'	23359	22351
26	22365	23373	26'	23373	22365
27	22379	23387	27'	23387	22379
28	22393	23401	28'	23401	22393
29	22407	23415	29'	23415	22407
30	22421	23429	30'	23429	22421
31	22435	23443	31'	23443	22435
32	22449	23457	32'	23457	22449
33	22463	23471	33'	23471	22463
34	22477	23485	34'	23485	22477
35	22491	23499	35'	23499	22491
36	22505	23513	36'	23513	22505
37	22519	23527	37'	23527	22519
38	22533	23541	38'	23541	22533
39	22547	23555	39'	23555	22547
40	22561	23569	40'	23569	22561
41	22575	23583	41'	23583	22575

Table B-66 23 GHz ETSI 28 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
3	22078	23086	3'	23086	22078
4	22106	23114	4'	23114	22106
5	22134	23142	5'	23142	22134
6	22162	23170	6'	23170	22162
7	22190	23198	7'	23198	22190
8	22218	23226	8'	23226	22218
9	22246	23254	9'	23254	22246
10	22274	23282	10'	23282	22274
11	22302	23310	11'	23310	22302
12	22330	23338	12'	23338	22330
13	22358	23366	13'	23366	22358
14	22386	23394	14'	23394	22386
15	22414	23422	15'	23422	22414
16	22442	23450	16'	23450	22442
17	22470	23478	17'	23478	22470
18	22498	23506	18'	23506	22498
19	22526	23534	19'	23534	22526
20	22554	23562	20'	23562	22554

Table B-67 23 GHz ETSI 56 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
2	22134	23142	2'	23142	22134
3	22190	23198	3'	23198	22190
4	22246	23254	4'	23254	22246
5	22302	23310	5'	23310	22302
6	22358	23366	6'	23366	22358
7	22414	23422	7'	23422	22414
8	22470	23478	8'	23478	22470
9	22526	23534	9'	23534	22526

Table B-68 23 GHz UK 56 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
2	22092	23100	2'	23100	22092
3	22148	23156	3'	23156	22148
4	22204	23212	4'	23212	22204
5	22260	23268	5'	23268	22260
6	22316	23324	6'	23324	22316
7	22372	23380	7'	23380	22372
8	22428	23436	8'	23436	22428
9	22484	23492	9'	23492	22484
10	22540	23548	10'	23548	22540

Table B-69 23 GHz ITU 56 MHz Channels

TxLow			TxHigh		
Channel index	Tx RF (MHz)	Rx RF (MHz)	Channel index	Tx RF (MHz)	Rx RF (MHz)
16	22092	23324	16'	23324	22092
17	22148	23380	17'	23380	22148
18	22204	23436	18'	23436	22204
19	22260	23492	19'	23492	22260
20	22316	23548	20'	23548	22316

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Appendix C – Safety Information

Safety Information for Radio Equipment

The Federal Communications Commission (FCC), with its action in ET Docket 96-8, has adopted a safety standard for human exposure to radio frequency (RF) electromagnetic energy emitted by FCC-certified equipment. DragonWave Horizon Compact meets the uncontrolled environmental limits found in OET-65 and ANSI C95.1, 1991. Proper operation of this radio according to the instructions found in this manual or any other product manuals or user guides for the DragonWave family of products or equipment will result in user exposure that is substantially below the FCC recommended limits.

1. Do not touch or move antenna(s) while the unit is transmitting or receiving.
2. Do not hold any component containing the radio in such a way that the antenna is very close to or touching any exposed parts of the body, especially the face or eyes, while the unit is transmitting.
3. Do not operate a portable transmitter near unshielded blasting caps or in an explosive environment unless it is a type especially qualified for such use.

The design of the high-gain mast mount antennas is such that professional installation is required.

