



2.048Mbps Wireless Modem:

G703: MWU2000-G703

X.21: MWU2000-X21

V.35: MWU2000-V35

Directional Antennas with 10 m of cable:

12dBi Transmit/ 12dBi Receive:

MWU2000-1212

12dBi Transmit/ 18dBi Receive:

MWU2000-1218

12dBi Transmit/ 24dBi Receive:

MWU2000-1224

2.048Mbps Wireless Modem

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Introduction

About this Manual

The following summary will help you quickly locate the information you need in this User Manual.

This introductory chapter contains a description of the product, its main features, components and benefits.

Chapter 2; Installation and Antennas provides the basic installation guidelines, lists the different antennas, cables and RF accessories, gives a description of the available antenna sets, guides you in selecting the correct antenna or antenna set for specific applications, explains how to align the antennas for optimal performance and how to synchronize two or more co-located 2.048 Wireless modems units.

Chapter 3; Setup and Configuration explains how to access the system monitoring and configuration functions, lists the statistical information, the system configuration parameters and the various system diagnostic tests. All explanations refer to software version 1.7.

Chapter 4. Troubleshooting provides some useful troubleshooting tips.

Chapter 5. Technical Specifications lists system specifications of the 2.048Mbps Wireless Modem and accessories.

Appendix A. V.35/RS-530/X.21 Applications contains a description of possible configurations when connecting V.35/RS-530/ X.21 end equipment to the 2.048Mbps Wireless Modem.

Appendix B. E1/T1 Applications describes ways to connect an E1/T1 2.048Mbps Wireless Modem to E1/T1 end equipment.

Appendix C. Fractional E1/T1 Applications describes the relevant parameters for Fractional E1/T1 applications, including the importance of using echo cancellation with voice channels.

Appendix D. Installing Other Types of Receive Amplifiers provides tips on installation of different types of receive amplifiers, which are supported by the 2.048Mbps Wireless Modem but are not supplied by Black Box.

Note: This manual describes 2.048Mbps Wireless Modems with hardware version 2 that are running software version 1.7. A 2.048Mbps Wireless Modem running software version 1.7 should be only used in links where the same software version is running on the other modem. It is not recommended to run software version 1.7 on hardware version 1, since many features available in software version 1.7 are not supported. This includes support of FractionalE1 and Fractional T1 LIUs, synchronization of collocated units and RSSI measurement using a DVM.



Product Description

The 2.048Mbps Wireless Modem is a high-speed full-duplex wireless modem, employing two separate RF channels for simultaneous transmission and reception of data. Using Frequency Hopping Spread Spectrum Radio Frequency modulation, the 2.048Mbps Wireless Modem permits robust and reliable wireless communication between remote sites where a physical wired connection would be impossible, impractical or too expensive. The 2.048Mbps Wireless Modem/2048 supports data Transfer at speeds of up to 2.048 Mbps. A DSP modem with adaptive equalization provides a dependable communication link even in bad line-of-sight conditions.

The compact dimensions of the 2.048Mbps Wireless Modem permit easy installation. The unit is housed in a 1U half 19" enclosure for simple and time-saving installation. Optional line adapters enable interfacing of T1, E1, Fractional E1, Fractional T1, RS-530, V.35 or X.21 digital terminal equipment. A built-in echo canceller provides improved voice quality in voice applications using the Fractional E1/T1 line interface unit. An RS232/V.24 interface is provided for local and remote status monitoring, diagnostics and configuring system parameters. The system operates in the 2.4 GHz ISM band allowing license-free installation.

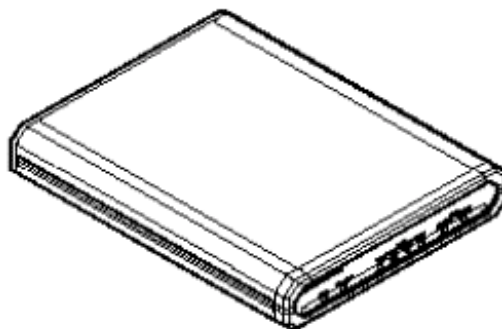


Figure 1.1: 2.048Mbps Wireless Modem



Figure 1.2: 2.048Mbps Wireless Modem Front Panel

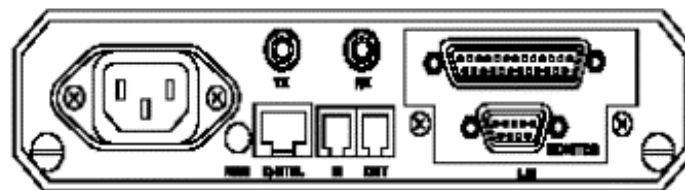


Figure 1.3: 2.048Mbps Wireless Modem Rear Panel



2.048Mbps Wireless Modem

Main Features of the 2.048Mbps Wireless Modem

Wireless Connectivity

The 2.048Mbps Wireless Modem provides a wireless data link. The DSP modem with adaptive equalization provides robust and reliable communication, overcoming problems caused by fading or interfering signals.

Seamless Communication

A full-duplex system with independent transmitting and receiving modems and RF channels allows seamless two-way communication.

Versatility

The 2.048Mbps Wireless Modem can transfer any kind of data, voice or video transmissions and can be operated together with most types of bridges, routers and multiplexers. The system supports the E1/T1 communication standards and with the appropriate Line Interface Unit, is compatible with any other communication link standards and operates transparently to data protocols. Fractional E1/T1 applications with voice channels are supported by a special line interface unit, incorporating a built-in echo canceller for improved voice quality.

Error-Free Data Transfer

Spread Spectrum Frequency Hopping gives reliable low BER (Bit Error Rate) data transfer and protection against interference. Error correction is provided by ARQ (Automatic Retransmission Queuing).

High Speed Communication

High data rates enable fast, time saving communication. The 2.048Mbps Wireless Modem supports full E1 rate of 2048 Kbps, full T1 rate of 1544 Kbps and transparent synchronous speeds of $n \times 64$ Kbps.

Easy Control and Monitoring

Eight LED indicators are provided for system status monitoring. Simple, easy to use management menus provide configuration and diagnostics for both the local and remote unit via an RS-232/V.24 connection. For further information on LED indicators see page15.

Remote Management

2.048Mbps Wireless Modem enables management of each unit from the other unit through the Radio link.

RSSI

Antenna reception can be fine-tuned by checking the strength of the received signal. To check signal strength, connect a Digital Voltmeter (DVM) to the Receive Signal Strength Indicator (RSSI) test point on the rear panel of the 2.048Mbps Wireless Modem.

Co-location

This option enables to simultaneously establish a number of co-located links in star or parallel topology, when they are synchronized in frequency via a synchronizing cable. Using this option may be restricted by regulation in certain countries.

Choice of Antennas, Cables and RF Accessories

Several optional types of antennas, cables and RF accessories are provided allowing selection of the RF components best suited for different applications.

2.048Mbps Wireless Modem Benefits

- Provides a cost-effective alternative to leased telephone cable service.
- Saves the expense of costly wire or fibre optic cable installation.
- Connects off-shore installations and sites separated by water, hazardous terrain or difficult weather conditions.
- Is simple to install, giving immediate communication ability to remote sites.
- Links headquarters with branch offices.
- Provides a back-up link for cable connections.

2.048Mbps Wireless Modem Components

The 2.048Mbps Wireless Modem is comprised of four main components:

- Line Interface Unit
- Modem
- Radio
- Antennas

These components are described in detail in the following sections.



2.048Mbps Wireless Modem

Line Interface Unit

The Line Interface Unit connects the 2.048Mbps Wireless Modem to the WAN or to the DTE (Data terminal Equipment). Any data, voice or video system can be connected to the 2.048Mbps Wireless Modem using standard interfaces:

- T1 DSX-1 - Line code B8ZS or Bipolar AMI
- E1 G703 - Line code HDB3 or Bipolar AMI
- Fractional T1 DSX-1 – Line code B8ZS or Bipolar AMI
- Fractional E1 G703 – Line code HDB3 or Bipolar AMI
- RS-530 digital interface. This interface also supports X.21 using an additional adapter cable.
- V.35 digital interface.

The Line Interface Unit consists of an internal Network Interface Card and the applicable connectors mounted on the rear panel of the unit. The 2.048Mbps Wireless Modem can be ordered with the following optional Line Interfaces:

RS530

The rear panel connection is made with a D-Type, 25 pins female connector.

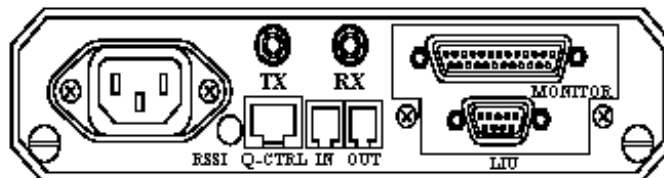


Figure 1-4. 2.048Mbps Wireless Modem Rear Panel (RS-530/X.21 LIU and V.35 LIU).

V.35

The rear panel connection is a D-Type, 25 pins female connector, the same as the RS-530 connector (see Figure 1-4). An additional cable plugs into this connector and comprises the D-Type, 25 pins male connector on one end and a 34 pins female - “Winchester”- type V.35 connector on the other end.

X.21

The rear panel connection is a D-Type, 25 pins female connector, the same as the RS-530 connector (See Figure 1-4). An additional cable plugs into this connector and comprises the D-Type, 25 pins male connector on one end and a D-Type, 15 pins female X.21 connector on the other end.

E1

The rear panel connector module consists of one E1/CEPT-1 balanced (RJ-45) connector and two unbalanced (2 x BNC) connectors.

Fractional E1 (with Echo Cancellation)

The rear panel connector module consists of one E1/CEPT-1 balanced (RJ-45) connector and two unbalanced (2 x BNC) connectors

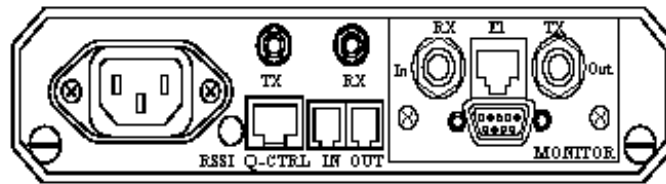


Figure 1-5. 2.048Mbps Wireless Modem Rear Panel (E1 LIU and Fractional E1 LIU)

T1

The rear panel connector module consists of one T1/DSX-1 balanced (RJ-45) connector.

Fractional T1 (With Echo Cancellation)

The rear panel connector module consists of one T1/DSX-1 balanced (RJ-45) connector.

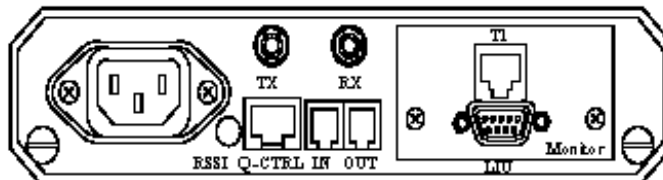


Figure 1-6. 2.048Mbps Wireless Modem Rear Panel (T1 LIU and Fractional T1 LIU)

Refer to Appendix E for a description of the E1/T1 and Fractional E1/T1 pin assignments.

Modem

Separate DSP Transmit and Receive Modems

The physical layer connection is established by two DSP (Digital Signal Processing) modems. Each modem is dedicated to one direction of the link; transmit or receive.

Adaptive Equalization

The time dispersion of the transmitted signal caused by multipath propagation causes intersymbol interference (ISI). To compensate for the ISI, an adaptive equalizer is included in the modem.

2.048Mbps Wireless Modem

ARQ – Based Error Correction

The 2.048Mbps Wireless Modem uses an Automatic Retransmission Queuing (ARQ) mechanism to detect errors in received data and to request retransmission. The use of ARQ results in a significant improvement in performance, overcoming problems caused by interfering signals.

Radio

Full Duplex

The radio uses full duplex communication, transmitting and receiving simultaneously.

Spread spectrum Frequency Hopping

Using Spread Spectrum Frequency Hopping, a technique that changes the frequency of the carrier over a hundred times per second, the radio “hops” in a pre-defined sequence through up to 79 channels in the 2.4 - 2.5 GHz band. The number of channels and the frequency band are determined by the specific model and relevant local regulations.

Frequency hopping provides reliable communication at low bit error rates as well as increased bandwidth and interference avoidance.

Output Power

Radio power output is 16dBm (min.) at antenna port. Power emitted from antenna is up to 36dBm EIRP - US version, or 20 dBm EIRP – European version. In Low power mode, power output is 2dBm.

Antennas

There is a variety of standard antennas and cable types for different gain levels.

Antenna Types

- Basic antenna - antenna gain of 8.5dBi.
- Medium gain antennas - antenna gain is either 12dBi or 18dBi.
- High gain antenna - antenna gain is 24dBi.

Cable Types

- Thin cable - this cable is thin and flexible, but its attenuation is relatively high.
- Thick cable - this cable is heavier and less flexible; its attenuation is lower.
- Low loss cable - this cable is thicker, heavier and more expensive, but its attenuation is very low.

For further information on antennas, cables and related accessories see Chapter 2, Installation, antennas and Accessories.

Antenna Interface

Antenna interface to the 2.048Mbps Wireless Modem is via two SMA connectors on the rear panel; Transmit antenna should be connected to TX and Receive antenna to RX.

Front Panel Indicators

The front panel of the 2.048Mbps Wireless Modem contains eight LED indicators for monitoring general functionality, DTE line functionality and radio functionality.



Figure 1-7. 2.048Mbps Wireless Modem Front Panel.,

General

PWR (On/Off)

Green lamp lights when power supply is connected. If lamp fails to light, check the power cable and connectors.

Test

System self-test. Green LED should light all the time after power supply is connected. If LED fails to light, disconnect from power supply, wait a few moments and try again. If self-test fails repeatedly, contact Black Box technical support. The TEST LED will blink upon identification of any alarm condition. Refer to pages 77-82 for more information on alarm conditions.

Line

(Loss Of Signal - E1/T1 and Fractional E1/T1 only). Red LED lights when the modem loses line signal from WAN or DTE. The main reason for loss of signal is a physical cable problem.

1. Check the cables and connectors linking the unit with the WAN or the DTE.
2. If these are OK, check WAN or DTE functionality..,



2.048Mbps Wireless Modem

AIS

(Alarm Indication Signal - E1/T1 and Fractional E1/T1 only). Red LED lights when WAN or DTE control frame is received by the modem indicating that information that should be sent by the modem is not received by the DTE (or the WAN). The main reason for alarm indication signal is a physical cable problem.

1. Check the cables and connectors linking the unit with the WAN or the DTE.
2. If these are OK, check WAN or DTE functionality.

RXD and TXD

Orange RXD and TXD LEDs indicate that data present at the LIU connector is sent over the RF link to the remote LIU connector (this does not indicate that end equipment exists or is synchronized).

Radio

Rx Sync

Green LED lights indicating radio receiving link active.

TX Sync

Green LED lights indicating radio transmission link active.

After power-on of the 2.048Mbps Wireless Modem configured as Master, the unit immediately starts transmitting. At this stage, the TX Sync LED on the Master is on while the RX Sync LED is off.

After power-on of the 2.048Mbps Wireless Modem configured as Slave, the unit starts to search for a transmitting Master. At this stage both RX Sync and TX Sync LEDs on the Slave are off.

After the Slave synchronizes with a transmitting Master, it immediately starts transmitting. Now, both RX Sync and TX Sync LEDs on the Slave are on..

The RX Sync LED on the Master is on after reception from the transmitting Slave is established. Failure of radio link reception or transmission may indicate one of the following:

- A problem in the radio configuration parameters (network ID, for example).
- A problem in the radio path (obstacles, for example).
- Antennas need adjustment.

2.048Mbps Wireless Modem Connectors

Figure 1-8 shows how to connect the 2.048Mbps Wireless Modem to its antennas, the power supply and to external equipment.

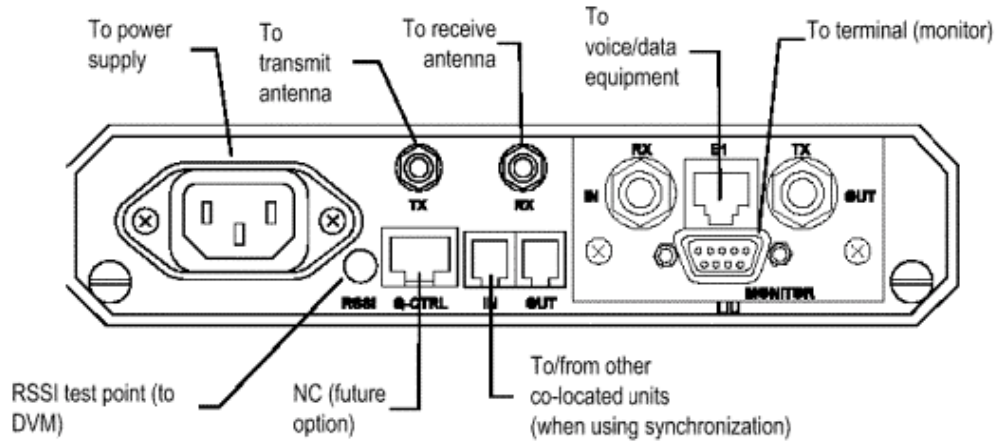


Figure 1-8. 2.048Mbps Wireless Modem Connections (E1 or Fractional E1 LIU)



Installation Antennas and Accessories

Package Components

The 2.048Mbps Wireless Modem is shipped from factory with the following components:

- The 2.048Mbps Wireless Modem
- Power cord (110/220 VAC models), AC connector not supplied
- Monitor cable
- Synchronization cable (for collocated units)
- Cable adapter for DTE (V.35 and X.21 only)
- This user's guide

Installing the 2.048Mbps Wireless Modem

General

The following steps provide a guide to the correct installation and configuration of the unit:

1. The 2.048Mbps Wireless Modem should be located indoors and positioned as close as possible to the antennas.
2. Connect the unit to the end equipment. If the data interface on the DTE is either V.35 or X.21, a cable adapter should be used as follows:

V35 25 pin D-Type connector to modem's 34 pin V35 to DTE

X21 25 pin D-Type connector to modem's 15 pin D-Type connector to DTE

3. Connect the antennas as follows:

- Connect the receive antenna to RX connector
- Connect the transmit antenna to the TX connector.

4. Connect the 2.048Mbps Wireless Modem to the power Outlet.

5. If you are using the 48 VDC model, open the two screws on the rear panel and slide out the board a few centimetres to allow easy access to the terminal block. Verify that the wires are securely connected and in the correct polarity according to Figure 2-1.

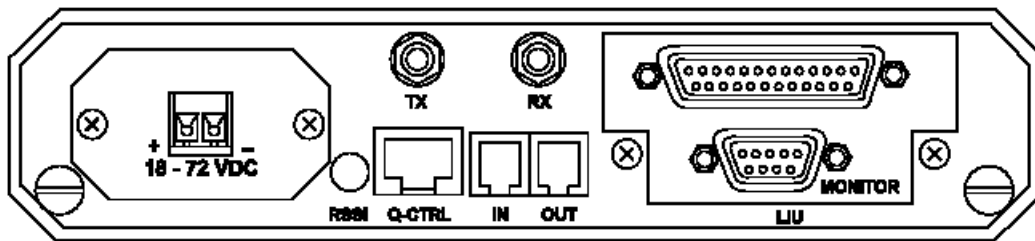


Figure 2-1. 2.048Mbps Wireless Modem Rear Panel Showing 48 VDC Connector

6. For two 2.048Mbps Wireless Modems to communicate with one another, one side of the link must be configured in Master mode, with the unit at the other side of the link configured in Slave mode. **Units are shipped from factory with a default setting of Slave.** In an E1 or T1 configuration, the Master modem must be located on the same side as the E1 or T1 master (of the external equipment that provides the system clock).

Other basic parameters that should be configured for a quick start are:

- The clock rate (V3.5/RS-530/X.21 only). Both units must use the same clock rate.
- Select channels (Fractional E1/T1 only). Both units must use the same channels.
- Select channels with echo cancellation (Fractional E1/T1 with voice channels only). Both units must be configured to use echo cancellation in the same channels.

To Configure the Unit as Master

1. From the Main menu, select 1 to access the Parameters menu.
2. From the Parameters menu, type 2 to select the MCP Parameters menu.
3. From the MCP Parameters menu, type 2. The Master-slave sub-menu opens.
4. Select the required configuration as follows:
 - Type **0** for master
 - Both units must be configured to operate at the same required clock rate. For E1 and T1 the rate is set in factory.

To Set the Clock Rate (V.35/RS-530/X.21 only)

1. From the Main menu, select **1** to access the Parameters menu.
2. From the Parameters menu, type **1** to select the LIU (Line Interface Unit) Parameters menu.
3. From the LIU Parameters menu, type 5. The V.35/RS-530/X.21 sub-menu opens.



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4. From the V.35/RS-530/X.21 Parameters menu, type 1. The Clock Rate sub-menu opens.
5. Select the required clock rate according the required data rate of $n \times 64\text{kb/S}$. For example:
 - Type 1 for 64 Kbps
 - Type 8 for 512 Kbps (8 x 64)
 - Type 32 for 2048 Kbps (32 x 64)

Model BL512 allows data rates up to 512 Kbps only.

To Configure Channels - Fractional E1

1. From the Main menu, select 1 to access the Parameters menu.
2. From the Parameters menu, type 1 to select the LIU Parameters menu.
3. From the LIU Parameters menu, type 2 to select the Fractional E1 Parameters menu.
4. From the Fractional E1 Parameters menu, type 1 to select the Add/Remove channels menu.
5. From the Add/Remove Channels menu, type 1 to select the Add Channels menu.
6. View the current active channels. If channels that should be used are not included, enter the numbers of the channels that should be added. Enter numbers between 1 to 31 separated by a comma. Use two dots to indicate a range. e.g. 1,8..11,14 means add channels 1, 8, 9, 10, 11 and 14.
7. From the Add/Remove Channels menu, type 2 to select the Remove Channels menu.
8. View the current active channels. If channels that should not be used are included, enter the numbers of the channels that should be removed from the list. Enter numbers between 1 to 31 separated by a comma. Use two dots to indicate a range. e.g. 2,5..7 means remove channels 2, 5, 6 and 7.

To Configure Channels with Echo Cancellation- Fractional E1

1. From the Fractional E1 Parameters menu, type 8 to select the Add/Remove Echo Cancellation on voice channels menu.
2. From the Add/Remove Echo Cancellation on voice channels menu, type 1 to select the Set (Add) Channels menu.
3. View the current list of channels with echo cancellation. If channels that should be used with echo cancellation are not included, enter the numbers of the channels that should be added. Enter numbers between 1 to 31 separated by a comma. Use two dots to indicate a range. e.g. 1,8..11,14 means set echo cancellation to channels 1, 8, 9, 10, 11 and 14.

Note: In systems with Channel Associated Signalling (CAS), echo cancellation should not be set on channel 16, which is used for signalling.

4. From the Add/Remove Echo Cancellation on voice channels menu, type 2 to select the Clear (Remove) Channels menu.
5. View the current list of channel with echo cancellation. If channels in which echo cancellation should not be used are included, enter the numbers of the channels that should be removed from the list. Enter numbers between 1 to 31 separated by a comma. Use two dots to indicate a range. e.g. 2,5..7 means remove echo cancellation from channels 2, 5, 6 and 7.
6. In Fractional T1 applications, both units should be configured to use the same channels. In applications with voice channels, both units should be configured to use echo cancellation in the same channels.

To Configure Channels- Fractional T1

1. From the Main menu, select 1 to access the Parameters menu.
2. From the Parameters menu, type 1 to select the LIU Parameters menu.
3. From the LIU Parameters menu, type 4 to select the Fractional T1 Parameters menu.
4. From the Fractional T1 Parameters menu, type 1 to select the Add/Remove channels menu.
5. From the Add/Remove Channels menu, type 1 to select the Add Channels menu.
6. View the current active channels. If channels that should be used are not included, enter the numbers of the channels that should be added. Enter numbers between 1 to 24 separated by a comma. Use two dots to indicate a range. e.g. 1,8..11,14 means add channels 1, 8, 9, 10, 11 and 14.
7. From the Add/Remove Channels menu, type 2 to select the Remove Channels menu.
8. View the current active channels. If channels that should not be used are included, enter the numbers of the channels that should be removed from the list. Enter numbers between 1 to 24 separated by a comma. Use two dots to indicate a range. e.g. 2,5..7 means remove channels 2, 5, 6 and 7.

To Configure Channels with Echo Cancellation- Fractional T1

1. From the Fractional E1 Parameters menu, type 0 to select the Add/Remove Echo Cancellation on voice channels menu.
2. From the Add/Remove Echo Cancellation on voice channels menu, type 1 to select the Set (Add) Channels menu.
3. View the current list of channels with echo cancellation. If channels in which echo cancellation should be used are not included, enter the numbers of the channels that should be added. Enter numbers between 1 to 24 separated by a comma. Use two dots to indicate a range. e.g. 1,8..11,14 means set echo cancellation to channels 1, 8, 9, 10, 11 and 14.



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4. From the Add/Remove Echo Cancellation on voice channels menu, type 2 to select the Clear (Remove) Channels menu.
5. View the current list of channel with echo cancellation. If channels in which echo cancellation should not be used are included, enter the numbers of the channels that should be removed from the list. Enter numbers between 1 to 31 separated by a comma. Use two dots to indicate a range. e.g. 2,5..7 means remove echo cancellation from channels 2, 5, 6 and 7.
6. Activate the new settings by selecting **4** from the Main Menu (System Reset) to reset the unit after configuration. The system must be reset for the modified parameters to take effect.
7. Verify link functionality using the LED indicators (See page 15, for LEDs description).
8. Further configuration may be done using the setup and configuration functions, as described in Chapter 3.

Note: A unit running software version 1.7 is not compatible and cannot be connected in a link to a unit running software version 1.6 and earlier.

Antennas, Cables and Accessories

There is a variety of standard antennas, cable types, and RF accessories for different gain levels available.

Antennas

Basic Antenna (Uni-8.5)

The basic antenna has a gain of 8.5 dBi. Low alignment accuracy is required because of the relatively large beam width (75 degrees horizontal, 50 degrees vertical). It is intended for indoor or outdoor installation in locations with relatively short distances between sites. UNI-8.5 dimensions are: 101 x 95 x 32 mm. (4 x 3.75 x 1.25 in.).



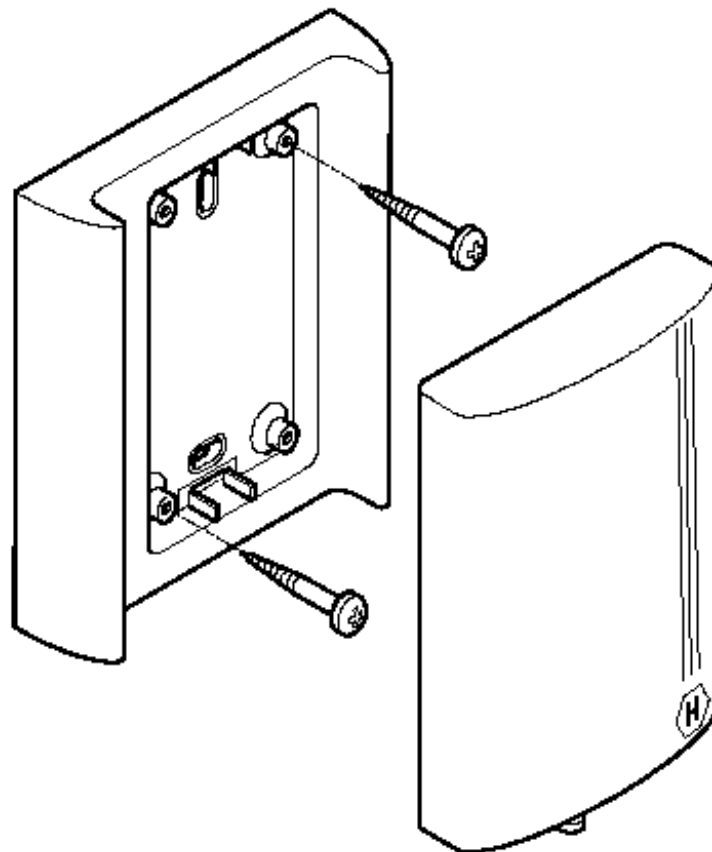


Figure 2-2. Basic 8.5 dBi Antenna Showing Installation screws.

Medium Gain 12dBi Antenna (Uni-12)

This medium gain antenna has a relatively wide beam width (22 degrees). It is intended for both indoor and outdoor installations with medium distances between sites. UNI-12 Antenna dimensions are: 15 x 15 x 38 cm. (6 x 6 x 15in.).



