



***DS1/E1 N2-Link
Installation and Operations Manual***

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N2-Link Installation and Operation Manual

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Welcome!

Welcome to the Wireless, Inc. N2 ACCESS Series product family. This manual is designed to introduce you to the DS1/E1 N2-Link, and to provide you with information necessary to plan, install, operate and maintain a DS1/E1 N2-Link wireless communication system.



The N2-Link is intended for **professional installation only**. This manual, however, is also designed for personnel who plan, operate and administrate the N2-Link communication system. Please review the entire manual before powering up or deploying any N2-Link.

Updates to this manual will be posted on the Wireless, Inc. Customer Service Website at <http://www.wire-less-inc.com/CustServ>. Registered Wireless customers can access Wireless' on-line information and support service, available 24 hours a day, 7 days a week. Our on-line service provides users with a wealth of up-to-date information, with documents being added or updated each month.

Radiation Warnings

Microwave Radio Radiation Warning

Under normal operating conditions, N2-Link radio equipment complies with the limits for human exposure to radio frequency (RF) fields adopted by the Federal Communications Commission (FCC). All Wireless, Inc. microwave radio equipment is designed so that under normal working conditions, microwave radiation directly from the radio is negligible when compared with the permissible limit of continuous daily exposure recommended in the United States by ANSI/IEEE C95.1-1991 (R1997), Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

Microwave signal levels that give rise to hazardous radiation levels can exist within transmitter power amplifiers, associated RF multiplexers, and antenna systems.

Never look into the open end of a Waveguide as eyes are particularly vulnerable to radiation.

Do not disconnect RF coaxial connectors, open microwave units, or break down any microwave screening while the radio equipment is operating.

Microwave Antenna Radiation Warning

Designed for point-to-point operation, an N2-Link microwave radio system will use directional antennas to transmit and receive microwave signals. These directional antennas are usually circular or rectangular in shape, are generally located outdoors, and are usually mounted on a tower or mast.

Referencing OET Bulletin 65 (Edition 97-01, August 1997) from the Federal Communication Commission's Office of Engineering & Technology, limits for maximum permissible exposure (MPE) to microwave signals have been adopted by the FCC for both Occupational/Controlled environments and General Population/Uncontrolled environments. These limits are 5.0 mW/cm² and 1.0 mW/cm², respectively, with averaging times of six-minutes and thirty-minutes, respectively.

The closer you are to the front center-point of a microwave antenna, the greater the power density of its transmitted microwave signal. Unless you are very close, however, microwave exposure levels will fall far below the MPE limits. To determine how close to a microwave antenna you can be and still remain below the MPE limits noted above, "worst case" predictions of the field strength and power density levels in the vicinity of an ACCESS Link microwave antenna can be made from the following calculations. The equation is generally accurate in the far-field of an antenna, and will **over-predict** power density in the near-field (i.e. close to the antenna).

$$S = PG/4\pi R^2$$

where: S = power density (in mW/cm²)
P = power input to the antenna (mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (cm)

Note that G, the power gain factor, is usually expressed in logarithmic terms (i.e., dB), and must be converted using the following equation:

$$G = 10^{dB/10}$$

For example, a logarithmic power gain of 27 dB is equal to a numeric gain of 251.19.

Assuming (1) maximum output power from the N2-Link (+3.5 dBm [2.238 mW]), (2) no signal loss in the cable connecting the N2-Link to the antenna, and (3) the use of a 27 dBi gain parabolic antenna, the 5.0 mW/cm² and 1.0 mW/cm² MPE power density limits would be reached at distances of approximately 4.22 cm and 9.44 cm, respectively.

Wireless, Inc. fully supports the FCC's adopted MPE limits, and recommends that personnel maintain appropriate distances from the front of all directional microwave antennas. Should you have questions about N2-Link microwave signal radiation, please contact the Wireless, Inc. Customer Service Department.

Notice Regarding Operation pursuant to FCC part 15 Rules

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 own expense.

1.0 General Overview

1.1 N2 ACCESS Series Product Family

All N2-Link radios are members of the N2 ACCESS Series radio product family. The N2 ACCESS Series is designed to provide an economical wireless solution for local access telecommunication requirements.

The N2 ACCESS Series radio product family consists of several product offerings, to include both the N2 ACCESS Link and ACCESS MicroLink product lines. This manual addresses, in detail, the operation of the N2-Link. For detailed information on other N2 ACCESS Link radios or other members of the ACCESS Series, please refer to the appropriate Operation Manual(s).

