

CarrierComm

CarrierWave-100/155



User Reference and Installation Manual

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CW-100 CW-155	MK-MAN-01	A	SN	Initial Release
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1 Safety Precautions

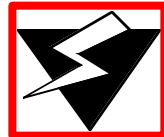
PLEASE READ THESE SAFETY PRECAUTIONS!

RF Energy Health Hazard



The radio equipment described in this guide uses radio frequency transmitters. Although the power level is low, the concentrated energy from a directional antenna may pose a health hazard. Do not allow people to come in close proximity to the front of the antenna while the transmitter is operating. The antenna will be professionally installed on fixed-mounted outdoor permanent structures where the antenna will be 2 meters away from any other antenna and all persons.

Protection from Lightning



Article 810 of the US National Electric Department of Energy Handbook 1996 specifies that radio and television lead-in cables must have adequate surge protection at or near the point of entry to the building. The code specifies that any shielded cable from an external antenna must have the shield directly connected to a 10 AWG wire that connects to the building ground electrode.

FCC Notice, USA

CarrierWave Digital Radios comply with Part 15 of the FCC rules. The radios are specifically designed to be used under Part 15, Section 15.247 of the FCC rules and regulations. Operation is subject to following conditions:

- The device to utilize a fixed mount antenna, for use on a permanent outdoor structure.
- The device to be installed by qualified installation/deployment personnel, and a minimum of 2 meter of separation must exist between the device and persons, when the device is operating.
- The device installers and operators should be aware of the transmitter operating conditions, specified in the installation manual and other associated user documentation, as well as the antenna co-location requirements of Part 1.1307 (b) (3), of FCC rules, pertaining to RF exposure.
- The device may not cause harmful interference.
- The device must accept interference received, including interference that may cause undesired operation.

The device is intended to be used only when installed in accordance with instructions outlined in this manual. Failure to comply with these instructions may void the user's authority to operate this device and/or the manufacturer's warranty. Furthermore, any unauthorized modification or changes to this device without the express approval of CarrierComm may also void the user's authority to operate this device.

FCC Part 15 Notice

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference, in which case the user will be required to correct the interference at his expense. Any external data or audio connection to this equipment must use shielded cables.

2 System Description

2.1 About This Manual

This manual is written for those who are involved in the “hands-on” installation of the CarrierWave Digital Radio, such as installation technicians, site evaluators, project managers, and network engineers. It assumes the reader has a basic understanding of how to install hardware, use Windows® based software, and operate test equipment.

2.2 Introduction

The CarrierWave family of digital license-free radios provides high capacity transmission, flexibility, features, and convenience for wireless digital communications networks. The CarrierWave digital radios are spectrum and data rate scalable, enabling service providers or organizations to trade-off system gain with spectral efficiency and channel availability for optimal network connectivity. CarrierComm’s digital radio family enables service providers and enterprises to offer a portfolio of secure, scalable wireless applications for data, video, and Voice over IP (VoIP).

The CarrierWave digital radio family operates in the Industrial, Scientific, and Medical (ISM) band of 5.725 to 5.850 GHz, which is typically referred generically as 5.8 GHz. The CarrierWave Digital Radio family supports two types of user data payload connectivity:

- SONET/SDH wireless bridging between two fixed coordinated locations without the delay and expense of trenching fiber or the added costs of leasing dedicated OC-3 lines.
- 100Base-TX intelligent bridging between two locations without the delay and expense of installing cable or traditional microwave
 - Scalable Ethernet capability of 25 and 50 Mbps is included. These scalable radios provide LAN connectivity and offer performance trade-offs between operational bandwidths, data rates, and distance.

For customers such as cellular carriers requiring backhaul and backbone extension as well as service providers requiring network redundancy, new Points of Presence (POPs), and last mile access, the CarrierWave-155 radio is a cost effective alternative to leased lines with carrier-class quality of performance. The CarrierWave-100 radio is a cost effective solution to meet the growing demand for enterprise Local Area Network (LAN) connectivity between buildings and campuses as well as service providers requiring reliable products for infrastructure expansion, extending Metropolitan Area Network (MAN) fiber access, and network redundancy.

The CarrierWave Digital Radio includes integrated Operations, Administration, Maintenance, and Provisioning (OAM&P) functionality and design features enabling simple commissioning when the radio network is initially set up in the field at the customer's premises. Furthermore, a highlight of CarrierComm's radio products is scalability and the capability to support a ring-type architecture. This ring or consecutive point radio architecture is self-healing in the event of an outage in the link and automatically re-routes data traffic, thereby ensuring that service to the end user is not interrupted.

The overall architecture consists of a single 2RU rack mount Indoor Unit (IDU) with a cable connecting to an Outdoor Unit (ODU) with an integrated antenna. There is an option for interfacing the ODU with an external antenna (contact factory for availability). The IDU/ODU architecture is advantageous when compared to a single IDU with external mount antenna since supporting a signal of 5.8 GHz from the IDU rack to the antenna will experience significant signal degradation requiring expensive coaxial cable or waveguide.

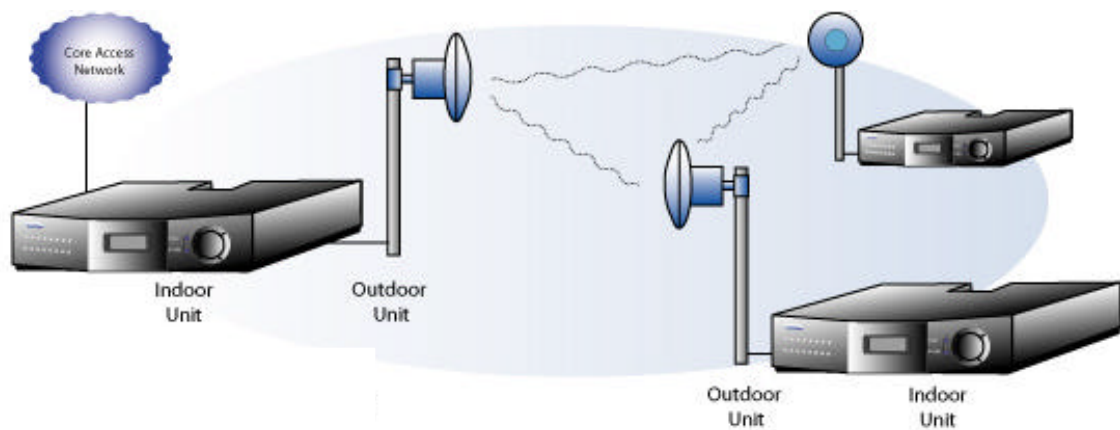


Figure 2-1. CarrierWave IDU/ODU Architecture

Table 2-1 lists key features that CarrierWave technology offers to those involved in the design, deployment and support of broadband fixed wireless networks.

Table 2-1. Key Benefits and Advantages of CarrierWave Digital Radios

Benefits	Advantages to Providers/Customers	Reference
Wireless license-exempt system		
ISM bands do not require expensive license band fees or incur licensing delays.	Fast return on investment.	2.2 – 2.4
Wireless connectivity supplements existing fiber (SONET) or cable (Ethernet).	Lower total cost of total ownership.	
	Media diversity avoids single points of failure.	

Table 2-1. CarrierWave Digital Radio Benefits and Advantages to Providers (continued)

Benefits	Advantages to Providers/Customers	Reference
Easy to install units		
Straightforward modular system enables fast deployment and activation. Carrier-class reliability.	Fast return on investment. No monthly leased line fees.	3.1
Complete support of payload capacity with additional wayside channels		
Aggregate capacity beyond basic payload (50 Mbps or 100 Mbps or 155 Mbps). Scalable and spectrally efficient system. Separate networks for radio overhead/management and user payload.	Increases available bandwidth of network. Allows customer full use of revenue-generating payload channel. T1 wayside channels supports extension of PBX connectivity between buildings without additional leased-line costs. Lowers total cost of ownership.	2.2 – 2.5
Ring Architecture		
Supports a ring (consecutive point) configuration, thus creating a self-healing redundancy that is more reliable than traditional point-to-point networks. In the event of an outage, traffic is automatically rerouted via another part of the ring without service interruption. Ring/consecutive point networks can overcome line-of-sight issues and reach more buildings than other traditional wireless networks. Networks can be expanded by adding more CarrierWave Digital Radios or more rings without interruption of service. A separate management channel allows for a dedicated maintenance ring with connections to each CarrierWave Digital Radio on the ring.	Enables network scalability. Increases deployment scenarios for initial deployment as well as network expansion with reduced line-of-sight issues. Increases network reliability due to self-healing redundancy of the network. Minimizes total cost of ownership and maintenance of the network. Allows for mass deployment.	2.4 – 2.5, 2.6, 3.7, 4.4

Table 2-1. CarrierWave Digital Radio Benefits and Advantages to Providers (continued)

Benefits	Advantages to Providers/Customers	Reference
Adaptive Power Control		
Automatically adjusts transmit power in discrete increments in response to RF interference	Enables dense deployment. Simplifies deployment and network management.	2.5, 2.7
Comprehensive Link/Network Management Software		
A graphical user interface offers security, configuration, fault, and performance management via standard craft interfaces. Suite of SNMP-compatible network management tools that provide robust local and remote management capabilities.	Simplifies management of radio network and minimizes resources as entire network can be centrally managed out of any location. Simplifies troubleshooting of single radios, links, or entire networks. Simplifies network upgrades with remote software upgrades. Allows for mass deployment.	2.8, 3.7, 4.5

2.3 System Features

- Selectable Rates
 - o CarrierWave-100/Ethernet: 25, 50, and 100 Mbps
 - o CarrierWave-155/SONET: 155 Mbps
- Selectable Spectral Efficiency of 5 bits/Hz
- QPSK, 16 –64 QAM Modulation
- Powerful Trellis Coded Modulation concatenated with Reed-Solomon Error Correction
- Built-in Adaptive Equalizer
- Support of T1 Wayside Channels
 - o CarrierWave-100: 2 T1 channels
 - o CarrierWave-155: 1 T1 channel

- Peak output power: +30 dBm
- Receive Sensitivity: -81 dBm (or lower, depending on data rate/modulation/FEC)
- Adaptive Power Control
- Built-in Network Management System (NMS)
- Consecutive Point ring architecture
- Built-in Bit Error Rate (BER) performance monitoring

2.4 Physical Description

The following section details the physical features of the CarrierWave digital radios

- Model types
- Front and rear panel configurations
- LED descriptions

2.4.1 Model Types

Table 2-2 lists the CarrierWave digital radios according to model number and associated capabilities of throughput, data interface, and wayside channel.

Table 2-2. CarrierWave Model Types

Product Name	Model Number	Throughput	Data Interface	Wayside
CarrierWave-100	5100	100 Mbps full duplex	100 BaseTX	Two T1s
CarrierWave-155	5155	155 Mbps full duplex	OC-3	One T1

2.4.2 Front Panel Indicators

All models of the CarrierWave Digital Radios have the following front panel configurations.

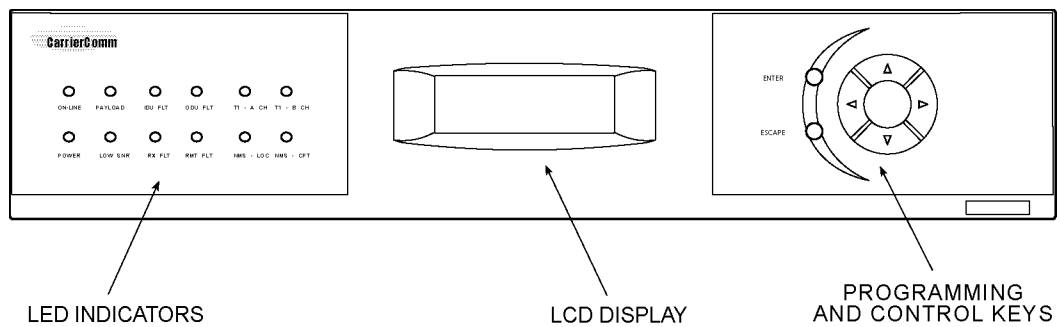


Figure 2-2. CarrierWave Digital Radio IDU Front Panel Configuration

The basic operation of the CarrierWave Digital Radio can be checked by viewing the LED indicators on the front panel. Normally, only green LEDs should be lit. A yellow LED indicates potential system degradation, though the link is still active and operational. A red LED is an alarm indicator. If it is lit, it indicates a potential problem in the radio system. Refer to Figure 2-3 and the table that follows for a detailed explanation of the LED indicators.

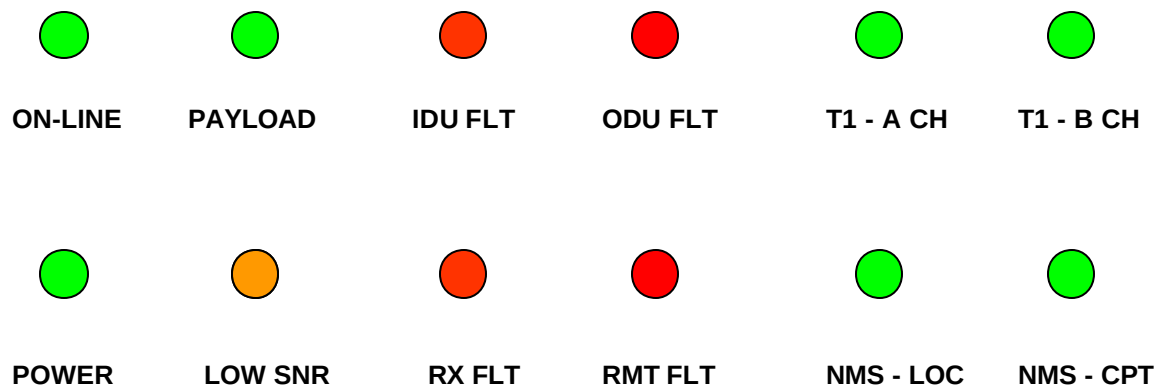


Figure 2-3. IDU Front Panel LEDs

Table 2-3. LED Status Indicator Functions

LED	Name	Function
ON-LINE	On-Line	When this LED is illuminated it indicates that the modem is locked and a link has been established with the far-end radio
PAYLOAD	Payload	When this LED is illuminated it indicates that the payload port is connected.
IDU FLT	IDU Fault	When this LED is illuminated it indicates that there is a fault detected in the IDU equipment. The menu interface can then be used to show all current faults.
ODU FLT	ODU Fault	When this LED is illuminated it indicates that there is a fault detected in the ODU equipment. The menu interface can then be used to show all current faults.
T1- A	T1 – A Channel	When this LED is illuminated it indicates that there is a T1 connection to the A port.
T1- B	T1 – B Channel	When this LED is illuminated it indicates that there is a T1 connection to the B port.
POWER	Power	When this LED is illuminated it indicates that power is on.
LOW SNR	Low Signal to Noise Ratio	When this LED is illuminated it indicates that the SNR is below the Error Free threshold.
RX FLT	Receive Fault	When this LED is illuminated it indicates that the Receiver does not detect a valid signal indicating a problem with the receiver or remote transmitter.
RMT FLT	Remote Fault	When this LED is illuminated it indicates that the far-end radio has a fault condition.
NMS LOC	Local NMS Port	When this LED is illuminated it indicates that there is a connection to the local NMS port.
NMS CPT	Consecutive Point NMS Port	When this LED is illuminated it indicates that there is a connection to the remote or Consecutive Point NMS port.

2.4.3 Rear Panel Connections

Please refer to the Figures 2-4 and 2-5 for a pictorial of the CarrierWave IDU rear panel followed by a descriptive text of the connections.

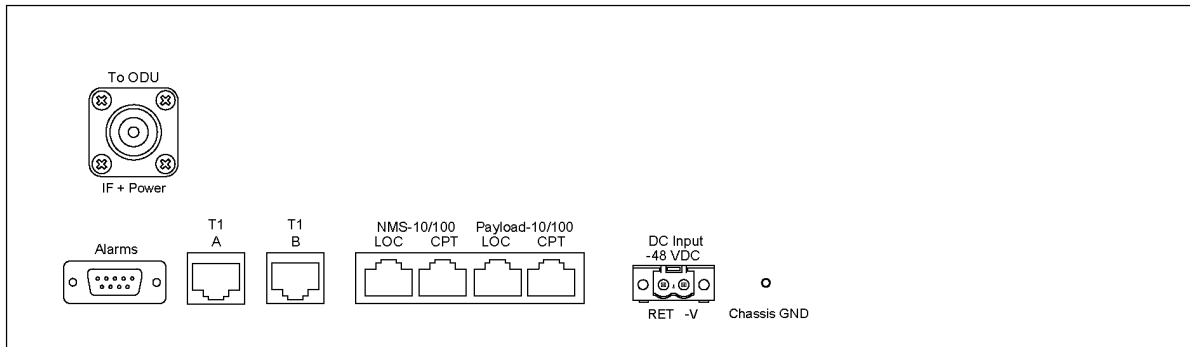


Figure 2-4. CarrierWave-100 Ethernet: IDU Rear Panel Connections

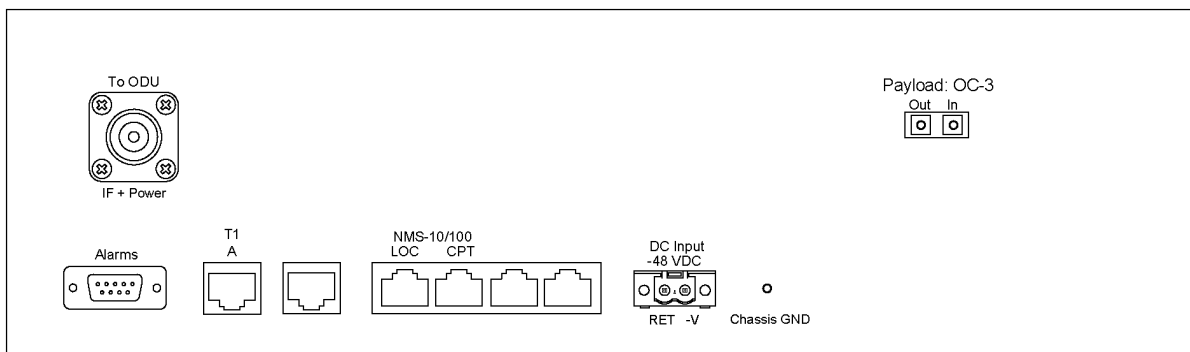


Figure 2-5. CarrierWave-155 SONET: IDU Rear Panel Connections

The recommended maximum length for all cables to terminal equipment is a maximum of 3 meters. The exception to this recommendation is the length of the ODU/IDU Interconnect cable, which connects the Outdoor Unit to the Indoor Unit.

Power Supply

DC Input -48 VDC	-48v (Isolated Input); 2-pin captive power connector. The CarrierWave Digital Radio requires an input of –37 to –60 volts dc at the rear panel DC Input connector. The total required power is a maximum of 70 W. The IDU rear panel power connector pin numbering is 1 through 2, from left to right, when facing the unit rear panel. Pin 1 is the power supply return and is connected to unit chassis ground internally. Pin 2 should be supplied with a nominal –48 V dc, with respect to the unit chassis (ground). A ground-isolated supply may be used, provided it will tolerate grounding of its most positive output. The recommended power input is –44 to –52 V dc at 2 Amps minimum. It is recommended that any power supply used be able to supply a minimum of 100 W to the IDU. A mating power cable connector is supplied with the CarrierWave IDU. It is a 2-pin plug, 5 mm pitch, manufactured by Phoenix Contact, P/N 17 86 83 1 (connector type MSTB 2,5/2-STF). This connector has screw clamp terminals that accommodate 24 AWG to 12 AWG wire. The power cable wire should be selected to provide the appropriate current with minimal voltage drop, based on the power supply voltage and length of cable required. The recommended wire size for power cables under 10 feet in length supplying –48 Vdc is 18 AWG. The IDU supplies the ODU with all required power via the ODU/IDU Interconnect cable. The CarrierWave Digital Radio IDU does not have a power on/off switch. When DC power is connected to the IDU, the digital radio powers up and is operational. There can be up to 200 mW of RF power present at the antenna port (external antenna version). The antenna should be directed safely when power is applied.
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Chassis Ground

Chassis GND	Chassis ground stud.
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Alarm Output Interface

Alarms	DB-9 female connector for two Form-C relay alarm outputs (rated load: 1A @ 30 VDC).
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CarrierWave-100/Ethernet Models: Ethernet 100BaseT Connection

100BaseTX LOC	100Base-TX RJ-45 modular port connector for the local Fast Ethernet interface.
100BaseT CPT	100Base-TX RJ-45 modular port connector. This port to be used for consecutive point networks.

