FIRELINK 2000
2.4 GHz and 2.3 GHz
SPREAD SPECTRUM RADIOS

LinkaNet Labs

INSTALLATION AND OPERATION MANUAL

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Important Notice

The AC powered version of this product is wired for chassis grounding and its respective AC power cord is supplied with a three-prong grounding plug. Please verify that the outlet you intend to use is also properly installed and grounded. LNL will not honor warranty claims resulting from alteration of the equipment or improper installation using a non-grounded outlet.

Before acquiring and installing this equipment, users should ensure that it is permissible for operation in the assigned frequency band and power settings. The user should also verify that the radio has been certified for use by the appropriate local telecommunications administrations.

LNL recommends that all tower and antenna installations be performed by trained and insured technicians.

LinkaNet Labs

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Warnings

Operator and maintenance personnel should be familiar with the safety requirements before attempting installation or operation of the equipment covered by this manual. Failure to follow the requirements and observe safety precautions could result in death or injury to personnel or damage to the equipment.

Observe all safety regulations. Dangerously high voltages are present within this equipment when in operation. Lethal line voltages may be present unless the main line power has been disconnected.

Keep away from live circuits. Whenever feasible in verifying circuits, check by continuity and resistance methods with all power off, rather than directly checking voltages.

Observe grounding precautions. Verify that the unit under test or being installed and all measurement equipment are properly grounded.

Do not test alone. Testing or adjusting the equipment should only be carried out in the presence of a person qualified to render aid.

When lifting the wireless terminal, use proper lifting techniques to prevent injury.

Equipment Precautions

Never operate the **FIRELINK 2000** radio without connecting a 50Ω termination to the antenna port. This termination can be a 50Ω antenna or a 50Ω resistive load capable of absorbing the full RF output of the RF Unit power amplifier.

Failure to properly terminate the RF output may cause permanent damage to the radio.

Two (2) Year Limited Warranty

Linkanet Labs, Inc. (**LNL**) warrants to the original purchaser that each of its hardware products, and all components thereof, when paid for and properly installed, operated and maintained will be free of defects in materials and/or workmanship for two (2) years from the date of purchase. Any warranty hereunder is extended only to the original purchaser and is not transferable.

In the event of malfunction or other indication of failure attributable directly to faulty workmanship and/or material, **LNL** will, at its option, repair or replace the defective products or components, to whatever extent it shall deem necessary to restore the product or component to proper operating condition, provided the purchaser sends with the defective product proof of the date of purchase. Please note that **LNL** may, at its option, replace the defective product with a new or re-manufactured, functionally-equivalent product of equal value. The process for returning equipment to the factory for repair is described in Section 7.
During the two years after date of purchase, all labor and materials will be provided without charge. There shall be no warranty for either parts or labor after expiration of two years from the date of purchase.
The products must be returned postage/shipping prepaid. It is recommended that the products be insured when shipped. Products returned without proof of date of purchase or out of warranty products will be repaired (at the option of **LNL**) and the customer will be charged for parts and labor. In the event that the cost of repair of returned products exceeds 40 percent of the replacement cost, the customer will be contacted for specific instructions and disposition.

The purchaser will be solely responsible for the failure of any **LNL** product or component thereof resulting from accident, abuse or misapplication of the product; **LNL** assumes no liability as a consequence of such events under the terms of this warranty.
This limited warranty is in lieu of all other express warranties, oral or written, which now or hereafter might otherwise arise with respect to this product. Any and all implied warranties of merchantability and fitness

for a particular use shall have no greater duration than the period for the express written warranty applicable to this product as shown above, and shall terminate automatically at the expiration of such period. No action shall be brought for breach of any implied or express warranty after twelve months subsequent to the expiration of the period of the express written warranty.

In no event shall **LNL** be liable for any special, incidental or consequential damages, including, but not limited to damages for loss of use of property, damage to equipment, downtime cost, cost of capital, economic loss, loss of good will, loss of profits or revenues caused by malfunction, defect or otherwise, and with respect to breach of any express or implied warranty, are not the responsibility of **LNL**, and to the extent permitted by law are hereby excluded both for property and for personal injury damage.
Please be aware that laws vary, and some of the provisions of this warranty may not be appropriate to the laws of your jurisdiction.

Regulatory Notices

Microwave Radios are subject to the regulations of the country in which they are used. The user should be aware of these policies and configure the **FIRELINK 2000** radios to be compliant with them. The following sections provide comments on some specific regulatory issues.

For use in the USA

There is a specific version of the radio for use in the USA. This radio must be professionally installed in compliance with FCC part 15 regulations. These regulations permit the use of a directional antenna for point to point applications and require the maximum output power to be reduced from +30dBm by 1dB for every 3dB of antenna gain exceeding 6dBi. Therefore, the **FIRELINK 2000** output power setting must not exceed +24dBm when using an antenna gain of 24dBi and a 30’ minimum of LMR400 (or equivalent) cable. Section 5.0 of this manual outlines the procedures for setting the transmitter power level. It is the responsibility of the installer to ensure that the radio is installed and configured to comply with FCC part 15 regulations.

For use in Mexico

There is a specific version of the radio for use in Mexico. This radio has the RF channel selection limited to the range of 2.450 -2.4835 GHz.

For use in countries following ETSI regulations

The radio installation must comply with ETS 300-328 regulations. The maximum EIRP allowed under the rule is +20dBm. In the ETSI configuration, the **FIRELINK 2000** output power is limited and the radio must use an antenna with a maximum gain of 23dBi and a minimum of 50m of LMR400 (or equivalent) cable. Section 5.0 of this manual outlines the procedures for setting the transmitter power level. This product must be installed by trained personnel. It is the responsibility of the installer to make sure that the radio is installed and configured to comply with the ETSI regulations.

For use in France

There is a specific version of the radio for use in France. This radio complies with ETSI standards and operates on an RF channel plan restricted to 2.446 -2.4835 GHz.

2.3 GHz Radios

There is a version of the **FIRELINK 2000** radio which operates in the 2.3 GHz band. These radios can only be used in countries where this band is approved for Spread Spectrum radio use. This radio has the RF channel selection range of 2.300 -2.400 GHz.

Preface

This manual describes how to install, configure and use the **FIRELINK 2000** family of Spread Spectrum radios in a typical environment. It also includes information about general system planning, with emphasis on antenna selection and path analysis.

This manual is intended for individuals who will install, configure and operate **FIRELINK 2000** Spread Spectrum microwave radios. It is assumed that the individual has a working knowledge of the concepts underlying telecommunications systems, as well as experience with radio equipment. Please contact **LNL** or your local distributor for any technical questions you may have regarding antennas, path analysis and installation.

READ THIS DOCUMENT!

It is extremely important that you read this document before attempting to install and configure the **FIRELINK 2000** radio. This equipment contains many configuration options. For proper operation of the equipment, you must follow the instructions provided in this document exactly.

Table of Contents

1. Introduction

This section provides an overview of the **FIRELINK 2000** family of Spread Spectrum radios, including:

- a list of features
- sample applications
- descriptions of the front and rear panel

1.1 Product Overview

The **FIRELINK 2000** radio provides a robust wireless solution for voice and sub-rate data connectivity. The **FIRELINK 2000** radio takes advantage of Direct Sequence Spread Spectrum (DSSS) modulation techniques to achieve high quality signal transmission over distances up to 100km.

FIRELINK 2000 models are available for operation in two RF bands. The "24-" models operate in the 2.4 GHz (2.400 - 2.4835) Industrial Scientific and Medical(ISM) band. The "23-" models operate in the 2.3 GHz (2.300 - 2.400) microwave band. The **FIRELINK 2000** radio versions are as follows:

- **24-64** or **23-64 (PRAD4850)** 64 kbps radio (supports 64/56/19.2/9.6/4.8/2.4/1.2 kbps synchronous and up to 19.2kbps asynchronous data rates).
- **24-128** or **23-128 (PRAD4851)** 128 kbps radio (supports 128/112 kbps synchronous and up to 56kbps asynchronous data rates).
- **24-256** or **23-256 (PRAD4852)** 256 kbps radio (supports 256/224 kbps synchronous and up to 115.2kbps asynchronous data rates).
- **24-384** or **23-384 (PRAD4853)** 384 kbps radio (supports 384/336 kbps synchronous and asynchronous data rates of at least 115.2kbps).
  - **24-512** or **23-512 (PRAD4854)** 512 kbps radio (supports 512 kbps synchronous and asynchronous data rates of at least 115.2kbps).

Higher speed asynchronous data can be supported using an external Sync to Async converter.

1.2 Features

The key features of the **FIRELINK 2000** radios are described in the following sections.

1.2.1 FIRELINK 2000 Features

- Minimum inventory - the standard radio includes:
  - All DTE interface types (V.35, V35/V.11, RS-232, RS-422, EIA 530, X.21)
  - Front and Rear Access
  - AC, -48 VDC, and +24 VDC input power
- Front and Rear Access Shelf
  - Same radio can mount with front or rear access
  - Field selection of mounting
  - Minimize inventory if both needed
  - Size compatible with ETSI rack
  - Wall or rack mount options
  - LCD display and keypad option eliminating the need for a terminal
- Remote Administration
  - Serial Admin interface for set up and loopbacks
  - Remote access via telephone line modems
  - Remotely monitor far end alarms, status, etc.
  - Remotely activate radio loopback
- All data rate radios can operate from the same hub
- Data rates of each radio can be easily upgraded in the field
- TDD Range limit 100 km
- Operates in the 2.4 or 2.3 GHz band
- Advanced diagnostic tools
  - Built in BERT tester
  - RSSI readings displayed in dBm on terminal screen
  - Spectrum analyzer feature to scan for clear channels
- Extensive Alarm Indicators
  - Receiver Sync
  - Bit Error Indicator
  - Transmit and Receive Data
  - Loopback active

- Alarm Relay Contact Closures
  - Alarms
  - Link Monitoring
- 8 Optimized spreading sequences
- Compact one RU (4.5 cm/1.75 inch) high shelf
- 19-inch (48 cm) rack and table-top mounting
- Far End loopback through V.54 or Admin interface
- Supports point-to-point and hub network configurations
- Supports repeater configurations for greater range or obstacle clearance
- Protocol transparent to host
- Full-duplex synchronous data rates of 64/56/19.2/9.6/4.8/2.4/1.2 kbps, 128/112 kbps, 256/224 kbps, 384/336 kbps and 448/512 kbps
- Signal intensity (RSSI) test points for ease in antenna alignment
- Selectable internal burst sync termination
- ***Optional:*** Directional Parabolic Antennas, cables and connectors.

When connected to your DTE equipment, the **FIRELINK 2000** family of Spread Spectrum radios transmit full-duplex synchronous or asynchronous data over a line-of-sight radio link. The asynchronous data rates are supported by over-sampling. **FIRELINK 2000** models simulate a DCE device by supporting all the necessary handshake signals required by the interface specifications. Higher speed asynchronous data can be supported using an external Sync to Async converter.

1.3 Applications

FIRELINK 2000 Spread Spectrum radios can be configured for point-to-point, hub or repeater applications. Examples of these network configurations are described in Section 4.

Using directional antennas (parabolic antennas offer optimum performance and protection against interference at a reasonable cost) where there is direct line-of-sight (LOS), the link distance can be greater than 50 km (30 mi.).

The **FIRELINK 2000** radios are commonly used to connect routers or bridges for LAN-to-LAN communications or for video teleconferencing applications. When connected to TDM multiplexers, **FIRELINK 2000** radios can support low-speed data, voice, and fax traffic on the link.

1.4 Front Panels

The **FIRELINK 2000** radios can be mounted with the Input/Output (I/O) connections facing either toward the front or toward the back. In some countries, it is common to have central office equipment installed with the I/O connections facing the front while in other countries they face the rear. Customer premises installations almost always have I/O connections facing forward.

1.4.1 Non-I/O Panel

Figure 1–1 and 1.2 show the Non-I/O panel of the **FIRELINK 2000** radios with and without the optional LCD interface.

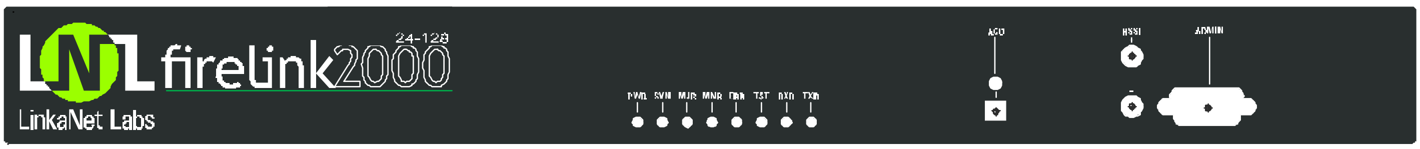


Figure 1–1. Non-I/O Panel - FIRELINK2000 Spread Spectrum Radio

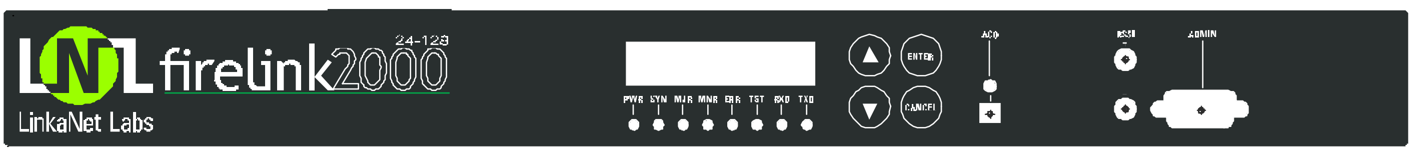


Figure 1–2. Non-I/O Panel with LCD Option- FIRELINK2000 Spread Spectrum Radio

This panel has a 9-pin D-type connector for administration terminal I/O, **RSSI** (Receive Signal Strength Indicator) test points and LED indicators for alarms, status and bit error indications. An ACO (Alarm Cut Off) switch and indicator is provided to allow suppression of alarm indications.

When the optional LCD interface is installed, a 4 button keypad and LCD provides access to all configuration items witout requiring an external terminal. When not is use, it can be used to continuously display the local or far end radio RSSI in dBm.

1.4.2 I/O Panel

The I/O panel (see **Error! Reference source not found.**3 and 1.4) has duplicates of the indicators, switches and administration port found on the non-I/O panel as well as the I/O connectors.

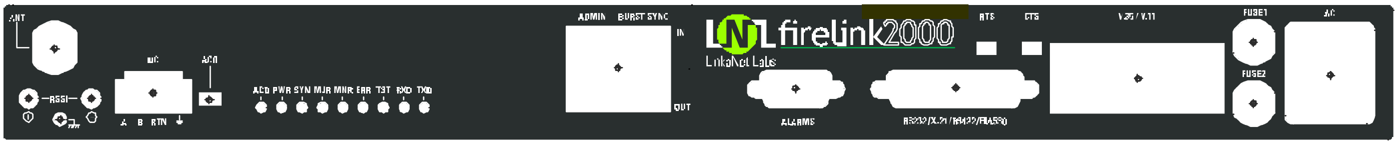


Figure 1–3. I/O Panel - FIRELINK 2000 Spread Spectrum Radio

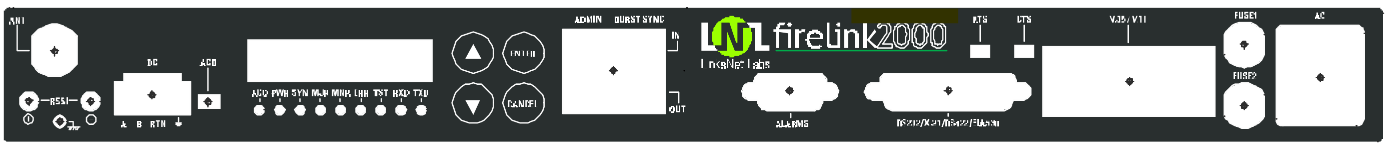


Figure 1–4. I/O Panel with LCD Option- FIRELINK 2000 Spread Spectrum Radio

Taken from left to right:

- The type N **RF** connector provides the radio connection to the antenna. A chassis ground lug is also provided.
- The **RSSI** test points provide an indication of the received signal strength and may be used to align the antenna.
- A 4-pin DC connector is provided and can be connected to a primary and a redundant DC source. This connection automatically detects positive and negative polarity.
- To the right of the DC connector are the LED indicators and ACO switch/indicator similar to those found on the non-I/O panel.
- When the optional LCD interface is installed, a 4 button keypad and LCD provides access to all configuration items without requiring an external terminal. When not is use, it can be used to continuously display the local or far end radio RSSI in dBm.
- Next are the RJ48 administration port connectors and burst sync connections. The burst sync connections are used for synchronization of transmission bursts (burst sync) between multiple co-located radios.
- A 9-pin D-type connector provides alarm contact closures for alarms.
- A 25-pin D-type connector and M34 (Winchester) connector follow and are used for providing the data interfaces. The DB25 provides the RS-232, RS-422, and EIA 530 **DTE** interface types and the M34 is used for V.35 and V/35/V.11 **DTE** interfaces.
- Last is a standard three-prong AC power connector/power switch and the AC power fuses. Only one fuse is used unless the redundant power option is installed.

2. Product Description

This section provides information about the following: • Technical overview • RF channel plan • The I/O panel • The non-I/O panel • Alarms and indicators

2.1 Technical Overview

The **FIRELINK 2000** consists of two families of Spread Spectrum Digital Microwave radios which operate in the 2.4 GHz "ISM" band or the 2.3 GHz band. The five radios in each product family (64 kbps, 128 kbps, 256 kbps, 384 kbps and 512 kbps) operate in the same fashion and differ only in data rate except that the RS-232 user data interface is only supported for data rates up to112 kpbs.

The **FIRELINK 2000** radios use QPSK modulation and the Time Division Duplex (TDD) method of duplex operation. With the TDD method the radio switches between a transmit and receive mode at a very high speed. The duty cycle consists of 4.25 milliseconds of transmit followed by 4.25 milliseconds of receive. Data buffers are used to convert the data bursts to a continuous data stream at the user interface.

Figure 2–1 shows a block diagram for the **FIRELINK 2000** radio baseband circuits. The user's equipment such as a multiplexer, bridge or router connects to the **USER INTERFACE PORT**. The **USER INTERFACE CIRCUITS** provides the interface line drivers and receivers and supports the interface control lead processing. **FIRELINK 2000** has all of the listed interfaces built in as a standard feature. The RS-232 interface is limited to data rates of 112kbps because the RS-232 standard does not support the higher rates. The user can select which of the interface types is active via the configuration menu.

The data received from the interface is passed to a **FIFO** buffer memory which is used to accommodate timing offsets. This memory buffer allows the **FIRELINK 2000** radio to be more flexible in its timing configurations than other radios. In the **MUX** circuit, the **FIFO** output is combined with CRC-6 parity information and other overhead information.

The **RATE BUFFER & STATE MACHINE** converts the continuous data stream into bursts of data which will be transmitted to the far end of the link during the transmit portion of the TDD cycle. This circuit also includes the circuitry used to synchronize transmission bursts between multiple radios at a site. The **SPREAD & DE-SPREAD** circuit performs the QPSK modulation and spectrum spreading functions.

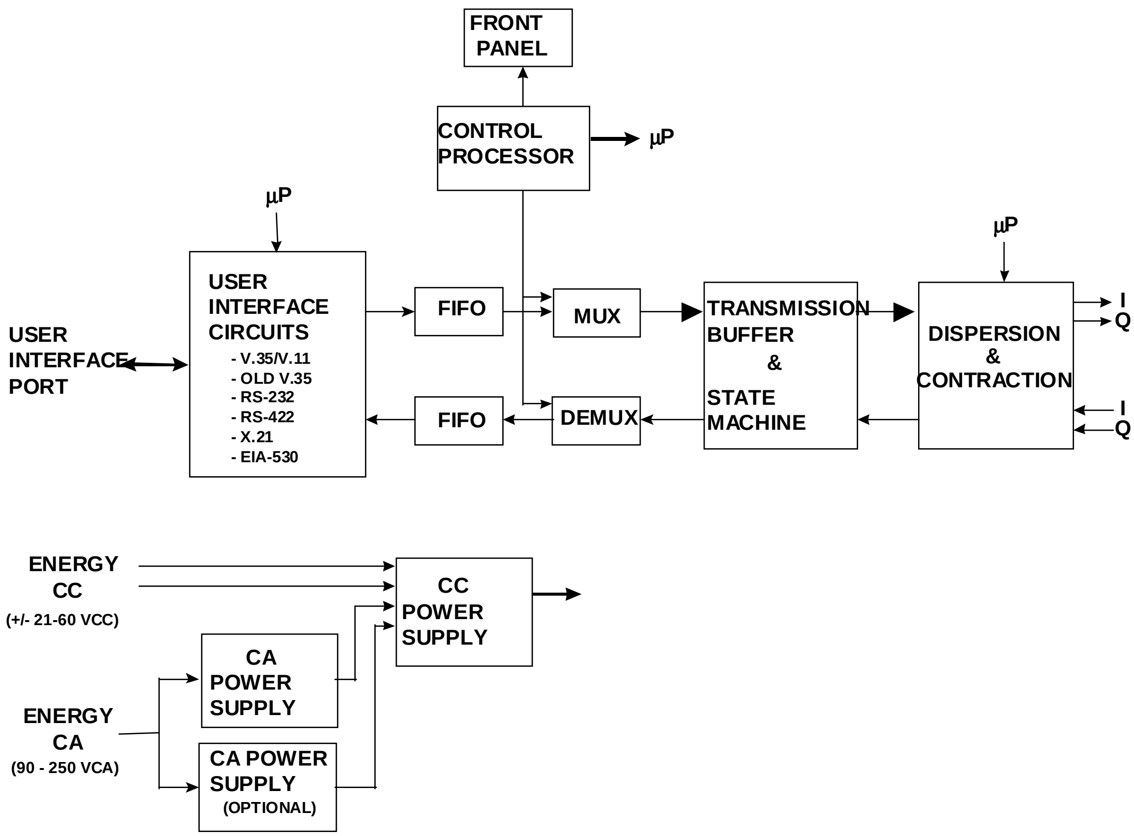


Figure 2–1. Baseband Circuitry - FIRELINK Spread Spectrum Radio

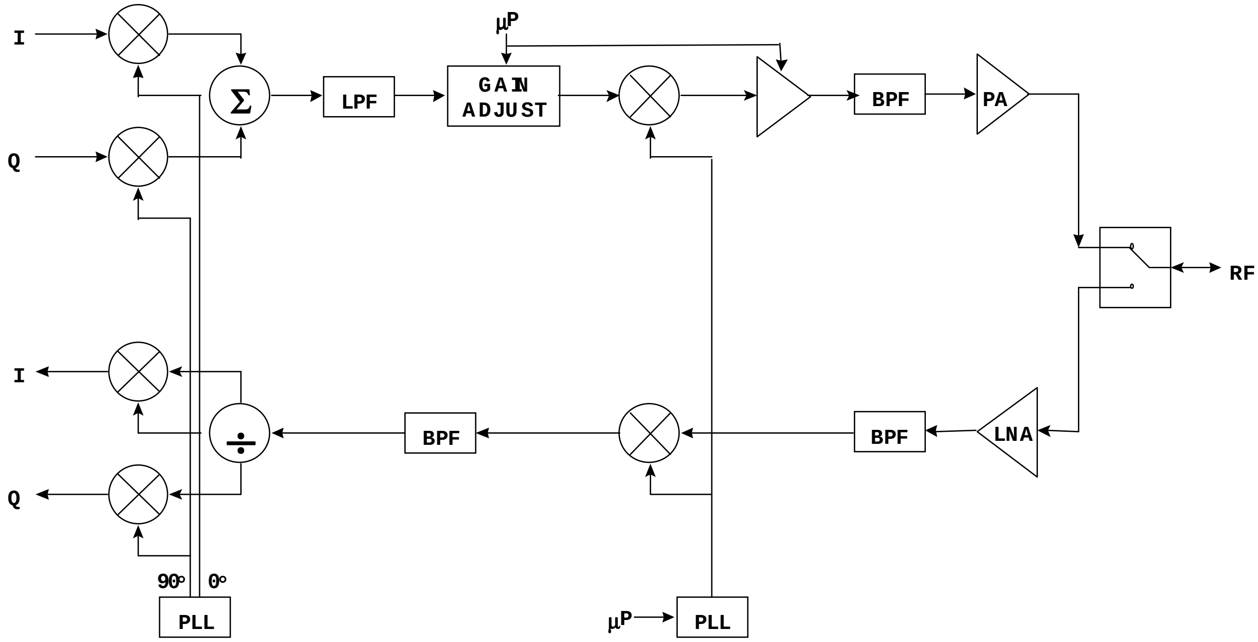


Figure 2–2. IF and RF Circuitry - FIRELINK 2000 Spread Spectrum Radio

Figure 2.2 shows the **FIRELINK 2000 IF** and **RF** circuits. Following the transmit path: the I and Q outputs of the **SPREAD & DE-SPREAD** circuit are converted to an IF signal by mixing with the output of the first **PLL** (phase locked loop). The I and Q IF signals are combined and low pass filtered to remove the mixing images. The resulting IF signal passes to the **GAIN ADJUST** circuit which uses digitally controlled attenuators to allow the transmit power level to be set under software control. The resulting signal is translated to the final RF channel by mixing with the output of the second **PLL**. The frequency of this **PLL** is controlled by microprocessor so that the RF channel can be set under software control. The signal is then filtered to remove mixing images and amplified to the final output level in the power amplifier (**PA**). The output of the **PA** passes to the **TDD** switch which switches the antenna connection between the **PA** output and the **LNA** (low noise amplifier) input.

In the receive path the output of the **LNA** is filtered to band limit the signal and then converted to IF by mixing with the output of the second **PLL**. The output of the mixer is filtered to remove the mixing images and then split into two signals. Each signal is converted to the I or Q baseband signal by mixing with the output of the first **PLL**.

2.2 RF Channel Plan

The **FIRELINK 2000** 24-xxx series radios operate in the 2.400 to 2.4835 GHz band. The **FIRELINK 2000** 23-xxx series radios operate in the 2.300 to 2.400 GHz band. These bands are subdivided into channels for individual radio links. The channel bandwidth is proportional to the bit rate and ranges from 5 MHz for the 64 kbps radios to 40 MHz for the 512 kbps radios. Figure 2–3 shows a plot of the channels for the example of the 256S radios.

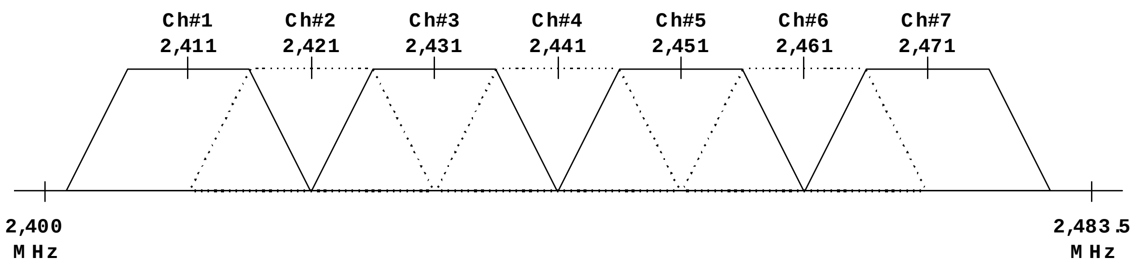


Figure 2–3. RF Channel Diagram Example: 24-256S radio

Several specific versions of the **FIRELINK 2000** radio have been designed for sale in various countries which have regulations differing from the USA. As an example, Mexico and France have the RF channels limited to comply with the narrower spread spectrum bands available in these countries. The channel assignments for all radio versions are found in Section 4.7.2.