1.2 Introduction to the N2-Link

The N2-Link series of radios are designed for operation in two of the Unlicensed National Infrastructures at frequencies of 5,250 - 5,350 MHz or 5,725 - 5,825 MHz.

Each N2-Link is comprised of 2 main units, a desktop or rack mountable indoor terminal unit and a pole mounted RF/antenna unit. Each link is powered by means of a AC wall transformer (optional DC powering available) located with the indoor terminal unit. The system has a data transmission capacity of 1xDS1 or E1 (1.544/2.048 Mb/s). The TU offers complete front-access for all interfaces, displays and controls. Refer to the N2-Link data sheets for information relating to product offerings and specifications.

1.3 Regulatory Information

In January 1997, the FCC made available 300 MHz of spectrum for Unlicensed National Information Infrastructure (U-NII) devices. The FCC believes that the creation of the U-NII band will stimulate the development of new unlicensed digital products which will provide efficient and less expensive solutions for local access applications.

The U-NII band is divided into three sub bands at 5.15 - 5.25, 5.25 - 5.35 and 5.725 - 5.825 GHz. The first band is strictly allocated for indoor use and is consistent with the European High Performance Local Area Network (HIPERLAN). The second and third bands are intended for high speed digital local access products for "campus" and "short haul" microwave applications.

Table 1.1 - FCC U-NII Bands

	Band 1	Band 2	Band 3
Frequency	5.15 to 5.25 GHz	5.25 to 5.35 GHz	5.725 to 5.825 GHz
Power (Max)	200 milliwatts EIRP	1 watt EIRP	4 watts EIRP
Intended Use	Indoor Use Only	Campus	Approx 6 miles

WL19-100-801

2.0 N2-Link Product Profile

2.1 General Overview

The N2-Link series of microwave radio products provides digital capacities for DSX, ITU-T and data rates for short-haul applications up to 15 km in the U.S. and up to 10/20 km. The radio terminal operates in the newly allocated Unlicensed National Information Infrastructure (U-NII) spectrum with a revolutionary Split Modulation system architecture that provides full duplex operation in the 5.3/5.7 GHz frequency bands.

The N2-Link series provides the unique advantage of a very robust digital transmission scheme which combines a high degree of error identification and correction.

Split Modulation uses two separate 100 MHz bands within the U-NII frequency spectrum. Within these bands, the N2-Link series operates in one of many independent channels providing for frequency re-use and network flexibility, ideal for dense network applications.

Synthesized RF channel selection is field configurable, as are the power output options for the selection of antenna sizes.

