



# ***AN-50 System User Manual [PTP/PMP]***

**Manual 70-0001-01R00  
Release 2.01**



# Redline Communications AN-50 System User Manual

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## Disclaimer

This manual was designed to help you install, use and troubleshoot the Redline AN-50 Broadband Fixed Wireless (BFW) system. Every effort has been made to ensure the accuracy of the material provided herein; however, Redline assumes no responsibility regarding the use of the material. Additionally, Redline makes no representations or warranties, either expressed or implied, regarding the contents of this product. Redline Communications shall not be liable for any misuse regarding this product.

## FCC & IC Information

**1** - 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 is likely to cause harmful interference in which case the user will be required to correct the interference at his/her own expense.

**2** - A Class A digital device is marketed for use in a commercial, industrial or business environment, exclusive of a device which is marketed for use by the general public or is intended to be used in the home.

**3** - Intentional or unintentional changes or modifications not expressly approved by the party responsible for compliance must not be made. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty.

## UL Information

**1** - Caution for all *AC and DC models* - Double Pole/Neutral Fusing.

**2** - The DC source must be fused at Time Delay 2.5A, 250V.

**3** - The DC input wiring must be 18 AWG minimum.

**4** - The DC powered unit wiring is secured and chassis grounded using the following parts:

a) Internal Grounding: Ground wire: 18 AWG, 600V, style 1015, Green/Yellow with ring terminal. Nut size: #6-32 Hex Machine. Washer size: #6 Flat Washer, and #6 Internal Tooth Lockwasher. These are assembled onto #6-32 stud mounted to the chassis.

b) External Grounding: Ground wire: 18 AWG, 600V (not supplied). Nut size: Part of chassis. Screw size: 6-32 X 7/16, PPHMS, SEMS, Internal, Zinc. Washer size: Part of screw.

**5** - The DC input source must be SELV.

**6** - The DC input source must comply with the US National Electrical Code in the US and the Canadian Electric Code in Canada.

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## 1. Getting Started

### 1.1. How To Use This Manual

This User Manual is designed to get you started using the Redline Communications Access Node-50 (AN-50) Broadband Fixed Wireless (BFW) system by guiding you through the step-by-step process of setting up the system for the first time.

To that end, the following principal steps will need to be followed in order:

1. Review the safety and service information (Sections 2 and 3 of this manual)
2. Unpack the AN-50 system (Section 4)
3. Install the outdoor radio (transceiver plus antenna) (Section 7)
4. Install the indoor terminal (Section 7)
5. Configure the system via a host computer and web browser interface (Section 8)
6. Ensure the Mac address of the remote AN-50 has been properly configured (see Section 8.2.1) on the local unit
7. Install the license key option (page 8.1)

This User Manual will also help with the following:

- Understanding Fixed Wireless Systems
- Referencing AN-50 System Specifications
- Troubleshooting the System

### 1.2. AN-50 System Overview

The AN-50 is a high-performance, high-speed wireless Ethernet bridge that provides a scalable platform for the deployment of multi-services over a common equipment infrastructure and management system. The AN-50 System can operate in a Point-To-Point (PTP) or Point-To-Multipoint (PMP) mode depending on the software configuration.

In PTP mode, only two stations can communicate with each other, while the PMP mode consists of one or more Subscriber Station(s) that communicate with the Base Station.

For complete procedures on software upgrade and use of the option key please refer to sections 8.1 and 8.6.

The AN-50 system operates in the unlicensed band of 5.8 GHz and includes advanced technologies to address any potential inter-cell interference issues. The system also features adaptive modulation in both directions in PTP mode for automatic selection of modulation schemes, including BPSK, QPSK, 16 and 64 QAM to maximize data rate, and hence spectral efficiency. Additionally, the system delivers enhanced security through a proprietary, over the air encryption scheme that significantly improves the privacy and integrity of all traffic.

The AN-50 can be equipped with a narrow beam antenna to provide high directivity for long-range operations beyond 50 miles (80 km) in line of sight (LOS) conditions, and up to 6 miles (10 km) in NLOS conditions. The AN-50 using wide beam antennas associated with the PMP mode of operation can operate at over 15 miles (24 km), depending on power limits mandated by regional regulation.

The AN-50 system is a Class A digital device for use in a commercial, industrial or business environment.

## 2. Important Safety Information



- 1** Read this User Manual and follow all operating and safety instructions.
- 2** Keep all product information for future reference.
- 3** This product is supplied with a grounding power plug. Do not defeat this important safety feature.
- 4** The power requirements are indicated on the product-marking label. Do not exceed the described limits.
- 5** Always replace the fuse with the correct type and current rating.
- 6** Position the power cord to avoid possible damage, and do not overload wall outlets.
- 7** Do not place this product on or near a direct heat source, and avoid placing objects on the terminal.
- 8** Do not operate this device near water or in a wet location.
- 9** Use only a damp cloth for cleaning. Do not use liquid or aerosol cleaners. Disconnect the power before cleaning.
- 10** Protect the unit by disconnecting the power if it is not used for long periods of time.
- 11** Locate the AN-50 terminal on a stable horizontal surface or mount it securely in a 19" Telco rack.
- 12** The T-58 Transceiver unit must not be located near power lines or other electrical power circuits.
- 13** The T-58 Transceiver must be properly grounded to protect against power surges and accumulated static electricity. It is the user's responsibility to install this device in accordance with Section 810 of the National Electrical Code, ANSI/NFPA No. 70-1984 or Section 54 of the Canadian Electrical Code. These codes describe correct installation procedures for grounding of the transceiver unit, mast, lead-in wire and discharge unit, location of discharge unit, size of grounding conductors and connection requirements for grounding electrodes. It is recommended that the installation of the transceiver be contracted to a professional installer.

The following symbols may be encountered during installation or troubleshooting. These warning symbols mean *danger*. Bodily injury may result if you are not aware of the safety hazards involved in working with electrical equipment and radio transmitters. Familiarize yourself with standard safety practices before continuing.



**Electro-Magnetic Radiation**



**High Voltage**

### 3. Important Service Information



- 1** Refer all repairs to qualified service personnel. Do not remove the covers or modify any part of this device, as this will void the warranty.
  
- 2** Disconnect the power to this product and return it for service if the following conditions apply:
  - a) The unit does not function after following the operating instructions outlined in this manual.
  - b) Liquid has been spilled, a foreign object is inside or the AN-50 terminal has been exposed to rain.
  - c) The product has been dropped or the housing is damaged.
  
- 3** Locate the serial number of the AN-50 Terminal, Antenna, and T-58 Transceiver and record these on your registration card for future reference. Use the space below to affix serial number stickers. Also record the MAC address, located on the back of the AN-50 Terminal.

<b>Product Information</b>
AN-50 Terminal SN: _____ AN-50 Terminal MAC Address: _____
T-58 Transceiver SN: _____ Model #: _____
Antenna Type: _____ Antenna SN: _____
<b>Serial Number / Options Key Stickers</b>

## 4. Unpacking the AN-50 System

The AN-50 system comes packaged with the following major items (refer to Figure 1 for a pictorial view):

- AN-50 Terminal (indoor unit)
- AN-50 Radio (outdoor unit):
  - T-58 Transceiver
  - Antenna
- Antenna Mounting Bracket:
- Power Cord and outdoor IF Cable (100 ft. / 30.5 m)
- User Manual

**AN-50 Terminal**



**AN-50 Radio**



**User Manual**



**Power/IF  
Cables**

**Figure 1: The AN-50 System Out Of The Box**

A complete list of items included in the system is available on the packing list included with the system. Note that a complete list of FCC approved antennas can be found on the Redline Web site under support.

## 5. AN-50 System Mode of Operation

The AN-50 system utilizes Redline's advanced Medium Access Control (MAC) design to provide efficient transmission of data in both PTP and PMP modes. In PMP mode, the MAC incorporates a proprietary polling algorithm to support up to 256 individual subscriber stations from a single base station operating in a single sector. Note that multiple base stations can be installed on a single roof-top or tower to provide multi-sector coverage.

A single sector AN-50 PMP implements a distributed wireless L2 switch, with one uplink port located on the sector controller (master) distributing bandwidth to a variable number of subscriber stations (slaves).

- Each subscriber station (or slave) is considered a separate wireless link.
- Each configured wireless link adds to the switch one slave port that is the Ethernet port on the corresponding subscriber station. This is achieved during provisioning.
- Each link (slave port) is assigned one ID that is used to manage both the connection traffic and the wireless link.
- The switch supports one broadcast/multicast group called default group.
- The default group is assigned automatically to a fixed ID.

The AN-50 MAC utilizes a request/grant polling mechanism to determine which subscriber station requires bandwidth. This is achieved by periodically polling each subscriber station to determine if there is a request for bandwidth. If the SS requests bandwidth then the MAC allocates the appropriate number of time slots, in both the downstream and upstream direction, in accordance with the CIR rate limits specified for that particular SS. The AN-50 PMP system supports 18 programmable CIR levels. Through an external calculator the minimum Committed Information rate CIR rates allowed for each SS can be determined. Note that a minimum CIR of 8kb/s implies almost no CIR, and is referred to as Best Effort (BE) services.

With multiple subscriber stations vying for bandwidth, the MAC ensures that time slots are allocated in a balanced manner, according to the different CIR levels, during periods of over-subscription. For example, during peak times, the MAC will first deny time slot allocations for everything above the provisioned CIR, and then reduce bandwidth in a proportional manner to the remaining units with varying CIR levels and priorities. With the support of CIR, the service provider can offer different grades of service to each end user in a controlled manner based on their service level agreements or contracts

## 6. The AN-50 Terminal at a Glance

The front panel of the AN-50 terminal includes a LAN interface and three main status indicators; System, Wireless, and Ethernet. The rear of the terminal includes the power cord connector and an F-Type female connector for the IF cable.

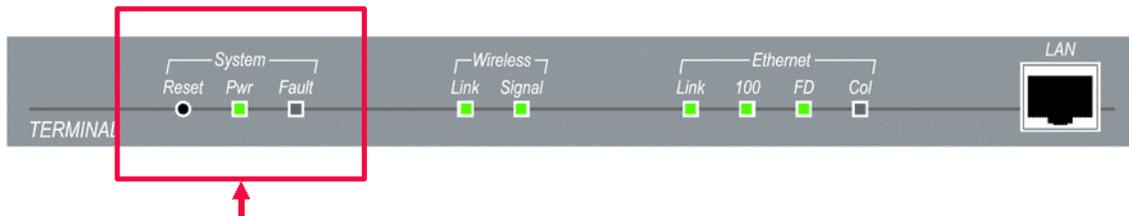
At power up, an LED power-up sequence occurs as follows:

All four Ethernet LEDs light for one second, then individual Ethernet LEDs blink twice in the following order: 100, FD, Col, Link. The Fault LED lights for approximately four seconds, then turns off. The two Wireless LEDs remain off for approximately five seconds, then blink once and resume their normal state.

For a detailed description of the status indicators on the front panel, see the Diagnostics section of this manual, Section 9.1 on page 46.

### A) System Status Indicators

The System portion of the front panel features a recessed reset switch and two LEDs (Pwr and Fault), as shown in the figure below.



**Figure 2: Front Panel – System**

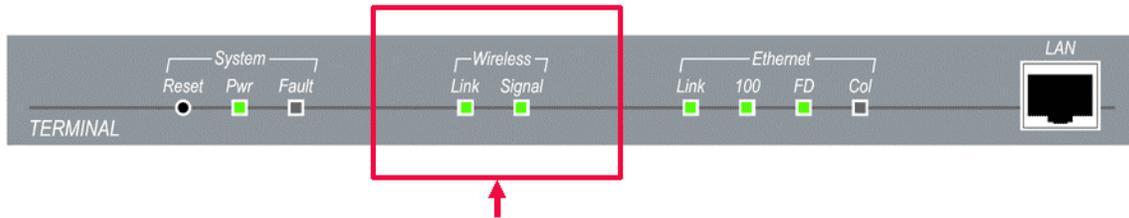
**Reset** – The system can be manually hard reset by depressing the “Reset” button recessed in the front panel. The reset button is used to reactivate the terminal in the event that it is functioning improperly or is in a state of suspension.

**Pwr** – The “Pwr” LED lights solid green when the AC power is properly applied to the terminal. In the event of internal power supply failure, if the cord is disconnected, or if the fuse is blown, the “Pwr” light will not illuminate.

**Fault** – The “Fault” LED lights solid red when a serious fault is detected within the system.

### B) Wireless Status Indicators

The Wireless portion of the front panel features two LEDs; Link and Signal, as shown below.



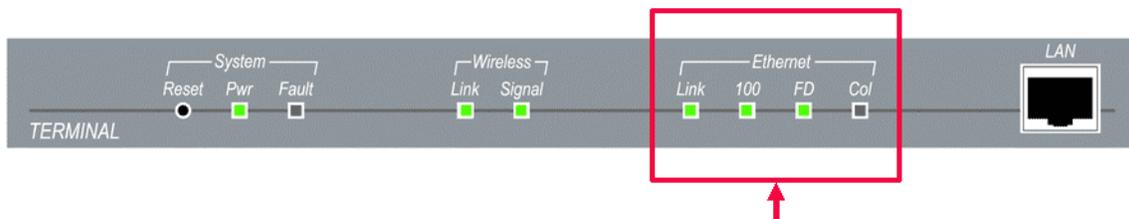
**Figure 3: Front Panel - Wireless**

**Link** – For a slave terminal, the “Link” LED lights solid green when the radio link to the master terminal is established and the LED will turn off if the link is lost. For a master terminal, the LED lights solid green when at least one radio link to any of the provisioned slaves is established and will turn off if all links are lost.

**Signal** – The “Signal” LED lights solid green if the system, the link (the (links for a master) and the provisioned connections all operate within configured parameters. See section 9.1.4 on page 49 for a detailed description.

### C) Ethernet Status Indicators

The Ethernet portion of the front panel display comprises four main LEDs; Link, 100, FD and Col, as shown below.



**Figure 4: Front Panel – Ethernet**

**Link** – The “Link” LED illuminates solid green when the Local Area Network (LAN) connection is established, and there is no traffic. The Link LED will flash when the Local Area Network (LAN) connection is established, and there is traffic.

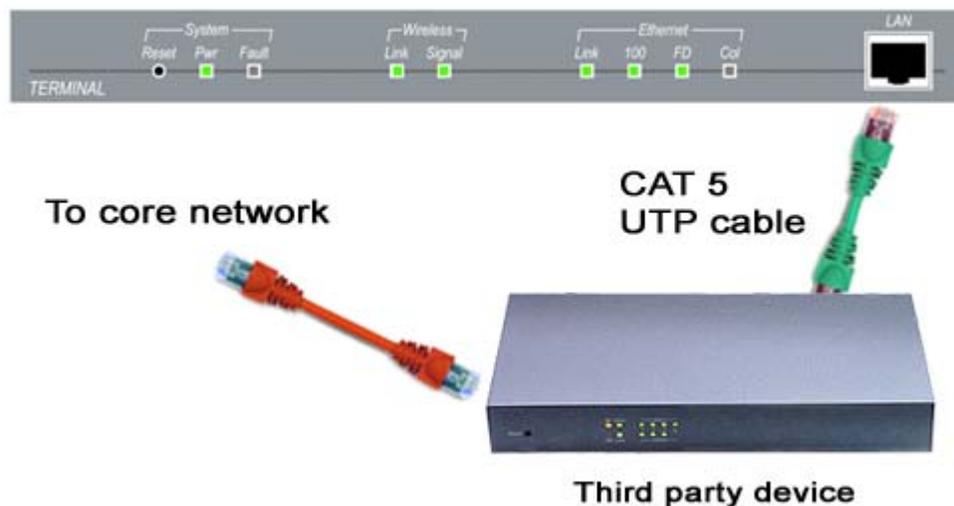
**100** – The “100” LED lights solid green when the Ethernet port is operating at 100 Mb/s. The LED will not illuminate if the port is operating in 10 Mb/s mode. The Ethernet port automatically selects the speed through auto-negotiation with either the host computer/server or router/switch.

**FD** – The “FD” LED illuminates solid green when the LAN connection is operating in Full Duplex mode. The system automatically selects the duplex mode through auto-negotiation with the host computer or switch.

**Col** – The “Col” LED flashes in amber when collisions are detected on the Ethernet port.

#### D) The LAN Interface

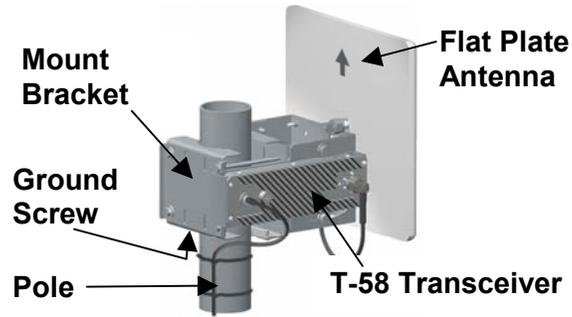
The LAN interface is a 10/100 BaseT Ethernet port, which is used to connect the AN-50 terminal to either the core network or to a host computer. A router or switch is often used to complete the connection to the core network, as shown in the figure below. Note that different cables are required for connection to a hub/switch/router or host computer. See Section 7.4 of this manual for more information regarding installation of the terminal.