For system planning in Hub configurations the RF channels for each radio pair are normally selected so that they do not overlap with other links. The **FIRELINK 2000** channels plans and burst synchronization timing are compatible for all data rates from 64kbps to 512kbps. The RF channel plans for the **FIRELINK 2000** radios maximize the use of the frequency band and are compatible with the channel plans of the **Skyplex I** and **Skyplex SS** radios. This simplifies channel planning when **FIRELINK 2000** radios are used at the same hub site with other products.

Experienced users may be able to use overlapping channels by providing sufficient isolation between the other channels in use. The PN sequence, antenna polarization, antenna directionality, and channel assignment are used to maximize the isolation for each installation.

2.3 I/O Panel Description

This section provides a detailed description of the items on the I/O panel shown in Figure 2–4.

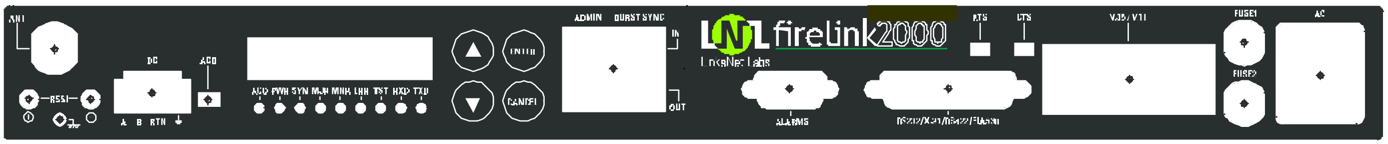


Figure 2–4. I/O Panel Diagram - 128S Radio

2.3.1 I/O Panel Connectors

The I/O panel has the following connectors as shown in Figure 2.4. The pinouts for all connectors are contained in Section 5.

Table 2-1. I/O Panel Connectors

Interface Connector	*Description*
System Ground Stud	Screw type lug used for grounding of the unit for safety, lightning protection and RF.
RF Interface	Type N female connector supports both transmit and receive RF signal. Connected via RF cable to antenna.
RSSI Test Points	These test points are used to measure a DC voltage which is proportional to the receive signal strength.
Burst Sync	Two RJ48 connectors are used for connection of a burst synchronization signal between radios located at the same site. The burst synchronization signal causes all radio transmit bursts to occur at the same time. Additional information on burst sync configurations is contained in Section 4.
Alarm Relays	There are two Form A, normally open (N/O) alarm relay contacts provided in the I/O panel. Access to the contacts is provided via a 9-pin D connector . The activation of these relays is under software control. The alarm state will cause the N/O contacts to close. ACO switches are provided on the I/O panel and non-I/O panel to deactivate the alarm relays.
V.35/V.11	The user interface connector for applications using the V.35 or V.11 interfaces. The connector is the M34 Winchester. The pin-out is per the V.35 standard. This is a **DCE** type interface.
RS232/RS422/EIA530	The 25-pin D user interface connector is used for applications using RS-232 (64 and 128 kbps radios only), RS-422 or EIA530 interfaces. Adapter cables are used to accommodate the pin-out for these different interfaces. This is a **DCE** type interface.
ADMIN. In	This RJ48 connector is used for a direct RS-232 connection to an ASCII terminal for radio administration. This is a **DCE** type interface.
ADMIN. Out	This RJ48 connector is for future use.
AC Power	AC Power uses the IEC 320 standard male connector with standard pin-out.
DC Power	A four-position terminal strip is used for DC power connections. The connector provides for redundant DC power input connections which are diode ORed in the radio.

2.3.2 I/O Panel Indicators

All of the indicators (see Table 2-2) are duplicated on both the I/O and non-I/O panels.

Table 2-2. I/O Panel Indicators

Indicator	*Description*
ACO	This yellow LED indicates whether a current alarm has been cut off. If the ACO switch is activated while an alarm is active, the ACO indicator is illuminated. This indicator remains illuminated until all alarms which were active when ACO was activated are cleared.
PWR	This green LED illuminates if the unit is powered on.
SYN	This green LED illuminates when the receiver successfully synchronizes with the received RF signal.
MJR	This red LED illuminates when a major alarm is detected. See Section 6.1.1
MNR	This yellow LED illuminates when a minor alarm is detected. See Section 6.1.1
ERR	This red LED flashes momentarily when CRC errors are detected in the receive bit stream.
TST	This yellow LED illuminates when any test mode is active.
TXD	This yellow LED illuminates momentarily when a logical one is received at the DTE interface from the DTE unit.
RXD	This yellow LED illuminates momentarily when a logical one is sent from the DTE interface toward the DTE unit.
RTS	This yellow LED illuminates when a logical one is received at the DTE interface from the DTE unit. The radio assumes RTS is asserted unless the interface is set to X.21 mode and the RF link is unavailable.
CTS	This yellow LED illuminates when a logical one is sent from the DTE interface toward the DTE unit. This will always be asserted unless the interface is in X.21 mode and the RF link is unavailable.
LCD/Keypad Interface (optional)	The LCD and 4 button keypad provide access to all internal configuration parameters without the need for an external terminal interface. When not in use, the LCD can continuously display near or far end RSSI. When in use, the up/down key is used to scroll the possible menu options, the enter key selects the current option displayed, and the cancel key exits the current menu.

2.3.3 I/O Panel Switches

Table 2-3. I/O Panel Switches

Switch	*Description*
ACO	There are two momentary push button switches labeled **ACO**. One is on the I/O panel and the other is on the non-I/O panel. The alarm contact closures in the radio are often connected to alarm bells at the site which attract the user's attention when an alarm occurs. The **ACO** (Alarm Cut-Off) switch is used to silence or cut off the bell once the operator has been alerted. When the **ACO** switch is activated while an alarm is active, the alarm contact relays will de-energize and the **ACO** indicator will be illuminated. If a new alarm subsequently occurs, the alarm relays will close again. If an alarm clears and then re-occurs, it is treated as a new alarm. The **ACO** indicator remains illuminated until all alarms which were active when the **ACO** was activated are cleared.

2.4 Non-I/O Panel

This section describes the connectors, indicators and switches for a non-I/O panel as shown in Figure 2–5.

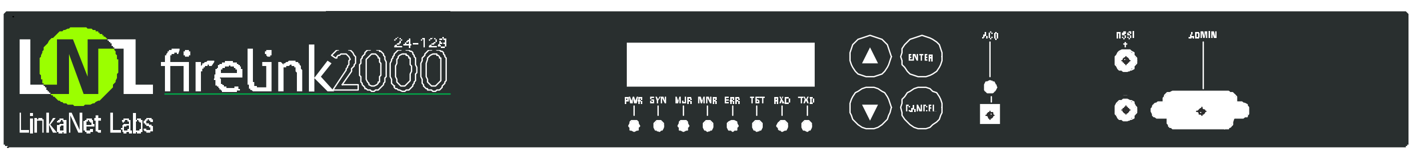


Figure 2–5. Non-I/O Panel

The Non-I/O panel has two connectors, the **ADMIN** Port and RSSI test points.

Table 2-4. Non-I/O Panel Connector

Connector	*Description*
ADMIN. Port	This 25-pin D connector provides local connection for the RS-232 terminal administration port. Connector pin-out is per the RS-232 standard. This is a **DCE** type interface.
RSSI Test Points	These test points are used to measure a DC voltage which is proportional to the receive signal strength.

2.4.1 Non-I/O Panel Indicators

All of the indicators are duplicated on both the I/O panel and the non I/O panel. See Section 2.3.2 for a description of these indicators.

2.4.2 Non-I/O Panel Switches

Table 2-5. Non-I/O Panel Switches

Switch	*Description*
ACO	There are two momentary push button switches labeled ACO. One is on the I/O panel, and the other is on the non-I/O panel. The alarm contact closures in the radio are often connected to alarm bells at the site which attract the user's attention when an alarm occurs. The ACO (Alarm Cut-Off) switch is used to silence or cut off the bell once the operator has been alerted. When the ACO switch is activated while an alarm is active, the alarm contacts relays will de-energize and the ACO indicator is illuminated. If a new alarm subsequently occurs, the alarm relays will close again. If an alarm clears and then re-occurs it is treated as a new alarm. The ACO indicator remains illuminated until all alarms which were active when the ACO was activated are cleared.

3. Specifications

This section provides specifications for the following:

- Radio
- User Data Interface
- Diagnostics
- Connectors
- ADMIN Port
- Power
- Environmental
- Mechanical

3.1 Radio

Output Power	+28 dBm Peak Maximum, Adjustable	
Frequency Range	"S" model:	2400 - 2483.5 MHz
	"FCC" model:	2400 - 2483.5 MHz
	"2.3" model:	2300 - 2400 MHz
	ETSI model:	2400 - 2483.5 MHz
	Mexican model:	2450 - 2483.5 MHz
	French model:	2446 - 2483.5 MHz
Maximum Range	100 km (60 mi.)	
Channel Spacing	Spacing	Bandwidth
64 kbps	5 MHz	3.7 Mhz
128 kbps	10 MHz	5.3 Mhz
256 kbps	20 MHz	10.5 MHz
384 kbps	30 MHz	21.0 MHz
512 kbps	30 MHz	21.0 MHz
Number of Channels:		
Standard Version:		
64 kbps	16 non-overlapping	
128 kbps	8 non-overlapping	
256 kbps	7 overlapping, 4 non-overlapping	
384 kbps	5 overlapping, 2 non-overlapping	
512 kbps	5 overlapping, 2 non-overlapping	

FCC Version:	
64 kbps	15 non-overlapping
128 kbps	8 non-overlapping
256 kbps	7 overlapping, 4 non-overlapping
384 kbps	5 overlapping, 2 non-overlapping
512 kbps	5 overlapping, 2 non-overlapping
2.3 GHz Version:	
64 kbps	19 non-overlapping
128 kbps	10 non-overlapping
256 kbps	9 overlapping, 5 non-overlapping
384 kbps	7 overlapping, 3 non-overlapping
512 kbps	7 overlapping, 3 non-overlapping
ETSI Version:	
64 kbps	16 non-overlapping
128 kbps	8 overlapping, 8 non-overlapping
256 kbps	7 overlapping, 4 non-overlapping
384 kbps	5 overlapping, 2 non-overlapping
512 kbps	5 overlapping, 2 non-overlapping
Mexican Version:	
64 kbps	6 non-overlapping
128 kbps	5 overlapping, 3 non-overlapping
256 kbps	5 overlapping, 2 non-overlapping
384 kbps	3 overlapping, 1 non-overlapping
512 kbps	3 overlapping, 1 non-overlapping
French Version:	
64 kbps	6 non-overlapping
128 kbps	5 overlapping, 3 non-overlapping
256 kbps	4 overlapping, 1 non-overlapping
384 kbps	2 overlapping, 1 non-overlapping
512 kbps	2 overlapping, 1 non-overlapping
Modulation	QPSK
Spreading Method	Direct Sequence
Spread Spectrum Processing Gain	>10 dB
Code Length	15 bits
Number of Stored Codes	8
Frequency Stability	10 ppm

Clock Source	Internal or DTE interface
Max Receive Level	0 dBm (No Damage)
	-30 dBm (No Errors)
Receive Sensitivity	Threshold = $1x10^{-6}$
64 kbps	-95 dBm min, -98dBm typ
128 kbps	-92 dBm min, -95dBm typ
256 kbps	-89 dBm min, -92dBm typ
384 kbps	-87 dBm min, -90dBm typ
512 kbps	-87 dBm min, -90dBm typ

3.2 User Data Interface

Interface Types & Connectors	V.35, V.35/V.11: 34-pin Winchester (F) RS-232 (up to 112kbps), RS-422 and EIA-530: DB25 (F)
Handshake Lead Processing	DCE
DTE Clock mode settings	Clock Internal with Auto ST/TT clock select: The radio will automatically select the clock on the TT lead if one is present. Clock Internal–ST: internal clocking with the TT detection disabled. Clock DTE: external timing Clock Link: for receiving the timing across the RF link. The radio will automatically select the clock on the TT lead if one is present. Clock Link-ST: for receiving the timing across the RF link with TT detection disabled. Clock Local: same as clock DTE except the clock provided on TT is also used to clock receive data to the DTE
DTE Clock phase settings	The ST clock can be set to normal phase or inverted.
Data Rates	
64 kbps	Sync: 1.2, 2.4, 4.8, 9.6, 19.2, 56, 64 kbps
	Async: up to 19.2 kbps
128 kbps	Sync: 128 or 112 kbps
	Async: up to 56 kbps
256 kbps	Sync: 256 or 224 kbps
	Async: up to 115.2kbps
384 kbps	Sync: 384 or 336 kbps
	Async: at least 115.2kbps
512 kbps	Sync: 512 or 448 kbps
	Async: at least 115.2kbps
Transmission Delay	
64 kbps	7.7 ms end to end
128 kbps	6.4 ms end to end
256 kbps	5.7 ms end to end

384 kbps	7.4 ms end to end
512 kbps	5.8 ms end to end

3.3 Diagnostics

Indicators	LEDs for Power, Alarms, Sync, Error, Test, TXD and RXD, RTS, CTS
Loopback	Bi-directional local and far-end loopbacks which may be initialted by terminal command or V.54 command.
Monitor/Control	ADMIN Port allows local and remote access to alarm summary. Menu-driven user interface.
Alarm Contact Closures	Form A alarm contact closures for alarm
Local and Far End RSSI	From either end of the link, access the current RSSI readings on both ends of the link.
Transmit test	Constant transmit mode

3.4 Connectors

V.35, V.35/V.11:	34-pin Winchester, Female
RS-232, RS-422 and EIA-530:	DB25, Female
RF	Type N, 50 Ohm, Female
Burst Sync	RJ-48
ADMIN Port	
I/O Panel	RJ48
Non-I/O Panel	DB-9, Female
Alarm Contact Closures	DB-9, Female
AC Power	Standard three-prong, EIA-320
DC Power	Four-position terminal block
System Ground	Screw type stud
RSSI (Receive Signal Strength Indication)	Test Points on both sides

3.5 ADMIN Port

Interface	RS-232, Asynchronous, DCE wired
Port Speed	9.6 kbps
Data Format	8 bits, no parity, 1 stop bit
Flow Control	None
User Interface	ASCII Terminal menu interface

3.6 Power

AC Voltage	90 - 260 VAC
AC Frequency	47.5 to 66 Hz
AC Fuse Type	2.0 Amp
DC Voltage, -48 VDC	-21 to -60 VDC
DC Voltage, +24 VDC	21 to 60 VDC
Power Consumption	15 Watts Maximum

3.7 Environmental

Operational Temperature	0 to +50° C
Storage	-50 to +70° C
Humidity	0 to 95% Non-condensing
Altitude, Operational	220 ft (67 meters) below to 13,000 ft (4600 meters) above mean sea level

3.8 Mechanical

Width	17.2 in (43.7 cm)
Height	1.7 in (4.3 cm)
Depth	9.7 in (24.6 cm)
Weight	
Unit	7.8 pounds (3.5 kg)
Shipping	11 pounds (5 kg)
Mounting Configurations	Can be mounted with I/O connections facing toward the front or rear. Optional detachable rack or wall mount brackets.
Mounting Choices	Table-top mount, optional mounting kits available for 19-in (48 cm) rack or wall mounting.

4. System Planning

This section contains some general planning requirements and considerations for a quick and efficient installation of the **FIRELINK 2000** family of Spread Spectrum radios. It includes:

- Sample applications
- Antenna selection
- Path analysis
- Configuration settings.

4.1 Introduction

Installation and effectiveness of a radio link varies and is dependent on the following:

- Configuration settings
- Height and distances between the antennas
- Line-of-sight (LOS) clearance for the path
- RF cable losses
- The type of antenna used
- The climate and terrain

The following section offers several typical applications and guidelines for the successful implementation of the **FIRELINK 2000** radios. Configuration Worksheets are provided in Appendix B to assist in this process.

4.2 Application Examples

Spread Spectrum radios can be used in point-to-point, repeater and multi-link hub configurations. The following paragraphs provide typical examples of each of these applications.

4.2.1 Point-to-Point Voice and Data Application

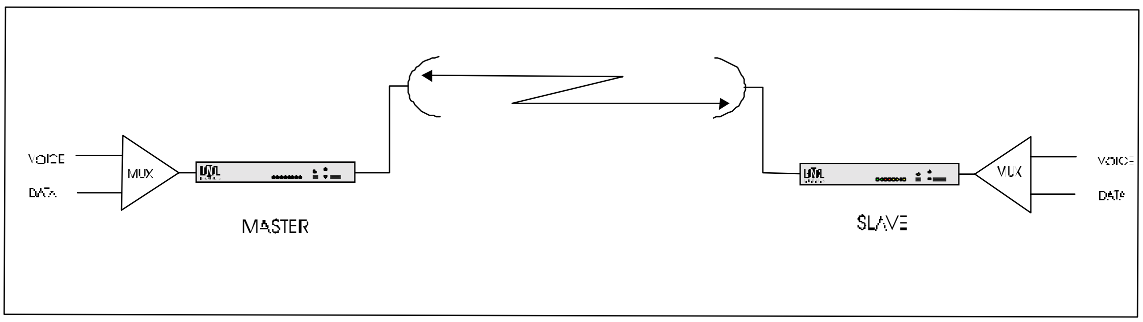


Figure 4–1. Point-to-Point Voice and Data Application

In Figure 4–1, the **FIRELINK 2000** 64 kbps radio link is used to link a remote office location via a **TDM** multiplexer to the main company facility.

Setting up the application involves only the setting of the radio parameters and cabling of the radios to the multiplexers and antennas.

The following table (Table 4-1) describes the parameters for this application.

Table 4-1. Configuration Parameters for Point-to-Point Voice and Data Application

Parameter	*Command*	*Description*
Transmit Power Level	**power** ***xx*** (xx is an even number from 0 to 28)	Typically, the maximum power legally allowed is recommended to begin installation. Once the link is optimized, the power setting should then be lowered until the receive power level is about 20 dB higher than the receiver threshold. Keeping this power as low as possible will maximize the channel reuse.
Channel Frequency	**chan** ***nn*** (nn is desired channel)	The two radios must be set to the same channel number. A Spectrum Analyzer can be used to determine which channels are not in use.
Master/Slave Burst Synchronization Timing	**mast/int** **mast/ext** **slave/int**	One radio is specified as Master and one as Slave. In single link point-to-point applications, it is not important which radio is set to Master or Slave. The Master radio transmits the first data burst. The Slave always transmits its burst in response to a received burst from the Master radio. The Master may configured for internal or external burst synchronization timing. The internal clock of the Master provides the burst sync timing signal (approximately 8.5 ms), while the Slave derives its burst synchronization from its received RF signal.
PN Sequence	**pnseq** ***n*** (n is pn seq number)	To reduce interference, a PN sequence must be specified on each radio. This PN sequence can be from 1 to 8 and must be set the same on each radio.
Data Rate	**nx64k** **nx56k** ***subrate***	Each radio type supports several data rates. For instance, the 24-64 or 23-64 radio can be set to 64, 56, 19.2, 9.6, 4.8, 2.4 or 1.2 kbps synchronous. The two radios must be set to the identical data rate. For this example, the data rate is 64 kbps.
Clock Source	**clkdte** **clkint** **clkintst** **clklink** **clklinkst** **clkloc**	One device in the link should provide timing for all other units. Typically in this type of application, one of the multiplexers is chosen as the timing source. The radios, as well as the other multiplexer, would take this timing. If the **MUX** on the left side of the diagram is chosen as the timing source (see on Figure 4–1) then the **FIRELINK 2000** radio on the left is configured for **DTE** (CLKDTE) timing. This causes it to take timing from its **DTE** interface. The **FIRELINK 2000** radio on the right side is configured for Link timing (CLKLink). This causes it to take its timing from the signal received over the radio link from the radio on the left. The **MUX** on the right is configured to take external timing from its **DTE** interface.

4.2.2 Point-to-Point Repeater Application

If the range is too great or there are obstacles in the line-of-sight path which cannot be overcome, installation of a repeater is the only solution, as shown in Figure 4–2. One or more repeater sites may be required, with each segment of the link set to a different frequency channel and PN sequence.

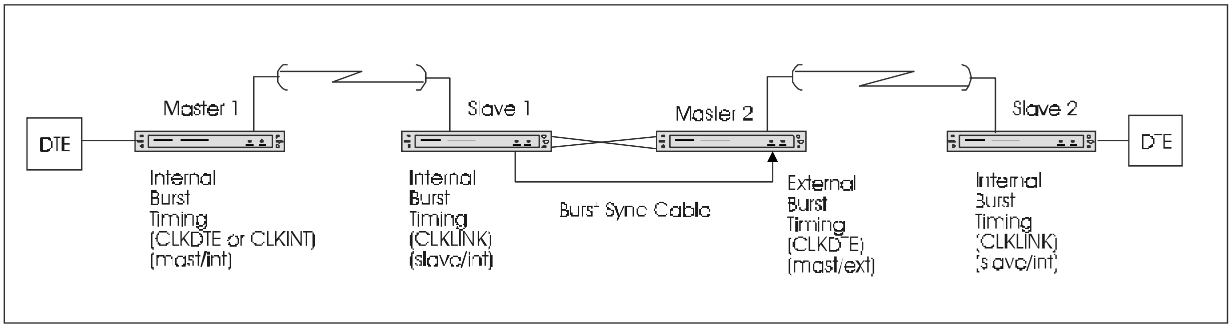


Figure 4–2. Point-to-Point Repeater Application

The **DTE** Master radio and first Slave radio are configured for internal burst timing. The repeater Slave then routes the **DTE** timing signals to the repeater Master, which is configured for external burst timing. Data is routed between the radios over a separate interconnect data cable, as shown in Table 4-2. Any of the cross-over cables described in Section 5.5.2 can be used. Any number of repeater sites can be used in a link.

Table 4-2. Repeater Data Interconnect Cable

Slave	**<-------------->**	***Master***
RT	<-------------->	TT
RD	<-------------->	TD
TT	<-------------->	RT
TD	<-------------->	RD
SGD	<-------------->	SGD
RTS (open)	<-------------->	RTS (open)

If more than one repeater site is used, the channel frequencies can be repeated. For example, the Master 1 to Slave 1 link might use channel 1 while the Master 2 to Slave 2 link uses channel 6. Due to the distance between the repeaters, if an additional repeater were used to extend the link past the Slave 2 site, it could use channel 1 again.

The antenna separation, **DTE** interface, and burst synchronization are all critical configuration considerations. The following table (Table 4-3) describes the parameters for this application.

Table 4-3. Configuration Parameters For Point-to-Point Repeater Application

Parameter	*Command*	*Description*
Transmit Power Level	**power** ***xx*** (xx is an even number from 0 to 28)	Typically, the maximum power legally allowed is recommended to begin installation. Once the link is optimized, the power setting should then be lowered until the receive power level is about 20 dB higher than the receiver threshold. Keeping this power as low as possible will maximize the channel reuse.
Channel Frequency	**chan** ***nn*** (nn is desired channel)	The channels selected will depend on the data rate for the radios. Channels can be repeated between some sites depending on the circumstances, but must be the same for each Master and Slave pair.
Master/Slave Burst Synchronization Timing	**mast/int** **mast/ext** **slave/int**	One radio is specified as Master and one as Slave, as shown in Figure 4–2. The Master radio #1 transmits the first data burst. The Slave #1 always transmits its burst in reaction to a received burst from the Master #1 radio. Master #2 will transmit its burst when commanded by the burst sync output of Slave #1. Slave #2 always transmits its burst in reaction to a received burst from the Master #2 radio. At the first site, the burst synchronization timing is derived from the internal clock of Master 1, while Slave 1 derives its burst synchronization from its received **RF** signal. At the repeater site, Slave 1 provides burst synchronization to Master 2 for the next link segment, as shown in Figure 4–2.
PN Sequence	**pnseq** ***n*** (n is pn seq number)	To reduce interference, a PN sequence must be specified on each radio. This can be from 1 to 8. The two radios in the Master/Slave pair must be set to the same PN sequence number. The two radios in the next repeater link segment should be set to a different PN sequence in order to get maximum protection against interference from the first link segment.
Data Rate	Automatically selected	The data rate selected for all radios in the link must be the same.
Clock Source	**clkdte** **clkint** **clkintst** **clklink** **clklinkst** **clkloc**	The clock source issues are the same as for the point-to-point case except at the repeater site. At the repeater site, the Master radio for the second link segment must be set for DTE (CLKDTE) timing in order to take timing from the Slave #1 radio on the left side of the diagram, as shown in . Both slave units are usually configured to receive clock timing over the RF link (CLKLINK).

4.2.3 Hub Application

This example will use 64 kbps **FIRELINK 2000** radios to connect the following devices at various remote locations to a host computer (see Figure 4–3) using three **FIRELINK 2000** links).

Table 4-4. Hub Application Example Devices

Workstation	Operating at 64 kbps sync with a V.11 (V.35) interface (approx. 10 km from Host Computer).
Printer	Operating at 9.6 kbps Sync, with a V.11 (V.35) interface (approx. 3 km from Host Computer).
Server	Operating at 56 kbps sync, with a V.35 interface (Server is approx. 15 km from the Host computer).

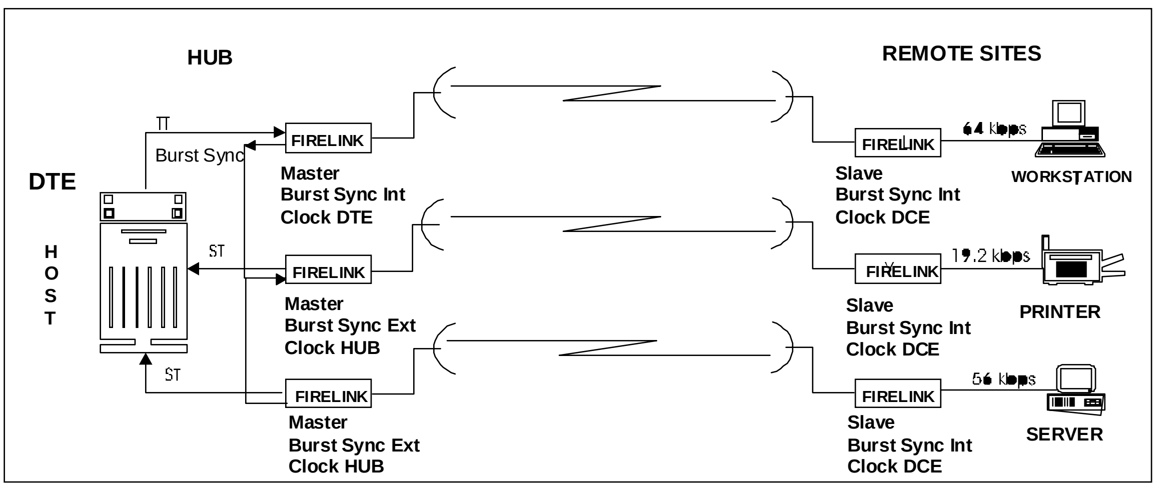


Figure 4–3. Hub Application Example (64 kbps radios)

A complete path study must be completed to determine proper antenna location and transmit power level for each link. Careful planning is required to achieve maximum isolation between each of the radio links at the hub site. This isolation is achieved using a combination of antenna isolation, transmit power level selection, channel frequency selection and PN sequence selection.