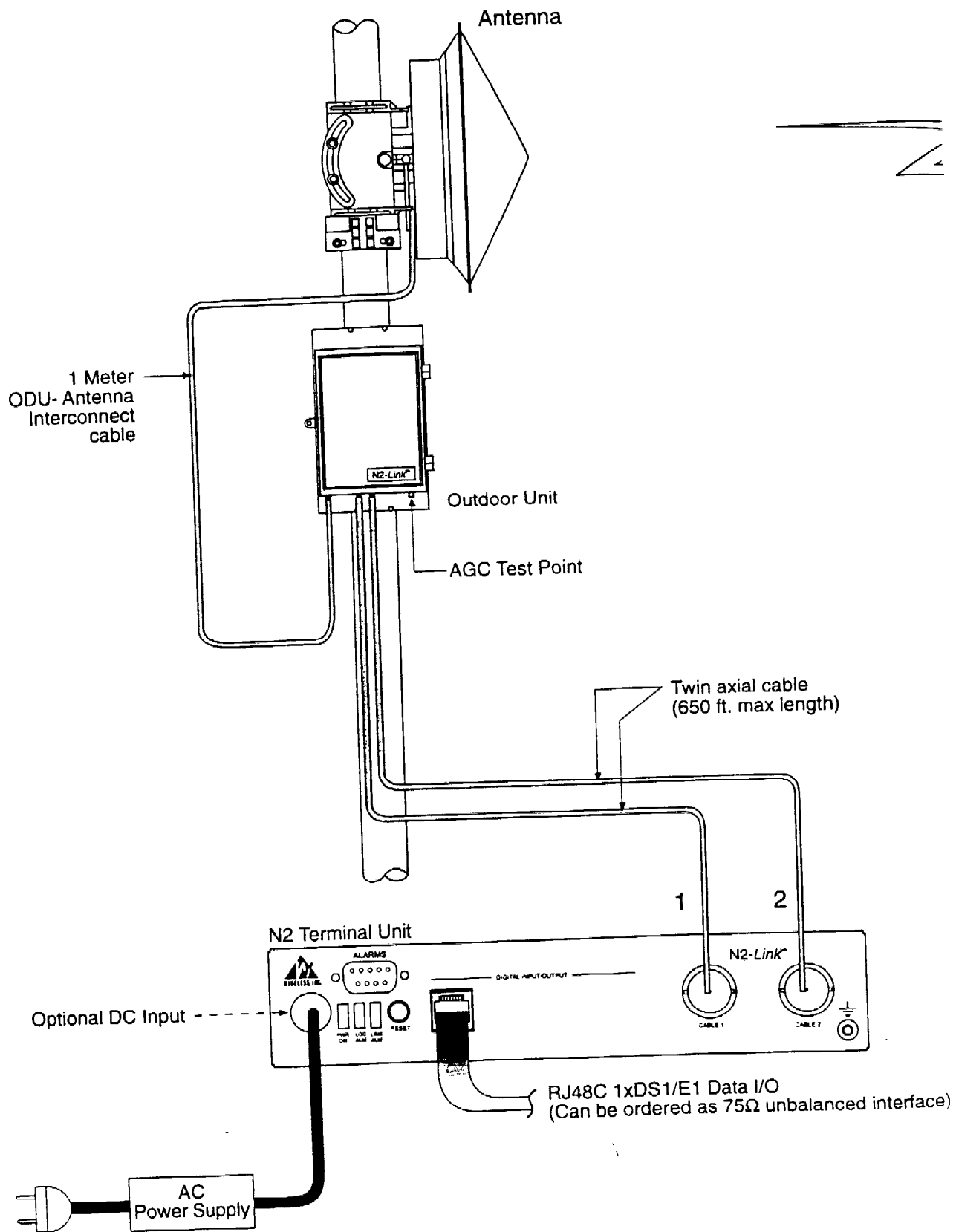
Complying with all aspects of FCC Rules Subpart (15.401-15.407), the transmission characteristics of the N2-Link series are ideally suited to meet the peak power spectral density requirements of the U-NII 5.250 - 5.350 and 5.725 - 5.825 GHz bands.



Note: From this point on in this Operations Manual, unless specified otherwise, the term N2-Link refers to the 5.3/5.7 GHz DS1/E1 N2-Link radio.

The N2-Link has been designed for complete front access to all interfaces, controls and displays. Information in this manual will familiarize you with all of these items. Figure 2.1 illustrates two(2) N2-Link terminals in a point-to-point configuration.