**Figure 5: LAN Interface**

#### 6.1. The AN-50 System’s T-58 Transceiver / Antenna at a Glance

An antenna bracket will always be provided with the system (see example below Figure 6).



**Figure 6: AN-50 Radio With Vertical Mount**

The Redline vertical mount bracket can accommodate 1  $\frac{3}{4}$ " to 4  $\frac{1}{2}$ " (4.45 cm – 11.45 cm) OD masts found on many commercial tower installations.

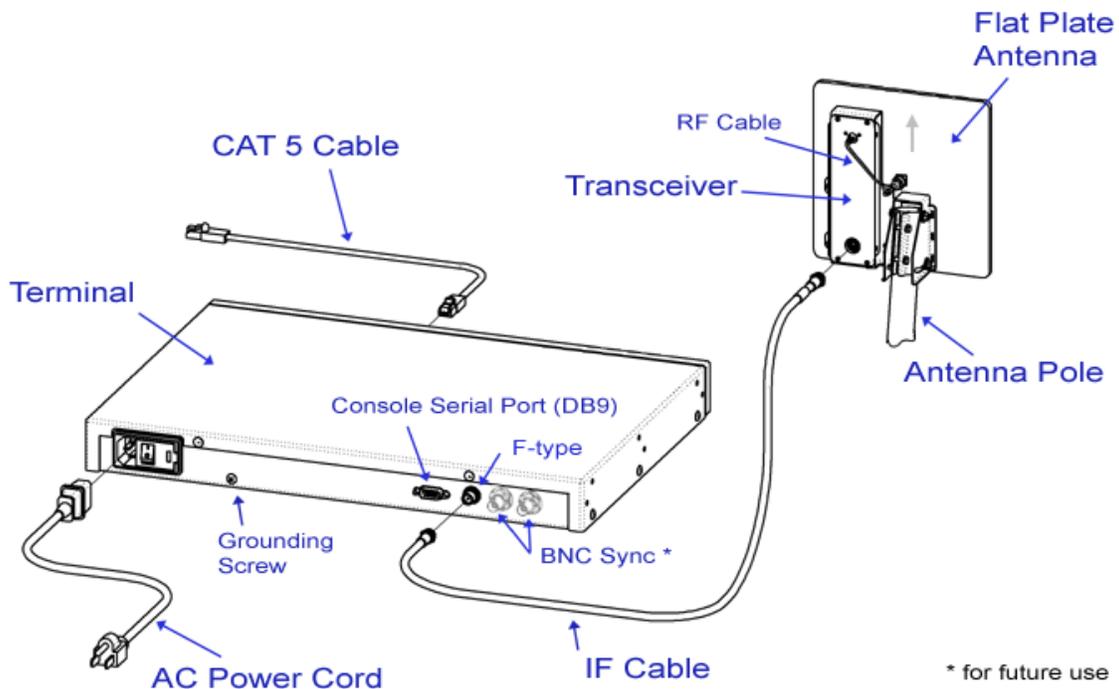


**Before connecting the AN-50 system, it is important to review the safety tips provided at the beginning of this manual.**

## 7. AN-50 System Installation

This section of the manual presents a basic overview of the steps required to install the AN-50 terminal, outdoor transceiver, antenna and associated equipment.

Figure 7 below illustrates the primary system components and cables. The power cord connects to a 110/220/240 VAC standard power outlet, while the CAT 5/UTP cable (not included) connects the terminal to the data network via a standard 10/100BaseT Ethernet connection. The provided IF cable connects the terminal (located indoors) to the T-58 Transceiver (located outdoors), and carries the transmitted and received signal, DC power for the AN-50 radio, as well as control and reference signals. Note that the provided IF cable is meant for exterior use, and should be used for only minimal interior runs to connect to the terminal. Also note that the BNC connectors are for future use.



**Figure 7: AN-50 System Installation**

The terminal is for indoor installation only, while the transceiver and antenna (together known as the AN-50 Radio) are mounted externally. The principal steps in installation are:

1. Conduct a general site survey
2. Install the transceiver and antenna
3. Install the IF cable
4. Install the AN-50 terminal
5. Align the antenna

Each step is addressed in more detail below.

## 7.1. General Site Survey

The first step in installing the AN-50 system is to conduct a general site survey. Although the installation steps are relatively straightforward, they do involve some construction and electrical work, which is best performed by a professional installer.

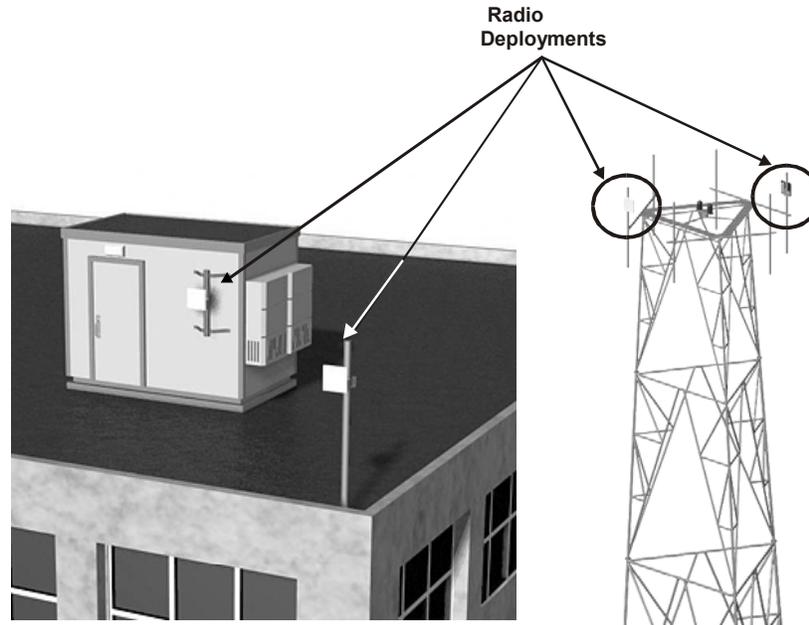
The following site survey steps should be followed:

**Determine the optimum location.** The first key step in the deployment exercise is to determine and identify building candidates that can be used to support the link. A critical parameter to consider is the range at which the subscriber station, base station or terminals are required to operate. Range performance is determined by empirical formulas that consider a number of equipment and environmental factors described in Section 9.7 of this manual. Ensure that the installation sites meet these range performance requirements before moving to the next step. You may use Redline's Link Budget Tool to determine the expected performance of the link. The Link Budget Tool can be obtained by contacting your Redline certified partner or system integrator. See Section 9.7.1 on page 59 for more information.

**Verify the accuracy of any building drawings/blueprints that may be available.** The installation process may require penetrating the building to run the IF cable between the outdoor and indoor units. In this regard, it is imperative that the blueprints and/or drawings of the building are up to date and accurate. It may also be possible for the IF cable to be installed on the outside of the building leading to the antenna location on the roof of the building.

**Identify the best path for the link.** For maximum performance, it is recommended to mount the antenna in a location where there is line of sight to the remote terminal. If possible, the antenna should be positioned such that there is maximum clearance within the first Fresnel zone of the direct path. Refer to Section 9.3 for a full description of Fresnel zone clearance and its impact on signal propagation. The best means of achieving Fresnel zone clearance is to mount the antennas as high as possible, on either a tall building or tower, as shown in Figure 8 (Vertical mount system is shown).

The AN-50 system is also designed to operate in non-line-of-sight (NLOS) conditions, as a result of the OFDM technology incorporated in the platform. Under NLOS conditions, the best method of obtaining a proper RF link is to evaluate different antenna orientations and choosing the one that results in the best Signal to Noise (SINADR) ratio and highest Received Signal Strength (RSSI) value. Often, this can be achieved by introducing an RF multipath condition by orienting the antennas towards a structure in sight of both the local and remote antennas. If the obstruction in the path is not exceptionally high, it may be possible to aim both antennas near the top of the obstruction. With the use of OFDM in the Redline system, any additional multipath signals introduced will provide additional opportunities for an improved link. For PTP and Subscriber Station it is very important that the above steps are carefully followed. For the Base Station the accuracy of the aiming is not so important as the antenna is using a wide angle.



**Figure 8: Radio Deployment Options**

**Identify potential sources of RF interference.** Test for possible RF interference on the roof-top or tower by utilizing appropriate test equipment. RF interference arises from any other wireless system operating within the same frequency band as the AN-50. Note that the AN-50 system supports nine different overlapping channels within the 5.8 GHz band and has the ability to use up to five of these channels at any one cell site; there is, therefore, some flexibility in addressing or avoiding interference should other transmitters in relatively close proximity present problems.

## 7.2. Installing The Antenna

Once the site survey has been completed and the exact location for the antenna identified, the next step is to assemble and mount the radio onto a building structure, pole or tower.

Note there is an arrow on the back of the antenna, which must point in the same direction for both the local and remote systems to ensure proper polarization when the antenna is deployed (see Figure 7 above). Ensure the proper polarization is used for the antenna after attaching it to the mounting bracket.

The universal or vertical mount bracket is installed first, then the antenna is attached to it. The antenna and mounting brackets have been designed to withstand strong winds; it is imperative that all hardware for the mounting brackets be securely fastened to avoid any movement, which could introduce misalignment.

The T-58 Transceiver is then mounted to the mounting bracket as shown in Figure 13. This assembly is in turn attached to the back of the antenna. Note the transceiver must be connected to the antenna via the short RF cable provided.

For building mounts, ensure the surface to which the mounting bracket will be attached is structurally sound, flat and vertical (use a level). Ensure that the installation can withstand wind loading.

### 7.3. Running The IF Cable

The system is shipped with a 100 foot (30.5 m) length of RG6 IF cable to connect the transceiver and indoor terminal. The IF cable carries the transmitted and received signal, DC power for the AN-50 radio, and control signals. One hundred feet is the mandatory minimum length; if a longer outdoor run is required, it is recommended that a single length of the appropriate cable be used; coupling the provided 100-foot cable to another length will result in increased attenuation. Refer to the cable requirements in the Specifications section at the end of this manual.

*Note: If male "F" crimp connectors are used with custom cables, the cable's core conductor diameter must be no larger than 1mm (.042 inches) or longer than 1cm (0.38 inches) to avoid damage to the T-58 and AN-50 connectors. If the core diameter exceeds 1mm, use solder type 'F' connectors that do not exceed these dimensions.*

The following steps define the cable installation process:

1. Run the cable alongside the antenna pole as shown. The IF cable is equipped with 75 ohm male F-type connectors at both ends. Ensure the cable is running downward as shown to prevent water from accumulating on the connector. The cable should be fastened to the pole to prevent movement or damage to the connector.



**Figure 9: IF Cable**

2. The RF cable should connect the antenna to the transceiver.
3. Connect the male IF cable connector to the female F-type connector on the transceiver. The connector should then be weatherproofed with a standard weatherproofing material for outdoor RF installations. Note that the provided IF cable is for exterior use. It is recommended that the cable terminate at the exterior wall using a grounding block, and that interior grade cable be used to connect the terminal to the grounding block according to local codes. For convenience, a grounding block is included with the AN-50 system. An optional

- lightning arrestor may be used to protect the terminal and other indoor equipment from sudden electrical surges. A suitable arrestor may be purchased through any of Redline's system integrators. Note that performance may be affected by the use of other arrestors.
4. Connect the IF cable to the F-type female connector located on the back of the terminal. The connector should be tightened finger-tight and then tightened an additional 1/8 of a turn.

#### 7.4. Installing The Terminal

Once the AN-50 terminal and the radio are connected, the terminal is ready to be installed and configured. The Ethernet data rate is determined automatically, depending on the type of device connected to the system.

If the terminal is used for connection to a core network, the network device is likely to be a router, hub, or switch as shown in Figure 10. A straight through cable is typically required for connecting to a router, for a switch, a cross-over Ethernet cable may be required.

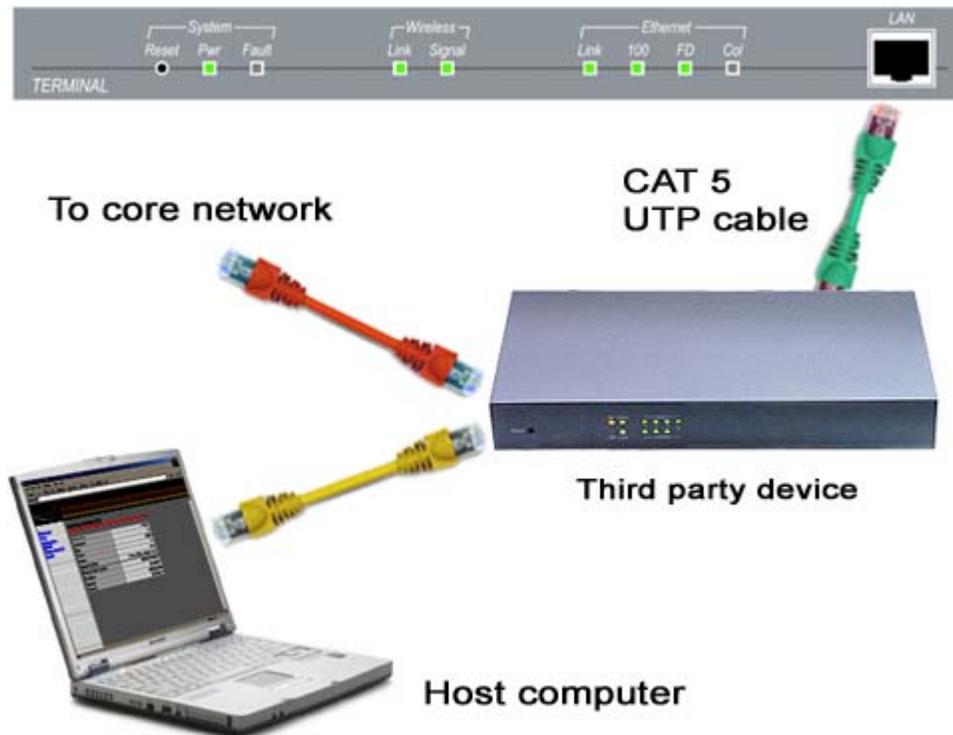
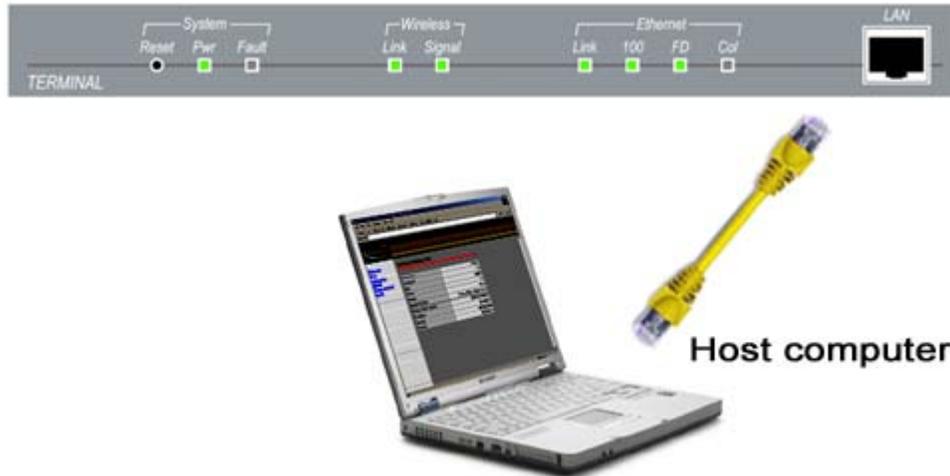


Figure 10: AN-50 Terminal Connected To Switch / Router / Hub

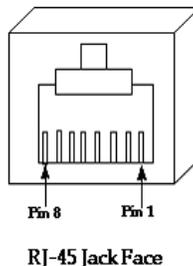
The AN-50 terminal may also be connected directly to the host computer, as shown in Figure 11. In this configuration, a straight-through CAT 5/UTP cable is required to complete the connection.



**Figure 11: AN-50 Terminal Connected To Host Computer**

To help you establish other implementations that are not addressed in this manual, Figure 12 provides an illustration of the pinout for the AN-50 terminal LAN interface.