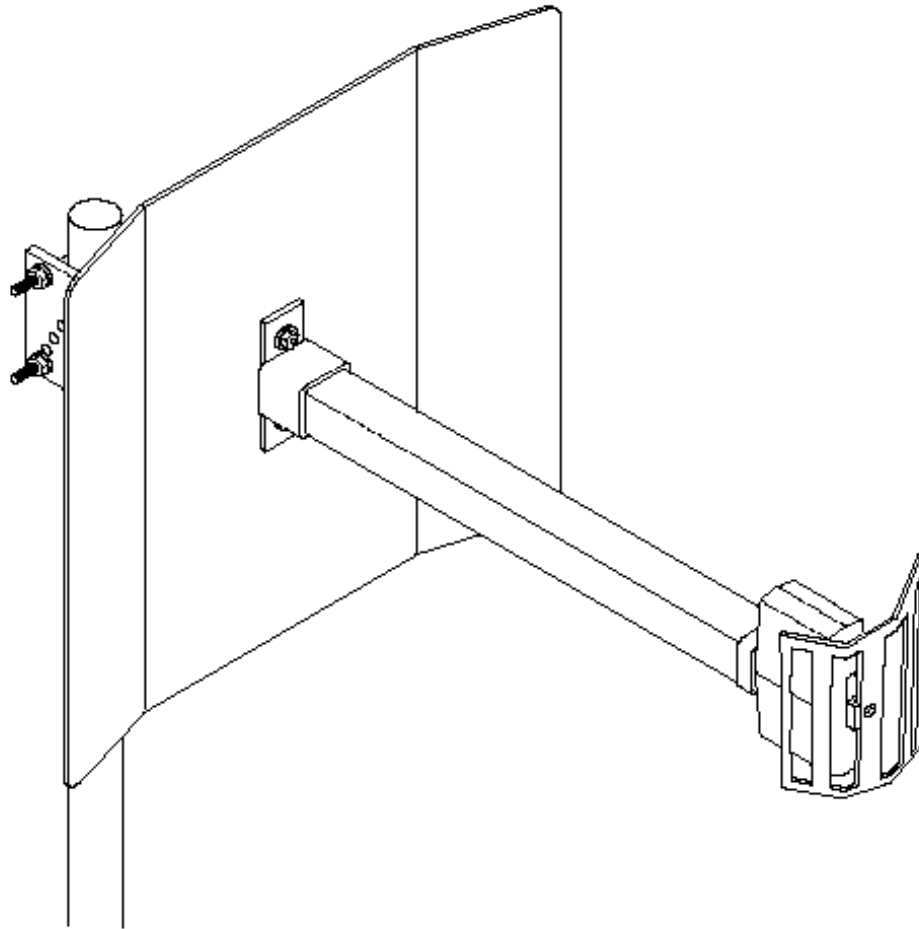


Figure 2-3. Medium Gain 12dBi Antenna

Medium Gain 18dBi Antenna (Uni-18)

This medium gain antenna has a medium beamwidth (14 degrees) which increases the sensitivity to inaccurate alignment, but decreases the influence of multipath propagation (fading). It is intended for outdoor installations over medium to long distances. It is probably the best choice for most medium to long range applications. UNI-18 Antenna dimensions are: 41 x 51 x 38 cm. (16 x 20 x 15 in.).



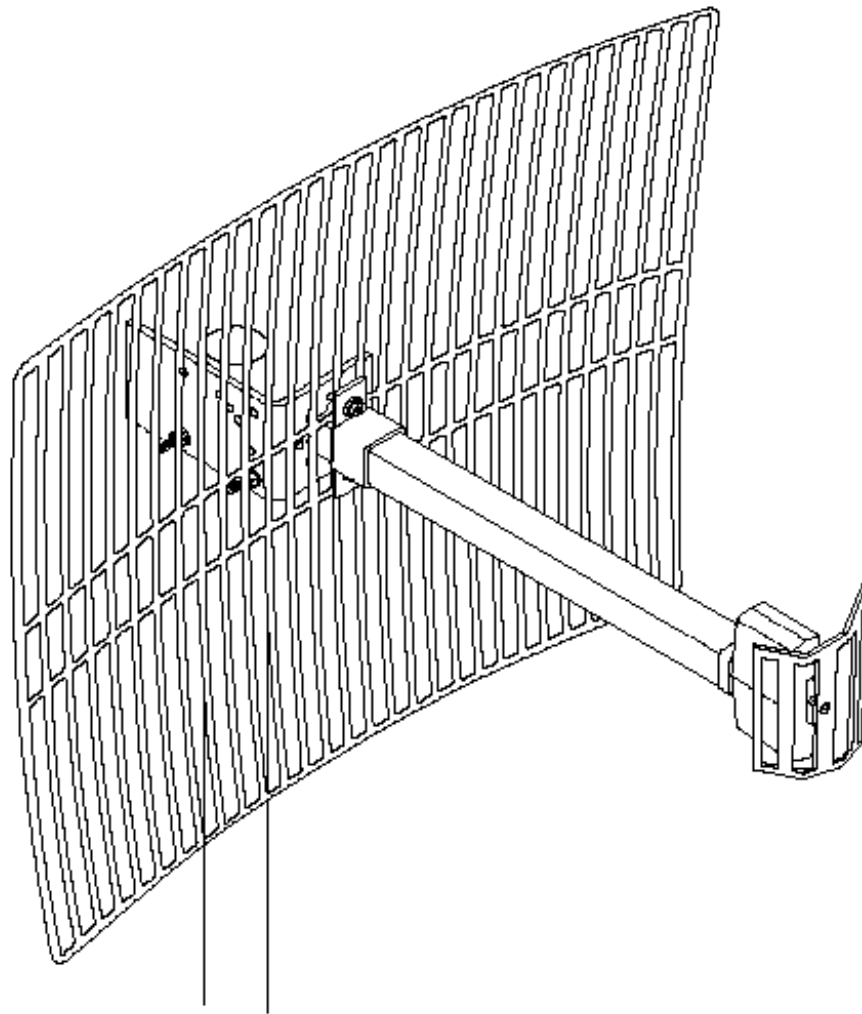


Figure 2-4. Medium Gain 18dBi Antenna

High Gain Antenna (Uni-24)

The gain of this antenna is 24dBi. It has a narrow beam width (7.5 degrees) which increases the sensitivity to alignment inaccuracy but decreases the influence of multipath propagation (fading). It is intended for outdoor installations for large distances. UNI-24 Antenna dimensions are: 61 x 91 x 38cm. (24 x 36 x 15in.).



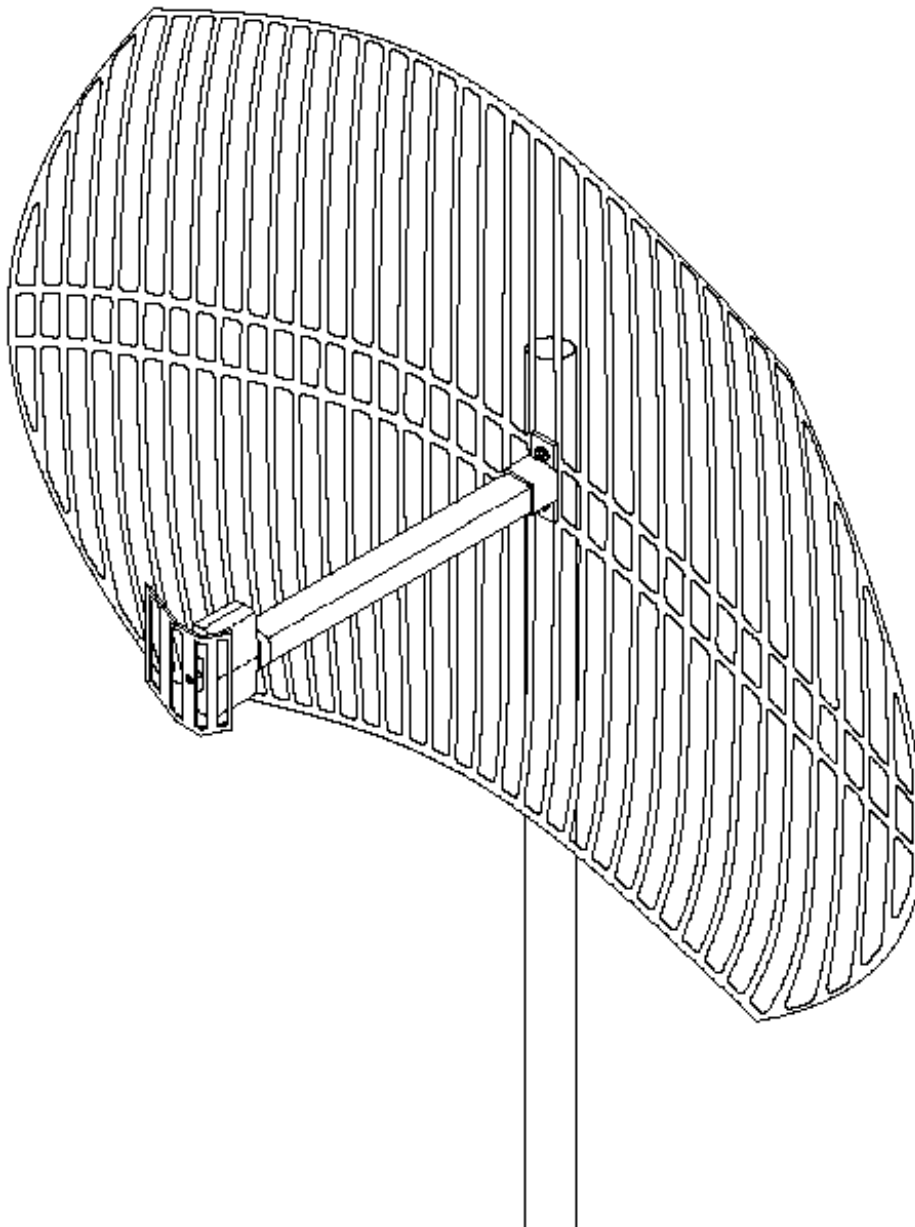


Figure 2-5. High Gain 24dBi antenna.

Table 2-1 provides a summary of the main characteristics of the basic, medium and high gain antennas:



Antenna Characteristics	Basic Antenna 8.5dBi	Medium Gain Antenna 12dBi	Medium Gain Antenna 18dBi	High Gain Antenna 24dBi
Gain level	low	medium	medium	high
Beam width	very wide	wide	medium	narrow
Required alignment accuracy	low	medium	high	high
Multipath sensitivity	high	medium	low	low
Antenna size	small	small	medium	large
Antenna cost	low	low	medium	medium

Table 2-1. Antenna Characteristics

RF Accessories

TPA 24 Transmit Power Amplifier

The TPA 24 amplifies the transmit power to a fixed output of 24 dBm (250 mW). The TPA 24 is especially useful when long RF cable runs are required. The TPA 24 also simplifies antenna alignment by enabling the use of wider dispersion transmit antennas.

The TPA 24 comes in two models: TPA 24 LL and TPA 24 LH. The TPA 24 LL receives input power in the range of -10dBm to 0dBm. The TPA 24 LH receives an input power of 0dBm to +10dBm. Both models then amplify the input power to a fixed output level of 24dBm (250mW). The TPA 24 gets its DC power supply from the modem transmitter through the RF cable.

When used in compliance with ETSI regulations, the TPA 24 can be connected to cables and antennas resulting in a total transmitted power of 20dBm (100 mW) EIRP.

See page 105 for further information.



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Installing the TPA 24

1. Install the TPA 24 as close as possible to the transmitting antenna.

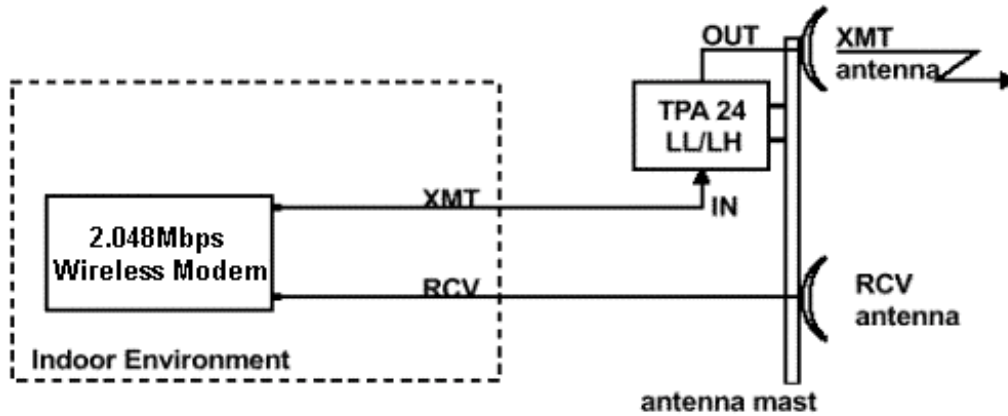


Figure 2-6. TPA 24 Connections Diagram

2. Set the transmitter DC power supply of the 2.048Mbps Wireless Modem to 12V using the internal jumpers according to Figure 2-15:

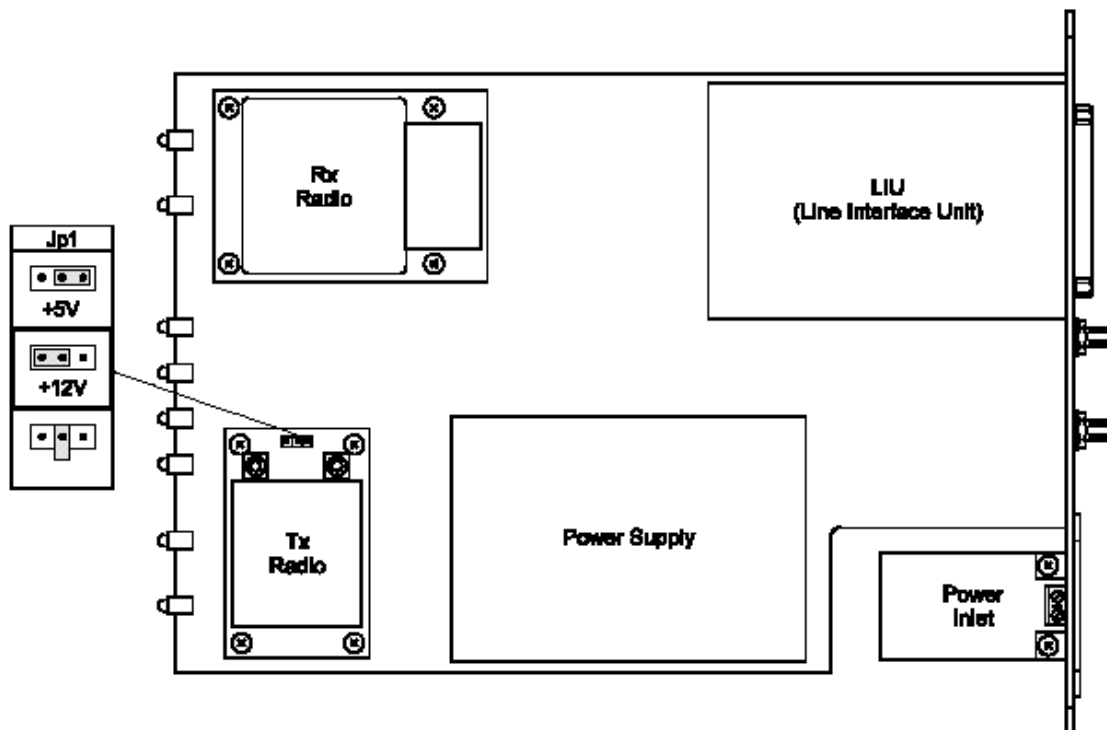


Figure 2-7. Jumper Setting for 12 VDC Power Supply Via the Transmit Radio



Note: Installations exceeding regulations set by local authorities expose the installer and the user to potential legal and financial liabilities.

LNA-10 Low Noise Receive Amplifier

The LNA-10 is a high-performance, low-noise preamplifier designed to enhance fringe area reception and to provide additional gain on the receive antenna, especially when using long cable runs. The exceptionally small size and lightweight of the LNA-10 enables it to be directly mounted on the antenna by means of the female RF IN connector. Power is obtained through an RG-59 coaxial cable connected to the power supply. The LNA-10 incorporates internal lightning and voltage surge protection.

See page 105 for further information.

The LNA improves performance by improving the Noise Figure (NF) of the system, as defined by the following formula:

LNA Improvement = NF (without LNA) / NF (with LNA) (*) Use this formula with absolute values (not dB).

Consider the following typical configuration:

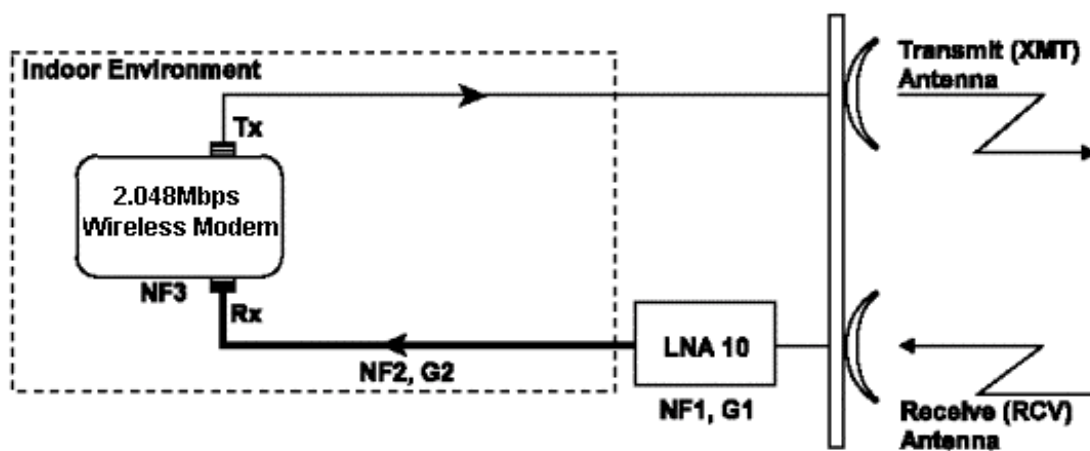


Figure 2-8. Achievable improvement through the use of LNA-10

To calculate the achievable improvement through the use of the LNA-10, use the following formulas:

$$\text{NF (without LNA)} = \text{NF2} + (\text{NF3} - 1)/\text{G2}$$

$$\text{NF (with LNA)} = \text{NF1} + (\text{NF2} - 1)/\text{G1} + (\text{NF3} - 1)/(\text{G1} * \text{G2})$$

Where:

$$\text{NF1} = \text{Noise Figure of LNA 10} = 1.4$$



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NF2 = Noise Figure of the cable = Loss of cable

NF3 = Noise Figure of the modem = 2.8

G1 = Gain of LNA 10 = 10

G2 = Gain of the cable = 1/Loss of cable

(*) All values above are taken in absolute value (not dB).

Use the following table to quickly determine the improvement of the LNA, given different cable-loss. For convenience, the "LNA Improvement" value is converted to logarithmic values (dB).

Cable Type	Cable Length	Cable Loss	LNA Improvement
Heliax	10 Meter	1.5 dB	4 dB
Heliax	20 Meter	3 dB	5 dB
Heliax	50 Meter	7.5 dB	7.5 dB
RG-214	10 Meter	6 dB	6.9 dB
RG-214	20 Meter	12 dB	9 dB
RG-214	50 Meter	30 dB	10 dB

Table 2-2. LNA Improvement table

For example: in a typical installation with a 20 Meter Heliax cable, the use of an LNA-10 results in an improvement of 5dB to the total link margin, in comparison to the same installation when not using the LNA-10.

1. Connect the LNA-10 RF input directly to the output of the receiving antenna.
2. Attach the LNA-10 RF output directly to the RF cable going down to the Rx connector on the 2.048Mbps Wireless Modem unit.
3. Connect the RG-59 coaxial cable between the "TO CONV" connector of the power inserter and the "Signal and Power out" connector on the LNA-10.



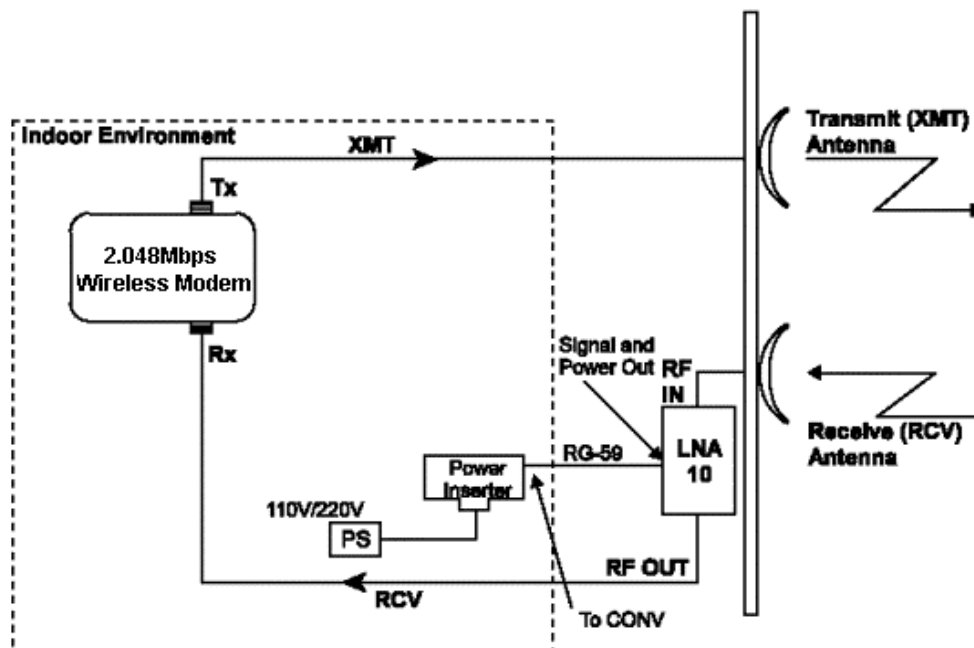


Figure 2-9. LNA-10 Cable Connection Diagram

The power supply (PS) and Power Inserter are supplied with the LNA-10. The RG-59 coaxial cable (with F-type connector) is not supplied and must be purchased separately.

Note: See Appendix C for installing other types of receive amplifiers

AL-1 Lightning Arrestor

The AL-1 Lightning Arrestor is used to protect transmitters and receivers from transients originating from lightning or EMP. The AL-1 is gas tube-based and is not radioactive. The gas discharge tube can sustain several transients if the time period between transients is sufficient to allow the tube to cool down.

See page 106 for further information.

Installing the AL-1 Lightning Arrestor

1. Connect the antenna to the AL-1 input, as shown in Figure 2-15.
2. Connect the AL-1 ground connector to the building's safety ground.
3. Connect the antenna from the AL-1 output to the antenna input in the modem.



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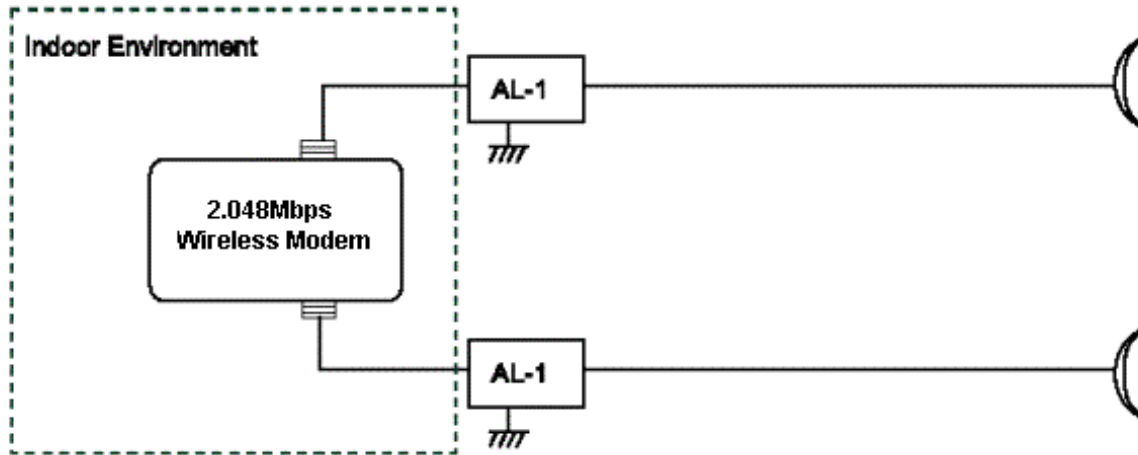


Figure 2-10. AL-1 Cable Connection Diagram

Cable Types

Thin Cable

This is a relatively thin and flexible cable. However, its attenuation is relatively high. Impedance is 50Ω. Outer diameter is 5mm (0.195").

Thick Cable

This cable is thicker, heavier and less flexible than the thin cable. However, its attenuation is less than that of the thin cable. Impedance is 50Ω. Outer diameter is 10.8mm (0.425").

Low Loss Cable

This cable is thicker, heavier and more expensive. However, its attenuation is very low. Impedance is 50Ω. Outer diameter is 12.5mm (0.5"). The following table provides details on the attenuation of standard cables available from Black Box.

Cable Type	Attenuation (dB/m) of standard cable	Attenuation (dB/100ft.) of US cables
Thin cable	RG-58: 1.0 dB/m	LMR-200: 17 dB/100ft.
Thick cable	RG-214: 0.6 dB/m	RG-8/U9913: 9 dB/100ft.
Low loss cable	Heliac: 0.15 dB/m	LMR-600: 4.5 dB/100ft.

Table 2-3. Attenuation of Standard Cables

Professional Installers Only

Antennas, whether installed indoors or out, are to be installed **ONLY** by experienced antenna installers that are familiar with local buildings and safety codes, and wherever necessary are licensed by appropriate government regulators. Failure to do so may void the Product Warranty and will certainly expose the end user to legal and financial liabilities. Black Box are not liable for injury, damage or violation of government regulations associated with the installation of antennas.

Antenna Sets

Black Box offers a variety of antennas, cables, RF accessories and installation accessories. The following is a short list of sets available. Please consult technical support for more details.

Examples of Black Box Antenna Sets

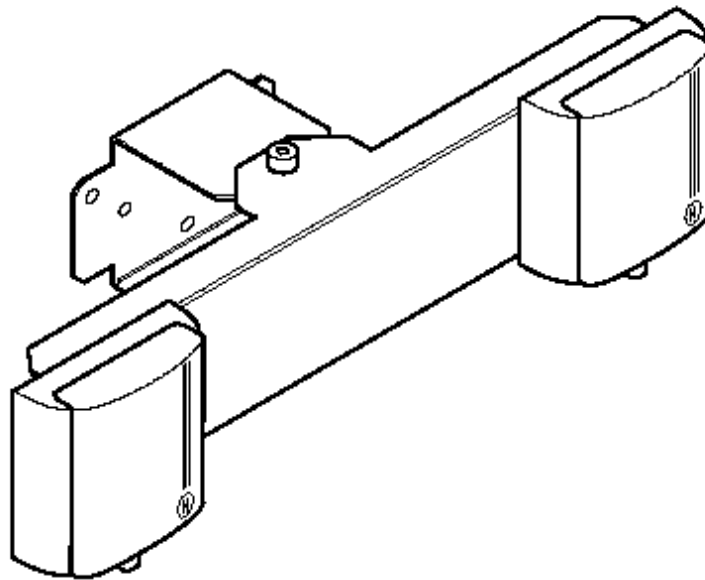


Figure 2-11. Wall Mount with Azimuth Alignment Only.



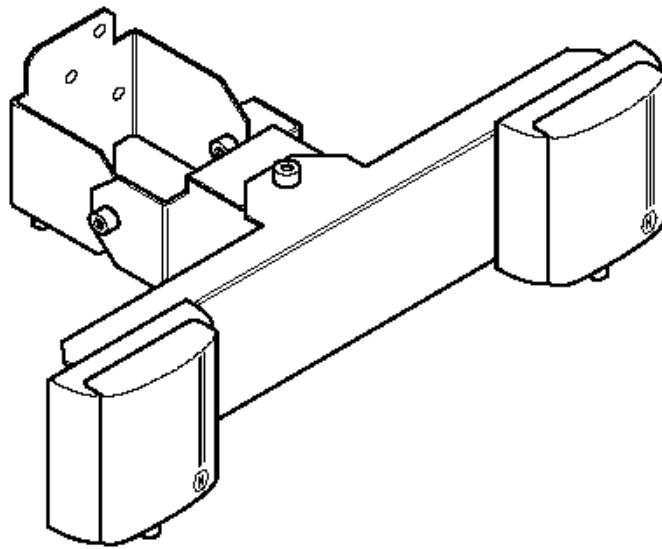


Figure 2-12. Wall Mount with Azimuth and Elevation Alignment

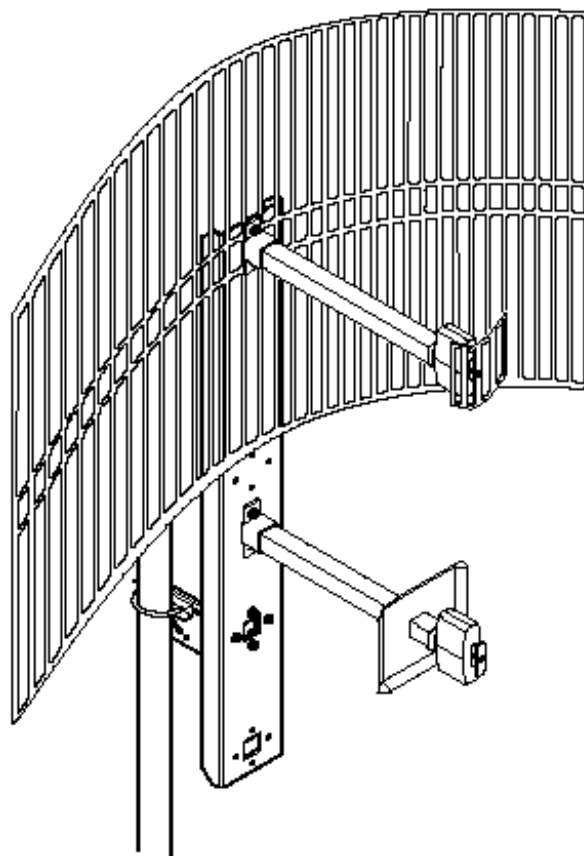


Figure 2-13 One 12dBi Antenna



Range Tables

Use the following tables to calculate the antennas and cables that will best suit your transmit/receive range requirements (assuming line-of-sight between 2.048Mbps Wireless Modem Master and Slave units). The tables are based on the assumption that the default modem rate is being used. If a modem rate higher than the default rate is being used, the achievable range should be estimated according to the actual modem rate.

Note: When selecting antennas, cables and RF accessories for your specific link, note that exceeding the recommended power level of the input signal to the 2.048Mbps Wireless Modem, may significantly reduce performance.

Maximal power level input into the Rx port should not exceed -10 dBm. For links with a radio link rate of 3 Mbps, maximal power level input should not exceed -25 dBm.