CarrierWave-155/SONET Models: OC-3 Connection

OC-3 Out	OC-3 type SC connectors for the OC-3 interface.
OC-3 In	OC-3 type SC connectors for the OC-3 interface.

ODU/IDU Interconnect

To ODU	N-type female connector. Used to connect the ODU to the IDU. Provides –48VDC and 2375 MHz Transmit IF to the ODU and receives 1675 MHz Receive IF from the ODU.
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NMS 10/100 Network Management System Connection

10/100BaseT LOC	10/100Base-TX RJ-45 modular local port connector for access to the CarrierWave Network Management System (SNMP or iConductor™, a CarrierWave proprietary system).
10/100BaseT CPT	10/100BaseTX RJ-45 modular remote port connector for access to the CarrierWave port Network Management System (SNMP or iConductor™, a CarrierWave proprietary system). This port to be used for consecutive point networks.

T1 Wayside Channels

T1 – A	Wayside channel for T1 (RJ-48C) interface voice connection. Operational for both CarrierWave-100 Ethernet and CarrierWave-155 SONET models.
T1 – B	Wayside channel for T1 (RJ-48C) interface voice connection. B channel option only available in CarrierWave-100 Ethernet model.

2.5 System Description

The overall digital radio architecture consists of a single 2RU rack mount Indoor Unit (IDU) with a cable connecting to an Outdoor Unit (ODU) with an integrated antenna. There is an option for interfacing the ODU with an external antenna (consult factory for this option). This IDU/ODU architecture is advantageous when compared to a single IDU with external mount antenna since supporting a signal of 5.8 GHz from the IDU rack to the antenna will experience significant signal degradation requiring expensive coaxial cable or waveguide.

Figure 2-6 shows a functional block diagram of the CarrierWave Digital Radio, which consists of an antenna, ODU RF Up/Down Converter with HPA and LNA, IF Processor, 64-QAM Modem, Multiplexer/Demultiplexer, and IDU Front Panel.

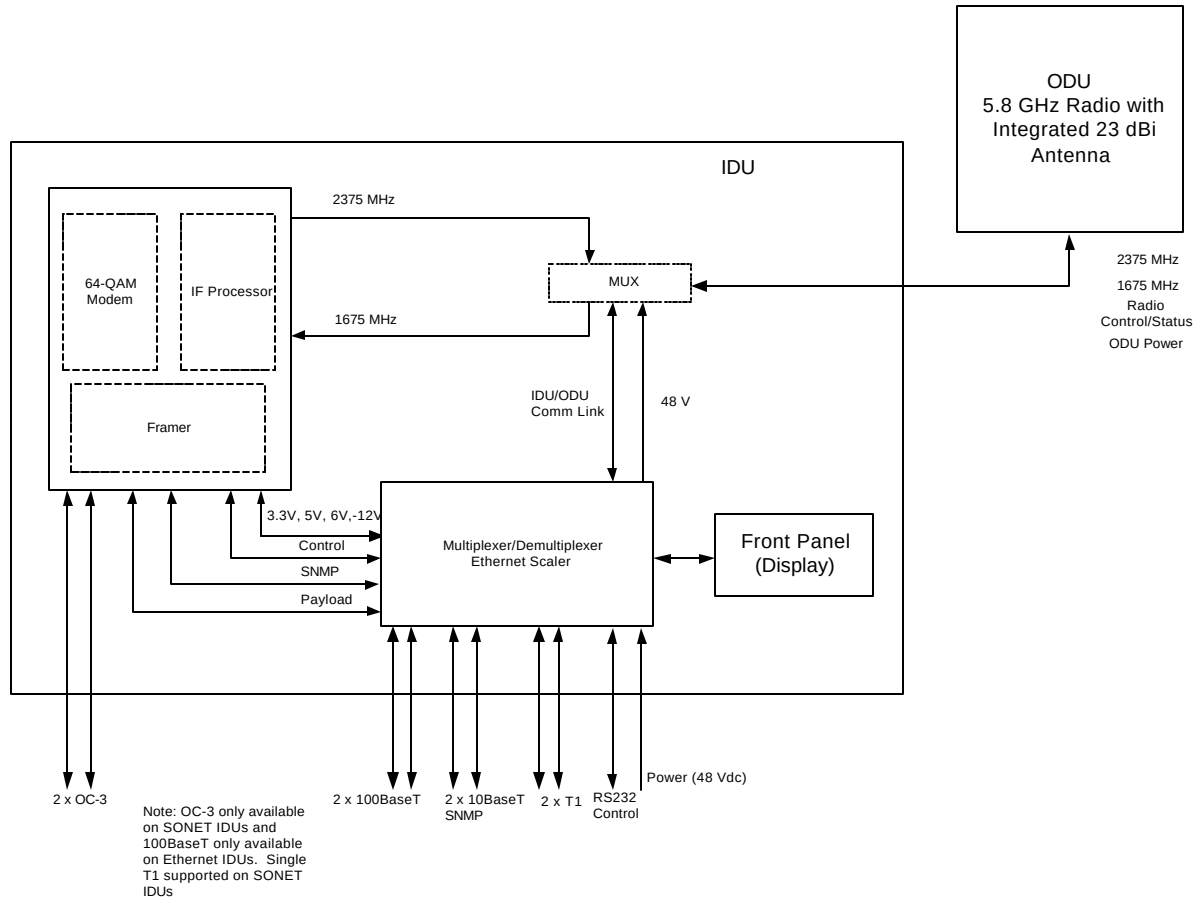


Figure 2-6. CarrierWave System Block Diagram

The IDU interfaces with the ODU to receive and provide modulated transmit and receive waveforms. The IDU interfaces provide SONET OC-3 (CarrierWave-155) and Fast Ethernet 100Base-T (CarrierWave-100) connections to the network. In addition, one (SONET model) or two (Ethernet model) T1 channels are provided for PBX extension. SNMP is provided on 10/100BaseT ports.

The ODU RF Up/Down Converter card provides the interface to the antenna. The transmit section up converts and amplifies the modulated Intermediate Frequency (IF) of 2.375 GHz from the IF Processor and provides additional filtering. The receive section down converts the received signal, provides additional filtering, and outputs an IF of 1.675 GHz to the IF Processor. The 64-QAM Modem performs the modulation and demodulation of the payload (OC-3 or Fast Ethernet or Scalable Ethernet), and forward error correction using advanced modulation and coding techniques. Using all-digital processing, the 64-QAM Modem uses robust modulation and forward error correction coding to minimize the number of bit errors and optimize the radio and network performance. The 64-QAM Modem also scrambles, descrambles and

interleaves/deinterleaves the data stream in accordance with Intelsat standards to ensure modulation efficiency and resilience to sustained burst errors. The modulation will vary by application, data rate, and frequency spectrum. The highest order modulation mode supported is 64 Quadrature Amplitude Modulation (QAM). Table 2-4 summarizes the TCM/convolutional code rates for each modulation type supported by the Digital Radio.

Table 2-4. CarrierWave Digital Radio TCM/Convolutional Code Rates

Modulation Type	Available Code Rates
QPSK	$\frac{1}{2}$, $\frac{3}{4}$, $\frac{7}{8}$, $\frac{1}{1}$
16-QAM	$\frac{3}{4}$, $\frac{7}{8}$, $\frac{11}{12}$
32-QAM	$\frac{4}{5}$, $\frac{9}{10}$
64-QAM	$\frac{5}{6}$, $\frac{11}{12}$

The IDU also provides the physical interface for the user payload and network management. In transmit mode, the Frammer merges user payload (OC-3 or Fast Ethernet) with radio overhead-encapsulated network management data. This combined data stream is transmitted without any loss of user bandwidth. In the receive mode, the Frammer separates the combined data stream received from the 64-QAM Modem. The IDU supports Scalable Ethernet data rates, such as 25 or 50 Mbps via the 100BaseT data interface port. The IDU provides network management data on 10 Mbps ports accessible via the 10/100BaseTX port. The Central Processor Unit (CPU) provides the embedded control and network element functionality of the OAM&P. The CPU also communicates with other functions within the IDU for configuration, control, and status monitoring. The CPU passes appropriate status information to the IDU front panel display.

The power supply converts 48 Vdc to the DC voltage levels required by each component in the system.

2.6 Consecutive Point Architecture

The consecutive point network architecture is based upon the proven SONET/SDH ring. Telecommunications service providers traditionally use the SONET/SDH ring architecture to implement their access networks. A typical SONET/SDH network consists of the service provider's Point of Presence (POP) site and several customer sites with fiber optic cables connecting these sites in a ring configuration (see Figure 2-7). This architecture lets providers deliver high bandwidth with high availability to their customers.

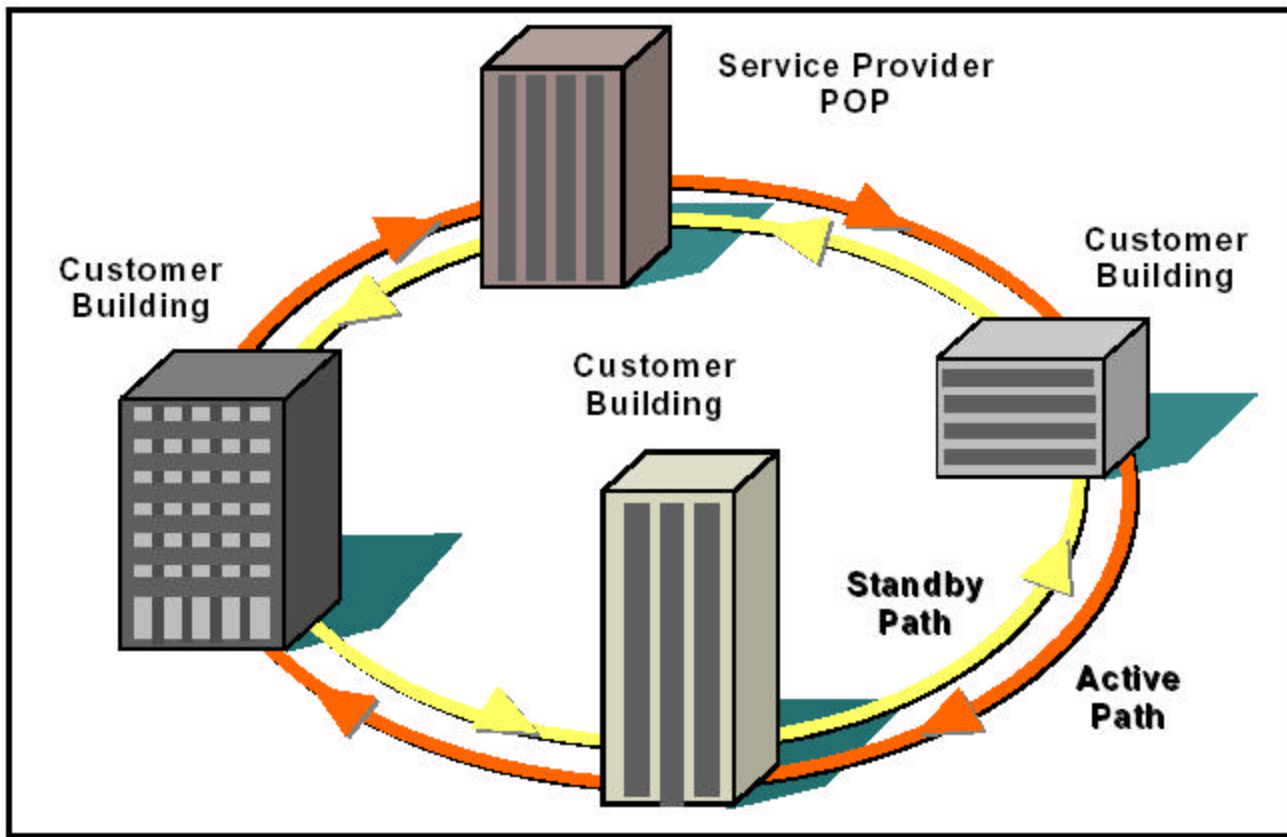


Figure 2-7. Ring Configuration.

SONET/SDH rings are inherently self-healing. Each ring has both an active path and a standby path. Network traffic normally uses the active path. Should one section of the ring fail, the network will switch to the standby path. Switchover occurs in seconds. There may be a brief delay in service, but no loss of payload, thus maintaining high levels of network availability.

The consecutive point architecture implemented in the CarrierWave Digital Radio family is based on a point-to-point-to-point topology that mimics fiber rings, with broadband wireless links replacing in-ground fiber cable. A typical consecutive point network consists of a POP and several customer sites connected using CarrierWave units. These units are typically installed in pairs in a building. Each unit installed at a customer site is logically connected to two other units. These connections are as follows:

- An over-the-air radio frequency (RF) link to a unit at an adjacent site
- A back-to-back Ethernet cable link to another unit in the same building through a switch

Each consecutive point network typically starts and ends at a POP. A pattern of wireless links and in-building connections is repeated at each site until all buildings in the network are connected in a ring as shown in Figure 2-8.

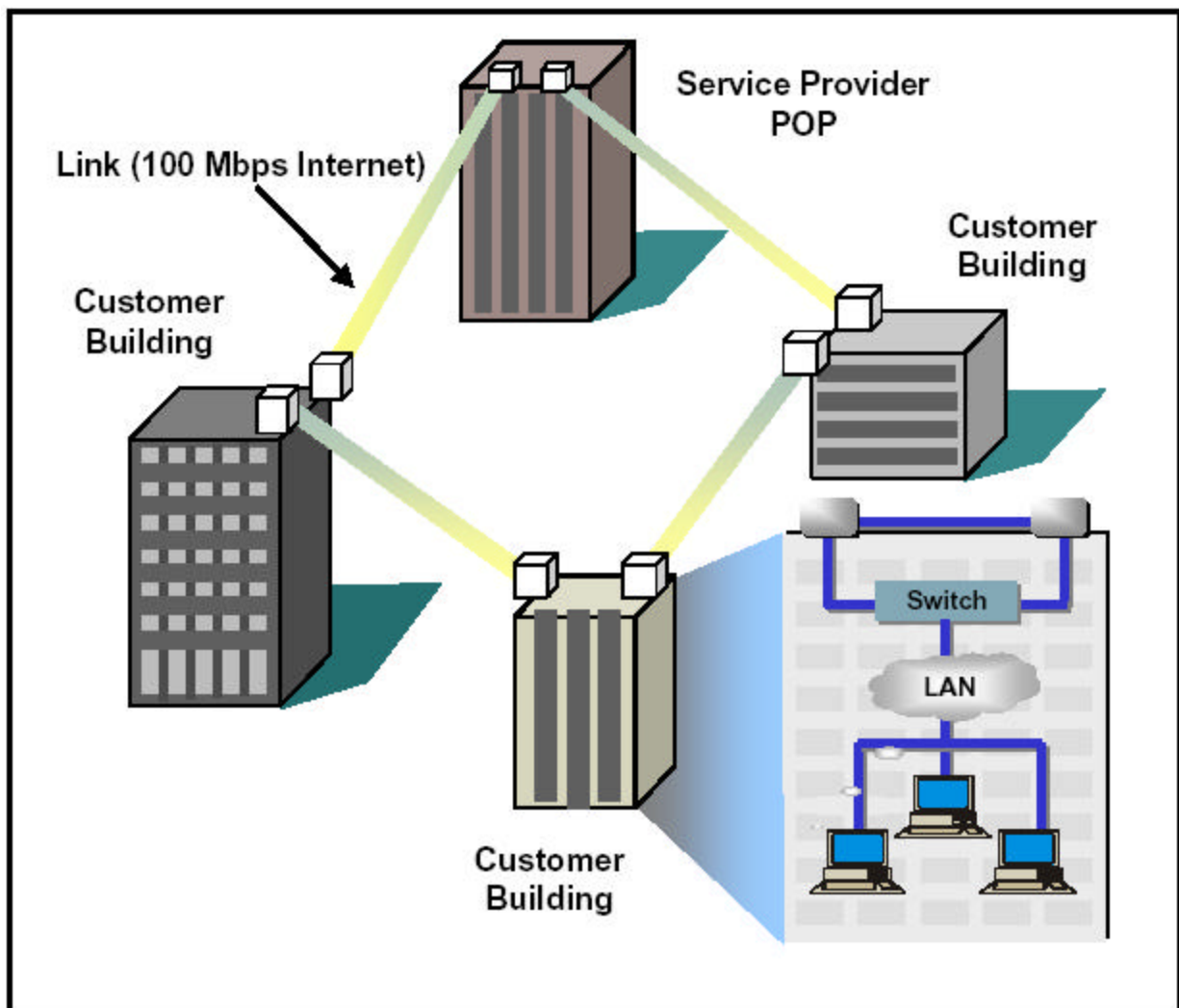


Figure 2-8. Consecutive Point Network

2.7 Power Management

RF power management is a radio design feature that controls the power level (typically expressed in dBm) of the RF signal received from a transmitter by a receiver. The traditional goal of power management is to ensure that the RF signal at a receiver is strong enough to maintain the radio link under changing weather and link conditions.

Traditional power management techniques such as Constant Transmit Power Control (CTPC) and Automatic Transmit Power Control (ATPC) transmit at a high power level to overcome the effects of fading and interference. However, these techniques continue to operate at a higher power level than needed to maintain the link in clear weather. Because transmit power remains high when the weather clears, the level of *system interference* increases.

Radios operating at high transmit power will interfere with other radios, even if the interfering source is miles away from the victim. High interference levels can degrade signal quality to the point that wireless radio links become unreliable and network availability suffers. The traditional solution to system interference is to increase the distance between radios. However, the resulting sparse deployment model is inappropriate for metropolitan areas.

In response to the need for a high-density deployment model the CarrierWave use a unique power control technique called A_d TPC. A_d TPC enables CarrierWave units to transmit at the minimum power level necessary to maintain a link regardless of the prevailing weather and interference conditions. The CarrierWave is designed and manufactured to not exceed the +30 dBm maximum power allowed. The purpose of power management is to minimize transmit power level when lower power levels are sufficient. A_d TPC also extends the concept of power management by controlling not only the power (dBm) of the RF signal, but its quality (signal-to-noise ratio) as well.

In contrast to ATPC, the A_d TPC technique dynamically adjusts the output power based on both the actual strength and quality of the signal. Networked CarrierWave units constantly monitor receive power and maintain 10^{-12} BER performance under varying interference and climate conditions. Each CarrierWave unit can detect when there is a degradation in the received signal level of quality and adjust the transmit power level of the far-end CarrierWave unit to correct for it.

A_d TPC provides maximum power in periods of heavy interference and fading and minimum power when conditions are clear. Minimal transmit power reduces potential for co-channel and adjacent channel interference with other RF devices in the service area, thereby ensuring maximum frequency re-use. The resulting benefit is that operators are able to deploy more CarrierWave units in a smaller area.

2.8 CarrierWave iWare™ Software and Network Management

iWare™ is the software suite that is fully compatible with SNMP (v1) and standard NMS software. All of the CarrierWave Digital Radio parameters are accessible through the fully featured MIB, allowing for automation of data collection and network management.

iWare™ includes:

- iPorter™: capability to remotely manage the software. It enables the user to install, backup and recover CarrierWave Digital Radio software
- iConductor™: a GUI-based management application that can be run locally, at the installation site, from a PC connected directly to the CarrierWave IDU, or it may be operated remotely from any from any point in a CarrierWave network.