**Warning:** do not connect a telephone cable to the AN-50 LAN interface, as this will damage the terminal.



Jack Pin	Function
1	Rx +
2	Rx -
3	Tx +
6	Tx -

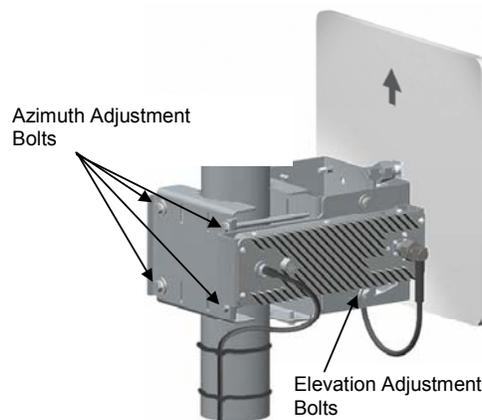
**Figure 12: AN-50 Terminal LAN Ethernet Port Pinout**

Now connect the AC cord to the 110/220/240 VAC outlet and turn the terminal on using the toggle switch at the rear of the unit. The system “Pwr” LED should illuminate green to

indicate power to the unit. The system is now ready to be configured. If the Pwr LED is not on and/or the "Fault" LED illuminates red, there is a problem with the terminal. Refer to the diagnostics section, Section 9 on page 46, for further details on how to address system faults.

## 7.5. Aligning The Antenna

Once the antenna is mounted and the terminal is installed, the antenna must be aligned in both the azimuth and elevation planes. For the base station antenna or first PTP antenna, position the antenna in the desired direction. Elevation alignment is accomplished by loosening the two bolts attached to the mounting bracket, as shown in Figure 13 below, and angling the antenna so it is aligned towards the remote terminal. The azimuth alignment is accomplished by loosening the bolts on the antenna bracket and rotating the antenna until alignment is achieved. For basic tuning using actual signal strength, an alignment "buzzer" (intermittent tone sweep generator) or a voltage pin is available on the T-58 Transceiver. Faster repetitions of the tone sweep indicate better alignment. The buzzer is enabled via the software interface described in section 8.1.



**Figure 13: Aligning The Antenna - Vertical Mount**

**NOTICE**

**1** - The AN-50 System is used as a fixed wireless Ethernet bridge that requires professional installation with specified antennas and output power levels certified under the FCC Grant for AN-50 System for Point-to -Point or Point-to-Multipoint mode of operations.

**2** - FCC RF Exposure Requirements - The antenna(s) used for this transmitter must be fixed-mounted on outdoor permanent structures with a separation distance of at least 3.1 meters (9.3 feet) from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

**3** - The AN-50 System is certified by the FCC and Industry Canada with 5.8 GHz Directional and Parabolic Antennas, listed bellow:

<i>Redline Part Number</i>	<i>Antenna Gain, dBi</i>	<i>Antenna Type</i>	<i>Application</i>
48-00017	14.0	<i>Directional, sector</i>	<i>PMP</i>
48-00025	14.0	<i>Omni Directional, flat panel</i>	<i>PMP</i>
48-00014	15.0	<i>Omni Directional, flat panel</i>	<i>PMP</i>
48-00041	21.0	<i>Directional, flat panel</i>	<i>PMP &amp; PTP</i>
48-00020	23.0	<i>Directional, flat panel</i>	<i>PMP &amp; PTP</i>
48-00006	28.0	<i>Directional, flat panel</i>	<i>PMP &amp; PTP</i>
48-00028	17.0	<i>Directional, sector</i>	<i>PMP</i>
48-00029	16.0	<i>Directional, sector</i>	<i>PMP</i>
48-00030	22.5	<i>Directional, parabolic</i>	<i>PMP &amp; PTP</i>
48-00031	29.0	<i>Directional, parabolic</i>	<i>PMP &amp; PTP</i>
48-00032	31.2	<i>Directional, parabolic</i>	<i>PMP &amp; PTP</i>
48-00033	34.8	<i>Directional, parabolic</i>	<i>PMP &amp; PTP</i>
48-00040	29.0	<i>Directional, parabolic</i>	<i>PMP &amp; PTP</i>
48-00039	31.0	<i>Directional, parabolic</i>	<i>PMP &amp; PTP</i>

**4** - For fixed, point-to-point mode of operations, the transmitting antennas must be directional as specified in this Users Manual; the use of omni-directional antenna is prohibited for point-to-point operation.

## 8. System Configuration and Operation Via the Web Interface

All operator communication with the AN-50 terminal is achieved over the Ethernet port using hypertext transfer protocol (HTTP). This offers the advantage of allowing the operator to access and control the AN-50 terminal remotely from any geographical location, providing there is access to the Internet. This section describes the procedures for configuring and operating the AN-50 terminal via the web interface. All screens and explanations refer to both PTP / PMP modes of operation unless otherwise specified.

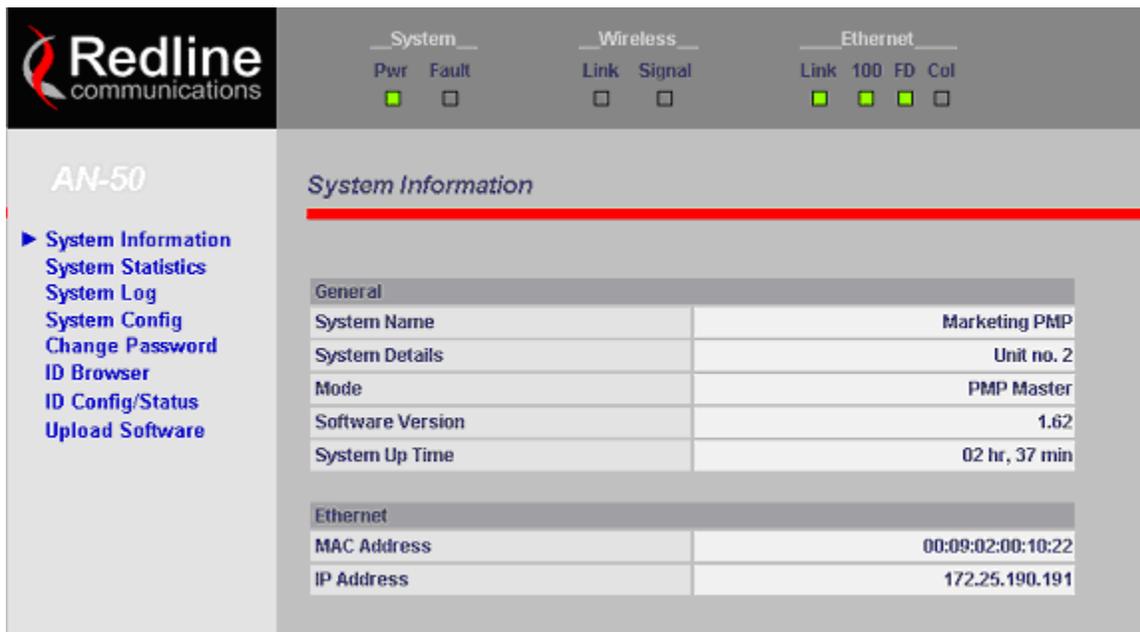
Note for the initial set-up, the operator must connect the host computer locally to the AN-50 terminal as shown in Figure 11.

Log on to the AN-50 General Information home page from a web browser. Microsoft Internet Explorer is recommended, as it enables context help when the cursor is positioned over any item.

Enter the system's default IP address - <http://192.168.25.2>.



Entering the IP address above will call up the General Information page, via the ID / Password dialog as shown in Figure 14 below. The items on this page are described in detail in section 8.4 below. If the General Information page is not accessible, check for possible text entry errors; otherwise refer to the Diagnostics section of this manual (section 9) for further assistance.



System Information	
<b>General</b>	
System Name	Marketing PMP
System Details	Unit no. 2
Mode	PMP Master
Software Version	1.62
System Up Time	02 hr, 37 min
<b>Ethernet</b>	
MAC Address	00:09:02:00:10:22
IP Address	172.25.190.191

It will be necessary to enter a valid user name and password. Note that a valid Administrator password is required to enter any of the following pages:

- **System Config**
- **System Password**
- **ID Config / Status**
- **Upload Software**
- **Reset button on System Status**

An example of the user name and password screen is shown in Figure 14. There are 2 users – “user” and “admin”. The default value (set at the factory) for both the user name and password for the Administrator is “admin”. This login allows access to all screens. The default value (set at the factory) for both the user name and password for the User is “user”. This login denies access to the System Config, System Password, ID Config / Status, Upload Software and Reset Button on System Status screens. Refer to the System Password screen to change the password for future sessions. If the password is changed, record it in a secure location for future reference. Note that the user name cannot be changed from “admin”.



**Figure 14: User Name And Password Dialog**

The main menu on the left includes the following links:

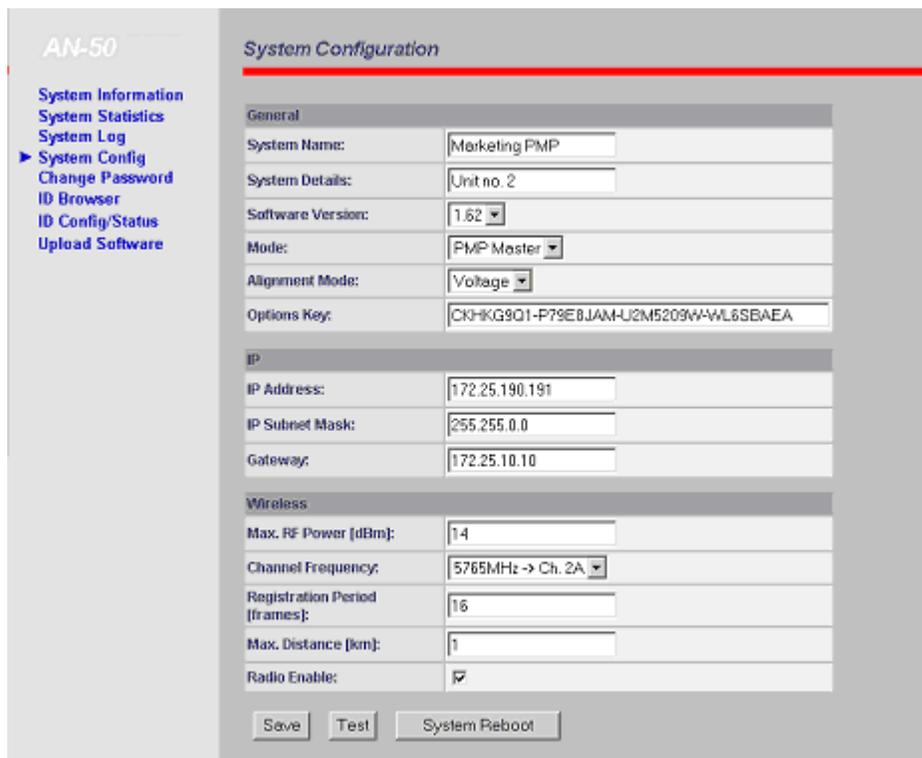
- **General Information**
- **System Status**
- **System Log**
- **System Config**
- **System Password**
- **ID Browser**
- **ID Config / Status**
- **Upload Software**

The General Information page does not accept input from the user. Data shown on this page may be modified via the Configuration page.

## 8.1. System Configuration

The System Configuration page provides a simple-to-use Graphical User Interface (GUI) for the operator to input a complete set of system parameters for both the Ethernet and Wireless components of the AN-50 terminal. Note all parameters under System Configuration are global and apply to every subscriber station. To store the parameters into memory, click the Save Configuration button at the bottom of this page. This operation is recorded in the System Logs.

*Note: It is important to ensure that all fields on the System Configuration page are filled out properly for local and remote terminals. Errors in these fields will result in the inability to establish a communication link. Please read carefully to ensure a quick, trouble-free deployment.*



**Figure 15: System Configuration**

The system configuration includes the following fields:

### System Configuration:

**System Name:** An alphanumeric identifier for the local terminal, which can consist of any combination of letters and numbers up to 20 characters in length. The default name for the system from the factory is set to WEB01. The name remains with the system, even during power off states, until the operator re-types a new name using this menu field.

**System Details:** Specifies the location of the unit, telephone number and/or contact information of the network administrator. Can be up to 20 characters in length.

**Software Version:** Specifies the current version of the system software. Note that software can be remotely downloaded into the AN-50 terminal. The system includes sufficient memory to hold two independent software loads. The operator can specify which software load is used in the system. See section 8.6 for additional details.

**Mode:** Sets the AN-50 to serve as the PMP master, PTP master or PMP / PTP slave. One and only one unit must be set as the master. A slave will not communicate with another slave.

**Alignment Mode:** Specifies the current alignment mode: buzzer or vu-meter (future release). The buzzer provides an alignment tone sweep generator located in the T-58 Transceiver for fine-tuning based on signal strength. Faster repetitions of the tone sweep indicate better alignment.

**Options Key:** The key is personalized to each unit's MAC address. The 64 QAM License Key (an optional purchase item) raises the available Uncoded Burst Rate from the default 36 Mbps to 54 Mbps. Please ensure that the correct MAC address is provided when requesting a key from your local Redline representative, or register directly at <http://www.redlinecommunications.com/support/register>. Enter the key (case sensitive), ensure it is correct, and click "Send Key". Please note that the system cannot be used without the option key.

#### IP Configuration:

**IP address:** This field is used to provide an IP address for the local AN-50 terminal. The default address from the factory is 192.168.25.2. For the initial setup, the terminal should not be connected to the Internet, i.e., the host computer should be connected directly to the terminal Ethernet port, to avoid address conflicts with other devices on a public network. Once an IP address has been set, the terminal can be connected to the core network.

**IP Subnet Mask:** This field is used to set the desired IP subnet mask. The default mask value is set to "255.255.255.0" (Class C subnet).

**Default Gateway Address:** Specifies the IP address of the default router / gateway on the local Ethernet segment. The default gateway address is 192.168.25.1

#### Wireless Configuration:

**Max RF Power:** this parameter specifies the maximum power level of the system. Depending on the RF channel, FCC regulations and / or local / regional regulation, the user must follow the table below when determining the power to be used.

**Table 1: Max. Operational Power Per Antenna (in dBm)**

Redline's Part Number	Antenna Gain (dBi)	Antenna Type	Application	Minimum Conducted Power (dBm)	Max Conducted Power Ratings (dBm)	Max EIRP (dBm)
48-00017	14	Directional, Sector	PMP	-20	22	36 dBm
48-00025	14	Omni Directional, Flat Panel	PMP	-20	22	36 dBm
48-00014	15	Omni Directional, Flat Panel	PMP	-20	21	36 dBm
48-00041	21	Directional, Flat Panel	PMP	-20	15	36 dBm
48-00020	23	Directional, Flat Panel	PMP	-20	13	36 dBm
48-00006	28	Directional, Flat Panel	PMP	-20	8	36 dBm
48-00028	17	Directional, Sector	PMP	-20	19	36 dBm
48-00029	16	Directional, Sector	PMP	-20	20	36 dBm
48-00030	22.5	Directional, Parabolic	PMP	-20	13.5	36 dBm
48-00031	29	Directional, Parabolic	PMP	-20	7	36 dBm
48-00032	31.2	Directional, Parabolic	PMP	-20	4.8	36 dBm
48-00033	34.8	Directional, Parabolic	PMP	-20	1.2	36 dBm
48-00040	29	Directional, Parabolic	PMP	-20	7	36 dBm
48-00039	31	Directional, Parabolic	PMP	-20	5	36 dBm
48-00041	21	Directional, Flat Panel	PTP	-20	26	47
48-00020	23	Directional, Flat Panel	PTP	-20	26	49
48-00006	28	Directional, Flat Panel	PTP	-20	26	54
48-00030	22.5	Directional, Parabolic	PTP	-20	26	48.5
48-00031	29	Directional, Parabolic	PTP	-20	26	55
48-00032	31.2	Directional, Parabolic	PTP	-20	26	57.2
48-00033	34.8	Directional, Parabolic	PTP	-20	26	60.8
48-00040	29	Directional, Parabolic	PTP	-20	26	55
48-00039	31	Directional, Parabolic	PTP	-20	26	57

**Table 2: Max. Operational Power Per Channel (in dBm) vs. Modulation**

	64QAM 3/4 (54 Mb/s)	64QAM 2/3 (48 Mb/s)	16QAM 3/4 (36 Mb/s)	16QAM 1/2 (24 Mb/s)	QPSK 3/4 (18 Mb/s)	QPSK 1/2 (12 Mb/s)	BPSK 3/4 (9 Mb/s)	BPSK 1/2 (6 Mb/s)
<b>Max Tx Power</b>	14	15	19	20	20	20	20	20

**Channel Frequency:** specifies the operating channel of the system, within the 100 MHz available in the 5.8 GHz band. The table below specifies the center frequencies of each permitted channel.

Channel	Frequency
1	5735 MHz
1A	5745 MHz
2	5755 MHz
2A	5765 MHz
3	5775 MHz
3A	5785 MHz
4	5795 MHz
4A	5805 MHz
5	5815 MHz

To avoid interference, two PMP / PTP links operating in the same physical location (co-located) or within close proximity must be separated by at least one channel, i.e., the gap between channels must be 20 MHz or more (e.g., channels 2 and 3).

**Registration Period (frames):** Specifies how often the Base Station needs to register with the Subscriber Station. This only needs to be configured at the Base Station

**Max Distance (km):** Specifies the max distance between the Base Station and the farthest Subscriber Station in the same sector.