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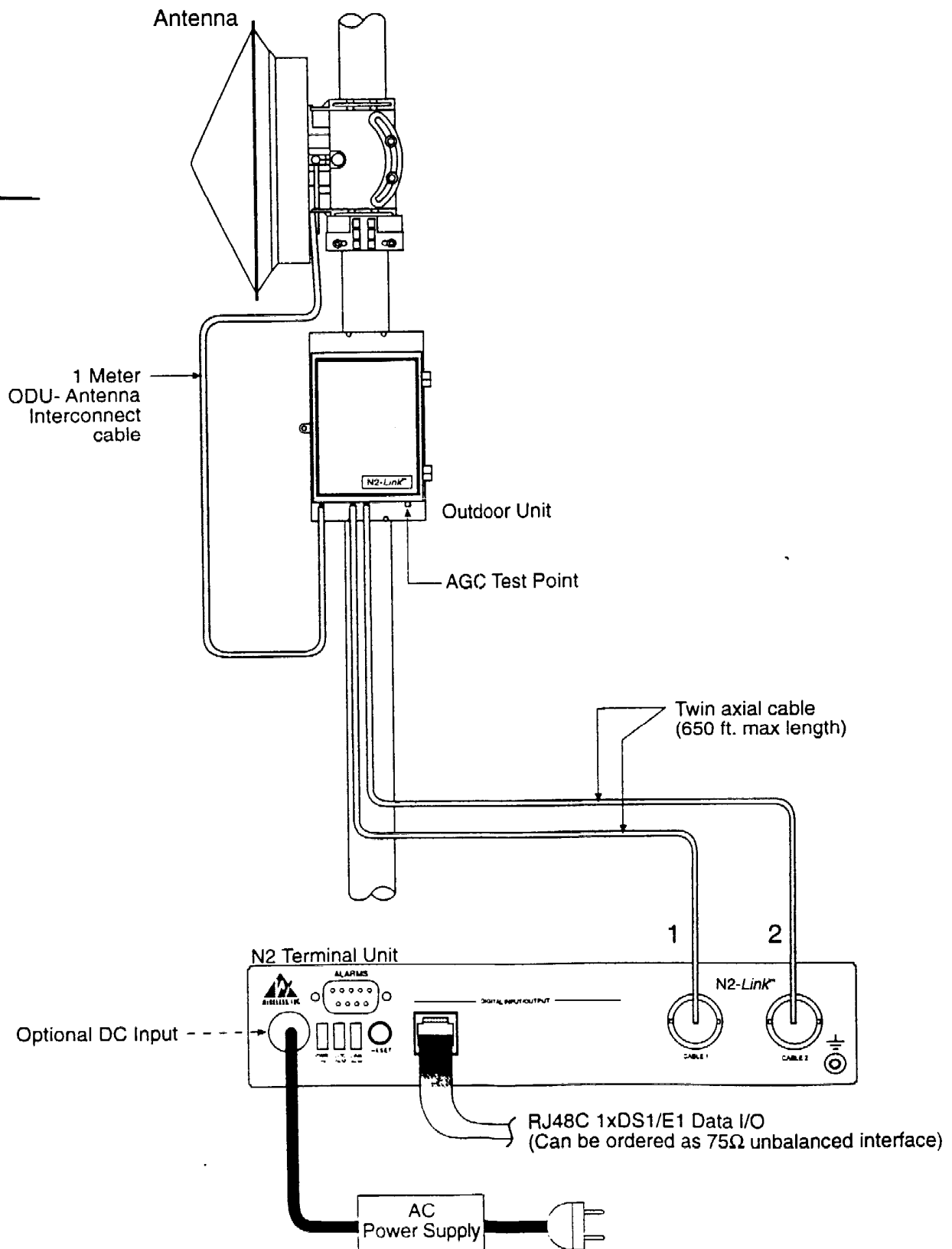


Figure 2.1 - Typical Deployment of a N2-Link in a Point-to-Point Configuration

2.2 Specifications

2.2.1 General

Frequency Band	Full-duplex operation in both 5.2 and 5.7 GHz
Regulations	Complies with FCC Ruling 15.407, U-NII
Frequency Range	5,250 - 5,350 MHz and 5,725 - 5,825 MHz
Frequency agility	Tunable in 2.5 MHz steps
Low Band	5.2608 to 5.34016 GHz
High Band	5.73568 to 5.81504 GHz
Channel Pairs	8 x 10 MHz (3 MHz max overlap)
	5.2608/5.73568 GHz
	5.27104/5.74592 GHz
	5.28128/5.75616 GHz
	5.29152/5.7664 GHz
	5.30176/5.77664 GHz
	5.31200/5.78688 GHz
	5.32224/5.79712 GHz
	5.33248/5.80736 GHz
Capacity options	1xDSS1 and 1xE1
Error Correction	4 x oversampling (bit interleaved)
Modulation	BPSK

2.2.2 Digital Interface

Type	DS1 - Bellcore TR-NWT-00499 E1 - ITU-T
Line Rate	DS1 - 1.544 Mb/s E1 - 2.048
Line Code	DS1 - AMI or B8ZS (field selectable) E1 - HDB3
Interface	DS1 - 100 Ohm balanced E1 - 75 Ohm unbalanced (optional 120 ohm balanced). On 75 Ohm systems, the Tx and Rx shields are DC coupled to ground. The Rx shield can be optionally AC coupled to ground by the user at the Interface Panel.
Physical Connection	DS1 - RJ-48C E1 - BNC (optional RJ-48C)

2.2.3 Transmitter

Frequency Bands	Low Band - 5.250 to 5.350 GHz High Band - 5.725 to 5.825 GHz
Output Power	Low Band - -8.5 or -2.5 dBm or +7.5 dBm High Band - -2.5 dBm or +3.5 dBm
Maximum EIRP	Low Band - +24.5 dBm High Band - +30.5 dBm
Power Spectral Density Requirements for BW <20 MHz	Low Band - 12.5 mW/MHz High Band - 50 mW/MHz
Inband Emissions	Low Band - 34 dB attenuation High Band - 40 dB attenuation
Out of Band Emissions	Low Band - 44 dB attenuation High Band - 50 dB attenuation
Frequency Tolerance	±5 ppm