Information sur la sécurité de l'appareil radio

En vertu de l'ET Docket 96-8, la FCC a adopté une norme de sécurité sur l'exposition humaine à l'énergie électromagnétique de radiofréquence (RF) émise par le matériel homologué par la FCC. L'appareil Horizon Compact de DragonWave respecte les limites environnementales non contrôlées décrites dans le bulletin OET-65 et dans la norme ANSI C95.1 de 1991.

Si l'appareil radio est utilisé selon les instructions décrites dans le présent manuel ou tout autre manuel de nos produits ou dans le guide de l'utilisateur relatif à la ligne de produits ou équippement de DragonWave, résultera à des expositions aux champs électromagnétiques sensiblement moins élevés que les limites recommandées par la FCC.

1. Ne jamais toucher ou déplacer la ou les antennes lorsque l'appareil fonctionne en mode de transmission ou de réception.
2. Lorsque l'appareil fonctionne en mode de transmission, tenir les éléments contenant la radio de manière que l'antenne ne soit pas trop proche des parties du corps exposées (surtout le visage ou les yeux) ou n'y touche pas.
3. Ne pas faire fonctionner un émetteur transportable à proximité de détonateurs non protégés ou dans un milieu explosif, à moins qu'il s'agisse d'un émetteur autorisé.

Les antennes à gain élevé montées sur mât sont conçues pour être installées par des professionnels.

Professional Installation

DragonWave Horizon Compact devices require professional installation. It is the responsibility of the installer to be sure that all building and safety codes are met and that the installation is complete and secure.

The Horizon Compact shall be installed according to local Electrical Safety Codes.

For Canadian installations, the entire equipment installation must comply with Canadian Standard CSA 22.2, No. 60950, Safety of Information Technology Equipment. For installations in the United States, the entire equipment installation must be in accordance with Article 810 of the United States National Electrical Code.

Installations Professionel

Les appareils Horizon Compact de DragonWave doivent être installés par un personnel professionnel. Le personnel responsable doit s'assurer que l'installation est bien achevée, et qu'elle répond aux exigences de tous les codes de sécurité.

Une installation faite au Canada doit observer les normes 22.2, numéro 60950 du CSA, Sécurité des matériels de traitement de l'information. Une installation faite aux États-Unis doit être faite selon les stipulations de l'Article 810 du United States National Electrical Code.

Lightning Protection

When installed, this equipment is to be connected to a Lightning/Surge Protection Device that meets all applicable national safety requirements.

Before Ethernet cables enter buildings, voltages shall be clamped down to SELV by Approved type primary protectors.

Protection contre la foudre

L'installation exige aussi que l'appareil soit branché à un parafoudre qui répond à toutes les normes nationales de sécurité.

Electrocution Hazard

	Warning **Electrocution Hazard**

This product is intended to be connected to a –36 to -60V DC power source (power adapter supplied by DragonWave Inc.), which must be electrically isolated from any ac sources and reliably connected to Earth ground. Do not install DragonWave products near any type of power line. Should your antenna or related hardware come in contact with power lines, severe bodily harm or death could result!

Risque d'électrocution

	Avertissement **Risque d'électrocution**

Cet appareil est raccordée à une source de tension de –36 a -60V CD (adapteur fourni par DragonWave), qui doit être isolée de toute autre source de tension et raccordée à une mise à terre isolée. Les produits de DragonWave ne doivent pas être installés près de ligne à haute tension. Des dommages corporels sévères et même la mort peuvent survenir si l'antenne ou toute autre pièce viennent en contact avec des lignes de haute tension Dommage corporel.

Radio Frequency Safety

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF fields in excess of the general population limits as defined by FCC CFR 47, Part 2.1091, Radiofrequency radiation exposure evaluation for fixed devices & Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada's website www.hc-sc.gc.ca/rpb.

RF Radiation Safety Information

The antenna must be located such that humans will not approach within 5m of the forward transmitting direction of the antenna and 0.46m in all other directions. This distance provides additional safety margin for the product, as well as minimizing exposure to microwaves.