**Radio Enable:** Specifies whether radio transmission is enabled.

#### System Configuration Buttons:

**Save:** Saves the currently entered parameters. Note that when certain parameters (for example the Mode) are changed clicking Save Configuration will also initiate a system reboot

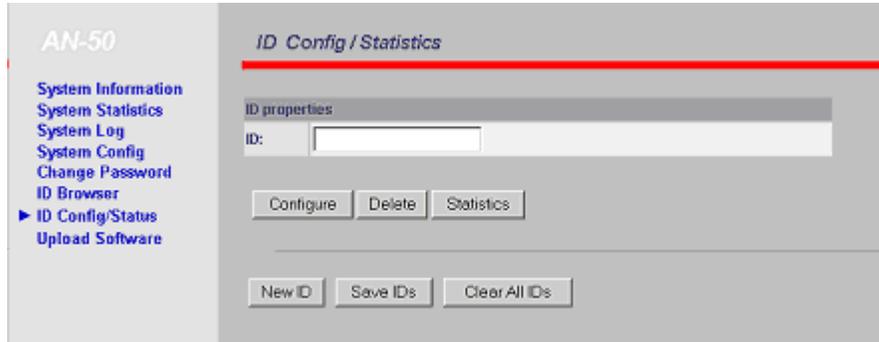
**Test:** Allows testing of the current settings for five minutes, after which the system reverts to the previously saved settings. To make settings permanent, click 'Save'.

**System Reboot:** Resets all statistics and reboots the.

## 8.2. ID Configuration and Status

The ID Configuration and Status page provides a simple to use Graphical User Interface (GUI) for the operator to configure all channel parameters. To store the parameters into memory, click the Save IDs in Flash button at the bottom of this page. This operation is recorded in the System Logs.

**Note:** *It is important to ensure that all fields on the ID Configuration page are filled out properly for local and remote terminals. Errors in these fields will result in the inability to establish a communication link. Please read this section carefully to ensure a quick, trouble-free deployment.*



**Figure 16: ID Config / Status**

ID Properties:

**ID:** Select the channel ID to be configured, deleted or displayed for the system in which you are interested. In order to locate the proper ID number use the ID Browser described in section 8.3.

ID Screen Buttons:

**Configure:** Calls the Link Configuration screen (see section 8.2.1) for the selected ID.

**Delete:** Deletes the selected ID.

**Statistics:** Displays the Link / Connection Status screen (see section 8.2.2) for the selected ID.

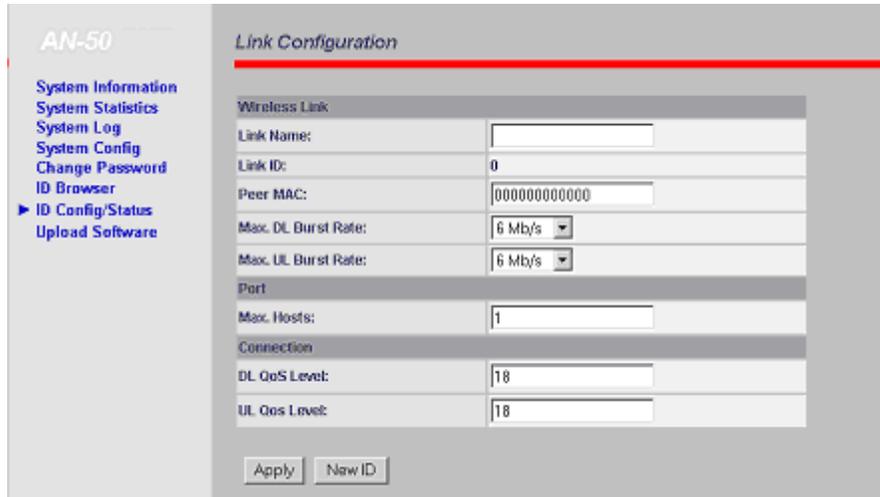
**New ID:** Adds a new ID by calling the Link Configuration screen (see section 8.2.1).

**Save IDs:** Saves the entire ID table in Flash.

**Clear All IDs:** Clears all IDs from the FLASH. **Note: This process cannot be undone.**

**8.2.1. Link Configuration**

This screen is displayed through the ID Config / Status screen by clicking the Config button. Please note that this screen will be active only on the AN-50 operating in PMP / PTP master mode. The fields in the Link Configuration screen need to be filled out for each individual subscriber station.



**Figure 17: Link Configuration**

Wireless Link:

**Link Name:** A user specified alphanumeric identifier for the link. The name remains with the system, even during power-off states, until the operator re-types a new name using this menu field. This field should be limited to 8 characters

**Link ID:** Automatically generates a numeric ID for the specified link name. For a new link, the default ID is always zero. After saving the parameter on the Link Configuration screen, the AN-50 system will automatically choose a link ID other than zero. Using the ID Browser, one can search for the specific Link ID associated with the link name.

**Peer MAC:** Enter the MAC address of the subscriber station to register the remote unit. If the MAC address is not properly entered, the wireless link will not be established and no Ethernet packets can be transferred.

**Max. DL Burst Rate:** Maximum downlink (DL) burst rate. Note: Defines the maximum downstream burst rate

**Max UL Burst Rate:** Maximum uplink (UL) burst rate. Defines the maximum upstream burst rate.

Port:

**Max Host:** Defines the maximum number of hosts (i.e. PCs, ...etc) to be learned from the corresponding Subscriber Station.

Connection:

**DL QoS Level:** Enter the downlink QoS level. See “PMP Configuration Tool” appendix section below for more information.

**UL QoS Level:** Enter the uplink QoS level. See “PMP Configuration Tool” appendix section below for more information.

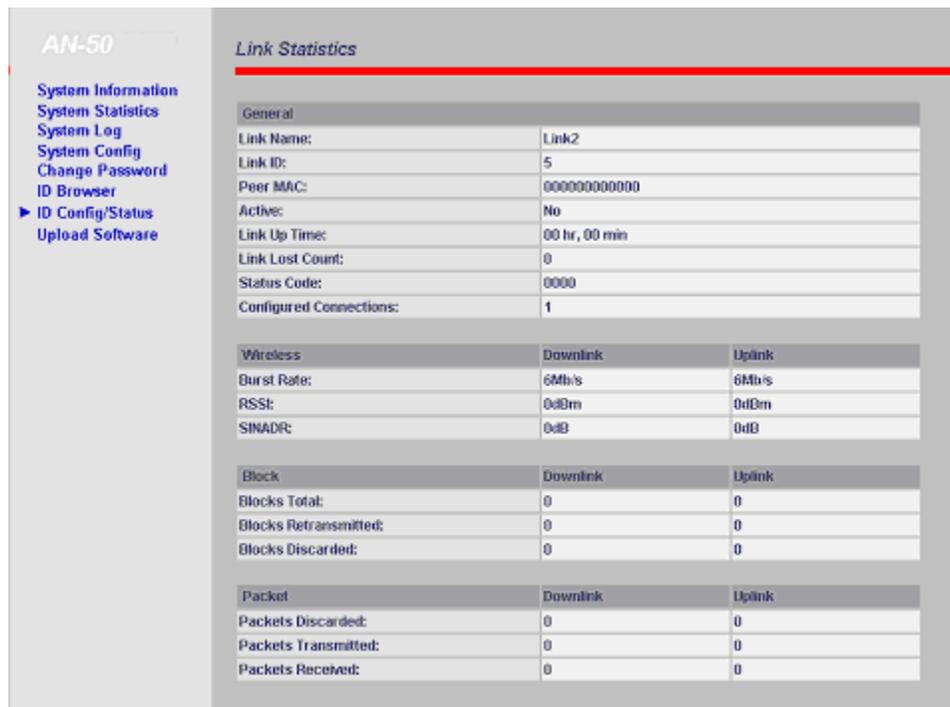
Link Configuration ID:

**Apply:** Saves changes to the current link ID configuration. Ensure that “Save ID” is completed before rebooting the system, otherwise configuration information will be lost

**New ID:** Save current ID configuration under a new Link Name.

### 8.2.2. Wireless Link Statistics

This screen is displayed through the ID Config / Status screen by pressing the Status button.



AN-50		
<ul style="list-style-type: none"> <li>System Information</li> <li>System Statistics</li> <li>System Log</li> <li>System Config</li> <li>Change Password</li> <li>ID Browser</li> <li>▶ ID Config/Status</li> <li>Upload Software</li> </ul>		
Link Statistics		
General		
Link Name:	Link2	
Link ID:	5	
Peer MAC:	000000000000	
Active:	No	
Link Up Time:	00 hr, 00 min	
Link Lost Count:	0	
Status Code:	0000	
Configured Connections:	1	
Wireless	Downlink	Uplink
Burst Rate:	6Mb/s	6Mb/s
RSSI:	0dBm	0dBm
SINADR:	0dB	0dB
Block	Downlink	Uplink
Blocks Total:	0	0
Blocks Retransmitted:	0	0
Blocks Discarded:	0	0
Packet	Downlink	Uplink
Packets Discarded:	0	0
Packets Transmitted:	0	0
Packets Received:	0	0

**Figure 18: Wireless Link Status**

#### Wireless link Statistics

**Link Name:** Displays the link name from the system memory. The name remains with the system even during power off states, until the operator re-types a new name using this menu field.

**Link ID:** Displays the link ID automatically defined by the AN-50 System for the link name.

**Peer MAC:** Shows the MAC address of the subscriber station

**Active:** "Yes" indicates the RF link with the remote terminal is established. "No" indicates there is no RF link to the remote terminal. This indicator is correlated to the Wireless Link LED of the slave AN-50.

**Link up time:** Specifies the time since the unit was started.

**Link Lost Count:** Specifies how many times the link was lost since system was started.

**Status Code:** A code shown as a hex number indicating the condition of the RF components within the AN-50 terminal and T-58 Transceiver.

**Configured Connections:** Shows the total number of connections configured for this link. For the current AN-50 revision the system will always display one (1) connection.

Link Status Downlink / Uplink:

**Burst Rate [Mb/s]:** Indicates for this wireless link the current Tx burst rate used by the master (downlink) and by the slave (uplink) ..

**RSSI [dBm]:** Indicates the average received signal strength (RSSI) at slave (downlink) and master (uplink).

**SINADR [dB]:** Indicates the average signal to interference noise and distortion ratio (SINADR) at slave (downlink) and master (uplink). The ratio is based on the digital information provided from the output of the A/D converter and includes the effects of the AGC.

Link Statistics Downlink / Uplink:

**Blocks Total:** Shows the total blocks transmitted from master to slave (downlink) and from slave to master (uplink). Note that, in order to utilize efficiently the wireless bandwidth and to allow tight QoS control, the system fragments and concatenates Ethernet packets in blocks, where blocks are then transmitted over the air.

**Blocks Retransmitted:** Shows the total blocks retransmitted.

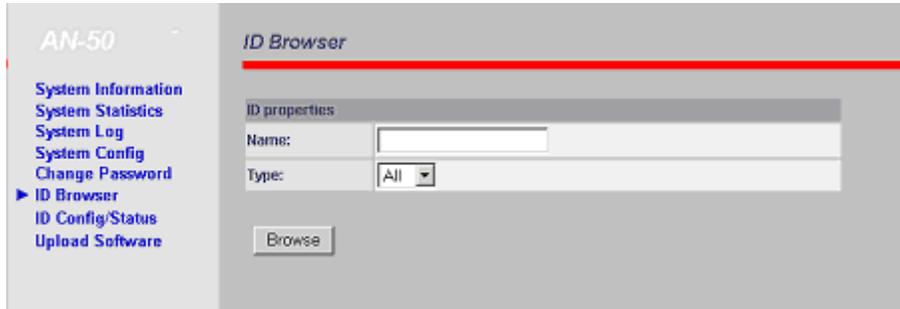
**Blocks Discarded:** Shows the total blocks lost

**Packets Discarded:** Indicates the total number of packets discarded due a full buffer full

**Packets Transmitted:** Indicates the total number of packets transmitted.

**Packets Received:** Indicates the total number of packets received.

### 8.3. ID Browser



**Figure 19: ID Browser**

ID Properties:

**Name:** Name of remote unit being searched. Note partial string pattern or entire link name can be input.

**Type:** Defines search criteria based on entity type: Link, Connection or All

ID Browser Button and Results:

**Browse:** Displays the ID Browser results as a list of IDs, one per line as shown below:



ID	Name	Type
0	default	Group
3	rootlink	Link
4	test	Link

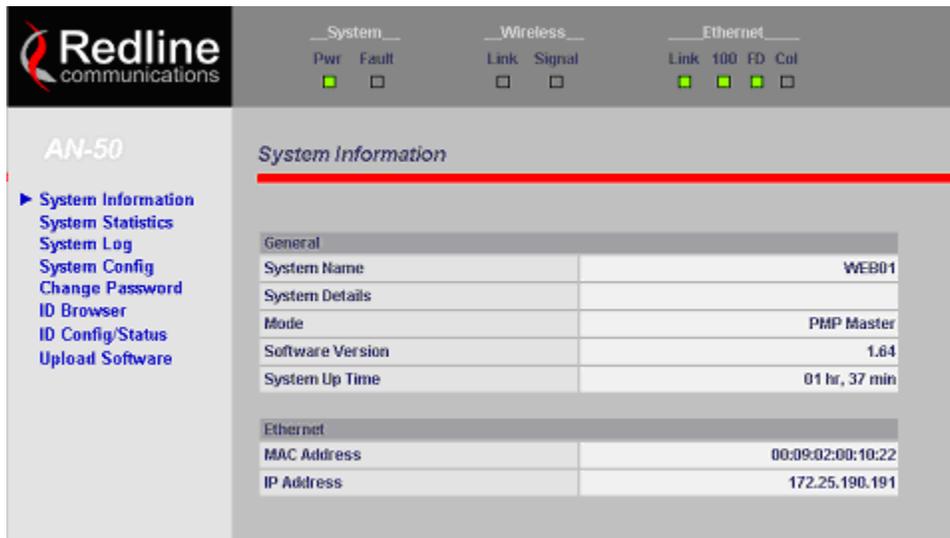
**Figure 20: ID Browser Results**

**ID:** List the channel ID associated with each link

**Name:** List the name associated with each ID

**Type:** List the type of the link, e.g. Group or link.

## 8.4. System Information



**Figure 21: AN-50 General Information**

Located at the top of this page is a graphic interface providing a real-time synoptic view of the AN-50 terminal front panel (refreshed every 30 sec.), plus a summary of general information related to the configuration and status of the local unit.

The following is a brief description of each field on the General Information page:

General:

**System Name:** Identifies the local terminal. The factory default name for the system is “WEB01”.

**System Details:** Specifies the location, telephone number and/or contact information.

**Mode:** Specifies whether the AN-50 operates in PMP / PTP master or slave.

**Software Version:** Specifies the software version in use.

**System Up Time:** Specifies the time [dd/hh/mm/ss] since the system started.

Ethernet:

**Ethernet MAC Address:** Specifies the Ethernet MAC address used by the local terminal.

**IP Address:** Specifies the IP address used by the local terminal.

## 8.5. System Statistics

Clicking on System Status in the main menu will load this page, which provides General Information, Ethernet LAN Statistics and Wireless Statistics of the unit of interest, as shown in Figure 22.

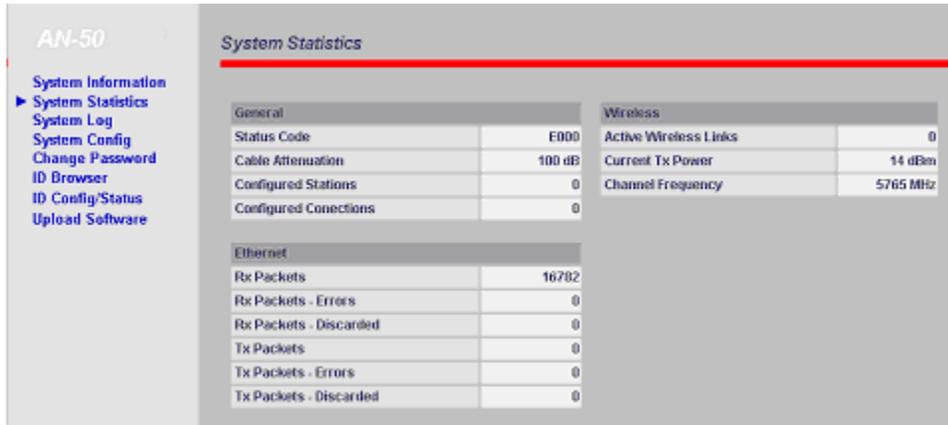


Figure 22: System Status

### General:

**Status Code:** An global error code indicating the condition of different components within the AN-50 terminal and T-58 Transceiver as well as the status of all links and connections involving the terminal. See error list below for details:

**AN-50 PLL Error:** The PLL (Phase Locked Loop) section within the AN-50 terminal experienced an error. The System Fault LED may light. Try resetting the unit.