Cable length [m]	Cable type	Tx Ant. Gain (dB)	Rx Ant. Gain (dB)	Range[m] for 1536 to 2048 Kbps (modem rate 3Mbps)	Range [m] for 768 to 1472 Kbps (modem rate 2Mbps)	Range [m] for 384 to 704 Kbps (modem rate 1Mbps)	Range[m] for 64 to 320 Kbps (modem rate 0.5Mbps)
4.5	RG58	8.5	8.5	200	400	800	900
15	RG214	12	18	700	1000	2300	2600
15	RG214	12	12	400	500	1200	1700
15	RG214	12	24	1000	1500	3600	5000

Table 2-4. European Range Table

Cable length [ft.]	Cable type	Tx Ant. Gain (dB)	Rx Ant. Gain (dB)	Range [miles] for 1536 to 2048 Kbps (Modem rate 3Mbps)	Range [miles] for 768 to 1472 Kbps (modem rate 2Mbps)	Range [miles] for 384 to 704 Kbps (modem rate 1Mbps)	Range [miles] for 64 to 320 Kbps (modem rate 0.5Mbps)
8	LMR-200	8.5	8.5	500 ft.	1500 ft.	0.6	0.9
20	RG-8/U9913	12	12	1000 ft.	0.5	1	1.5
30	RG-8/U9913	12	18	0.4	0.7	1.5	2
30	RG-8/U9913	18	18	0.5	1.5	3	4.5
50	LMR-600	24	24	1.5	3	6	9
50	RG-8/U9913	24	24 + LNA	1.5	3	6	9
30	RG-8/U9913	12 + TPA	18 + LNA	1.5	3.5	8	10
50	RG-8/U9913	12 + TPA	24 + LNA	2.5	6	12	15

Table 2-5. USA Range Table



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Cable length [m]	Cable type	Tx Ant.	Rx Ant.	Range[m] for 1536 to 2048 Kbps (modem rate 3Mbps)	Range[m] for 768 to 1472 Kbps (modem rate 2Mbps)	Range[m] for 384 to 704 Kbps (modem rate 1Mbps)	Range[m] for 64 to 320 Kbps (modem rate 0.5Mbps)
20	Heliacx	18	18	1000	2000	5000	6500
20	Heliacx	24	24	4000	8000	10000	14000
20	Heliacx	18 + TPA	24 + LNA	5000	10000	15000	20000
20	Heliacx	24 + TPA	24 + LNA	15000	20000	30000	35000

Table 2-6. Maximum (Unregulated) Range Table

Antenna Alignment

In order to function properly and to provide quality results, the modems on either side of the link must have a stable RF link. The alignment procedure is performed in three steps. First, you visually align the antennas on both sides of the link. Next, you activate the Radio and Line LEDs on the front panels of the units (which show basic synchronization) by a process of adjusting the antennas. Finally, you fine-tune the adjustment of the antenna using the RSSI (Received Signal Strength Indication) measurement procedure, described below.

For more information on pre-installation (Site Survey mode) and post-installation tests (Counters and Tracers menu) see Chapter 3.

Step-1 Visually Aligning the antennas

1. Loosen the screws on the U-bolt that fasten the antenna to the mast (or the bolts on the wall mount), and slowly move the antenna up and down (elevation) and from side-to-side (azimuth), until the antenna points roughly in the direction of the site on the other side of the link. For long distance links or when it is not possible to see the remote location, use a GPS or a map and a compass for the first alignment.

2. Tighten the screws on the U-bolt (or the bolts on the wall mount).

Note: Repeat for each antenna - Rx and Tx on both units.

Step 2 –Activating the front panel LEDs

Two pairs of LEDs on the 2.048Mbps Wireless Modem front panel are lit when the units are synchronized. When the Radio LEDs are both lit it is an indication that the radio link is synchronized, and when the Line RXD and TXD LEDs are lit it is an indication that the line to the DTE is synchronized.



To activate the front panel LEDs:

1. If the LEDs are not lit, loosen the screws on the U-bolt that fasten the Rx and Tx antennas to the last (or the bolts on the wall mount) and slowly move the antennas up and down (elevation) and from side-to-side (azimuth), until all four LEDs are lit (*Radio - RX Sync and TX Sync, Line -RXD and TXD*).
2. Tighten the screws on the U-bolt (or the bolts on the wall mount).

Step 3 – Fine tuning the adjustment of the antenna using RSSI Measurement

The RSSI (Receive Signal Strength Indicator) enables to fine-tune antenna alignment by supplying a measured value of the signal received by the unit. Maximizing the RSSI value optimises performance.

The RSSI value can be viewed using the local monitor, as described on page 72. The RSSI per channel feature displays in graphic format the strength of the received signal on each of the RF channels in use. The modem also enables to collect a measurement of the average RSSI using a DVM (digital voltmeter) connected to the RSSI test pin in the rear panel of the unit. The measured DC voltage is relative to the RSSI value as indicated in Figure 2-15. The 2.048Mbps Wireless Modem enables to perform RSSI measurement using a DVM also near the Receive Antenna. This procedure simplifies the tuning process, by allowing easier reading of the RSSI level while moving the antenna.

The RSSI measurement (with DVM or monitor) indicates the strength of reception. In order to maximize the reception strength, the receive antenna and the transmit antenna on the remote site of the link must be aligned facing each other until maximum signal quality is obtained. This procedure should be repeated on the modems on both sides of the link.

Note: The RSSI measurement indicates the strength of received signal in the 2.4 -2.5 GHz band. Verify that you are not aligning the antenna towards an undesired source of energy in this band (See also page 82).

⇒ To fine-tune the antenna alignment using a DVM connected directly to the unit:

1. Connect one of the DVM probes to the RSSI test pin. Connect the other probe to the case chassis.

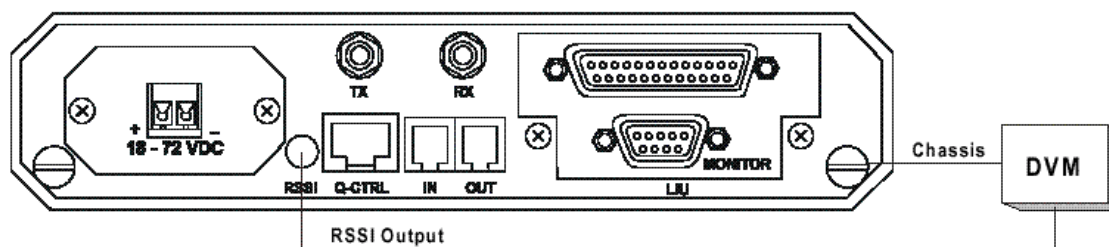


Figure 2-14. RSSI measurement connection diagram



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2. Loosen the screws on the U-bolt that fasten the receive antenna to the mast (or the bolts on the wall mount) and slowly move the antenna up and down (elevation) and from side-to-side (azimuth) until you receive a maximum RSSI reading on the DVM. (See Figure 2-15).
3. Tighten the screws on the U-bolt (or the bolts on the wall mount).

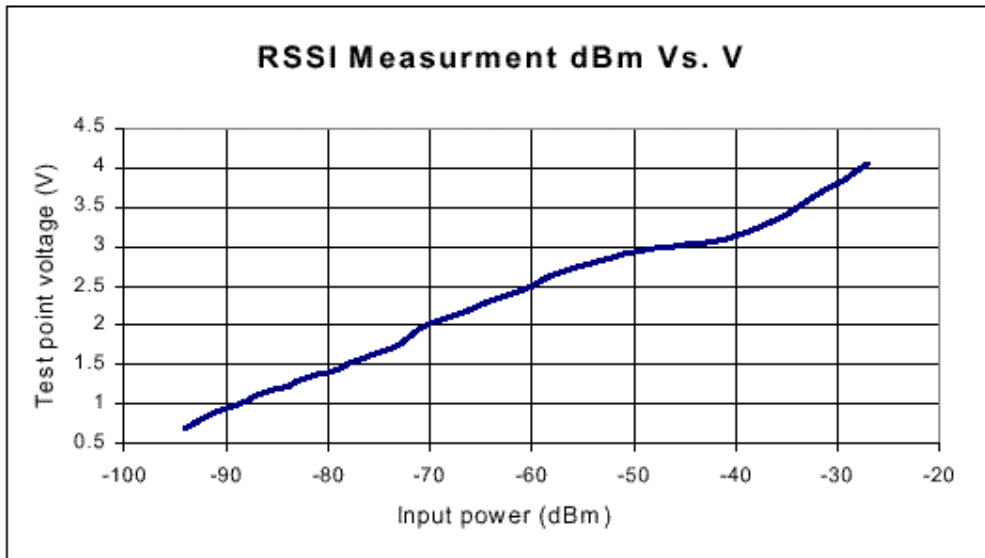


Figure 2-15. RSSI test point accuracy.

⇒ **To fine-tune the antenna alignment using a DVM near the receive antenna:**

The modems can be configured send a DC signal through the RCV antenna connector. This signal is proportional to the RSSI voltage, which is present at the RSSI output on the rear panel.

1. Set a Bias-T connection before the Receive Antenna.

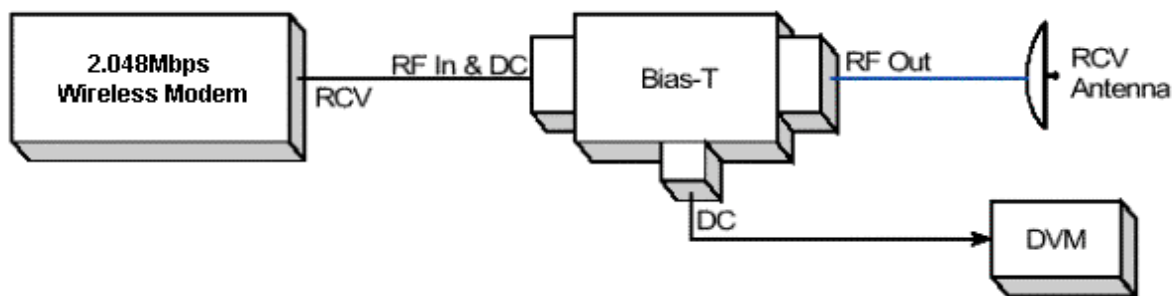


Figure 2-16. A Bias-T connection for RSSI measurement near the Receive Antenna

2. Set the jumpers in the Receive module of the 2.048Mbps Wireless Modem to the RSSI position.



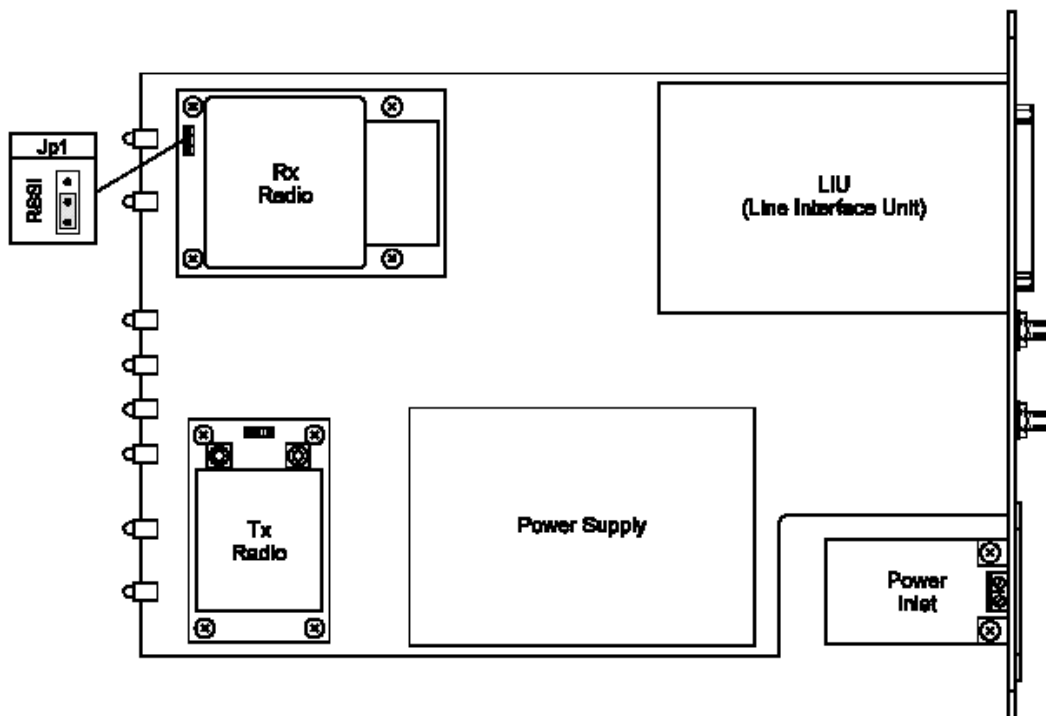


Figure 2-17. Jumper Setting for RSSI measurement via the Receive RF Cable

3. Connect a DVM to the DC port of the Bias-T.
4. Loosen the screws on the U-bolt that fasten the receive antenna to the mast (or the bolts on the wall mount) and slowly move the antenna up and down (elevation) and from side-to-side (azimuth), until you get a maximum RSSI reading on the DVM.
5. Tighten the screws on the U-bolt (or the bolts on the wall mount).

Note: If you remove the Bias-T connection after the fine-tuning process, you must set the Jumpers in the Receive module back to the default position (NC), otherwise the modem will not function. In addition, damage might be caused to the modem if the Receive Antenna is connected directly to the Receive cable, and the jumpers are not in the default position



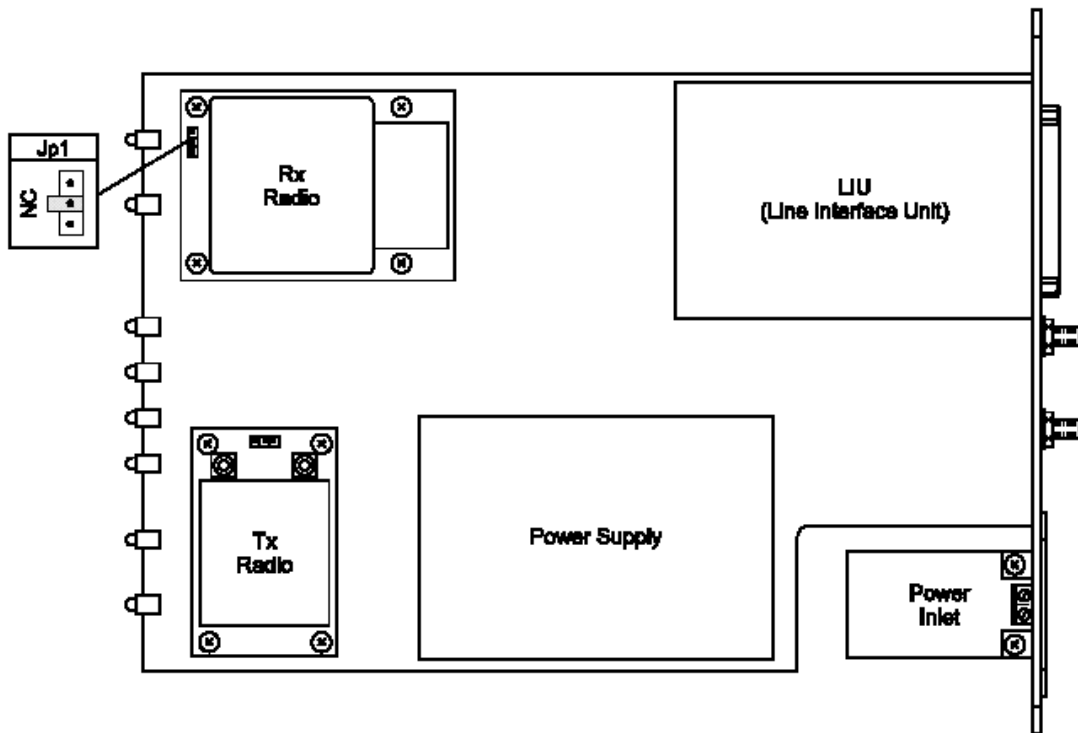


Figure 2-18. Default position (NC) of the Jumpers in the Receive Module.

Synchronizing Co-located Modem Units

When two or more 2.048Mbps Wireless Modem units are co-located, you should perform the following procedures in order to allow optimal performance. These procedures enable synchronization of the hopping sequences used by the links, and ensure sufficient separation between frequencies used by the links at any given time.



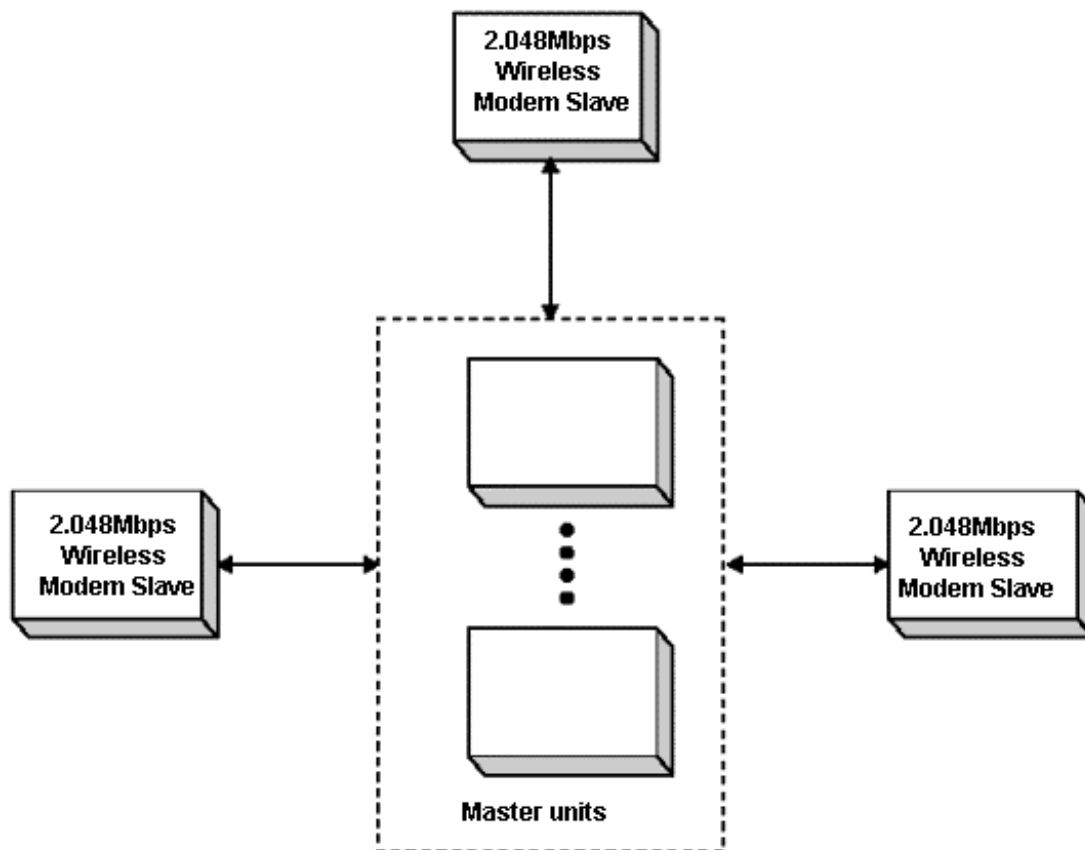


Figure 2-19. Several Co-located modems in a “star” configuration

Note: On the Master side, the 2.048Mbps Wireless Modem units with a SW version 1.6 and up and HW version 2 must be used. On the Slave side, 2.048Mbps Wireless Modem units with a SW version 1.6 and up can be used with either HW version 2 or previous HW version.

Step-1: Installing the Antennas

Install the antennas of the co-located units to minimize interference. The antennas of the different units should be located as far from each other as possible, and no antenna should be located in the radiating direction of any of the other antennas.

Step-2: Setting the relevant parameters

Set the Modem Rate, the Network I.D., the Master-Slave mode and the Number of Links to synchronize according to these guidelines:

- Configure all units connected by the synchronization cable as “Master”. Configure the units on the other side of the link as “Slave”.
- All units should have the same “Modem rate”, “Hopping standard”, “Hopping sequence” and “Number of links to synchronize”. It is not possible to synchronize two 2.048Mbps Wireless Modems that have different modem rates.



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- Set “Number of links to synchronize” to a value greater or equal to the actual number of connected links. This setting is not necessary for the “Slave” units.

Note: Selecting the option “Synchronize as many links as possible” may result in less than optimal performance. Use this option only in situations where co-located links are added and/or deleted frequently.

- Use the following table to determine the maximum number of links to synchronize:

Country/Standard	Max number of Links to synchronize
USA/FCC	7
Europe/ETSI	6
Australia	3
Canada	2
Israel	2
Japan	2
France	2
One Antenna - Duplexer	5

Table 2-7. Maximum Number Synchronized Links

- Set “Network I.D.” for the links consecutively from 1 up to the “Number of links to synchronize” (assign a different Network I.D. for each link). *Note: You can access the above parameters through the Setup and Configuration Menu (in Chapter 3).*
- If several links are established between two “centers”, define the units in one of the centers as Master.



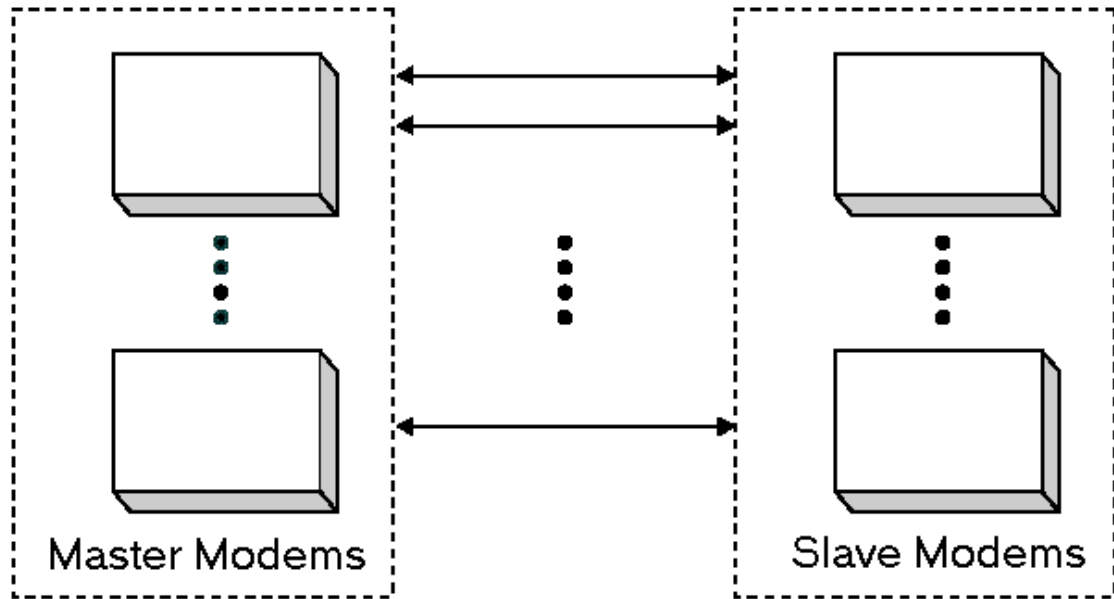


Figure 2-20. Several Co-located 2.048Mbps Wireless Modems in a “center-to-center” configuration.

Step-3 Connecting the Master units

Establishing synchronization is a “Hot Plug-In” process: You can add a new link without interfering with the normal operation of the working link(s), provided the relevant parameters are properly set (as described above).

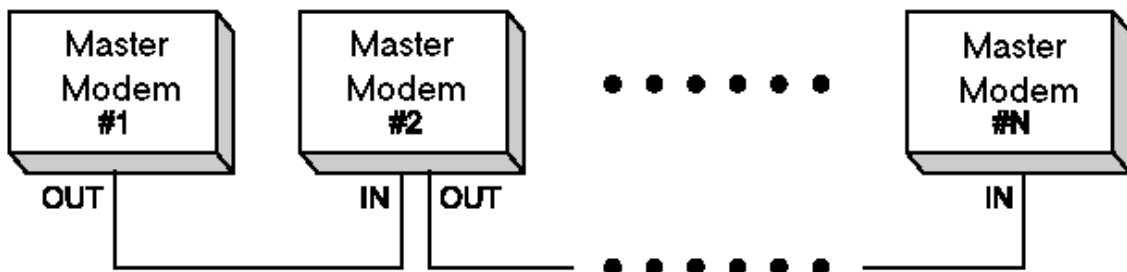


Figure 2-21. Connecting Units for Synchronization

Use a standard FCC 68 4-pin plug (male) to FCC 68 4-pin plug (male) telephone cable with two twisted pairs (supplied by Black Box) to interconnect the Master units that should be synchronized.

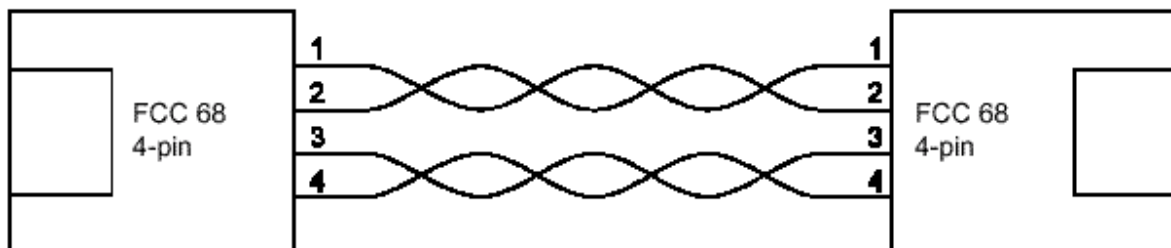


Figure 2-22. Synchronization Cable



Set-up and Configuration

Set-up and Configuration Functions

This section explains how to access and set the Set-up and Configuration functions that are provided for the 2.048Mbps Wireless Modem. The main parameters to set are:

- Line interface unit set-up parameters
- Management control parameters
- Modem set-up parameters
- Radio set-up parameters

Accessing the Set-up and Configuration Functions

You can access the Set-up and Configuration functions by connecting a terminal to the RS232/V.24 monitor interfaces on the rear panel of the 2.048Mbps Wireless Modem.

The local monitor allows you to access the set-up parameters from an ASCII ANSI terminal, or from a PC running a terminal emulation program, such as the Windows Hyper Terminal or Procomm. Use the following settings:

- Baud rate 9600
- Data bits 8
- Stop bits 1
- Parity None
- Flow control None
- Connector Available Com port

Connect the terminal to the monitor interface of the 2.048Mbps Wireless Modem. The monitor appears displaying the main menu.

Main Menu

When the Setup and Configuration screen appears the main menu is displayed, providing general status information and access to other menus:

```

Master or Slave
Local or Remote
Normal, Test or Site Survey
Hardware version
V.2 Master (Local monitor)
$Revision: 1.7 $
System is in Normal Mode

=====
1 - Parameters Menu
2 - Counters and Tracers Menu
3 - Mode and Access Control Menu
4 - System Reset
T - Testing Menu (password required)

```

Figure 3-1. Main Menu

Note: Hardware version 2 includes all features of Hardware version 1, plus co-location support through synchronization and RSSI test point.

Parameters Menu

This menu enables the authorized user to set the main system parameters:

- LIU parameters – setting Line Interface Unit Parameters
- MCP parameters – setting Management and Control Parameters
- Radio and Modem Parameters – setting Radio and Modem Parameters
- REMOTE parameters –viewing and/or setting parameters of the remote unit
- Load Default Values –loading the factory default values
- Parameters Info. Screen –viewing the status of main parameters

Counters and Tracers Menu

This menu enables you to view system statistics and alarms.

Mode and Access Control Menu

The Mode and Access Control menu enables to define the access rights. It also enables access to the Site Survey Mode for surveying the applicable electromagnetic environment of the site (this does not require a password).



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System Reset

Resetting the system from the System Reset menu implements all the changes made to the parameters of all the Setup and Configuration functions.

Testing

This menu is for authorized Black Box technical staff only.

Parameters Menu

You can access most of the items for configuring your 2.048Mbps Wireless Modem from the parameters Menu:

To access the Parameters Menu:

- In the Main menu, at the Select Option prompt, type 1.
The Parameters menu appears.

```
Parameters menu
=====
1 - LIU Parameters
2 - MCP Parameters
3 - RADIO and MODEM Parameters
4 - REMOTE Parameters
5 - Load Default Values
6 - Parameter Info. Screen
```

Figure 3-2. Parameters Menu

To make selections using the Parameters menu:

At the Select Option prompt, type the number that corresponds to the option you require:

- Type **1** to select the LIU Parameters menu.
-
- Type **2** to select the MCP Parameters menu.
-
- Type **3** to select the Modem and Radio Parameters menu.
-
- Type **4** to select the Remote Parameters menu.
-
- Type **5** to select the Load Default Values menu.
-
- Type **6** to select the Parameters Info. Screen.

1. Follow the instructions on the screen.

2. Press **Esc** at any stage to return to the previous menu (if you press **Esc** before making any selection, the message:

Loading cancelled, old value retained appears).

Note: You can operate all the Setup and Configuration sub-menus by using these procedures and by following the instructions on the screens.

LIU Parameters Menu

The LIU Parameters menu gives you access to the following sub-menus:

- E1 Parameters Menu (select if an E1 LIU is used).
- Fractional E1 Parameters Menu (select if a Fractional E1 LIU is used).
- T1 Parameters Menu (select if an T1 LIU is used).
- Fractional T1 Parameters Menu (select if a Fractional T1 LIU is used).
- V.35/RS-530/X.21 Parameters Menu. (Select if a V.35/RS-530/X.21 LIU is used).
- Loopback Mode.
- Line Interface Unit type (set at factory and should not be changed unless LIU changes).