These calculations were done in accordance with:

1. FCC Radio Frequency Exposure Limits 1.1310
2. Health Canada Safety Code 6 / Industry Canada RSS 102
3. EMF Exposure Directive (99/519/EC)

Information sur la Securité des Radiations des FR

L'antenne doit être localisée de façon à ce que les humains ne puissent pas s'en approcher à moins de 5m dans l'axe de transmission à l'avant de l'antenne et de 0.46m dans toutes autres axes. Ceci la distance fournit une marge de sûreté additionnelle pour ce produit en minimisant l'exposition aux micro-ondes.

Ces calculs ont été faits selon :

1. L'Exposition De Fréquence Par radio de FCC Limite 1.1310
2. Industrie Canada RSS 102 / De l'Indicatif 6 De Sûreté Du Santé Canada
3. Le Directif d'Exposition De EMF (99/519/EC)

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Appendix D - Regulatory Compliance Information

This section contains information regarding regulatory compliance with the Federal Communication Commission, Department of Communications and the European Telecommunications Standards Institute applies to the Horizon Compact radio link.

Federal Communication Commission Declaration of Conformity Statement

This device complies with Part 15 of 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.

This equipment has been tested and found to comply with the limits of a Class B digital device, pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses and radiates radio-frequency energy, and if not installed and used in accordance with the instructions, can cause harmful interference. However, there is no guarantee that interference will not occur. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to correct the interference by one of the following measures:

1. Reorient or relocate the receiving antenna;
2. Increase separation between the equipment and receiver; or
3. Connect the equipment into an outlet on a circuit different from that which the receiver is connected.

Warning

The Part 15 radio device operates on a non-interference basis with the other devices operating at this frequency. Any changes or modification to said product not expressly approved by DragonWave Inc. could void the user's authority to operate this device.

Department of Communications – Canada - Compliance Statement

This class B Digital apparatus meets all the requirements of the Canadian Interference-Causing Equipment Regulations.

This device complies with RSS-210 of Industry Canada. Operation is subject to the following two conditions:

1. this device can not cause harmful interference; and
2. this device must accept any interference received, including interference that can cause undesired operation.

The use of this device in a system operating either partially or completely outdoors can require the user to obtain a license for the system according to Canadian regulations. For further information, contact your local Industry Canada office.

Ministère des Communications – Canada

Déclaration de conformité aux normes canadiennes

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Cet appareil est conforme à la norme RSS-210 d'Industrie Canada. Son exploitation est soumise aux deux conditions suivantes :

1. il ne doit pas provoquer de brouillage préjudiciable et
2. il doit tolérer le brouillage reçu, notamment le brouillage susceptible de perturber son fonctionnement.

Si l'appareil doit être utilisé dans un système qui fonctionne partiellement ou complètement à l'extérieur, l'utilisateur devra obtenir une licence à cet effet, conformément aux règlements canadiens. Pour de plus amples renseignements, communiquer avec le bureau local d'Industrie Canada.

Certification Note From Industry Canada for 24 GHz DEMS

CERTIFICATION NOTE FROM INDUSTRY CANADA: While this equipment meets the technical requirements for its operation in its rated paired block arrangement, this block arrangement is different than the 40+40 MHz block arrangement prescribed in documents RSS-191 and SRSP-324.25. The operation of this equipment IS NOT permitted if the out-of-band and spurious emission limits are not met at the edge of any contiguous licensed spectrum. It should be noted that all current relevant spectrum policies, licensing procedures and technical requirements are still applicable. For additional information, please contact the local Industry Canada office.

European Telecommunications Standards Institute Statement of Compliance

This equipment has been tested and found to comply with the European Telecommunications Standard ETS 300.328. This standard covers Wideband Data Transmission Systems referred to in CEPT Recommendation T/R 10.01.

This type of accepted equipment is designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy. If the equipment is not installed and used in accordance with the instruction manual, it can cause harmful interference to radio communications.

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Visit us on the Internet at:
http://www.dragonwaveinc.com/