**Communication Error Over IF Cable:** Communication between the AN-50 terminal and the T-58 Transceiver failed. Check the IF cable and connectors.

**Radio High Temp. Warning:** The T-58 Transceiver’s internal temperature rose above 185F / 85C. The transceiver will shut down for 30 seconds to allow cooling time.

**Radio Power Supply Fault:** Indicates a fault in the transceiver’s power supply. This error could be due to a problem with the internal power supply, or with the power source from the AN-50 terminal. If the Low DC Voltage At Radio error is also indicated, (see below) check the IF cable and connectors. If the Low DC Voltage At Radio error is *not* indicated, the T-58 Transceiver will require servicing.

**Low DC Voltage At Radio Input:** The DC voltage at the transceiver (carried by the IF cable from the AN-50 terminal) is lower than the required 24VDC. Check the IF cable and connectors. The minimum required voltage for operation is 12VDC.

**Cable Attenuation:** Indicates the attenuation of the signal over the IF cable.

**Registered Station:** Shows the total number of configured links. If the AN-50 operates in PTP mode this field will display one.

**Configured Connection:** Shows the total number of configured connections. If the AN-50 operates in PTP mode this field will display one.

Ethernet Status:

**Rx Packets:** Indicates the total number of received packets.

**RX Packets – Errors:** Indicates the total number of packets received with errors

**Rx Packets - Discarded:** Indicates the total number of packets discarded due to full buffer.

**Tx Packets:** Indicates the total number of all transmitted packets

**Tx Packets – Errors:** Indicates the total number of packets transmitted with error

**Tx Packets – Discarded:** Indicates the total number of packets discarded due to full buffer

Wireless Statistics:

**Active Wireless Links:** Shows the total number of active links

**Current Tx Power:** Specifies the actual current transmit power level

**Channel Frequency:** Specifies the center frequency of the channel in use

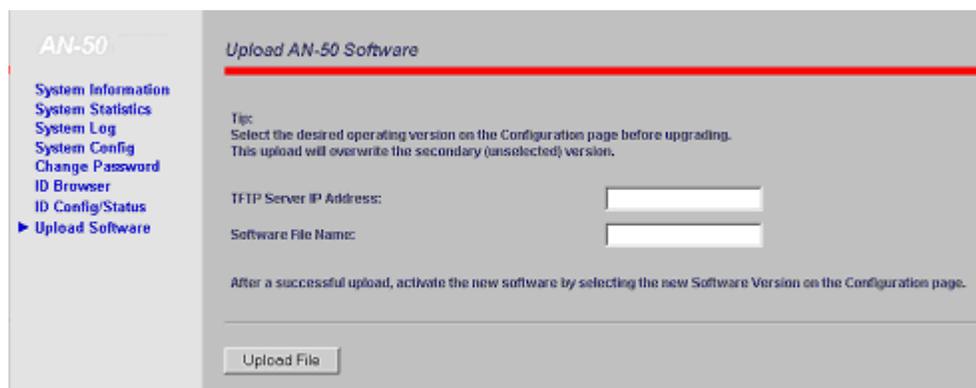
## 8.6. Upload Software

To move from a PTP to PMP configuration, one end must be designated as the new Base Station (BS) site, the software must be upgraded, and the antenna must be changed from the typical narrow beam PTP antenna to a 60 or 90 degree sector antenna. Redline offers the necessary upgrade parts in order to accomplish this.

It should be noted that when migrating a PTP system to PMP, the designated Subscriber Station (SS) side will see an overall reduction in signal strength due to the BS antenna's lower gain. The installer must take this into consideration before upgrading any installation. Failure to do so could result in performance degradation in terms of throughput at a given range. It is recommended that customers contact their Redline Partner to calculate the expected link budget before proceeding with any upgrade.

The upload screen shown below is used to upgrade the existing software load of the AN-50 terminal with new software stored in a binary file on the server or host computer. Note the AN-50 terminal contains two FLASH banks for storing two versions of the software/firmware. The user can select the operating version using the Configuration screen. The upload will always overwrite the non-operational (unselected) version; therefore it is important to select the desired operating version before beginning the upgrade process.

The upgrade process is achieved remotely, using the Trivial File Transfer Protocol (TFTP) over the Internet. The operator must fill in two input fields: TFTP Server IP Address and File Name. The TFTP Server IP Address is the IP address of the host computer or server that contains the upgrade software in binary format, while File Name is the name of the actual binary file. [Note: only the filename should be specified]

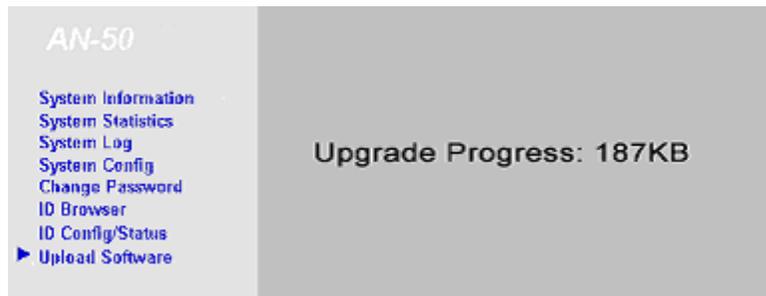


The screenshot shows the 'AN-50' system interface with a sidebar menu on the left containing options like 'System Information', 'System Statistics', 'System Log', 'System Config', 'Change Password', 'ID Browser', 'ID Config/Status', and 'Upload Software'. The main content area is titled 'Upload AN-50 Software' and includes a tip: 'Select the desired operating version on the Configuration page before upgrading. This upload will overwrite the secondary (unselected) version.' Below the tip are two input fields: 'TFTP Server IP Address:' and 'Software File Name:'. A note at the bottom states: 'After a successful upload, activate the new software by selecting the new Software Version on the Configuration page.' An 'Upload File' button is located at the bottom of the form.

**Figure 23: Upload Software**

After typing the TFTP Server IP Address and File Name, click Upload File to begin the file transfer. A status screen (see Figure 24) will appear, displaying the number of bytes being transferred from the host computer/server to the AN-50 terminal in real time. The upgrade file size is approximately 1.8 MB, and will take approximately two to four minutes to download from the server to the AN-50 terminal memory. To activate the new version, it is necessary to go to the Configuration page and select the new Software Version.

Upon successful transfer of the file, the terminal will verify the integrity of the new software. If errors were introduced during the transfer process as a result of (for example) link degradation, the AN-50 terminal will reject the new software load and provide a warning that the upgrade was unsuccessful. In this case, the operator will need to repeat the upload process.



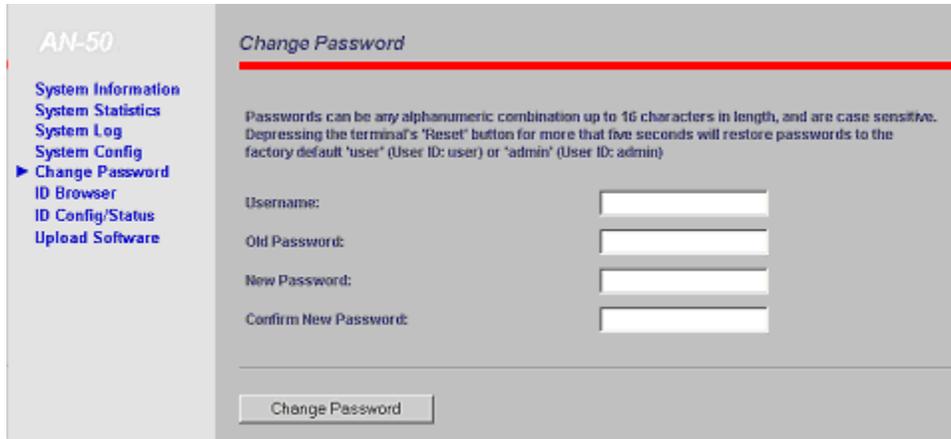
**Figure 24: File Transfer Progress**

## 8.7. System Password

The factory default password for the system is "admin" for the administrator's ID, and "user" for the user's ID. To change the password, click on System Password from the main menu and apply a new value in the New Password field (see Figure 25) using any alphanumeric combination. Note the field is case sensitive and can be up to 16 characters in length.

For more information on password related issues, see section 8 on page 27.

Note: depressing the front panel Reset button for more that five (5) seconds will restore the factory default passwords.

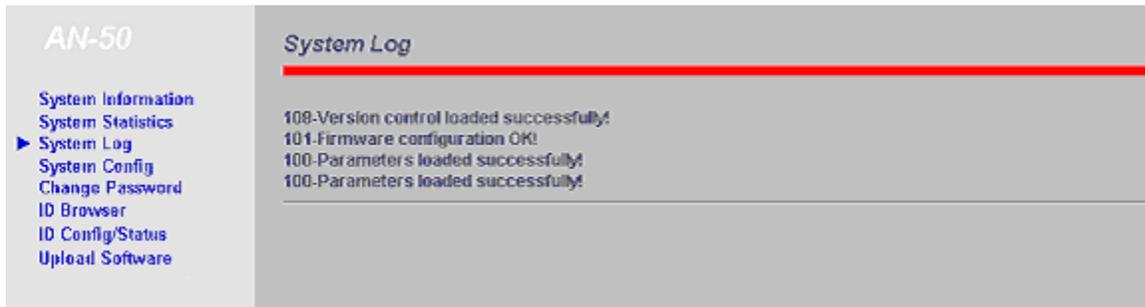


The screenshot shows a web interface for the AN-50 system. On the left is a navigation menu with the following items: System Information, System Statistics, System Log, System Config, Change Password (highlighted with a blue arrow), ID Browser, ID Config/Status, and Upload Software. The main content area is titled "Change Password" and contains the following text: "Passwords can be any alphanumeric combination up to 16 characters in length, and are case sensitive. Depressing the terminal's 'Reset' button for more that five seconds will restore passwords to the factory default 'user' (User ID: user) or 'admin' (User ID: admin)". Below this text are four input fields: Username, Old Password, New Password, and Confirm New Password. At the bottom of the form is a "Change Password" button.

**Figure 25: System Password**

## 8.8. System Logs

The System Logs page, shown in Figure 26 below, provides a list of the last forty messages recorded by the AN-50 terminal, describing either system activity or errors that have occurred.



**Figure 26: System Logs Screen**

The logs will also indicate if the following transactions were successfully completed:

- **Save Configuration** – Under the Configuration screen.
- **Upload** – Under the Upload Software screen.
- **Change Password** – Under the System Password screen.
- **Send Options Key**

The following table provides a brief description of the key messages recorded in the logs by the system:

Log Message	Description
100-Parameters loaded successfully!	All system parameters have been successfully downloaded.
101-Firmware configuration OK!	The onboard firmware configuration has been properly set up.
102-Ethernet port configured!	The Ethernet port has been properly configured and is operational.
103-Parameters saved successfully!	The latest configuration parameters have been successfully saved into the system memory.
104-Upgrade OK!	The software upgrade process completed successfully.
105-Password changed successfully!	The system password was successfully changed.
106-Firmware programmed OK!	The firmware was successfully programmed.
107-Statistics initialized!	Reset of statistics was successful.
108-Version control loaded successfully!	Software version control data was successfully loaded.
109-Options Key activated!	Product Options Key was accepted.
110-Options Key already used!	The Product Options Key was not accepted because it was already used once. Contact your local Redline representative.
201-EEPROM corrupted. Def. param. loaded!	The memory area containing the system configuration has been corrupted. Default parameters loaded.
202-Error while saving parameters!	The latest configuration parameters have not been successfully saved. In this case, repeat the save

	configuration process to try to resolve the problem.
203-Another upgrade in progress!	The system is already in upgrade mode, in the event the operator inadvertently invoked multiple simultaneous upgrades.
204-Invalid upgrade parameters!	The parameter entered is in error. If this message appears, check for typing errors.
205-Upgrade failed!	The software upgrade process completed unsuccessfully.
206-Password changed unsuccessfully!	The new password entered into the system was not successful. In this case, repeat the process.
207-Timeout on reading data packet!	The system has timeout looking for packets from the host computer or server. Check for obvious problems such as disconnected or faulty cable. A mis-configured TFTP server will also cause this error
209-TFTP error received!	The Trivial File Transfer Protocol (TFTP) routine used to download the software to the AN-50 terminal during the Upgrade process failed. Likely cause is disconnected or faulty cable.
210-Error: TFTP unknown message!	The TFTP client received an unknown message. In this case, repeat the upgrade process.
211-Error: while writing flash!	While writing the new software into AN-50 terminal flash memory an unexpected error occurred. Try to repeat the process and if the error persist contact your local Redline representative.
212-Error firmware configuration!	An unexpected error occurred while writing the onboard firmware configuration. Try to repeat the process.
213-Firmware programming failed!	The firmware programming failed.
214-Error while loading version control!	Software version control data was not loaded successfully.
215-Log buffer full!	The log buffer overflowed.
216-Invalid Options Key!	User entered an invalid Product Options key.
217- PLL unlocked!	One or more RF synthesizers unlocked. The unit stopped RF transmissions and attempted to reprogram the synthesizers. If this message repeats or if the RF link is not back on, try to reset the terminal. If the problem persists, contact customer support.
218-Outdoor unit over temperature!	The T-58 Transceiver's internal temperature rose above 185F / 85C. The transceiver will shut down for 30 seconds to allow cooling.
219-Excessive DC loss on IF cable!	The DC voltage at the transceiver (carried by the IF cable from the AN-50 terminal) is lower than the required 24VDC. Check the IF cable and connectors.
220-Outdoor unit power supply fault!	Indicates a fault in the transceiver's power supply. This error could be due to a problem with the internal power supply, or with the power source from the AN-50 terminal. If the 'Excessive DC loss on IF cable' error is also indicated, check the IF cable and connectors. If not, the T-58 Transceiver will require servicing.

## 9. Diagnostics and Troubleshooting

Troubleshooting can be performed using the front panel LEDs and the host computer/server connected locally or remotely to the AN-50 terminal.

**Before beginning any troubleshooting via the front panel, it is important to ensure that all fields on the System Configuration page are filled out properly for local and remote terminals, as outlined in Section 8.1. Errors in these fields will result in the inability to establish a communication link. Also ensure that all cables are properly connected as outlined in Section 7.**

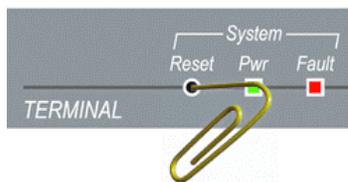
This section provides basic diagnostic and troubleshooting procedures to help solve problems that may occur with the AN-50 system. If, after reading this section, you are unable to get the system operating properly, please contact your local Redline representative. Include the model name and serial number of the system (located on the back of the unit) in your communications.

### 9.1. Diagnostics Via The Front Panel

The front panel of the AN-50 terminal comprises three sets of status LEDs, grouped under the headings System, Wireless and Ethernet, to help with first level diagnoses of problems encountered with the unit.



Figure 27: Front Panel Status LEDs



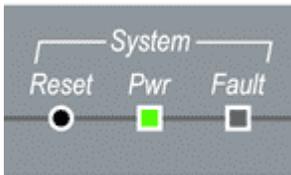
Throughout this section, reference is made to the **Reset** button, which is a micro-switch recessed in the front panel in the System block. Use a small narrow object, such as a paper clip, to access the button. Depressing the button for less than five (5) seconds will activate a "short reset", which is equivalent to turning the AN-50 terminal off and on. Statistical values are reset, and the currently loaded software / firmware will be retained. Note that a short reset may be accomplished remotely by clicking on the Save Configuration button on the System Configuration screen.

Depressing the Reset button for more than five (5) seconds executes a "long reset". **A long reset reloads the factory default configuration settings such as IP Address, IP Subnet Mask, Channel, System Name, Passwords and restarts the system.** The software version that existed in the system before the long reset is retained. An example of when a long reset will help is in the event that a password or IP address is forgotten. The long reset function will simply restore the system back to its original factory default settings. A long reset is confirmed by the Wireless Link LED flashing three times, followed by the LED power-up sequence:

All four Ethernet LEDs light for one second, then individual Ethernet LEDs blink twice in the following order: 100, FD, Col, Link. The Fault LED lights for approximately four seconds, then turns off. The two Wireless LEDs remain off for approximately five seconds, then blink once and resume their normal state.

The remainder of this section lists possible problems that may occur and the corresponding remedies.

**9.1.1. System Power**

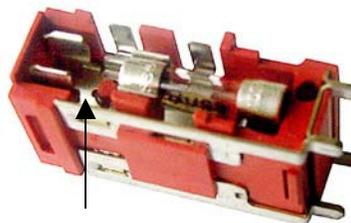


If the **Pwr** LED is not illuminated solid green, power is not getting to the unit. The most probable causes are:

**Table 3: System Power Diagnostics**

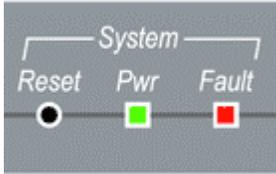
Symptom	Possible Problem	Solution
Pwr LED does not illuminate	On/Off switch in Off position	Turn on switch at back of unit.
	Fuse blown	Replace fuse. (spares provided)
	Power cord disconnected	Securely connect cord to terminal and outlet.