E1 Parameters Menu

Menu Item	Action	Options/Notes
1. Line Coding	View current selection. Enter 0 or 1 to change settings.	0 = AMI 1 = HDB3 (default)
A. Alarm Buffer	View E1 Alarms (if any).	See E1 Alarm Buffer below for details.

Table 3-1. E1 Parameters Menu Items and Actions



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E1 Alarm Buffer

The Possible alarms are:

- LOS (all zeros signal): Loss Of Signal – No signal is received from the data equipment.
- AIS: Alarm Indication Signal – No signal is received by the connected end equipment.

When an alarm is detected, a note appears at the bottom of the display (Note: An alarm has been activated), and the message ALARM EXISTS is displayed on the menu header (see Figure 3-1). In addition, the TEST LED will blink.

Fractional EI Parameters Menu

See also Appendix C.

Menu Item	Action	Options/Notes
1. Add/Remove Channels	Enter 1 to Add channels Enter 2 to Remove channels	1 = Add channels 2 = Remove channels
1.1 Add channels	View current active channels. Enter additional channels to become active after next Reset.	Enter numbers between 1 to 31 separated by a comma. Two dots are used to indicate a range. e.g. 1, 8..11,; Add channel 1 and all channels from 8 to 11.
1.2 Remove channels	View current active channels. Enter channels to be removed from list of active channels after next Reset.	Enter numbers between 1 to 31 separated by a comma. Two dots are used to indicate a range. e.g. 1, 8..11,; Remove channel 1 and all channels from 8 to 11.
2. Line Coding	View current selection. Enter 0 or 1 to change settings.	0 = AMI 1 = HDB3 (default)
3. Remote alarm method	View current selection. Enter 0 or 1 to change settings.	0 = Bit 3 of TS 0 (default) 1 = Unframed all ones See Remote alarm method below for details
4. Long haul / Short haul	View current selection. Enter 0 or 1 to change settings.	0 = Short haul (default) 1 = Long haul See Long haul/Short haul below for details
5. Balanced / Un-Balanced	View current selection. Enter 0 or 1 to change settings. If changed-set LIU jumpers (see manual)	0 = Balanced (120 Ohm, default) 1 = Un-Balanced (75 Ohm)



Menu Item	Action	Options/Notes
6. CRC4 Usage	View current selection. Enter 0 or 1 to change settings.	0 = CRC4 not used 1 = Auto detect CRC4 (default) See CRC4 Usage below for details
7. Echo canceler disabling method	View current selection. Enter 0 or 1 to change settings.	0 = Straight 2100Hz tone (default) 1 = Phase reversed 2100Hz tone 2 = 2100Hz VPA tone See Echo canceler disabling method below
8. Add/Remove Echo cancellation on voice channels	Enter 1 to Set (Add) channels Enter 2 to Clear (Remove) channels	0 = Set Echo cancellation on voice channels 1 = Clear Echo cancellation on voice channels
8.1 Set Echo cancellation on voice channels	View current channels with Echo cancellation. Enter additional channels to have Echo cancellation after next Reset.	Enter numbers between 1 to 31 separated by a comma. Two dots are used to indicate a range. e.g. 1, 8..11.; Set Echo cancellation to channel 1 and all channels from 8 to 11.
8.2 Clear Echo cancellation on voice channels	View current channels with Echo cancellation. Enter channels to be removed from list of channels with Echo cancellation after next Reset.	Enter numbers between 1 to 31 separated by a comma. Two dots are used to indicate a range. e.g. 1, 8..11.; Remove Echo cancellation from channel 1 and all channels from 8 to 11.
A. Alarm Buffer	View Fractional E1 Alarms (if any).	See Fractional E1 Alarm Buffer below for details.

Table 3-2. Fractional E1 parameters Menu Items and Actions

Remote Alarm Method

Two methods may be used to indicate to the end equipment of an alarm condition following loss of synchronization:

- Bit 3 of TS (Time Slot) 0: Under normal conditions, this bit is always set to 0. Upon identification of an alarm condition, it is set to 1.
- Unframed all ones: The transmitted signal comprises a continuous sequence of ones without any ramming or other signalling messages The Remote alarm method should be set in accordance with the configuration of the end equipment.



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Long haul/Short haul

This parameter determines the sensitivity of the receiver circuits in the line interface to the end equipment. If the distance between modem and the end equipment is up to 500 meters, it should be set to 0 (short haul). If the distance is more than 500 meters, it should be set to 1 (long haul) to compensate for losses by increasing the sensitivity of the receiver circuits by approximately 30 dB.

CRC4 Usage

When there is a need for an enhanced error monitoring capability, bit 1 of each frame is used for a Cyclic Redundancy Check 4 (CRC4) procedure. Bit 1 of each frame is used for CRC4 bits and other related information such as a CRC4 alignment sequence to verify identification of the CRC4 bits. These bits are the result of a certain calculation performed on all the bits of the applicable sub-multiframe (8 frames). CRC4 bits may be used by the receiving equipment to determine proper reception of all bits sent to it. If the end equipment does not use CRC4, these bits may be used for other purposes, and the CRC4 Usage parameter should be set to 0 (CRC4 not used). If the end equipment uses CRC4, or if it is not known whether the end equipment uses CRC4, this parameter should be set to 1 (Auto detect CRC4).

Echo Canceller disabling method

Set these parameters in accordance with the echo cancellation disabling method used by the end equipment (see also appendix C).

- *Straight 2100Hz tone (0)*: The most popular method based on transmitting a straight 2100Hz tone.
- *Phase reversed 2100Hz tone (1)*: A 2100Hz tone with phase reversals for improved differentiation from voice signals.
- *2100Hz VPA tone (2)*: A tone in the range 2000-2100Hz.

Fractional E1 Alarm Buffer

LOS (Loss Of Signal) Also referred to as all zeros signal, indicates that no signal is received from the data equipment.

AIS (Alarm Indication Signal) No signal is received by the connected end equipment.

Remote Frame Alarm Indication from the connected end equipment that it is not able to synchronize with the modem.

Frame-slip Indicates lack of compatibility between the clocks of the modem and the end equipment.

Remote-BreezeLINK-Unsync Indicates a temporary incidence of a very noisy radio channel. Repeated occurrences indicate either a very noisy radio channel or a hardware problem (e.g. clocks with excessive jitter) or a problem related to configuration of clocks.
Too many BPV/CV Too many Bipolar code violations, indicates selection of Bipolar AMI line code in the modem when the end equipment uses HDB3 line code.

When an alarm is detected a note appears at the bottom of the display: (Note:An alarm has been activated), and the message ALARM EXISTS is displayed on the menu header (see Figure 3-1). In addition, the TEST LED blinks.

T1 Parameters Menu

Menu Item	Action	Options/Notes
1. Line Coding	View current selection. Enter 0 or 1 to change.	0 = AMI 1 = B8ZS (default)
2. Pulse Shape	View current selection. Enter one digit from 0 to 5.	0 - DSX-1 (DSU), line length of 0 - 133 feet (default) 1 - DSX-1 (DSU), line length of 133 - 266 feet 2 - DSX-1 (DSU), line length of 266 - 399 feet 3 - DSX-1 (DSU), line length of 399 - 533 feet 4 - DSX-1 (DSU), line length of 533 - 655 feet 5 - CSU interface For more information see Pulse Shape below.
A. Alarm Buffer	View T1 Alarms (if any).	For details see T1 Alarm Buffer below.

Table 3-3. T1 Parameters Menu Items and Actions

Pulse Shape

The current selection is displayed (the “NOT DEFINED” message is displayed if LIU used is not T1). The selection should be made according to the length of the line connecting the terminal equipment to the 2.048Mbps Wireless Modem, and according to the type of application (CSU or DSU network interface). The selection affects the pulse mask used in the interface according to the requirement specified in the applicable standard (DSX-1 for DSU network interface, ANSI T1.403 for CSU network interface). See Appendix B for more details about CSU and DSU network interfaces.

T1 Alarm Buffer

The possible alarms are:

- LOS (all zeros signal): Loss Of Signal – No signal is received from the data equipment.
- AIS: Alarm Indication Signal – Signal is not received by the data equipment.



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When an alarm is detected, a note appears at the bottom of the display (Note: An alarm has been activated) and the message: ALARM EXISTS is displayed on the menu header (see Figure 3-1). In addition, the TEST LED will blink.

Fractional T1 Parameters Menu

See also Appendix C.

Menu Item	Action	Options/Notes
1. Add/Remove Channels	Enter 1 to Add channels Enter 2 to Remove channels	1 = Add channels 2 = Remove channels
1.1 Add channels	View current active channels. Enter additional channels to become active after next Reset.	Enter numbers between 1 to 24 separated by a comma. Two dots are used to indicate a range. e.g. 1, 8..11,: Add channel 1 and all channels from 8 to 11.
1.2 Remove channels	View current active channels. Enter channels to be removed from list of active channels after next Reset.	Enter numbers between 1 to 24 separated by a comma. Two dots are used to indicate a range. e.g. 1, 8..11,: Remove channel 1 and all channels from 8 to 11.
2. Line Coding	View current selection. Enter 0 or 1 to change.	0 = AMI 1 = B8ZS (default)



Menu Item	Action	Options/Notes
3. Superframe method	View current selection. Enter 0 or 1 to change.	0 = D4 1 = ESF (default) See Superframe method below for details
4. D4 yellow alarm method	View current selection. Enter 0 or 1 to change.	0 = D4 bit 2 mode (default) 1 = D4 F-bit mode See D4 yellow alarm method below for details
5. Pulse Shape	View current selection. Enter one digit from 0 to 8.	0 - DSX-1 (DSU), line length of 0 - 133 feet (default) 1 - DSX-1 (DSU), line length of 133 - 266 feet 2 - DSX-1 (DSU), line length of 266 - 399 feet 3 - DSX-1 (DSU), line length of 399 - 533 feet 4 - DSX-1 (DSU), line length of 533 - 655 feet 5 - CSU interface, Sensitivity level -7.5dB 6 - CSU interface, Sensitivity level -15dB 7 - CSU interface, Sensitivity level -22.5dB 8 - CSU interface, Sensitivity level 0dB See Pulse Shape below for details
6. CRC6 Usage	View current selection. Enter 0 or 1 to change. (applicable only with ESF Superframe method)	0 = ANSI/AT&T/ITU-T (default) 1 = Japanese JT-704 See CRC6 Usage below for details



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Menu Item	Action	Options/Notes
7. Bit 7 Zero Suppression	View current selection. Enter 0 or 1 to change.	0 = No bit 7 zero suppression (default) 1 = Force bit 7 zero suppression See Bit 7 Zero Suppression below for details
8. Pulse Density Enforcer	View current selection. Enter 0 or 1 to change. (applicable only with AMI line code)	0 = Disable Pulse Density Enforcer (default) 1 = Enable Pulse Density Enforcer See Pulse Density Enforcer below for details
9. Echo canceler disabling method	View current selection. Enter 0 or 1 to change settings.	0 = Straight 2100Hz tone (default) 1 = Phase reversed 2100Hz tone 2 = 2100Hz VPA tone See Echo canceler disabling method below
0. Add/Remove Echo cancellation on voice channels	Enter 1 to Set (Add) channels Enter 2 to Clear (Remove) channels	0 = Set Echo cancellation on voice channels 1 = Clear Echo cancellation on voice channels
0.1 Set Echo cancellation on voice channels	View current channels with Echo cancellation. Enter additional channels to have Echo cancellation after next Reset.	Enter numbers between 1 to 24 separated by a comma. Two dots are used to indicate a range. e.g. 1, 8..11,; Set Echo cancellation to channel 1 and all channels from 8 to 11.



Menu Item	Action	Options/Notes
0.2 Clear Echo cancellation on voice channels	View current channels with Echo cancellation. Enter channels to be removed from list of channels with Echo cancellation after next Reset.	Enter numbers between 1 to 24 separated by a comma. Two dots are used to indicate a range. e.g. 1, 8..11.; Remove Echo cancellation from channel 1 and all channels from 8 to 11.
A. Alarm Buffer	View Fractional T1 Alarms (if any).	For details see "Fractional T1 Alarm Buffer" below.

Superframe Method

Each frame transmitted to (or received from) the end equipment is comprised of 193 bits, numbered 1 to 193. Bit numbers 2 to 193 are used for data. The first bit of each frame is designated an F-bit, and is used for purposes such as frame alignment, performance monitoring (CRC check) and providing a data link. There are two alternative methods for allocation of F-bits:

- ESF: A 24-frame multiframe. F-bits provide frame alignment signal (FAS), a 4Kbps data link with the connected equipment (DL), and CRC-6 block check field.
- D4: A 12-frame multiframe. F-bits provide frame and multiframe alignment signal (No CRC or data link). Set this parameter to 0 (D4) or 1 (ESF) in accordance with the connected end equipment.

D4 Yellow Alarm Method

Yellow alarm is an indication, using the D4 multiframe method, that the sending equipment is unsuccessful in synchronizing with the receiving equipment. There are two methods of transmitting the yellow alarm message:

- *D4 bit 2 mode*: Setting bit number 2 of all channels to 1
- *D4 F-bit mode*: Setting a specific F-bit to 1

Set the D4 yellow alarm method to 0 (bit 2 mode) or 1 (F-bit mode) in accordance with the configuration of the connected end equipment.

Pulse Shape

The current selection is displayed (the NOT DEFINED message is displayed if LIU used is not T1). The selection should be made according to the length of the line connecting the terminal equipment to the 2.048Mbps Wireless Modem, and according to the type of application (CSU or DSU network interface). The selection affects the pulse mask used in the



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interface, as per the requirement specified in the applicable standard (DSX-1 for DSU network interface, ANSI T1.403 for CSU network interface). See Appendix C for more details about CSU and DSU network interfaces.

CRC6 Usage

The F-bits in an ESF multiframe (see Superframe method above) provide Cyclic Redundancy Check 6 (CRC6) information. These bits are the result of a certain calculation performed on all the bits of the previous multiframe (24 frames). CRC6 bits may be used by the receiving equipment to determine correct reception of all bits sent to it. There are two common CRC6 procedures:

- In accordance with the ANSI, AT&T and ITU-T standards
- In accordance with the Japanese JT-704 standard.

Set CRC Usage in accordance with the CRC6 procedure used by the connected end equipment.

Bit 7 Zero Suppression

When using AMI line code, the occurrence of too many successive zeros should be avoided to ensure accurate reconstruction of the data. Some devices use a method known as zero suppression. This method forces bit 7 of each 8-bit channel to 1 if all the bits in the original channel are zero. If the connected end equipment uses the bit 7 zero suppression method, this parameter should be set to 1 (Force bit 7 zero suppression). Otherwise (see also Pulse Density Enforcer below) it should be set to 0 (no suppression). If the line code used is B8ZS, it must be set to 0 (no suppression). When transmitting data (non-voice) it must be set to 0 (no suppression) unless the data is preconditioned not to send “all zero” bytes.

Pulse Density Enforcer

When using AMI line code, the occurrence of too many successive zeros should be avoided to ensure accurate reconstruction of the data. Some devices use a method known as Pulse Density Enforcer according to ANSI T1.403. This method checks the number of ones, and upon detecting too many successive zeros it forces certain bit(s) to one. If the connected end equipment uses the Pulse Density Enforcer method, this parameter should be set to 1 (Enable Pulse Density Enforcer). Otherwise (see Bit 7 Zero Suppression above) it should be set to 0 (Disable Pulse Density Enforcer). If the line code used is B8ZS, it must be set to 0 (Disable Pulse Density Enforcer). When transmitting data (non-voice) it must be set to 0 (Disable Pulse Density Enforcer) unless the data is preconditioned not to send “all zero” bytes.

Echo Canceler

Set this parameters in accordance with the echo cancellation disabling method used by the end equipment(see also appendix C).

- *Straight 2100Hz tone (0)*: The most popular method based on transmitting a straight 2100Hz tone.
- *Phase reversed 2100Hz tone (1)*: A 2100Hz tone with phase reversals for improved differentiation from voice signals.
- *2100Hz VPA tone (2)*: A tone in the range 2000-2100Hz.

Fractional T1 Alarm buffer

The possible alarms are:

LOS (Loss Of Signal): Also referred to as all zeros signal, indicates that no signal is received from the data equipment.

AIS (Alarm Indication Signal): Signal is not received by the data equipment.

RLOS (framer un-synchronized): The modem does not succeed to synchronize with the end equipment.

Yellow-alarm: Indication from the connected end equipment that it does not succeed to synchronize with the modem.

Frame-slip: Indicates lack of compatibility between the clocks of the modem and the end equipment.

Remote-BreezeLINK-Unsync: Indicates a temporary incidence of a very noisy radio channel. Repeated occurrences indicate either a very noisy radio channel or a hardware problems (e.g. clocks with excessive jitter) or a problem related to configuration of clocks.

Too many BPV/CV: Too many Bipolar code violations-indicates selection of Bipolar AMI line code in the modem when the end equipment uses B8ZS line code.

When an alarm is detected a note appears at the bottom of the display: Note: An alarm has been activated and the message: ALARM EXISTS is displayed on the menu header (see Figure 3-1). In addition, the TEST LED will blink.



V.35/RS530/X.21 Parameter Menu

Menu Item	Action	Options/Notes
1. Clock Rate	View current selection. To change, enter a number N for a clock rate of N*64 Kbps.	Any number (1...32) For example: Enter N=4 for 256 kbps.
2. DCE/DTE	View current selection. Enter 0, 1 or 2 to change settings.	0=DTE (V.35 & RS-530) 1=DCE Internal Clock (V.35 & RS-530 & X.21) 2=DCE External Clock (V.35 & RS-530) 3=DTE (X.21) See DCE/DTE below for more information.
Transmit Clock Polarity	View current selection. Enter 0 or 1 to change settings.	0 – Positive Edge (default) 1 - Negative Edge See Clock Polarity below for more information.
Receive Clock Polarity	View current selection. Enter 0 or 1 to change settings.	0 – Positive Edge 1 - Negative Edge (default) See Clock Polarity below for more information.

Table 3-5. V.35/RS-530/X.21 Parameters Menu Items and Actions

DCE/DTE

The current selection is displayed (or a “NOT DEFINED message, if a different LIU is used). Table 3-6 displays DCE/DTE functionality options:

Functional Description	Option in monitor	Jumper Position
V.35, RS-530, X.21 DCE internal clock	DCE internal clock	Figure A-5
V.35, RS-530 DCE external clock	DCE external clock	Figure A-6
V.35, RS-530 DTE	DTE (V.35 and RS-530)	Figure A-7
X.21 DTE	DTE (X.21)	Figure A-8

Table 3-6. DCE/DTE Functionality Options



See Appendix A for details on DCE/DTE options and for instructions on setting the LIU jumpers according to the end equipment configuration.

Unless specially ordered, the 2.048Mbps Wireless Modem with a V.35 or RS-530/X.21 LIU is supplied from the factory with the settings DCE, internal clock.

Clock Polarity

The current selection is displayed (or a NOT DEFINED message, if a different LIU is used). The selection determines if data bits are sampled on the negative or positive edge of the clock signal. Non-standard sampling (negative edge for Transmit Clock and positive edge for Receive Clock) should be selected only if a non-standard terminal equipment is used, operating in accordance with a non-standard definition.

Loopback Mode Menu

Menu Item	Action	Options/Notes
Loopback Mode	View current status. Enter 0 or 1 to change settings.	0 – No Loopback (default) 1 – Loopback Mode See Loopback Mode below for more information.

Table 3-7. Loopback Mode Menu Items and Actions

If you are in loopback mode, a loopback is performed on the LIU input and also on the LIU side connected to the modem, as described in Figure 3-3.

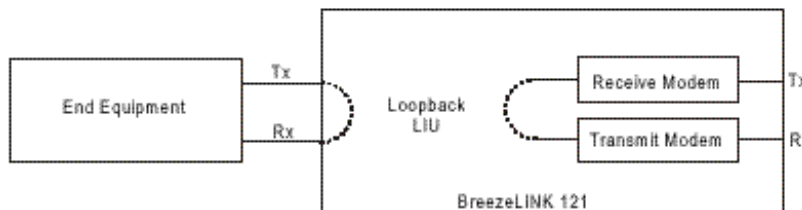


Figure 3-3. Loopback Mode

In this situation the local Tx data is diverted back to the local Rx side of the DTE, and the remote Tx data is diverted back to the remote Rx side. The loopback mode is useful for pinpointing the source of certain problems. For example, if data is transmitted by the end equipment in the loopback mode but nothing is received by the end equipment, then there is a problem either in the cable(s) connecting the end equipment to the Wireless Modem or in the end equipment itself. When the end equipment supports local loopback testing, this helps to identify whether the source of the problem is in the end equipment or in the connection. Problems in the modem itself can be identified in a similar fashion (assuming that reception conditions are normal). See Chapter 4 for more details.



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For fractional E1/T1, the LIU card performs the loopback. Both clock and data are looped back. When the Master modem is set for loopback operation, the clock starts drifting from the clock of the end equipment (under normal conditions, the system clock is supplied by the Master end equipment). Eventually this will lead to error messages and the link will be disconnected. Therefore, loopback tests on the Master side should be as short as possible and should be limited to 1 to 2 minutes at the most. It is recommended to avoid performing loopback test on the Master unit in Fractional E1/T1 applications, or alternatively to switch the master/slave definitions of both sides for the duration of the test. For V.35 LIU and RS-530/X.21 LIU configured to operate with an external clock, the end-equipment (or alternatively a BER meter) should be connected to the unit during the test in order to supply the required clock.

Line Interface Unit Type Menu

Menu Item	Action	Options/Notes
Line Interface Unit type	View selection. Enter 1, 3 or 5 to change settings.	This parameter is set in the factory. Change it if the LIU is replaced by a different type. 1 – E1 2 – Fractional E1 3 – T1 4 – Fractional T1 5 – V.35/RS-530/X.21

Table 3-8. Line Interface Unit Type Menu Options

MCP Parameters Menu

The MCP Parameters menu gives you access to the following parameters:

- Network ID
- Master-Slave
- Total Link Delay
- Modem Initialisation String
- Number of Links to Synchronize.



Menu Item	Action	Options/Notes
1. Network ID	Enter up to two decimal digits from 1-16	If you are using more than one link, make sure that each link has its own unique Network ID (default is 1). If you are using synchronization of co-located units, number consecutively from 1.
2. Master - Slave	Enter 0 or 1	For E1/T1 equipment, the Master BreezeLINK must be connected to the end equipment which is the source of the clock. 0 = Master 1 = Slave (default) See Master-Slave below for more information
3. Total Link Delay	Enter one digit from 0-4	0 = Minimum delay 1 = Short delay 2 = Normal delay (default) 3 = Medium delay 4 = Long delay See Total Link Delay below for more information.
4. Modem Initialization String	Enter up to 50 printable ASCII characters	For more details, see Modem Initialization String below.
5. Number of Links to Synchronize	Enter up to 2 decimal digits from 0 to 12	0=Disable Synchronization 1=Synchronize as many links as possible 2-12: Number of links to synchronize. See Section 2.6 for more information.

Table 3-9. MCP Parameters Menu Options

Master-Slave

In synchronous data communications systems, all components of the link should operate using the same clock. The Master unit provides the clock and the Slave unit reconstructs it from the data received from the master unit.

Total Link Delay

In order to improve performance the 2.048Mbps Wireless Modem uses an Automatic Retransmission Queuing (ARQ) mechanism that enables to detect errors in the received data and to request retransmission of that data. The ARQ mechanism breaks the data into fragments (called *buffers*) and adds a Cyclical Redundancy Check (CRC) code, which enables detection of errors in the received fragment. A header providing unique identification as well as Acknowledge/Not Acknowledge response is attached to each fragment.



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In order to maintain a continuous flow of reconstructed received data transferred to the terminal equipment, a delay must be introduced. The longer the delay, the more effective the ARQ mechanism. A longer delay can improve performance in applications not sensitive to delay. The same delay settings must be configured on both Master and Slave modems.

In voice applications, select the maximum acceptable delay. It is recommended to use an echo canceller. This allows use of a higher delay and improves performance.

Some data communications protocols are sensitive to delay. Select the appropriate delay while taking into consideration the relevant performance.

The actual value of the link delay is dependent on the modem rate and data rate configuration, and is displayed when setting the total link delay.

Modem Initialisation String

In order to enable remote site management, it is possible to connect an external dial-up modem to the 2.048Mbps Wireless Modem instead of a local monitor. This feature is usually used to allow remote management of the local and remote wireless units from a central location (see Figure 3-4). The Modem initialisation string is sent after each modem reset via the monitor port. The initialisation string is a set of commands, called “AT” commands, which configure the dial-up modem’s operation.

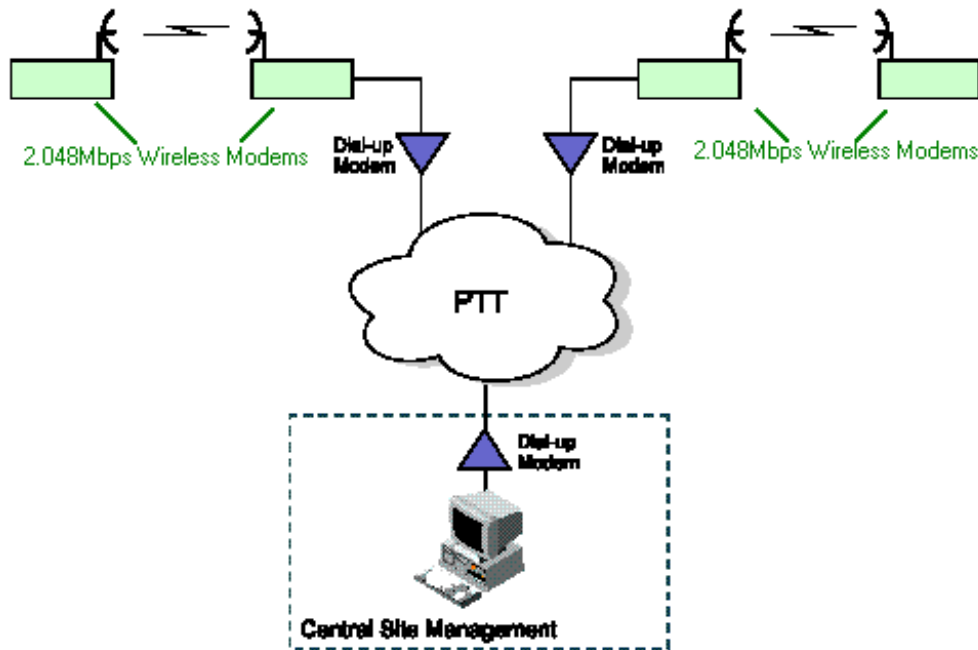


Figure 3-4. Central Site Management Using a Dial-up Modem

The initialisation string can configure the modem for several operational modes, such as “auto- answer” for incoming calls or dialling a certain phone-number, all according to the modem specification.



The following commands are set as a default initialisation string in the modem:

```
AT&f\n
```

The meaning of this string is initialising default configuration (“n” means “new line”).

An example for a more informative initialisation string is:

```
AT&f\nATS0=1\nAT&K0\nATS23=3B\nATQ1\n
```

This default string is consistent with a few modem types, for example MICROCOM desktop.

The meaning of the above string is as follows:

- AT&T – Initialise default configuration.
- ATS0=1 – Auto-Answer after one ring
- AT&K0 - Disable flow control
- ATS23=3B - Rate initialisation set to 9600bps.
- ATQ1 - No messages are output

It is possible to change the modem initialisation string, to configure it to specific modes and to adopt it to different modems (most AT commands are generic, but some vary from modem to modem). In order to determine the initialisation string, you must obtain the user’s manual of the dial-up modem you plan to use, and locate the correct AT commands, resembling the ones in the default string above. Then you must enter the new initialisation string accordingly. The maximum length of the string is 50 characters. For example: if you wish to add to the above example a command that will cause the dial-up modem to dial the phone number 1234567 using DTMF tone dialling after every reset of the modem, use the following string:

```
AT&f\nATS0=1\nAT&K0\nATS23=3B\nATQ1\nATDT 1234567\n
```

To check that the wireless modem received your new modem string, reset the wireless modem; on power-up, you should see your string printed on the monitor.

To physically connect a dial-up modem to the 2.048Mbps Wireless Modem, use a straight RS-232 cable, 9-pin male for the Wireless modem side and 25-pin male for the modem side (this is the most common interface for modems). This cable is NOT compatible to the monitor cable supplied with the 2.048Mbps Wireless Modem unit.

To activate the dial-up modem, first connect the RS-232 cable to the monitor interface of the Wireless Modem and then the modem, and then re-start the wireless modem when the modem is on.

Note: Dial-up modems and connection cables can be obtained from Black Box.



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Radio and Modem Parameters Menu

The Radio and Modem Parameters menu gives you access to the following parameters:

- Modem Rate
- Hopping Sequence
- Transmit Power
- Test Sequence Add/Remove Channels menu

Menu Item	Action	Options/Notes
1. Modem rate	Enter 1 digit	1 = 1 Mbs 2 = 2 Mbs 3 = 3 Mbs 5 = 0.5 Mbs See Modem Rate below for more information.
2. Hopping Sequence	Enter 1 decimal digit from 0 to 3.	See Hopping Sequence below for more information.
3. Transmit Power	Enter 1 or 2.	1=High, 15dBm (default) 2=Low, 2 dBm Use 2 (Low) if working with a Transmit Power Amplifier connected by a short RF cable, in order to reduce the level of power input into the amplifier.
4. Add/Remove Channels from Test Sequence		See Add/Remove Channels from Test Sequence below

Table 3-10. Radio and Modem Parameters Menu Options

Modem Rate

The modem rate is set automatically according to the selected LIU Data Rate (Clock Rate), according to the following table:

DTE Data Rate (Kbps)	Default Modem Rate (Mbps)
64 - 320	0.5
384 - 704	1
768 - 1472	2
1536 - 2048	3

Table 3-11. Default Modem Rate According to Selected LIU Data Rat



Changing the modem rate above the default value results in the following:

- The higher the modem rate, the lower the sensitivity. Achievable distances decrease as the modem rate increases.
- The higher the modem rate relative to the LIU data rate, the higher the effective bandwidth. Better use is made of the frequency diversity capability inherent to the frequency hopping mechanism.