Antenna isolation is achieved by using larger, more directional antennas. Additional isolation can be achieved by using different antenna polarizations for links. Power levels should be set to the minimum level which provides the required 20 dB fade margin. Channel frequency and PN sequence selection should be based upon achieving maximum isolation between links which point in nearly the same direction.

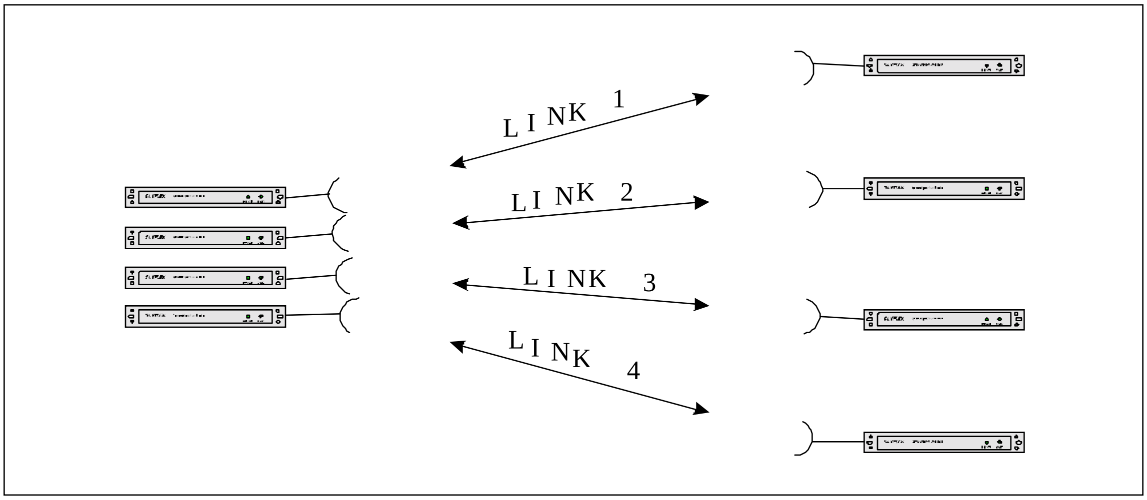


Figure 4–4. Hub Application Example

Figure 4–4 shows four links connected to a hub site. All four links are located in roughly the same direction from the hub. In this case the antenna polarization, the frequency channel and the PN code should be selected to provide maximum isolation between adjacent links.

Table 4-5 shows a set of good choices for these parameters:

Table 4-5. Hub Application Example Design Choices

Link 1	Horizontal Antenna Polarization Frequency Channel 1 PN Sequence #1
Link 2	Vertical Antenna Polarization Frequency Channel 4 PN Sequence #2
Link 3	Horizontal Antenna Polarization Frequency Channel 7 PN Sequence #3
Link 4	Vertical Antenna Polarization Frequency Channel 10 PN Sequence #4

The following table (Table 4-6) describes the unit setup for this application.

Table 4-6. Configuration Parameters for Hub Application

Parameter	Command	Description
Transmit Power Level	**power** ***xx*** (xx is an even number from 0 to 28)	Typically, the maximum power legally allowed is recommended to begin installation. Once the link is optimized, the power setting should then be lowered until the receive power level is about 20 dB higher than the receiver threshold. Keeping this power as low as possible will maximize the channel reuse. **In hub applications it is critical to use the minimum acceptable transmit power level.**
Channel Frequency	**chan** ***nn*** (nn is desired channel)	Each radio pair is assigned a unique channel to avoid interference.
Master/Slave Burst Synchronization Timing	**mast/int** **mast/ext** **slave/int**	In a hub configuration, the hub radios are set to Master. The radios at the remote sites are configured as Slave. In the hub configuration (more than one radio pair) it is critical that all the hub sites transmit and receive at the same time to minimize inter-channel interference. The burst sync ports of the hub radios must be daisy-chained together. One hub site radio is configured for internal burst timing (Mast/Int). All other hub site radios are configured for external burst timing (Mast/Ext) and synchronize their transmit bursts to the signal from the first radio. The Slave radios are configured for internal burst timing and derive their burst synchronization from their received **RF** signal.
PN Sequence	**pnseq** ***n*** (n is pn seq number)	Set the PN sequence number different for radio links which use the same (or close to the same) RF channel.
Data Rate	**nx56k** **nx64k** ***subrate***	In this application, shown in Figure 4–3, the workstation is operating at 64 kbps synchronous. The printer is operating at 9.6 kbps synchronous data rate using the 64 kbps radio. The Server is operating at 56 kbps synchronous using the 64 kbps radio. Please note: Some radio products have restrictions on the combinations of data rates used together at a hub site. The **FIRELINK 2000** eliminates these restrictions and allows radios with any data rates to operate from the same hub site. The **FIRELINK 2000** radios can also operate from hub sites using the **Skyplex I** 64kbps, 128 kbps, 256 kbps, 384 kbps and 512kbps radios and the **Skyplex SS** 64 kbps, 128 kbps and 256 kbps radios. See Section 4.6 for additional information.
Clock Source	**clkdte** **clkint** **clkintst** **clklink** **clklinkst** **clkloc**	The selection of clock source for the **FIRELINK 2000** radio is independent of hub operation. Any setting of clock source can be used.

4.3 Antenna Selection

The **FIRELINK 2000** radios should always be used with a directional parabolic or narrow lobe (less than 15 degrees) antenna. The following paragraphs describe typical considerations made in selecting the proper antenna, including the cable distances (see "Path Analysis" in Section 4.5 for more details concerning distances).

> **Important Note:** Antennas must be selected in compliance with local regulations and limitations on radiated power. The professional installer must be familiar the regulatory information at the front of this manual and is responsible for compliance with all local regulations.
>
> Omni-directional antennas should be avoided in all outdoor applications. They are susceptible to interference from signals from all directions and may create interference with other systems.

4.3.1 Parabolic, High Gain Antenna

When distances longer than one kilometer are required, it is best to use a parabolic, narrow lobe, directional antenna. Distances of up to 100 km (60 miles) can be accommodated with these antennas. The antenna size and gain for various antennas are provided in the **LNL** price list. Accurate antenna alignment is imperative to ensure an effective radio link. Please refer to the antenna manufacturer's manual for complete details.

Directional antennas are typically mounted on the roof of a building or a transmission tower and are connected to the radios with a coaxial **RF** cable.

4.4 RF Cable Selection

The **RF** cable is used to connect the radio to the antenna. The selection of the cable type is a trade-off between cost and **RF** signal loss. The path analysis calculations provide information concerning what loss can be tolerated. For shorter links, a higher loss cable such as LMR 400 can be used. For longer links, low loss cables such as ½ inch or $^{7}/_{8}$ inch Heliax are commonly used. The cable losses and pricing for various cable types are provided in the **LNL** price list.

4.5 Path Analysis

A path analysis must be performed to determine the following:

- Whether a particular link can provide the desired level of performance;
- What antenna and cable types must be used in order to achieve the desired performance;
- To insure the projected system performance, special attention should be paid to verifying Line of Sight (LOS), calculating the fade margin and determining the link availability. The following three sections discuss each of these issues. The last section discusses a series of spreadsheets that are available to automate these calculations.

The path analysis involves three steps:

1. Determine how high the antennas must be mounted in order to provide a clear LOS propagation path between the antennas
2. Determine if the various link power gains and losses will provide an adequate fading margin.
3. Determine if the fading margin is large enough to produce the desired level of availability (low enough outage time).

These calculations should be repeated while varying the radio power levels, antenna gains, cable losses and tower heights to obtain the desired availability at the lowest cost. If the calculations do not yield the desired availability, possible solutions include increasing the radio output power level, increasing the antenna size, or reducing the cable loss. If additional loss must be eliminated in order to meet the desired availability, it is generally less costly first to select better **RF** cable and then use a larger antenna.

4.5.1 LOS Verification

FIRELINK 2000 requires a direct LOS propagation path between the two antennas to provide the performance which the path analysis calculations predict. Although it is possible for very short links to operate without LOS, this approach is not commonly used. When performing LOS calculations, we must take into account the Fresnel Zone, the earth curvature and the height of any obstacle between the antennas.

4.5.1.1 Fresnel Zone

An obstacle which does not block the path but is close to the direct propagation path between the antennas can still cause degradation. There should be no obstacle blocking the imaginary ellipsoid surface (Fresnel Zone) that surrounds the straight line path between two antennas (Figure 4–5).

The objective is to keep the lower 0.6 Fresnel Zone in the clear to prevent echoes or multi-path from reducing the received signal. Multi-path is to wireless as "ghosting" is to TV. The lower part of the 0.6 Fresnel Zone is like a "sag" or widening of the radio beam at the middle of the path. The lower 0.6 Fresnel Zone, as well as the radio center line between the antennas, must clear all obstacles for best results. The formula for calculating the lower 1st Fresnel Zone is:

$$F1 = 72.1 \times \sqrt{\frac{d_1 \times d_2}{f \times D}}$$

where: $F1$=1st Fresnel Zone radius in feet, d_1=distance from first antenna in miles, d_2=distance from second antenna in miles, D=pathlength in miles, and f= frequency in GHz. Then 0.6F=(F1×0.6).

If using the metric system, the formula is:

$$F1 = 17.3 \times \sqrt{\frac{d_1 \times d_2}{f \times D}}$$

where: F1=1st Fresnel Zone radius in meters, d_1=distance from first antenna in kilometers, d_2=distance from second antenna in kilometers, D=path length in kilometers, and f= frequency in GHz.

4.5.1.2 Earth Curvature

This factor accounts for the curvature of the earth and atmospheric refraction. Typically, in transmissions of less than 16 km (10 miles) the earth bulge can be ignored. Refer to Figure 4–5 for the concept of earth curvature.

The midpoint clearance for earth curvature is approximately 13 feet (4m) for a 10 mile (16 km) path and approximately 200 feet (60m) for a 40 mile (65 km) path.

Clearance for earth curvature can be calculated for various “K” factors using the formula:

$$h = d_1 \times d_2 / 1.5 \times K$$

K is the equivalent earth radius and under normal atmospheric conditions, $K = 4/3$ to give:

$$h = (d_1 \times d_2)/2$$

where:

- h = change in vertical distance from a horizontal line (feet);
- d1 = distance from first antenna (miles);
- d2 = distance from second antenna (miles).

If using the metric system, the formula for earth curvature is:

$$h = d_1 \times d_2 / 12.75 \times K$$

where h is in meters and d_1 and d_2 are in kilometers

4.5.1.3 Minimum Height Calculation

The minimum antenna height to obtain a direct LOS, is determined by adding the height of any obstacle to 0.6 Fresnel Zone at that point and the earth curvature at that point. This calculation should be made for each significant obstacle along the path. Clearance for terrain can be determined from accurate topographic maps (the height of trees and/or buildings needs to be considered). Alternatively, the path can be surveyed along the direct route. There are also digital maps available for many parts of the world that have accurate information on terrain.

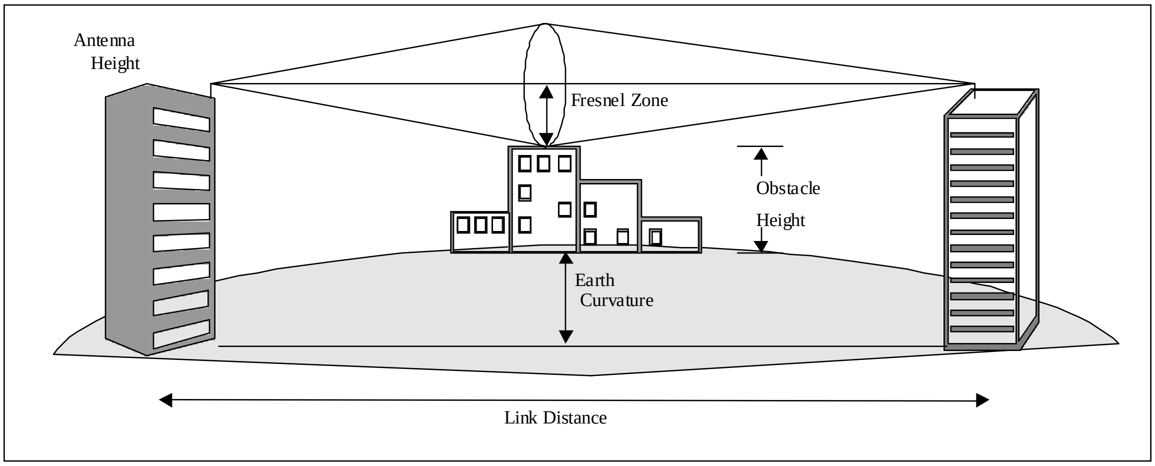


Figure 4–5. Determining Minimum Antenna Height for a direct LOS application

4.5.2 Determining the Fade Margin

To achieve reliable communication, the radio path must have a received signal level that will protect the path against reduction in signal due to multi-path fading and other anomalous propagation effects. This factor is called a fade margin.

The fade margin is a measure of how much signal attenuation the system can withstand without dropping below a minimum **BER** level. A fade margin higher than 15 dB is considered adequate, but anything above this will provide better protection against fading.

The fade margin is calculated by using the following formula:

$$\textbf{Fade Margin} = G_S + G_A - L_C - L_P$$

G_S is the total system gain, G_A is total antenna gain, L_C is the total connector/cable loss and L_P is the path loss (Figure 4–6). More fade margin can be obtained by increasing the radio output power level, increasing the antenna gain, using lower loss cable, or shortening the path between the antennas. The Path Analysis Spread Sheets discussed in Section 4.5.4 automate these calculations. A Configuration Worksheet is also provided in Appendix B to assist in calculating the fade margin.

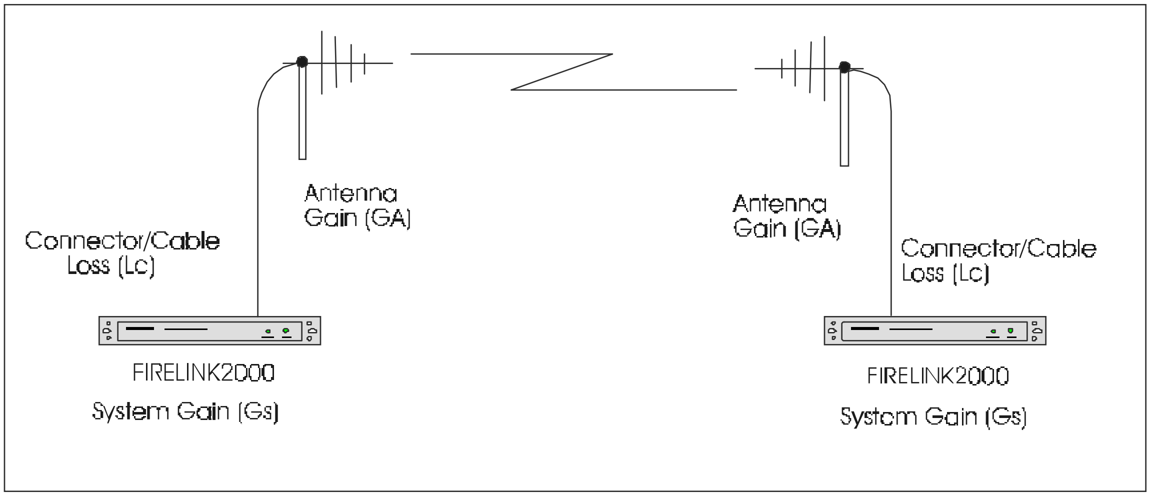


Figure 4–6. Fade Margin Calculation

4.5.2.1 System Gain

System gain is the minimum performance standard for any radio link. It is measured at the radio's output (not including any antenna gain).

Calculation of system gain is determined by using the following formula:

System Gain = Transmit Power - Receiver Sensitivity

System gain is presented in Table 4-7.

Table 4-7. System Gain

Radio Model	*Receiver Sensitivity*	*System Gain at +28 dBm*
24-64 or 23-64	– 95 dB	123 dB
24-128 or 23-128	– 92 dB	120 dB
24-256 or 23-256	– 89 dB	117 dB
24-384 or 23-384	– 87 dB	115 dB
24-512 or 23-512	– 87 dB	115 dB

4.5.2.2 Antenna Gain

Antenna gain indicates the antenna's ability to focus the radio's energy into a narrow beam and is measured in dBi. Both antennas on a link contribute to overall antenna gain.

4.5.2.3 Free Space Path Loss

The largest attenuation factor in a radio system is the loss of power as the signal travels through space. Path loss is determined by the distance between radios.

The formula for calculating the path loss attenuation is:

where:

$$PL(\text{dB}) = C + 20\log_{10} F + 20\log_{10} D$$

- C is 96.6 if D is in miles, and 92.45 if D is in kilometers
- F is the frequency in GHz

4.5.2.4 Cable/Connector Loss

The directional antenna is connected to the radio with a coaxial cable. Cable losses at 2.4 and 2.3 GHz can be very significant and are linear (in dB) in relation to the length of the RF cable used. The cable losses for various cable types are provided in the **LNL** price list.

4.5.2.5 Received Signal Strength Indicator (RSSI)

The received signal strength may be determined by either reading the value from the terminal or LCD screen, or by measuring a voltage provided on the RSSI test points located on both front panel of the radio. The value displayed on the terminal screen is shown in dBm and also includes the RSSI reading of the far end radio. The RSSI test points provide a voltage which is proportional to the received signal strength according to the table below.

Table 4-8. RSSI Output Voltage

Received Signal Level	***RSSI Voltage***
< – 95 dBm	0V
– 90 dBm	1.0V
– 80 dBm	3.0V
– 70 dBm	5.0V
– 60 dBm	7.0V
> – 58 dBm	7.4V

RSSI readings may be used during installation to align the antennas and to minimize the transmit power to obtain sufficient link margin. After installation, the **SAVEREF** command stores an RSSI reference value for later comparison of link margin.

4.5.3 Fading Outages and Availability

The formula for calculating the unavailability, *U*, of a path (due to multipath fading) is:

$$U = a \times b \times 2.5 \times 10^{-6} \times f \times D^3 \times 10^{-F/10}$$

where:

- a = climate factor (0.1 = Dry, 0.25 = temperate, 0.5 = Hot and Humid)
- b = terrain factor (0.25 = Mountainous, 1 = Average, 4 = Smooth)
- f = frequency in GHz
- D = path length in miles
- F = fade margin in dB

If D is measured in kilometers, then the formula is:

$$U = a \times b \times 6 \times 10^{-7} \times f \times D^3 \times 10^{-F/10}$$

The formula for calculating the availability, A, of a path is:

$$\mathrm{A} = (1 - \mathrm{U}) \times 100\%$$

where: U = unavailability

Table 4-9. Typical Objectives for Availability

Availability	*Outage per Day*	*Application*
99.9%	86 seconds	Typical Business Application
99.99%	8.6 seconds	High Reliability Business Application
99.999%	0.86 seconds	Critical Applications

4.5.4 Path Analysis Spread Sheets

The **FIRELINK 2000** link engineering calculations can be greatly simplified by using LNL provided spreadsheets for antenna pointing analysis, line of sight (LOS) path analysis and Link Budget analysis. These spread sheets are provided for Microsoft® Excel Version 5. Contact your distributor or **LNL** for copies of the spreadsheet files.

4.5.4.1 Path Profile Spreadsheet (PATHPRO.XLS)

The Path Profile spreadsheet is a Microsoft Excel version 5 spreadsheet used to determine how high the two antennas must be in order to have a clear LOS path between the two antennas, the distance between the sites, and the pointing angles of the antennas. You will need to enter the information into the Link Configuration section to get the antenna pointing and distance values. Then enter the Path Profile Data to get a path profile.

1. Enter the link information in the Link Configuration section on the left side of the spreadsheet.
2. The latitude and longitude for both sites (denoted as Hub and Remote) must be in decimal degrees. If the latitudes and longitudes are known only in degrees / minutes / seconds, enter them in the **CONVERT DEGREES / MINUTES / SECONDS TO DECIMAL DEGREES** section of the spreadsheet. Enter the computed decimal angle value in the appropriate field above. Be sure to use positive numbers for North latitudes and West longitudes and negative values for South latitudes and East latitudes.
3. Enter the elevation of the two sites in meters above mean sea level (AMSL).
4. Enter the antenna height in meters at each end of the link.

The Path Profile Data section on the right side of the spreadsheet is used to enter ground elevations and any obstructions along the path that must be considered in order to have a clear line of sight.

5. Enter the ground elevation at all the intervening points along the path. This data can be obtained from topographic maps.
6. Enter the blockage height of any obstruction (buildings, trees, etc.) along the path. The value entered should be the height above ground, in meters, of the obstruction.
7. When finished, select the 'Profile Chart' tab and print the profile.

The Profile Chart will have lines showing the Line of Sight (blue) and the lower 1st Fresnel zone (magenta). The 1st Fresnel zone must be clear of obstructions.

The three lower lines show the earth curvature (red dashed line), the normalized ground level elevations (brown dashed line), and the blockage profile (green line) taken from the path profile data entered.

If the blockage profile touches or crosses the 1st Fresnel Zone line, there will be a heavy red line showing the section of the path that is affected. In order to eliminate this line and make a clear line of sight, you must adjust the antenna heights on the Link Information tab, in step 4 above.

Note: The reason for leaving this zone clear simply is to make the path loss calculations accurate. If there is a small intrusion into the Fresnel Zone, the link may still work, but the path losses will be somewhat greater than what the Link Budget spreadsheet calculates. How much greater is difficult to determine, as it must take into account the amount that it intrudes into the zone, the reflectivity of the material, the shape and position of the object, whether the obstruction is stationary or moving, and several other *physical properties. These spreadsheets are not designed to take into account any of these factors.*

4.5.4.2 Link Budget Spreadsheet (LNLLINK.XLS)

The Link Budget spreadsheet is a Microsoft Excel version 5 spreadsheet used to determine the size of antenna, the type of RF cable and the required **RF** power level required to provide adequate performance.

1. Upon opening the spreadsheet, you are presented with a spreadsheet that has a button on it labeled “Configure Link Parameters”. Click this button with your mouse.
2. A dialog box comes up that looks like Figure 4-7. Enter all values, beginning with the Restrictions. This will set the default units for the other fields.
3. Enter the Path Length in miles or kilometers (this value can be obtained from the **PATHPRO** spreadsheet described above); select the units for the path length.
4. Enter the information data rate of the **FIRELINK 2000** link in kb/s.
5. Select the percentage of availability from the drop down list that better fits the application.
6. Select the Terrain Factor (Mountainous, Average, Flat or River Delta) from the drop down list.
7. Select the Climate Factor (Dry, Temperate or Hot and Humid) from the drop down list.
8. Enter the gain of the transmit antennas at both ends of the link. The Antenna Gain cell at the spreadsheet gives the gains of standard **LNL** antennas.
9. Select the output power level for both ends of the link from the drop down list.
10. Select the cable type and loss values for both ends of the link. The drop down list has the cable loss values for the cable provided by LNL. These values are in loss per meter.
11. Enter the cable length for both ends of the link. These lengths can be in either feet or meters. Select the units in which you are entering the lengths. The spreadsheet will convert the values to metric for calculation purposes.

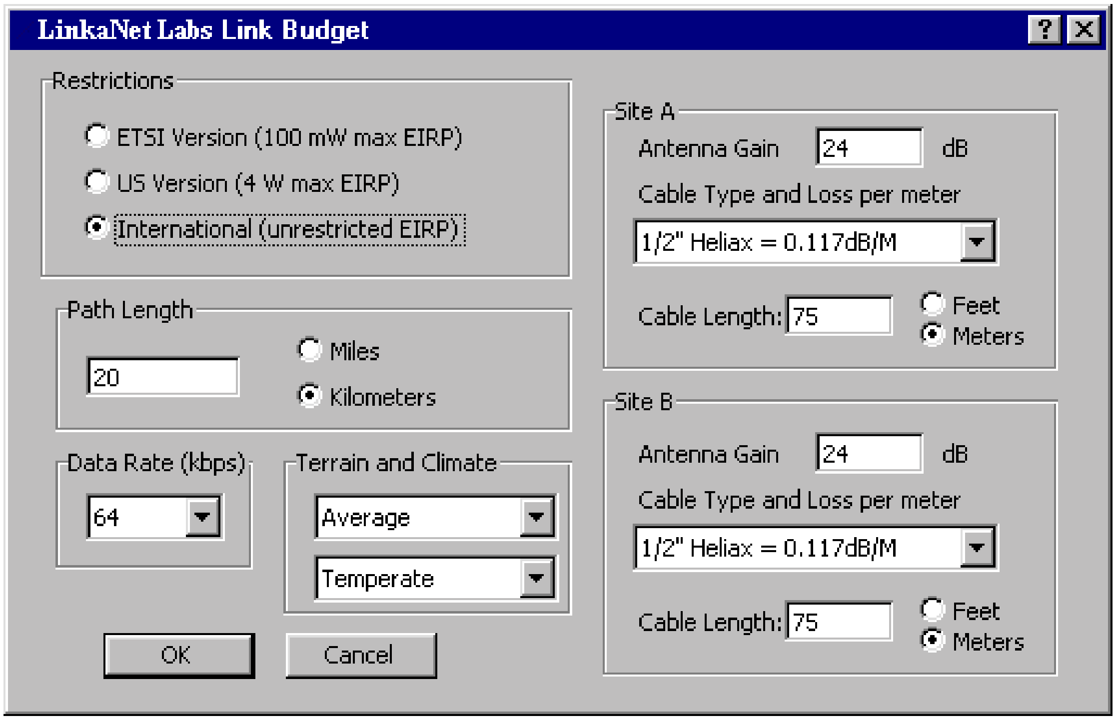


Figure 4–7

When you are finished, press the OK button and you will be taken back to the spreadsheet where you can see if the link budget is sufficient for your purposes. You will see two values indicated as "**FADE MARGIN**", one for Site A and one for Site B. The margin for each site should greater than 15dB, and displayed in green.

If your fade margins are in red (<15dB), you must change the size of the transmit or receive antenna, or select lower loss cables. If none of these methods provide adequate performance, an intermediate repeater site must be added to the link.

You may also elect to modify the availability of the link to meet the fade margins. Doing this will give you a less reliable link, but this may be an acceptable trade off for your application.

If the value in the Fade Margin field reads a negative value, then the power in the radio is calculated to be set below 0dB. This is not a valid setting for the **FIRELINK 2000**. To correct this, you must reduce the total gains for the link side in question. You can do this by using a lower gain antenna, increasing the cable length, or using a higher loss cable. If these methods are not sufficient, you must consider putting in a repeater site and using shorter hops.

4.6 Burst Sync Configuration Planning

The burst sync signal is used to minimize potential interference by synchronizing the transmission/reception burst intervals of all radios at a site. The **FIRELINK 2000** radios use a TDD modulation technique in which the radios alternately transmit and receive. Thus, there is a potential for interference in which one radio may be transmitting at the same time another is receiving. In addition, the radios operate in the same general band and the transmit power is very high relative to the receive power. Thus, there is a potential for interference even though the two radios in question are operating on different RF channels. This problem is avoided by using the burst sync signal to cause all radios at a site to transmit at the same time.

The burst sync distribution architecture is shown in Figure 4–8.