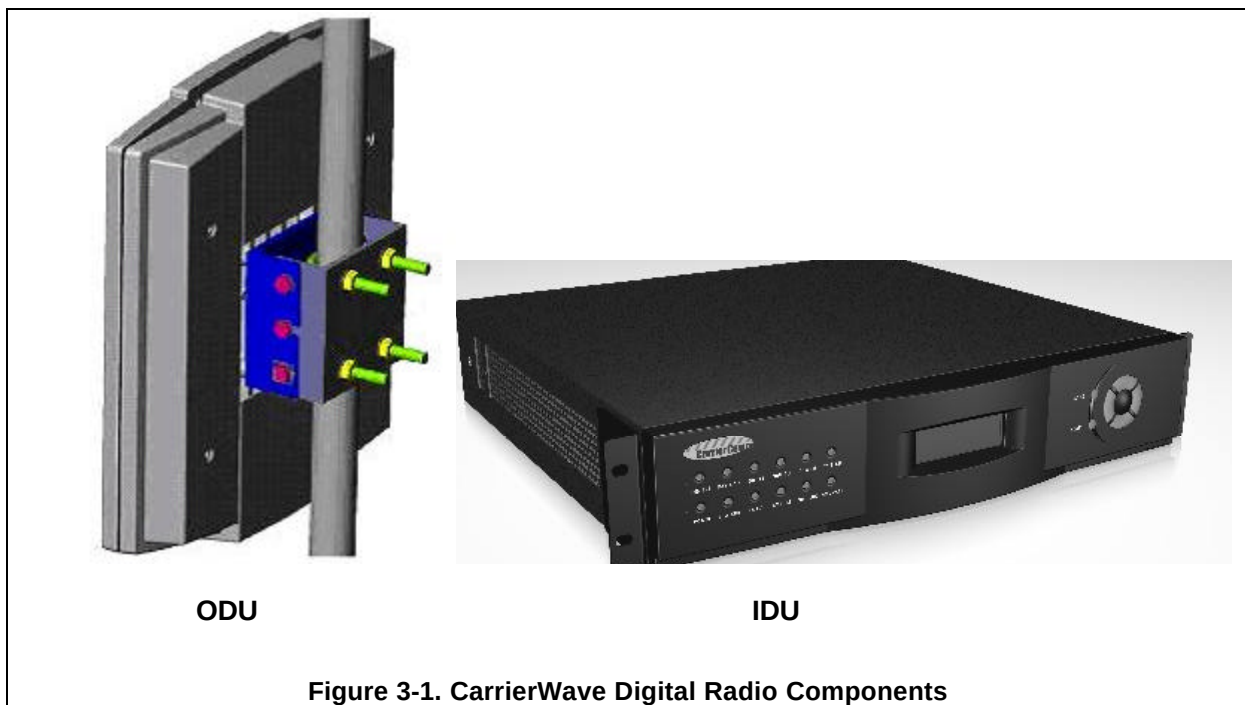
Detailed descriptions of iWare™ are provided in a separate document.

3 Installation

3.1 Unpacking

The following is a list of all included items.

Description	Quantity
Digital Radio IDU (2RU chassis)	1
ODU (with hardware)	1
Manual (or Soft copy on a CD)	1
Test Data Sheet (customer documentation)	1



Be sure to retain the original boxes and packing material in case of return shipping. Inspect all items for damage and/or loose parts. Contact the shipping company immediately if anything

appears damaged. If any of the listed parts are missing, call the distributor or the factory immediately to resolve the problem.

3.2 Notices

CAUTION

IF USING EXTERNAL ANTENNA OPTION (SEE FACTORY FOR DETAILS), DO NOT OPERATE UNITS WITHOUT AN ANTENNA, ATTENUATOR, OR LOAD CONNECTED TO THE ANTENNA PORT. DAMAGE MAY OCCUR TO THE TRANSMITTER DUE TO EXCESSIVE REFLECTED RF ENERGY.

ALWAYS ATTENUATE THE SIGNAL INTO THE RECEIVER ANTENNA PORT TO LESS THAN -20 dBm. THIS WILL PREVENT OVERLOAD AND POSSIBLE DAMAGE TO THE RECEIVER MODULE.

WARNING

HIGH VOLTAGE IS PRESENT INSIDE THE ODU and IDU WHEN THE UNIT IS PLUGGED IN. TO PREVENT ELECTRICAL SHOCK, UNPLUG THE POWER CABLE BEFORE SERVICING. UNIT SHOULD BE SERVICED BY QUALIFIED PERSONNEL ONLY.

3.3 PRE-INSTALLATION NOTES

It may be useful to gain familiarity with the CarrierWave Digital Radio via back-to-back bench testing prior to final installation. We highly recommend installation of lightning protectors on the ODU/IDU Interconnect Cable to prevent line surges from damaging expensive components.

3.3.1 Back-to-Back Bench Testing

Back-to-back bench testing prior to final installation is highly recommended in order to gain familiarity with the product. This test requires external antenna support. The following additional equipment is required for back-to-back testing:

- Low-loss cables, N-male connectors on ODU interfaces.
- Four Inline RF attenuators, 40 dB each (or replace two with single 80 dB attenuator), rated for 5.8 GHz.

The IDU and ODUs must be configured in an operational configuration and set-up as shown in Figure 3-2. When equipment is connected in operational configuration, no errors should be reported on the front panel.

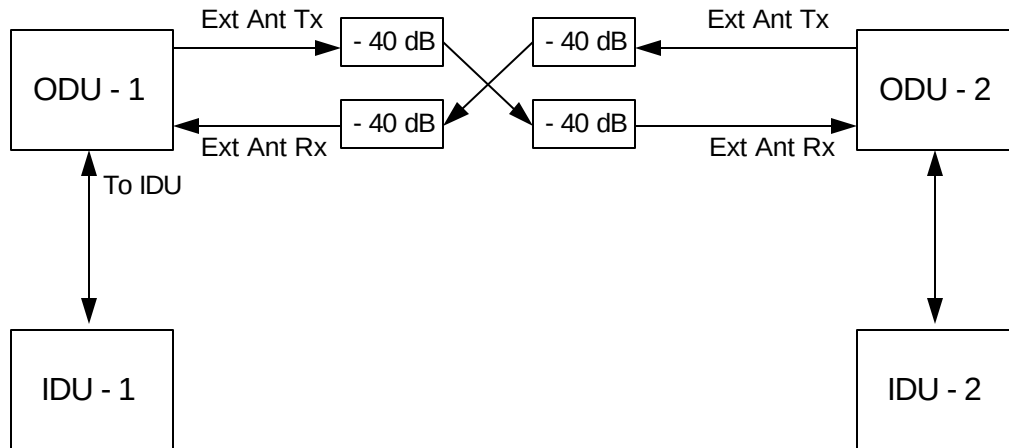


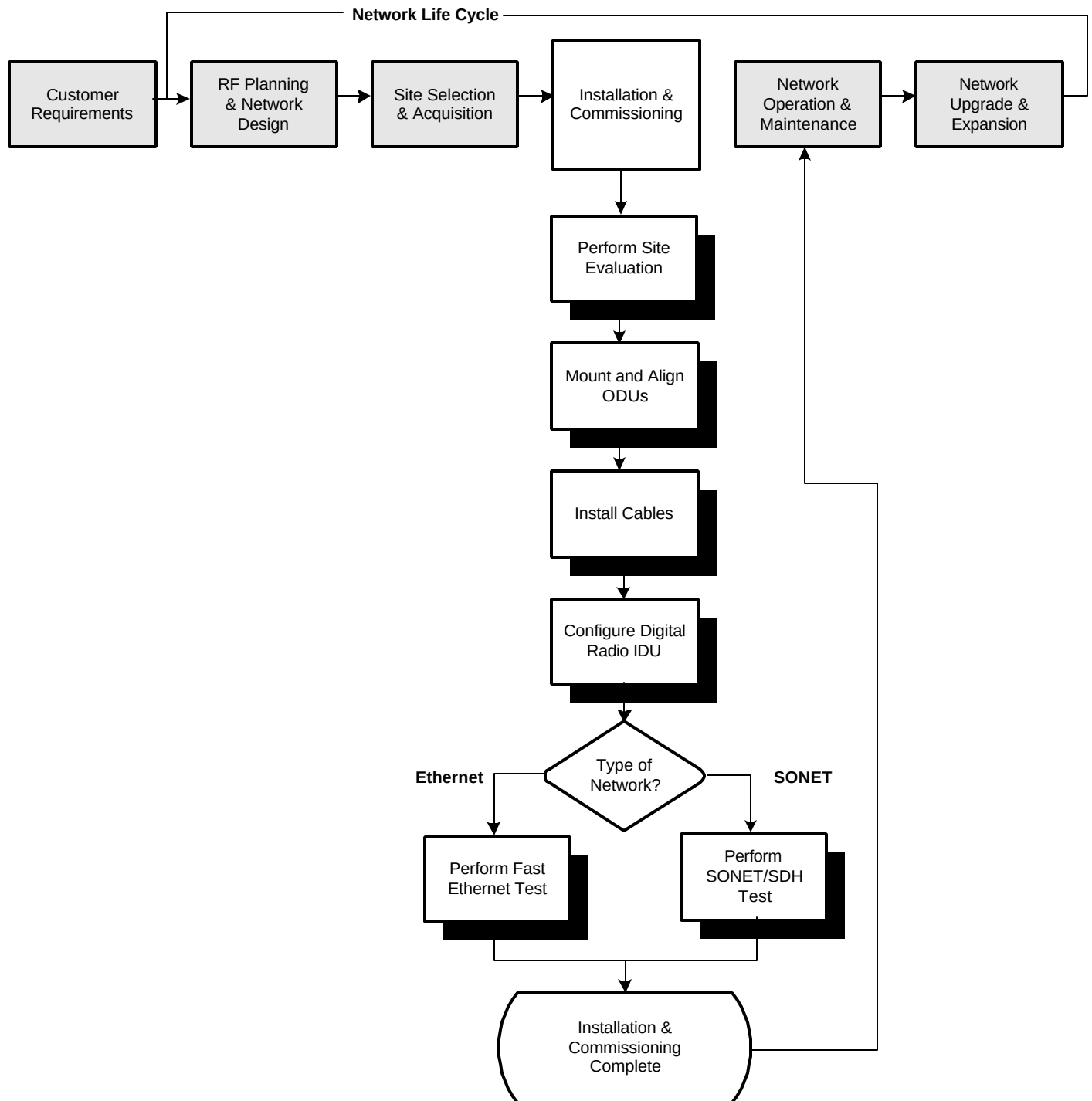
Figure 3-2. CarrierWave Digital Radio Back-to-Back Testing Configuration

3.4 Overview of Installation and Testing Process

The installation and testing process is accomplished by performing a series of separate, yet interrelated, procedures, each of which is required for the successful implementation of a production CarrierWave Digital Radio network. These procedures are as follows:

- Site Evaluation: gathering specific information about potential CarrierWave Digital Radio installation sites.
- Cable and Installation: Testing and installing CarrierWave ODU cables and optional interface devices at installation sites.
- CarrierWave ODU Mounting and Alignment: Mounting ODUs to a pole or wall, performing link alignment and radio frequency (RF) verification.
- CarrierWave Digital Radio Configuration: Using CarrierWave Link Manager software to install network- and site-specific parameters in the radios.
- CarrierWave Digital Radio Testing: Performing cable continuity checks and RF tests for links, the payload/radio overhead channel, and the management channel.

The following diagram shows where installation and commissioning resides within the CarrierWave Digital Radio network deployment life cycle and defines the sequence in which the processes that comprise installation and commissioning should be performed.



03-01-013a

3.5 Site Evaluation

A site evaluation consists of a series of procedures for gathering specific information about potential CarrierWave Digital Radio locations. This information is critical to the successful design and deployment of a network.

Site evaluations are required to confirm whether or not a building meets network design requirements. The main objectives are as follows:

- Confirm
 - Line of sight for each link
 - CarrierWave Digital Radio ODU mounting locations
 - Site equipment locations
 - Cable routes
 - Any other potential RF sources
- Prepare site drawings and record site information

3.5.1 Preparing for a Site Evaluation

The following tools are required to perform a site evaluation:

- RF and network design diagrams (as required)
- Binoculars
- Global positioning system (GPS) or range finder
- Compass
- Measuring tape and/or wheel
- Digital camera
- Area map
- Aerial photograph (if available)
- List of potential installation sites ("targeted buildings")

The following tasks must be completed prior to performing a site evaluation:

- Prepare the initial network design by performing the following:

- Identify potential buildings by identifying targeted customers (applicable if you're a service provider)
- Identify potential links by selecting buildings based on the high probability of line of sight
- Arrange for access with the facility personnel into the buildings, equipment rooms, and architectural plans to become familiar with the location of all ducts, risers, etc.

3.5.2 Site Evaluation Process

The following steps must be completed to perform a successful site evaluation. Each step in the process is detailed in the following subparagraphs:

- **Ensure RF Safety compliance:** Ensure that appropriate warning signs are properly placed and posted at the equipment site or access entry. For a complete list of warnings, refer the Safety Precautions listed at the beginning of this manual.
- **Ensure Compliance with Laws, Regulations, Codes, and Agreements:** Ensure that any installation performed as a result of the site evaluation is in full compliance with applicable federal and local laws, regulations, electrical codes, building codes, and fire codes.
- **Establish Line of Sight between CarrierWave Digital Radios:** **The most critical step in conducting a site evaluation is confirming clear Line of Sight (LOS) between a near CarrierWave Digital Radio and a far CarrierWave Digital Radio. If LOS does not exist, another location must be used.**

CarrierWave Radios in a link must have a clear view of each other, or "line of sight". Binoculars may be used evaluate the path from the desired location of the near CarrierWave Radio to the desired location of the far CarrierWave Radio.

To confirm Line of Sight:

- Ensure that no obstructions are close to the transmitting/receiving path. Take into consideration trees, bridges, construction of new buildings, unexpected aerial traffic, window washing units, etc.
- Ensure that each CarrierWave Digital Radio can be mounted in the position required to correctly align the CarrierWave Digital Radio with its link partner.
- **Determine CarrierWave ODU Mounting Requirements:** CarrierWave ODUs can be mounted on an antenna mast, brick, masonry or wall. Refer to detailed installation sections.
- **Determine CarrierWave IDU Installation Location:** CarrierWave IDUs can be installed tabletop or cabinet, wall mount, or rack mount. The site must provide DC power. Refer to detailed installation sections.
- **Document Potential Sources of Colocation Interference:** When CarrierWave ODUs are located on a roof or pole with other transmitters and receivers, an interference analysis may be required to determine and resolve potential interference issues. The interference analysis needs to be performed by an RF engineer. The specific information required for each transmitter and receiver includes the following:

- Transmitting and/or receiving frequency
- Type of antenna
- Distance from CarrierWave ODU (horizontal and vertical)
- Polarity (horizontal or vertical)
- Transmit power level
- Antenna direction
- Measure the Link Distance: The two ways to measure link distance are as follows:
 - GPS: record the latitude and longitude for the near and far CarrierWave ODU sites and calculate the link distance. Record the mapping datum used by the GPS unit and ensure the same mapping datum is used for all site evaluations in a given network.
 - Range finder: measure the link distance (imperial or metric units may be used).

Once the link distance has been measured, verify that the link distance meets the availability requirements of the link.

- Select the Grounding Location for both the CarrierWave ODU and IDU: The CarrierWave Digital Radio must be properly grounded in order to protect it and the structure it is installed on from lightning damage. This requires
 - Grounding all ODUs as specified in the Installation section
 - Grounding all IDUs to the rack.
- Determine the Length of Interconnect Cable from ODU to IDU: The primary consideration for the outdoor interconnect cable from the ODU to IDU is the distance and route between the ODU and IDU. This cable should not exceed 300 feet using Times Microwave LMR-400 cable. Longer lengths and distances are possible, but require higher quality cable, as illustrated in the table below.

Cable Type	Loss at 2.5 GHz (dB/100 ft.)	Cable Length Allowed (ft.)
LMR-200	16.9	120
LMR-300	10.4	200
LMR-400	6.8	300
LMR-600	4.4	450
LMR-900	3.0	650
Listed cable types are from Times Microwave, equivalent cable from other manufacturers may be used		

- Confirm the Presence of DC Power for the CarrierWave IDU.
- Ensure Building Aesthetics: The CarrierWave ODU's streamlined exterior is designed to complement building aesthetics. Ensure that the ODU can be mounted so that it is aesthetically pleasing to the environment and to the property owner. Aesthetics must be approved by the property owner and the network engineer.
- Take Site Photographs
- Sketch the Site

3.5.3 Critical System Calculations

3.5.3.1 Received Signal Level (RSL) and Link Budget

The received signal level (RSL) can be estimated using the following formula:

$$\text{RSL (dBm)} = P_{\text{TX}} + G_{\text{TX ANT}} - L_{\text{Path}} + G_{\text{RX ANT}}$$

Where: P_{TX} is the transmitter output power (in dBm)

$G_{\text{TX ANT}}$ is the gain of the transmit antenna (in dB), 23 dBi for ODU's internal antenna

$G_{\text{RX ANT}}$ is the gain of the receive antenna (in dB), 23 dBi for ODU's internal antenna

L_{Path} is the Path loss, defined by:

$$L_P \text{ (dB)} = 36.6 + 20\log_{10}(F \cdot D)$$

Where: F is the Frequency in MHz (5800), D is the Distance of path in miles

This link budget is very important in determining any potential problems during installation. The expected RSL and measure RSL should be close (+/- 5 to 10 dB)

3.5.3.2 Fade Margin Calculation

The fade margin is the difference between the actual received signal and the CarrierWave Digital Radio's threshold for the modulation mode selected. The fade margin can be used to determine availability and should be at least 10 dB.

3.5.3.3 Availability Calculation

Availability of the microwave path is a prediction of the percent of time that the link will operate without producing an excessive BER due to multipath fading. Availability is affected by the following:

- Path length
- Fade margin

- Frequency
- Terrain (smooth, average, mountainous, valleys)
- Climate (dry, temperate, hot, humid)

Depending on the type of traffic carried over the link and the overall network design redundancy, fade margin should be included to support the desired availability rate. Critical data and voice may require a very high availability rate (99.999% or 5.3 minutes of predicted outage per year). To improve availability, the fade margin can be increased by shortening the path length, transmitting at a higher power level, or by using higher gain antennas.

Availability can be computed using the following formula, which is known as the *Vigants Barnett Method*.

$$\text{Availability} = 100 \times (1 - P)$$

$$P = 2.5 \times 10^{-9} \times C \times F \times D^3 \times 10^{(-FM/10)}$$

Where F is the frequency in MHz (5800)

D is the distance in miles

FM is the fade margin in dB

C is the climate/terrain factor as defined below:

Humid/Over Water: C = 4 (worst case channel)

Average Conditions: C = 1

Dry/Mountains: C = 0.25 (best case channel)

Example: Assume 21 dB fade margin, over 5 miles with average climate/terrain. The availability comes out to be 99.9986. This corresponds to the link being unavailable for 7.6 minutes per year.

3.5.3.4 Frequency Plan Determination

When configuring CarrierWave Digital Radios in a point-to-point or consecutive point configuration, careful engineering of the CarrierWave Digital Radio frequency plans and antenna locations should be performed in order to minimize potential interference between nearby radios. Nearby radios should operate on different frequencies, transmitting in the same band (high side or low side). When designing multi-radio configurations, antenna size, antenna polarization, and antenna location are critical.

The frequency plan must be selected based on desired data rate and expected link conditions. In a high interference environment or with lower gain antennas, higher bandwidth, more robust modulation formats must be employed. The available frequency plans are illustrated in Figure 3-3.