To replace a fuse, pop the black plastic cover located on the back panel beside the power switch, and extract the red fuse holder. Be certain to replace the fuse(s) into the lower half of the holder, as shown in the diagram below. The fuse holder holds two fuses, both of which are active. Be certain to use fuses of the same type and rating.



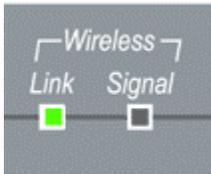
Note space

### 9.1.2. System Fault



If the **Fault** LED illuminates solid red, it is an indication that there is a serious problem with the system software or hardware. Check the IF cable. A short or long reset may fix the problem. If not, contact your local Redline representative. Also refer to the RF Status codes, as well as the System Logs.

### 9.1.3. Wireless Link



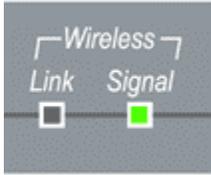
**Link** – For a slave terminal, the “Link” LED lights solid green when the radio link to the master terminal is established and the LED will turn off if the link is lost. For a master terminal, the LED lights solid green when at least one radio link to any of the provisioned slaves is established and will turn off if all links are lost.

The Wireless **Link** LED illuminates solid green when the wireless link is established to the remote terminal. When the Link LED is off, it is an indication there is a problem with either the terminal link, radio, or with the actual propagation path itself. Check the RF Status parameters in the System Status screen. The table below lists some of the potential causes:

**Table 4: Wireless Link Diagnostics**

Symptom	Possible Problem	Solution
No wireless link (Link LED does not illuminate)	Remote terminal is not on or is malfunctioning.	Verify operation of remote terminal.
	The propagation path is blocked.	Clear path or re-locate antennas.
	The transceiver is malfunctioning.	Repair or replace transceiver
	Antenna has moved and is no longer aligned with remote terminal.	Re-align the antenna.
	Cable between transceiver and antenna or between transceiver and terminal not properly connected.	Properly secure cables.
	Power not getting to the transceiver from the terminal.	Repair or replace terminal.
	Receiver and transmitter have been set to different RF channels.	Make sure both units are operating on the same RF channel.

### 9.1.4. Wireless Signal



**Signal** – The “Signal” LED lights solid green if the system, the link (the links for a master) and the provisioned connections all operate within configured parameters.

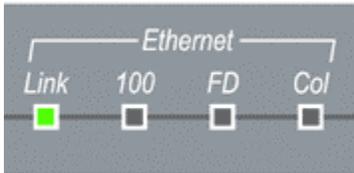
Wireless Signal LED will light solid green if the system is operating at an error rate of less than one out of one million packets. If errors exceed one in one million, the LED will flash. If the wireless link becomes poor, the LED will turn off.

Flashing may not be a serious problem if the LED flashes only intermittently, however, if it flashes constantly, the table below summarizes some possible causes:

**Table 5: Wireless Signal Diagnostics**

Symptom	Possible Problem	Solution
Weak RF Link ( <b>Signal</b> LED flashes)	Obstructions in the propagation path causing signal degradation.	Try to remove obstacles or re-locate antenna.
	Antenna moved, due to high winds.	Re-align the antenna.
	Poor cable connection between transceiver and antenna.	Repair or replace the RF cable.

### 9.1.5. Ethernet Link

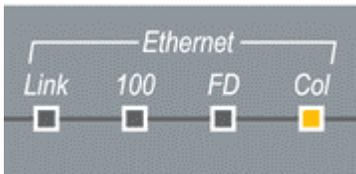


The Ethernet **Link** LED will light solid green when the LAN connection to the host computer/server or switch/router is functioning properly. The Link LED flashes when the LAN connection to the host computer/server or switch/router is functioning properly and there is traffic. If the LED is off, look for the following problems:

**Table 6: Ethernet Link Diagnostics**

Symptom	Possible Problem	Solution
No Ethernet Link ( <b>Link</b> LED off)	Poor cable connection between terminal and computer/server or between terminal and switch/router.	Carefully check all cable connections.
	Wrong type of Ethernet cable between terminal LAN port and host computer/server or switch/router.	If the terminal LAN port is connected to a host computer or server directly, then ensure a straight-through cable is used. Otherwise, to connect the terminal to a switch or router, ensure a crossover cable is used.
	The auxiliary Network equipment including switch/router, host computer/server, may be malfunctioning.	Repair or replace faulty units.
	Processor malfunction.	Try short reset or long reset.

**9.1.6. Ethernet Collision**



The Ethernet **Col** LED flashes amber when packet collisions occur over the LAN. Note that when connected to a hub, it is typical for packet collisions to occur intermittently. On a Half-Duplex link, there will be collisions. Some possible causes include:

**Table 7: Ethernet Collision Diagnostics**

Symptom	Possible Problem	Solution
Link Collision ( <b>Col</b> LED flashes)	Poor cable connection between terminal and computer/server or between terminal and switch/router.	Carefully check all cable connections.
	Incompatible Ethernet port speed.	Confirm speed and duplex mode of devices.

## 9.2. Troubleshooting The Web Interface

The section assumes that the status LEDs on the front panel of the AN-50 terminal indicate normal functionality.

If, after using HTTP commands to try to log onto the AN-50 terminal the General Information page does not appear on-screen, several possibilities exist. The first test is to ping the terminal from the host computer by entering the following text from the command line:

**>Ping 192.168.25.2**

Note the IP address used in this example is the default address supplied by the factory. If the IP address has been changed, it is important to use the current address. The system will always respond to ping frames less that 577 bytes in length.

If the ping test is successful (i.e., the computer was able to send and receive packets to/from the terminal) then the problem may be with the IP address that was entered or with the HTTP client itself. Retype the address or re-boot the host computer to try to resolve the problem.

If the ping is unsuccessful, there may be problems with the IP address that you are using. Try retyping the address. If this fails, and it appears you have forgotten the IP address of the terminal, perform a long reset to restore the terminal to the default value.

Warning: performing a long reset will restore the AN-50 terminal's IP address (192.168.25.2) and IP Subnet Mask (255.255.255.0) to the factory default value.

**Table 8: Web Interface Diagnostics**

Symptom	Possible Problem	Solution
Home page (General Information) cannot be accessed.	Incorrect IP address and/or Subnet Mask.	Perform a ping test from the host computer command line. If the ping test is unsuccessful, then the problem is with the IP address. Perform a long reset to apply the default address (192.168.25.2) and Subnet Mask (255.255.255.0)
	Problems with host computer, or AN-50 terminal.	If the ping is successful try a short reset of the AN-50, and/or reboot the host computer.
	Host PC ARP table is incorrectly configured	Run "arp -d" whenever the AN-50 terminal is swapped. Check that the host PC's Subnet Mask matches that of the AN-50 terminal. Check that the host PC's address is 192.168.25.n, where 'n' is not equal to 0, 2, or 255.

### 9.3. Broadband Fixed Wireless Primer

This section provides an overview of the design and benefits of a Broadband Fixed Wireless (BFW) network architecture based on the Redline AN-50 system.

There are several advantages of a BFW system over traditional wireline alternatives such as PSTN, ISDN, T1, DSL, cable and fiber, including:

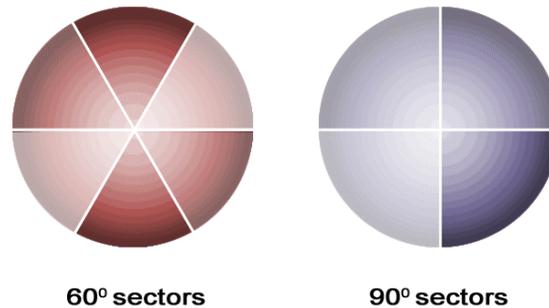
- Greater availability
- Lower cost of ownership per link
- Higher throughput (with the exception of fiber)
- Greater distances
- Quicker time to market
- Greater portability

The AN-50 system functions logically as a transparent bridge, providing all the benefits of a converged IP network, i.e., "IP everywhere". A converged network allows operators to reduce network build out costs significantly by employing standard IP appliances everywhere, from backbone to end-user.

## 9.4. Deployment Scenarios

This section provides a general overview of typical AN-50 Point to Multi-Point (PMP) deployment scenarios.

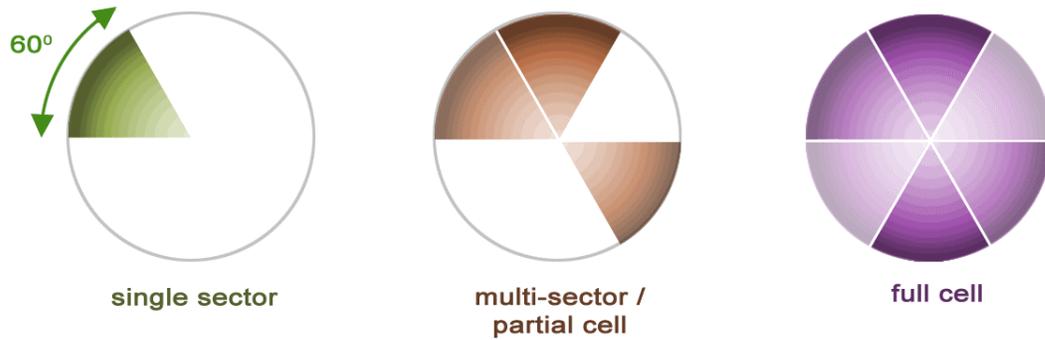
The AN-50 base station PMP system supports both 60 and 90 degree cell sectorization, as illustrated below.



**Figure 28: Cell Sectorization**

The advantage of the narrower 60 degree beam antenna is that it achieves higher subscriber density per cell through frequency reuse, higher gain (at greater distances) and provides greater flexibility in dealing with external interference, again through proper reuse of the channels. In terms of capacity, the 60 degree pattern can provide a threefold increase in bandwidth over an omni pattern, while the 90 degree sectorization scheme can double the bandwidth. This is achieved by reusing the bandwidth – for example, assume there are two channels, A and B. The 60 degree scheme can support a sector-to-sector scheme of AB-AB-AB while the 90 degree can support AB-AB. In terms of interference, a narrower sector provides finer granularity in isolating and re-allocating channels to avoid the problem, whereas a larger sector has less flexibility. The key advantage of the 90 degree sector antenna is that fewer systems are required at the base station to provide full omni coverage. This is an important consideration when trying to limit the initial capital expenditure necessary to create and grow the network.

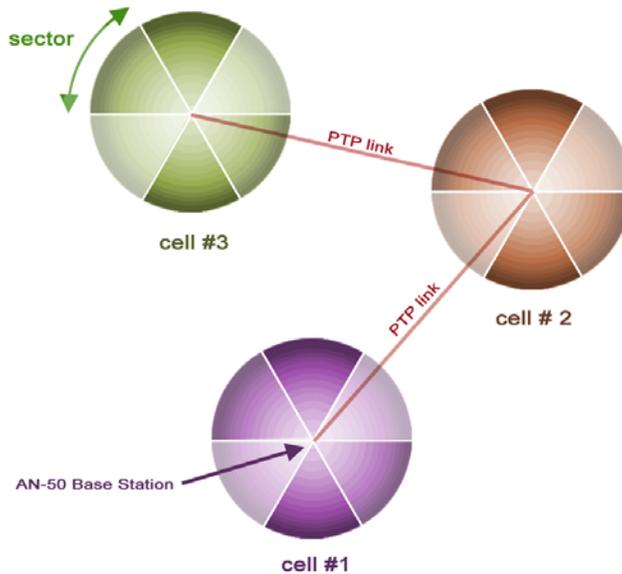
Another means of gracefully growing the network, using narrower sectors, is to begin with a single sector, and then, as the customer base grows in other directions, to add sectors until full coverage is achieved. This is shown below, starting with one sector, to three and then to the full 6 sectors in final deployment.



**Figure 29: Growing a Network**

Note that in some deployment situations involving high tower installations, it may be prudent to install all six antennas and radios initially, and begin with only a single AN-50 system operating out of one of the sectors. Later, as the customer base grows, the other sectors can be easily put online by the addition of only the indoor terminals.

Illustrated below is a sample hybrid PTP/PMP sectorized multi-cell deployment constructed using 60 degree antennas.

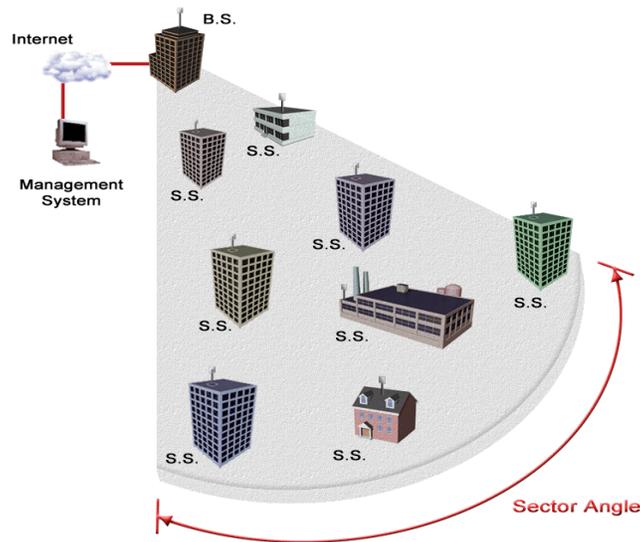


**Figure 30: Hybrid PTP/PMP**

In multi-sector or multi-cell deployments, proper frequency planning is essential in order to avoid the possibility of co-channel interference. The operator is encouraged to consider the use of standard cell planning software tools, available from multiple vendors, for this purpose.

### 9.5. Who Can Benefit From The AN-50 System?

This section describes various applications addressed by the AN-50 system. All applications are applicable to both PTP and PMP deployments. Although PMP offers significant cost saving benefits over PTP deployments, this must be balanced against throughput and range trade-offs associated with PMP. The figure below illustrates a typical single sector PMP deployment. As shown, a single BS can service multiple subscriber stations within its antenna coverage area.



**Figure 31: Single Sector PMP Deployment**

QoS is guaranteed, in terms of CIR at each SS as described previously in this manual.

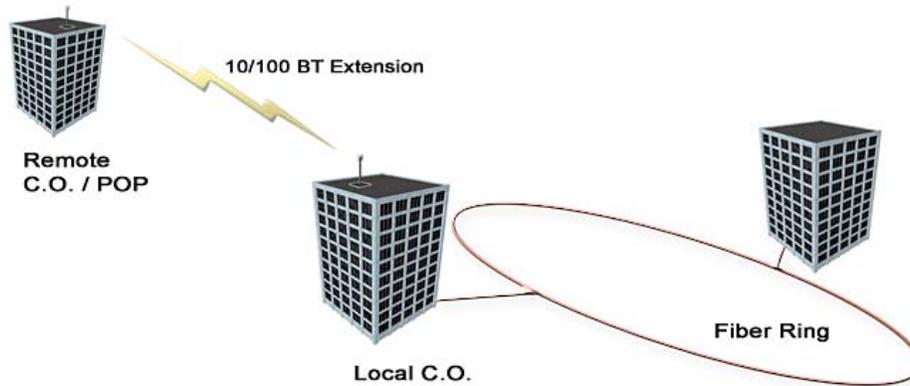
The AN-50 system is an ideal solution for:

- Carriers
- Internet Service Providers (ISPs)
- Enterprises
- Educational Institutions and Campuses

#### A) Carriers

The AN-50 system will provide benefits to both Incumbent and Competitive Local Exchange Carriers (ILECs and CLECs, respectively). Although ILECs own and provide services over wireline infrastructures within a specific geographical area, they are faced with the challenges of reaching outlying regions suffering from poor to no service. The ILEC is usually compelled to provide an expensive solution using a series of PTP radio links, with low throughput (e.g., T1) and costly license fees and network interfaces including T1 multiplexers. The AN-50 system provides a cost-effective alternative, by

connecting a remote site from the local CO, as shown in see Figure 32. Additional remote sites can be deployed using the PMP variant.