2.2.4 Receiver

Type	Coherent Detection
Sensitivity, BER 10 E-6	DS1 - 89 dBm E1 - 89 dBm
Unfaded BER	1 x 10 E-12 or better
Maximum Rx Input	Error-Free - 30 dBm Without Rx Damage - 0 dBm
Co-channel Interference	+15 dB
Adjacent Channel Interference (±10 MHz)	+5 dB
Semi-Adjacent Channel Interference (±20 MHz)	-12 dB

2.2.5 Antennas

General Specifications and Performance

Input	RG-8 Female connector
Regulatory Compliance	FCC Part 15
Frequency Range	5.2 - 5.9 GHz
E-plane Polarization	± 1 deg.

2 ft. Single Polarization

Gain (mid-band)	27 dBi
Beamwidth, 3 dB	6.0 degrees
Cross Pol Disc.	28 dB
Front/Back Ratio	36 dB
VSWR	1.35:1 (RL)/16.5 dB

4 ft. Single Polarization

Gain (mid-band)	33 dBi
Beamwidth, 3 dB	3.0 degrees
Cross Pol Disc.	28 dB
Front/Back Ratio	42 dB
VSWR	1.35:1 (RL)/16.5 dB

2 ft Dual Polarization

Gain (mid-band)	26.5 dBi
Beamwidth, 3 dB	6.0 degrees
Cross Pol Disc.	28 dB
Front/Back Ratio	36 dB
VSWR	1.35:1 (RL)/16.5 dB
Isolation	35 dB min

4 ft Dual Polarization

Gain (mid-band)	32.5 dBi
Beamwidth, 3 dB	3.0 degrees
Cross Pol Disc.	28 dB
Front/Back Ratio	42 dB
VSWR	1.35:1 (RL)/16.5 dB
Isolation	35 dB min

Mechanical/Environmental

Wind Loading	EIA/TIA-195C and EIA/TIA-222E
Operational	112 km/hr (70 mph) 25 mm (1")
Survival	201 km/hr (125 mph) 25 mm (1")

2.2.6 Diagnostics

Interface Panel Front Panel Indicators	Power (normally On) - Green LED Local Alarm (normally Off) - Red LED Link Alarm (normally Off) - Red LED
Interface Panel Alarm Relays - Form C	Connector Type - DB-9 Female Local Alarm - (Non-energized in the power-up state) Link Alarm - (Energized in the power-up state)
ODU Alarm Indicators (for MFG and Maintenance)	Normal Operation - Green LED (and no red LEDs) Link Alarm - Red LED Local Alarm - Red LED Loss of Signal (LOS) - Red LED Page Indicator - Red LED RSSI - Red LED
ODU Performance Monitoring	RSSI - A voltage provided through a BNC connector on the outside of the ODU. The RSSI port is used for antenna alignment during installation and for periodic measurement of Receiver/ Path performance. The RSSI voltage is related to BER from -30 dBm to -90 dBm, with an accuracy of ± 5 dB. Remote Loopback - Accessed from the ODU Local Loopback - Accessed from the ODU

2.2.7 Power Requirements

Primary AC power supply, with AC to DC conversion	
AC	110 -240 VAC
DC	12 to 15 VDC
Power Consumption	Maximum 8 Watts
Power Input Connector	Coaxial DC connector, "snap and lock"

2.2.8 Environmental Specifications

Interface Panel	Temperature Range -30 to +55°C Altitude - 4,500 meters max Humidity - 95%, non-condensing
Outdoor Unit	Temperature Range -30 to +55°C Altitude - 4,500 meters max Humidity - Outdoor, all-weather enclosure

2.2.9 Mechanical

Interface Panel

Dimensions (HxWxD) - 43 x 200 x 152 mm

Weight - 1.2 kg

Outdoor Unit

Dimensions (HxWxD) - 356 x 203 x 76 mm

Weight - 3.5 kg

Interface to Outdoor
Unit Connection

2 cables max

Maximum separation

650 ft.