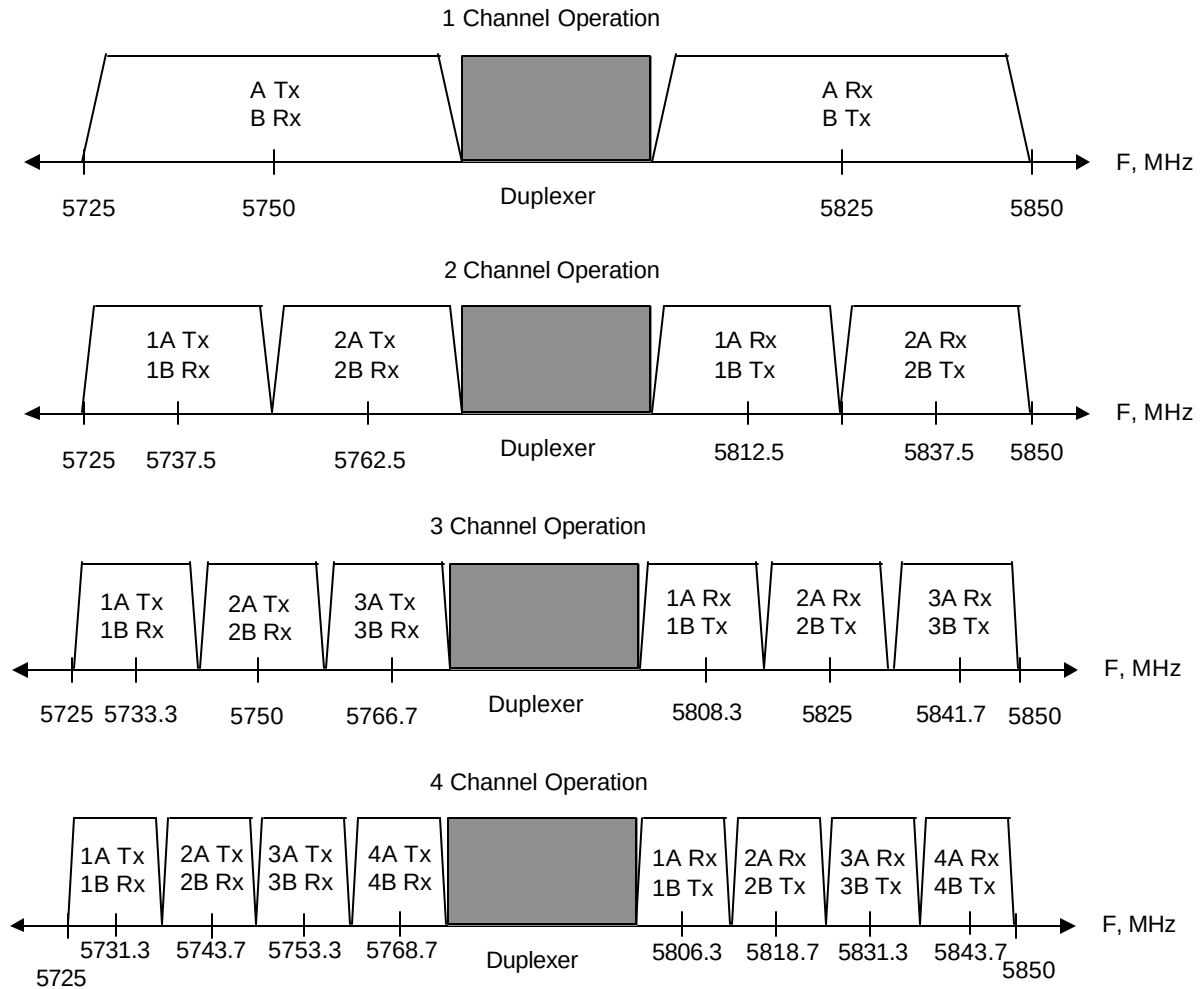


Figure 3-3. CarrierWave Digital Radio Channel Frequency Plans

3.5.3.5 Antenna Planning

The ODU comes with a built in 23 dBi gain antenna. This should provide adequate link performance for most applications.

Larger antennas have the advantage of providing narrower beamwidths and high isotropic gain, which yields better link performance (higher fade margin, better availability), and improves immunity to spatial interference (due to the smaller beamwidths). However, larger antennas are more costly to purchase and install than smaller antennas and in some cases, they require special equipment for installation due to narrower beamwidths. They are also more easily affected by wind.

Only directional antennas can be used with the CarrierWave Digital Radios. Consult factory for antenna manufacturer options.

The ISM band does not restrict antenna gain or EIRP, therefore there is no need to back off transmit power due to excessive antenna gain.

1. Select where the cable will enter the building from the outside.
2. Determine the length of cable required. Allow three extra feet on each end to allow for strain relief, as well as any bends and turns.

3.5.4 Documenting a Site Evaluation

Use the site evaluation form provided on the following pages to document the results of your site evaluation. Optimally, this complete site form would be stored with the IDU for future reference.

Site Evaluation Form				
Address			Site Engineer	
		Contact Person		
		Phone		
Site No		Site Agent		
Site Type				
ODU Roof Location				
ODU	#	Latitude	Longitude	Mapping Datum (ex. NDA27)
Roof Requirements	Example	Information	Information	Information
	ODU#	4		
	Clear Line of Sight	Yes		
	Mounting Method	Wall or Pole		
	FCC Compliance	Yes		
	Collocation			
	Aesthetics			
	ODU Azimuth	60 degrees		
	GPS Reading	80 21' 48"		
	Cable Lengths			
	Alarm			
	Interconnect Cable	250 feet		
	Grounding/Lighting			
	Instructions			
	Photographs*			
	Photo 1			
	Photo 2			
	Photo 3			
	Sketches**			
	Sketch 1			
Sketch 2				
Recommendations for Site Photographs and Sketches				
<u>*Photographs</u> Photo 1 - ODU mounting location Photo 2 - View from the ODU mounting location to the link partner Photo 3 - IDU location		<u>**Sketches</u> Sketch 1- Roof and cable route to entry point Sketch 2 - Details for grounding and lighting protection Sketch 3 - IDU room and cable routes from entry port		

Site Evaluation Form					
Colocated Antenna	Parameters	Example Information	Information	Information	Information
	Source	PCS			
	Tx and/or Rx	Tx/Rx			
	Frequency	2.1 GHz			
	Distance from ODU	5 feet			
	Owner	Sprint PCS			
	Azimuth	210 degrees			
	Elevation	2 degrees downtilt			
	Antenna Type				
	Power				
Power	14W				
IDU	Parameters	Example Information	Information	Information	Information
	IDU room Identified	Yes			
	Space for cabinet	Yes			
	Phone line	Need to install			
	48 VDC available?	Yes			
	Cables	Confirm cables			
	Take Photo 3				
	Sketch 3				
Indoor Space Requirements	Front View Top View Side View Equipment Dimensions Equipment Cabinet Batteries				
Notes					

3.6 Installation of the CarrierWave Digital Radio

The following sections provide installation guides for:

- IDU Installation
- ODU Installation

3.6.1 Installing the CarrierWave IDU

The CarrierWave IDU can be installed in the following three options:

1. Table top or cabinet
2. Wall mount
3. Rack mount

The CarrierWave IDU should be:

- Located where you can easily connect to a power supply and any other equipment used in your network, such as a router or PC.
- In a relatively clean, dust-free environment that allows easy access to the rear panel connectors as well as the front panel controls and indicators. Air must be able to pass freely over the chassis.
- Accessible for service and troubleshooting.
- Protected from rain and extremes of temperature (it is designed for indoor use).

3.6.1.1 Installing on a Table Top or Cabinet

The CarrierWave IDU can be placed on a tabletop or cabinet shelf. In order to prevent possible disruption, it is recommended to use a strap to secure the IDU.

3.6.1.2 Installing on a Wall

An installation option for the IDU is mounting the unit to a wall. Consult factory for details.

If the wall mount option is being considered, plan to position the CarrierWave IDU at a height that allows LEDs, the display on the front panel, and the rear connectors to be visible at all times and easily accessible. Also, including plastic clamps to support and arrange the ODU/IDU Interconnect Cable should also be considered.

3.6.1.3 Installing in a Rack

To maintain good airflow and cooling, it is preferred that the CarrierWave IDU in a slot that has blank spaces above and below the unit.

To rack-mount the IDU, use the supplied mounting brackets (CarrierComm part number 82-3184A01) to secure the chassis to the rack cabinet. As shown in Figure 3-4, the brackets can be attached at any of four points on the sides of the enclosure – front, back, middle facing front, and middle facing back. This flexibility ensures compatibility with most rack mounting arrangements.

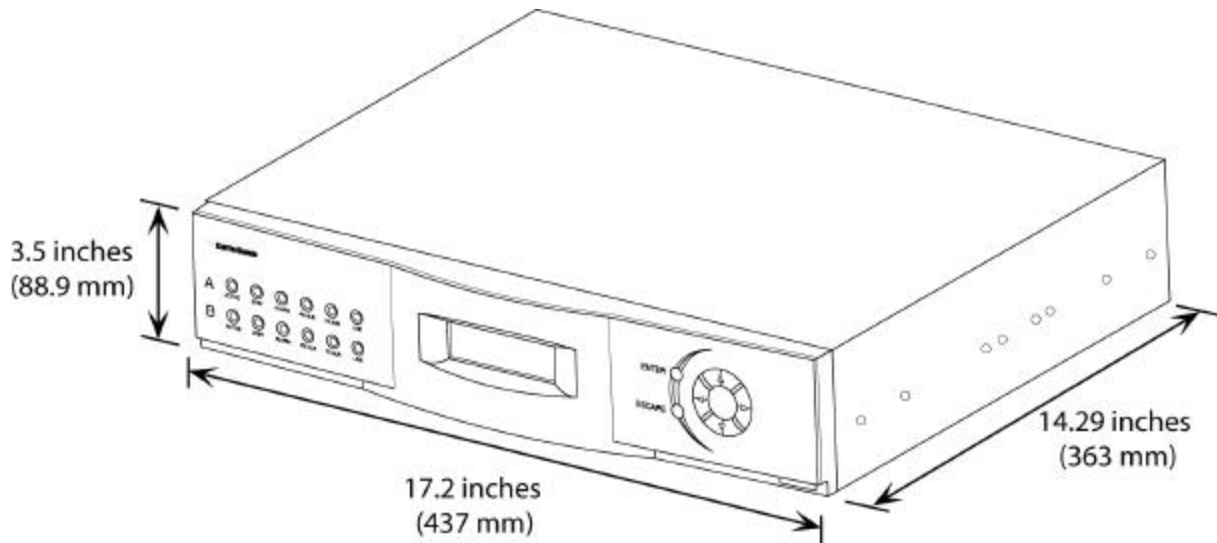


Figure 3-4. CarrierWave IDU Dimensions

3.6.2 Installing the CarrierWave ODU

There are three options for mounting the CarrierWave ODU

- Antenna mast
- Pole
- Building

Each site must be assessed for the mounting method, location, and height. After defining the mounting location and height for the CarrierWave ODU, re-confirm the line of sight.

Tools and Equipment required for installation of the ODU:

Tools Required	Equipment Required
Compass and protractor	¼ inch grounding rod
Area map	Grounding clamp
Phillips-head screwdriver	Grounding wire
Flat-head screwdriver	Coaxial cable assembly
Hammer or mallet	#6 wood screws
Power drill	Cable clips
1/8 inch drill bit	Anchor sleeves
¼ inch masonry drill bit	
5mm hex (Allen) wrench	
Bubble level or plumb line	
Adjustable wrench	
Wire snake (if routing cable through interior walls)	

3.6.2.1 Installing the Mounting Poles

First install the mounting poles, on which you will mount the CarrierWave ODU. The mounting pole J bracket is optional equipment. Consult factory for supply and part number. It is important to note the direction in which the ODU will point when installing the mounting pole.

The mounting pole must be mounted in a vertical position. Failure to do so may result in improper alignment of the ODU. If you need to tilt the ODU to avoid self-interference, you should use a tilt (optional) bracket. Consult factory for tilt bracket.

The mounting pole must be grounded.

3.6.2.1.1 Installing on an Antenna Mast

1. Position the mounting pole on the antenna mast. The mounting pole J-bracket is optional equipment. Consult factory for supply and part number.
2. Insert the U-bolts around the mast and through the holes in the mounting pole. Install a washer and nut to each side of the threaded U-bolt and hand tighten. Repeat this step for the second U-bolt.

3. Tighten nuts equally until mounting pole is secure and cannot rotate.

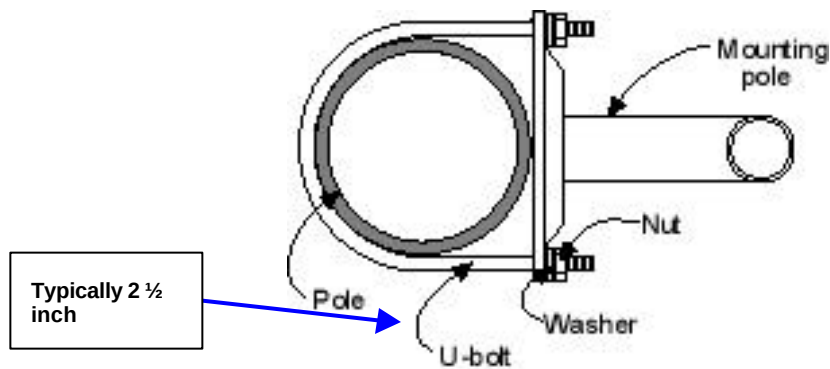


Figure 3-5. Optional Mounting Pole J Bracket Installed on Pole or Antenna Mast

3.6.2.1.2 Installing on Brick or Masonry

1. Place the mounting plate against the wall. Use a level or plumb line to set the mounting pole perpendicular to the ground (J-bracket is optional, consult factory for supply and part number).
2. Mark the hole locations.
3. Set the pole aside.
4. Drill 1/4 inch holes at the marked locations. Drill the holes approximately 1/2 inch deep.
5. Insert the expansion shields into the drilled holes and tap them home.
6. Align the mounting pole with the drilled holes and fix with the lag bolts.

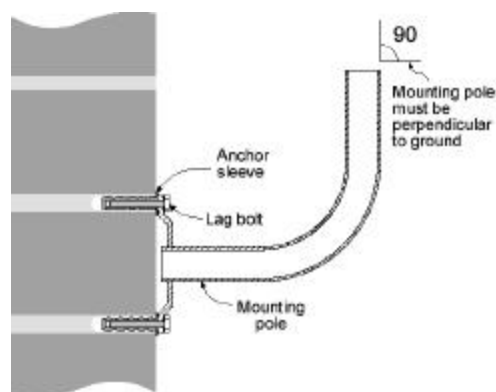


Figure 3-6. Optional Mounting Pole J Bracket Installation

3.6.2.1.3 Installing on a Wall with Wood Siding

1. Place the mounting plate against the wall.
2. Using a level, be sure that the mounting pole is perpendicular to the ground (J bracket is optional. Consult factory for part number and supply). You may need to use spacers, as shown in Figure 3-7.
3. Mark the hole locations for the drilled hole locations. Remove the mounting pole and set aside.
4. Drill 1/8-inch holes in the places marked.
5. Use #10 or #12 wood screws to secure the mounting pole to the wall and tighten.

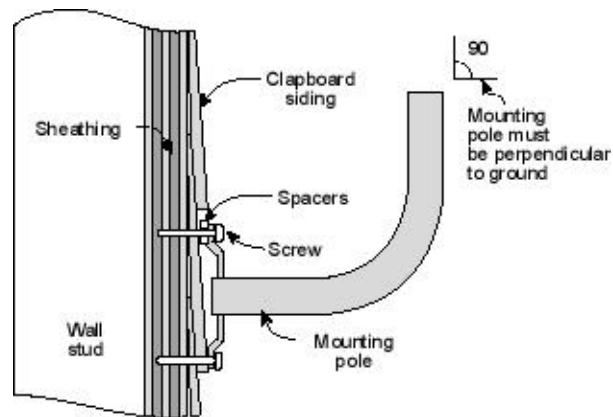


Figure 3-7. Optional Mounting Pole J Bracket on Clapboard Siding

Now that you have installed the mounting pole, you are ready to install the CarrierWave ODU onto the mounting poles. Reference Figures 3-8 through 3-11.

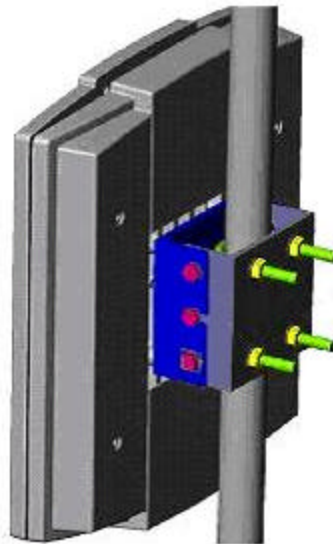


Figure 3-8. Mounting Parts for the CarrierWave ODU

2. Place the CarrierWave ODU on the mounting pole.
3. Align the pole clamp with the mounting holes.
4. Insert the mounting screws and hand tighten.
5. Rotate the CarrierWave ODU so it is pointing in the correct direction.
6. Tighten the mounting screws.

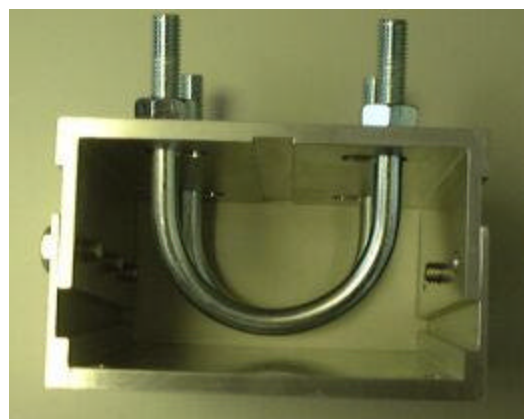
**Figure 3-9. CarrierWave ODU Rear View****Figure 3-10. Tilt Bracket**



Figure 3-11. CarrierWave ODU with Mounted Tilt Bracket

3.6.3 Routing the ODU/IDU Interconnect Cable

1. Select where the cable will enter the building from outside.
2. Determine the length of cable required. Allow three extra feet on each end to allow for strain relief, as well as any bends and turns.
3. Route the cable.

The ODU and IDU are equipped with N-type female connectors at their interconnecting ports. A length of coaxial cable (such as Times Microwave Systems LMR-400, LMR-300 or LMR-200) fitted with two N-type male connectors is required to connect the ODU to the IDU. This cable assembly may be supplied in fixed lengths with the digital radio. Bulk coaxial cable of equivalent specification may also be used, with terminating connectors applied during cable installation.

Based on an evaluation of the cable routing path, pull the ODU/IDU Interconnect cable from one unit to the other, utilizing cable trays, ducts, or conduit as required. Take care that the ODU/IDU Interconnect cable is not kinked or damaged in any way during installation. Be sure to protect the N-type connectors from stress, damage and contamination during installation (do not pull the cable by the connectors). If multiple ODU/IDU Interconnect cables are to be installed along the same route, the cables should all be pulled at one time. Be sure the installed cable does not have any bends that exceed the specified cable bend radius. The ODU/IDU Interconnect cable should be adequately supported on horizontal runs and should be restrained by hangers or ties on vertical runs to reduce stress on the cable. Outside the building, support and restrain the cable as required by routing and environmental conditions (wind, ice).

The CarrierWave ODU/IDU and interconnection must be properly grounded in order to protect it and the structure it is installed on from lightning damage. This requires that the ODU, any mounting pole or mast and any exposed interconnect cable be grounded on the outside of the structure. The IDU must be grounded to a rack or structure ground that also has direct path to earth ground.

The ODU must be directly connected to a ground rod or equivalent earth ground. The ODU/IDU interconnect cable should also be grounded at the ODU, where the cable enters the structure and at intermediate points if the exposed cable run is long (typically at intervals of 100 ft), with the cable manufacturer's grounding kits. Lightning protection devices used with the interconnect cable must be appropriate for the transmission of the interconnect signals (DC to 2.4 GHz).

Provide a sufficient but not excessive length of cable at each end to allow easy connection to the ODU and IDU without stress or tension on the cable. Excessive cable length, especially outdoors, should be avoided to minimize signal attenuation and provide a more robust and reliable installation. If installing using bulk coaxial cable, terminate the ODU/IDU Interconnect cable at each end with an N-type male connector appropriate for the cable type. Use of connectors, tools and termination procedures specified by the cable manufacturer is recommended.

Once the cable has been installed but before connection has been made to either unit, a simple DC continuity test should be made to verify the integrity of the installed cable. A DC continuity tester or digital multimeter may be used verify a lack of DC continuity between the cable center conductor and outer conductor, with the opposite end of the cable unconnected. With a temporary test lead or shorting adapter connected to one end of the cable, DC continuity should be verified between the center and outer conductors at the opposite end.

3.6.3.1 Installing the ODU/IDU Interconnect Cable

1. Screw on the ODU/IDU Interconnect cable with N-type connector.

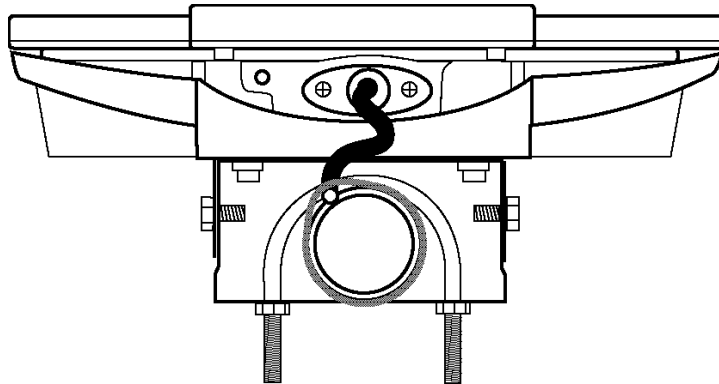


Figure 3-12. N-type Connector Location – Underside of CarrierWave ODU

2. Insert the N-type connector into the receptacle located underneath the ODU. Make sure that the connector tab engages the slot in the receptacle.
3. Slide the grommet up the cable and press it into the bottom of the ODU.