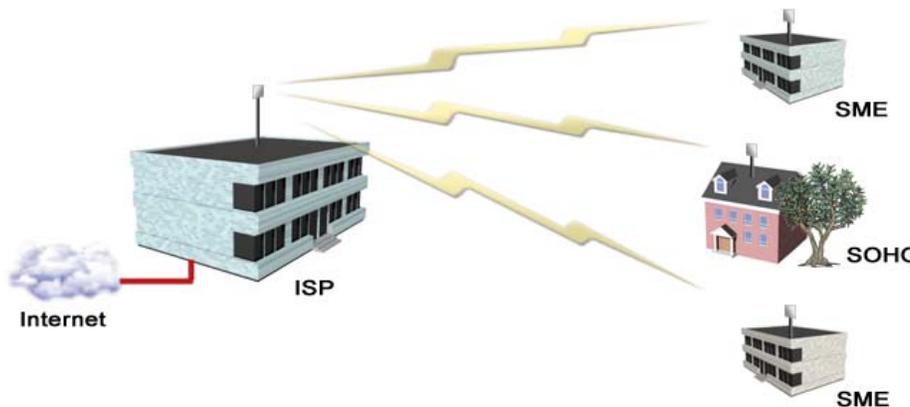
**Figure 32: Wireless Extension for Carriers**

The same challenges are faced by CLECs, who can use the AN-50 system to:

- Extend their existing fiber network, and
- Establish a remote Point of Presence (POP).

**B) Internet Service Providers**

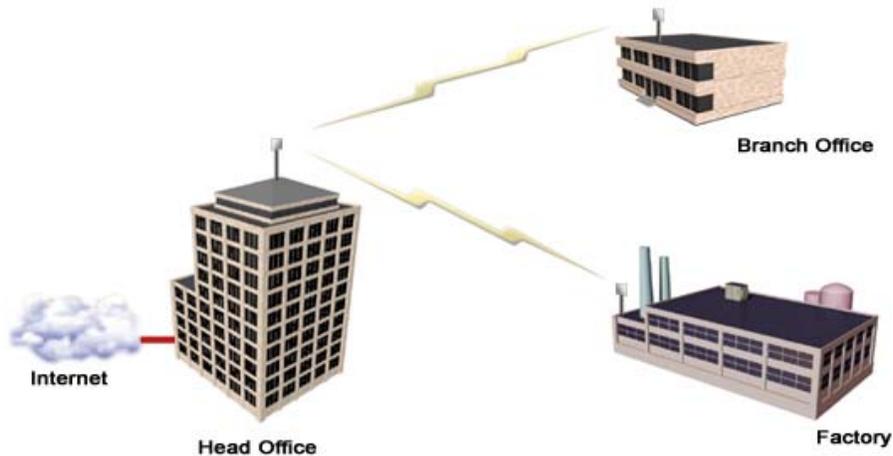
The AN-50 system is perfect for ISPs looking to provide cost-effective broadband solutions to demanding business customers including Small Office Home Office (SOHO) and Small to Medium sized Enterprises (SME) located just outside of the downtown core, where there is a lack of infrastructure. As well, the AN-50 is well suited for MTU/MBUs and backhaul for Hotspots/Internet Cafés. High-speed leased lines are expensive and hard to obtain, especially from local telephone companies. Wireless access provides a reliable quality of service over longer distances, while avoiding Telco access fees.



**Figure 33: Wireless Solution For ISPs**

### C) Enterprises

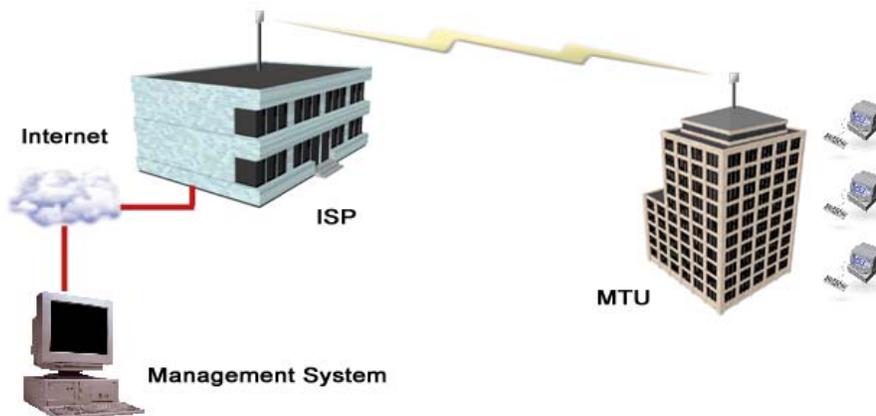
Enterprises are particularly frustrated by the lack of broadband connectivity to branch offices, factories, or warehouses located just outside of the urban core. Establishing a LAN solution over several remote locations presents a significant inter-network challenge using conventional wireline solutions. The AN-50 system is well suited for addressing LAN extension requirements, offering superior data rates in a secure format using encryption to protect sensitive information.



**Figure 34: Wireless Solution For Enterprise**

### D) Educational Institutions and Campuses

The World Wide Web is a key element within the education system today, with BFW systems serving as an important enabler in bringing Internet content to the student body. Fixed wireless systems such as the AN-50 provide a cost effective means of creating a backbone for connecting existing and new campus buildings to the educational infrastructure to support distance learning and two-way interactive training.



**Figure 35: Wireless Solution for MTUs**

## 9.6. The AN-50 Advantage

The Redline AN-50 system includes several key features to mitigate the effects of interference arising from other systems operating co-channel in the vicinity, as well as coping with propagation anomalies such as multipath. These features include:

### **Advanced Error Correction**

In addition to conventional forward error correction techniques, the AN-50 terminal uses an Automatic Repeat Request (ARQ) scheme to dramatically reduce errors from interference and multipath.

### **Orthogonal Frequency Division Multiplex (OFDM) Processing**

The Redline OFDM technique offers tremendous robustness in the presence of harsh multipath interference.

### **Narrow Beam Width**

Narrow antenna beams reduce considerably the probability of interference entering the system.

In addition to the anti-interference features described above, the AN-50 system also holds several other competitive advantages:

- High Data Rates
- High Bandwidth Efficiency
- Long Reach and Wide Coverage
- Higher Power Efficiency
- "Over-the-Air" Security

## 9.7. Wireless Facts

Wireless technology has existed for many years, proving itself to be a reliable communication medium, primarily for long haul point-to-point applications supporting critical links across the country for telephony and broadcast services. With the surge of broadband two-way internet use, fixed wireless systems are playing an even more important role in supporting network infrastructures.

The AN-50 system has been designed to operate in the 5.8 GHz band, which occupies the license exempt portion of the spectrum. This allows an operator to set up a wireless network without requiring formal consent from the regulatory agent. While this provides great advantages in terms of cost and time to market, the ease of access to the spectrum can bring with it undesirable effects, such as potential interference arising from other users exploiting the "free" band. By following the simple deployment guidelines in this manual, issues of this nature can be avoided.

This section provides additional background material to section 7 of this manual, including a description of the Link Budget tool, Fresnel zone considerations, height calculations and radar horizon issues, interference issues with other systems, etc.

### 9.7.1. The Link Budget Tool

Redline has developed a Link Budget Tool to help characterize the range performance of the AN-50 system for LOS, OLOS (optical line of sight) and NLOS conditions and various system parameters. The Link Budget Tool can be obtained by contacting your Redline certified partner or system integrator. Note the tool provides a first-order approximation, and does not consider the details of any specific terrain profile which may impact performance; rather, a generalized terrain is used in the calculations, based on empirical formulas approved by governing bodies such as the IEEE and ITU. Also, the tool does not consider system parameter variations arising from temperature fluctuations, cable loss tolerance, antenna alignment errors, etc.

The Link Budget Tool estimates the distance over which the system can operate at a desired error rate while achieving robust communication. A link is considered robust if the average error rate is less than 1 bit out of every 1000 million, expressed as  $10^{-9}$ , for an availability of 99.99%. Availability is described in more detail below.

The table below describes the net data rate (after coding overhead) that can be obtained for each modulation type in an ideal propagation situation.

**Table 9: Modulation Scheme vs. Data Rate**

Modulation	Coding Rate	Over The Air Rate (Mbps)	Coded Burst Rate (Mbps)	Average Ethernet Rate (Mbps)
BPSK	1/2	12	6	5.7
BPSK	3/4	12	9	8.4
QPSK	1/2	24	12	11.2
QPSK	3/4	24	18	16.5
16 QAM	1/2	48	24	21.6
16 QAM	3/4	48	36	31.4
64 QAM	2/3	72	48	40.5
64 QAM	3/4	72	54	44.9

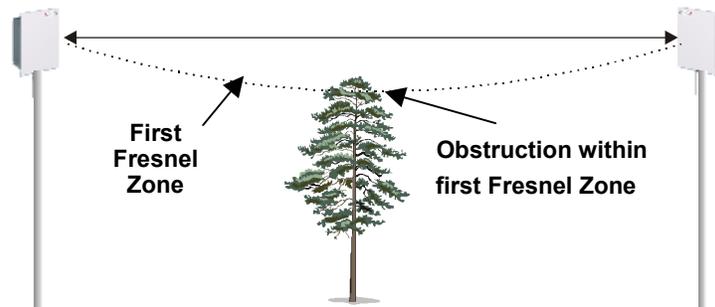
As indicated in the table above, higher order modulation schemes require greater S/N to maintain the same BER performance. The noise in this case is defined as the noise floor of the receiver, i.e., it assumes no interference from other sources (interference from other sources are addressed below). The main path calculation for determining range performance is given as:

$$RSL = Ptx + Gtx - FSL + Grx$$

Where:

- Ptx is the transmit power level in dBm
- Gtx is the transmit antenna gain in dB
- FSL is the free space loss attenuation in dB, and
- Grx is the receive antenna gain in dB

The FSL value is dependent on the range between the two terminals, the type of terrain over which the link is deployed, and whether or not the link is operating line of sight (LOS), optical line of sight (OLOS) or non-LOS (NLOS). The LOS FSL calculation is well understood and easy to calculate, and relies on the fact there is absolutely no obstacle near the direct path. The precise method for determining the amount of clearance required for LOS involves making use of a factor known as the Fresnel zone. A Fresnel zone is defined as a path difference of  $\lambda/2$  away from the direct path, as shown in Figure 36. A "cleared LOS" link assumes there are no obstacles within 60% of the first Fresnel zone of the direct path. The diagram below illustrates OLOS conditions, where a treetop is within the first Fresnel zone, and a clear direct path exists between the antennas.



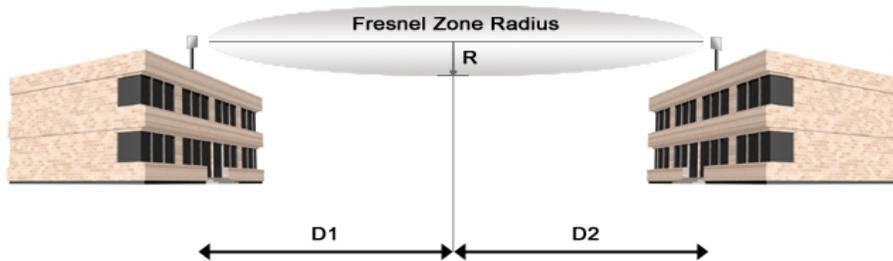
**Figure 36: Fresnel Zone Obstruction**

The formula for calculating the radius of the first Fresnel zone, as depicted in Figure 37, is given as:

$$R = 72.1 \sqrt{\frac{D1 * D2}{f * (D1 + D2)}} \text{ (ft)}$$

where,

- D1 and D2 are the distances from the terminals to the point of interest (in miles), and
  - *f* is the frequency (in GHz)
- (Note: multiply results by 0.3048 to obtain a solution in meters)



**Figure 37: Fresnel Zone Radius Calculation**

Specific FSL formulas are required to deal with this NLOS phenomenon. There are many NLOS calculations available from established institutions including the Institute of Electrical and Electronics Engineers (IEEE) and International Telecommunications Union (ITU), who are chartered with developing standardized calculations. The Redline Link Budget Tool is built upon these formulas; however, it is important to bear in mind that the calculations are an estimate only, with relatively large standard deviations (5-15 dB) depending on the exact deployment scenario and obstacle characteristics.

The last element to consider in the path calculation is the signal to noise (S/N) ratio, which is defined as:

$$S/N = RSL - Smin$$

where,

*Smin* is the receiver sensitivity expressed in dBm.

The *Smin* is determined by the thermal noise generated by the amplifier as well as the bandwidth of the filter used in the receiver front end. It defines the power level at which the receiver is sensitive enough to properly detect the signal. For the AN-50 operating in a channel spacing of 20 MHz, the *Smin* is approximately -96 dBm.

To ensure the link is sufficiently robust to deal with unexpected attenuation effects and seasonal fades, the S/N must be set higher than the *S/N<sub>min</sub>* specified in Table 9. The difference between these two levels is called the Fade Margin (FM). FM is similar to a

"power reserve", in which extra power is designed into the link budget to deal with additional fades arising from such factors as climatic conditions (seasonal), multipath dispersions, and shadowing effects from natural (foliage) and man-made obstacles (buildings). The FM is determined by the availability one desires. Availability is defined as the amount of time (expressed in % per year) that a link properly detects the signal. "Properly" in this case is a BER that is less than  $10^{-9}$ . The table below describes the outage period per year that corresponds to the different availability values.

**Table 10: Availability Versus Outage Time**

Availability (%)	Outage Period Per Year
99.9	8.8 hours
<b>99.99</b>	<b>53 minutes</b>
99.999	5.3 minutes
99.9999	32 seconds

It is recommended that the link be designed for availability greater than 99.99%. The tool automatically calculates the estimated required fade margin over distance to achieve this availability.

A key advantage of the Redline product is that it features a transmission correction scheme called Automatic Repeat Request (ARQ). The ARQ algorithm essentially detects when a packet(s) has been lost, due to fading, and makes a request to the remote system to re-transmit the lost packet(s). This feature provides an equivalent link budget gain of over 5 dB, which translates directly to an improved margin.

Another key advantage of the Redline product is that it features dynamic adaptive modulation, i.e., the system selects the modulation scheme automatically on a burst-by-burst basis, based on the measured S/N response. In this manner, the network is constantly balanced for the optimum spectral efficiency, no matter what propagation conditions prevail. Higher order modulation schemes (e.g., 64 QAM) are typically deployed at reduced ranges while lower order modulation schemes (e.g., BPSK) are implemented at long distances.

A sample link budget is shown in Figure 38 for the AN-50 system operating in 64 QAM, 3/4 code rating, providing a net burst throughput of 54 Megabits per second (Mbps). This provides an average throughput of 43 Mbps to the Ethernet port. The calculation is performed for LOS, however the graph (shown in Figure 39 below) also covers the OLOS and NLOS conditions.



mode:  zoom:

**Transmitter**

		Down	Up	
<b>Frequency</b>		5.8		GHz
<b>Max. Power Into Antenna</b>	N. America	14	14	dBm
<b>Tx Antenna Gain</b>	4.5 deg. 4.5 deg.	28	28	dBi
<b>Tx Cable Loss</b>		0.5	0.5	dBm
<b>EIRP :</b>		41.5	41.5	dBm

**Propagation**

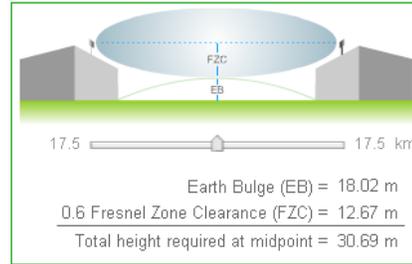
<b>Range</b>	<input type="radio"/> miles <input checked="" type="radio"/> km	35	km
<b>Path Loss</b>	Line of Sight (LOS)	138.5	dB

**Signal Profile**

<b>Channel Bandwidth</b>	20		MHz
<b>Channel Frequency</b>	CH 3 (5.775 GHz)		
<b>Modulation / Coding Rate</b>	64 QAM 3/4 (7.2Mbps)		
<b>Uncoded Burst Rate :</b>		54	Mbps
<b>Average Ethernet Throughput :</b>		42	Mbps

**Receiver**

<b>Receiver Antenna Gain</b>	28	28	dBi	
<b>Rx Cable Loss</b>	0.5	0.5	dB	
<b>Implementation Loss</b> (due to antenna misalignment, etc.)	0.5	0.5	dB	
<b>Received Signal (RSSI) :</b>		-70	-70	dBm
<b>Threshold @ BER=10<sup>-9</sup> :</b>		-66	dB	
<b>Fade Margin :</b>		-4	-4	dB
<b>System Gain :</b>		80	80	dB



**Auto Range**

Find the maximum Range for the given Signal Profile.

Use an ideal fade margin  or

Use a fade margin of :  dB

**Auto Rate**

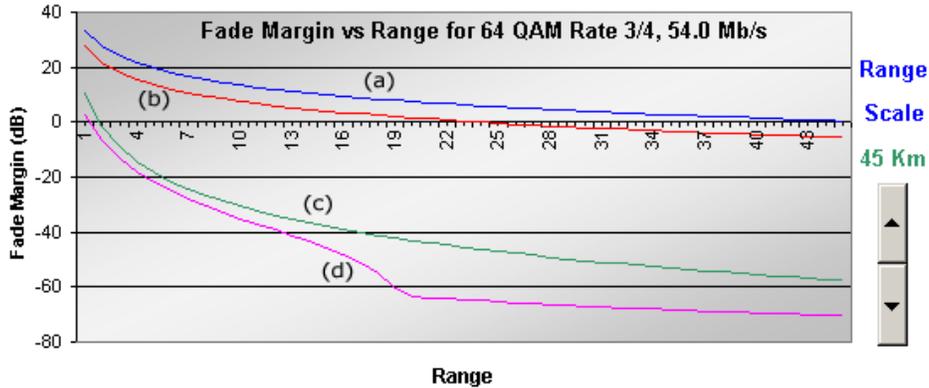
Find the maximum Burst Rate for the given Range.