In conclusion, providing that the received signal level is sufficient, selecting a higher modem rate can significantly improve performance in the presence of interference.

Hopping Sequence

Current HOPPING SEQUENCE and HOPPING STANDARD are displayed. The number of available hopping sequences depends on the Hopping Standard of each country. The Hopping Standard is set in the factory. If several links in the same area are used (without using the synchronization feature), select a different hopping sequence for each pair of 2.048Mbps Wireless Modems. Master and Slave units must use the same hopping sequence. If co-located units are synchronized, the same hopping sequence should be used for all units (or else the synchronized units will interfere with each other as though not synchronized) – the synchronization process verifies that each pair uses a sequence that is sufficiently “shifted” in frequency relative to sequences used by other pairs.

Add/Remove Channels from Test Sequence

Selection of this option in the RADIO and MODEM Parameters menu opens the Add/Remove Channels from Test Sequence menu. This menu allows you to determine the specific channels to be used when Test Sequence is used as the Hopping Standard. **Test Sequence should only be used as the Hopping Standard by authorized Black Box technicians.** Any changes to the Test Sequence channels shall have no effect when regular Hopping Standards are being used. Therefore, do not attempt to select this option or to modify the test sequence channels under normal conditions.

REMOTE Parameters

2.048Mbps Wireless Modem supports full management of the remote unit, providing that there is a working link between the two units. Therefore the user should refrain from making changes to the remote units that may result in a complete loss of the link. The Remote Parameters menu gives you access to the following parameters:

- Switch to remote monitor
- Switch to local monitor
- PING remote unit
- Download remote database to remote unit



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- Copy local database and download to remote unit.

Menu Item	Action	Options/Notes
1. Switch to remote monitor	Enter 1 digit	
2. Switch to local monitor	Enter 0 or 1	0 – Switch back to local monitor (remote database will be lost) 1 – Do not switch back to local monitor.
3. PING remote unit	Enter 1 digit	
4. Download remote database to remote unit	Enter 0 or 1	0 – Download database. All changes will take effect. 1 – Do not download database yet.
5. Copy local database and download to remote unit	Enter 0 or 1	0 – Copy local database and download to remote unit. All changes will take effect. 1 – Do not copy database and download to remote unit yet.

Table 3-12. REMOTE Parameters Menu Options

Switch to Remote Monitor

When selecting option 1 (Switch to remote monitor) in the REMOTE Parameters Menu, the database of the remote unit starts loading into the local unit. This process takes some time, and the time required is even longer if the quality of the link is poor. Once the remote database is loaded, you can view or change the parameters of the remote unit. At this state, an indication of being in “Remote Monitor” mode appears at the end of the first line of each menu.

Switch to Local Monitor

When selecting 2 in the REMOTE Parameters Menu, the “Switch to local monitor” menu appears:

- 0 – Switch back to local monitor (remote database will be lost)
- 1 – Do not switch back to local monitor.

Note: If parameters of the remote units were changed, select 4 in the REMOTE Parameters Menu (Download remote database to remote unit) before switching back to local monitor mode. Note that this takes effect only after resetting the unit.



Ping Remote Unit

The remote management process involves transfer of large quantities of data between the units, in addition to normal data and signals. Since this transfer can take a long time, the PING mode is used to verify that there is a working link between the two units and that remote management operation is feasible. Entering this mode causes transmission of a short “PING remote” message, followed shortly by a “PONG received” message indicating the existence of a remote management link.

Download remote database to remote unit

When selecting 4 in the REMOTE Parameters Menu, the Download remote database selection menu appears:

- 0 – Download database. All changes will take effect.
- 1 – Do not download database yet.

Reset the remote unit for the changes to take effect.

Copy database and download to remote unit

Typically, this is the simplest, fastest and safest procedure for changing parameters in the remote unit, assuming that parameters of the local and remote units are the same. The remote unit will automatically adapt its Master/Slave parameter (if the parameter in the database is Master, the remote unit will change its setting to Slave and vice versa). When selecting 5 in the REMOTE Parameters Menu, the Copy local database and download to remote unit selection menu appears:

- 0 – Copy database and download to remote unit. All changes will take effect.
- 1 – Do not copy database and download to remote unit yet.

Reset the remote unit for the changes to take effect.

Load Default Values Menu

The Load Default Values menu gives you access to the following options:

- Cancel Operation
- Load Values



Menu Item	Action	Options/Notes
1. Load default values	Enter 1 digit	0 = Cancel operation 1 = Load values Loads the factory default values for all Parameters menus. Change takes effect after system Reset.

Table 3-13. Load Default Values Menu options

Note: The Hopping Standard and LIU type parameters are fixed and are not affected by this operation.

Parameter Info. Screen

Option 6 in the Parameters menu opens the Info Screen, which presents information on the current status of main parameters of either the local or the remote unit (depending on local/remote monitoring status). Press any key to return to the Parameters menu.

Local Unit Parameters:		
Unit is Master	V.35/RS-530/X.21	DCE External clock
NET.I.D is 13	Synchronize 0 links	
Clock Rate 64Kb/S	Modem Rate 0.5Mb/S	Link Delay 45.0mS (Normal)
Hop Sequence 0	Hop Standard is Europe/ETSI	
Hit any key >		

Figure 3-5. Example of a Typical Info Screen



Counters and Tracers Menu

To access the Counters and Tracers Menu:

- From the Main Menu, type 2. The Counters and Tracers Menu appears.

```

Counters menu
=====
1 - Display System Counters
2 - Display Channel Tracer: RSSI per channel
3 - Display Channel Tracer: Errors per channel
4 - Clear System Counters and Channel Tracer
5 - Display Time Tracer: Errors versus time
6 - Display Time Tracer: Consecutive errors versus
time
7 - Set Time Tracer resolution
8 - Display Reset Counter
9 - Clear System Reset Counter (System Reset)
A - Watch Alarms

```

Figure 3-6. Counters and Traces Menu

To make selections from the Counters and Tracers Menu:

- At the Select Option prompt, type the number that corresponds to the option you require:
- Type 1 to display the System Counters.
- Type 2 to display Channel Tracer RSSI (Received Signal Strength Indication) per channel.
- Type 3 to display Channel Tracer errors per channel.
- Type 4 to clear the System Counters and the Channel Tracer.
- Type 5 to display Time Tracer errors versus time.
- Type 6 to display maximum number of consecutive traced errors versus time.
- Type 7 to set the Time Tracer resolution.
- Type 8 to display the Reset Counter.
- Type 9 to clear the Reset Counter.
- Type A to display Alarms.



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System Counters

In the Counters and Tracers menu, type 1 to display the System Counters.

LIU TX BUFFERS	0
LIU RX BUFFERS#	0
LIU ERROR BUFFERS	0
LIU BUFFER ERROR RATE	0.00e+00
RADIO NOT ACK BUFFERS	0
RADIO TX BUFFERS	70321
RADIO RX BUFFERS	0
RADIO ERROR BUFFERS	0
RADIO NO RX BUFFERS	0
RADIO BUFFER ERROR	0.00e+00
Rate	
Hit any key >	

Figure 3-7. 2.048Mbps Wireless Modems Counter display.

The System Counters give you statistical information on the quality of communications with the terminal equipment (LIU side) and with the other end of the wireless link (Radio side). The data stream received/transmitted from/to the 2.048Mbps Wireless Modems is divided internally in the 2.048Mbps Wireless Modem into buffers, and the statistics are based on these buffers. The data is accumulated continuously until the System Counters are cleared. Thus, the numbers represent the accumulated results since the last time the counters were Cleared. The 2.048Mbps Wireless Modem uses an Automatic Retransmission Queuing (ARQ) mechanism that enables to detect errors in the received data and to request retransmission of that data. The ARQ mechanism breaks the data into fragments (called *buffers*) and adds a Cyclical Redundancy Check (CRC) code which enables detection of errors in the received fragment. A header providing unique identification as well as Acknowledge/Not Acknowledge response is attached to each fragment.

Figure 3-8 displays the 2.048Mbps Wireless Modem system counters flow:

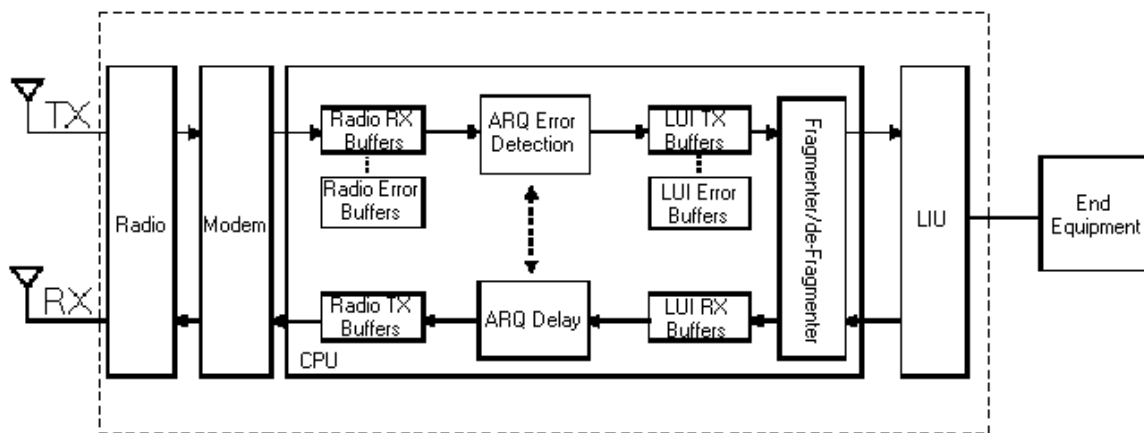


Figure 3-8. 2.048Mbps Wireless Modem System Counters flow



The following is a table of the buffers and their description:

Name	Description
LIU TX BUFFERS	The number of buffers transmitted to the line interface.
LIU RX BUFFERS	The number of buffers received from the line interface.
LIU ERROR BUFFERS	The number of buffers with errors sent to the line interface (after the ARQ error correction algorithm).

Name	Description
LIU BUFFER ERROR RATE	LIU ERROR BUFFERS divided by LIU TX BUFFERS.
RADIO NOT ACK BUFFERS	The number of buffers that were transmitted from the unit (Radio TX buffers) but were not acknowledged by the other unit, indicating on the quality of the received signal at the other side of the link.
RADIO TX BUFFERS	The number of buffers transmitted by the radio.
RADIO RX BUFFERS	The number of buffers received by the radio.
RADIO ERROR BUFFERS	The number of buffers with errors received by the radio (before ARQ error correction), including buffers that were not received at all.
RADIO NO RX BUFFERS	The number of buffers that were not received at all (were lost).
RADIO ERROR BUFFERS RATE	RADIO ERRORS BUFFER divided by RADIO RX BUFFERS.

Table 3-14. Buffers Name and Description

- Under normal conditions, the number of LIU TX BUFFERS is approximately (± 2) equal to the number of LIU RX BUFFERS.
- Under normal conditions, communication with the end equipment is not subject to any interruptions, and LIU ERROR BUFFERS as well as the LIU BUFFERS ERROR RATE should be 0.

Note: Buffer Error Rate is different from Bit Error Rate. Each buffer contains between 40 to 300 bytes, depending on modem rate. A buffer with errors means errors in between 1 to all bits in the buffer. Thus, the Bit Error Rate may be any number between the Buffer Error Rate and the Buffer Error Rate divided by number of bits in the buffer (number of bytes times 8).



The RSSI per channel test displays in graphic format the strength of the received signal on each of the RF channels used by the 2.048Mbps Wireless Modem. Each vertical column represents the level of the received RF signal on one of the channels. Available channels are from 0 to 100 (0 representing 2.400GHz and 100 representing 2.500GHz), depending on hopping sequence setting.

Note: In the diagram, 1 represents channel number 10, 2 represents channel 20, and so on; channels 5, 15 and so forth are marked as +, while the other channels are marked as =.

The height of the column (# signs) represents the relative signal strength. At the top of the graph the maximum and minimum RSSI levels are given in dBm. An empty column indicates that this is the channel(s) with the minimal RSSI (channel 47 in the example above). A column with a – sign at the bottom (channel 39 in the example above) represents a channel that is either blocked or is not included in the hopping sequence

Note: This graph is used only for measuring an operational link. Note that it measures the received energy in the band, including possible emissions from other sources. See page82 for further information on measuring the energy received from undesired sources.

For good fade margin, RSSI levels should allow for at least a 10 dB margin above the minimal level, determined by the sensitivity at the applicable rate. The following table provides the RSSI levels required for 10dB fade margin:

Radio Link Rate (Mbps)	Minimal RSSI (dB)
0.5	-79
1	-76
2	-68
3	-62

Table 3-16. RSSI Levels

Note: The maximum RSSI level must not exceed -10dBm (-25dBm for a Radio Link Rate of 3Mbps)

Channel Tracer Errors Per Channel

In the Counters and Tracers menu, type 3 to view the Channel Tracer errors per channel graph.

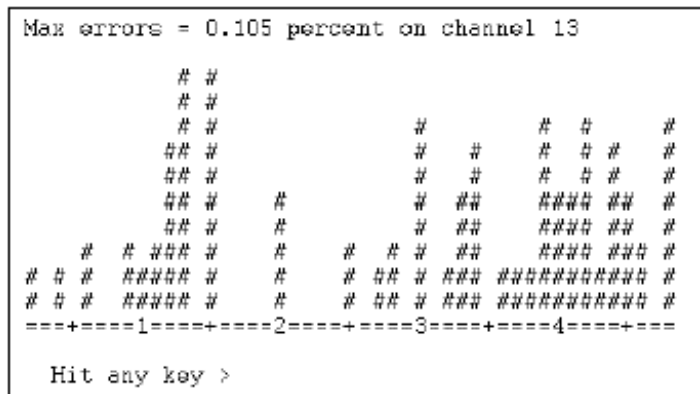


Figure 3-10. Errors Per Channel Graph



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Each column represents the percent of RADIO ERROR BUFFERS in each of the RF channels, out of all the buffers that were transmitted on the channel. A “-” sign at the bottom represents a channel that is not included in the set of hopping frequencies. On top of the graph, information is provided on the channel with the highest error rate (Max errors in percentage and the number of the channel with the maximum error rate). The distribution of errors by the channel graph is useful to identify problematic channels with an unacceptable error rate. Under normal conditions, the error rate should be similar for all channels and recommended to be no more than about 2%.

Clear System Counters and Channel Tracer

In the Counters and Tracers menu, type 4 to clear the Systems Counters and the information accumulated in the Channel Tracer graphs.

The System Counters and Channel Tracer graphs display information accumulated since the last time they were cleared.

Time Tracer Errors versus Time

In the Counters and Tracers menu, type 5 to display the Time Tracer errors over time graph.

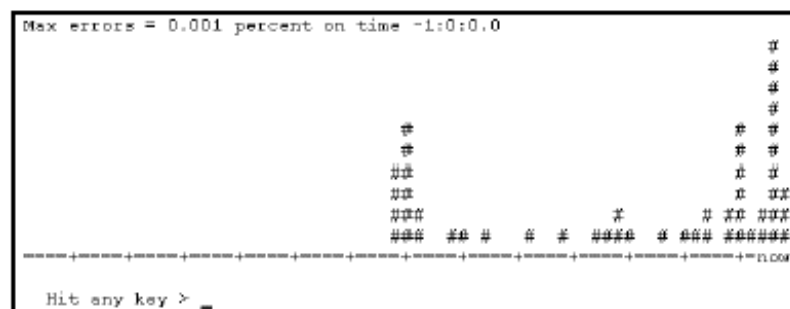


Figure 3-11. Time Tracer Errors vs. Time Graph

The graph displays the Radio Error Buffers Rate over time (up to the present moment) using the resolution defined in Set Time Tracer Resolution (option 7 in the Counters and Tracers Menu). Information on the maximum error rate in the tracing period, and how much time passed since this event occurred appears at the top of the graph. Each column in the graph represents the relative error rate in the relevant time period. A column with 10 # signs represents the channel with the maximal error rate, and the height (number of # signs) of each of the other columns represents the error rate in each channel relative to the above maximum. This graph is useful for identifying the existence of time-dependent interference, e.g. activation of a nearby transmitting device at a specific time every day. The graph displays the history of the last 69 time units according to the defined resolution, or the history since the last time the Time Tracer was reset (see also page 76).

Time Tracer Max Consecutive Errors versus Time

In the Counters and Tracers menu, type 6 to view the Time Tracer Max Consecutive Errors versus Time graph.



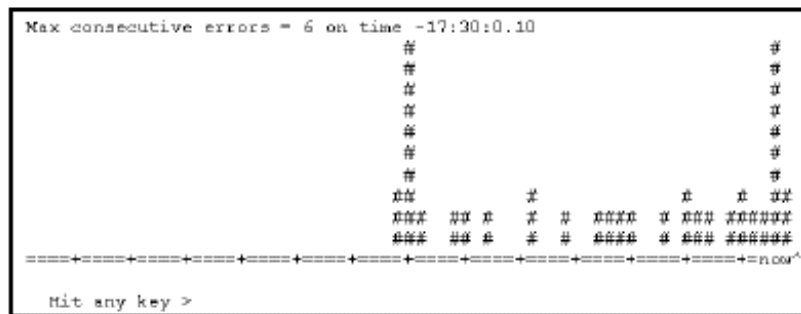


Figure 3-12. Time Tracer Max Consecutive Errors Graph

Using the same time resolution as the Time Tracer Errors versus Time, this graph displays the maximum number of consecutive errors in each time unit. At the top of the graph appears information on the maximum number of consecutive errors identified during the tracing period, and how much time passed since this event. Each column in the graph represents the relative number of consecutive errors in the relevant time period. The graph displays the history of the last 69 time units according to the defined resolution (“Set Time Tracer Resolution” - option 7 in the Counters and Tracers Menu), or the history since the last time the Time Tracer was reset (see also page 76).

This tracer is very important, since long bursts of consecutive errors can pass the ARQ error correction algorithm uncorrected. The above tracer shows when these long bursts occurred, and their length. The longest (isolated) burst of consecutive errors tolerated by the ARQ algorithm depends on the delay setting. The following table displays for each delay setting the maximum number of consecutive errors and blocked frequency channels resulting in no errors at the LIU due to the ARQ algorithm:

Delay Setting	No. of errored buffers (consecutive)	No. of blocked frequency channels
minimum	6	1
short	12	2
normal	24	4
medium	42	7
long	90	15

Table 3-17. Delay Setting

Set Time Tracer Resolution

When the Time Tracer is displayed, you can view up to 69 traced time intervals.

⇒ **To set the time intervals:**

1. In the Counters and Tracers menu type 7. The Set Time Tracer Resolution screen shows, displaying the current resolution.

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2. Select a new resolution. You can enter up to 11 characters in hh:mm:ss.ss format. For example, to display a tracer of 69 minutes, set the Time Tracer resolution to 00:01:00.0.

Note: Each time you define a new resolution; the time tracer graphs are reset.

Reset Counters

In the Counters and Tracers menu, type 8 to view the Reset Counters. The following information is displayed:

RESET COUNTER: The number of times the system was reset since the last time the Reset Counter was cleared.

CAUSE OF LAST RESET: The cause of the last reset. Possible causes are:

- Normal Error Condition: A “normal” reset following an error burst. A “normal” reset is defined as a reset that may occur during regular operation and does not necessarily indicate a problem, unless its’ rate of occurrence is too high.
- Loss of Power: A “normal” reset following an interruption in the power supply
- Unexpected Internal Error
- Unexpected assertion of HW reset line
- Unexpected Loss of CPU clock
- Unexpected software reset
- Unexpected assertion of SW reset line

All the “Unexpected” causes indicate HW problems that must be checked by Black Box engineer

Clear Reset Counter

In the Counters and Tracers menu, type 9 to clear the Reset Counter.

Watch Alarms

Alarms for V1.7

LIU Alarms

In the Counters and Tracers menu, type A to display the alarms of the monitored unit

Message: Input CLK to LIU is 0

Description: Appears in a unit with V.35/RS-530/X.21 hardware that is configured in software as an E1/T1 unit.

Correction: Select the correct LIU type in the LIU parameters menu.

Message: LOS (all zeros signal)

Description: Indicates an all zeros signal to an E1/T1 or a Fractional E1/T1 LIU. This may be caused by a cable problem, or because the end equipment is not connected to the unit.

Correction: Check the cable and/or the connection of the end equipment to the unit.

Message: AIS

Description: Indicates an all ones signal to an E1/T1 or a Fractional E1/T1 LIU. This may be caused by a problem in the cable, which connects the end equipment.

Correction: Check the cable, which connects the end equipment.

Message: No Input CLK to LIU, Set End-Equipment to source clock

Description: Appears in V.35/RS-530/X.21 units that are configured as DCE EXTERNAL CLOCK or as DTE; indicates that the end equipment does not supply a clock to the LIU.

Correction: Configure the end equipment to supply the clock, and connect it to the modem..



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Message: Remote Frame Alarm

Description: In fractional E1 applications, an indication from the connected end equipment that it was unsuccessful in synchronizing with the 2.048Mbps Wireless Modem.

Correction: Check the cable, which connects the end equipment to the modem.

Message: Yellow-alarm

Description: In fractional T1 applications, an indication from the connected end equipment that it was unsuccessful in synchronizing with the 2.048Mbps Wireless Modem.

Correction: Check the cable that connects the end equipment to the modem.

Message: Frame-slip

Description: In Fractional E1 or Fractional T1 applications, indicates lack of compatibility between the clocks of the 2.048Mbps Wireless Modem and the end equipment.

Correction: Configure properly the clocks in the end equipment.

Message: Remote-BreezeLINK-Unsync

Description: In Fractional E1 or Fractional T1 applications, indicates a temporary incidence of a very noisy radio channel. Repeated occurrences indicate a very noisy radio channel, a hardware problem (e.g. clocks with excessive jitter) or a problem related to configuration of clocks. Correction: Check the quality of the radio link. If the quality is low, try to improve it. Otherwise, the unit should be checked by an authorized Black Box technician

Message: Too many BPV/CV

Description: In Fractional E1 applications, too many Bipolar code violations-indicates selection of bipolar AMI line code in the 2.048Mbps Wireless Modem when the end equipment uses HDB3 line code. In Fractional T1 applications, too many Bipolar code violations indicates selection of Bipolar AMI line code in the modem when the end equipment uses BHZS line code.

Correction: Configure the line code correctly.

Message: RLOS (framer un-synchronized)

Description: In Fractional T1 applications, the wireless modem was unsuccessful in synchronizing with the end equipment.

Correction: Check the cable that connects the end equipment to the modem. Check that parameters of the modem and end equipment match each other (e.g. framing method and line coding).

Radio Alarms

Message: WARNING: RSSI (based on channel tracer) more than maximum allowed power

Description: The radio receives too much power from one or more channels.

Correction: Use a lower gain receive antenna or a low power setting or a lower gain transmit antenna on the transmitter at the opposite end.

Message: WARNING: RSSI (based on channel tracer) below reception threshold

Description: The radio does not receive enough power on one or more channels.

Correction: Use a higher gain receive antenna, use a higher gain transmit antenna or a Transmit Power Amplifier at the opposite end, or reduce losses in the RF cables.

Message: WARNING: RSSI (based on channel tracer) indicates fade margin less than 10dB

Description: There is less than 10dB fade margin on the power received by the radio on one or more channels. Correction: Use a higher gain receive antenna, use a higher gain transmit antenna or a Transmit Power Amplifier at the opposite end, or reduce losses in the RF cables.

Message: WARNING: Modem rate too low for RADIO BUFFER ERROR RATE (based on counters)

Description: The difference between the modem rate and the LIU rate is too small to allow the ARQ error correction protocol to correct all the errors.

Correction: Increase the modem rate, decrease the LIU rate or improve the error rate on the radio by improving the quality of the RF link.



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Message: WARNING: Delay setting may be too short to correct all errors

Description: The selected delay setting might be too short to allow the ARQ to correct the bursts of radio errors present. Correction: Increase the delay setting or identify and eliminate the cause of the bursts by using the tracers.

General Alarms

Message: WARNING: LIU Clock drift, Check clock configuration

Description: In E1/T1 configuration, failure to set the clock source of the end equipment connected to the slave unit to loop-back mode.

Correction: Check the clock configuration.

Message: WARNING: LIU Clock frequency differs from set value

Description: Indicates a clock rate different from the one specified in a V.35/RS-530/X.21 unit configured as DCE EXTERNAL CLOCK or as DTE.

Correction: Correct clock frequency to set value.

Message: WARNING: DPLL is noisy due to bad link conditions or noisy input clock

Description: Indicates that bad link conditions prevent the slave unit from synthesizing a stable LIU clock.

Correction: Check the link and the clock.

Message: WARNING: Too many links to synchronize, Reduce requested number

Description: The specified number of links to synchronize is too high for the selected hopping standard.

Correction: Reduce the number of links to synchronize.

Message: **WARNING: Net I.D. too high (relevant only regarding synchronization)**

Description: The Net I.D. for a link that should be synchronized is higher than the requested number of links to synchronize.

Correction: Adjust the Net I.D.

Message: **WARNING: Difference in parameter(s) between two units**

Description: Different setting of parameters in the two units forming the links. This message will be followed by more details, as follows:

Normal/Test Mode Setting: one of the units is in Test mode and the other one is set to Normal mode.

HOP Standard Setting: different HOP standards setting are used in the two units.

HOP Sequence setting: different hopping sequences are selected in the two units.

Test Sequence channels: different sequences used in test mode

Clock Rate: different clock rates selected in the two units.

Delay Setting: different link delay settings in the two units.

Master/Slave setting: both units are defined as Master.

Echo Canceler parameters: in a fractional E1/T1 application, different echo canceler parameters (disabling method) are selected in the two units.

E1/T1 Channel Selection: in a fractional E1/T1 application, different channels are selected in the two units.

Echo Canceler Channels: in a fractional E1/T1 application, a difference in the channels in which echo cancellation is used in the two units.

E1/T1 Parameters setting: different parameters used in the two units in a E1/T1 application.

Correction: Configure the parameters properly.

Note: HOP Standard setting can only be configured by an authorized Black Box technician.



Mode and Access Control Menu

The Mode and Access Control menu enables to define the access rights. It also enables access to the Site Survey Mode for surveying the applicable electromagnetic environment of the site (this does not require a password).

```
Mode and Access menu
=====
1 - Change Access Rights
2 - Enter Site Survey Mode (System Reset)
3 - Exit Site Survey Mode (System Reset)
```

Figure 3-13. Mode and Access Control menu

Change Access Rights

The Change Access Rights option displays the current rights and determines whether the user has access rights to 2.048Mbps Wireless Modem Testing menus. This option is available to authorized technicians only. To enable access to the Testing menu, type the Password (8 printable ASCII characters). The access rights revert from “authorized technician” to “user” when any incorrect password is given in this or the next option.

Note: “User” access rights enable access to Set-up and Configuration functions Only

Site Survey Mode

The Site Survey test gives you an indication of the electromagnetic environment. It can also be used prior to final installation in order to determine the best location for the equipment and antennas.

During the Site Survey test, the 2.048Mbps Wireless Modem does not transmit, and a link cannot be established. Only one unit is required for Site Survey. The Site Survey graph presents the history of the received signal’s strength on each of the frequency channels (only channels included in the selected hopping set are monitored), and it performs a function similar to a spectrum analyser (Received Interference Level Spectrum Analysis). Based on the results, you can search for better location or try to identify and remove the source of the interfering signals.

Troubleshooting

Introduction

In the process of establishing a link, various problems may arise, either single link problems or co-located link problems. The possible problems are:

- Two units are connected but there is no radio link between them
- Poor performance of a radio link
- There is a radio link but the LIU does not operate or is not synchronized
- There is a radio link and the LIU operates, but the end equipment does not synchronize
- The radio link is stable, but the error rate on the end equipment is unacceptable
- The radio link is fine, but the voice quality/data rate is poor, or the end equipment loses synchronization from time to time
- The system resets with an error message
- One or more links function (are synchronized), but when adding another link performance degrades
- The Fractional E1/T1 link is synchronized, but one or some systems that are connected to the end equipment (i.e. telephone, fax, voice mail) is not working properly

This chapter helps you to identify the source of the problems, and provides a recommended solution.

Use this chapter as guidelines to troubleshooting, but remember that at any given site more than one of these problems can arise, and in different variations.

Troubleshooting problems and solutions

Problem 1: Two units are connected together but there is no radio link between them

Probable cause:

- Wrong unit configuration
- RF installation problems

⇒ **To check the configuration of each unit:**

1. From the Parameters menu, select *Parameters Info. Screen*.
2. Verify that one unit is configured as Master and the other as Slave.
3. Verify that the following parameters are set identically on both units:

- Network I.D.
- Hopping Standard and Hopping Sequence
- Modem Rate

⇒ **To check RF Installation:**

- Verify that the TX and RX cables are connected correctly, and that the antennas are aligned.
- Check the TX radio High/Low power setting.
- If you use a Diplexer:
 - * Verify that TX and RX connectors are not reversed.
 - * Verify that the One Antenna Standard (Diplexer) is the selected hopping sequence.
- If you use the Transmit Power Amplifier (TPA-24):
 - * Check the 12 VDC power supply jumpers on the Modem transmitter.
 - * Check the power level of the Transmit Power Amplifier(TPA-24).
- If you use an LNA, check the LNA power supply connection.
- If all the above are correct, but there is still no radio link:
 - * Measure RF power at the RX radio connector.
 - * Measure RF power at the TX radio connector.