3.6.4 Grounding the System

The CarrierWave IDU/ODU System must be properly grounded in order to protect it and the structure it is installed on from lightning damage. This requires:

1. Grounding all the ODUs as shown in Figure 3-13.

2. Grounding the IDU to the rack.

3.6.4.1 Grounding the ODU

1. Place the grounding rod so as to allow for the shortest possible path from the grounding cable to the ODU.
2. Drive the grounding rod into the ground at least eight inches from the ground surface.
3. Attach a grounding clamp to the grounding rod. You will use this clamp to attach grounding wires for both the ODU and indoor junction box, reference Figure 3-13.

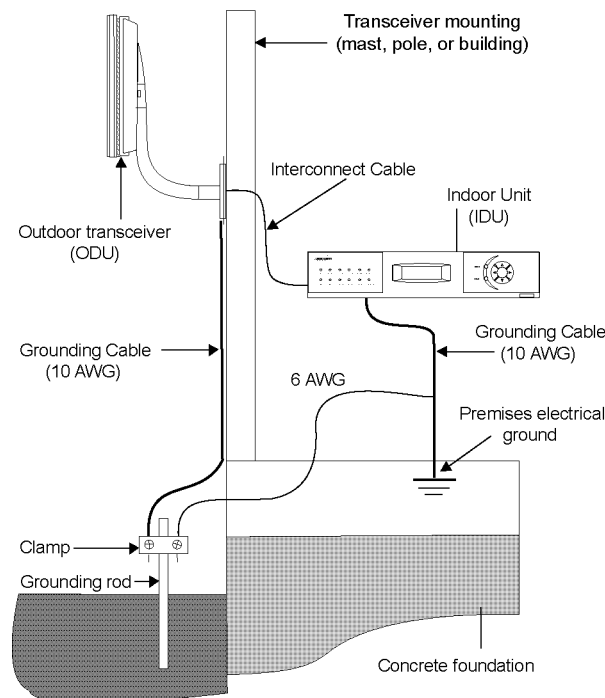


Figure 3-13. Ground Connections to ODU

4. Connect a ground lug to one end of the grounding wire.
5. Remove one of the lower mounting screws of the mounting pole. Insert a screw through the grounding lug terminal and re-install it to the mounting pole.
6. Attach the grounding wire to the clamp on the grounding rod, reference Figure 3-14. If necessary, use wire staples to secure the grounding wire to the outside wall.

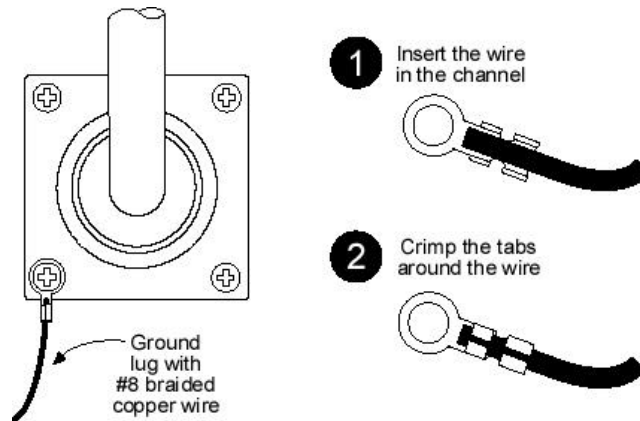


Figure 3-14. Mounting Pole with Ground Lug

7. Install a grounding wire from the junction box to the grounding rod.

3.6.4.2 Grounding the IDU

1. Remove the nut and ring lug terminal from the IDU Chassis GND stud.
2. The provided ring lug crimp terminal is intended to be used with 18 AWG wire (provided by the customer). The IDU should be able to be connected to a system or building electrical ground point (rack ground or power third-wire ground) with a cable of 36" or less.
3. Crimp the ring lug terminal to one end of the wire to be used as the IDU ground wire. Connect the opposite end of the IDU ground wire to the local source of ground in an appropriate manner.
4. Place the ring lug of the IDU ground cable on the IDU Chassis GND stud.
5. Place the nut on the IDU Chassis GND stud and tighten appropriately.

3.7 Configuration of the CarrierWave Digital Radio

Configuration of the CarrierWave Digital Radio IDU does not require a connection to the ODU. It is suggested to configure the IDU prior to connecting to the ODU.

3.7.1 Materials Required

The following items are needed to configure an IDU:

- Power supply (-48 V DC @ 2 Amps)

- IDU power cable
- Digital voltmeter with test leads
- Computer with networking capability, consisting of either:
 - Laptop computer with Windows 98/2000/XP operating system, an Ethernet card with any necessary adapters and a Cat-5 Ethernet crossover cable
 - or
 - Networked computer with Windows 98/2000/XP operating system and an additional Ethernet cable providing access to the network.
- CarrierWave iConductor™ software
- Site engineering folder with site drawings, or equivalent IDU configuration information

3.7.2 IDU Configuration Process

Using the site attributes identified in the site assessment or equivalent configuration information, configure each IDU by completing the following procedures:

- Installing CarrierWave iConductor™
- Connecting the IDU to the PC and Power Source
- Setting the IDU IP Address
- Configuring the IDU
- Logging Into the IDU Using CarrierWave iConductor™
- Configuring the IDU Site Attributes

3.7.2.1 Installing CarrierWave iConductor™

If IDU iConductor™ software is not already installed on your PC, perform the following steps:

1. Insert the IDU iConductor™ CD into the CD-ROM drive on your personal computer (PC). Be sure that the PC has Windows 98/2000/XP software installed.
2. Double click on the **My Computer** icon located on the desktop.
3. Double click on the CD-ROM drive associated with the computer.
4. Double click on the IC-vX-XX icon, where X-XX is the version of iConductor™ software appropriate for your unit.
5. Follow the instructions of the installer.

6. When the installation is complete, test the iConductor™ by going to the Windows Programs->CarrierComm->vX-XX->IC menu (or the appropriate menu or icon) and start the iConductor™ software.

3.7.2.2 Connecting the IDU to the PC and Power Source

Perform the following steps to ensure the IDU is powered up and connected to you PC:

1. To connect to the IDU DC power connector (located on the IDU rear panel), an IDU power cable is required. A mating power cable connector (Phoenix Contact P/N 17 86 83 1) is provided with the CarrierWave IDU for construction of this cable. This connector has screw clamp terminals that accommodate 24 AWG to 12 AWG wire. The recommended wire size for construction of power cables under 10 feet in length, supplying –48 V dc, is 18 AWG. The opposite end of the IDU power cable should have a termination appropriate for the power supply being used. The IDU power cable should be of sufficient length to avoid tension in the cable and provide a service loop for connection, but not be of excessive length. Stranded wire should be used over a solid conductor to reduce tension on the IDU DC Power connector. Using the supplied power cable connector, pin 2 (labeled **-V**) should be connected to the power supply terminal supplying –48 V dc, while pin 1 (labeled **RET**) should be connected to the power supply return. Refer to Figure 3-15. Note that pin 1 (**RET**) of the IDU DC Power connector is connected to the IDU chassis ground internal to the IDU. Use of a power supply with an inappropriate ground reference may cause damage to the IDU and / or the supply.
2. Connect the IDU power cable to the –48 V dc power supply, and place the voltmeter probes on the unconnected IDU end of the power cable, with the positive voltmeter probe on pin 2 (**-V**) of the cable connector and the negative probe on pin 1(**RET**). The connector screw terminal screw heads may be used as convenient monitor points. Refer to Figure 3-15.
3. Turn on the –48 V dc supply. Verify that the digital voltmeter reads between –44 V dc and –52 V dc when monitoring the cable points specified above. Adjust the power supply output voltage and/or change the connections at the power supply to achieve this reading.
4. With the negative voltmeter probe still on pin 1 (**RET**) of the power cable connector (and the power supply still on), press the positive voltmeter probe to the IDU chassis and verify a potential of zero volts between the IDU chassis and cable pin 1 (**RET**). If the measured potential is not zero, the power supply may be grounded incorrectly and should not be used in this condition with an IDU. Note that this measurement assumes that the IDU is installed and properly grounded. If this is not the case, the same measurement can be made between cable pin 1 (**RET**) and a convenient ground (such as an ac outlet third-wire ground).
5. Turn the –48 V dc supply off.
6. Plug the IDU power cable into the IDU rear panel DC Power connector (**DC Input**). Place the voltmeter probes on the cable connector screw terminal screw heads as per step 2 above. Refer to Figure 3-15. Note that the CarrierWave Digital Radio IDU does not have a power on/off switch. When DC power is connected, the digital radio powers up and is operational. There can be up to 200 mW of RF power present at the antenna port. The antenna should be directed safely when power is applied.
7. Turn on the –48 V dc power supply, and verify that the reading on the digital voltmeter is as specified in step 3 above.

8. Turn the –48 V dc supply off.
9. Connect the IDU to the laptop computer, using the Cat-5 Ethernet crossover cable or connect the IDU to a computer network, using a normal Cat-5 Ethernet cable. Connect the Ethernet cable to **OAMP 10/100BaseTX Ch1** connector on the IDU rear panel. Refer to Figure 3-16 for the IDU rear panel connections.

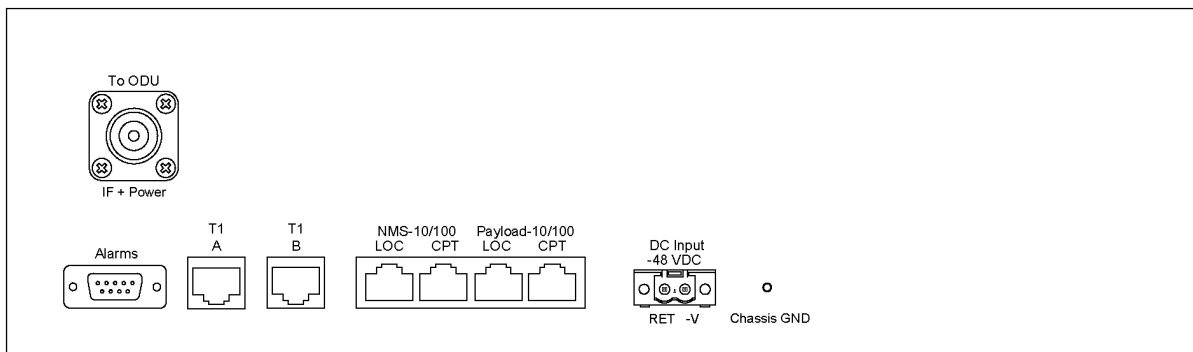
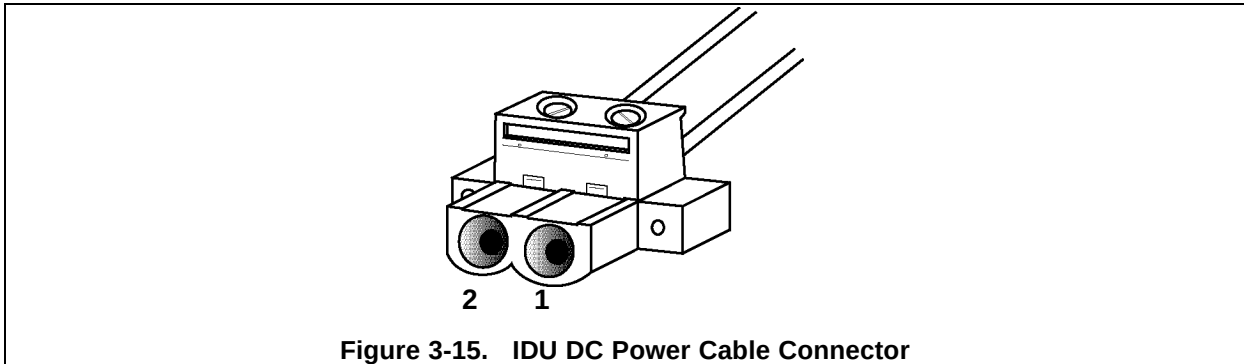


Figure 3-16. IDU Rear Panel – CarrierWave-100/Ethernet

3.7.2.3 Setting the IDU IP Address

Use the Front Panel Menu to set the IDU IP address as follows:

1. Power up the IDU and wait for the main menu to appear on the front panel. The menu will be titled “CarrierWave” and will have several elements, beginning with “Modify Config”.
2. Use the Down arrow key to move the cursor (asterisk or *) three times to scroll it down until it is aligned with the “Super User” menu item. When the cursor is opposite the Super User item, press the Enter key.
3. On the Super User menu, move the cursor down and select the “Chg OA&M Params” item.
4. On the “OA&M Params” menu, move the cursor down to the IP: line. Use the right arrow key to move the cursor into the IP address area. When you see the underline cursor beneath a character, you can use the up/down keys to change that character. Continue moving back and forth with the left/right keys and changing the characters as necessary with the up/down

keys. When the IP address is correct for your network (it must at least be in the same subnet as the PC you have connected), use the left arrow key to move back to the menu (move left until there are no flashing underlines).

5. Continue moving down in the "OA&M Params" menu and change the NM: (Netmask) parameter to be compatible, in the same manner as the IP address. The GW: (gateway) and FR: (far end) addresses do not need to be changed at this time.
6. When the IP and NM parameters are correct, move the cursor up to the "Save Changes" item and press the enter key.
7. Use the escape key to back up to the Super User menu, then select the "Reboot IDU" item to reboot. Press the Enter key to initiate the IDU reboot.

When the reboot process is complete, the IDU should be accessible from your PC.

3.7.2.4 Configuring the IDU

Use the Front Panel Menu to configure the IDU as follows:

1. From the main menu select "Modify Config".
2. From the Modify Config menu select "Link Params".
3. On the Link Parameters menu move the cursor to "Mode:" and use the left/right keys to select from the list of available operating modes.
4. When the correct operating mode is visible, use the Enter key to save it.
5. Move the cursor down to the "Chan:" item and select the proper channel in the same manner.
6. Use the Escape key to back up to the Modify Config" menu and then select the "Adaptive Pwr Ctrl" menu.
7. Move the cursor to the Start Power item and use left/right keys to select the desired output power level. When Power Control is off, this will be the fixed output power level.
8. Navigate back up to the Modify Config menu and select the TX Control item.
9. On the TX Control menu, use the left/right arrows to turn the transmitter on or off, and then use the Enter key to save the setting.

The CarrierWave Digital Radio is now ready for operation (assuming the ODU is connected to the IDU via the ODU/IDU Interconnect cable (labeled **To ODU**)).

3.7.2.5 Logging Into the IDU Using CarrierWave iConductor™

Use the following procedure to log into an IDU using CarrierWave iConductor™:

1. On your desktop, click the **Start** button and select **Programs**. Then click on the **MS-DOS Prompt** icon.
2. In the MS-DOS window, type ping xxx.xxx.xxx.xxx (where xxx.xxx.xxx.xxx represents the IP address of the IDU) and press enter.
3. If the ping is successful, the following message will appear: Reply from xxx.xxx.xxx.xxx: bytes=a. time=b ms, TTL=c. Refer to Figure 3-17 for an example of a ping. A successful ping implies that the IDU and the PC can communicate with one another across an Ethernet connection.
4. Close the MS-DOS prompt window.
5. Using the Windows Programs->CarrierComm->vX-XX->IC menu (or the appropriate menu or icon), start up the iConductor™ application.
6. Select the IDU that you wish to login to from the drop-down menu (see Figure 3-18). If there is not a network element for that IDU, simply select any IDU icon

Note: If there is not an IDU icon, one must be added. To add an IDU icon, use the Network drop-down menu and select Add. Refer to IDU iConductor™ Online Help at C:\Program Files\CarrierComm\help\TOC.html for additional information on how to add an IDU.
--

7. Use the **Network** drop-down menu and select **Connect** (see Figure 3-19). In the IDU Connect window, complete the following:
 - Verify the information in the IP Address field
 - Enter engineer in the User ID field
 - Enter the password assigned by the System Administrator in the Password field

8. Click the Connect button to login to the IDU. Login should take less than 30 seconds and the iConductor™ Workspace window will appear (see Figure 3-20).