DS1/E1

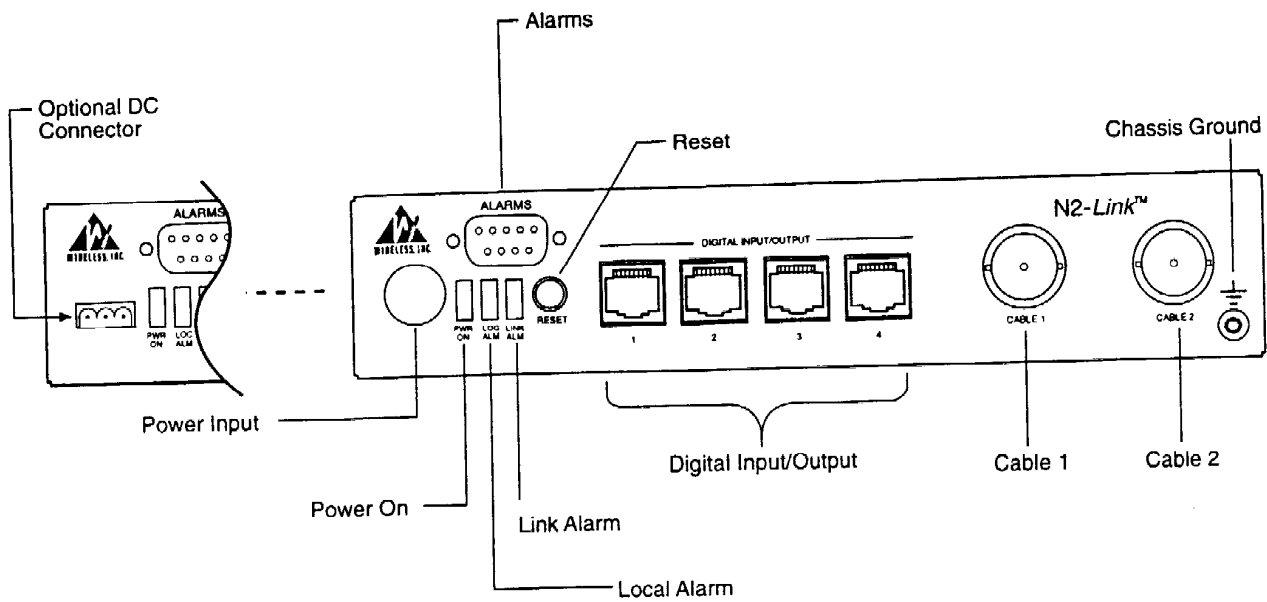
Tx/Rx

12 - 15 VDC

2.2.10 Safety

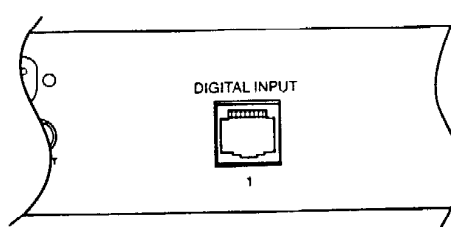
EN 60950

Figure 2.2 - Terminal Unit Interfaces

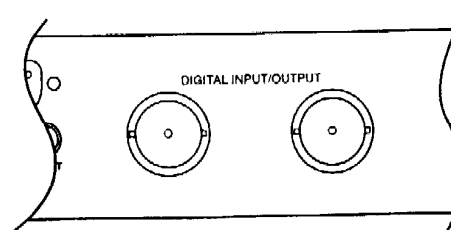


Optional Data I/O:

1xDS1/E1 120Ω

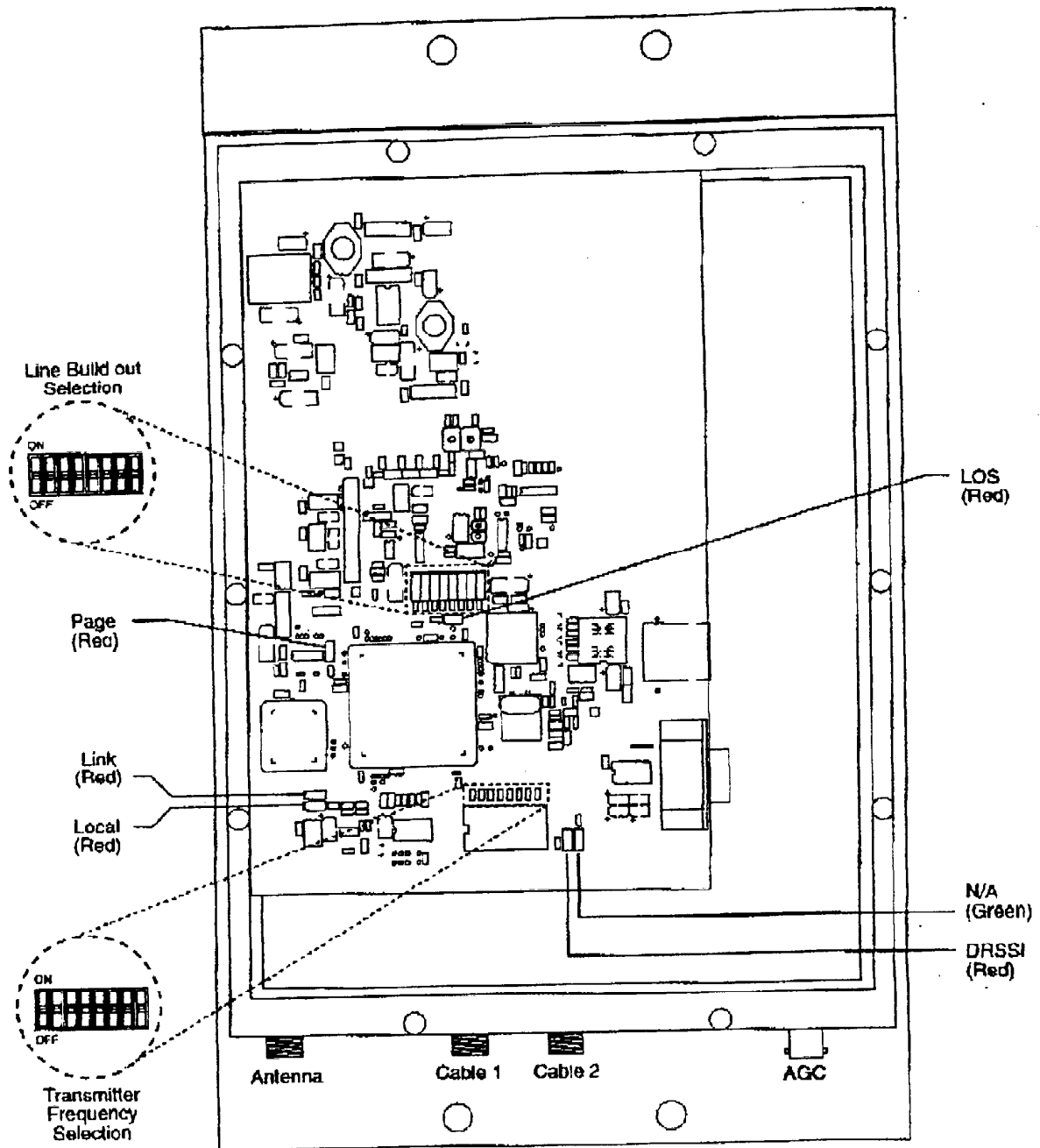


1xE1 75Ω



WL19-117-803

Figure 2.3 - Outdoor Unit



WLIS-113-801

2.4 Alarms and Indicators (Interface Panel)

The N2-Link Interface Panel is equipped with diagnostic tools in the form of LED indicators. The following describes the functions of these items as shown in Figure 2.2.

2.4.1 Power LED

The Power LED:

- **Green** - The N2-Link has proper DC power applied, and the unit is On.
- **Clear/Off** - The N2-Link is Off and has no DC power supplied.

2.4.2 Local Alarm LED

The Local Alarm LED is a single-color (red) device:

- **Red** - The N2-Link is registering one or more monitored alarm functions: summary radio alarm, loss of local data input, bipolar violations (BPV) detected on local incoming data, or power supply failure.
- **Clear/Off** - The N2-Link is not registering any alarm condition.

2.4.3 Link Alarm LED

The Link Alarm LED is a single-color (red) device:

- **Red** - A loss of data signal from the far terminal has occurred.

2.5 Alarms, Indicators and Displays (Outdoor Unit)

The N2-Link outdoor RF unit is provided with several LED indicators that supply operational status. Figure 2.3 shows the location of each indicator.

2.5.1 ODU Alarm Indicators

- Normal Operation (Green LED) -
- Page 0 (Red LED) - When lit (red), indicates that page 0 of the EEPROM has loaded to the FPGA indicating that a reset or start condition has occurred.
- Link Alarm (Red LED) - Indicates that the data signal from the far end terminal is not present.
- Local Alarm (Red LED) - An alarm condition is present at the local terminal.
- Loss of Signal (LOS) Alarm (Red LED) - The signal from the far end terminal has dropped below threshold.
- DRSSI Alarm (Red LED) -

2.5.2 ODU Performance Monitoring

RSSI - A voltage provided through a BNC connector on the outside of the ODU. The RSSI port is used for antenna alignment during installation and for periodic measurement of Receiver/Path performance. The RSSI voltage is related to Rx BER from -20 dBm to -90 dBm, with an accuracy of ± 5 dB.