Problem 2: Poor performance of radio link

⇒ **To check radio link performance:**

4. From the main menu, select the *Counters and Tracers menu*.
5. In the Counters and Tracers menu, type 4 to clear the System Counters and the Channel Tracer.
6. Type 2 (Display Channel Tracer RSSI per channel) to check RSSI per channel.



2.048Mbps Wireless Modem

The received power should be above the reception threshold for the modem rate in use. It is preferable to keep the received power level at least 10 dB above the threshold for an adequate fade margin.

If the received power level is not sufficient, check RF installation and increase the antenna gain, use cables with lower loss or add a Transmit Power Amplifier or an LNA.

7. Type 3 (Display Channel Tracer errors per channel) to check packet error rate. A channel that has adequate RSSI but many errors indicates the presence of an interfering signal at that frequency, or incorrect configuration of the unit. Interference from a Direct Sequence Spread Spectrum or narrowband radio equipment usually occupies a well defined frequency range, and therefore is easy to detect and avoid. Interference from a Frequency Hopping radio equipment is harder to detect with the channel tracer.

To correct the configuration:

- From the Parameters menu select *Parameter Info. Screen*. The following parameters must be identical on both units: Hopping Standard, Hopping Sequence, Modem Rate.

Problem 3 There is a radio link but LUI does not operate, or is not synchronised

Probable cause:

- Both sides of the link are not synchronized at radio level
- Wrong unit configuration

To check synchronization at radio level:

1. From the Counters and Tracers menu select *Display system counters*.
2. Verify that both Radio TX buffers and Radio RX buffers are advancing in time.

⇒ To check each unit configuration:

1. From the Parameters menu, select *Parameters Info. Screen*.
2. In the Parameters Info. Screen, verify that:
 - The Clock Rate on both units is the same.
 - The LIU type definition matches the LIU that you are using.
 - For X.21, RS-530 and V35, verify that the DCE Internal Clock or DCE External Clock or DTE on each unit matches the jumper setting on the LIU board.
 - For Fractional E1 or T1, verify that the same channels are used in both sides of the link.

3. For X.21, RS-530 and V.35 configured as DCE External Clock or DTE, verify that:

- The end equipment is defined as DTE or DCE accordingly.
- The end equipment is connected to the unit.
- In the Counters and Tracers menu select *Watch Alarms*. Verify that the alarm monitor checks that the clock rate setting of the end equipment matches the clock rate setting of the unit.

4. For Fractional E1:

- Verify that the line coding selected (HDB3/AMI) matches the setting of the end equipment.
- Verify that echo cancellation is not activated on channel 0.
- In CAS (Channel Associated Signalling) systems, verify that echo cancellation is not activated on channel 16.
- Check correct connection of the cable connecting the unit to the end equipment. Verify that the LOS LED is not On.
- Check that the balanced/unbalanced configuration of the LIU module (jumpers setting) matches the setting of the end equipment.

5. For Fractional T1:

- Verify that the line coding selected (B8ZS/AMI) matches the setting of the end equipment.
- Verify that the framing method configuration (ESF/D4) matches the setting of the end equipment.
- Check correct connection of the cable connecting the unit to the end equipment. Verify that the LOS LED is not On.
- Verify that the pulse shape setting matches the actual length of the cable connecting the unit to the end equipment

Problem 4: There is a radio link and the LIU Operates, but the equipment does not synchronize

Probable cause:

- Problem with the cable connecting the unit and the end equipment.

⇒ **To check the cable connecting the unit and the end equipment:**

1. From the Parameters menu, select *Parameters Info. Screen*.



2.048Mbps Wireless Modem

2. For X.21, RS-530 and V.35, verify that:

- The DCE Internal clock or DCE External clock or DTE setting on each unit is matched by the DCE/DTE configuration of the end equipment.
- The clock rate setting of the end equipment matches the clock rate setting of the unit.

3. For E1, T1, Fractional E1, Fractional T1 verify that:

- The line coding scheme used by the 2.048Mbps Wireless Modem and the end equipment are the same.
- For E1 or Fractional E1 verify that the Balanced/Unbalanced configuration of the LIU (set by the jumpers on the LIU board) matches that of the end equipment.

Problem 5: The radio link is stable, but the error rate on the end equipment is unacceptable

To check error rate on end equipment:

1. From the Counters and Tracers menu, select *Watch Alarms*.
2. If the “Modem rate too low for RADIO BUFFER ERROR RATE” alarm appears, this indicates that the difference between the LIU clock rate and the modem rate is too low to correct all radio errors.

To solve this problem:

- Improve the radio link quality (reduce error rate).
 - Decrease the LIU clock rate.
 - Increase the modem rate.
3. If the “Delay setting may be too short to correct all errors” alarm appears, this indicates that long bursts of errors overcome or nearly overcome the error correction mechanism. To solve this problem Increase the link delay.
 4. If no alarm appears, this indicates that the errors are not a result of errors on the radio link, but rather a configuration or a physical cable problem with the end equipment. Use the *Loopback mode* in the LIU Parameters menu to locate the source of the problem.
- For X.21, RS-530 and V.35, verify that the DCE Internal Clock or DCE External Clock or DTE settings on each unit is matched by the DCE/DTE configuration of the end equipment.
 - For E1, T1, Fractional E1 and Fractional T1, verify that the line coding scheme used by the 2.048Mbps Wireless Modem and the end equipment are the same.



- For E1 and Fractional E1, verify that the balanced/unbalanced configuration of the LIU (set by the jumpers on the LIU board) matches that of the end equipment.

Problem 6: The radio link is fine, but the voice quality/data rate is poor, or the end equipment loses synchronization from time to time.

Probable cause:

- There is an echo on the voice channels created by the end equipment.
- Low data rate on a high bandwidth link, which results from the transmission delay of the link or from errors on the link.
- End equipment loses synchronization (even on a link featuring low radio bit error rate) due to long bursts of errors.

To reduce echo on voice channels:

1. From the MCP Parameters menu, select *Total Link Delay*.
2. Select a reduced delay setting.

Note: The better the radio link quality the lower the delay that can be set without introducing errors. Where the delay cannot be reduced, an external echo canceller is required. In fractional E1/T1 applications, use the built-in echo canceller to reduce echo in voice channels

To improve data rate:

1. From the MCP Parameters menu, select *Total Link Delay*. The Total Link Delay parameter controls the trade off between error rate and delay.
2. Select the required delay setting and test how the new setting affects your performance.

Note: Low delay implies less correction on the raw radio error rate.

To view isolated bursts of errors:

- From the Counters and Tracers menu, select *Display Timer Tracer errors versus time* and *Display Time Tracer max consecutive errors versus time* to view isolated bursts of errors or noisy reception periods.
- From the Counters and Tracers menu, select *Set Time Tracer resolution* to view the Time Tracer time resolution. Change the resolution to “zoom-in” or “zoom-out” in order to locate and understand the error bursts.



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Problem 7: The system resets with an error message

Use the following table to determine the source of the error messages:



Message	Description
"no far lock"	The unit at the remote site fails to synchronize its hopping sequence with the local unit, and therefore both units will reset. This usually happens because of poor RF link conditions.
"LIU SCC Tx Error"	Internal error. Usually indicates a HW or configuration problem.
"LIU SCC Rx Error"	Internal error. Usually indicates a HW or configuration problem.
"PCM SCC Tx Error"	Internal error. Usually indicates a HW or configuration problem.
"PCM SCC Rx Error"	Internal error. Usually indicates a HW or configuration problem.
"PCM master doesn't receive"	No reception due to poor RF link conditions or non-consistent definitions of parameters on both sides of the link."
"PCM slave doesn't receive"	No reception due to poor RF link conditions or non-consistent definitions of parameters on both sides of the link."
"Too many frgm err"	Poor RF link conditions caused by too many consecutive fragment errors.
"no Tx counter increment"	Internal error. Usually indicates a HW or configuration problem.
"no Rx counter increment"	No reception due to poor RF link conditions.
"no counters increment"	Both TX and RX counters do not increment.

Message	Description
"Advanced E1/T1 LIU not detected-MASTER will reset", or "Advanced E1/T1 LIU not detected-SLAVE will reset"	This message can be the result of defining the LIU as a Fractional E1 or Fractional T1, when the actual LIU is different. If the unit does have the correct LIU, this may indicate a hardware problem. Turn the power off and than turn it back on. If the problem persists, refer to an authorized technician. The unit will reset after this message.
"Unable to synchronize advanced E1/T1 LIU"	This message may indicate a hardware problem in a Fractional E1/T1 system. Turn the power off and than turn it back on. If the problem persists, refer to an authorized technician. The unit will reset after this message.
"Frame sync missing at advanced E1/T1 LIU"	This message indicates that the unit has not been able to synchronize with the end equipment. The link will be set up without synchronization. Due to lack of synchronization the unit will reset after several minutes. These few minutes may be used to try to correct the configuration of the remote side (if necessary) via the remote parameters management capability.



Message	Description
"Queue runaway"	The internal data queues have overflowed. This might happen in E1/T1 units because of failure to loop back the clock at the end equipment on the slave side. The unit will reset.
"Loading defaults to NVRAM (DIP-SW2 is set)"	This message is printed when DIP-SW2 is set by the user in order to force reloading of default values. Reset DIP-SW2 to eliminate the message.
"CPU synchronization driver failure"	This message indicates a HW failure or too many non-powered units connected to the synchronization connector and loading it.
"MASTER Cannot collect enough consecutive non-errored PCM buffers" or "Slave Cannot collect enough consecutive non-errored PCM buffers"	This message can result from poor RF link conditions or from a mismatch between the HOPPING SEQUENCE setting on the two sides of the link.
"Slave cannot lock DPLL"	This message can result from poor RF link conditions or from a mismatch between the CLOCK RATE (RS-530/V.35/X.21) or Channels (Fractional E1/T1) setting on the two sides of the link. The unit will reset after this message.
"ReSync LIU"	This message can result from loss of synchronization with the end equipment either by the local or the far end BreezeLINK unit. It can be an indication of a physical problem in the interconnecting cable or a mismatch in setting of LIU and end equipment parameters. The unit will reset after this message.
"ReSync DPLL"	This message can result from losing clock synchronization with the end equipment due to a LOS condition. The unit will reset after this message.

Table 4-1. Error Messages Source

Problem 8: One or more links function properly (are synchronised), but when adding another link, performance degrades.

Probable cause:

- Incorrect configuration of all units connected by the synchronization cable.
- Physical problems with the synchronization cable.

⇒ **To check the configuration of each unit:**

1. In the Counters and Tracers menu select *Watch Alarms* and make sure no alarms regarding synchronization are present.
2. From the Parameters menu, select *Parameters Info. Screen*.
3. Verify that all units are configured as Master and each has a different Network I.D.



4. Verify that the following parameters are the same in both units:

- Hopping Standard and Hopping Sequence
- Clock Rate and Modem Rate

5. Check that the number of links to synchronize parameter is greater or equal to the number of connected units.

Problem 9: The fractional E1/T1 link is synchronised, but one or some systems that are connected to the end equipment (i.e. telephone, fax voicemail) is not working properly.

Probable cause:

- Incorrect configuration of the channels selected in the modem
- Echo cancellation is activated on data/signaling channels
- Non-matching tone disabling method
- The link delay is too high
- Too many errors

If the telephone(s) does not work properly:

1. Verify that echo cancellation is not active on channel(s) carrying signalling information.
2. Check that all the relevant channels are selected in both 2.048Mbps wireless Modems.

If Fax(es) does not work properly:

1. Verify that the tone disabling method selected in the 2.048Mbps Wireless Modem matches the capabilities of the fax equipment
2. Check the errors in the LIU link. Some fax equipment are highly sensitive to errors and too many errors may even cause automatic disconnection. It is recommended that the LIU BUFFER ERROR RATE will not exceed 10⁻⁵.
3. Check that the one-way delay of the link does not exceed one (1) second. If necessary, try to decrease the delay.

If voice mail/auto-attendant/other PBX systems/features does not work properly:

1. Verify that echo cancellation does not interfere with proper operation of the relevant voice channels. If necessary, disable echo cancellation on this channel(s)
2. Check sensitivity of the protocol used by the relevant application to the delay of the link. Try to decrease the link delay to solve the problem



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3. Check that the error rate of the LIU link is not too high. It is recommended that the LIU BUFFER ERROR RATE should not exceed 10-5.

Contact Black Box

Should you still have problems, contact your local Black Box. All of the phone numbers are listed at the front of this manual.

Technical Specifications

Wireless Modem Technical Specifications

Models

2.048Mbps Wireless Modem

For data rates of up to 2.048 Mbps, with E1, T1, RS-530, V.35 or X.21 interface

512Kbps Wireless Modem

For data rates of up to 512kbps, with RS-530, V.35 or X.21 interface. Call Black Box for a quote for this model.

Radio and Modem Specifications

Radio Type

Full duplex point to point, independent transmit and receive radio channels.

Transmission Technique

Frequency Hopping Spread Spectrum radio.

Hopping Rate: 160 hops per second

Hopping Steling time: 200uS max.

Spectrum Utilization and Modulation

Table 5-1 details the Spectrum utilization and modulation:

Modem Bit rate (Mb/S)	Modulation	Modem symbol rate (Kb/S)	Spectrum utilization (bits/Hz)
0.5	2 GFSK	500	0.5
1	2 GFSK	1000	1
2	4 GFSK	1000	2
3	8 GFSK	1000	3

Table 5-1. Spectrum Utilization and Modulation



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The modem rate is selected automatically by the selected LIU Data Rate (Clock Rate), according to the following table:

DTE Data Rate (Kbps)	Default Modem Rate (Mbps)
64 - 320	0.5
384 - 704	1
768 - 1472	2
1536 - 2048	3

Table 5-2. Default Modem Rate According to Selected LIU Data Rate

Channel Bandwidth

The bandwidth for each channel is -20dBc at $\pm 500\text{KHz}$ from carrier, regardless of bit rate.

System Bandwidth

2400-2500MHz.

Different frequency bandwidth is available according to the different country standards.

Country/Standard	Frequency Bandwidth
US/FCC	2.402-2.480 MHz
Europe/ETSI	2.402-2.480 MHz
Australia	2.402-2.448 MHz
Canada	2.452-2.482 MHz
Israel	2.420-2.455 MHz
Japan	2.473-2.495 MHz
France	2.449-2.482 MHz

Table 5-3. Frequency Bandwidth According to Country/Standard

Transmitter Output Power

16dBm (typical), 15dBm (minimum) at the antenna port, in high power mode.

2dBm (typical), at the antenna port in low power mode.



Maximum Spurious Level

60dBc

Receiver Sensitivity

The receiver sensitivity, as a function of the radio BER, is determined according to Table 5-4. Note that the radio error rate does not include the error correction algorithm, which can improve sensitivity by up to 3dB, depending on the settings of the unit.

Modem rate (Mbps)	Sensitivity (dBm) at BER 1E-4	Sensitivity (dBm) at BER 1E-5	Sensitivity (dBm) at BER 1E-6
0.5	-90	-89	-88
1	-87	-86	-85
2	-79	-78	-77
3	-73	-72	-71

Table 5-4. Receiver Sensitivity as a Function of the Radio BER

Receiver Sensitivity

- Retransmission of packets with errors.
- Elastic buffer to maintain continuous data flow.

The Radio BER improvement for the various bit rates at the default delay setting is according to the following graph



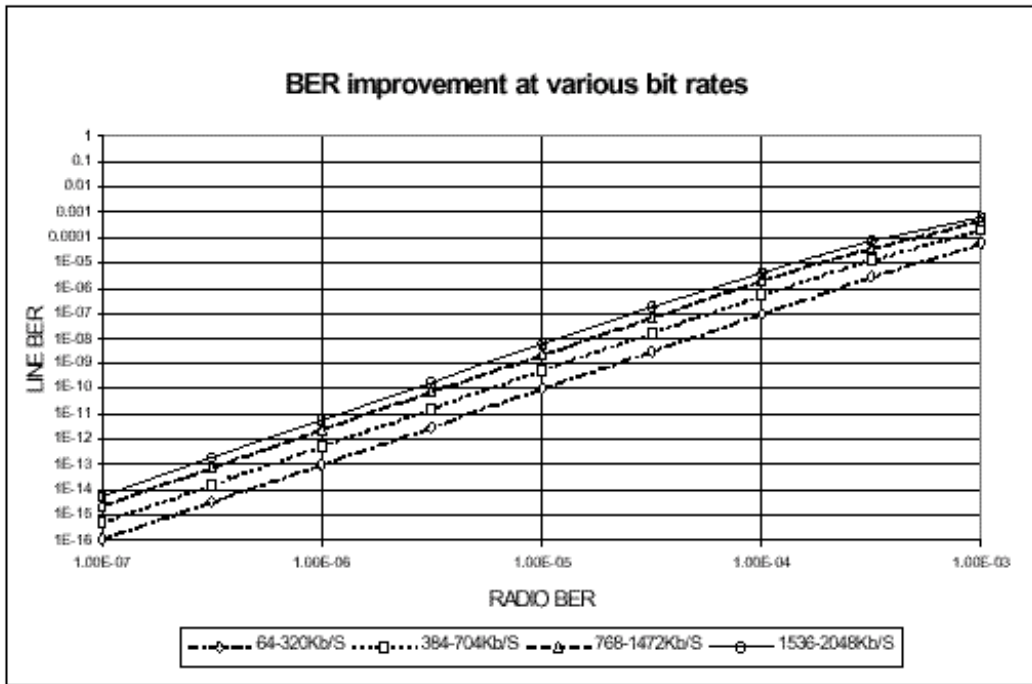


Figure 5-1. Radio BER Improvement

Modem rate (Mbps)	System gain (dB)
0.5	105dB
1	102dB
2	94dB
3	88dB

Table 5-5. System Gain

Maximum Receive Level

-10dBm for modem rates: 0.5Mbps, 1Mbps, 2Mbps.

-25dBm for modem rate of 3Mbps.

Recommended Receive Level

10dB above sensitivity threshold for an adequate fade margin.

Adjacent Channel Rejection

Adjacent channel rejection indicates the difference (in dB) between the power level of an interfering RF signal and the power level of a desired signal, where the interfering signal



causes a degradation of 3db in the sensitivity of the receiver. The graph below displays the adjacent channel rejection of the modem receiver as a function of the frequency separation (Delta F in MHz) between the frequency of the interfering signal and the desired signal.

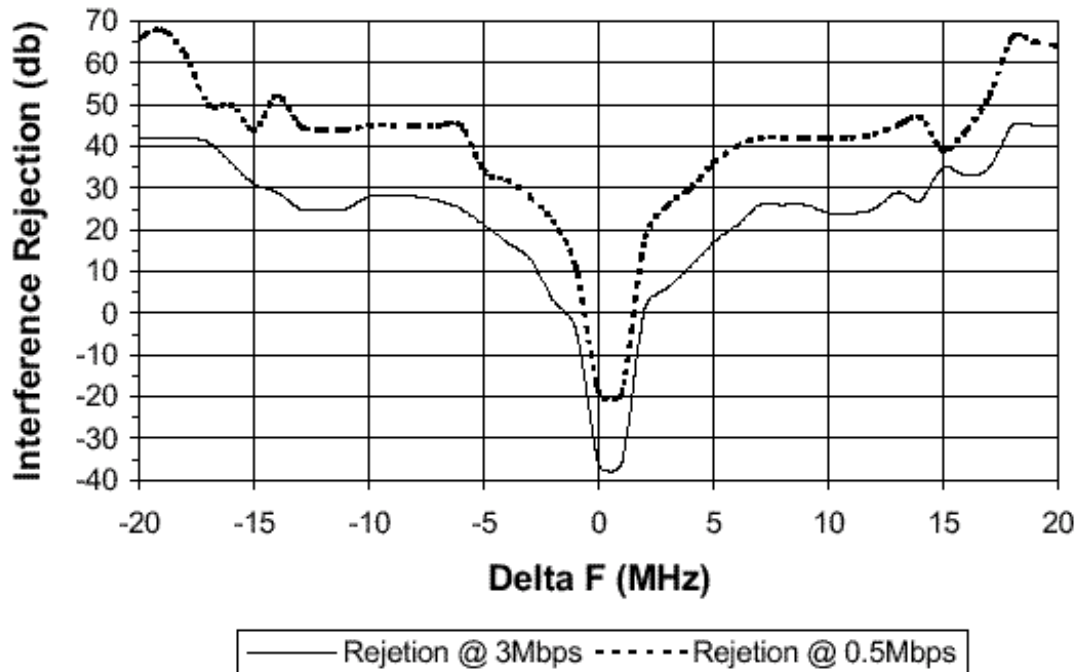


Figure 5-2. Adjacent Channel Rejection

Separate between TX and RX frequencies

Minimum 12MHz for sensitivity degradation of 1dB.



2.048Mbps Wireless Modem

Maximum Number of Links to Synchronize

Country/Standard	Max number of Links to synchronize
USA/FCC	7
Europe/ETSI	6
Australia	3
Canada	2
Israel	2
Japan	2
France	2
One Antenna - Duplexer	5

Table 5-6. Maximum Number of Synchronized Links

Filter Curves

Filter curves for the transmitter and receiver are shown in the graph below. Note that the receiver contains two cascaded filters of this type.

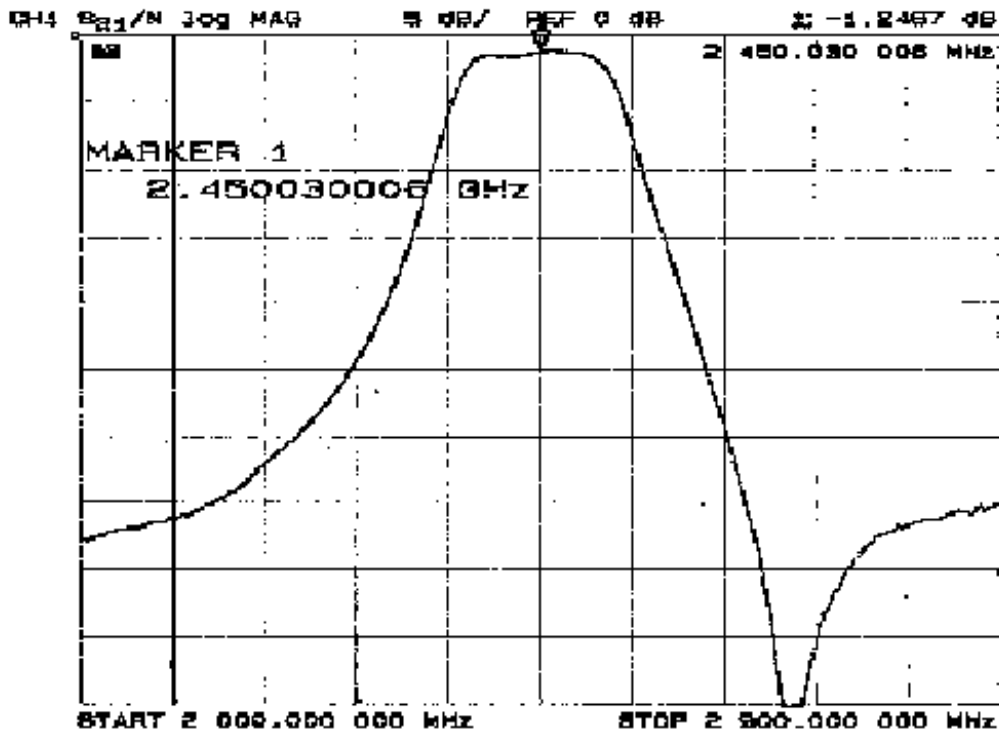


Figure 5-3. Filter Curves.

Frequency Accuracy

±15ppm.

Noise Figure

5dB max.

Total Link Display

Controllable, between 14ms to 156ms, depending on the Data and Radio rates.

Line Interface Specifications**Data Rates (Full Duplex)**

Nx64Kbps: 64, 128, ... 2048kbps

N x 64Kbps: 64, 128, ... 2048 Kbps.

LIU Options**T1 Interface**

Data Rate: 1544 Kbps

Type: DSX-1, meets CCITT G.703 and G.823

Connector: RJ-45

Line Mode: Bipolar AMI or B8ZS

Impedance: 100Ω

E1 Interface

Data Rate: 2048 Kbps

Type: CEPT-I, meets CCITT G.703 and G.823

Connector: 2 x BNC (unbalanced), RJ-45 (balanced)

Line Code: HDB3 or AMI

Impedance: 75Ω (unbalanced), 120Ω (balanced).



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Fractional T1 Interface

Data Rate: 1544 Kbps
Type: DSX-1, meets CCITT G.703, G.704 and G.823
Connector: RJ-45
Line Mode: Bipolar AMI or B8ZS
Impedance: 100Ω

Fractional E1 Interface

Data Rate: 2048 Kbps
Type: CEPT-I, meets CCITT G.703, G.704 and G.823
Connector: 2 x BNC (unbalanced), RJ-45 (balanced)
Line: Code HDB3 or AMI
Impedance: 75Ω (unbalanced), 120Ω (balanced)

V.35 Interface

Data Rate: 64 - 2048 Kbps (N x 64)
Type: Synchronous Data, V.35 levels
Connector: Winchester 34 pins, female (An adapter cable connected to the 25 pins D-Type connector on the V.35 LIU)

RS-530 Interface

Data Rate: 64 - 2048 Kbps (N x 64)
Type: Synchronous Data, RS-422 levels
Connector: D-type, 25 pins, female

X.21 Interface

Data Rate: 64 - 2048 Kbps (N x 64)

Type: Synchronous Data, RS-422 levels

Connector: D-type, 15 pins, female (An adapter cable connected to the 25 pins D-Type connector on the RS-530/X.21 LIU)

Echo Canceller (Fractional E1/T1)

Meets ITU-T recommendations G.165 and G.168

Front Panel LED Indicators**General**

Power

TEST

Line

Data Link Status - LOS (Loss of Signal), T1/E1 only
 - AIS (Alarm Indication Signal), T1/E1 only

Data Link Activity - RXD
 - TXD

Radio

Rx Sync

Tx Sync

Connectors

Antenna: 2 x SMA Female

Power: AC Appliance Inlet or 48 VDC terminal block

DTE: Modular

Monitor: D-Type 9-pins female

In/Out Synchronization 2 x molex jack, 4-pin (mate with FCC 68 plugs)



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Q-CTRL (future option) RJ-45, 8 pin, female

RSSI Test point (for DVM), accuracy = $\pm 20\%$.

Power

100 - 240 VAC or 18 - 72 VDC, 25 W max.

Management

Monitoring, diagnostics and configuration.

Interface - V.24/RS-232, 9 pins D Type female connector.

Access using a locally connected ASCII terminal or remotely via dial-up modem.

Remote unit management, through the wireless link.

Mechanical Specifications

Dimensions

Standard 1U half 19"

7.7" x 9.6" x 1.7" (195mm x 244mm x 44mm)

Weight

2.2 lb (1 Kg)

Environmental Specifications

Operating Temperature Operating: 0 - 55 °C (32 ° - 130 ° F)

Humidity: 5% to 90%, non-condensing

Standards

US: FCC Part 15.247, UL, UL/C

Europe: CEPT T/R 10-01, ETS 300-328, CE, TUV/GS.

Antennas Sets

One transmit antenna, one receive antenna.

Standard Antennas:

- low - 8.5dBi, 8.5dBi.
- Basic – 12 dBi, 12dBi
- Medium Gain - 12dBi, 18dBi.
- High Gain – 12, 24dBi.

TPA 24 Technical Specifications

Models used with 2.048Mbps Wireless Modem: TPA 24 LL
TPA 24 LH.

Input Power:	TPA 24 LL: -10dBm - 0dBm (Lowinput) TPA 24 LH: 0dBm - +10dBm (High input)
Output Power:	24 dBm (250mW) (fixed output level)
Input Impedance:	50Ω
Output Impedance:	50Ω
Operating Temperature:	-20°C to 50°C
Power Requirements:	12V; 420 mA (power is supplied via the RF cable)
Connectors:	IN - N-type Male OUT - N-type Female
Dimensions:	70mm x 150mm x 25mm (2.8"x 6"x 1")
Operating Environment:	For outdoor/indoor use.

LNA-10 Technical Specifications

Gain:	10dB
Noise Figure:	1.5dB Typ, 2dB Max.
Response Flatness:	± 1.5dB
Max. RF Input Level:	-15dBm
Input Impedance:	50Ω
Output Impedance:	50Ω



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Connectors

- LNA 10
- RF IN: N-type, female
 - RF OUT: N-type, male
 - Signal and Power IN: not in use
 - Signal and Power OUT: F-type, female
- Power Inserter
- To CONV: F-type, female
 - To TV: F-type, female (not in use)

Power Supply

- Required Voltage: +12V to +28Vdc
- Required Current: 20mA
- Operating Temperature: -20°C to +50°C
- Dimensions: 60mm x 35mm x 25mm (2.3"x 1.3"x 1")

Operating Environment:

- LNA 10 outdoor/indoor
- Power Supply indoor
- Power Inserter indoor

* Technical specifications are listed as provided by the manufacturer

AL-1 Technical Specifications

- Turn on voltage: 75V
- Insertion loss: 0.3dB typical
- DC path from input to output existing
- Operating Temperature: -55°C to +70°C
- Dimensions: 67.5mm x 25mm x 25mm (2.7" x 1" x 1")
- Connectors:
- Antenna Port N-type, Female
- Equipment Port N-type, Female

Operating Environment: Indoor/Outdoor

Grounding: One of the female-type N connectors is mounted directly through a hole in the shelter wall and held in place with a lockwasher and nut.



Appendix A - V.35/RS-530/X.21 Applications

DCE/DTE Configuration

The following is a description of the possible configurations when connecting V.35/RS-530/X.21 end equipment to the 2.048Mbps Wireless Modem. The configurations described are applicable to software version 1.5 and up with a V.35/RS-530/X.21 LIU equipped with jumpers for setting the mode of operation.