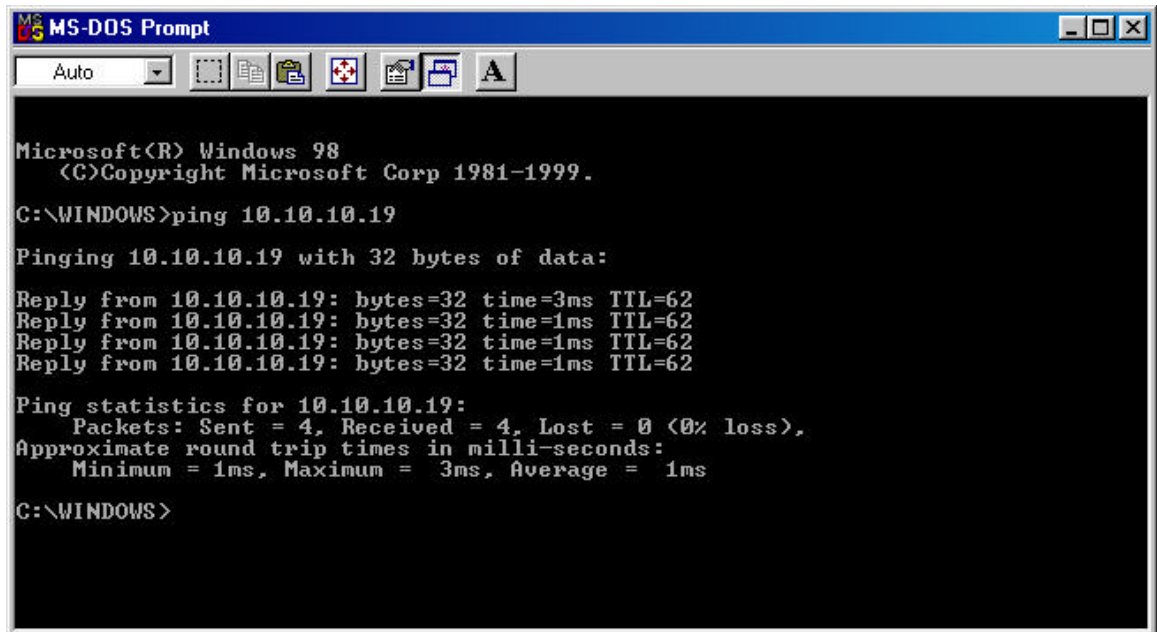


Figure 3-17. IDU Ping Example

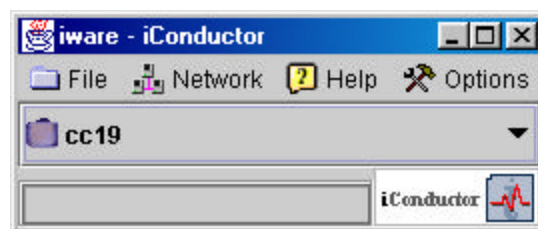


Figure 3-18. Login IDU Name Insert

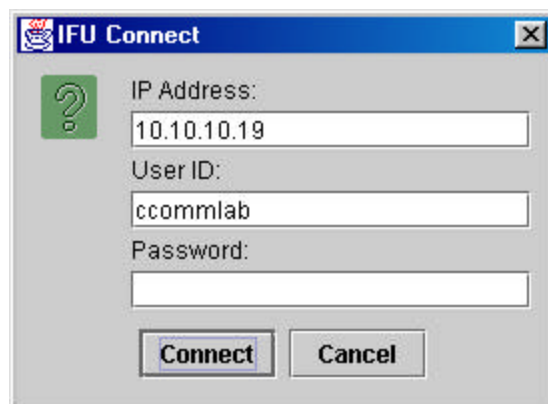


Figure 3-19. Login IDU Connect Screen

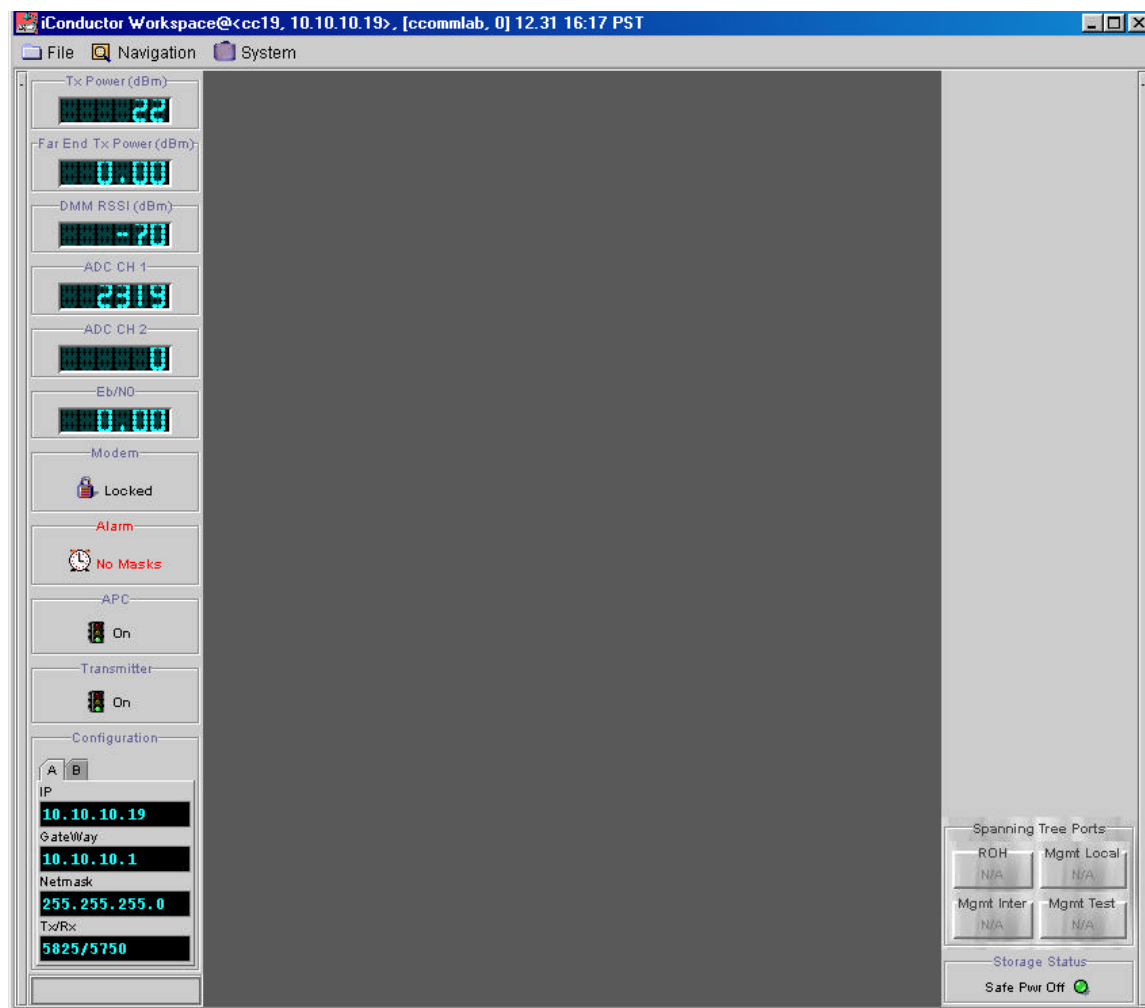


Figure 3-20. iConductor™ Workspace Window (Typical) Insert

3.7.2.6 Configuring the IDU Site Attributes

1. In the iConductor™ Workspace window, select **Navigation > Administration > Network** to display the Network Administration window (see Figure 3-21).
2. Select the **General** tab (bottom tabs) and complete following:
 - Enter site information in the Site Name, Site Contact, and Site Location fields as required.
 - Click the Set button beside the Installation and/or In-Service fields to automatically generate the system date and time. If you want to enter a date on your own, enter the date without selecting set.

Note: If NTP has been defined on the Link Administration window, IDU iConductor™ will use the time on the NTP server. If you do not have NTP running, IDU iConductor™ accesses the system time and sets the text field to the value returned by the system clock

3. Click the **Save** icon to save the data and then select the Network tab (see Figure 3-22).

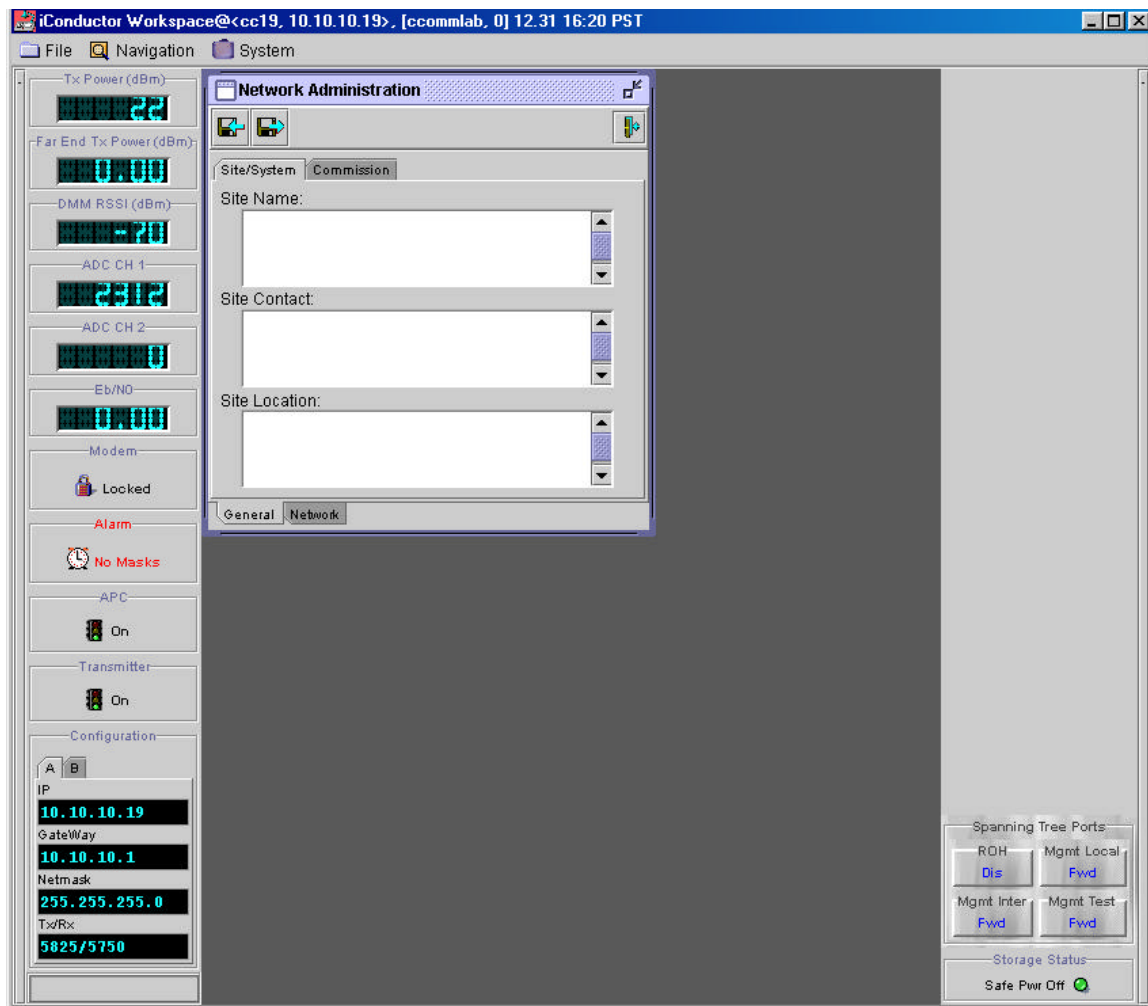


Figure 3-21. Network Administration Window (General Tab) Insert

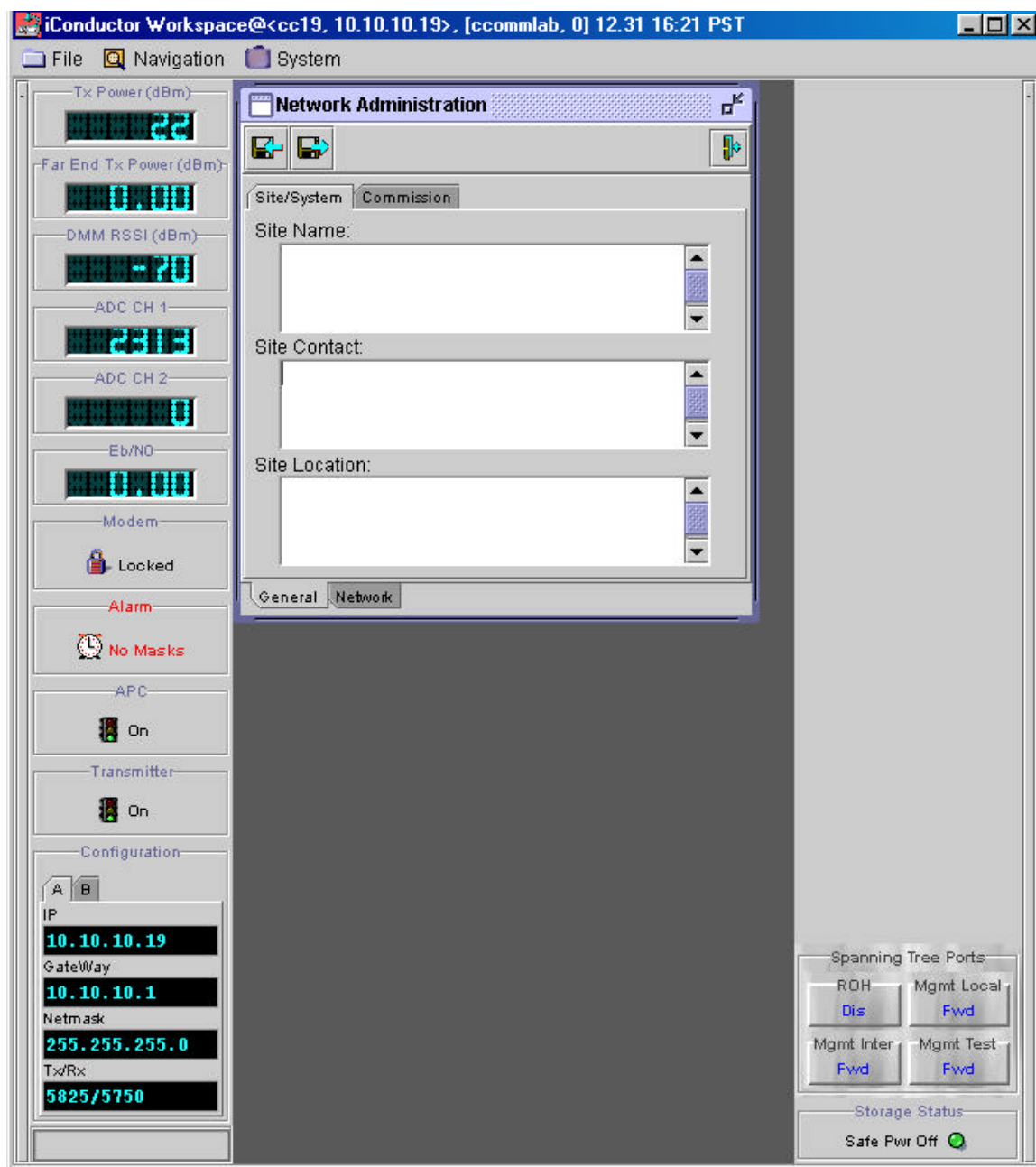


Figure 3-22. Network Administration Window (Network Tab) Insert

3.7.3 Documenting CarrierWave Digital Radio Configuration

Use the CarrierWave Digital Radio configuration form provided at the end of this section, or a similar form, to document the results of the IDU configuration procedure. Optimally, this complete site form would be stored with the IDU for future reference.

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CarrierWave Digital Radio Configuration Form

1

Link ID

Radio Type (A/B) A=Low band, Horizontal polarization, odd serial number
B=High band & Vertical polarization, even serial number

Radio ID # Radio S/N

Site Name

Network Administration - Radio	
Addresses	
Near IP:	Far IP:
Routing	
Net Mask:	IP EMS 1:
NTP:	IP EMS 2:
Gateway:	IP EMS 3:
	IP EMS 4:
SNMP Community Names	
Trap:	Super User:
Read/Write:	Read:

Link Administration - Radio	
Commissioning:	
Rain Model	
Frequency	TX RX
Grade of Service	
Rain Region	
Link Distance	
Distance (meters)	
	OR
GPS Location	
Near Latitude	deg min sec
Near Longitude	deg min sec
Far Latitude	deg min sec
Far Longitude	deg min sec

2

Radio Type (A/B)

Radio ID# Radio S/N

Site Name

Network Administration - IFU	
Addresses	
Near IP:	Far IP:
Routing	
Net Mask:	IP EMS 1:
NTP:	IP EMS 2:
Gateway:	IP EMS 3:
	IP EMS 4:
SNMP Community Names	
Trap:	Super User:
Read/Write:	Read:

Link Administration - Radio	
Commissioning:	
Rain Model	
Frequency	TX RX
Grade of Service	
Rain Region	
Link Distance	
Distance (meters)	
	OR
GPS Location	
Near Latitude	deg min sec
Near Longitude	deg min sec
Far Latitude	deg min sec
Far Longitude	deg min sec

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4 Front Panel Operation

4.1 Introduction

This section describes the front panel operation of the CarrierWave Digital Radio. This includes:

- LCD display (including screen menus)
- Cursor and screen control buttons
- LED status indicators

4.2 Front Panel Operation

The CarrierWave IDU front panel is depicted in Figure 4-1 below. All models of the CarrierWave Digital Radio family have this standardized front panel and chassis.

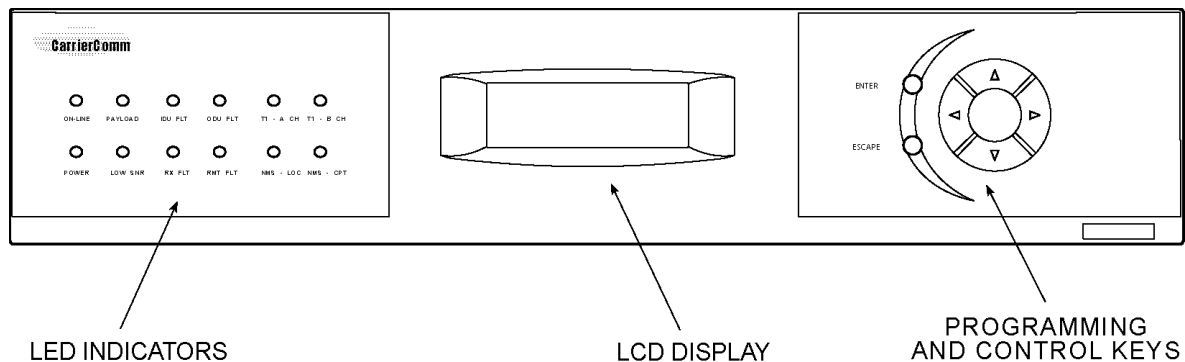


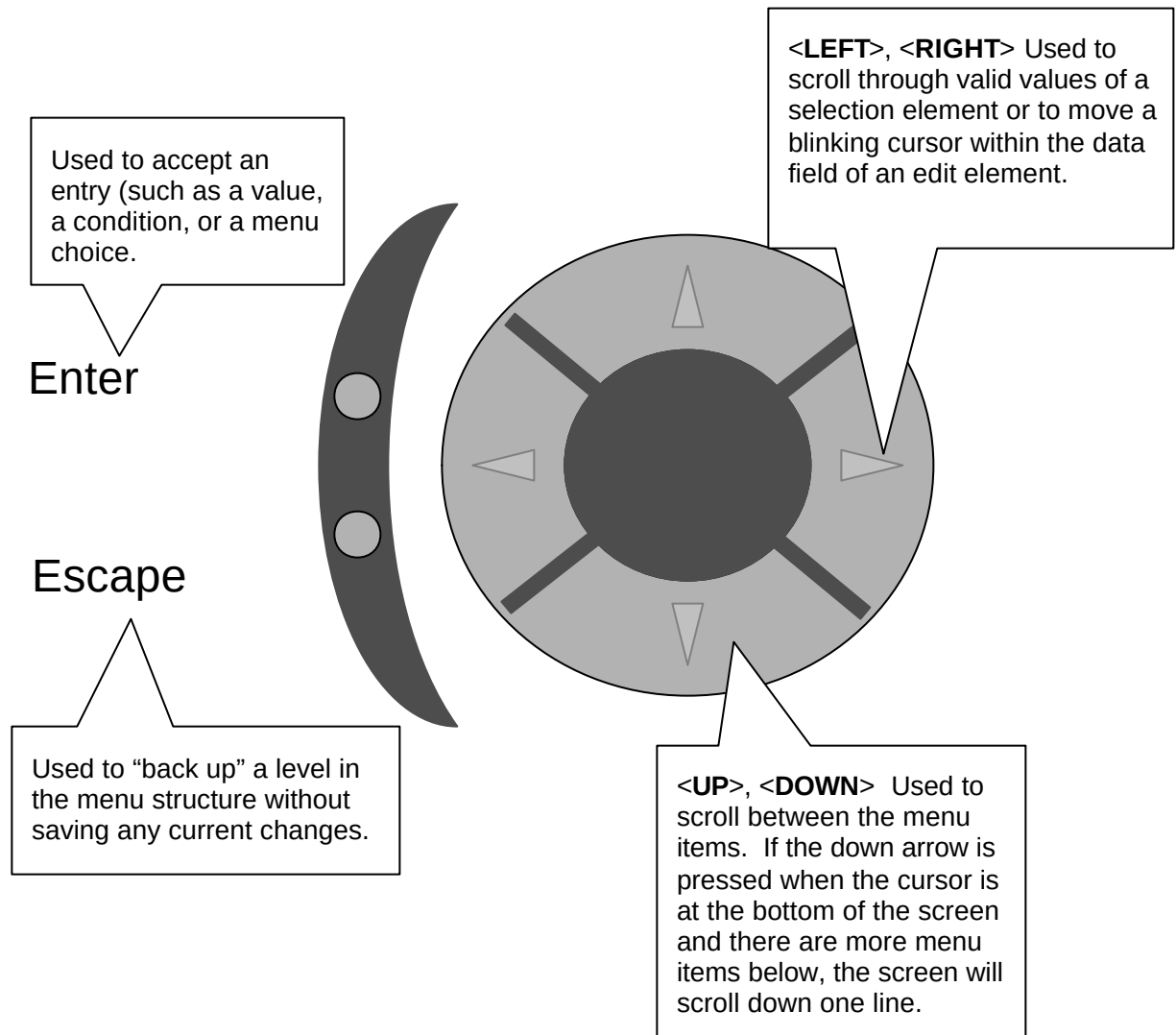
Figure 4-1. CarrierWave IDU Front Panel

4.2.1 LCD Display

The Liquid Crystal Display (LCD) on the CarrierWave IDU front panel provides status, control, and configuration functionality. The front panel used on the CarrierWave IDU has a 20 character wide by 4 character high LCD display that is capable of displaying ASCII characters in any position on the screen. The menu navigation and various screens are explained in detail later in this section.

4.2.2 Cursor and Screen Control Buttons

The buttons on the CarrierWave Digital Radio front panel are used for LCD screen interface and control functions. The unit has 6 buttons for user input (Up, Down, Left, Right, Enter, and Escape) as depicted in the figure below.



4.3 LED Status Indicators

The basic operation of the CarrierWave Digital Radio can be checked by viewing the LED indicators on the front panel. Normally, only green LEDs should be lit. A yellow LED indicates potential system degradation, though the link is still active and operational. A red LED is an alarm indicator. If it is lit, it indicates a potential problem in the radio system. Refer to Figure 4-2 and the table that follows for a detailed explanation of the LED indicators.