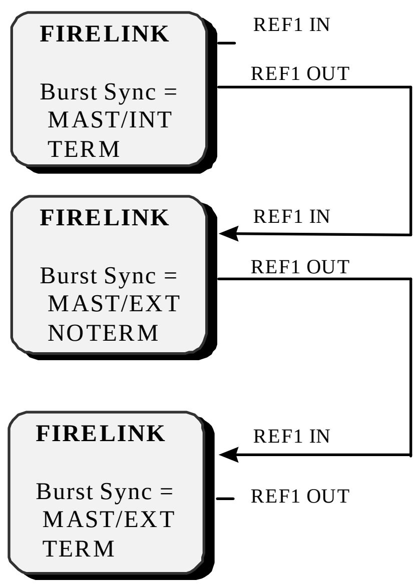


Figure 4–8. Burst Sync Distribution Architecture

The radio which is configured as burst sync Master/Internal will transmit a burst sync signal on its BURST SYNC OUT output. All radios at the site will use this signal for burst synchronization. All radios configured as burst sync Master/External will normally take burst sync from the BURST SYNC IN input. The last radio in the chain is configured to terminate the burst sync cable.

The Burst Sync signal uses RS-485 electronics which allows up to 30 radios to be driven from one radio. If more than 30 radios must be connected at a site, an RS-485 driver can be added in line.

> **Note:** If a unit is configured as Burst Sync External and BURST SYNC IN signal fails, a major alarm will be generated and the radio will stop transmitting.

4.6.1 Burst Sync Operation with other Radios

Burst sync distribution is affected when the **FIRELINK 2000** radios are used at a site with old **SKYPLEX** radios. The **FIRELINK 2000** radio can provide or accept the burst sync signal to or from the **SKYPLEX I** radio by using the BSRJ45 command**.** The **FIRELINK 2000** radio cannot provide a burst sync signal to the older **SKYPLEX SS** radio. If both **FIRELINK 2000** and **SKYPLEX SS** radios are used at a common site, one of the older **SKYPLEX SS** radios must be selected to provide burst sync to all other radios at the site.

The burst sync output signal from the old **SKYPLEX SS** radio uses RS-232 electronics, but the **FIRELINK 2000** and **SKYPLEX I** radios use RS-485 which can drive longer cables. An RS-232 to RS-485 converter will be required to convert the RS-232 burst sync output from the **SKYPLEX SS** radio into the RS-485 burst sync input on the **FIRELINK 2000** as shown in Figure 4–9. An RS-232 to RS-485 converter assembly is available in your LNL price list. The last radio in the chain is configured to terminate the burst sync cable.

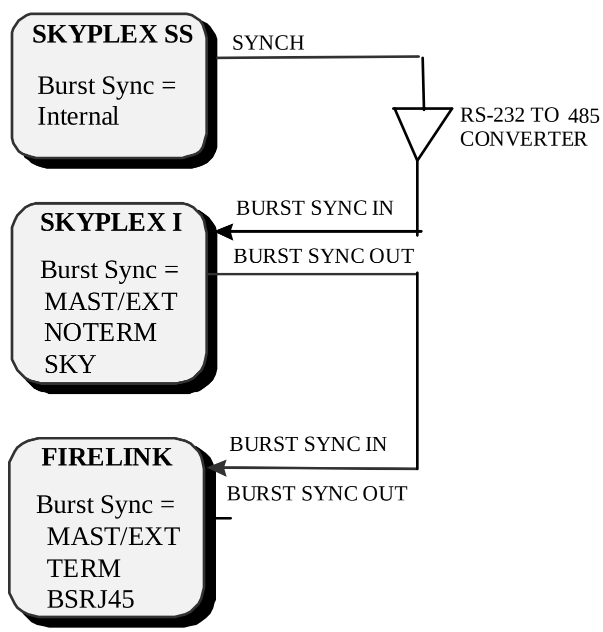


Figure 4–9. Burst Sync Distribution using SKYPLEX SS, SKYPLEX I, and FIRELINK 2000 Radios

4.7 Configuration Setting Planning

This section describes the configuration parameters and provides guidance for making the settings. It is recommended that the planning engineer should fill out a planning worksheet from Appendix B and note down the desired parameter settings. Section 5, Installation and Setup, describes the configuration screens.

4.7.1 Transmit Power Selection

The radio transmit power can be set to any even number value from 0 dBm to +28 dBm, and typically, the maximum power legally allowed is recommended to begin installation. Once the link is optimized, the power setting should then be lowered until the receive power level is about 20 dB higher than the receiver threshold. Keeping this power as low as possible will maximize the channel reuse. In hub applications it is critical to use the minimum acceptable transmit power level.

The transmit power level must always be set to comply with the governmental regulations of the country of installation. This equipment is intended to be professionally installed and it is the responsibility of the installer to ensure the system configuration is in compliance with these regulations. Trained professional microwave radio installers should refer to the Regulatory Notices in the front of this manual for additional compliance information.

4.7.2 RF Channel Selection

The **FIRELINK 2000** frequency bands are divided into channels. The frequency assigned to each channel varies according to the version of the radio selected. The channel spacing varies with the bit rate and is designed to enable compatible channels plans across all data rates. Channel spacing ranges from 5 MHz for the 64 kbps radios to 30 MHz for the 384 and 512 kbps radios. All channel plan frequencies are designed to allow maximum flexibility for the user and to ensure that all channel plans are compatible from 64kbps up to 512kbps.

The available radio versions include: Standard, FCC, 2.3GHz, ETSI, Mexican and French models. Each of these models account for restricted channel access for various countries where the product is installed. For other countries which have similar restrictions, contact **LNL** to determine which version best fits the application.

Experienced users should note that it may be possible to use many of the alternate channels if sufficient isolation can be provided between channels. This isolation can be provided be using the PN sequence, antenna polarization and directionality, and channel assignment, but results will be dependent on each installation.

4.7.2.1 RF Channels - "S" Model Radios

The **FIRELINK 2000** frequency band of the "S" model radios extends from 2.400 GHz to 2.4835 GHz and channel location is consistent with international standards. It is divided into channels spaced as shown in the following table.

Table 4-10. "S" Model Radio RF Channel Spacings and Center Frequencies

Channel Number	*24-64S (5 MHz)*	*24-128S (10 MHz)*	*24-256S (20 MHz)*	*24-384S (30 MHz)*	*24-512S (30 MHz)*
0	2403.500				
1	2408.500	2406.000	2411.000 A	2421.000 A*	2421.000 A*
2	2413.500	2416.000	2421.000 B	2431.000 B	2431.000 B
3	2418.500	2426.000	2431.000 A	2441.000 C*	2441.000 C*
4	2423.500	2436.000	2441.000 B	2451.000 A	2451.000 A
5	2428.500	2446.000	2451.000 A	2461.000 B*	2461.000 B*
6	2433.500	2456.000	2461.000 B		
7	2438.500	2466.000	2471.000 A		
8	2443.500	2476.000			
9	2448.500				
10	2453.500				
11	2458.500				
12	2463.500				
13	2468.500				
14	2473.500				
15	2478.500				

* may be used simultaneously if channel isolation is sufficient in field application

The 64S radio has 16 non-overlapping channels and the 128S has 8 non-overlapping channels. All other radios have some channels which overlap with others. The overlapping channels are provided to give the system designer flexibility in making channel assignments to avoid interfering signals. Several channel sets may be used without overlap as shown by the letter designations.

In some cases, the use of spatial diversity and polarization may permit channels to be spaced closer than the recommended channel spacing.

Note that these channels are generally compatible with previously installed **SKYPLEX I** and **SKYPLEX SS** systems and that the 64S channel plan has been modifed to add channel 0.

Table 4-11. RF Channel Availability

Radio Type	*Total Number of Channels Available*	*Number of Non-Overlapping Channels*
64S	16	16
128S	8	8
256S	7	4
384S	5	2
512S	5	2

Each radio pair must be configured with the same channel. Channel spacing equal or exceeding the values shown will optimize performance. In some cases the use of spatial diversity and polarization may permit channels to be spaced closer that the recommended channel spacing, but overlapping channels in a hub configuration is not recommended unless channel interference can be controlled.

4.7.2.2 RF Channels - "FCC" Model Radios

The **FIRELINK 2000** frequency band of the "FCC" model radios extends from 2.400 GHz to 2.4835 GHz and channel location is consistent with US FCC standards. It is divided into channels spaced as shown in the table below.

Table 4-12. "FCC" Model Radio RF Channel Spacing and Center Frequencies

Channel Number	*24-64FCC (5 MHz)*	*24-128FCC (10 MHz)*	*24-256FCC (20 MHz)*	*24-384FCC (30 MHz)*	*24-512FCC (30 MHz)*
0	2403.500	-	-	-	-
1	2408.500	2406.000	2411.000 A	2421.000 A*	2421.000 A*
2	2413.500	2416.000	2421.000 B	2431.000 B	2431.000 B
3	2418.500	2426.000	2431.000 A	2441.000 C*	2441.000 C*
4	2423.500	2436.000	2441.000 B	2451.000 A	2451.000 A
5	2428.500	2446.000	2451.000 A	2458.000 B*	2458.000 B*
6	2433.500	2456.000	2461.000 B		
7	2438.500	2466.000	2468.000 A		
8	2443.500	2474.500			
9	2448.500				
10	2453.500				
11	2458.500				
12	2463.500				
13	2468.500				
14	2473.500				

* may be used simultaneously if channel isolation is sufficient in field application

The 64FCC radio has 15 non-overlapping channels and the 128FCC has 8 non-overlapping channels. All other radios have some channels which overlap with others. The overlapping channels are provided to give the system designer flexibility in making channel assignments to avoid interfering signals. Several channel sets may be used without overlap as shown by the letter designations. In some cases, the use of spatial diversity and polarization may permit channels to be spaced closer that the recommended channel spacing.

Note that these channels are generally compatible with previously installed **SKYPLEX I** and **SKYPLEX SS** systems and the 64FCC channel plan has been modifed to add channel 0 and delete channel 15.

Table 4-13. RF Channel Availability

Radio Type	Total Number of Channels Available	Number of Non-Overlapping Channels
64FCC	15	15
128FCC	8	8
256FCC	7	4
384FCC	5	2
512FCC	5	2

Each radio pair must be configured with the same channel. Channel spacing equal or exceeding the values shown will optimize performance. In some cases the use of spatial diversity and polarization may permit channels to be spaced closer that the recommended channel spacing, but overlapping channels in a hub configuration is not recommended unless channel interference can be controlled.

4.7.2.3 RF Channels - "2.3" Model Radios

The **FIRELINK 2000** frequency band of the "2.3" model radios extends from 2.300 GHz to 2.400 GHz. It is divided into channels spaced as shown in the table below.

Table 4-14. "2.3" Model Radio RF Channel Spacing and Center Frequencies

Channel Number	*23-64 (5 MHz)*	*23-128 (10 MHz)*	*23-256 (20 MHz)*	*23-384 (30 MHz)*	*23-512 (30 MHz)*
1	2304.500	2307.000	2312.000 A	2322.000 A*	2322.000 A*
2	2309.500	2317.000	2322.000 B	2332.000 B	2332.000 B
3	2314.500	2327.000	2332.000 A	2342.000 C*	2342.000 C*
4	2319.500	2337.000	2342.000 B	2352.000 A	2352.000 A
5	2324.500	2347.000	2352.000 A	2362.000 B*	2362.000 B*
6	2329.500	2357.000	2362.000 B	2372.000 C	2372.000 C
7	2334.500	2367.000	2372.000 A	2382.000 A*	2382.000 A*
8	2339.500	2377.000	2382.000 B		
9	2344.500	2387.000	2392.000 A		
10	2349.500	2397.000			
11	2354.500				
12	2359.500				
13	2364.500				
14	2369.500				
15	2374.500				
16	2379.500				
17	2384.500				
18	2389.500				
19	2394.500				

* may be used simultaneously if channel isolation is sufficient in field application

The 23-64 radio has 19 non-overlapping channels. All other radios have some channels which overlap. The overlapping channels are provided to give the system designer flexibility in making channel assignments to avoid interfering signals. Several channel sets may be used without overlap as shown by the letter designations. In some cases, the use of spatial diversity and polarization may permit channels to be spaced closer that the recommended channel spacing.

Note that all channels are compatible with previously installed **SKYPLEX I** systems.

Table 4-15. RF Channel Availability

Radio Type	Total Number of Channels Available	Number of Non-Overlapping Channels
23-64	19	19
23-128	10	10
23-256	9	5
23-384	7	3
23-512	7	3

Each radio pair must be configured with the same channel. Channel spacing equal or exceeding the values shown will optimize performance. In some cases the use of spatial diversity and polarization may permit channels to be spaced closer that the recommended channel spacing, but overlapping channels in a hub configuration is not recommended unless channel interference can be controlled.

4.7.2.4 RF Channels - ETSI Model Radios

The **FIRELINK 2000** frequency band of the "E" model radios extends from 2.400 GHz to 2.4835 GHz and channel location and power level is consistent with ETSI standards. It is divided into channels spaced as shown in the table below.

Table 4-16. ETSI Model Radio RF Channel Spacing and Center Frequencies

Channel Number	*24-64E (5 MHz)*	*24-128E (10 MHz)*	*24-256E (20 MHz)*	*24-384E (30 MHz)*	*24-512E (30 MHz)*
0	2403.500	-	-	-	-
1	2408.500	2406.000	2411.000 A	2421.000 A*	2421.000 A*
2	2413.500	2416.000	2421.000 B	2431.000 B	2431.000 B
3	2418.500	2426.000	2431.000 A	2441.000 C*	2441.000 C*
4	2423.500	2436.000	2441.000 B	2451.000 A	2451.000 A
5	2428.500	2446.000	2451.000 A	2461.000 B*	2461.000 B*
6	2433.500	2456.000	2461.000 B		
7	2438.500	2466.000	2471.000 A		
8	2443.500	2476.000			
9	2448.500				
10	2453.500				
11	2458.500				
12	2463.500				
13	2468.500				
14	2473.500				
15	2478.500				

* may be used simultaneously if channel isolation is sufficient in field application

The 64E has 16 non-overlapping channels and the 128E radio has 8 non-overlapping channels. All other radios have some channels which overlap with others. The overlapping channels are provided to give the system designer flexibility in making channel assignments to avoid interfering signals. Several channel sets may be used without overlap as shown by the letter designations. In some cases, the use of spatial diversity and polarization may permit channels to be spaced closer that the recommended channel spacing.

Table 4-17. RF Channel Availability

Radio Type	Total Number of Channels Available	Number of Non-Overlapping Channels
64E	16	16
128E	8	8
256E	7	4
384E	5	2
512E	5	2

Each radio pair must be configured with the same channel. Channel spacing equal or exceeding the values shown will optimize performance. In some cases the use of spatial diversity and polarization may permit channels to be spaced closer that the recommended channel spacing, but overlapping channels in a hub configuration is not recommended unless channel interference can be controlled.

4.7.2.5 RF Channels - Mexican Model

The version of the **FIRELINK 2000** radios designed for sale in Mexico have the RF channels limited to comply with the narrower spread spectrum band of 2.450 to 2.4835 GHz used in Mexico. The table below provides the desired RF channel spacing and center frequencies for the Mexican radios.

Table 4-18. Mexican Model Radio RF Channel Spacing and Center Frequencies

Channel Number	24-64M (5 MHz)	24-128M (10 MHz)	24-256M (20 MHz)	24-384M (30 MHz)	24-512M (30 MHz)
1	2453.500	2456.000 A	2456.000 A	2461.000 A*	2461.000 A*
2	2458.500	2461.000 B	2461.000 B	2466.000 B	2466.000 B
3	2463.500	2466.000 A	2466.000 C	2471.000 C *	2471.000 C *
4	2468.500	2471.000 B	2471.000 D		
5	2473.500	2476.000 A	2476.000 A		
6	2478.500				

* may be used simultaneously if channel isolation is sufficient in field application

The 64M has 6 non-overlapping channels. All other rate radios have some channels which overlap with others. The overlapping channels are provided to give the system designer flexibility in making channel assignments to avoid interfering signals. Several channel sets may be used without overlap as shown by the letter designations. In some cases, the use of spatial diversity and polarization may permit channels to be spaced closer that the recommended channel spacing.

4.7.2.6 RF Channels - French Model

The version of the **FIRELINK 2000** radios designed for sale in France have the RF channels limited to comply with the narrower spread spectrum band of 2.446 to 2.4835 GHz used in France. The table below provides the desired RF channel spacing and center frequencies for the French radios.

Table 4-19. French Model Radio RF Channel Bandwidths and Center Frequencies

Channel Number	*24-64F (5 MHz)*	*24-128F (10 MHz)*	*24-256F (20 MHz)*	*24-384F (30 MHz)*	*24-512F (30 MHz)*
1	2453.500	2456.000 A	2456.000 A	2461.000 A	2461.000 A
2	2458.500	2461.000 B	2461.000 B	2466.000 B	2466.000 B
3	2463.500	2466.000 A	2466.000 C		
4	2468.500	2471.000 B	2471.000 D		
5	2473.500	2476.000 A			
6	2478.500				

The 64F has 6 non-overlapping channels. All other radios have some channels which overlap with others. The overlapping channels are provided to give the system designer flexibility in making channel assignments to avoid interfering signals. Several channel sets may be used without overlap as shown by the letter designations. In some cases, the use of spatial diversity and polarization may permit channels to be spaced closer that the recommended channel spacing.

4.7.3 PN Sequence Selection

This parameter selects one of 8 direct sequence pseudo-random noise (**PN**) spreading codes for the radio. The radio pair (Master and Slave) must be configured for the same **PN** sequence. The radio uses the **PN** sequence to provide direct sequence spreading gain and these 8 optimized PN sequences provide the best channel isolation and maximize interference rejection. The performance enhancements of these sequences are used in conjunction with RF channelization to improve reception in all environments. Different links in a hub configuration should use different **PN** sequences.

4.7.4 Data Rate Selection

The user can select the **DTE** interface data rate at which the radio operates (Table 4-20). The options vary depending upon the type of radio. Asynchronous inputs are supported by oversampling or by using an external Async to Sync converter.

Table 4-20. Data Rate Selection Parameters

Radio Type	*Date Rates Available*	*Default*
64S	Synchronous: 64, 56, 19.2, 9.6, 4.8, 2.4, or 1.2 kbps Asynchronous: up to 19.2 kbps	64 kbps
128S	Synchronous: 128 or 112 kbps Asynchronous: up to 56 kbps	128 kbps
256S	Synchronous: 256 or 224 kbps Asynchronous: up to 115.2 kbps	256 kbps
384S	Synchronous: 384 or 336 kbps Asynchronous: up to 115.2 kbps	384 kbps
512S	Synchronous: 512 kbps Asynchronous: up to 115.2 kbps	512 kbps

4.7.5 DTE Interface Type Selection

This selection determines the active **DTE** interface connector and the interface type. If either V.35/V.11 or Old V.35 is selected, the M34 (Winchester) connector is active. If the RS-422, RS-232 or EIA-530 interface is selected, the 25-pin D connector is active. The RS-232 interface is available only for the 24-64 and 23-64 radios.

The selection of interface type is based upon the interface available on the **DTE** unit. The only unusual issue is whether to choose V.35/V.11 or the old V.35 interface for V.35 **DTE** devices.

Since low amplitude (0.5V) limits the range of the old V35 interface, the V.35/V.11 interface is recommended for all applications. This is the new interface which the **ITU** selected to replace the old V.35.

The V.35/V.11 interface provides significantly improved performance and is completely compatible with the old V.35 interface. It can be used with **DTE** units having the old V.35 interface or the newer V.11 line drivers and receivers. Almost all new devices which have V.35 interfaces actually have this type.

4.7.6 System Timing Selection

This parameter determines the source of bit timing for the **DTE** interfaces. The user can choose to take transmit timing from one of the following:

- The **DTE** interface (CLKDTE).
- An internal oscillator (CLKINT) with automatic TT detection on the DTE interface. If no TT transitions are detected, ST timing will be used.
- An internal oscillator (CLKINTST) using ST timing on the DTE interface.
- The radio at the far end of the link (CLKLINK) with automatic TT detection on the DTE interface. If no TT transitions are detected, ST timing will be used.
- The radio at the far end of the link (CLKLINKST) using ST timing on the DTE interface.
- Local clock (CLKLOC) is a special mode in which both transmit and receive timing are taken from the **DTE** interface.

Each link should be configured with one source of timing for all other devices in the link. Typically timing is taken from the public network via a **PBX** or a **MUX**. In applications like simple LAN interconnection using routers, one of the radios can be selected as the timing source using its internal clock, with the routers and other radio set to take timing from the first radio.

Table 4-21. Bit-Timing Sources for User Data Interfaces

DTE ***(CLKDTE)***	In this case, the signal applied on the Terminal Timing (TT) lead is used to clock the data from the **DTE** into the **FIRELINK 2000** transmit buffer. The clock recovered from the received RF signal is used to transfer data from the radio to the **DTE**. **Note**: When the radio is set for **DTE** clock and there is no clock signal present on the TT lead an Alarm will be declared.
Internal ***(CLKINT)***	The **FIRELINK 2000** uses its internal clock to transfer the data into its transmit buffer. If the Terminal Timing (TT) signal is routed back from the **DTE** device, it is automatically used to avoid any clock skewing due to cable lengths. If the TT signal is not present, the radio will use the Send Timing (ST) signal to clock the **DTE** transmit interface. The clock recovered from the received RF signal is used to transfer data from the radio to the **DTE**.
Internal ***(CLKINTST)***	The **FIRELINK 2000** uses its internal clock to transfer the data into its transmit buffer. This mode does not detect Terminal Timing (TT) and always uses the Send Timing (ST) signal to clock the **DTE** transmit interface. The clock recovered from the received RF signal is used to transfer data from the radio to the **DTE**.
Link Receive Clock ***(CLKLINK)***	This selection uses the clock received over the link from the far end radio to transfer data into its transmit buffer. If the Terminal Timing (TT) signal is routed back from the **DTE** device, it is automatically used to avoid any clock skewing due to cable lengths. If the TT signal is not present, the radio will use the Send Timing (ST) signal to clock the **DTE** transmit interface. The clock recovered from the received **RF** signal is used to transfer data from the radio to the **DTE**.
Link Receive Clock ***(CLKLINKST)***	This selection uses the clock received over the link from the far end radio to transfer data into its transmit buffer. This mode does not detect Terminal Timing (TT) and always uses the Send Timing (ST) signal to clock the **DTE** transmit interface. The clock recovered from the received **RF** signal is used to transfer data from the radio to the **DTE.**
Local Clock ***(CLKLOC)***	This is a slight variation from **DTE** timing. In this case the signal applied on the Terminal Timing (TT) lead is used to clock the data from the **DTE** into the **FIRELINK 2000** transmit buffer and to transfer data from the radio to the **DTE**. There are some models of multiplexers and other devices which require this setting in order to avoid occasional bit errors at the **DTE** interface.

There are several significant design enhancements in the **FIRELINK 2000** clock processing. Some older radio products permitted only master radios or hub radios use **DTE** timing and all radios at a hub site take timing from the same source. These restrictions have been eliminated.

Table 4-22. System Timing Selections for Typical Applications

Application	*Recommended System Timing Configuration*
Dedicated LAN to LAN Connections	Many **DTE** devices such as routers and bridges can either provide timing or use timing from the **DTE** interface. These devices are normally set up to take timing from their **DTE** interface. In this case, the routers or bridges would be set for external timing. One **FIRELINK 2000** radio is selected to provide timing for all other devices. This radio is set to internal clock (CLKINT). The other radio should be set for Link Clock (CLKLINK) which uses the clock recovered from the received **RF** signal. Some models of routers and bridges can provide timing from an internal clock. If one of the routers is the source of system timing, the routers and radios should be configured in the fashion described below for multiplexers.
Video Conferencing	Video teleconferencing units usually require an external bit timing clock. In this application, one **FIRELINK 2000** radio is selected to provide timing for all other devices. This radio is set to internal clock (CLKINT). The other radio should be set for Link Clock (CLKLINK), which uses the clock recovered from the received RF signal.
Multiplexers or PBX	When the radio is connected to a multiplexer, one of the multiplexers is normally the source of timing. In this case, the radio connected to the multiplexer that is the source of timing should be set for **DTE** timing (CLKDTE). The far end radio should be set for Link Clock (CLKLINK), which uses the clock recovered from the received **RF** signal. The **DTE** unit connected to the far end radio is normally configured to take timing from its **DTE** interface.

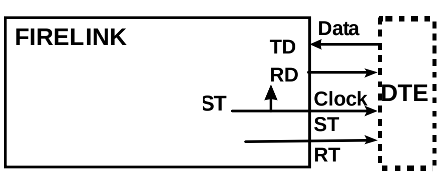
4.7.6.1 TT and ST Clock Phase Selection

FIRELINK 2000 supports both **ST** and **TT** clocking with or without automatic selection of **TT** clock. **ST** and **TT** clocks are standard methods of clocking data between the **DCE** and **DTE** devices. If the user desires to use **ST** clocking, the configuration screen can be used to select normal (STNORM) or inverted (STINV) **ST** clock. If the **FIRELINK 2000** is in CLKINT or CLKLINK mode and detects a clock on the TT lead, it automatically selects this clock to load transmit data into its transmit buffer. Using the CLKINTST or CLKLINKST modes will disable the automatic switching and always use the **ST** signal for clocking data into the radio, even if a TT signal is present. Receive Timing (**RT**) is always used to clock the receive data unless the radio is in CLKLOC mode.

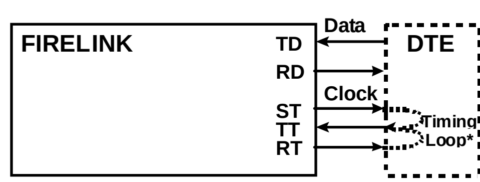
ST clocking, the older method, is supported by all **DTE** devices and can be selected by using the CLKINTST or CLKLINKST modes. It is not recommended if **TT** clock is available. Figure 4–10a shows how **ST** clocking works. The **DCE** device generates the **RT** clock and uses it to clock data (RD) toward the **DTE**. Both the **RT** lead and **RD** lead are passed to the **DTE**. The **DTE** is expected to use the **RT** clock to clock the data out in the other direction (**TD**). The **DCE** device uses the **ST** clock (which is the same as **RT**) to load the data from the **DTE** device into the **FIRELINK 2000** transmit buffer.

ST clocking is based upon the assumption that there is very little delay between when the **ST** clock changes state and the new **TD** data bit arrives at the **DCE**. As the cable length or the delay in the **DTE** increases, this assumption may no longer be valid and the **TD** data may arrive at the **DCE** device at the same time that the **ST** clock is changing states. This is particularly true for higher data rates. It is also possible to have an interface that works well at installation but starts making errors as the temperature and delays change. If ST timing must be used and bit errors are occurring at the interface, the user can solve the problem by selecting inverted **ST** clock phasing on the configuration screen.

TT Clocking is the recommended method if it is supported by the DTE equipment. Figure 4–10b shows how it works. In this case the **DTE** device returns the **ST**(or **RT**) clock to the **DCE** device over the **TT** lead. The advantage of this method is that the clock goes over the same cable as the data and therefore has the same delay. The user can choose **TT** clocking by simply connecting the **TT** wire in the interface cable and selecting CLKINT or CLKLINK mode. The **FIRELINK 2000** radio will automatically use the **TT** clock if it detects transitions on the **TT** lead.