V.35/RS-530/X.21 Standards

These standards define the operation of a communications channel, consisting of end equipment units connected to the communications channel by a modem. The standards define DATA circuits and LOCK circuits to time them.

The end equipment is normally called DTE and the modem is normally called DCE. A DTE connects to a DCE. DTE or DCE assignments define the direction of the DATA, CLOCK, and CONTROL circuits supported by the standard.

Table 1 describes the possible configurations:

CIRCUIT (DTE name)	Configuration	V.35		RS-32		X.21	
		DTE	DCE	DTE	DCE	DTE	DCE
TX-DATA	Normal	→		→		→	
RX-DATA		←		←		←	
TX-CLOCK		←		←		-	
RX-CLOCK		←		←		←	
TX-DATA	External Clock	→		→		-	
RX-DATA		←		←		-	
EXT.-CLOCK		→		→		-	
RX-CLOCK		←		←		-	

Table A-1. Possible DTE/DCE Configurations

Configuration Options

The 2.048 Mbps Wireless modem can be configured either as a DTE or as a DCE. The configuration is set by jumpers on the LIU board and through the RS-232 monitor.

It is important to note that modem assumes that the clock frequency on both sides of the link is exactly the same, therefore the clock frequency can be forced on the Master side of the link only.

Possible configurations are described in Table A-2.

Typical Application Description	Setting	2.048Mbps Wireless Modem V.35		2.048Mbps Wireless Modem RS-530		2.048Mbps Wireless Modem X.21		Comments
		Master Setting	Slave Setting	Master Setting	Slave Setting	Master Setting	Slave Setting	
Standard Configuration	Monitor	DCE Internal Clock	DCE Internal Clock	DCE Internal Clock	DCE Internal Clock	DCE Internal Clock	DCE Internal Clock	
	Jumpers	See Fig. A-5	See Fig. A-5	See Fig. A-5	See Fig. A-5	See Fig. A-5	See Fig. A-5	
Synchronize to Network	Monitor	DCE External Clock	DCE Internal Clock*	DCE External Clock	DCE Internal Clock*	DTE (X.21)	DCE Internal Clock	
	Jumpers	See Fig. A-6	See Fig. A-5	See Fig. A-6	See Fig. A-5	See Fig. A-8	See Fig. A-5	
Connect to another modem link	Monitor	DTE (V.35 & RS-530)	DCE Internal Clock	DTE (V.35 & RS-530)	DCE Internal Clock	DTE (X.21)	DCE Internal Clock	TX and RX clock supplied to DTE must have the exact same frequency
	Jumpers	See Fig. A-7	See Fig. A-5	See Fig. A-7	See Fig. A-5	See Fig. A-8	See Fig. A-5	

Table A-2. Configuration

* Slave can also be configured as DCE with external clock provided that the external clock supplied by the DTE is identical to the clock supplied by the

2.048Mbps Wireless Modem Standard Configuration

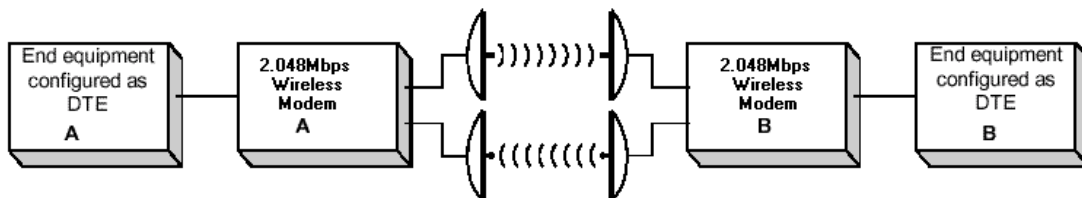


Figure A-1. Standard modem Application

- Both wireless modem units are configured as DCE, internal clock.
- Either unit A or B can be defined as the Master unit.

Synchronizing your Modem to Another Network

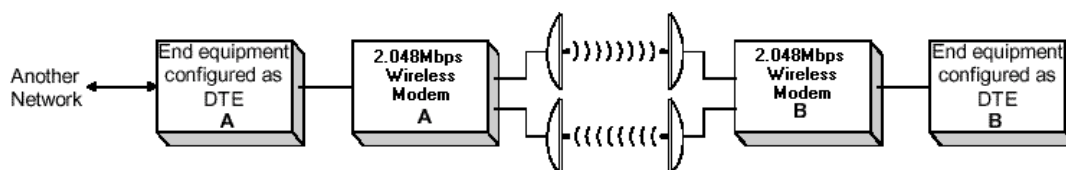


Figure A-2. Modem Synchronized to Another Network



2.048Mbps Wireless Modem

- DTE A supplies the Master clock.
- Modem A is configured as “Master”, DCE external clock.
- Modem B is configured as “Slave”, DCE internal clock.

Connecting your 2.048Mbps Wireless Modem to another modem

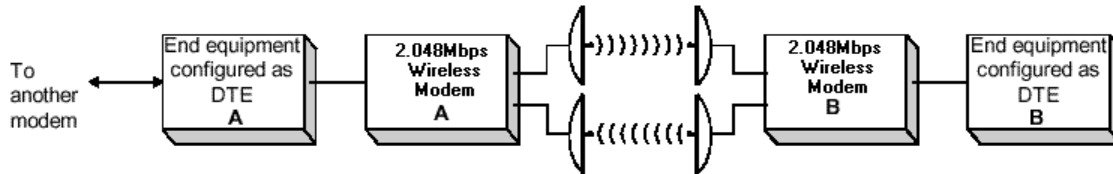


Figure A-3. Modem configured as DCE

- Modem A is defined as a DCE. It supplies the clock for the 2.048Mbps Wireless Modems.
- 2.048Mbps Wireless Modem A is configured as “Master”, DTE (except in applications with an X.21 interface).
- 2.048Mbps Wireless Modem B is configured as “Slave”, DCE internal clock.

RS-530/V.35/X.21 Back-to-Back Configuration

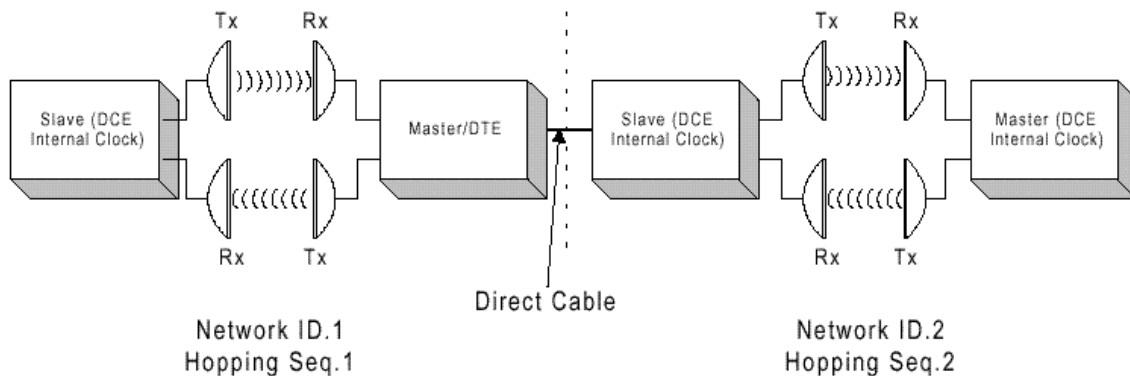


Figure A-4. RS-530/V.35/X.21 Back-to-Back Configuration

Setting the Jumper Configuration for the LIU-V.35 and LIU RS-530/X.21 Boards

You can access the jumpers by opening the two screws of the rear panel and carefully sliding out the boards. The jumpers are located at the upper side of the LIU board, close to the D-25 connector. Disconnect all cables, including the power cable from the unit before opening.

The LIU configuration is set by both software and hardware. Software setting is done in the *DCE/DTE* menu in the *LIU parameters* sub-menu of the *Parameters* menu. Hardware setting is done by jumpers on the LIU-V.35 or the LIU-RS-530/ X.21 circuit board. The following settings are available:

DCE Options

1. DCE, internal clock - Supported by V.35, RS-530 and X.21.

Jumper configuration:

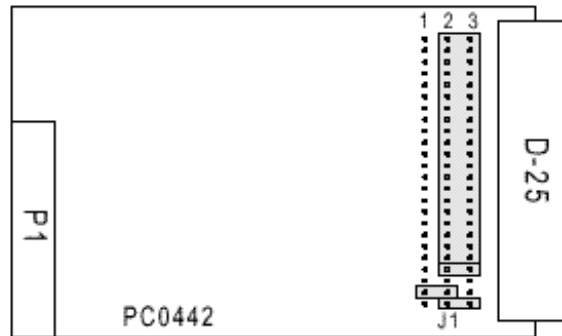


Figure A-5. DCE, Internal Clock Jumpers

2. DCE, external clock - Supported by V.35 and RS-530.

Jumper configuration:

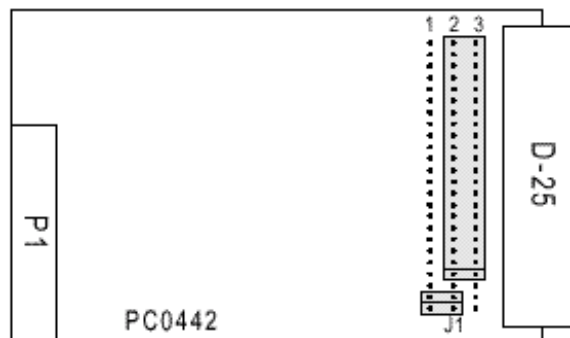


Figure A-6. DCE, External Clock Jumpers

DTE Options

1. DTE - Supported by V.35, RS-530. Jumper configuration:



Figure A-7. DTE, V.35 and RS-530

2. DTE - Supported by X.21. Jumper configuration:

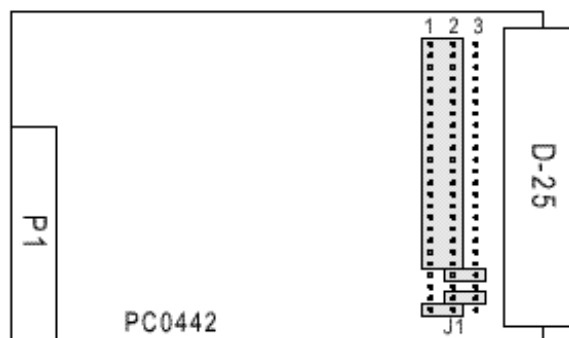


Figure A-8. DTE, X.21

Setting the DCE/DTE Mode Parameter

To set the DCE/DTE mode:

1. From the Setup and Configuration Main menu, type **1** to access the Parameters menu.
2. From the Parameters menu, type **1** to access the LIU Parameters menu.
3. From the LIU Parameters menu, type **5** to access the V.35/RS-530/X.21 menu.
4. From the V.35/RS-530/X.21 menu, type **2** to access the DCE/DTE menu.
5. Select the required mode as follows:
 - Type **0** for DTE (V.35 and RS-530) mode.
 - Type **1** for DCE internal clock.
 - Type **2** for DCE external clock.

- Type **3** for DTE (X.21) mode

Valid selections are in accordance with following guidelines:

- DCE internal clock (V.35 & RS-530 & X.21)- Supported by V.35, RS-530and X.21
- DCE external clock (V.35 & RS-530)- Supported by V.35 and RS-530
- DTE (V.35 & RS-530) - Supported by V.35, RS-530
- DTE (X.21) - Supported by X.21.



Appendix B - E1 / T1 Applications

Introduction

This appendix describes some of the possible ways to connect an E1/T1 Wireless Modem to E1/T1 end equipment. For each possible connection, the indications given by the 2.048Mbps Wireless Modem unit and the expected end equipment behaviour are described. The RJ-45 balanced four-wire interface is also discussed.

The second part of this appendix provides information about E1/T1 LIU board jumper settings. In addition, some explanation is provided on T1 CSU/DSU applications.

E1/T1 Connections and Common Problems - Link Setup

The set-up includes two 2.048Mbps Wireless Modem units, each connected to end equipment. One end equipment unit is the source of the clock and is called “CO” (Central Office). The other unit uses loopback timing (i.e. lock on the CO clock and return it) and is called PBX. The modem connected to the CO is configured as Master, and the other modem as Slave.

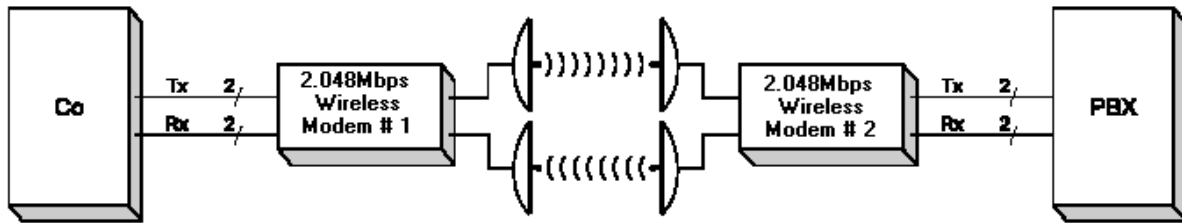


Figure B-1. E1/T1 Application.

Table B- 1 summarizes the possible connections and the resulting behaviour

Master/Slave Connection	TX/RX Pairs Connection	TIP/RING Connection	Modem Monitor Alarm Message	Modem LED Status	End Equipment Behavior	Comments
#1 - Master #2 - Slave	OK	OK	None	No alarms	Synchronized	Right connection
		Reversed	None	No alarms	Synchronized	Wrong but works
	Reversed	-	LIU Clock Drift	LOS can be indicated	Not synchronized, LOS can be indicated	Wrong, does not work
#1 - Slave #2 - Master	OK	OK	LIU Clock Drift	No alarms	Synchronized, but E1/T1 frame slips occur	Wrong and dangerous, since it seems right and the frame slips can be rare
		Reversed	LIU clock drift	No alarms	Synchronized, but E1/T1 frame slips occur	Wrong and dangerous, as above
	Reversed	-	LIU clock drift	LOS can be indicated	Not synchronized, LOS can be indicated	Wrong and does not work

Table B- 1. E1/T1 Connections

In addition to the faults mentioned in the above table, there is a possibility of a cable being disconnected or shortened. Both these situations usually result in LOS indication either by the modem or by the end equipment.

E1/T1 LIU Jumper Settings

The LIU default setting is E1 balanced or T1 balanced, unless an E1 unbalanced configuration is specified. The following diagrams show the jumper configurations on the LIU board for each configuration option.

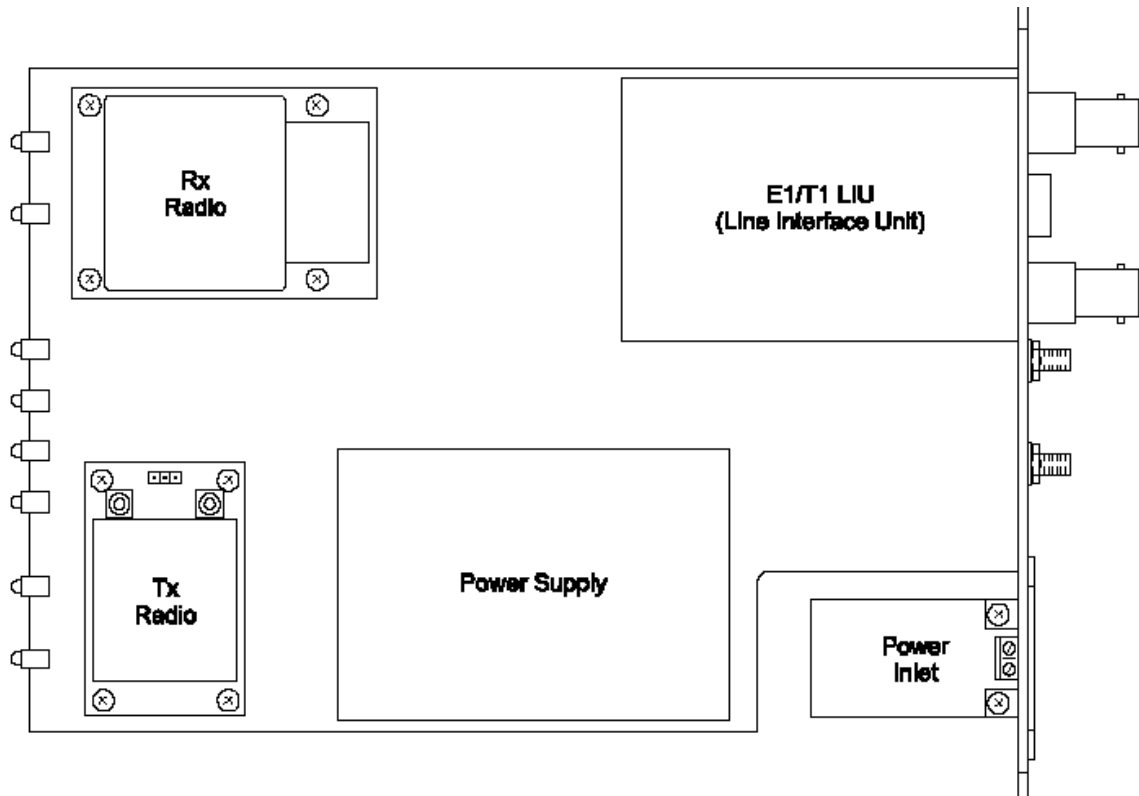


Figure B-2. E1/T1 Board Location

To access the jumpers:

1. Disconnect all cables, including the power cable, from the unit.
2. Loosen and remove the two screws on the rear panel. Carefully slide out the boards. The jumpers are located at the bottom side of the LIU board shown in Figure B-3.
3. Turn the boards over, loosen and remove the three screws connecting the LIU board to the main board.
4. Unscrew and remove the nuts and the spring washers from the Tx and Rx connectors. For easier removal of the LIU board, unscrew the small metal panel holding the LIU connectors.
5. Carefully separate the LIU board from the main board, taking care not to damage the P1 and P2 pins.
6. Set the jumpers according to diagrams B-3 to B-5.

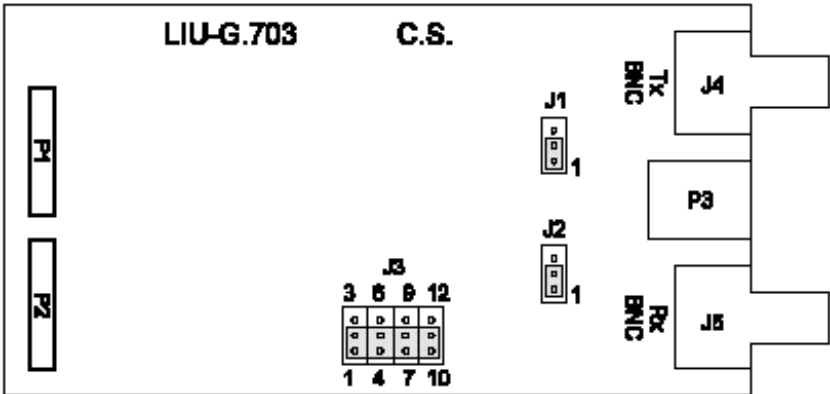


Figure B-3. E1 Unbalanced (Coax connector, 75 W)

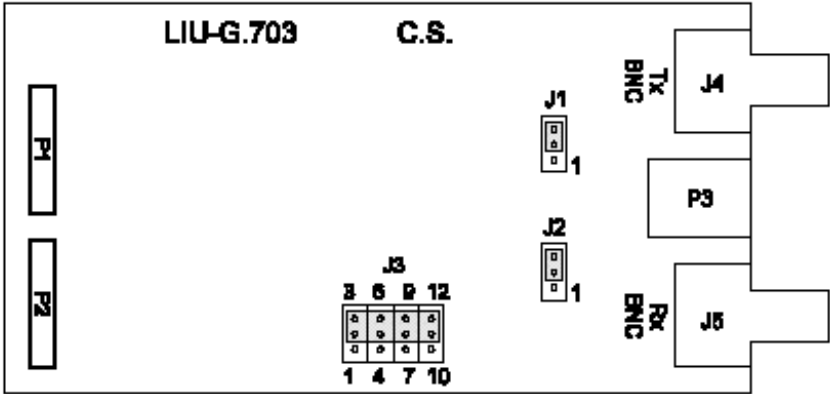


Figure B-4. E1 balanced (RJ-45 connector, 120 W)

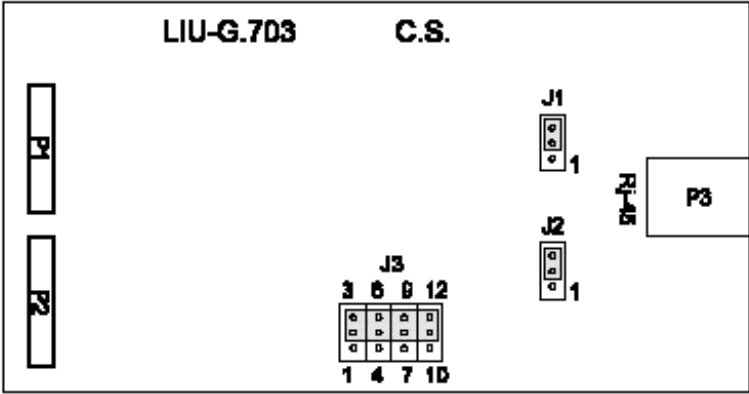


Figure B-5. T1 balanced (RJ-45 connector, 100 W)

2.048Mbps Wireless Modem

T1 CSU/DSU Applications

In most T1 applications, the 2.048Mbps Wireless Modem replaces the CSU/DSU (or OCU) used in regular wired connections.

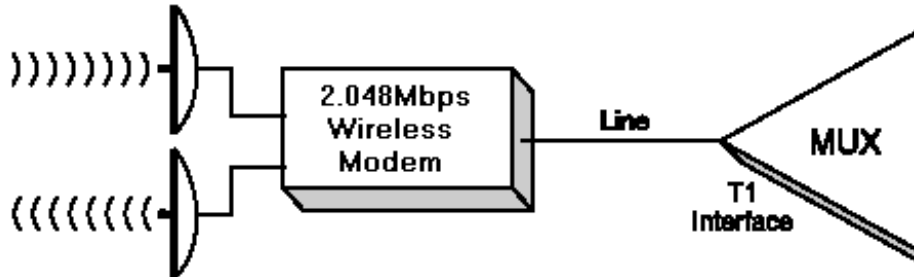


Figure B-6. T1/DSU Network Interface

This type of connection is referred to as “DSU network connection”. In order to meet the applicable pulse mask requirements of the DSX-1 standard, the Pulse Shape Parameter should be set according to the line length.

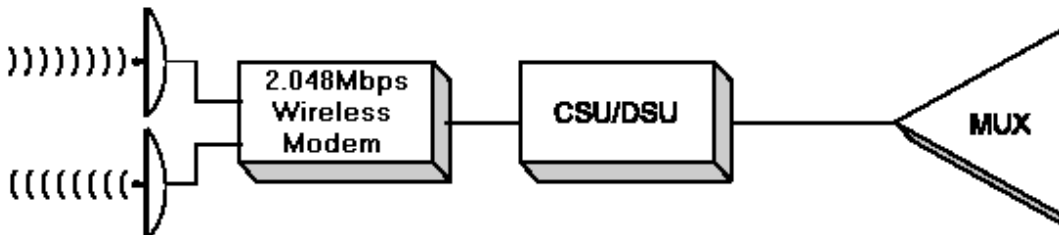


Figure B-7. T1/CSU Network Interface

In several applications, the modem may be connected to CSU/DSU equipment, as shown in Figure B-7. This type of connection may be chosen because of a technical (e.g., a special MUX interface not supported by 2.048Mbps Wireless Modem) or some other reason. This type of connection is referred to as a “CSU network connection”, and the Line Length Parameters menu should be set accordingly (option 6).

E1/T1 Back-to-Back Configuration

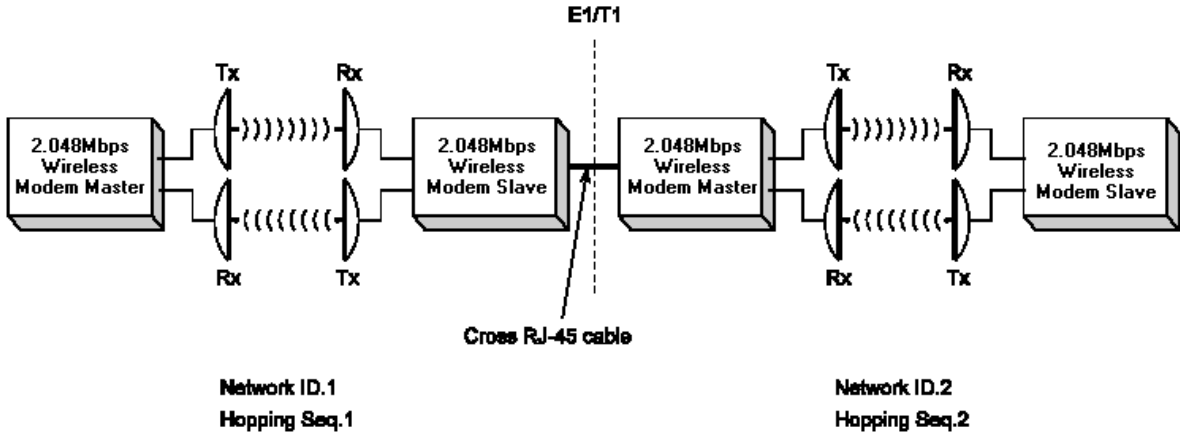


Figure B-8. E1/T1 Back-to-Back Configuration

Appendix C – Fractional E1/T1 Applications

Introduction

This appendix explains under which conditions it is recommended to use the Fractional E1/T1 LIU. It also describes some of the possible ways to connect a Fractional E1/T1 2.048Mbps Wireless Modem to Fractional E1/T1 end equipment. For each possible connection, the indications given by the modem unit and the expected end equipment behaviour are described. The RJ-45 balanced four-wire interface is also discussed.

This appendix also provides information about Fractional E1/T1 LIU board jumper settings. Some explanations are provided on T1 CSU/DSU applications.

The last part of this appendix provide explanations on echo cancellation and its use in voice channels.

When to Use the Fractional E1/T1 LIU

The Fractional E1/T1 LIU can only be used in applications in which the end equipment supports framed data streams in accordance with E1 (CEPT-1) or T1 (DSX-1) standards. The Fractional E1/T1 LIU cannot be used with unframed E1/T1 data streams (e.g. with routers).

It is recommended to use the Fractional E1/T1 LIU in applications with voice channels and to take advantage of the built-in echo canceller to achieve an improved voice quality.

The Fractional E1/T1 LIU may also be used in applications without voice channels. However, the cost of the Fractional E1/T1 LIU is higher than that of the regular E1/T1 LIU. In some cases, the use of the Fractional E1/T1 LIU in non-voice fractional E1/T1 applications should be preferred as it may improve the quality of the link and increase the achievable range.

An E1 link is comprised of 32 channels of 64 Kbps each. A T1 link is comprised of 24 channels. In Fractional E1/T1 applications, any number of links up to the maximum of 32 (E1) or 24 (T1) may be used for transmission of a data, fax or voice channels. The data stream of a regular fractional E1/T1 link is at the full rate of 2048(E1) or 1544 (T1) Kbps. When the 2.018Mbps Wireless Modem is used, it transmits, only the channels that are in actual use, typically resulting in a lower link data rate. For example, in a fractional E1 application with 4 channels in use, the effective data rate of the modem is 320Kbps (4 data channels plus 1 channel for frame alignment signals TSO), and the default modem rate is just 0.5Mbps vs. modem rate of 3Mbps required for a regular E1 link. The distance achievable with a modem rate of 0.5Mbps is approximately 4 to 5 times the distance achievable with a modem rate of 3Mbps. Thus, a significant improvement in achievable distance may be available through the use of the Fractional E1/T1 LIU compared with performance achievable with the regular E1/T1 LIU.

The following table provide details on effective data rate and default modem rate for Fractional E1/T1 applications. In general, effective data rate for N used channels is $(N+1) \times 64$ Kbps. For example, if the user needs 8 channels, the modem will effectively transmit a data rate of $(8+1) \times 64 = 576$ Kbps. In fractional T1 applications, the modem will add a full 64Kbps channel for signalling. The maximal data rate of the modem for a 24 channel T1 is therefore 1600Kbps, vs. the 1544Kbps of a regular T1. In Fractional E1 using Common Channel Signalling (CAS), as is also the case with a regular E1 using CAS, channel 0 is always used for frame alignment signals, and a maximum of 31 channels is available to the user, with a maximum data rate of 2048Kbps.

Number of Channels available to the user	Number of effective channels transmitted by the Wireless Modem	Wireless Modem's data rate (Kbps)	Default Modem rate
1 to 4 (E1 or T1)	2 to 5	128 to 320	0.5Mbps
5 to 10 (E1 or T1)	6 to 11	384 to 704	1Mbps
11 to 22 (E1 or T1)	12 to 23	768 to 1472	2Mbps
23 to 24 (T1)	24 to 25	1536 to 1600	3Mbps
23 to 31 (E1)	24 to 32	1536 to 2048	3Mbps

Table C-1. Channels Characteristic

The default modem rate for both regular T1 and regular E1 is 3Mbps. Therefore, an improvement in achievable distance is available through using the Fractional E1/T1 LIU for any number of channels up to 22.

Fractional E1/T1 Connections and Common Problems -Link Set-up

The set-up includes two 2.048Mbps Wireless Modems, each connected to end equipment. One end equipment unit is the source of the clock and is called CO (Central Office). The other unit uses loopback timing (i.e. lock on the CO clock and return it) and is called PBX. The modem connected to the CO is configured as Master, and the other modem as Slave.