Remote Loopback - Accessed from the ODU

Local Loopback - Accessed from the ODU

ODU Alarm Indicators

ODU Performance monitoring

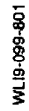
2.6 Theory of Operation

2.6.1 N2-Link Transmitter

This description should be used in conjunction with the system block diagram Figure 2.4.

- At the terminal unit (TU), a T1/E1 data signal is input through the RJ-48C connector in the case of a balanced impedance interface or BNC type connectors for unbalanced interfaces.
- A 15 VDC voltage is input to the TU by means of the supplied AC power supply. This will supply the voltage necessary to operate the TU and the Outdoor Unit (ODU).
- The T1/E1 data signal and the 15 VDC supply voltage are connected to the ODU by means of a twin-axial type cable. The supply voltage drives three DC regulators within the ODU. One regulator provides -5 VDC, the second 11 VDC and the third being a dual output type supplies +5 and +5.8 volts. The data signals are transformer decoupled from the DC voltage and connected to the Data level converter. The AMI/B8ZS or HDB3 formatted data is converted to TTL level.
- The FPGA coder interleaves and scrambles the TTL data from the coder. The FPGA is programmed to output the data at 4 times the input rate (6.176 MHz for the T1 rate or 8.192 for E1 rates). This provides a data rate which is optimal with respect to the FCC rules for spectral power densities defined for this frequency allocation.
- The data is passed through a 7th order low pass filter to reduce unwanted high frequency signal images prior to modulation. A double balanced mixer is used to modulate the data signal on to a CW signal provided by the synthesizer at the desired output frequency. The output of the mixer contains the BPSK modulated signal at the desired frequency.
- A high pass filter eliminates spurious noise, rejects harmonic images and insures that the proper bandwidth is maintained prior to being amplified.
- The RF output section consists of three main components: a RF driver amplifier, a logic controlled switch attenuator and a RF power amplifier. The driver amplifier provides the first stage of RF amplification, the switch attenuator serves a dual purpose. The first is to provide a customer selectable 6 dB attenuator to reduce output power when needed. Secondly, this circuit acts as an RF impedance matching network between the driver and power amplifier gain stages. The power amplifier provides the amplification required prior to being output through a diplexing filter and ultimately to the antenna.

Figure 2.4 - N2-Link Block Diagram



2.6.2 N2-Link Receiver

The description should be used in conjunction with the system block diagram (Figure 2.4).

- At the antenna, the received BPSK modulated signal from the opposite terminal is passed through a diplexing filter which is used to isolate the incoming signal from the transmitter output and to bandpass filter the received signal thereby reducing the chance of unwanted signal products from entering the receiver. A low noise amplifier (LNA) detects and amplifies the signal bandpass filter on the output of the LNA provides band limiting of the received spectrum to reject unwanted signal products. The first downconverter combines a CW signal at the receiver frequency from the synthesizer and the incoming signal by means of a mixer to produce the first IF product at 474.880 MHz. A 75 MHz bandpass filter limits the possibility of unwanted out of band products from entering the 2nd IF. The first IF is amplified by a MMIC device and is downconverted by mixer a 389.76 MHz signal from the synthesizer with the 474.880 MHz 1st IF signal. The result is a 85.12 MHz 2nd IF product which is bandpass filtered and fed to an RSSI IF processing IC which derives an AGC voltage used to determine signal strength.
- A BPSK demodulator places the 85.12 MHz 2nd IF and 85.12 MHz crystal source out of phase. The resultant product is a DC level I and Q signal of which only the I signal is input to the Bit Synchronizer to re-clock the data. The re-clocked data is decoded and output at TTL level to the T1/E1 level converter which outputs the data in AMI, B8ZS or HDB3 format as needed. The data is interconnected to the TU and output on the front panel by means of RJ-48C or BNC connector depending on the data format being used.

2.6.3 Synthesizer

The FPGA provides four 22-bit streams in a serial format loaded to the synthesizer. This data provides all of the possible frequencies at which the system can operate. Depending upon the dip switch settings selected, the actual frequency being used is selected. When the reset button is pressed, the FPGA will reload this data to the synthesizer. The PROM contains all of the possible frequency combinations.