4-10a ST Timing



* Loop with *either* ST or RT as TT

4-10b TT Timing

Figure 4–10. Clock Phase Examples

4.7.7 Radio Burst Coordination Parameters

Three parameters are used to cause the data bursts of the radios to occur at the proper time. The link burst sync master choice affects burst coordination between the two radios in a particular link. The burst sync source affects burst coordination between all radios at a particular hub site. The burst sync cable termination provides proper signal termination on the cable used at hub sites for burst sync timing distribution.

Section 4.6 discusses important planning issues for burst sync coordination.

4.7.7.1 Link Burst Sync Mode and Burst Sync Source

The **FIRELINK 2000** radio uses time division duplexing (TDD) method of duplex operation. This means that the radio alternates between transmitting and receiving bursts of data. It is necessary to coordinate the burst times between the two radios in a particular link. This is done by designating one radio to be a Master unit and the other a Slave unit with respect to burst control.

The Master radio transmits continuous bursts while the Slave transmits only in response to a received burst from the Master. For every link, one radio must be configured as a *Master* and the other as a *Slave*. For point-to-point applications the selection of which radio is Master and which is Slave is arbitrary. The hub radios in a hub network must all be Masters and the radios at the remote sites must all be Slaves. See Section 4.2.2 for information concerning this setting for the repeater application.

If two radios are located at the same site (hub and repeater applications), it is important that the radios should transmit at the same time in order to eliminate interference between the radios at that site. This parameter determines the timing used to synchronize the communication bursts. The burst synchronization can be set to either *internal burst timing* or *external burst timing*.

One radio at the hub site should be selected to provide burst sync timing to the other radios at the hub site. This radio is set to internal burst timing. All other radios at the hub site are set to external burst timing.

Notice that external burst timing is required only for repeater and hub applications and that radios using external burst timing must always also be Master radios. Therefore the setting of TDD mode (Master/Slave) and burst sync source are combined into one setting as shown in Table 4-23.

Table 4-23. TDD/Burst Sync Mode Settings

Setting	*Application*
Mast/Int	Use at one end of a point to point link. Use in first radio at hub site.
Mast/Ext	Use for all but first radio at hub site. See Figure 4–2 for repeater application.
Slave/Int	Use at one end of a point to point link. Use at all remote sites in a hub application. See Figure 4–2 for repeater application.

0

The radio providing burst sync timing may be either a **FIRELINK 2000** or an older **SKYPLEX** radio. The Burst Sync Type parameter on any **FIRELINK 2000** radio using external burst sync must be set to indicate the format of the incoming burst sync signal. The **FIRELINK 2000** and **SKYPLEX I** use RS485 signaling and can be selected by entering **BSRJ45**. A common cable can also be used to connect the burst sync lines of a **FIRELINK 2000** and **SKYPLEX I**. The **SKYPLEX SS** radio uses RS232 signaling and requires and external RS232 to RS485 converter and the command **BSBNC.** See Section 4.6 for more details.

4.7.7.2 Burst Sync Cable Termination

As discussed in Section 4.6 the cable used to distribute the burst sync signal between radios at a hub or repeater site must be terminated at the last radio in the burst sync distribution chain. The termination is built into the radio and is set on the configuration screens, with the use of the TERM command.

5. Installation and Setup

This section describes how to:

- install
- configure
- cable

the **FIRELINK 2000** Spread Spectrum radios.

For use in the USA

This product requires installation by a trained professional when used in the USA. The equipment and installation must comply with FCC part 15 regulations and it is the responsibility of the installer to ensure the system configuration is in compliance with these regulations. For specific details of regulatory information, please see the Regulatory Notices at the front of this manual.

5.1 System Setup

Your standard shipping container has the following items:

- One or two **FIRELINK 2000** radios
- Manual
- AC power cord (US Standard)
- Table top mounting rubber feet
- Mating connector for DC power
- Spare AC fuses

The shipping container may also contain any of the following optional items:

- Rack mount brackets
- Appropriate data cable to connect the data equipment to the radio **DTE** port
- An RS232 to RS-485 converter assembly for burst sync signal connections (hub or repeater applications) when using with old **SKYPLEX SS** radios.
- Directional antennas, RF coaxial cable and "N" connectors to connect the antenna to radio
- Repeater application interconnect data cable
- Administration port cable

- Low gain lab test antennas
- Lightning protection devices.

The test antennas which can be connected directly to the **FIRELINK 2000** units are very useful for bench testing and setting up the link parameters **before** actual link installation. Short RF test cables with attenuators can also be very useful for lab testing.

Check your packing list to ensure that items have been received. Contact **LNL** or the local distributor from whom you acquired this equipment if anything outlined above is missing.

5.2 Terminal Connections for Unit Setup

All configuration, or setup of the **FIRELINK 2000** is performed using the ADMINistration terminal or an optional LCD/keypad interface. These interfaces enable users to enter information about the **FIRELINK 2000** into the radio databases. Both interface menus provide an list of the available commands as well as information concerning the current settings.

The terminal connected to the **FIRELINK 2000** must be an ASCII terminal or equivalent, or any device capable of emulating an ASCII terminal. Typically, a laptop or desktop PC-compatible computer with terminal emulation software is used.

The terminal (or laptop computer) may be connected directly to the **FIRELINK 2000** at either the "ADMIN" connector on the non-I/O panel or the "ADMIN IN" (RJ-48) connector on the I/O panel. The "ADMIN" connector on the non-I/O panel is a 9-pin D-type connector as shown in Figure 5–1.

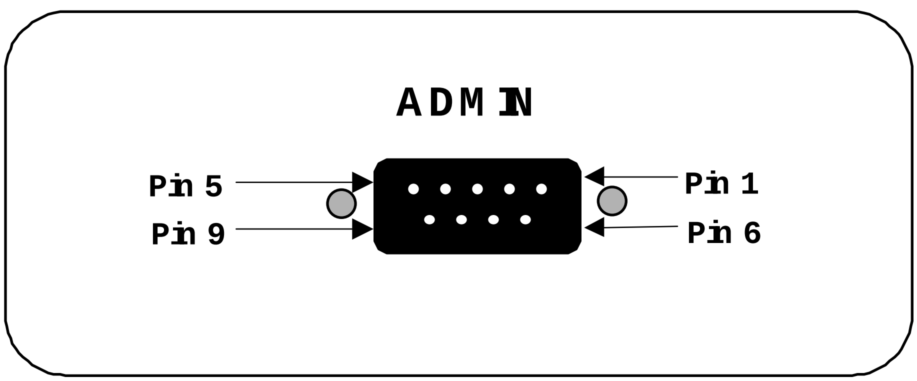


Figure 5–1. ADMIN Connector on the Non-I/O Panel

The "ADMIN" connector on the I/O panel is an eight-pin RJ-48 connector as shown in Figure 5–2. There are two "ADMIN" connectors on the I/O panel. The terminal should be connected to the "ADMIN IN" connector. The "ADMIN OUT" connector is for future use.

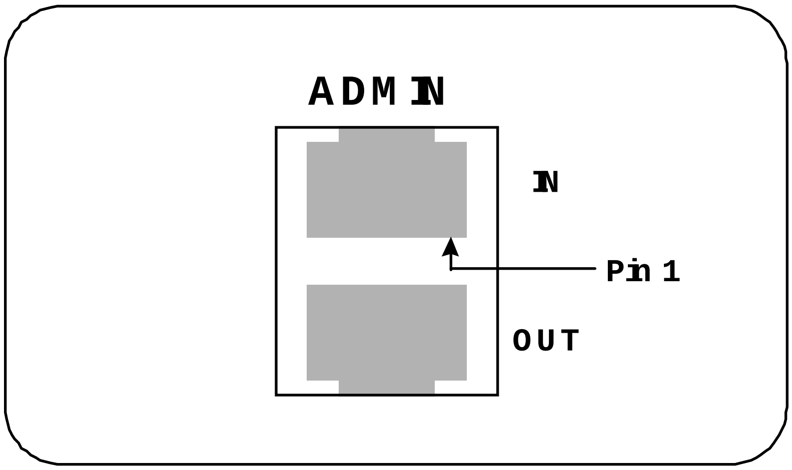


Figure 5–2. ADMIN Connector Non-I/O Panel

The electrical interfaces for the ADMIN ports are RS-232 three-wire asynchronous, wired to operate as a DCE.

Pin assignments for the ADMIN connectors are given in Table 5-1.

Table 5-1. FIRELINK 2000 ADMIN Assignments

Pin Assignment	*DB-9 Pin No.*	*RJ-48C Pin No*
TXD	2	6
RXD	3	5
GND	5	4

The following tables (Table 5-2, Table 5-3, Table 5-4 and Table 5-5) provide cable pinouts required to interface the front or rear panel ADMIN connectors for commonly used DTE and DCE connectors.

Table 5-2. DB-25, DTE to FIRELINK 2000 ADMIN Cable Pinout

DTE (Terminal or Modem)	*DCE FIRELINK 2000*	
DB-25	**DB-9**	**RJ-48**
Pin 2	Pin 3	Pin 6
Pin 3	Pin 2	Pin 5
Pin 7	Pin 5	Pin 4

Table 5-3. DB-9, DTE to FIRELINK 2000 ADMIN Cable Pinout

DTE (Terminal or Modem)	*DCE FIRELINK 2000*	
DB-9	**DB-9**	**RJ-48**
Pin 3	Pin 3	Pin 6
Pin 2	Pin 2	Pin 5
Pin 5	Pin 5	Pin 4

Table 5-4. DB-25, DCE to FIRELINK 2000 ADMIN Cable Pinout

DCE (Terminal or Modem)	*DCE FIRELINK 2000*	
DB-25	**DB-9**	**RJ-48**
Pin 2	Pin 2	Pin 5
Pin 3	Pin 3	Pin 6
Pin 7	Pin 5	Pin 4

Table 5-5. RJ-48, DCE to FIRELINK 2000 ADMIN Cable Pinout

DCE (Terminal or Modem)	*DCE FIRELINK 2000*	
RJ-48	**DB-9**	**RJ-48**
Pin 6	Pin 2	Pin 5
Pin 5	Pin 3	Pin 6
Pin 4	Pin 5	Pin 4

The "ADMIN" terminal should be set for:

- 9600 baud
- no echo
- no parity
- 8 data bits
- 1 stop bit

Remote connection to the ADMIN Interface can be accomplished by attaching a telephone line modem or telnet server to either ADMIN port.

5.3 Configuration Settings

The **FIRELINK 2000** radio has six adminstration screens which are used to configure the **FIRELINK 2000** radio settings and to veiw the current radio status. The **RADIO MAIN MENU** is used to display a summary of the six screens and the commands used to display each screen. If the terminal is connected to the **FIRELINK 2000** radio before the radio is powered on, the **RADIO MAIN MENU** will be displayed after the radio completes the power-on diagnostics. If the terminal is connected to an already running **FIRELINK 2000** radio, type the **return key** or type **'MAIN'** to display the **RADIO MAIN MENU** . The use of the screens is described in the following sections.

5.3.1 Radio Main Menu

```
                              Firelink RADIO MAIN MENU

        CFG            Configuration
        BSCFG          Burst Sync Configuration
        PWR            Power Alarm Configuration
        ALARM          Alarms
        STATUS         Operation Status
        DIAG           Diagnostics


Firelink Radio Code Version:       V02.01.00
CTU Hardware Version:              1.8
RFM Hardware Version:              1.0
RFM Software Version:              Not Applicable
```

Figure 5–3. FIRELINK 2000 Main Menu Screen

Table 5-6. FIRELINK 2000 Radio Main Menu Data Fields

	Commands	Description
Configuration	CFG	Configure and view radio Power, Channel, PN Sequence, Data Rate, DTE Interface, DTE Clock Source and ST Clock Phase settings. Burst sync source information is also displayed.
Burst Sync Configuration	BSCFG	Configure and view TDD Mode / Burst Sync Source, Burst Sync Type, and Burst Sync Termination.
Power Alarm Configuration	PWR	Configure and view radio power supply alarm settings and current power supply alarm states.
Alarms	ALARM	View current alarm states for the Major Alarms, which include Radio Sync, Transmit, TT Fail, Burst Sync, Far End Major Alarm and Unit alarms. Also displays a summary of the current Minor Alarms which include Receive Level Alarm, Power alarm, and Far End Power alarm states.
Operations Status	STATUS	Displays the current state of the TT line, Burst Sync, Local and Far End RSSI values, Local and Far End User Alarm sensors, Major and Minor Alarm states and whether there is an active Diagnostic running. Also provides a command to save the current local and far end RSSI values as reference values.
Diagnostics	DIAG	Configure and view current diagnostic settings, including Near End and Far End Loopback status, V.54 Loopback status, and Transmit test mode state.

5.3.2 Configuration Menu

```
                         Firelink RADIO CONFIGURATION MENU

Transmit Power       POWER     <number>
Channel #            CHAN      <number>
PN Sequence #        PNSEQ     <number>
Data Rate            Nx56k     Nx64k
DTE IFC              V35/V11   OLDV35    RS422    RS232    EIA530      X21
DTE Clk Source       CLKDTE    CLKLink   CLKInt   CLKLoc   CLKLinkST   CLKIntST
ST Clk Phase         STNORM    STINV

-------------------------------------------------------------------------------
                         CURRENT CONFIGURATION
Trans    Chan     PN Seq   Data     DTE      ST Clk
Power    #        #        Rate     IFC      Phase

0dBm     1        1        512k     V.11     Norm

Clock Source:  Internal      TDD Mode/Source:  Slave/Int
```

Figure 5–4. FIRELINK 2000 Radio Configuration Menu

Table 5-7. FIRELINK 2000 Radio Configuration Data Fields

Data Field	*Command*	*Description*
Transmit Power	POWER <number> (default 20 dBm)	Sets the Transmit Power level. The number can be any even number value from 0 to 28. (e.g. 0, 2, 4 … 28)
Channel #	CHAN <number> (default 1)	Sets the RF channel number to 0 or 1 through N, where N varies with data rate. For channel plan details, see section 4.7. Possible values: the screen indicates the allowable range for the particular data rate.
PN Sequence #	PNSEQ <number> (default 1)	Sets the PN sequence number. Possible values: 1 through 8.
Data Rate	Nx56k	Sets the data rate to a multiple of 56 kbps. For example, for the 128S model radio this selection would result in a data rate of two times 56k or 112 kbps.
	Nx64k (default)	Sets the data rate to a multiple of 64 kbps. For example, for the 128S model radio this selection would result in a data rate of two times 64k or 128 kbps.

	1200	Used for 1,200 bps synchronous applications. Available on the model 24-64S and 23-64S radios only.
	2400	Used for 2,400 bps synchronous applications. Available on the model 24-64S and 23-64S radios only.
	4800	Used for 4,800 bps synchronous applications. Available on the model 24-64S and 23-64S radios only.
	9600	Used for 9,600 bps synchronous applications. Available on the model 24-64S and 23-64S radios only.
	19200	Used for 19,200 bps synchronous applications. Available on the model 24-64S and 23-64S radios only.

DTE IFC	V35/V11 (default)	Selects V.11 electronic DTE interface with a V.35 (M34) connector. V.11 is the new electrical interface for V.35.
	OLDV35	Selects the old V.35 electrical interface with the V.35 (M34) connector.
	RS-422	Selects the RS-422 electrical interface with the 25-pin D connector and RS-449 handshake lead processing.
	RS-232	Selects the RS-232 electrical interface with the 25-pin D connector and RS-232 handshake lead processing. **Note**: This interface is only available for the 24-64S and 23-64S radios.
	EIA530	Selects the RS-422 electrical interface with the 25-pin D connector and EIA-530 handshake lead processing.
DTE Clk Source	CLKDTE	The transmit clock is taken from the TT input on the user data terminal interface. If the TT signal is absent or is not adequate, then the radio will activate a major alarm.

	CLKLink	The ST transmit clock is taken from the clock derived from the received RF signal. If a signal is received on the TT clock line, the radio will automatically assume TT timing and use the TT clock.
	CLKInt (default)	The ST transmit clock is taken from the fixed internal oscillator. If a signal is received on the TT clock line, the radio will automatically assume TT timing and use the TT clock.
	CLKLoc	The transmit clock is derived from the TT input on the user data terminal interface. The receive clock RT is derived from TT and then used to clock the receive data. If the TT signal is absent or is not adequate, then the radio will activate a major alarm.
	ClkLink/ST	The ST transmit clock is taken from the clock derived from the received RF signal and the TT signal is always ignored.
	ClkInt/ST	The ST transmit clock is taken from the fixed internal oscillator and the TT signal is always ignored.

ST Clock Phase	STNORM (default)	The ST clock has rising edges coincident with the data transitions.
	STINV	The ST clock has rising edges at the mid-point of the data transitions.

Table 5-8. FIRELINK 2000 Radio Configuration Status Information

Current Configuration Information	
The following configuration status information is provided:	
Trans Power[1]	Reflects the current transmit power setting.
Chan #	Reflects the current channel number setting.
PN SEQ #	Reflects the PN Sequence number setting.
Data Rate	Reflects the current data rate setting.
DTE IFC	Reflects the current DTE interface type selection.
ST Clk Phase	Reflects the current ST clock phase setting.
Clock Source	Reflects the current transmit clock source setting.
TDD Mode/Source	Reflects the current Burst Sync source setting.

[1] Refer to Footnote 1.

5.3.3 Burst Sync Configuration Menu

```
                     Firelink RADIO BURST SYNC CONFIGURATION MENU

Tdd/Burst Sync Mode      Mast/Int         Mast/Ext         Slave/Int
Burst Sync Type          BSBNC            BSRJ45
Burst Sync Termination   TERM             NOTERM
-------------------------------------------------------------------------------
                      CURRENT CONFIGURATION

TDD      Burst Sync   Burst Sync   Burst Sync
Mode     Source       Termination  Type

Slave    Int          NoTerm       BSRJ45




Firelink 512S>
```

Figure 5–5. FIRELINK 2000 Burst Sync Configuration Screen

Table 5-9. FIRELINK 2000 Radio Burst Sync Configuration Data Fields

Data Field	*Commands*	*Description*
Tdd/Burst Sync Source	Mast/Int	Burst duration timing is taken from an internal oscillator. This selection is used when the radio is the only radio at the site or is the burst sync timing source for other radios.
	Mast/Ext	Configures the radio to take burst duration sync timing from its BURST SYNC IN external input.
	Slave/Int (default)	Burst duration timing is taken from the received RF signal.
Burst Sync Type	BSBNC	Configures the **FIRELINK 2000** to accept an external burst sync signal provided by a **Skyplex SS** or compatible radio when the burst sync source is set for external. If this signal is using RS232 level signaling, an external RS232 ro RS485 converter is required.
	BSRJ45 (default)	Configures the **FIRELINK 2000** to accept an external burst sync signal provided by a **FIRELINK 2000, Skyplex SS** or compatible radio when the burst sync source is set for external.
Burst Sync Termination	TERM (default)	The radio provides a termination resistor for the burst sync bus. This is the proper setting for the last radio in the burst sync chain.
	NOTERM	The radio does not provide a termination resistor for the burst sync bus.

Table 5-10. FIRELINK 2000 Radio Burst Sync Configuration Status Information

RADIO BURST SYNC CONFIGURATION Information	
The following configuration status information is provided:	
TDD Mode	Reflects whether the radio initiates data bursts (**Master**) or sends data bursts in response to the reception of a data burst (**Slave**).
Burst Sync Source	Indicates whether the burst sync signal for this radio is being generated internally or taken from another radio.
Burst Sync Termination	Reflects the current burst synchronization termination setting.
Burst Sync Type	Indicates what type of signal is providing burst sync. This parameter is active only when external burst sync is being used.

5.3.4 Power Alarm Configuration Menu

```
                Firelink POWER ALARM CONFIGURATION MENU

Standard AC PS Alarm       SPSEN       SPSDIS
Redundant AC PS Alarm      RPSEN       RPSDIS
DC Input A Alarm           DCAEN       DCADIS
DC Input B Alarm           DCBEN       DCBDIS

-----------------------------------------------------------------------------
--
                           CURRENT CONFIGURATION
-----------------------------------------------------------------------------
--
           STD AC     Redundant AC      DC            DC
        Power Supply  Power Supply    Input A       Input B

Detected:    Yes           No            No            No

Alarm:    Disabled      Disabled      Disabled      Disabled
```

Figure 5–6. FIRELINK 2000 Radio Alarm Configuration Screen

Table 5-11. FIRELINK 2000 Power Alarm Configuration Menu Data Fields

Data Field	Commands	Description
Standard AC PS Alarm	SPSEN	Provides alarm capability for the standard AC power supply. If the Power Supply is absent or failing, the alarm will be signaled.
	SPSDIS (default)	Disables alarming for the standard AC power supply. If the Power Supply is absent or failing no alarm will be declared.
Redundant AC PS Alarm	RPSEN	Provides alarm capability for the redundant AC power supply. If the Power Supply is absent or failing, the alarm will be signaled.
	RPSDIS (default)	Disables alarming for the standard redundant AC power supply. If the Power Supply is absent or failing no alarm will be declared.
DC Input A Alarm	DCAEN	Provides alarm capability for the DC Input A power supply. If the Power Supply is absent or failing, the alarm will be signaled.
	DCADIS (default)	Disables alarming for the standard DC Input A power supply. If the Power Supply is absent or failing no alarm will be declared.
DC Input B Alarm	DCBEN	Provides alarm capability for the DC Input B power supply. If the Power Supply is absent or failing, the alarm will be signaled.
	DCBDIS (default)	Disables alarming for the standard DC Input B power supply. If the Power Supply is absent or failing no alarm will be declared.

Table 5-12. FIRELINK 2000 Power Alarm Configuration Menu Status Information

POWER ALARM CONFIGURATION MENU	
The following configuration status information is provided:	
STD AC Power Supply	Indicates if power in the standard AC power supply has been detected.
Redundant AC Power Supply	Indicates if power in the redundant AC power supply has been detected.
DC Input A	Indicates if power in the standard DC power supply has been detected.
DC Input B	Indicates if power in the redundant DC power supply has been detected.

5.3.5 Radio Alarms

```
                              Firelink RADIO ALARMS

              Enable ACO:                 ACO
              Clear Alarm History:        ALARMCLR

------------------------------------------------------------------------------
                              MAJOR ALARMS
------------------------------------------------------------------------------
  SYNC    XMT    TT Fail    BS    UNIT    FE MJR

   ACT     -        -        -      -        -

------------------------------------------------------------------------------
                              MINOR ALARMS
------------------------------------------------------------------------------
   RCV        PWR                         FAR END PWR

    -          -                              -

MAJOR ALARM:  ACT         MINOR ALARM:   -         Active Diagnostic:  -
FAR END MAJOR ALARM:   -

Firelink 513S>
```

Figure 5–7. FIRELINK 2000 Radio Alarms Screen

Table 5-13. FIRELINK 2000 Radio Alarms Data Fields

Data Field	*Commands*	*Description*
Enable ACO	ACO	Clears the signals on the exterior alarm output.
Clear Alarm History	ALARMCLR	Removes history (HST) alarm indication from fields displaying historical alarms.

Table 5-14. FIRELINK 2000 Radio Alarms Information

RADIO ALARMS Information	
The following RADIO ALARMS status information is provided: **"ACT"** The Alarm is currently Active, and the Alarm Relay is Closed. **"—"** A dash indicates that the Alarm is not Active, and the Alarm Relay is Open. **"ACO"** Alarm Cut Off indicates that the Alarm is Active, but it has been but off and the Alarm Relay (mayor or minor) is now open. The ACO state can be achieved by pressing the ACO switch on the panel of the radio or by issuing the ACO command on the LCD or the Admin screen. **"HST"** The historical state shows that the Alarm was previously active, but now is inactive. HST can be cleared using the ALARMCLR command.	
MAJOR ALARMS	***The following alarms are in the Major Alarm group.***
SYNC	"ACT" indicates that the radios are not in RF sync. "— " indicates that the radios are in RF sync. "HST", "ACO". See above.
XMT	"ACT" indicates that the RF Power Amplifier is not operational. "—" indicates that the RF Power Amplifier is operational. "HST", "ACO". See above.
TT Fail	This Alarm can be Active only on CLKDTE and CLKLOC clock modes. "ACT" indicates the absence of the TT clock coming into the radio. "—" indicates that the TT clock is present on the DTE interface. "HST", "ACO". See above.
BS	Reflects the alarm state of the Burst Sync signal. "ACT" indicates the absence of the Burst Sync signal coming into the radio. "—" indicates that there is activity on the Burst Sync signal and therefore, there is no alarm. "HST", "ACO". See above.

RADIO ALARMS Information	
UNIT	"ACT" Will indicate that the radio failed under one of several conditions: - Self Test failed, including RAM, ROM, NVRAM and auto load failure. - Failure between the communication between the radio internal modules. - It is also used to display buffer overflow or underflow in the receive and transmit buffers. "HST", "ACO". See above.
FE MJR	"ACT" indicates that any member of the Major Alarm group from the far end radio is in active alarm. "—" indicates that there are no current alarms on the far end radio. "HST", "ACO". See above. "???" will be displayed if the information from the far end radio has not been retreived.
MINOR ALARMS	***The following alarms are in the Minor Alarm group.***
RCV	"ACT" indicates that the receive signal level (RSSI) is within 10dB of the threshold sensitivity. This indicates low link margin. See section 3-1 "—" indicates that the received signal level (RSSI) is strong enough to sustain RF data reception. "HST", "ACO". See above.
PWR	"ACT" indicates that any of the "enabled" power supplies has failed. "—" indicates that all of the "enabled" power supplies are operational. "HST", "ACO". See above. See previous power alarm section to disable certain Power supply alarms and avoid undesirable alarm conditions.
FAR END PWR	"ACT" indicates that any of the "enabled" power supplies on the far end radio has failed. "—" indicates that all of the "enabled" power supplies on the far end radio are operational. "HST", "ACO". See above. "???" will be displayed if the information from the far end radio has not been retreived. See Section 5.3.4 to learn how to disable certain Power supply alarms and avoid undesirable alarm conditions.
MAJOR ALARM	"ACT" indicates that any member of the Major Alarm group is in

RADIO ALARMS Information	
	active alarm. "—" indicates that there is no current alarm. "HST", "ACO". See above.
MINOR ALARM	"ACT" indicates that any member of the Minor Alarm group is in active alarm. "—" indicates that there is no current alarm. "HST", "ACO". See above.
FAR END MAJOR ALARM	"ACT" indicates that any member of the Major Alarm group from the far end radio is in active alarm. "—" indicates that there are no current alarms on the far end radio. "HST", "ACO". See above. "???" will be displayed if the information from the far end radio has not been retreived.
Active Diagnostic	"ACT" indicates ACT whenever there is any test running on either radio of a link, like a loopback. "—" indicates that no test is being performed. "HST", "ACO". Does not apply.