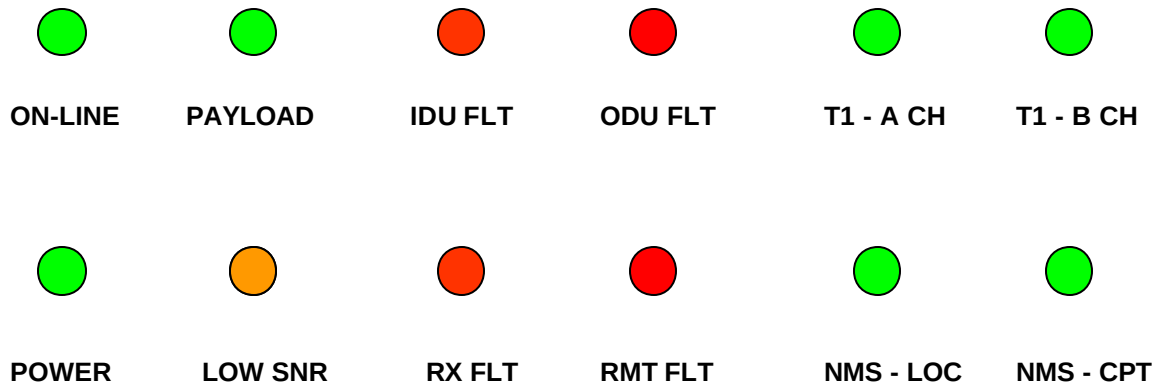


Figure 4-2. CarrierWave IDU Front Panel LEDs

Table 4-1. LED Status Indicator Functions

LED	Name	Function
ON-LINE	On-Line	When this LED is illuminated it indicates that the modem is locked and a link has been established with the far-end radio
PAYLOAD	Payload	When this LED is illuminated it indicates that the payload port is connected.
IDU FLT	IDU Fault	When this LED is illuminated it indicates that there is a fault detected in the IDU equipment. The menu interface can then be used to show all current faults.
ODU FLT	ODU Fault	When this LED is illuminated it indicates that there is a fault detected in the ODU equipment. The menu interface can then be used to show all current faults.
T1- A	T1 – A Channel	When this LED is illuminated it indicates that there is a T1 connection to the A port.
T1- B	T1 – B Channel	When this LED is illuminated it indicates that there is a T1 connection to the B port.
POWER	Power	When this LED is illuminated it indicates that power is on.
LOW SNR	Low Signal to Noise Ratio	When this LED is illuminated it indicates that the SNR is below the Error Free threshold.
RX FLT	Receive Fault	When this LED is illuminated it indicates that the Receiver does not detect a valid signal indicating a problem with the receiver or remote transmitter.
RMT FLT	Remote Fault	When this LED is illuminated it indicates that the far-end radio has a fault condition.
NMS LOC	Local NMS Port	When this LED is illuminated it indicates that there is a connection to the local NMS port.
NMS CPT	Consecutive Point NMS Port	When this LED is illuminated it indicates that there is a connection to the remote or Consecutive Point NMS port.

4.4 Screen Menus

The front panel used on the CarrierWave IDU has a 20 character wide by 4 character high LCD display that is capable of displaying ASCII characters in any position on the screen. The unit has 6 buttons for user input: Up, Down, Left, Right, Enter, and Escape.

There are two basic screen types used to build the interface application, Text Screens and Menu Screens.

4.4.1 Text Screens

Text screens are used to display information to the user, but do not allow for any user input.

4.4.1.1 Display

When the screen is displayed on the LCD panel the first four lines are visible, and if there are more than four lines in the screen, a plus (+) sign is displayed in the lower right hand corner of the display.

4.4.1.2 Buttons

The *Enter*, *Left*, and *Right* buttons do nothing on a text screen.

If the screen contains more than four lines the *Up* and *Down* buttons scroll up and down one line at a time.

The *Escape* button navigates to the previously viewed screen.

4.4.1.3 Example

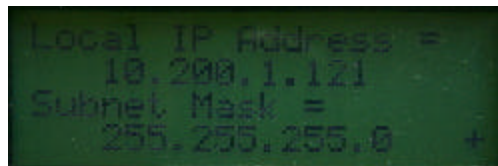


Figure 4-3. OA&M Parameter Display

4.4.2 Menu Screen

Menu screens are used to navigate around the system and for data entry. Each menu is composed of menu elements that serve different purposes. There are currently four menu element types, Text, Command, Selection, and Edit.

4.4.2.1 Display

Each line is one menu element as described above. Normally the first line is a Text element, which is the title of the menu. When the menu is scrolled, the title remains fixed while the bottom three lines scroll. The plus (+) sign is displayed in the bottom right corner to indicate that there are more lines below just as in the Text Screen.

A menu screen has a cursor that is displayed as an asterisk (*) in the left most character position and indicates the active element. When the screen is entered the cursor is on the second line (first line below the title).

The display characteristics of the different menu element types differ slightly. The text element is centered horizontally in the display. The command element is also text but is left justified with room for the cursor. Both the selection and edit types have a label that is left justified, then a colon, then the data field.

4.4.2.2 Buttons

All buttons are active on a menu screen, depending on the type of the active element. The *Up* and *Down* buttons move the cursor up and down, changing the active element. If the cursor is on the bottom row, there are more rows below, and the *Down* button is pressed, the bottom three lines scroll upward exposing the next line. The *Up* button has the same behavior in the opposite direction. The Escape button will always navigate to the previously viewed screen. The Enter, Left, Right, Up, and Down button behaviors differ slightly depending on the type of the active menu element and will be described below.

If the active element is a command element, the *Left* and *Right* buttons have no effect and the Up and Down buttons will behave as detailed above. The Enter button executes the command associated with that element. The command can be a navigation command that takes the user to another screen, or action command that performs an action.

If the active element is a selection element, the Left and Right buttons scroll through a list of valid values, displaying the currently selected value on the right side of the active line on the screen. The Up and Down buttons still have their normal behavior of moving the cursor up or down to a different element. The Enter button will execute a command passing the selected value.

If the active element is an edit element, the Up and Down buttons still have their normal behavior until the Right button is pressed. The Left and Right buttons move a blinking cursor within the data field to facilitate editing that field. Once the blinking cursor is in the data field, the Up and Down buttons scroll through a list of valid characters for that field, allowing limited data entry. If the blinking cursor is on the first character of the data field and the Left button is pressed, the blinking cursor disappears and the Up and Down buttons behave normally again. As with the selection element, the Enter button executes a command and passes the data field to the command.

4.4.2.3 Examples

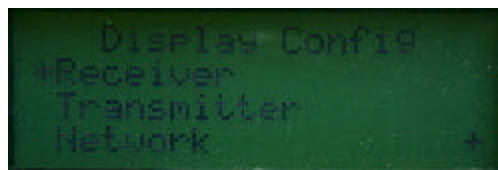


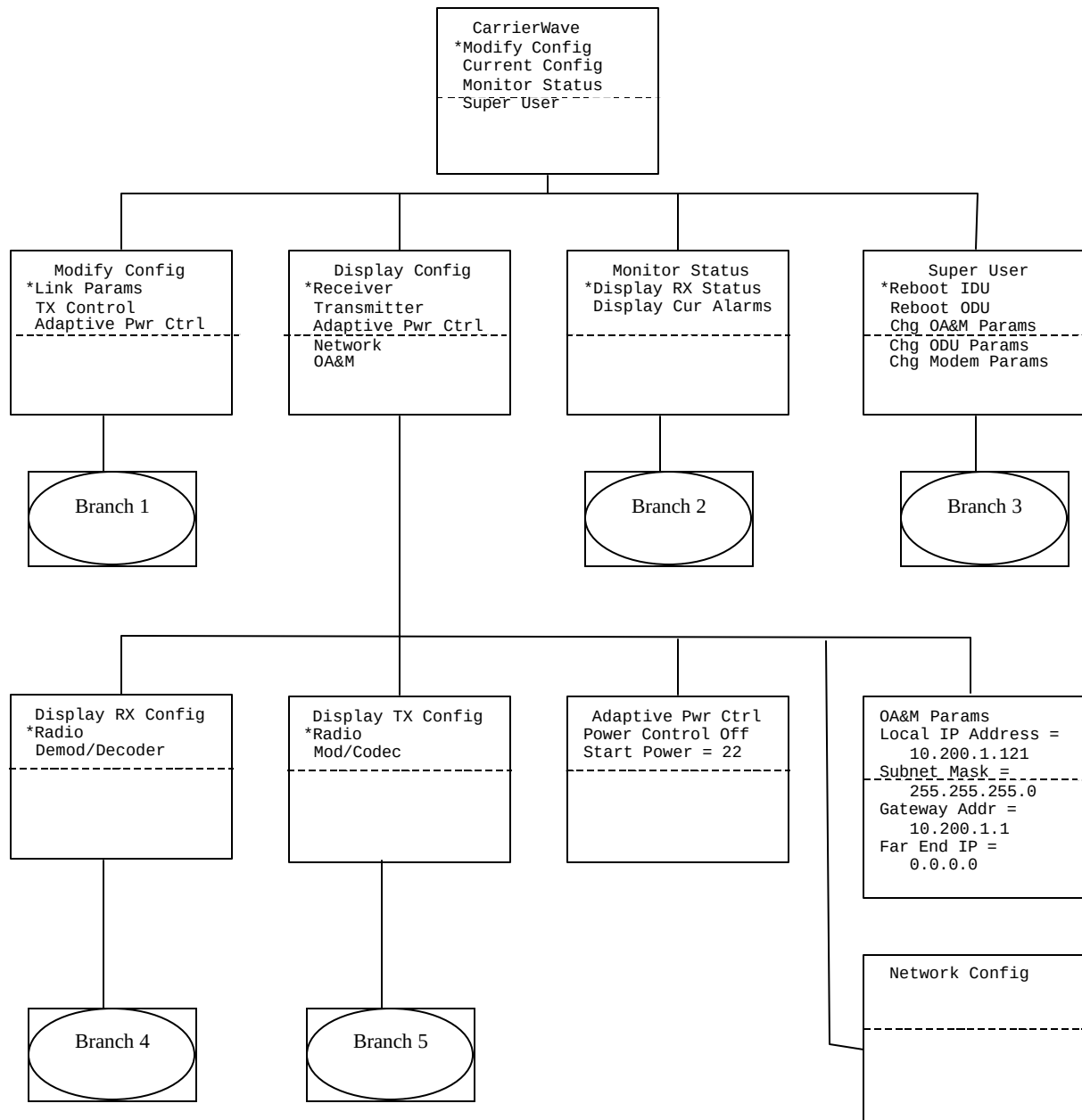
Figure 4-4. Menu Screen with Command elements

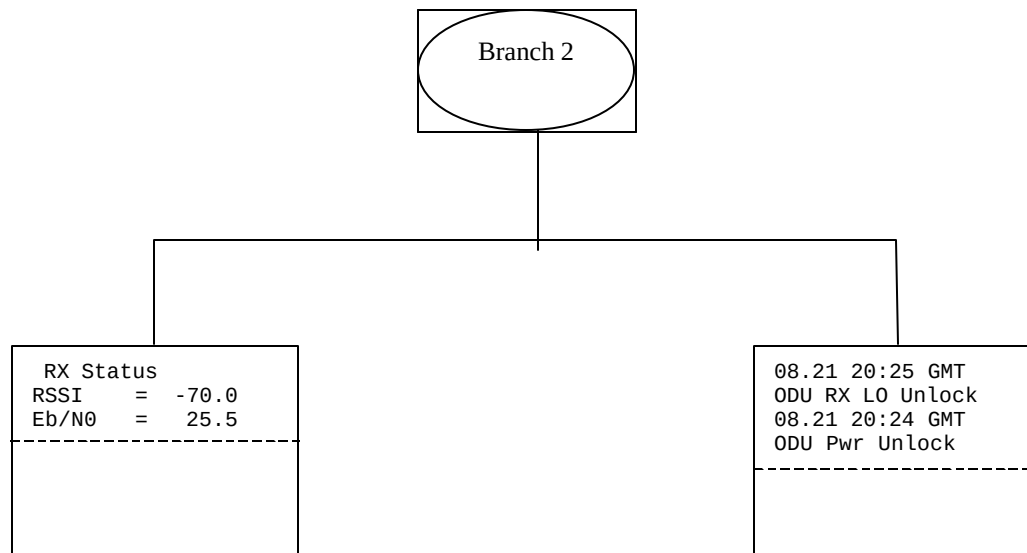
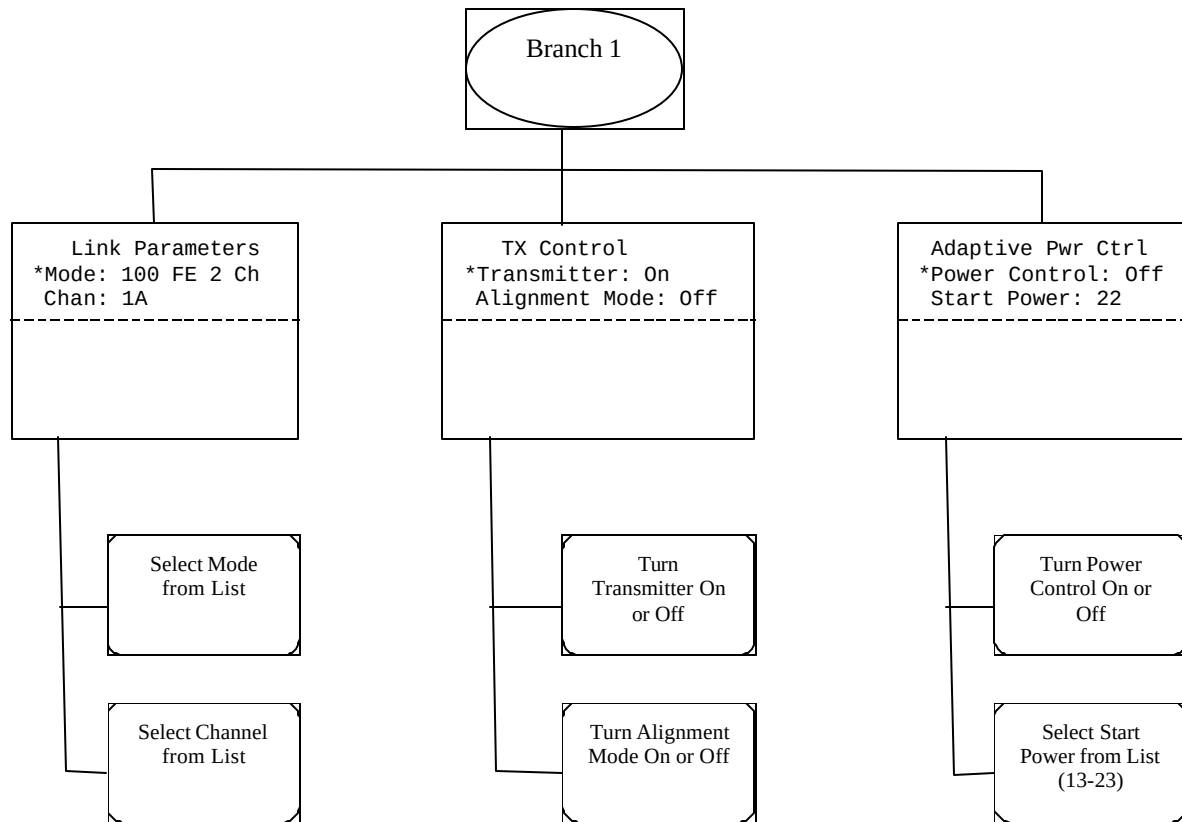


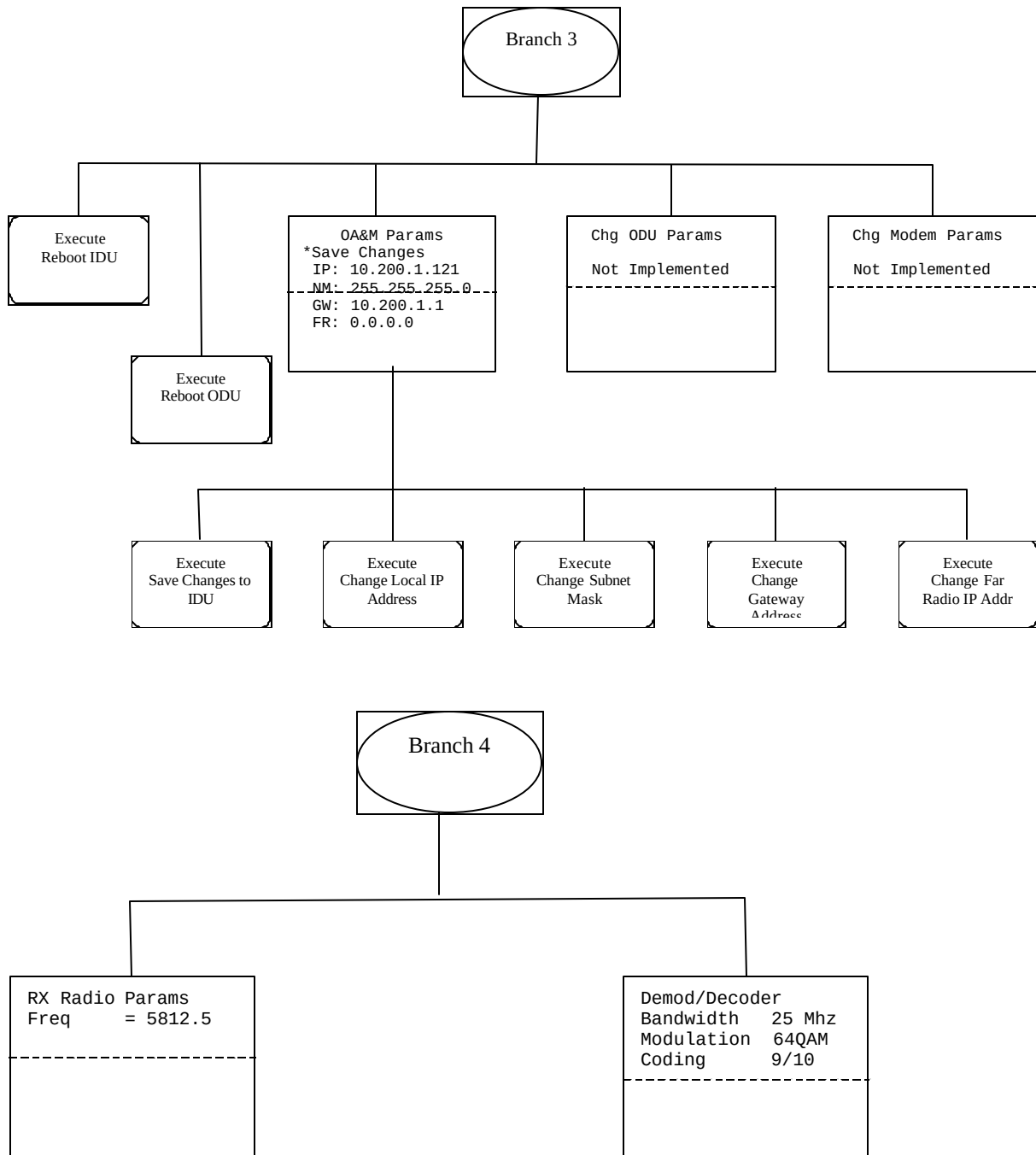
Figure 4-5. Menu Screen with one Command and two Edit elements

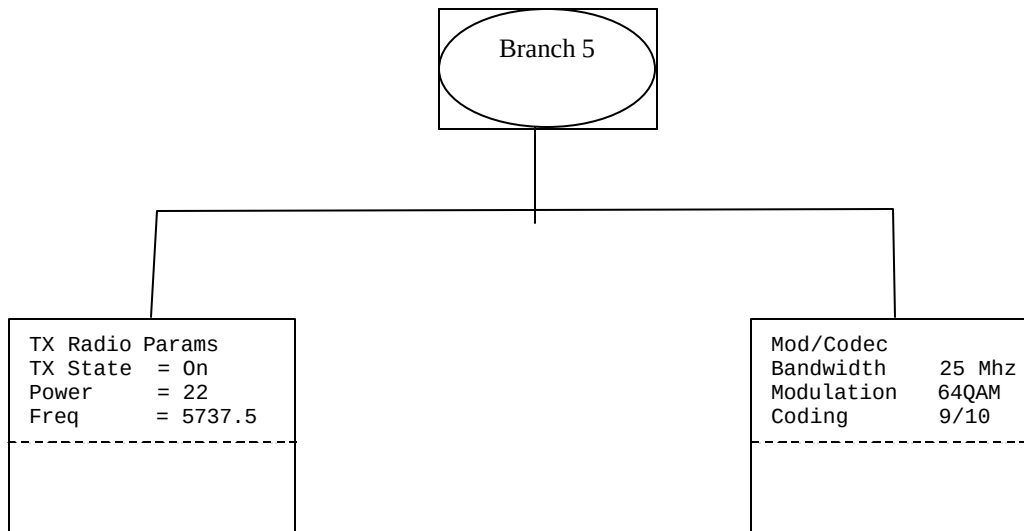
4.5 Menu Tree Structure

This section shows the hierarchy of the menu system. In general, **<ENTER>** will take you to the next screen from a menu choice, **<UP>** or **<DOWN>** will scroll through screens within a menu choice, and **<ESC>** will take you back up one menu level. The dashed lines indicate the bottom of the screen – to show lower (or upper) entries, use **<UP>** or **<DOWN>**.