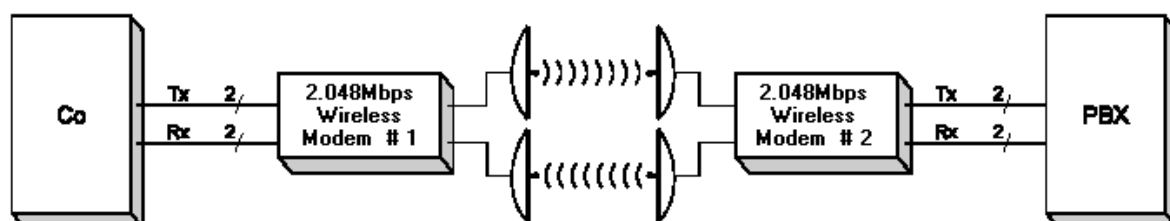


Figure C-1. Fractional E1/T1 Application

2.048Mbps Wireless Modem

Table C-2 summarizes the possible connections and the resulting behaviour:

Master/ Slave Connection	TX/RX Pairs Connection	TIP/RING Connection	Modem Monitor Alarm Message	Modem LED Status	End Equipment Behavior	Comments
#1 - Master #2 - Slave	OK	OK	None	No alarms	Synchronized	Right connection
		Reversed	None	No alarms	Synchronized	Wrong but works
	Reversed	-	LIU Clock Drift	LOS can be indicated	Not synchronized, LOS can be indicated	Wrong, does not work
#1 - Slave #2 - Master	OK	OK	LIU Clock Drift	No alarms	Synchronized, but E1/T1 frame slips occur	Wrong and dangerous, since it seems right and the frame slips can be rare
		Reversed	LIU clock drift	No alarms	Synchronized, but E1/T1 frame slips occur	Wrong and dangerous, as above
	Reversed	-	LIU clock drift	LOS can be indicated	Not synchronized, LOS can be indicated	Wrong and does not work

Table C-2. Fractional E1/T1 Connections

In addition to the faults mentioned in the above table, there is a possibility of a cable being disconnected or shortened. Both these situations usually result in LOS indication either by the 2.048Mbps Wireless Modem or by the end equipment.

Fractional E1 LIU Jumper Settings

The Fractional E1 LIU default setting is balanced, unless a Fractional E1 unbalanced configuration is specified. The following diagrams show the jumper configurations on the Fractional E1 LIU board for each configuration option.

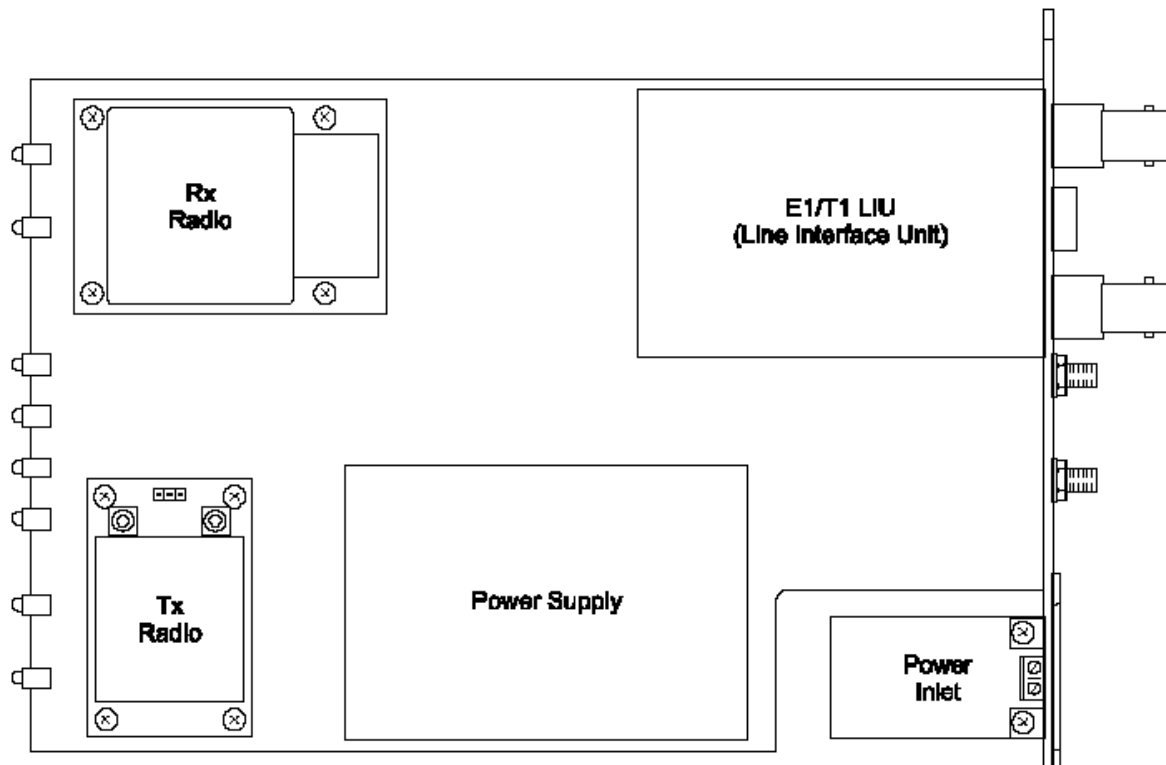


Figure C-2. Fractional E1 Board Location

To access the jumpers:

1. Disconnect all cables, including the power cable, from the unit.
2. Loosen and remove the two screws on the rear panel. Carefully slide out the boards. The jumpers are located at the upper side of the LIU board shown in Figure C-3.
3. Set the jumpers according to diagrams C-3 to C-4.



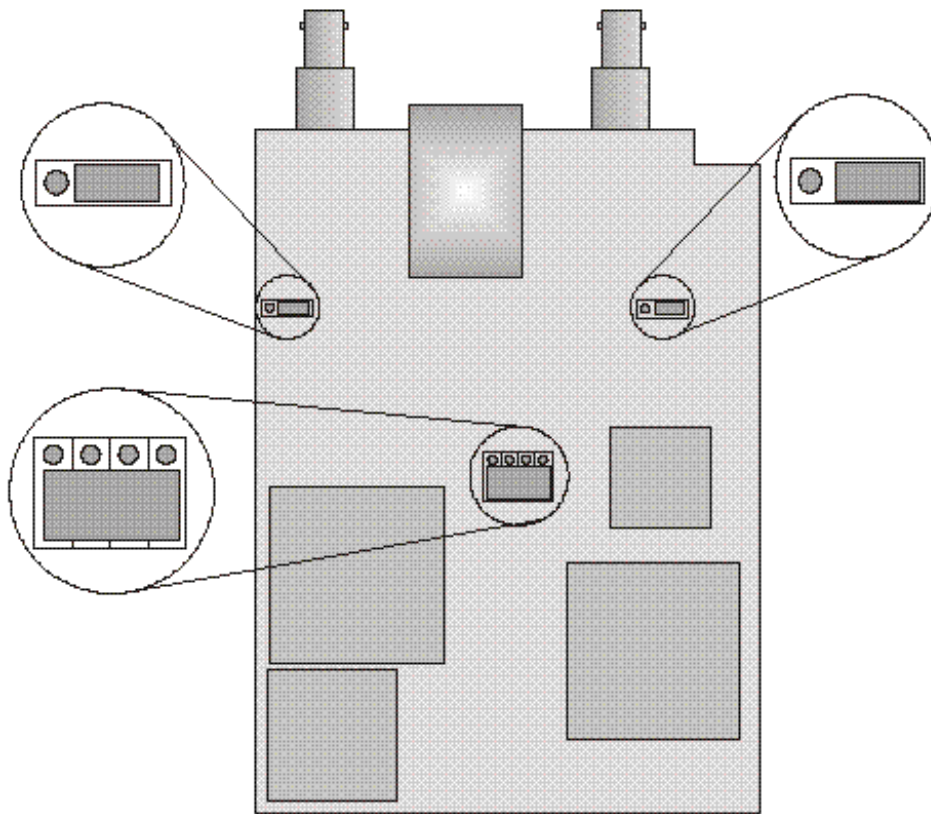


Figure C-3. Fractional E1 Unbalanced (Coax connector, 75 W)

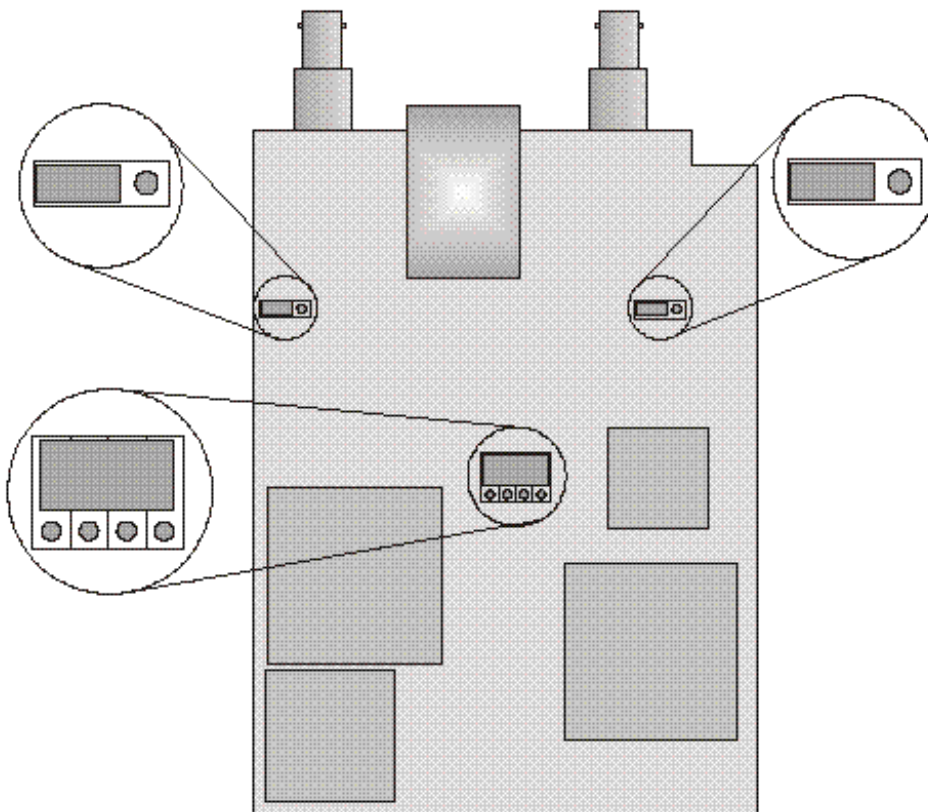


Figure C-4. Fractional E1 balanced (RJ-45 connector, 120 W)

Fractional T1 CSU/DSU Applications

- In most Fractional T1 applications, the 2.048Mbps Wireless Modem replaces the CSU/DSU (or OCU) used in regular wired connections.

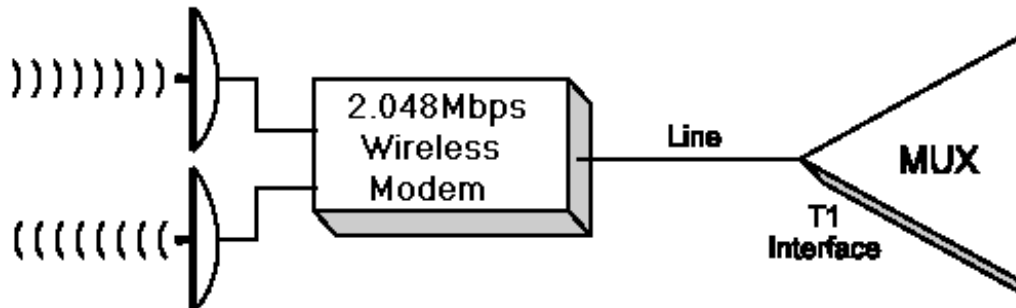


Figure C-5. Fractional T1/DSU Network Interface

This type of connection is referred to as a DSU network connection. In order to meet the applicable pulse mask requirements of the DSX-1 standard, the Pulse Shape Parameter should be set according to the line length (option 1 to 5).

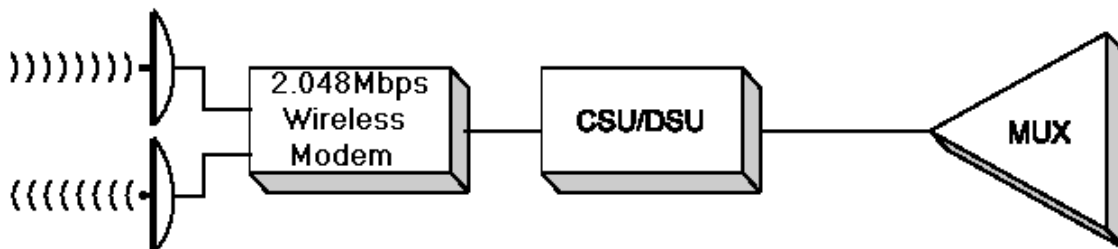


Figure C-6. Fractional T1/CSU Network Interface

In several applications, the 2.048Mbps Wireless Modem might be connected to CSU/DSU equipment, as shown in Figure C-7. This type of connection may be chosen because of a technical (e.g., a special MUX interface not supported by 2.048Mbps Wireless Modem) or other reason. This type of connection is referred to as a CSU network connection and the Line Length Parameters menu should be set according to the sensitivity level of the CSU/DSU (option 6 to 8)



Fractional E1/T1 Back-to-Back Configuration

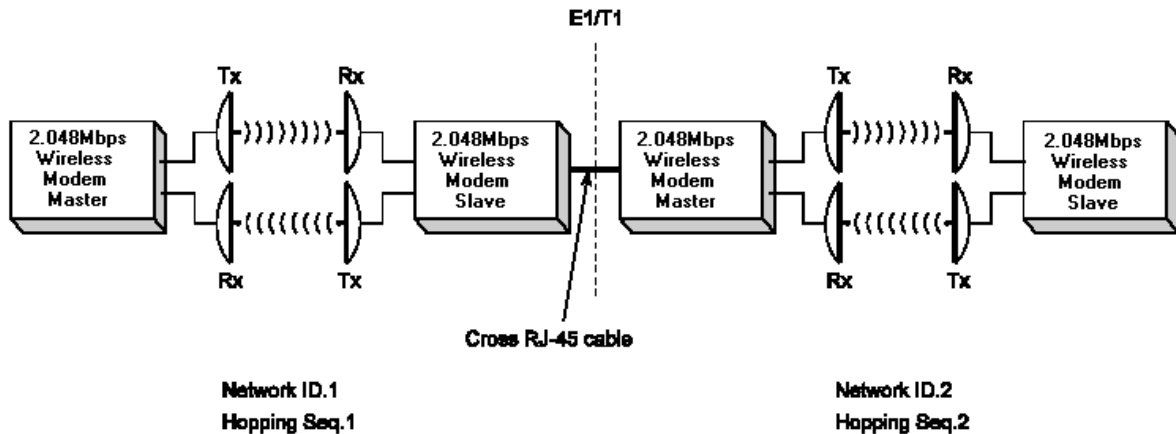


Figure C-7. Fractional E1/T1 Back-to-Back Configuration

Echo Cancellation in Fractional E1/T1 Applications

Regular telephony systems use 4 wires circuits: one pair for the transmitted signal (microphone) and one pair for the received signal (earphone). The transmission system is comprised of a single pair (2 wires) and a hybrid component used for the required conversion from 4- to 2-wires and vice versa.

The operation of the hybrid circuit is highly dependent on the impedance of the transmission lines, and since this impedance may vary, optimal performance of the hybrid cannot be assured. This imperfection results in the generation of an echo signal (the transmitted signal at a level that is determined by the quality of the hybrid and the actual impedance of the line).

In short distance links, the echo generated in the far end has a negligible impact on the user, since the delay time is insignificant. However, in some long distance links and in many wireless links this delay may be significant and can reduce the quality of the communications. People are used to hearing themselves while speaking. However, they will be very uncomfortable when hearing themselves after a delay of more than several milliseconds.

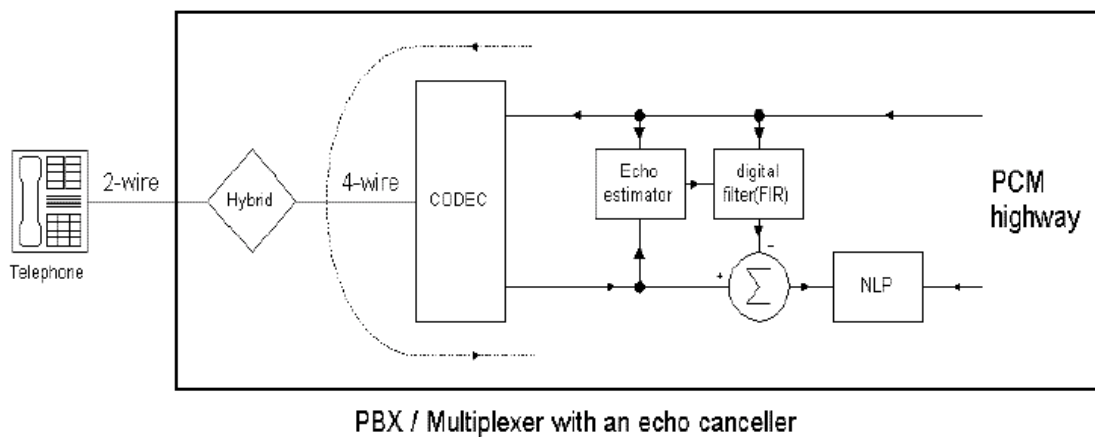


Figure C-8. The Source of Echo in Telephony

Echo cancellers circuits are used in long distance and some wireless links to solve the echo problem. The operation of echo cancellers is based on estimation of the interfering echo signal that is added to the desired signal and subtraction of a similar signal, thus cancelling or significantly reducing the interfering echo signal.

Regular voice channels are used in many applications for modem and fax communications. These devices have a built-in special echo canceller, as the echo canceller designed for regular voice signal is inadequate for cancellation of modem/fax signals. Thus, the echo canceller used in a voice circuit should be disabled when the channel is used for transmission of voice or fax signals. To support identification of modem and fax signals by echo canceller circuits, these devices transmit a signal at 2100Hz. Upon detection of such a signal the echo canceller will be disabled for the duration of the presence of this signal. Some modem/fax devices use a 2100Hz signal with phase reversal, reducing the probability of identifying a voice signal as a 2100Hz tone. Another method for disabling echo cancellation is VPA – Voice Path Assurance, based on identification of a continuous tone in the 2000-2100Hz range.

Echo cancellation should not be used in non-voice channels, as it may interfere with proper reception of data or signalling information.

Potential Problems in Fractional E1/T1 Applications

Echo cancellation should not be used in channels carrying data or signalling. This includes channel 0 in Fractional E1, channel 16 in Fractional E1 systems using CAS (Channel Associated Signalling) or any other channel(s) that may be used to transfer signalling information between both sides of the link. This may also be true for some channels that are used by voice-mail, auto-attendant or other PBX systems.

In systems where fax equipment is being used, it should be verified that the tone disabling method selected in the modem matches the capabilities of the fax equipment.

Fax machines and some protocols used by specific PBX auxiliary systems (Voice-mail, auto-attendant, etc.) might be highly sensitive to errors. It is recommended to achieve a good link with a LIU BUFFER ERROR RATE of 10^{-5} or better.

Fax machines and some protocols used by specific PBX auxiliary systems (Voice-mail, auto-attendant, etc.) might be highly sensitive to link delay. It is recommended to use a one-way delay that does not exceed 1 second.



Appendix D - Installing Other Types of Receive Amplifiers

General

The 2.048Mbps Wireless Modem supports other types of Receive Amplifiers which are not supplied by Black Box. Following are some tips regarding installation of different types of Receive Amplifiers.

The installation of other types of Receive Amplifiers is usually similar to the installation of the LNA-10. 2.048Mbps Wireless Modem can be set to provide 12 VDC power via the Receive RF cable.

There are two ways to supply 12 VDC to the receive amplifier:

- Separate DC input
- DC input through the RF cable

To separate DC input :

1. Connect the RF + Power Cable to the Bias-T unit.
2. Connect RF Output from the Bias-T unit to RF output in the Receive Amplifier.
3. Connect DC Output from the Bias-T unit to DC input in the Receive Amplifier.

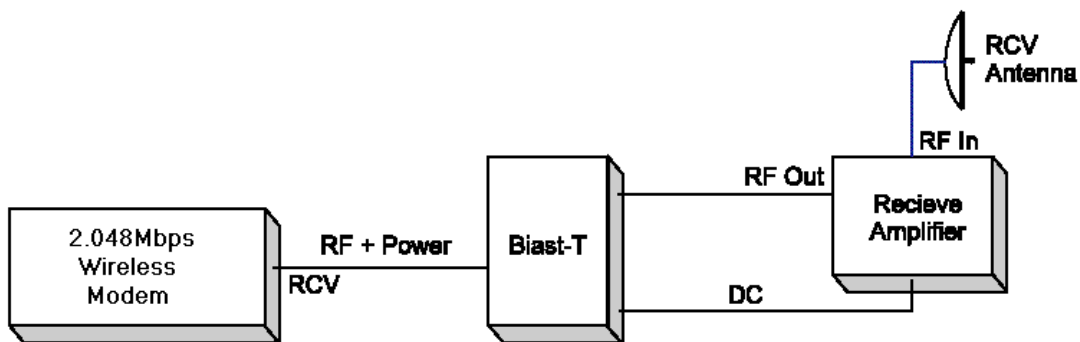


Figure D-1. Separate DC input Using Bias-T Unit Connection Diagram

4. Set the jumper Jp1 in the Rx Radio module to 12 VDC.

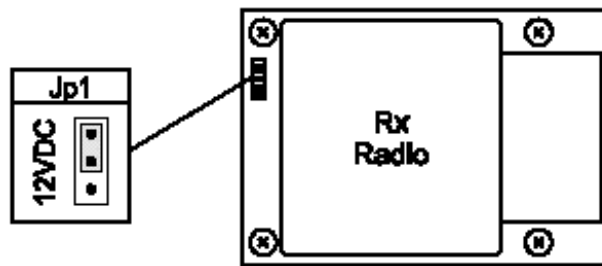


Figure D-2. Jumper Setting for 12 VDC Power Supply

To supply DC input through the RF cable

1. Connect the RF + Power Cable directly to the RF input in the Receive Amplifier.
2. Set the jumper Jp1 in the Rx Radio module to 12 VDC.

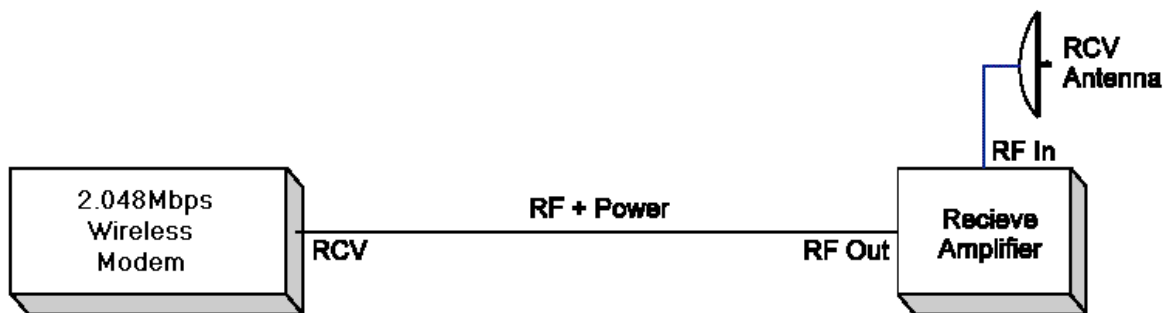


Figure D-3. Receive Amplifier powered via the RF cable Connection Diagram

Appendix E – Pin Assignments

E1/T1 and Fractional E1/T1 Pin Connections

RJ-45 pin	Description
1	Rx Ring
2	Rx Tip
4	Tx Ring
5	Tx Tip

Table E-1. E1/T1 and Fractional E1/T1 Pin Connections

LIU RS-530 Connector Pin Assignments

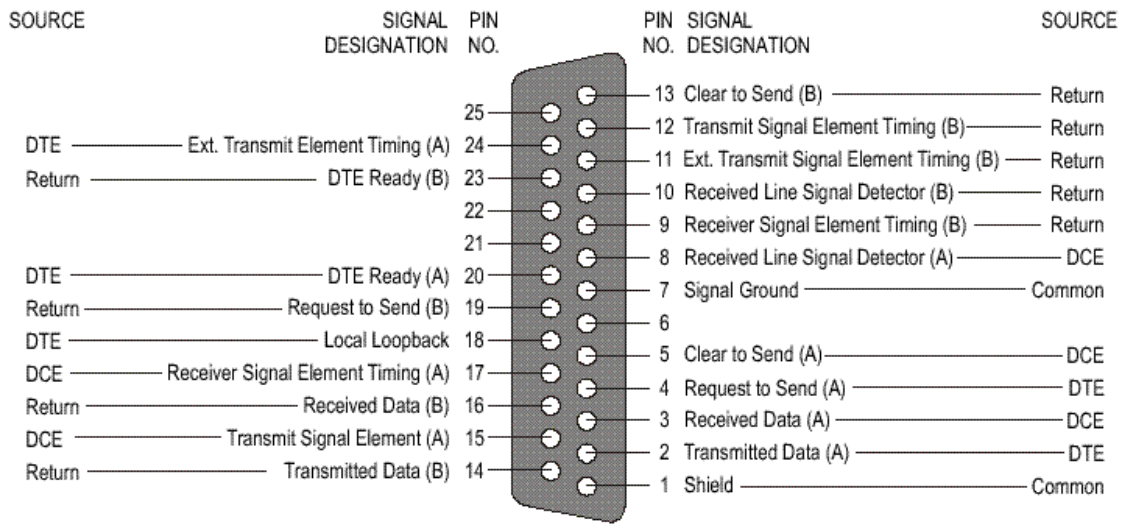


Figure E-1. LIU RS-530 Pin Assignments.

LIU D-25 to V.35 Cable Pin Assignments

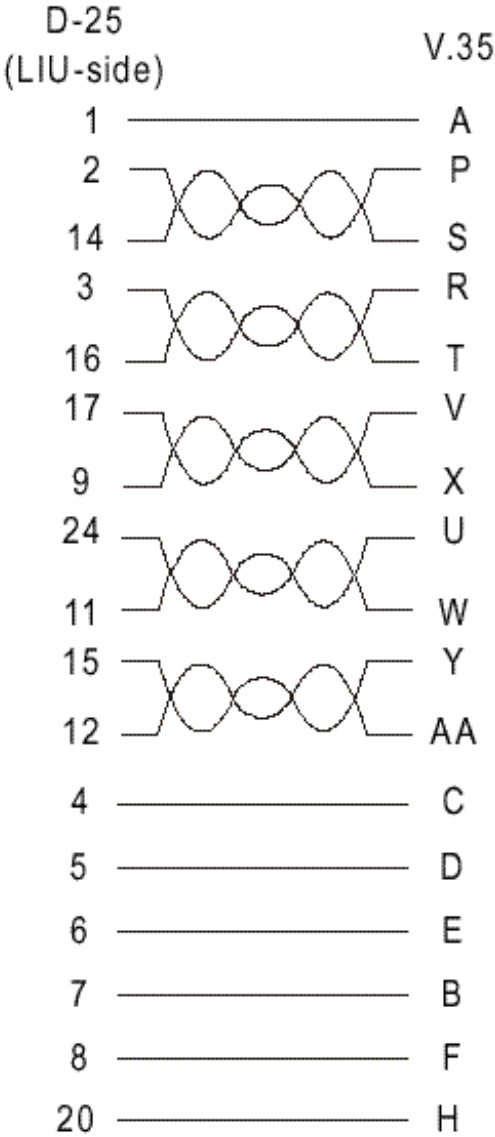


Figure E-2. LIU D-25 to V.35 Cable Pin Assignments.

LIU D-25 to X.21 Cable Pin Assignments

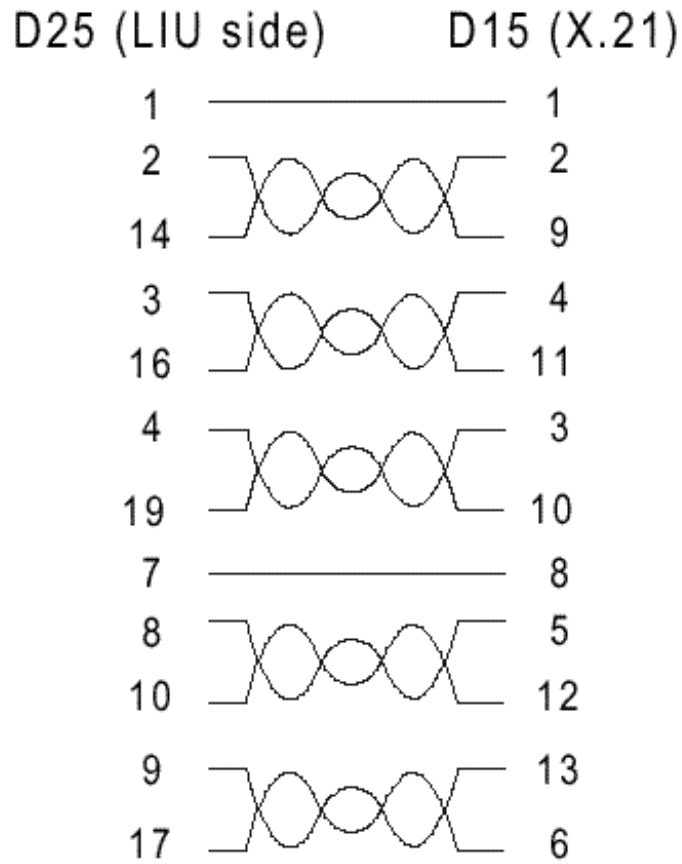


Figure E-3. LIU D-25 to X.21 Cable Pin Assignments