5.3.6 Radio Status Screen

```
                    Firelink STATUS SCREEN

              Save RSSI Reference Levels:          SAVEREF

------------------------------------------------------------------------------
                          CURRENT STATUS
------------------------------------------------------------------------------
       TT      BS1                RSSI              FAR END RSSI
                             Current Ref (dBm)    Current Ref (dBm)
       NO      YES              -64  >-58              -64   >-58
------------------------------------------------------------------------------
                               ALARM SENSORS
           LOCAL RADIO                             FAR END RADIO
------------------------------------------------------------------------------
        #1       #2       #3                     #1       #2       #3

       Open     Open     Open                  Open     Open     Open

   MAJOR ALARM:  ACT     MINOR ALARM:  -      Active Diagnostic: -


Firelink 5128>
```

Figure 5–8. FIRELINK 2000 Radio Status Screen

Table 5-15. FIRELINK 2000 Radio Status Data Fields

Data Field	*Commands*	*Description*
Save RSSI Reference Levels	SAVEREF	Stores the current RSSI levels of both radios in non-volatile memory and displays this reference level on the STATUS Screen.

Table 5-16. FIRELINK 2000 Radio Diagnostic Screen Status Information

Current STATUS Information	
The following radio status information is provided:	
CURRENT STATUS	**The following data reflect the current operating status of the radio.**
TT	Indicates whether a TT signal is present or not.
BS1	Indicates whether or not a signal is present on the burst sync input 1.
RSSI Current/Ref (dBm)	Indicates the local radio's current RSSI value and the previously stored reference RSSI value.
FAR END RSSI Current/Ref (dBm)	Indicates the Far End Radio's current RSSI value and the previously stored reference RSSI value. "???" will be displayed if the information from the far end radio has not been retreived.
ALARM SENSORS	**The following sensors are user supplied inputs which are displayed in this section.**
LOCAL RADIO #1	Displays the state of the local radio's number 1 contact. A contact can be either Open or Closed.
LOCAL RADIO #2	Displays the state of the local radio's number 2 contact. A contact can be either Open or Closed.
LOCAL RADIO #3	Displays the state of the local radio's number 3 contact. A contact can be either Open or Closed.
FAR END RADIO #1	Displays the state of the Far End radio's number 1 contact. A contact can be either Open or Closed. "???" will be displayed if the information from the far end radio has not been retreived.
FAR END RADIO #2	Displays the state of the Far End radio's number 2 contact. A contact can be either Open or Closed. "???" will be displayed if the information from the far end radio has not been retreived.
FAR END RADIO #3	Displays the state of the Far End radio's number 3 contact. A contact can be either Open or Closed. "???" will be displayed if the information from the far end radio has not been retreived.

5.3.7 Radio Diagnostics Screen

```
                     Firelink RADIO DIAGNOSTICS SCREEN

Loopback:                LPON        LPOFF        FELPON       FELPOFF
Detect V.54 Loopback:    V54EN       V54DIS
Transmit Test Mode:      TXTESTON    TXTESTOFF



-------------------------------------------------------------------------------
                       DIAGNOSTICS STATUS

Near End       Far End     V.54 Loopback     Transmit
Loopback       Loopback       Enable         Test Mode
-------------------------------------------------------------------------------
  Off            Off          DISABLED          Off





Firelink 512S>
```

Figure 5–9. FIRELINK 2000 Radio Diagnostics Screen

Table 5-17. FIRELINK 2000 Radio Diagnostics Data Fields

Data Field	*Commands*	*Description*
Loopback	LPON	This activates a bi-directional loopback in the local radio, with data looped toward the DTE interface and toward the far-end radio.
	LPOFF (default)	Loopback is deactivated.
	FELPON	This activates a bi-directional loopback in the far end radio, with data looped toward the far end DTE interface and toward the local radio.
	FELPOFF (default)	Loopback at the far end radio is deactivated.
Detect V.54 Loopback	V54EN	Enables a radio to detect V.54 'loopback on' and 'loopback off' command signals in-band in the RF data stream. When the 'loopback on' command is received across the RF link, the radio will create a local loopback. If the command is received on the DTE interface, it will be transported to the far end radio, which will then perform a bi-directional loopback.
	V54DIS (default)	Disables the radio's ability to detectV.54 signals from the air (RF) and will ignore this pattern, even if the V.54 patterns are present.
Transmit Test Mode	TXTESTON	Causes the radio to emit a continuous transmit signal.
	TXTESTOFF (default)	The radio returns to the TDD default mode.

Table 5-18. FIRELINK 2000 Radio Diagnostic Screen Status Information

Current Diagnostic Information	
The following configuration status information is provided:	
Near End Loopback	Indicates whether or not the local radio is in loopback mode.
Far End Loopback	Indicates whether or not the far end radio is in loopback mode. "???" will be displayed if the information from the far end radio has not been retreived.
V.54 Loopback Enable	Indicates the V.54 detect mode of the radio.
Transmit Test mode	Reflects the current state of the radio's transmit test mode.

5.4 Configuring the system through the LCD.

5.4.1 LCD Menu Navigation & Operation

Moving around in the LCD menu interface is very easy and rapid. The LCD screen consists of 2 lines. The top line displays the user's current location in the Radio Configuration Menu. The second line defines either another branch in the menu or a radio configuration value selection.

There are 4 function keys, which allow the user to enter, scroll through various menu branches or parameter value selections, exit a menu or cancel an operation.

Enter Enters a new menu or Selects a configuration value.

Up Scrolls up a menu list or parameter value selection list.

Down Scrolls down a menu list or parameter value selection list.

Cancel Exits from the current branch of the menu or Cancels the current configuration activity.

The LCD **Radio** interface consists of two menu trees, the **Default Radio Menu** and the **Main Menu.** The **Default Radio Menu** displays the current RSSI value and allows an authorized user to log into the **Main Menu**. The **Main Menu** allows the user to configure and monitor all of the radio parameters and alarm conditions.

To view the various options, menus, or parameter selection values available in the menu displayed on the top line use the **Up** or **Down** key. The option will be displayed on the second line. To select the option displayed on the second line press the **Enter** key. To exit a menu the **Cancel** key is pressed.

Many of the radio's menus also display the current state of one of the radio's parameters, such as an alarm, or a current radio configuration value.

Firelink 64S
RSSI = -71 dBm

Every function available in the Radio Admin system has been provided in the LCD system. This allows the complete configuration of the radio by the LCD system. Refer to the Administration Screen section 5.3 of the manual for a full description of each radio configuration parameter and radio state parameter, including alarms, and RSSI values. The user is only presented with valid configuration selection values based on the radio type. Just as on the Admin screens, some parameters will be displayed only when they are valid for your particular radio type.

The following diagrams show the **Default Radio Menu** tree and the **Main Menu** tree.

5.4.1.1 Default Radio Menu

	RSSI = -(value) dBm	
Firelink 256S	**FE RSSI =-(value)dBm**	
	Login	**>0000000**
	Internal Number	**123456-123456-12**

Figure 5–10. LCD Default Radio Menu

After a user successfully enters the radio's Password, which can be optionally undefined for quick access in secure sites, the **Main Menu** is displayed.

5.4.1.2 Main Menu

	Radio Cfg	Radio Cfg menu	Figure 5–12
	Burst Sync Cfg	Burst Sync CFG menu	Figure 5–13
	Alarm Cfg	Alarm Cfg menu	Figure 5–14
Main Menu	**Diagnostics**	Diagnostics menu	Figure 5–15
	Alarm Status	Alarm Status menu	Figure 5–16
	Status	Status menu	Figure 5–17
	System	System & Logout menu	Figure 5–18
	Logout	System & Logout menu	Figure 5–18

Figure 5–11. LCD Main Menu

The **Main Menu** is divided in several sub menus that are shown in the following sections.

5.4.1.3 Radio Cfg Menu

- Main Menu
  - Radio Cfg
    - Power (value)
      - >0 dBm
      - >2 dBm
      - . . .
      - >28 dBm
    - Channel (value)
      - >0
      - >1
      - . . .
      - >15
    - PN Sequence (value)
      - >1
      - >2
      - . . .
      - >8
    - Data Rate (value)
      - >Nx56
      - >Nx64
      - >1200
      - >2400
      - >4800
      - >9600
      - >19200
    - Interface (value)
      - >V35V11
      - >OLDV35
      - >RS422
      - >RS232
      - >EIA530
      - >X21
    - DTE Clk (value)
      - >DTE
      - >LINK
      - >INTERNAL
      - >LOCAL
      - >LINK/ST
      - >INTERNAL/ST
    - ST Phase (value)
      - >NORMAL
      - >INVERTED
  - Burst Sync Cfg
  - Alarm Cfg
  - Diagnostics
  - Alarm Status
  - Status
  - System
  - Logout

Figure 5–12. LCD Radio Cfg Menu

5.4.1.4 Burst Sync Cfg Menu

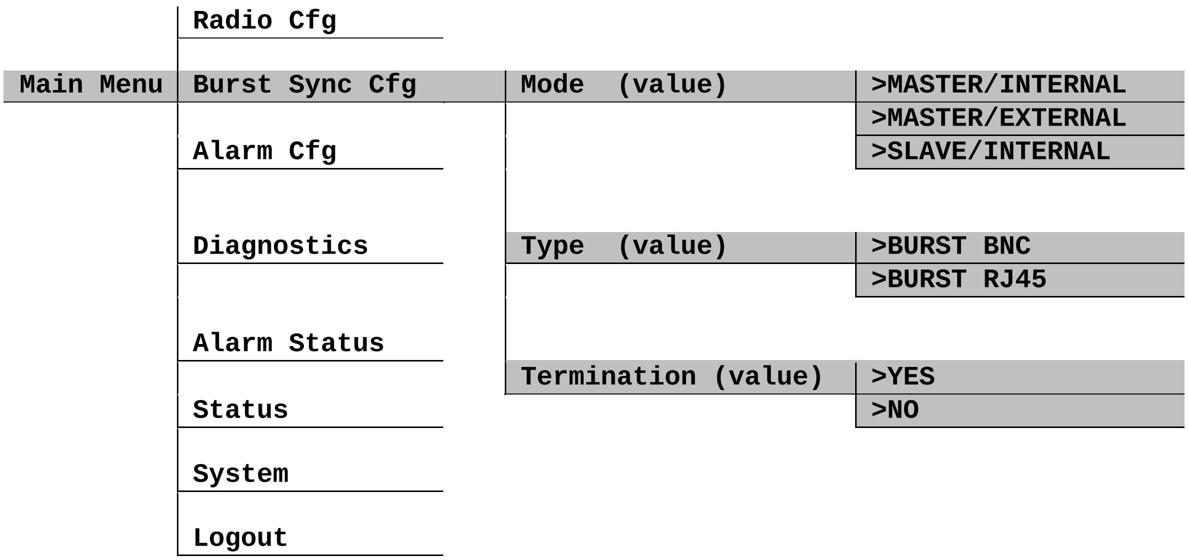


Figure 5–13. LCD Burst Sync Cfg Menu

5.4.1.5 Alarm Cfg Menu

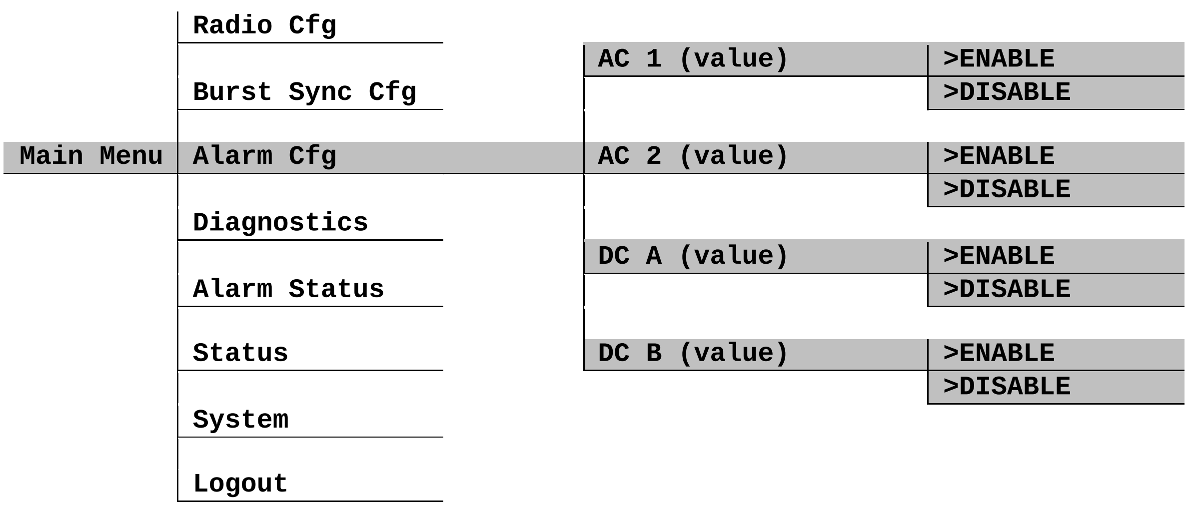


Figure 5–14. LCD Alarm Cfg Menu

5.4.1.6 Diagnostics Menu

	Radio Cfg	Local Loop (value)	>ON
			>OFF
	Burst Sync Cfg		
		FarEnd Loop (value)	>ON
	Alarm Cfg		>OFF
Main Menu	Diagnostics	Xmit Test (value)	>ON
			>OFF
	Alarm Status		
		V54 Detection (value)	>ON
	Status		>OFF
	System	Local Loop (value)	>ON
			>OFF
	Logout		

Figure 5–15. LCD Diagnostics Menu

5.4.1.7 Alarm Status Menu

	Radio Cfg	Major - *(A. status)*	>Sync *(A. STATUS)*
			>Transmit *(A. STATUS)*
	Burst Sync Cfg		>TT Fail (A. *STATUS)*
			>Burst Sync *(A. STATUS)*
	Alarm Cfg		>Unit Alarm *(A. STATUS)*
			>FE Major *(A. STATUS)*
	Diagnostics		>5.7GHz Conv *(A. STATUS)*
			>5.7 Conv PS *(A. STATUS)*
Main Menu	Alarm Status	Minor - *(A. STATUS)*	>Pwr Sup *(A. STATUS)*
			>FE Pwr Sup *(A. STATUS)*
	Status		>Low RSSI *(A. STATUS)*
	System	FE Major (A. STATUS)	
	Logout	Active Diag (D.STATUS)	
		Alarm Clear	Press ENTER to >clear HST alarms

Figure 5–16. LCD Alarm Status Menu

A. STATUS (*Alarm Status*): ACT, -, HST, ACO, DIS.

5.4.1.8 Status Menu

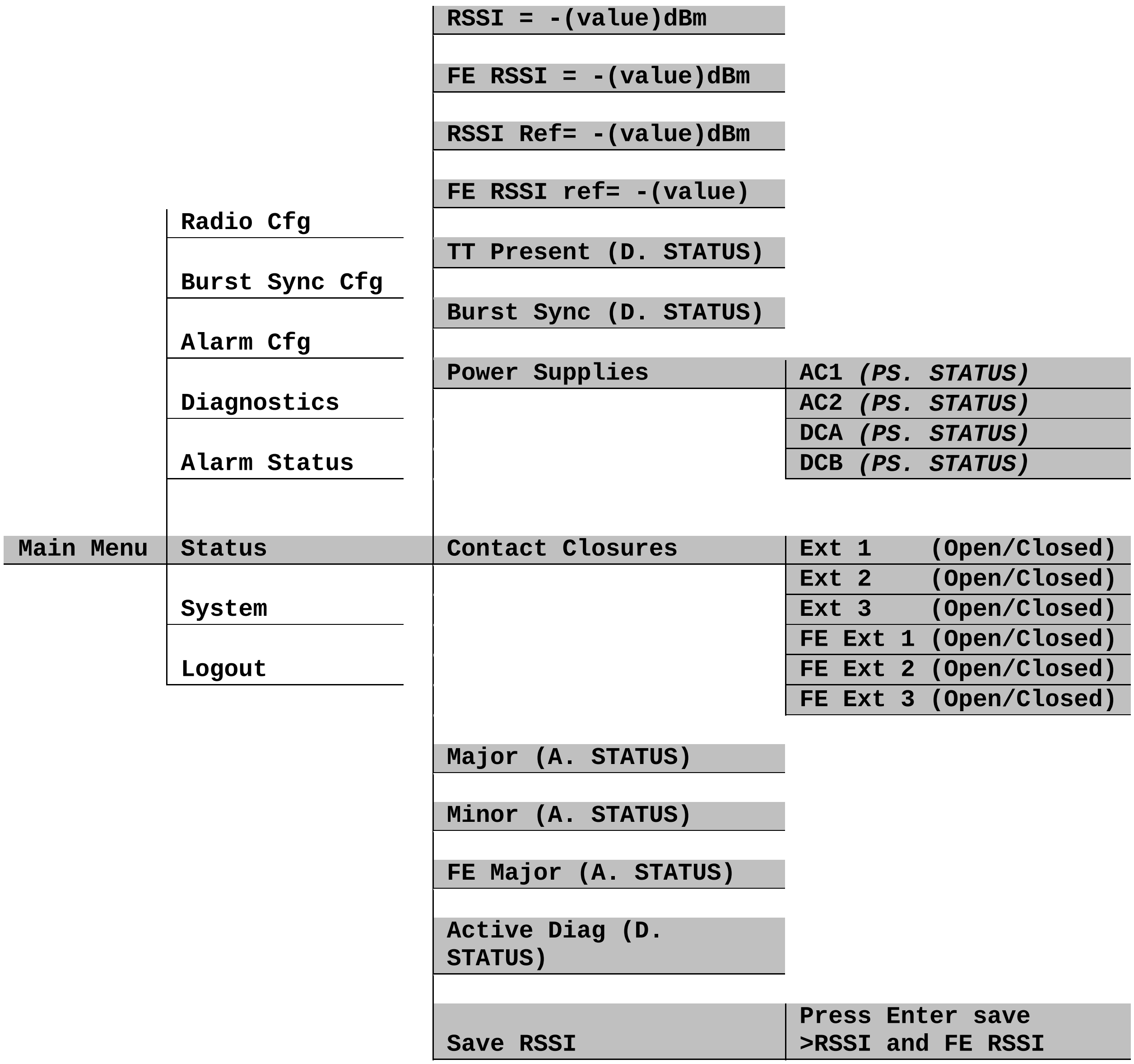


Figure 5–17. LCD Status Menu

A. STATUS (*Alarm Status*): ACT, -, HST, ACO, DIS.
D. STATUS (*Detection Status*): YES, NO.
PS. STATUS (*Power Supply Status*): DETECTED, NOT DETECTED.

5.4.1.9 System & Logout Menus

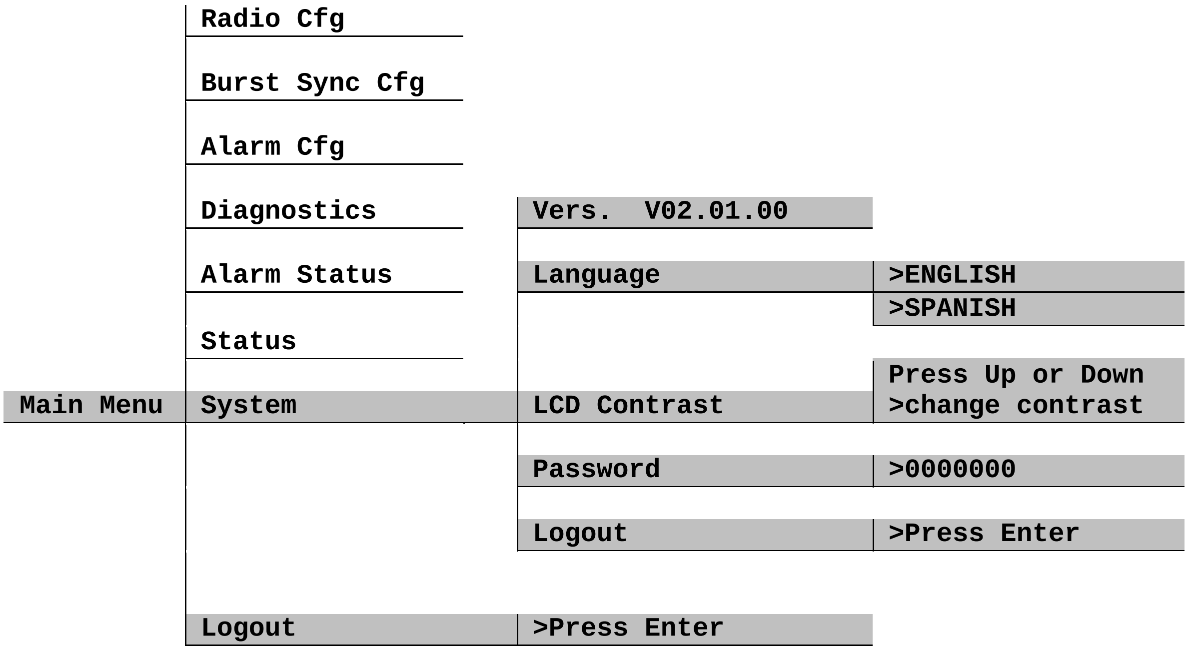


Figure 5–18. LCD System and Logout menus.

5.4.2 Login, Password Definition, and LCD Contrast Adjust examples.

5.4.2.1 Login example

To access the **Main Menu** the **Enter** key is pressed when the **Login** submenu is displayed on the bottom line of the LCD screen. The LCD will then display the **Login** menu name on the LCD's top line and **>0000000** will be displayed on the bottom line. The current character position will be the leftmost 0 and is indicated by the flashing cursor. The **Up** and **Down** keys scroll through various choices available for the password character in that position, (lowercase alphabetic letters and the numbers 0-9). When the desired character is displayed, the **Enter** key is pressed and the cursor will move to the right. In this manner each character of the Password can be entered. When the cursor is in the last character position and the **Enter** key is pressed the displayed password is compared to the stored password. If the password is correct the **Main Menu** is entered and the words **Main Menu** will be displayed on the LCD's top line. When an incorrect password is entered, the words **Access denied** are displayed for 3 seconds and then the default LCD screen will be displayed.

When entering a password, the **Cancel** key can be used at any time to backup, which will move the cursor to the left. When the **Cancel** key is pressed in the first position of the password field, the Login menu is exited without any password verification action taking place.

The password **0000000** is used to bypass the Login password check. When the password is defined as all zeroes and the **Login** menu is entered the **Main Menu** is immediately accessed without any password verification procedure.

The initial display on the LCD after radio power up is the **Default Radio Menu**, which displays the radio type and the radio's current RSSI value. On the example display below, the radio type is 64K Standard.

```
Firelink 64S
RSSI = -71 dBm
```

	RSSI = -(value) dBm	
Firelink 64S	**FE RSSI =-(value)dBm**	
	Login	**>0000000**
	Internal Number	**123456-123456-12**

1. The **Down** key is pressed to display the next menu item under the default radio menu which is the Far End radio's RSSI.

```
Firelink 64S
FE RSSI =-71dBm
```

	RSSI = -(value) dBm	
Firelink 64S	**FE RSSI =-(value)dBm**	
	Login	**>0000000**
	Internal Number	**123456-123456-12**

2. The **Down** key is pressed again to display the next menu item, which is the LCD **Login**.

```
Firelink 64S
Login
```

	RSSI = -(value) dBm	
Firelink 64S	**FE RSSI =-(value)dBm**	
	Login	**>0000000**

	Internal Number	123456-123456-12

3. The **Enter** key is pressed which will select the **Login** menu. The current character position is indicated by a blinking cursor.

```
Login
>0000000
```

	RSSI = -(value) dBm	
Firelink 64S	FE RSSI =-(value)dBm	
	Login	>0000000
	Internal Number	123456-123456-12

4. Suppose the Login password is y20000z (password letters are always lowercase). Pressing the **Up** key will alter the 1st key.

```
Login
>z000000
```

5. By pressing the **Up** key again the current character will be changed to a ‘y’.

```
Login
>y000000
```

6. Once the desired character is displayed, use the **Enter** key to move the cursor right to the next character position.

```
Login
>y000000
```

7. By pressing the **Down** key the current character will be changed to a ‘1’.

```
Login
>y100000
```

8. By pressing the **Down** key again the current character will be changed to a ‘2’.

```
Login
>y200000
```

9. Since ‘2’ is the desired character, the **Enter** key is pressed to move the cursor right to the next character position (3^{rd} character position).

```
Login
>y200000
```

10. The character for the 3^{rd}, 4^{th}, 5^{th}, & 6^{th} positions is ‘0’, so the **Enter** key is pressed 4 times to move the cursor to the 7^{th} position.

```
Login
>y200000
```

11. Since ‘z’ is the chosen character, the **Up** key is pressed once.

```
Login
>y20000z
```

12. Now that the entire password is displayed and the current character position is the last available position (the 7^{th} position) the **Enter** key is pressed. When the current character position is the last and the **Enter** key is pressed, the system software will compare the displayed password against the password stored in the database, when they match the **Main Menu** is entered and displayed.

5.4.2.2 Radio Configuration example

Once that the user has logged in to the radio, the **Main Menu** will be dispalyed, and the user can start doing any required configuration changes.

Main Menu
Radio Cfg

	Radio Cfg	*Radio Cfg menu*	Figure 5–12
	Burst Sync Cfg	*Burst Sync CFG menu*	Figure 5–13
	Alarm Cfg	*Alarm Cfg menu*	Figure 5–14
Main Menu	**Diagnostics**	*Diagnostics menu*	Figure 5–15
	Alarm Status	*Alarm Status menu*	Figure 5–16
	Status	*Status menu*	Figure 5–17
	System	*System & Logout menu*	Figure 5–18
	Logout	*System & Logout menu*	Figure 5–18

a. Suppose that in this example the Burst Sync Mode is to be set to **SLAVE/INT**. The radio's Burst Sync Mode is set in the **Burst Sync Cfg** menu. To scroll to the **Burst Sync Cfg** menu from the **Radio Cfg** menu option, the **Down** key is pressed once.

Main Menu
Burst Sync Cfg

	Radio Cfg	*Radio Cfg menu*	Figure 5–12
	Burst Sync Cfg	*Burst Sync CFG menu*	Figure 5–13
	Alarm Cfg	*Alarm Cfg menu*	Figure 5–14
Main Menu	**Diagnostics**	*Diagnostics menu*	Figure 5–15
	Alarm Status	*Alarm Status menu*	Figure 5–16
	Status	*Status menu*	Figure 5–17
	System	*System & Logout menu*	Figure 5–18

Logout	*System & Logout menu*	Figure 5–18

b. To enter the **Burst Sync Cfg** menu the **Enter** key is pressed. Notice that the current value for the **Burst Sync Mode** is displayed, which is **MASTER/INT**.

```
Burst Sync Cfg
Mode MASTER/INT
```

Burst Sync Cfg	**Mode (value)**	**>MASTER/INTERNAL**
		>MASTER/EXTERNAL
		>SLAVE/INTERNAL
	Type (value)	**>BURST BNC**
		>BURST RJ45
	Termination (value)	**>YES**
		>NO

c. To enter the **Burst Sync Cfg Mode** menu the **Enter** key is pressed. The LCD will display the **Mode** menu, which allows the user to scroll through the various mode options using the **Up** or **Down** key.

```
Mode MASTER/INT
>MASTER/INTERNAL
```

Burst Sync Cfg	**Mode (value)**	**>MASTER/INTERNAL**
		>MASTER/EXTERNAL
		>SLAVE/INTERNAL

d. To display the 'SLAVE/INT' option the **Down** key is pressed twice.

```
Mode MASTER/INT
>SLAVE/INTERNAL
```

Burst Sync Cfg	**Mode (value)**	**>MASTER/INTERNAL**
		>MASTER/EXTERNAL
		>SLAVE/INTERNAL

e. Now that the **SLAVE/INT** mode is displayed on the second line of the LCD, the **Enter** key is pressed. The system will permanently replace the current value of **MASTER/INT** in the database with the new value **SLAVE/INT**. The LCD display will now return to the **Burst Sync Cfg** menu and the new current mode value, **SLAVE/INT** is displayed.