4.6 Screen Menu Summaries

The following tables and text provide a screen view for that topic as well as the functions and settings of that screen. The order of the descriptions below is from left to right from the menu tree in the section above.

4.6.1 Modify Config/Link Params

Link Parameters *Mode: 100 FE 2 Ch Chan: 1A

Function	Settings	Summary
Mode	155 OC-3 1 Ch 100 FE 1 Ch 100 FE 2 Ch 50 FE 1 Ch 50 FE 2 Ch 50 FE 3 Ch 25 FE 1 Ch 25 FE 2 Ch 25 FE 3 Ch 25 FE 4 Ch	Selects the data rate in Mbps and number of channels in system. For SONET OC-3 Digital Radios, the top entry is the only setting shown. For Ethernet Digital Radios, all settings other than OC-3 will be shown.
Chan	A B 1A 1B 2A 2B 3A 3B 4A 4B	Selects the receive and transmit center frequency. Choices depend on the channel mode selected above.

The configurations above correspond to the channel center frequencies in the table below:

Channel Group Name	1 Channel	2 Channel	3 Channel	4 Channel
Chan 1A TX Freq	5750	5737.5	5733.3	5731.25
Chan 1A RX Freq	5825	5812.5	5808.3	5806.25
Chan 1B TX Freq	5825	5812.5	5808.3	5806.25
Chan 1B RX Freq	5750	5737.5	5733.3	5731.25
Chan 2A TX Freq		5762.5	5750	5743.75
Chan 2A RX Freq		5837.5	5825	5818.75
Chan 2B TX Freq		5837.5	5825	5818.75
Chan 2B RX Freq		5762.5	5750	5743.75
Chan 3A TX Freq			5766.7	5756.25
Chan 3A RX Freq			5841.7	5831.25
Chan 3B TX Freq			5841.7	5831.25
Chan 3B RX Freq			5766.7	5756.25
Chan 4A TX Freq				5768.75
Chan 4A RX Freq				5843.75
Chan 4B TX Freq				5843.75
Chan 4B RX Freq				5768.75

4.6.2 Modify Config/TX Control

TX Control *Transmitter: On Alignment Mode: Off
--

Function	Settings	Summary
Transmitter	On Off	Turns transmitter on or off.
Alignment Mode	Off On	Set transmitter to alignment mode on or off.

4.6.3 Modify Config/Adaptive Pwr Ctrl

Adaptive Pwr Ctrl *Power Control: Off Start Power: 22

Function	Settings	Summary
Power Control	On Off	Turns adaptive power control on or off.
Start Power	13 - 23	Select Start Power 13 = Min power (short range) 23 = Max Power (long range)

4.6.4 Display Config/Display RX Config/Radio

RX Radio Params Freq = 5812.5

Function	Settings	Summary
Freq	5725 - 5850	Displays received center frequency

4.6.5 Display Config/Display Rx Config/Demod/Decoder

Demod/Decoder Bandwidth 25 Mhz Modulation 64QAM Coding 9/10
--

Function	Settings	Summary
Bandwidth	12.5 MHz 16.7 MHz 25 MHz 50 MHz	Displays channel bandwidth.
Modulation	QPSK 16-QAM 32-QAM 64-QAM	Displays modulation type.

Coding	$\frac{3}{4}$ 7/8 4/5 9/10 5/6 11/12	Displays channel code rate.
--------	---	-----------------------------

4.6.6 Display Config/Display TX Config/Radio

```

TX Radio Params
TX State   = On
Power      = 22
Freq       = 5737.5

```

Function	Settings	Summary
TX State	On Off	Displays transmitter on/off status.
Power	13 - 23	Displays transmit power in dBm
Freq	5725 - 5850	Displays transmit center frequency

4.6.7 Display Config/Display Tx Config/Mod/Encoder

```

Mod/Codec
Bandwidth  25 Mhz
Modulation  64QAM
Coding      9/10

```

Function	Settings	Summary
Bandwidth	12.5 MHz 16.7 MHz 25 MHz 50 MHz	Displays channel bandwidth.
Modulation	QPSK 16-QAM 32-QAM 64-QAM	Displays modulation type.
Coding	$\frac{3}{4}$ 7/8 4/5 9/10 5/6 11/12	Displays channel code rate.

4.6.8 Display Config/Adaptive Pwr Ctrl

Adaptive Pwr Ctrl Power Control Off Start Power = 22

Function	Settings	Summary
Power Control	On Off	Displays adaptive power control on or off.
Start Power	13 - 23	Displays adaptive power control initial power setting.

4.6.9 Display Config/Network Config

Network Config

Currently not used.

4.6.10 Display Config/OA&M Params

```

OA&M Params
Local IP Address =
  10.200.1.121
Subnet Mask =
  255.255.255.0
Gateway Addr =
  10.200.1.1
Far End IP =
  0.0.0.0

```

Function	Settings	Summary
Local IP Address	xxx.xxx.xxx.xxx	Displays the IP address of the CarrierWave on the OA&M LAN.
Subnet Mask	xxx.xxx.xxx.xxx	Displays the subnet mask of the CarrierWave on the OA&M LAN.
Gateway Addr	xxx.xxx.xxx.xxx	Displays the gateway (default router) used by the CarrierWave on the OA&M LAN.
Far End IP	xxx.xxx.xxx.xxx	Displays the IP address of the CarrierWave unit at the other end of the link.

4.6.11 Monitor Status/Display RX Status

```

RX Status
RSSI    =  -70.0
Eb/N0   =  25.5

```

Function	Settings	Summary
RSSI	-70 to -20	Displays received signal strength.
Eb/N0	5 to 25.5	Displays received Eb/N0 in dB.

4.6.12 Monitor Status/Display Cur Alarms

```

08.21 20:25 GMT
ODU RX LO Unlock
08.21 20:24 GMT
ODU Pwr Unlock

```

The table below describes the alarms.

Alarm Name	Severity	Description
Payload Offline	Critical	The link to the far-end radio is down.
Modem Unlock	Critical	The Modem has not achieved lock
ODU: TX LO Unlock	Critical	The ODU is reporting the TX LO is not locked
ODU: RX LO Unlock	Critical	The ODU is reporting the RX LO is not locked
ODU: TX Disabled	Critical	The transmitter has been commanded to the Off state by either iConductor or the Front Panel interface
ODU: PwrLoop Unlock	Critical	The internal power control loop in the ODU is not functioning correctly
ODU: DC Pwr Err	Critical	There is a problem with the DC supply to the ODU
ODU: Comm Failure	Critical	The IDU is unable to communicate with the ODU
Pwr Mgmt Timeout	Major	Problem with the Adaptive Power Control
Internal Temp High	Major	The internal temperature of the IDU is above the allowable threshold.
Internal Temp Low	Major	The internal temperature of the IDU is below the allowable threshold.
Tx Power Max	Major	The transmitter output power is set at its maximum value

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5 Summary Specification

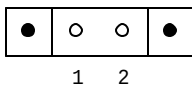
Parameter	Fast Ethernet	SONET OC-3
System		
Capacity	100/50/25 Mbps + 2 T1	155.52 Mbps + T1
Output Power - Average	13 to 23 dBm	13 to 23 dBm
Output Power - Peak	30 dBm	30 dBm
Input Sensitivity	-81 dBm	-72 dBm
Maximum Input Power	-20 dBm	-20 dBm
Internal Antenna	Flat Panel, G = 23 dBi	Flat Panel, G = 23 dBi
External Antenna	Optional	Optional
Regulatory Compliance	Compliance with: FCC Part 15.247 (ISM)	Compliance with: FCC Part 15.247 (ISM)
Radio Interfaces		
External Antenna	2 × N Type Female	2 × N Type Female
IDU/ODU Link	N Type Female	N Type Female
Data Interfaces		
Payload	100Base-Tx, RJ-45 Female	OC-3, Fiber SC, multimode LED (1300 nm)
T1	DSX-1, RJ-48C Female	DSX-1, RJ-48C Female
Control		
Network Management	SNMP, Proprietary GUI (iConductor™)	SNMP, Proprietary GUI (iConductor™)
NMS Connector	10Base-T/100Base-Tx	10Base-T/100Base-Tx
Alarm Port	2 Form C (SPDT), DB9	2 Form C (SPDT), DB9

Parameter	Fast Ethernet	SONET OC-3
Power/Environment		
DC Power	±37 to ±60 Volts, <70 W	±37 to ±60 Volts, <70 W
IDU Operational Temperature	0° to 55° C	0° to 55° C
ODU Operational Temperature	-30° to 65° C	-30° to 65° C
IDU Humidity	0 to 95%, non-condensing	0 to 95%, non-condensing
ODU Humidity	Up to 100% at 45° C	Up to 100% at 45° C
Altitude	15,000 feet/4572 meters, maximum	15,000 feet/4572 meters, maximum
Physical Dimensions		
IDU Size (WxHxD)	17.2 x 3.5 x 14.5 inches	17.2 x 3.5 x 14.5 inches
IDU Weight	10 lbs	10 lbs
IDU Mounting/Installation		
EIA Rack Mount	19 inch/48.2 cm, 2 rack unit	19 inch/48.2 cm, 2 rack unit
ODU Size (WxHxD)	14.6 x 15.4 x 2.6 inches	14.6 x 15.4 x 2.6 inches
ODU Weight	15 lbs	15 lbs
ODU Mounting/Installation		
Mounting	Custom Bracket	Custom Bracket

6 Rear Panel Connectors

6.1 DC Input (Power) Connector

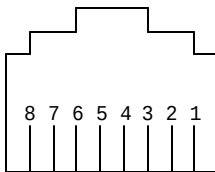
Two-pin male



PIN	TYPE	SIGNAL
1	POWER	Power supply return / IDU chassis ground
2	POWER	-48 Vdc, nominal

6.2 CarrierWave-100 Ethernet 100BaseTX Payload LOC Connector

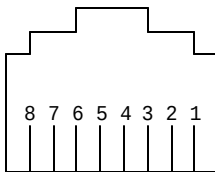
RJ-45 Female



PIN	TYPE	SIGNAL
1	OUTPUT	TX+
2	OUTPUT	TX-
3	INPUT	RX+
4	N/A	N/A
5	N/A	N/A
6	INPUT	RX-
7	N/A	N/A
8	N/A	N/A

6.3 CarrierWave-100 Ethernet 100BaseTX CPT Connector

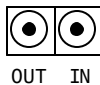
RJ-45 Female



PIN	TYPE	SIGNAL
1	OUTPUT	TX+
2	OUTPUT	TX-
3	INPUT	RX+
4	N/A	N/A
5	N/A	N/A
6	INPUT	RX-
7	N/A	N/A
8	N/A	N/A

6.4 CarrierWave-155 SONET Payload Connector

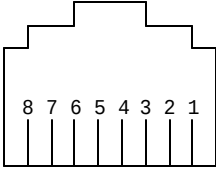
SC Duplex Female Fiber



PIN	TYPE	SIGNAL
OUT	OUTPUT	SONET OC-3 payload output (optical)
IN	INPUT	SONET OC-3 payload input (optical)

6.5 NMS 10/100BaseTX LOC Connector

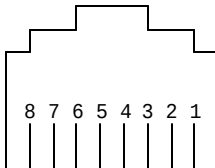
RJ-45 Female



PIN	TYPE	SIGNAL
1	OUTPUT	TX+
2	OUTPUT	TX-
3	INPUT	RX+
4	N/A	N/A
5	N/A	N/A
6	INPUT	RX-
7	N/A	N/A
8	N/A	N/A

6.6 NMS 10/100BaseTX CPT Connector

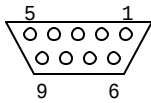
RJ-45 Female



PIN	TYPE	SIGNAL
1	OUTPUT	TX+
2	OUTPUT	TX-
3	INPUT	RX+
4	N/A	N/A
5	N/A	N/A
6	INPUT	RX-
7	N/A	N/A
8	N/A	N/A

6.7 Alarm Port Connector

DB-9 Female

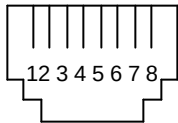


PIN	TYPE	SIGNAL
1	I/O	Alarm 2 Form-C NO (Normally Open) relay contact
2	N/A	N/A
3	N/A	N/A
4	I/O	Alarm 1 Form-C common relay contact
5	N/A	GND
6	I/O	Alarm 2 Form-C common relay contact
7	I/O	Alarm 2 Form-C NC (Normally Closed) relay contact
8	I/O	Alarm 1 Form-C NO (Normally Open) relay contact
9	I/O	Alarm 1 Form-C NC (Normally Closed) relay contact

6.8 T1- A Wayside Channel Connector

This is available in both Digital Radio models, CarrierWave-100 Ethernet and CarrierWave-155 SONET.

RJ-48C Female

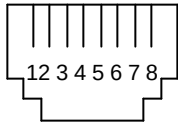


PIN	TYPE	SIGNAL
1	OUTPUT	TX+
2	OUTPUT	TX-
3	N/A	GND
4	INPUT	RX+
5	INPUT	RX-
6	N/A	GND
7	N/A	N/A
8	N/A	N/A

6.9 T1- B Wayside Channel Connector

This is available only in the CarrierWave-100 Ethernet Digital Radio.

RJ-48C Female



PIN	TYPE	SIGNAL
1	OUTPUT	TX+
2	OUTPUT	TX-
3	N/A	GND
4	INPUT	RX+
5	INPUT	RX-
6	N/A	GND
7	N/A	N/A
8	N/A	N/A

6.10 ODU Connector

Type N coaxial female

PIN	TYPE	SIGNAL
Center	I/O	2375 MHz TX IF / 1675 MHz RX IF / -48 VDC
Shield	N/A	Shield / Chassis GND

7 Appendix

7.1 Abbreviations & Acronyms

A/D, ADC	Analog-to-Digital, Analog-to-Digital Converter
ABAM	Designation of Lucent for twisted pair cable to connect ADM switch to T1 distribution panel
ADM	Add/Drop Multiplexer
ADPCM	Adaptive Differential Pulse Code Modulation
A _d TPC	Adaptive Power Control
AGC	Auto Gain Control
AIS	Alarm Indication Signal
ATM	Asynchronous Transfer Mode
BER	Bit Error Rate
CLEC	Competitive Local Exchange Carrier
CMRR	Common Mode Rejection Ratio
CO	Central Office
Codec	Coder-Decoder
CPE	Customer Premise Equipment
CPU	Central Processing Unit
CPFSK	Continuous-Phase Frequency Shift Keying
CSU	Channel Service Unit
D/A, DAC	Digital-to-Analog, Digital-to-Analog Converter
DB	Decibel
DBc	Decibel relative to carrier
DBm	Decibel relative to 1 mW
DBu	Decibel relative to .775 Vrms
DCE	Data Circuit-Terminating Equipment
DMM	Digital Modem Module
DSP	Digital Signal Processing
DSTL	Digital Studio-Transmitter Link
DTE	Data Terminal Equipment
DVM	Digital Voltmeter

EIRP	Effective Isotropic Radiated Power
EMI	Electromagnetic Interference
EMS	Element Management System
ESD	Electrostatic Discharge/Electrostatic Damage
FCC	Federal Communications Commission
FEC	Forward Error Correction
FET	Field effect transistor
FMO	Frequency Modulation Oscillator
FPGA	Field Programmable Gate Array
FSK	Frequency Shift Keying
FT1	Fractional T1
GPI	General Purpose Input
HP OpenView®	Hewlett Packard's network management product
IC	Integrated circuit
IDU	Indoor Unit
IEC	International Electrotechnical Commission
IF	Intermediate frequency
IMD	Intermodulation Distortion
IP	Internet Protocol
ISDN	Integrated-Services Digital Network
ISM	Industrial, Scientific, and Medical
ISP	Internet Service Provider
ITU	International Telecommunications Union
Kbps	Kilobits per second
kHz	Kilohertz
LAN	Local Area Network
LED	Light-emitting diode
LOS	Line of Sight
LO, LO1	Local oscillator, first local oscillator
LSB	Least significant bit
MAN	Metropolitan Area Network
Mbps	Megabits per second
MIB	Management Information Base
Modem	Modulator-demodulator
MMW	Millimeter Wave
ms	Millisecond

MSB	Most significant bit
MUX	Multiplex, Multiplexer
μs	Microsecond
μV	Microvolts
NC	Normally closed
NIC	Network Interface Card
NMS	Network Management System
NO	Normally open
NOC	Network Operations Center
OAM&P	Operations, Administration, Maintenance, and Provisioning
OC-3	Optical Carrier level 3
ODU	Outdoor Unit
OS	Operating System
PCB	Printed circuit board
PCM	Pulse Code Modulation
PGM	Program
PLL	Phase-Locked Loop
POP	Point of Presence
PRBS	Pseudo Random Bit Stream
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
R	Transmission Rate
RF	Radio Frequency
ROH	Radio Overhead
RPTR	Repeater
RSL	Received Signal Level (in dBm)
RSSI	Received Signal Strength Indicator/Indication
RX	Receiver
SCA	Subsidiary Communications Authorization
SCADA	Security Control and Data Acquisition
SDH	Synchronous Digital Hierarchy
SNMP	Simple Network Management Protocol
SNR	Signal-to-Noise Ratio
SONET	Synchronous Optical Network
SQM	Signal Quality Metric
SRD	Step Recovery Diode

STL	Studio-Transmitter Link
STM-1	Synchronous Transport Module 1
TCM	Trellis Coded Modulation
TCP/IP	Transmission Control Protocol/Internet Protocol
TDM	Time Division Multiplexing
THD	Total harmonic distortion
TP	Test Point
TTL	Transistor-transistor logic
TX	Transmitter
Vrms	Volts root-mean-square
Vp	Volts peak
Vp-p	Volts peak-to-peak
VOIP	Voice Over Internet Protocol
VPN	Virtual Private Network
VRMS	Volts, root-mean-square
VSWR	Voltage standing-wave ratio
WAN	Wide Area Network
ZIN	Input Impedance
ZOUT	Output Impedance

7.2 Conversion Chart

microvolts to dBm (impedance = 50 ohms)

<u>microvolts</u>	<u>dBm</u>	<u>microvolts</u>	<u>dBm</u>
0.10	-127.0	180	-61.9
0.25	-119.0	200	-61.0
0.50	-113.0	250	-59.0
0.70	-110.1	300	-57.4
1.0	-107.0	350	-56.1
1.4	-104.1	400	-54.9
2.0	-101.0	450	-53.9
2.5	-99.0	500	-53.0
3.0	-97.4	600	-51.4
3.5	-96.1	700	-50.1
4.0	-94.9	800	-48.9

<u>microvolts</u>	<u>dBm</u>	<u>microvolts</u>	<u>dBm</u>
4.5	-93.9	900	-47.9
5.0	-93.0	1,000	-47.0
6.0	-91.4	1,200	-45.4
7.0	-90.1	1,400	-44.1
8.0	-88.9	1,600	-42.9
9.0	-87.9	1,800	-41.9
10	-87.0	2,000	-41.0
11	-86.2	2,500	-39.0
12	-85.4	3,000	-37.4
14	-84.1	3,500	-36.1
16	-82.9	4,000	-34.9
18	-81.9	4,500	-33.9
20	-81.0	5,000	-33.0
25	-79.0	6,000	-31.4
30	-77.4	7,000	-30.1
35	-76.1	8,000	-28.9
40	-74.9	9,000	-27.9
45	-73.9	10,000	-27.0
50	-73.0	22.36 mV	-20 (10 mW)
60	-71.4	70.7 mV	-10(100 mW)
70	-70.1	223.6 mV	0 (1 mW)
80	-68.9	707.1 mV	+10 (10mW)
90	-67.9	2.23 V	+20(100 mW)
100	-67.0	7.07 V	+30 (1 W)
120	-65.4	15.83 V	+37 (5 W)
140	-64.1	22.36 V	+40 (10 W)
160	-62.9		