Use an ideal fade margin  or

Use a fade margin of :  dB

**Figure 38: Link Budget For 64 QAM 3/4 Code Rate**

A fade margin graph for this link budget is given in Figure 39 below for four conditions: LOS (a - blue line), OLOS with the first Fresnel zone obstructed (b - red line), NLOS scattered trees and buildings (c - green line) and heavily treed residential NLOS (d - magenta line).



- (a) ■ LOS - Complete clearance, no first Fresnel zone obstacles.
- (b) ■ Optical LOS - First Fresnel obstructed, giving rise to diffractive fading.
- (c) ■ Erce g type C - Non line of sight, scattered trees and buildings, similar to business park scenario.
- (d) ■ Residential, under the eave - Non line of sight, heavily treed, dense housing scenario.

**Figure 39: Fade Margin Graphs For LOS, OLOS and NLOS**

The graph assumes a fade margin of 3 dB. The effects of rain at 5.8 GHz bands are negligible, hence are not included in the link budget.

It is important to note the link calculation assumes that the Earth’s curvature is not blocking the propagation path. The equation for determining the distance at which the Earth will cause blockage is called the Radar Horizon, and is given as follows:

$$R_h = 4.1(\sqrt{h_1} + \sqrt{h_2}) \quad (\text{km})$$

where,

$h_1$  is the height of terminal 1 (m)

$h_2$  is the height of terminal 2 (m)

The table below specifies the horizon distance (km) that can be achieved for different terminal heights ranging from 10 to 70 m above mean terrain level.

**Table 11: Radar Horizon Ranges For Different Terminal Heights ( $H_1$  and  $H_2$ )**

		$H_2$						
		10	20	30	40	50	60	70
$H_1$	10	25.9	31.3	35.4	38.9	42.0	44.7	47.3
	20	31.3	36.7	40.8	44.3	47.3	50.1	52.6
	30	35.4	40.8	44.9	48.4	51.4	54.2	56.8
	40	38.9	44.3	48.4	51.9	54.9	57.7	60.2
	50	42.0	47.3	51.4	54.9	58.0	60.7	63.3
	60	44.7	50.1	54.2	57.7	60.7	63.5	66.1
	70	47.3	52.6	56.8	60.2	63.3	66.1	68.6

## 10. Appendix

### 10.1. PMP Configuration Tool

The PMP Configuration tool helps calculate the desired CIR across the sector for each Subscriber Station, based on 18 programmable QoS levels. By configuring AN-50 PMP Configuration tool with the sector parameters (numbers in black) the CIR of each Subscriber Station can be adjusted as desired. Then the AN-50 needs to be configured using the green values that were calculated based on the input provided.

A typical display of the configuration tool is shown below. Three different colored numbers are used as follow:

1. White – User desired performance parameters for the Subscriber Stations within the sector
2. Blue – Calculation results
3. Green – Values used for AN-50 configuration settings

**Usage:** Fill in white boxes, verify results in blue, then config AN50 using green values.

**System Configuration**

Registration Period [frames]	50
Max Distance [km]	7
Max QoS Level	18
Max Traffic Latency [us]	10,745
Registration Cycle [ms]	266
Bandwidth Used [%]	70

**Link ID Configuration**

Link ID	Desired CIR [kbps]		Burst Rate [Mbps]		Distance [km]	QoS Level		Obtained CIR [kbps]	
	DL	UL	DL	UL		DL	UL	DL	UL
4	4,000	2,000	54	36	3	18	9	5,752	2,872
5	2,000	2,000	54	36	5	9	9	2,872	2,872
6	2,500	2,500	48	24	6	12	12	3,832	3,832
7	2,500	1,500	54	36	2	12	7	3,832	2,232
8	1,300	1,000	48	24	7	6	5	1,912	1,591

#### PMP Configuration Tool Data Input

Registration Period (frames) – The registration period is the number of frames that the base station passes before sending out a broadcast to look for new subscribers. Input a

number between 10 and 100 and check to see if the calculated Registration Cycle is below 1000 usec. Lower the entered number to bring the Cycle below 1000 usec. Higher numbers give better efficiency. A good starting number is approximately double the number of subscribers.

Max Distance (km) – Input the distance between the base station and the most distant subscriber in the sector in km. This parameter is used to allow for sufficient time to receive responses from subscribers that may be new to the PMP sequence.

Max QoS Level – This represent the maximum Quality of Service levels that will be used within the sector. The tool sets the priority level within a subscriber for actual data rate traffic as a result of the desired rate selected by the user. Levels vary from 1 to 18, with 18 being the higher level. Enter a value between 1 and 18 with 18 being the highest efficiency. A value of 18 is usually entered unless a cap on the Obtained Date Rate calculation is desired.

Desired CIR (kbps) – Enter the CIR (Committed Rate Information) desired on both the downlink (base station to subscriber) and uplink (subscriber to base station) direction of the PMP link for each individual subscriber beginning with subscriber Link ID #4. Enter as many subscribers as desired up to a maximum of 256.

Burst Rate (Mbps) – Enter the Uncoded Burst Rate that will be used by both the downlink (base station) and uplink (Subscribers). The uncoded burst rate is a function of the modulation mode that will be the typical one used for an individual link and can be taken from the table below:

Modulation	FEC Coding Rate	Uncoded Burst Rate (Mbps)
BPSK	1/2	6
BPSK	3/4	9
QPSK	1/2	12
QPSK	3/4	18
16QAM	1/2	24
16QAM	3/4	36
64QAM	2/3	48
64QAM	3/4	54

Distance (km) – Enter the distance between the base station and the individual subscriber.

**PMP Configuration Tool Results**

Max. Traffic Latency (us) – Shows the time required for one complete PMP cycle communicating once with all active subscribers.

Registration Cycle (ms) – Should be less than 1000 usec. If not, lower the number of frames in the Registration Period. The time the base station spends polling active

subscribers before looking for new ones. This cycle is a result of the Registration Period set above.

Bandwidth Used (%) – Must be less than 100%. 70% is more conservative. If values are too high or above 100%, the user entered a desired CIP higher than the total possible Obtained CIR.

Obtained CIR (kbps) – The calculated Committed Information Rate based on the entered parameters. Adjust input parameters to change CIR's for individual subscribers if desired.

## 10.2. Appendix 1 - Glossary Of Terms

<b>AN-50</b>	Redline Communications' Access Node-50 Broadband Fixed Wireless (BFW) system.
<b>Antenna</b>	A device for transmitting and/or receiving a radio frequency (RF). Antennas vary in design and frequencies supported.
<b>Antenna Gain</b>	The measure of antenna performance relative to a theoretical antenna called an isotropic antenna.
<b>ARQ</b>	Automatic Repeat Request. This is the protocol used over the air for error correction.
<b>Beamwidth</b>	The angle of signal coverage provided by an antenna.
<b>BFW</b>	Broadband Fixed Wireless
<b>Bps (Bits Per Second)</b>	A unit of measurement for the rate at which data is transmitted.
<b>BPSK</b>	Binary Phase Shift Keying.
<b>BS</b>	Base Station
<b>Channel</b>	A communications path wide enough to permit a single RF transmission.
<b>CID</b>	Channel Identification
<b>CIR</b>	Committed Information rate
<b>DB</b>	A ratio expressed in decibels.
<b>dBi</b>	A ratio, measured in decibels, of the effective gain of an antenna compared to an isotropic antenna.
<b>DBm</b>	Decibels above a milliwatt
<b>DHCP</b>	Dynamic Host Configuration Protocol. A DHCP server will automatically issue IP addresses within a specified range to devices on a network.
<b>Directional Antenna</b>	An antenna that concentrates transmission power into one direction.
<b>Encryption</b>	For the purposes of privacy, the transformation of data into an unreadable format until reformatted with a decryption key.
<b>Ethernet</b>	A LAN architecture using a bus or star topology
<b>FD</b>	Full Duplex. Refers to the transmission of data in two directions simultaneously (i.e. a telephone)
<b>FWA</b>	Fixed Wireless Access
<b>Gain</b>	The ratio of the output amplitude of a signal to the input amplitude of a signal. Typically expressed in decibels (dB).
<b>Gateway</b>	A network point that acts as an entrance to another network.
<b>GHz</b>	Gigahertz. 1,000,000,000 Hz, or 1,000 MHz
<b>GUI</b>	Graphical User Interface
<b>Hertz (Hz)</b>	The international unit for measuring frequency, equivalent to the number of cycles per second. One megahertz (MHz) is one million Hertz. One gigahertz (GHz) is one billion Hertz.
<b>IF</b>	Intermediate Frequency.
<b>IP (Internet Protocol)</b>	See TCP/IP.
<b>Isotropic</b>	A theoretic construct of an antenna that radiates its signal 360 degrees both vertically and horizontally—a perfect sphere. Generally used as a reference.
<b>IXC (Inter-exchange Carrier)</b>	A long-distance phone company.
<b>LAN (Local Area Network)</b>	A data communications network, typically within a building or campus linking computers, printers and other devices together.
<b>LEC (Local Exchange Carriers)</b>	The traditional local wired phone company.
<b>LED</b>	Light Emitting Diode

<b>LOS</b>	Line Of Sight. A clear direct path between two antennas, with no obstructions within the first Fresnel zone.
<b>MAC (Media Access Control)</b>	A unique number assigned to a network device. It corresponds to the ISO Network Model Layer 2 data link layer.
<b>MHz</b>	Megahertz. 1,000,000 Hz
<b>Modem (MOdulator/DEModulator)</b>	A hardware device which converts digital data into analog and vice versa.
<b>Modulation</b>	Any of several techniques for combining user information with a transmitter carrier signal.
<b>Multipath</b>	The radio echoes created as a radio signal bounces off of objects.
<b>NLOS</b>	Non Line Of Sight. Completely obstructed path between two antennas.
<b>OFDM</b>	Orthogonal Frequency Division Multiplexing. OFDM spreads data to be transmitted over a large number of orthogonal carriers.
<b>OLOS</b>	Optical Line Of Sight. A clear direct path between two antennas, with obstructions within the first Fresnel zone.
<b>Packet</b>	A bundle of data organized in a specific way for transmission. The three principal elements of a packet include the header, the text, and the trailer (error detection and correction bits).
<b>PHY (Physical Layer)</b>	Provides for the transmission of data through a communications channel by defining the electrical, mechanical, and procedural specifications.
<b>PMP</b>	Point to Multipoint
<b>PTP</b>	Point to Point
<b>QAM</b>	Quadrature Amplitude Modulation
<b>QoS</b>	Quality of Service
<b>QPSK</b>	Quadrature Phase Shift Keying
<b>Receiver Sensitivity</b>	A measurement of the weakest signal a receiver can receive and still correctly translate it into data.
<b>RF</b>	Radio Frequency
<b>Rx</b>	Receiver
<b>S/N</b>	Signal to Noise Ratio
<b>SINADR</b>	Signal to noise and distortion ratio.
<b>SS</b>	Subscriber Station
<b>TCP/IP (Transmission Control Protocol/Internet Protocol)</b>	The standard set of protocols used by the Internet for transferring information between computers, handsets, and other devices.
<b>TFTP</b>	Trivial File Transfer Protocol
<b>Tx</b>	Transmitter

### 10.3. Appendix 2 - AN-50 System Specifications

AN-50 System Specifications										
System Capability	Non-line-of-sight operations, PTP / PMP mode									
RF Band	5.725 - 5.825 GHz Band									
Channel Center Frequencies	Channel	1	1A	2	2A	3	3A	4	4A	5
	Freq.	5.735 GHz	5.745 GHz	5.755 MHz	5.765 GHz	5.775 GHz	5.785 GHz	5.795 GHz	5.805 GHz	5.815 GHz
Channel Size	20 MHz									
RF Dynamic Range	> 50 dB									
Modulation/Throughput	Modulation	Coding Rate		Over The Air Rate (Mbps)		Uncoded Burst Rate (Mbps)		Average Ethernet Rate (Mbps)		
	BPSK	1/2		12		6		5.7		
	BPSK	3/4		12		9		8.4		
	QPSK	1/2		24		12		11.2		
	QPSK	3/4		24		18		16.5		
	16 QAM	1/2		48		24		21.6		
	16 QAM	3/4		48		36		31.4		
	64 QAM	2/3		72		48		40.5		
64 QAM	3/4		72		54		44.9			
Maximum Tx Power	-20 to +20 dBm (region specific) *									
Rx Sensitivity	-86 dBm at 6 Mbps									
IF Cable	<ul style="list-style-type: none"> <li>• Maximum length up to 250 ft (76m) using RG6U / 500 ft (152m) using high-grade RG11U</li> <li>• Maximum allowable losses at 2.5 GHz: <ul style="list-style-type: none"> <li>RG6: 10 dB/30m (100 feet) at 25°C</li> <li>RG11: 5 dB/30m (100 feet) at 25°C</li> </ul> </li> <li>• Multiplexed IF, DC power, control (Tx/Rx, AGC, APC)</li> </ul>									
Network Attributes	<ul style="list-style-type: none"> <li>• Transparent bridge</li> <li>• DHCP passthrough</li> <li>• VLAN passthrough</li> </ul>									
Max Channel IDs (CID)	256 CIDs, one CID per Subscriber Station									
Provisioning	Best effort and Common Information Rate (CIR)									
Modulation	Dynamic Adaptive Modulation (bi-directional) auto selects: <ul style="list-style-type: none"> <li>• BPSK • QPSK • 16 QAM • 64 QAM</li> </ul>									
Over The Air Encryption	Proprietary 64-bit encryption									
Coding Rates	1/2, 3/4 and 2/3									
MAC	<ul style="list-style-type: none"> <li>• Point to point or Point to Multipoint</li> <li>• Automatic Repeat Request (ARQ) error correction</li> <li>• Concatenation/Fragmentation</li> </ul>									
Range	<ul style="list-style-type: none"> <li>• Over 10 km / 6 miles non-line-of sight</li> <li>• Over 80 km / 50 miles line-of-sight</li> </ul>									
Network Services	Transparent to 802.3 services and applications									
Duplex Technique	Dynamic TDD (time division duplex)									
Wireless Transmission	OFDM (orthogonal frequency division multiplexing)									
Backhaul Connection	10/100 Ethernet (RJ45)									
System Configuration	<ul style="list-style-type: none"> <li>• Web interface</li> </ul>									

\* **Note:** In some countries outside of North America, the Max. Operational Power Per Channel with a given antenna is limited in accordance to maximum allowable EIRP levels for the region.

AN-50 System Specifications continued....

Power Requirements	Single or dual 110/220/240 VAC (auto-sensing) 50/60 Hz 39W maximum												
Operating Temperature Range	AN-50 Terminal Operating Conditions: 41F to 104F / 5C to 40C AN-50 Terminal Short-Term Conditions: 23F to 41F and 104F to 131F / -5C to 5C and 40C to 55C for up to 16 hours T-58 Operating Conditions: -40F to +140F / -40C to +60C												
Wind Loading	AN-50 Radio: 137 mph / 220 km/hr												
Physical Configuration	AN-50 terminal, AN-50 Radio (T-58 Transceiver and antenna)												
AN-50 Dimensions	17" x 12" x 1.75" / 431.8 mm x 304.8 mm x 44.45 mm												
Component Weights	<table border="0"> <tr> <td>AN-50 Terminal .....</td> <td>2.0 kg</td> </tr> <tr> <td>T-58 Transceiver .....</td> <td>1.0 kg</td> </tr> <tr> <td>Vertical Mast Bracket Kit .....</td> <td>3.0 kg</td> </tr> <tr> <td>Vertical Mast Bracket Hardware Kit .....</td> <td>0.5 kg</td> </tr> <tr> <td>Cable, F Male/F Male, RG6, 100 ft</td> <td>1.3 kg</td> </tr> <tr> <td>Antenna.....</td> <td>1.0 to 27.0 kg</td> </tr> </table>	AN-50 Terminal .....	2.0 kg	T-58 Transceiver .....	1.0 kg	Vertical Mast Bracket Kit .....	3.0 kg	Vertical Mast Bracket Hardware Kit .....	0.5 kg	Cable, F Male/F Male, RG6, 100 ft	1.3 kg	Antenna.....	1.0 to 27.0 kg
AN-50 Terminal .....	2.0 kg												
T-58 Transceiver .....	1.0 kg												
Vertical Mast Bracket Kit .....	3.0 kg												
Vertical Mast Bracket Hardware Kit .....	0.5 kg												
Cable, F Male/F Male, RG6, 100 ft	1.3 kg												
Antenna.....	1.0 to 27.0 kg												









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