Burst Sync Cfg
Mode SLAVE/INT

Burst Sync Cfg	Mode (value)	>MASTER/INTERNAL
		>MASTER/EXTERNAL
		>SLAVE/INTERNAL

5.4.2.3 Create a New Password example

Defining a password is identical to entering a **Login** password. To define a password the user should enter the '**System**' menu from the **Main Menu** and then use the **Up** or **Down** key to display the **Password** submenu option. Then after pressing the **Enter** key the LCD screen will display the word **Password** on the top line and >**0000000** on the bottom line. Using the same procedure as described in the **Login** procedure each character of the proposed password is displayed. When the cursor is in the last character position and the **Enter** key is pressed, the displayed password will be stored in the database. The LCD will return to the **System** menu after storing the new password.

When defining a password, the **Cancel** key can be used at any time to backup (move the cursor to the left). When the **Cancel** key is pressed in the first position of the password field, the **Password** menu is exited without any update taking place in the database.

This example will set the Login password to **2z000b8**.

Main Menu
System

	Radio Cfg	*Radio Cfg menu*	Figure 5–12
	Burst Sync Cfg	*Burst Sync CFG menu*	Figure 5–13
	Alarm Cfg	*Alarm Cfg menu*	Figure 5–14
Main Menu	**Diagnostics**	*Diagnostics menu*	Figure 5–15
	Alarm Status	*Alarm Status menu*	Figure 5–16
	Status	*Status menu*	Figure 5–17
	System	*System & Logout menu*	Figure 5–18
	Logout	*System & Logout menu*	Figure 5–18

a. Enter the **System** menu from the **Main Menu** by pressing the **Enter** key.

System
Vers. V02.01.00

	Radio Cfg		
	Burst Sync Cfg		
	Alarm Cfg		
	Diagnostics	Vers. V02.01.00	
	Alarm Status	Language	>ENGLISH
			>SPANISH
	Status		
Main Menu	System	LCD Contrast	Press Up or Down >change contrast
		Password	>0000000
		Logout	>Press Enter
	Logout	>Press Enter	

b. Press the **Down** key three times to display the **Password** menu selection.

System
Password

	Radio Cfg		
	Burst Sync Cfg		
	Alarm Cfg		
	Diagnostics	Vers. V02.01.00	
	Alarm Status	Language	>ENGLISH
			>SPANISH
	Status		
Main Menu	System	LCD Contrast	Press Up or Down >change contrast
		Password	>0000000
		Logout	>Press Enter
	Logout	>Press Enter	

c. Press the **Enter** key to enter the **Password** menu.

```
Password
>0000000
```

	Vers. V02.01.00	
	Language	>ENGLISH
		>SPANISH
System	LCD Contrast	Press Up or Down >change contrast
	Password	>0000000
	Logout	>Press Enter

d. The 1st character of the new password is ‘2’ so the **Down** key is pressed twice.

```
Password
>2000000
```

e. To advance to the next character the **Enter** key is pressed.

```
Password
>2000000
```

f. The next key is ‘z’ so the **Up** key is pressed once.

```
Password
>2z00000
```

g. To move the cursor to the next character the **Enter** key is pressed.

```
Password
>2z00000
```

h. The 3rd, 4th, & 5th characters of the password are all ‘0’, so the **Enter** key is pressed three times.

```
Password
>2z00000
```

i. The 6th character of the password is ‘b’, so the **Down** key is pressed 11 times.

```
Password
>2z000b0
```

j. To advance to the next character, which is in the last position, the **Enter** key is pressed.

```
Password
>2z000b0
```

k. The 7th character of the password is ‘8’, so the **Down** key is pressed 8 times.

```
Password
>2z000b8
```

l. The new password has now been completely entered. To store the new password the **Enter** key is pressed. In the **Password** menu, when the cursor is in the 7th position, and the **Enter** key is pressed, the new password will be stored in the database. The LCD displays the **System** menu after the new password is stored.

```
System
Password
```

	Radio Cfg		
	Burst Sync Cfg		
	Alarm Cfg		
	Diagnostics	Vers. V02.01.00	
	Alarm Status	Language	>ENGLISH
			>SPANISH
	Status		
Main Menu	System	LCD Contrast	Press Up or Down >change contrast
		Password	>0000000
		Logout	>Press Enter
	Logout	>Press Enter	

5.4.2.4 LCD Contrast Adjust.

The LCD contrast level can be adjusted in either a temporary manner or permanently by storing the current setting in the database where it will be used as a default value each time the radio is powered on.. Use the **Enter** key to access the LCD Contrast Adjust menu from the ‘System’ menu. Using either the **Up** key or the **Down** key the LCD’s contrast can be adjusted. Each time the **Up** or **Down** key is pressed the contrast is immediately adjusted. When the contrast is correctly adjusted the user can exit the LCD Contrast Adjust menu by pressing the **Cancel** key **without** storing the new contrast level as a permanent setting. To store the current contrast in the database, press the **Enter** key. This will store the value permanently in the database and will become the default value whenever the radio is powered on.

5.5 Pre-Installation Radio Test

5.5.1 Visual Inspection

- Verify that the shipping box is not damaged.
- Check that radios are not physically damaged.

> **Note**: If radios are damaged, contact shipper or **LNL**, if necessary, to arrange for a return authorization (RMA) number.

5.5.2 Test

> **Note:** If the radios are being tested at levels near the receiver threshold, the units should be separated by a few meters and careful attention should be paid to the unit grounding.

Test your unit, by doing the following:

1. Connect the RF ports of the two radios together using RF cable with an RF attenuator of at least 60 dB in line with the cable.
2. If the DTE units (e.g. multiplexers, routers, etc.) that the radios will be used with are available connect the radios to the DTE units just as they will be connected in the actual installation. If the DTE units are not available substitute Bit Error Rate test sets for them. Be sure to set up the Bit Error Rate test sets in the same fashion as the DTE units with particular attention to the source of bit timing.
3. Attach power to the radios and turn the radios on.
4. Set up the two radios in the same fashion as in the actual installation.
5. The radios should both indicate no alarms and the Bit **ERROR** LED should be off indicating no errors.
6. If the actual DTE units are used for the test, check for an operational system. If Bit Error Rate test sets are used for the test verify that no errors are being detected.
7. If the test does not pass, repeat the test with only the radios. Set one of the radios to internal clock and the other to use the Link clock. If an external loopback is used, it must be placed on the radio using link timing to maintain a timing reference. Verify that both radios show no alarms and that the bit **ERROR** LEDs on both radios are off.

> **Note**: If RSSI level is not high enough:
> 1. Check connections.
> 2. See that all configuration settings are set properly.

5.6 User Data Cabling Considerations

The **FIRELINK 2000** radios have two user data connectors. A female 34-pin M34 (Winchester) is provided for Old V.35 or V.11/V.35 interfaces. A female DB-25 connector is provided for RS-422 (449), RS-232 or EIA-530 interfaces. All **FIRELINK 2000** user data connections are DCE type. It is recommended that you use a shielded cable and secure the hold-down hardware.

The following tables provide cable wiring diagrams for the **FIRELINK 2000** user data connections. Since the Old V.35 and the V.35/V.11 interfaces use the standard M34 connector pin assignments, adapter cables are not needed and any standard V.35 cable can be used. The RS-232 interface also uses standard pin assignments on the DB-25 connector which allows any standard RS-232 cable to be used.

5.6.1 FIRELINK 2000 to DTE Cables

The following tables (Table 5-19, Table 5-20, Table 5-21, Table 5-22, Table 5-23) provide the cable wiring for use with DTE devices.

Table 5-19. Old V.35, V.35/V.11 DTE Cable Pin Assignments

ID	*FIRELINK 2000 Signal Name*	*DTE UNIT M-34 Pin*	*Data Flow*	*FIRELINK 2000 M-34 Pin*
101	Shield	A	< >	A
102	Signal Ground	B	< >	B
103	Transmitted Data	P	>	P
	Transmitted Data Return	S	>	S
104	Received Data	R	<	R
	Received Data Return	T	<	T
113	Transmit Signal Element Timing **(TT)**	U	>	U
	Transmit Signal Element Timing Return **(TT)**	W	>	W
114	Transmit Signal Element Timing **(ST)**	Y	<	Y
	Transmit Signal Element Timing Return **(ST)**	AA	<	AA
115	Receive Signal Element Timing	V	<	V
	Receive Signal Element Timing Return	X	<	X
105	Request-to-send	C	>	C
106	Ready-to-send	D	<	D
107	Data Set Ready	E	<	E
109	Data Channel Receive Line Signal Detector	F	<	F

Table 5-20. RS-232 DTE Cable Pin Assignments

ID	FIRELINK 2000 Signal Name	DTE Unit DB-25 Pin	Data Flow	FIRELINK 2000 DB-25
	Shield Ground	1	< >	1
BA	Transmit Data	2	>	2
BB	Receive Data	3	<	3
CA	Request-to-send	4	>	4
CB	Clear-to-send	5	<	5
CC	Data Set Ready	6	<	6
AB	Signal Ground	7	< >	7
CF	Carrier Detect	8	<	8
	Send Timing	15	<	15
	Receive Timing	17	<	17
CD	Data Terminal Ready	20	>	20
	Terminal Timing	24	>	24

Table 5-21. RS-422/449 DTE Cable Pin Assignments

ID	FIRELINK 2000 Signal Name	DTE Unit DC-37 Pin	Data Flow	FIRELINK 2000 DB-25
	Shield	1	< >	1
SG	Signal Ground	19	< >	7
SD	Send Data	4	>	2
	Send Data Return	22	>	14
RD	Receive Data	6	<	3
	Receive Data Return	24	<	16
TT	Transmit Signal Element Timing	17	>	24
	Transmit Signal Element Timing Return	35	>	11
ST	Send Timing	5	<	15
	Send Timing Return	23	<	12
RT	Receive Timing	8	<	17
	Receive Timing Return	26	<	9
RS	Request-to-send	7	>	4
	Request-to-send Return	25	>	19
CS	Clear-to-send	9	<	5
	Clear-to-send Return	27	<	13
TR	Terminal Ready	12	>	20
	Terminal Ready Return	30	>	23
DM	Data Mode	11	<	6
	Data Mode Return	29	<	22
RR	Receiver Ready	13	<	8
	Receiver Ready Return	31	<	10

Table 5-22. EIA-530 DTE Cable Pin Assignments

ID	*FIRELINK 2000 Signal Name*	*DTE Unit DB-25*	*Data Flow*	*FIRELINK 2000 DB-25*
	Shield	1	< >	1
AB	Signal Ground	7	< >	7
BA	Transmitted Data	2	>	2
	Transmitted Data Return	14	>	14
BB	Receive Data	3	<	3
	Receive Data Return	16	<	16
DA	Transmit Signal Element Timing (DTE Source)	24	>	24
	Transmit Signal Element Timing Return (DTE Source)	11	>	11
DB	Transmit Signal Element Timing (DCE Source)	15	<	15
	Transmit Signal Element Timing Return (DCE Source)	12	<	12
DD	Receive Signal Timing	17	<	17
	Receive Signal Timing Return	9	<	9
CA	Request-to-send	4	>	4
	Request-to-send Return	19	>	19
CB	Clear-to-send	5	<	5
	Clear-to-send Return	13	<	13

Table 5-23. X.21 DTE Cable Pin Assignments

ID	FIRELINK 2000 Signal Name	DTE Unit DB-25	DTE Unit DB-15	Data Flow	FIRELINK 2000 DB-25
	Shield	1	1	< >	1
	Signal Ground	7	8	< >	7
TxD	Transmitted Data (A)	2	2	>	2
	Transmitted Data Return (B)	14	9	>	14
RxD	Receive Data (A)	3	4	<	3
	Receive Data Return (B)	16	11	<	16
Timing X	Signal Element Timing Out (A)-Transmit Timing X (A) (DTE Source)	24	7	>	24
	Signal Element Timing Out (A)-Timing X Return (B) (DTE Source)	11	14	>	11
N/A	Transmit Signal Element Timing (DCE Source)	Not used	Not used	<	15
	Transmit Signal Element Timing Return (DCE Source)	Not used	Not used	<	12
Timing S	Signal Element Timing In (A)-Timing S (A)	17	6	<	17
	Signal Element Timing In (A)-Timing S (B)	9	13	<	9
Control	Control (A)	4	3	>	4
	Control (B)	19	10	>	19
Indicator	Indicator (A)	5	5	<	5
	Indicator Return (B)	13	12	<	13

5.6.2 FIRELINK 2000 to DCE Cross-over Cables

The following tables (Table 5-24, Table 5-25, Table 5-26, Table 5-27) provide the cable wiring for connecting the **FIRELINK 2000** to DCE devices.

Table 5-24. Old V.35, V.35/V.11 DCE Cable Pin Assignments

ID	*FIRELINK 2000 Signal Name*	*DCE UNIT M-34 Pin*	*Data Flow*	*FIRELINK 2000 M-34 Pin*
101	Shield	A	< >	A
102	Signal Ground	B	< >	B
103	Transmitted Data	R	>	P
	Transmitted Data Return	T	>	S
104	Received Data	P	<	R
	Received Data Return	S	<	T
113	Transmit Signal Element Timing **(TT)**	V	>	U
	Transmit Signal Element Timing Return **(TT)**	X	>	W
115	Receive Signal Element Timing	U	<	V
	Receive Signal Element Timing Return	W	<	X
105	Request-to-send	F	>	C
109	Data Channel Receive Line Signal Detector	C	<	F

Table 5-25. RS-232 DCE Cable Pin Assignments

ID	FIRELINK 2000 Signal Name	DCE Unit DB-25 Pin	Data Flow	FIRELINK 2000 DB-25
	Shield Ground	1	< >	1
BA	Transmit Data	3	>	2
BB	Receive Data	2	<	3
CA	Request-to-send	8	>	4
AB	Signal Ground	7	< >	7
CF	Carrier Detect	4	<	8
	Send Timing	15	<	15
	Receive Timing	24	<	17
	Terminal Timing	17	>	24

Table 5-26. RS 422/449 DCE Cable Pin Assignments

ID	FIRELINK 2000 Signal Name	DCE Unit DC-37 Pin	Data Flow	FIRELINK 2000 DB-25
	Shield	1	< >	1
SG	Signal Ground	19	< >	7
SD	Send Data	6	>	2
	Send Data Return	24	>	14
RD	Receive Data	4	<	3
	Receive Data Return	22	<	16
TT	Transmit Signal Element Timing	8	>	24
	Transmit Signal Element Timing Return	26	>	11
RT	Receive Timing	17	<	17
	Receive Timing Return	35	<	9
RS	Request-to-send	9	>	4
	Request-to-send Return	27	>	19
CS	Clear-to-send	7	<	5
	Clear-to-send Return	25	<	13
TR	Terminal Ready	13	>	20
	Terminal Ready Return	31	>	23
RR	Receiver Ready	12	<	8
	Receiver Ready Return	30	<	10

Table 5-27. EIA 530 DCE Cable Pin Assignments

ID	FIRELINK 2000 Signal Name	DCE Unit DB-25	Data Flow	FIRELINK 2000 DB-25
	Shield	1	< >	1
AB	Signal Ground	7	< >	7
BA	Transmitted Data	3	>	2
	Transmitted Data Return	16	>	14
BB	Receive Data	2	<	3
	Receive Data Return	14	<	16
DA	Transmit Signal Element Timing	17	>	24
	Transmit Signal Element Timing Return	9	>	11
DD	Receive Signal Timing	24	<	17
	Receive Signal Timing Return	11	<	9
CA	Request-to-send	5	>	4
	Request-to-send Return	13	>	19
CB	Clear-to-send	4	<	5
	Clear-to-send Return	19	<	13

5.7 RF Cable And Antenna Installation

When running cables from the equipment location to the antenna tower or post, remember not to run cables close to motors, transformers, fans or any equipment that may cause noise or interference to the **FIRELINK 2000** radio. Any kind of electrical or electronic equipment may cause interference. Try to identify any possible source of noise. Also, identify any other telecommunication equipment similar to Spread Spectrum radio technology that may interfere with the radio signals.

If you find any other Spread Spectrum radio on site, identify the:

- Manufacturer
- Operation frequency
- PN Code
- Data rate
- Output power
- Antenna direction.

5.7.1 Antenna Installation

To place the antenna, you must have line-of-sight with the far end. When mounting the antenna, be sure you have enough vertical separation from any other antennas and devices that could cause interference. If there is not enough room on the tower or building, you can put a physical barrier between the antennas. This barrier can be as simple as a mesh wire. The barrier must extend outward beyond the antenna and be properly grounded. And. It may detune your antenna if located too close to it.

While proper grounding is essential for any installation, the fact that the antenna must be higher than other objects means that it will attract lightning. There is no protection from a direct lightning hit, but nearby hits can cause very large voltage surges. Please see Appendix A on procedures for grounding an antenna mast or tower.

5.7.2 RF Cables And Connectors

Most **FIRELINK 2000** problems are caused by bad connectors and poorly run cables. Cables must be well attached to a tower or posts using plastic tie wraps. As shown in Figure 5–19, use one tie wrap every meter to ensure that the cable is secure.

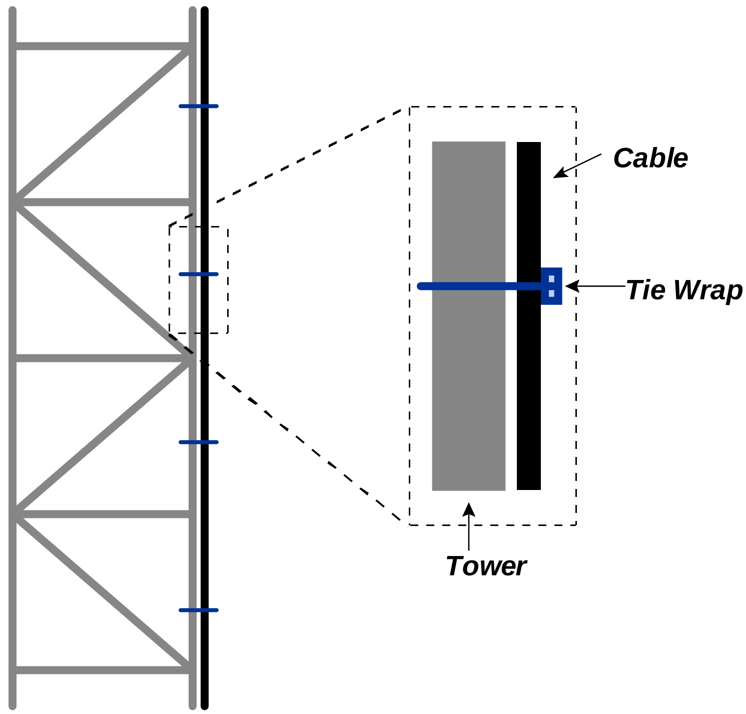


Figure 5–19. Cable Installation

If you break the cable or its insulation, you will alter the electrical characteristics of the cable, increase the radio losses and affect the quality of the link.

When installing the cable, watch for the following:

- Tighten the connectors well to make good solid contact with the cabling.
- Don't bend the cable tighter than its rated bend radius.
- Put the connectors on correctly and completely so that there is no grounding in the connector that will result in loss of signal.
- Weatherproof the connectors so that moisture cannot get inside. This may take multiple layers of weatherproofing tape moving progressively up the cable for about six inches (15 cm).
- When entering the building, be sure to allow for a drip loop in the cable so that rain water cannot get inside along the cable.
- Follow all regulations regarding building and fire codes.

When planning the cable runs, take into account all the extra cable needed for the entire run, along with the drip loops, the bend radius when making turns and any extra that might be needed. All of these lengths and any connectors add to the losses that must be accounted for in the link budget.

You can use an RF power meter to measure the power output at the antenna.

5.7.3 RF Connectors

FIRELINK 2000 radios use an N-type female connector. Since different cables could be used depending on the cable requirement, ensure that the connectors are the correct ones for each type of cable. There are two types of common connectors, as shown in Figure 5–20 and Figure 5–21. With the clamp connector, the cable is inserted by pressure. The crimp connector wraps around the cable and requires special tools to install. **The crimp connector is strongly recommended by LNL because it is much stronger and will last longer**.

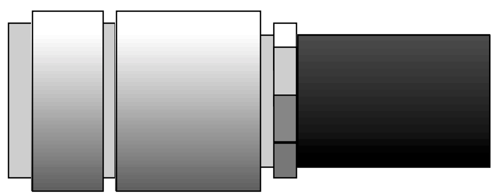


Figure 5–20. Clamp Connector

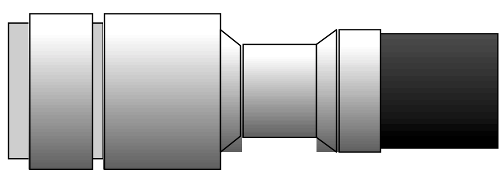


Figure 5–21. Crimp Connector (recommended)

Remember that where the connector is, there is a break in the cable. This means that it is a source for wind and rain to come in and affect the signal. Proper weatherproofing is critical to a long-lasting installation. For information on weatherproofing connectors contact **LNL**.

5.8 Burst Sync Cabling

For a hub (multi-link) application where more than one **FIRELINK 2000** radio is required, the burst sync connectors of the **FIRELINK 2000** radios must be connected together as described in Section 4.6.

1. Select a radio to be the source of burst timing for all of the radios at the hub site.
2. Connect a cable from the **Burst Sync Out** port of the selected radio to the **Burst Sync In** port of the next radio. Data grade cable (Category 3 UTP) cable is recommended. The connectors are RJ-48. Each cable is wired straight through (i.e. pin 1 is connected to pin 1, pin 2 to pin 2, etc.) All radios at the hub site must be connected together in this fashion.
3. The burst sync source and termination should be set as described in Section 4.6.

If the **FIRELINK 2000** radio is installed at a site which has **FIRELINK** radios in operation the **FIRELINK** radio must be used to provide burst sync for all radios. The burst sync signal from the **FIRELINK** radio uses RS-232 electronics. The **FIRELINK 2000** radio uses RS-485 which allows many more radios to be connected as well as longer cable length. Figure 5–22 shows the required connections for the RS-232 to RS-485 converter which must be used in this application.

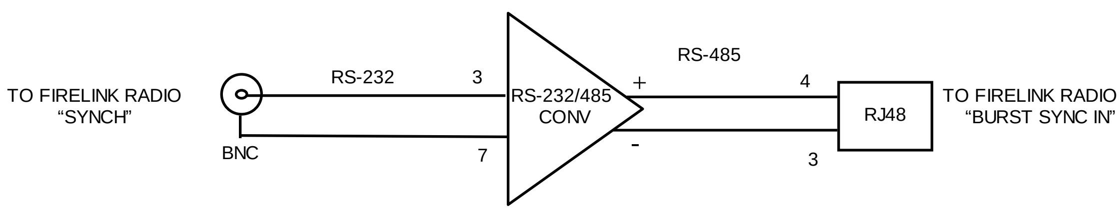


Figure 5–22. RS-232 to RS-485 Converter for Burst Sync

For a repeater application the **Burst Sync Out** port of the Slave radio at the repeater site must be connected to the **Burst Sync In** port of the Master radio at the repeater site. Use the same cable type as in the Hub application. See Section 4.2.2 for additional discussion of the repeater application.

5.9 Connecting Power

The **FIRELINK 2000** radio has power supplies for both AC and DC operation. The AC power supply converts the AC input power to 48 VDC. This output is one of four possible inputs to the DC power supply. A second AC power supply can be ordered as an option to provide redundant AC power supplies. AC power in connected to the unit via a standard three-prong (EIA 320) AC connector on the I/O panel.

Caution: To avoid danger of electrical shock or power loss, make sure that the power cord is securely seated in the receptacle of the radio. This equipment is designed to work with electrically grounded systems. To ensure your safety, connect the power cable only to a properly grounded outlet.

The DC power supply can operate using an input from either of the two DC power inputs or from the primary or redundant AC power supply outputs. The four inputs to the DC power supply are diode connected so that the radio will operate if any of the four power sources are present.

DC power is connected via a four-position terminal block as shown in Figure 5–23. The polarity (+/-) of the DC power inputs is automatically selected. Connect the highest potential (+ or -) DC input to the A or B input and connect the return side to the RTN pin. This return should be the voltage closest to the chassis ground potential. The DC ground input GND should be connected to the ground of the external DC supply.

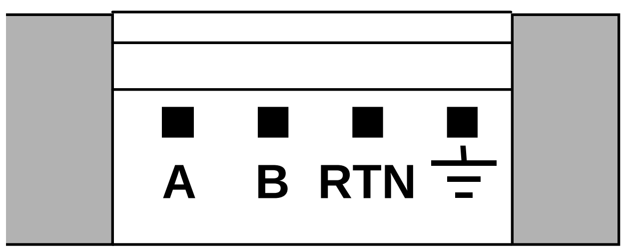


Figure 5–23. DC Power Connections

5.10 Connecting Ground

Proper equipment grounding between the radio and the DTE equipment and the power supply sources is critical to prevent large common mode voltages and currents in the data lines. The **FIRELINK 2000** radio has a ground lug located directly under the RF connector. This connector should be tied directly to the building ground to provide the radio chassis, the DTE equipment and power supplies the same reference ground. Failure to connect this common chassis ground may create excessive common mode current on the data or ground pins in the cable connecting the equipment and result in failure of the interface drivers.

5.11 Connecting the Alarm Contact Closures

The **FIRELINK 2000** radio has two alarm relay contact closures for the Major and Minor summary alarms. These relays are type A and close when in the alarm state. In addition, 3 contact closure inputs are provided for customer inputs to be transported across the RF link. The contact closure inputs are considered inactive when inputs are open and active when shorted to ground.

Connection to the alarm relay contact closures and contact closure inputs uses the nine-pin D-type connector on the I/O panel labeled "ALARMS". This connector is shown in Figure 5–24.

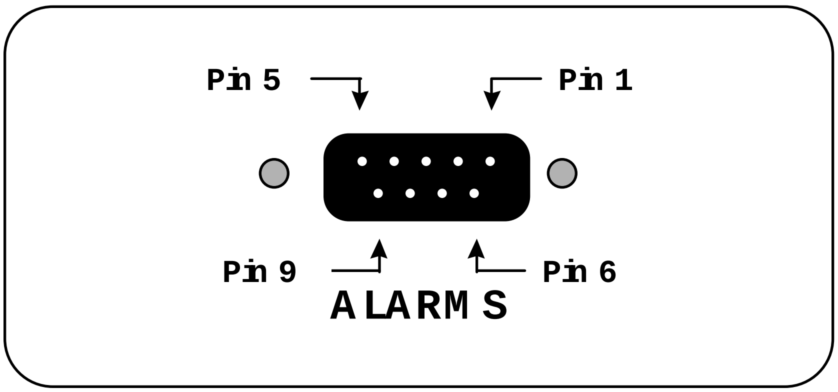


Figure 5–24. Alarm Relay Contact Closure Connector

The connector pin number assignments are shown in Table 5-28.

Table 5-28. FIRELINK 2000 Connector Pinout

Pin Assignment	*DB 9 Pin No.*
Major Alarm (A)	1
Major Alarm (B)	2
Minor Alarm (A)	3
Minor Alarm (B)	4
Future Use	5
Contact Closure 1	6
Contact Closure 2	7
Contact Closure 3	8
Ground	9

5.12 System Start Up

After you have configured and cabled your **FIRELINK 2000** radios (Master and Slave), the green **POWER LED** on the front of the equipment will be illuminated. If the **POWER LED** is not on, check your connections.

5.13 Antenna Alignment

FIRELINK 2000 radios require a clear line of sight, and a very solid structure to hold the antenna. To make sure the equipment is operating optimally, the antennas **must be** properly aligned. Directional antennas must be aligned so that maximum antenna gain is achieved in the direction of the far-end antenna. Once the antenna is assembled and mounted in place, follow these steps:

1. Perform initial alignment using a map and compass. If the remote location is difficult to see, have a person at the remote location use a mirror to flash the sunlight so that you can locate the tower.
2. Connect the RF cable to **FIRELINK 2000**.
3. Set the output power level of the **FIRELINK 2000** radio to the maximum legally approved level according to your local regulations. This power should be reduced at the completion of the installation.
4. Turn the radio on. The **POWER** light should turn on, but not the **SYNC LED**.
5. Follow the same procedure (steps 1-4) at the remote site and be careful to use the same polarization in both antennas.
6. When both antennas are mounted on the towers and the radios are turned on, attach a multimeter to the **RSSI** test points on the back of the **FIRELINK 2000** radio. If the **SYNC LED** is not on, refer to Section 6 suggestions on troubleshooting.
7. Record the RSSI signal.
8. At site A, start sweeping the antenna in the horizontal plane until the highest RSSI is reached (see Figure 5–25).
9. Then make a vertical sweep until the highest RSSI is reached (see Figure 5–26).
10. Lock down the antenna. Make sure you do not move the antenna when tightening the bolts. Verify that the RSSI reading has not changed.

11. Follow the same procedure at remote site B.
12. Once the antennas have been aligned reduce the output power level to no more than 20 dB above the receiver threshold. This will minimize interference potential while providing sufficient margin for a high quality link.

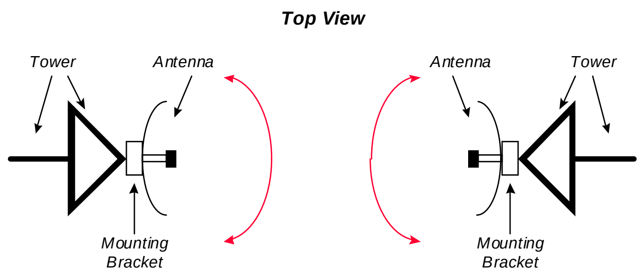


Figure 5–25. Horizontal Antenna Alignment

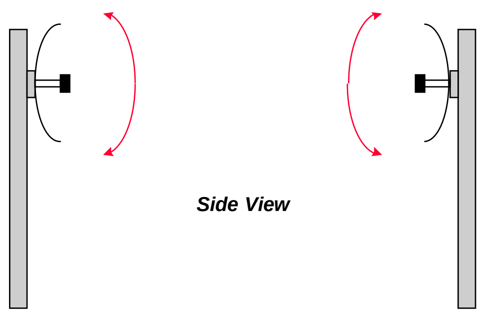


Figure 5–26. Vertical Antenna Alignment

This procedure must be performed by two people, one reading the RSSI and the second moving the antenna. You will either have to have the radio mounted temporarily near the antenna or have some communications between the two engineers, such as hand-held radios or cellular phones.

5.13.1 If the Signal Is Too Strong

If the signal is too strong, causing saturation of the RSSI reading, the signal must be attenuated during alignment to allow optimum adjustment.

1. Decrease the transmit power setting of the opposite radio or add a pad (attenuator) between the antenna and the radio;
2. When the alignment is complete, remove the attenuator.

5.13.2 Confusing the Main Lobe with the Side Lobes

Every directional antenna has side lobes. Typically, directional antennas have side lobes, which are just 15 to 20 dB below the main lobe. If the signal is strong, it is possible to confuse the main lobe with a side lobe, thereby aligning the antenna with a side lobe directed toward the opposite antenna. Verify that the correct lobe was chosen by rotating the antenna over a wide sector of at least 45 degrees and selecting the highest reading.

The strength of the received signal can be found by reading the RSSI value on the terminal, LCD screen, or by measureing voltage value (DC) at the RSSI test points. This voltage can be used to determine the RSSI power level in dBm using the tables in Section 4.5. About 15 to 20dB of fade margin should be present in the link to account for the various fading conditions. Make sure to bolt the antenna down securely to keep it from moving in wind.

Once you have determined that your link is in good condition and the antenna is properly aligned, secure the antenna cable on both sides of the connectors with tie wraps as shown in Figure 5–27.

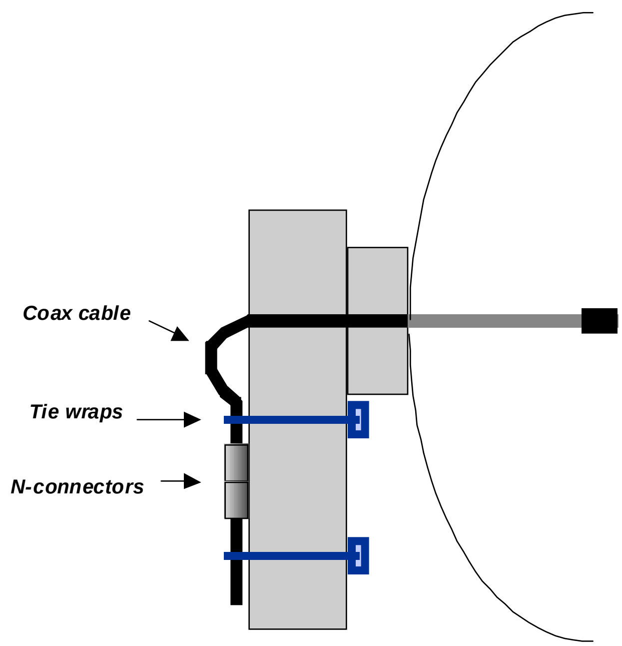


Figure 5–27. Secure RF Cable with Tie Wraps

6. Troubleshooting

This section describes how to:

- resolve operation problems
- maintain the **FIRELINK 2000** Spread Spectrum radios.

6.1 Status Indicators and Alarms

The following sections review the **FIRELINK 2000** radio status indicators and summary alarms. The alarm conditions result in illumination of LEDs and activation of contact closures. Status items result in the illumination of LEDs.

6.1.1 Status Indicators

FIRELINK 2000 has the following status indicators on both the I/O and Non-I/O panels. These indicators give the user immediate feedback on the status of the current link.

In addition, these indicators are used during power on self test to indicate various self test failures. During a normal power on sequence, the LED's will blink in a specific order indicating the stages of initialization. Normally this will complete in less than 1 minute and a few beeps will be heard. The main menu will also scroll on the terminal screen. At this time the ACO light will be always on or off.

If a power on self test failure should occur, it will be indicated by a continuous slow ACO light blinking along with one of the other with LED's. This condition should be reported to LNL technical support for further isolation and resolution.

Table 6-1. Status Indicators

Indicator	*Description*
ACO	This yellow LED indicates whether a current alarm has been cut off. If the ACO switch is activated while an alarm is active, the ACO indicator is illuminated. This indicator remains illuminated until all alarms which were active when ACO was activated are cleared.
PWR	This green LED illuminates if the unit is powered on.
SYN	This green LED illuminates when the receiver successfully synchronizes with the received RF signal.
MJR	This red LED illuminates when a major alarm is detected. See Section 6.1.2
MNR	This red LED illuminates when a minor alarm is detected. See Section 6.1.3
ERR	This yellow LED flashes momentarily when CRC errors are detected in the receive bit stream.
TST	This yellow LED illuminates when any test mode is active.
TXD	This yellow LED illuminates momentarily when a logical one is received at the DTE interface from the DTE unit.
RXD	This yellow LED illuminates momentarily when a logical one is sent from the DTE interface toward the DTE unit.
RTS	This yellow LED illuminates when a logical one is received at the DTE interface from the DTE unit. The radio assumes RTS is asserted unless the interface is set to X.21 mode and the RF link is unavailable.
CTS	This yellow LED illuminates when a logical one is sent from the DTE interface toward the DTE unit. This will always be asserted unless the interface is in X.21 mode and the RF link is unavailable.
LCD/Keypad Interface (optional)	The LCD and 4 button keypad provide access to all internal configuration parameters without the need for an external terminal interface. When not in use, the LCD can continuously display near or far end RSSI. When in use, the up/down key is used to scroll the possible menu options, the enter key selects the current option displayed, and the cancel key exits the current menu.

6.1.2 Major Alarms

A major alarm is declared if any of the following conditions occur.

Table 6-2. Major Alarm Conditions

Alarm	*Description*
SYNC Alarm (SYNC)	Alarm is indicated if the receiver is unable to obtain RF or data synchronization.
Transmit Fail (XMT)	Alarm is indicated if a radio transmitter failure is detected.
TT Fail Alarm (TT Fail)	Alarm is indicated if the radio is a master radio in DTE or CLKLoc timing mode and no transitions are detected on the TT clock pin.
Burst Sync Alarm (BS)	Alarm is indicated if the radio has been provisioned for external burst sync mode and the burst sync Ref In signal has failed.
Radio Self Test Alarm (UNIT)	Alarm is indicated if the radio fails a self test diagnostic after power up.

6.1.3 Minor Alarms

A minor alarm is declared if any of the following conditions occur.

Table 6-3. Minor Alarm Conditions

Alarm	*Description*
Receive Level Alarm (RCV)	Alarm is indicated if the received signal level is within 10dB of the threshold sensitivity. This indicates low link margin.
Power Supply Alarm (PWR)	Alarm is indicated if any power supply of the local radio has failed. This alarm is only activated if it has been enabled on the Power Alarm Configuration Menu.
Far End Power Supply Alarm (PWR)	Alarm is indicated if any power supply of the far end radio has failed. This alarm is only activated if it has been enabled on the Power Alarm Configuration Menu of the local radio.

6.2 Operational Problems

The following is a list of possible operational problems and their solutions. Follow the procedures described until the problem is resolved. If none of the procedures resolve the problem, contact your distributor or **LNL**, for additional assistance.

To determine the status of the Spread Spectrum radios, look at the **SYNC** light and the **RSSI** value.

6.2.1 Power LED is OFF

- Verify power connections.
- For DC power verify that the DC connections are properly wired.
- For AC power units verify that the power input meets the specifications in Section 3. Verify cabling.
- For AC power, verify that the fuses are not blown. Fuse 1 is for the standard AC power supply and Fuse 2 is for the optional redundant supply.
- If the POWER LED indicator is still off, call LNL for assistance or return the unit for repair.

6.2.2 SYNC LED is OFF, and was never ON before

- Verify that the POWER light is ON.
- Check the configuration settings.
- Verify that both radios are set to the same RF Channel number.
- Verify that both radios are set to the same **PN** sequence.
- Make sure that the Master/Slave setting is correct.
- Make sure that the Burst Sync timing setting is correct. If a radio is set for external burst timing and a suitable signal is not connected to the BURST SYNC IN connector, the radio will stop transmitting and declare an alarm.
- Check all cable connections.
- Check the antenna connection and alignment.
- Check the RSSI level. If the level is high and the other parameters are set correctly, it is possible that RF interference is present on the channel. In this case, try another channel or the changing antenna polarization and PN sequence.

6.2.3 SYNC light is OFF, but was ON before

Check the following:

- Verify that the Power light is ON.

- Verify that the configuration settings have not been changed for channel, PN sequence, master/slave and burst sync settings.
- Check all cable connections for loose or damaged cables or connectors for the burst sync and RF signals.
- Check the RSSI level. A low RSSI level can indicate a problem with the cables or antenna connection and alignment. This level can be compared to a saved reference value. If the RSSI level has reduced, pay particular attention to the RF cable connections. Water in the RF cables is a common source of problems.
- Check for interfering signals using a spectrum analyzer. If necessary change the RF Channel or antenna polarization.

6.2.4 SYNC light is ON, but no data is being transferred

- Check the wiring of the user data cable. Some DTE or DCE equipment requires the RTS and CTS lines be routed in the cable. The **FIRELINK2000** assumes these lines are asserted unless the radio is in X.21 mode. The RTS and CTS LED's can help identify if this is a problem.
- Verify that the radio clock source selection is correct. If a radio is set for DTE clock and there is no clock signal present on the TT lead, the radio will stop transmitting and declare an alarm.
- The TXD and RXD indicators can be useful to indicate whether there is data flow at the user data interface.

6.2.5 Link functions but has bit errors

- Observe if the RF sync light is steadily on and that the RSSI levels are as expected.
- Verify that the clock sources are properly configured on each end of the link and that the data cables are properly wired and connected. Improper clocks can cause streaming errors or occassional clock slips and sync losses to occur.
- Verify that the antenna is properly aligned and securely mounted so that it does not move during high winds. A loose antenna will often exhibit errors during rain storms because of the winds.
- Verify the path calculations including link margin and line-of-sight.
- Check for intermittent interfering signal using a spectrum analyzer set for peak or Max hold.

6.3 Diagnostic Aids

6.3.1 Loopbacks

Loopbacks are provided at the local and far-end radios. Local loopback is a bi-directional loopback at the local radio. The data received from the far end radio is transmitted back to the far-end radio. The data received from the **DTE** is sent back to the **DTE**.

Far-end loopback is bi-directional loopback at the far-end radio. The data received from the local radio is transmitted back to the local radio. The data received from the **DTE** at the far end is sent back to the **DTE**. The loopbacks are controlled from the **FIRELINK 2000** configuration screens. See Section 5.3.7 for more details.

6.4 Maintenance

FIRELINK 2000 units make use of very sophisticated component technology, including considerable surface mount components. For this reason field replacement of components or card repair are not within the scope of the field maintenance options. Any component replacements or internal adjustments made to the equipment will result in automatic nullification of the Warranty on the product.

6.4.1 Replacing the AC power fuses

The AC power fuses are located next to the AC power connector on the I/O panel. Fuse 1 is for the primary AC power input and Fuse 2 is for an optional redundant AC power supply. Remove AC power before checking any fuses. If a fuse blows, remove the fuse from the fuse holder and inspect the melted metal conductor. If the fuse is blown, replace with an identical fuse (5x20mm, 250V, 2 Amp fast blow, Bussman GDA or GDB equivalent). If the fuse blows immediately again, measure your AC line voltage. If the voltage is within the specification, report the condition to **LNL** technical support.

7. Equipment Return

This section describes the following:

- Customer Service
- Equipment Return Process
- Equipment/Material Return Form
- LNL Web Site

7.1 Customer Service

For **LNL** Customer Service:

Outside the USA, Contact your distributor. dial **1-770-368-2663 ext: 296**

To contact LinkaNet Labs technical support**:**

Email**: intl-support@linkanet.com**

Telephone number in USA: **770-368-2663**

9 AM to 6:00 PM EST ask for the **LinkaNet Technical Support Desk**

6:00 PM to 9 AM EST You will reach Technical Support through a paging service with guaranteed call back within 30 minutes.

7.2 Equipment Return Process

The following process should be used whenever returning equipment to **LNL**:

1. Fax a completed copy of the RMA Request Form (see Figure 7.1) to **LNL** or your distributor. The completed form should include customer name, return shipping address, part numbers, serial numbers, and a brief statement of the problem. Additional paperwork may be attached if needed.

   FAX: FAX to **LinkaNet Labs** at **1-770-417-3590**

   Phone: Call +**1-770-368-2663**, ask for the **LinkaNet Labs RMA Desk**

   E-Mail: **intl-support@linkanet.com**

2. **LNL** or your distributor will fax the form back to you with the RMA number written at the top of the form.

3. Make a photocopy of the returned RMA Request Form. **Pack the equipment and photocopy** in the original shipping containers if possible. If not, pack the failed unit so as to protect it from shipping damage. **LNL** is not responsible for shipping damage.

All equipment received without an RMA number will be returned.

4. Obtain insurance from the shipper which will cover the entire value of the equipment being returned.
5. Send the equipment (pre-paid shipping) and form to the following address. Some repairs may be able to be serviced at regional LNL repair depots. Contact your distributor for more information.

LinkaNet Labs, Inc.
3000 Northwoods Parkway, Building 330,
Norcross, Georgia, 30071
USA

6. **LNL** will contact the sender when the unit has arrived and has been inspected. At that time, **LNL** will provide an estimated return shipping date. An estimate of the repair cost will be given for all non-warranty repairs and the return shipping method will be requested.
7. All repairs covered under warranty will be completed at no cost and the return shipping (surface) will be paid for by **LNL**. Repairs not covered by the warranty will be performed at current **LNL** labor rates and material costs and billed to the customer. The customer will be billed for shipping for non-warranty repairs.
8. RMA status updates: The RMA Request Form or email may be used to request repair status from **LNL**. When the RMA form is faxed or emailed to **LNL** with the RMA number at the top, **LNL** will send it back with appropriate status information recorded.

7.3 Equipment/Material Return Form

The RMA Request Form is shown on the following page in Figure 7–1. Copy this form and include a completed copy with the equipment you are returning.

LinkaNet Labs

RMA REQUEST

RMA Number:

☐ Request For RMA Number

☐ Request For RMA Status

RMA Fax #: 770-417-3590
Shipping Address: 3000 Northwoods Pkwy, Bldg 330
Norcross, GA 30071 (USA)

Customer Information	
Customer Name:	Shipping Address:
Contact Name:	
Phone:	
Fax:	
Email:	

Equipment Information (Customer Use)	
Brief Description of the problem:	Part or Serial Numbers:
☐ Modem Unit Only ☐ RF Unit Only	

Status Information (LinkaNet Labs Use)

1) To request an RMA number, please complete the Customer Information and Equipment Information Sections. The form will be faxe back with a RMA number assigned. Please include a copy of this form with your shipment.
2) To request a RMA status update, please complete the Customer Information and the RMA number, and fax it to LinkaNet Labs. It will be faxed back with a status update.

Figure 7–1. RMA Request Form

7.4 LNL Web Site

Please visit our Web Site for the latest news and information about the **FIRELINK 2000**, the **FlexE1** Network Access Multiplexer product family and other quality **LNL** products. Our address is http://www.linkanet.com.

Appendix A

This appendix contains information on the following:

- Site Grounding Practices

Site Grounding Practices

Currents induced by lightning strikes are a menace for all facilities that involve an externally mounted antenna. Surge currents can be dangerous to people and equipment. Lightning can strike in virtually any type of weather, not just during thunderstorms . The best prevention method known is proper grounding of all metal components at the transmission site.

Site Grounding

The first major component in the grounding system is called the ground rod subsystem. It consists of a buried ring surrounding the facility. The ring is made of ground rods tied together by bare copper wire. The tower base must be surrounded by a similar ring. The copper wire must be buried between 2.5 and 3 feet (0.8 to 1 meter) deep depending on the quality of the soil. As soil conductivity decreases, depth must increase. If there is a separate generator shelter, this too must have its own subsystem. All ground rod subsystems must be tied together with copper wire, to form an integral ground rod subsystem. All metal objects within the facilities must be connected to the ring, including fences, metal roofs, fuel tanks, air-conditioning ducts and AC neutral.

Tower Grounding

The lightning arresting rod on the top of the tower must be close to any protruding object (beacon, antenna, etc.) and should surpass its height by at least two feet (0.6 meters). This is called the surge protection subsystem and ties into the ground rod subsystem by a run of bare copper wire on the outside face of the tower leg. This bare wire also should be grounded by at least three times: on the top of the tower, at the middle and just before the transition from vertical to horizontal prior to the entry point on the shelter. This last grounding point must be placed on the vertical side of the transition. Where feasible, all connections should be exothermic welds. On feedlines, grounding kits may be used.

External Site Grounding

Basically, all metal conductors must be grounded immediately before the entry point, and the ground should be tied to the ground rod subsystem.

Internal Site Grounding

All metal components within the site should be grounded to a single point, which in turn is connected to the external ground rod subsystem. All static discharge devices or lightning protection units on the feedlines should also be grounded to this point.

Static/surge protectors such as the Polyphaser units, should be installed in all lines, (power, feedlines or telephone lines) entering the facilities. Fast clamp surge arrestors, such as MOV (Metal Oxide Varistors) should be installed at all power outlets.

All racks, cabinets or equipment enclosures should be grounded.

At remote sites, specially mountain top, if there is a choice of AC versus DC power, DC should be chosen, and any battery charging equipment should be fed through an isolation transformer, with MOVs both on the primary and the secondary.

When grounding the tower, route the grounding wire on the external face of one of the legs, and the feed lines on a different one, or on open “ladder” cable guide. Also, the ground wire exiting the shelter should be separated from the conductors entering.

Guy wires should all be tied together and grounded to the ground rod subsystem, to avoid turnbuckle meltdown and possible tower collapse in the event of a direct strike.

Feed lines should be stripped to expose the braid or outer conductor, and ground wires clamped with stainless steel/cooper clamps and then weatherproofed.

When using DC power, the batteries should have an isolated DC return path (not grounded) to avoid division of the return path between other grounded conductors, and to provide additional protection from interference on the DC lines. This also keeps external surge currents away from the DC system.

When setting up a system in a building or in-town facility, all the requirements can’t be met, but proper antenna/mast grounding procedures should be implemented, with a lightning arresting rod and at least one ground rod. All indoor units must be tied to the AC frame ground, with separate grounding straps. (The ground wire in most power cables is too thin to handle heavy current.) Please remember to ground all racks and enclosures.

Appendix B

This Appendix contains:

- a Configuration Worksheet on which you can record the configuration settings for the **FIRELINK 2000** Spread Spectrum radios
- a Path Analysis Worksheet to assist you in calculating the Fade Margin described in the Section 4, System Planning.

The link designer can copy these forms and provide the completed form to the installer.

FIRELINK 2000 24-64/23-64 Configuration Worksheet

Engineers Name:	**Site Name:**	**RF Cable Type:**
Radio Serial Number:	**Antenna Type:**	**RF Cable Length:**
Radio Configuration Settings		
Parameter	***Values***	***Setting***
Transmit Power Level	0 to 28 dBm (even number values)	
RF Channel Number	See section 4.7.2	
PN Sequence Number	1 - 8	
Data Rate	64, 56, 19.2, 9.6, 4.8, 2.4, 1.2 kbps	
DTE Interface	V35/V11, Old V35, RS-422, RS-232, EIA530, X.21	
DTE Clock Source	DTE, Link, Internal, Local, Internal/ST, Link/ST	
ST Clock Phase	Normal, Inverted	
TDD/Burst Sync Mode	Burst Sync Master with Internal Burst Timing Burst Sync Master with External Burst Timing Burst Sync Slave with Internal Burst Timing	

Burst Sync Termination	Terminated or Not Terminated	

FIRELINK 2000 24-128/23-128 Configuration Worksheet

Engineers Name:	**Site Name:**	**RF Cable Type:**
Radio Serial Number:	**Antenna Type:**	**RF Cable Length:**
Radio Configuration Settings		
Parameter	**Values**	**Setting**
Transmit Power Level	0 to 28 dBm (even number values)	
RF Channel Number	See section 4.7.2	
PN Sequence Number	1 - 8	
Data Rate	Nx64 (128), Nx56 (112) kbps	
DTE Interface	V35/V11, Old V35, RS-422, RS-232, EIA530, X.21	
DTE Clock Source	DTE, Link, Internal, Local, Internal/ST, Link/ST	
ST Clock Phase	Normal, Inverted	
TDD/Burst Sync Mode	Burst Sync Master with Internal Burst Timing Burst Sync Master with External Burst Timing Burst Sync Slave with Internal Burst Timing	
Burst Sync Termination	Terminated or Not Terminated	

FIRELINK 2000 24-256/23-256 Configuration Worksheet

Engineers Name:	**Site Name:**	**RF Cable Type:**
Radio Serial Number:	**Antenna Type:**	**RF Cable Length:**
Radio Configuration Settings		
Parameter	**Values**	**Setting**
Transmit Power Level	0 to 28 dBm (even number values)	
RF Channel Number	See section 4.7.2	
PN Sequence Number	1 - 8	
Data Rate	Nx64 (256), Nx56 (224) kbps	
DTE Interface	V35/V11, Old V35, RS-422, RS-232, EIA530, X.21	
DTE Clock Source	DTE, Link, Internal, Local, Internal/ST, Link/ST	
ST Clock Phase	Normal, Inverted	
TDD/Burst Sync Mode	Burst Sync Master with Internal Burst Timing Burst Sync Master with External Burst Timing Burst Sync Slave with Internal Burst Timing	
Burst Sync Termination	Terminated or Not Terminated	

FIRELINK 2000 24-384/23-384 Configuration Worksheet

Engineers Name:	**Site Name:**	**RF Cable Type:**
Radio Serial Number:	**Antenna Type:**	**RF Cable Length:**
Radio Configuration Settings		
Parameter	**Values**	**Setting**
Transmit Power Level	0 to 28 dBm (even number values)	
RF Channel Number	See section 4.7.2	
PN Sequence Number	1 - 8	
Data Rate	Nx64 (384), Nx56 (336) kbps	
DTE Interface	V35/V11, Old V35, RS-422, RS-232, EIA530, X.21	
DTE Clock Source	DTE, Link, Internal, Local, Internal/ST, Link/ST	
ST Clock Phase	Normal, Inverted	
TDD/Burst Sync Mode	Burst Sync Master with Internal Burst Timing Burst Sync Master with External Burst Timing Burst Sync Slave with Internal Burst Timing	
Burst Sync Termination	Terminated or Not Terminated	

FIRELINK 2000 24-512/23-512 Configuration Worksheet

Engineers Name:	**Site Name:**	**RF Cable Type:**
Radio Serial Number:	**Antenna Type:**	**RF Cable Length:**
Radio Configuration Settings		
Parameter	**Values**	**Setting**
Transmit Power Level	0 to 28 dBm (even number values)	
RF Channel Number	See section 4.7.2	
PN Sequence Number	1 - 8	
Data Rate	Nx64 (512 kbps)	
DTE Interface	V35/V11, Old V35, RS-422, RS-232, EIA530, X.21	
DTE Clock Source	DTE, Link, Internal, Local, Internal/ST, Link/ST	
ST Clock Phase	Normal, Inverted	
TDD/Burst Sync Mode	Burst Sync Master with Internal Burst Timing Burst Sync Master with External Burst Timing Burst Sync Slave with Internal Burst Timing	
Burst Sync Termination	Terminated or Not Terminated	

FIRELINK 2000 Path Analysis Worksheet

The following worksheet is useful for path calculations if the spread sheets discussed in Section 4.5.4 are not available.

	Path Information	**Path Distance**
	Master	**Slave**
Latitude: Longitude: Antenna Azimuth: Cable Length: Fade Margin ( ): ( ) Target Fade Margin is > 15 dB		

Verifying Line-of-Sight (LOS)

Earth Bulge (Height)	+	________________
Obstacle Height	+	________________
0.6 First Fresnel Zone Height	+	________________
Minimum Antenna Height		________________
Actual Antenna Height	________________	

Fade Margin Calculations

System Gain		________________
Free Space Path Loss	-	________________
Antenna Gain Master	+	________________
Antenna Gain Slave	+	________________
Cable & Connector Loss - Master	-	________________
Cable & Connector Loss - Slave	-	________________
Net Fade Margin		________________

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