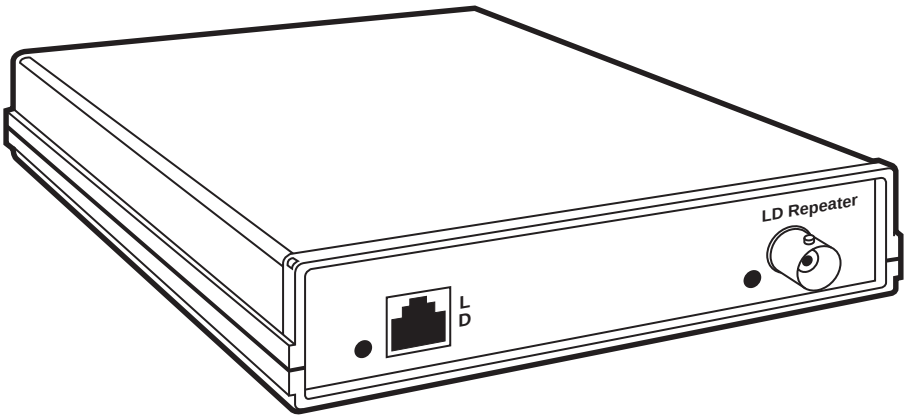
1000 Park Drive • Lawrence, PA 15055-1018 • 724-746-5500 • Fax 724-746-0746

BLACK BOX®
NETWORK SERVICES

MAY 2000
LZ1500A-R3
LZ1502A-R3
LZ1503A-R4
LZ1504A-R3

Long-Distance Repeaters
UTP/BNC
UTP/(2)BNC
UTP/BNC/RJ-45
UTP/(4)BNC/AUI



CUSTOMER SUPPORT INFORMATION

Order **toll-free** in the U.S. 24 hours, 7 A.M. Monday to midnight Friday: **877-877-BBOX**
FREE technical support, 24 hours a day, 7 days a week: Call **724-746-5500** or fax **724-746-0746**
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FEDERAL COMMUNICATIONS COMMISSION
AND
CANADIAN DEPARTMENT OF COMMUNICATIONS
RADIO FREQUENCY INTERFERENCE STATEMENTS

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio communication. It has been tested and found to comply with the limits for a Class A computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when the equipment is operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be necessary to correct the interference.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This digital apparatus does not exceed the Class A limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la classe A prescrites dans le Règlement sur le brouillage radioélectrique publié par le ministère des Communications du Canada.

TRADEMARKS

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NORMAS OFICIALES MEXICANAS (NOM)
ELECTRICAL SAFETY STATEMENT

INSTRUCCIONES DE SEGURIDAD

1. Todas las instrucciones de seguridad y operación deberán ser leídas antes de que el aparato eléctrico sea operado.

2. Las instrucciones de seguridad y operación deberán ser guardadas para referencia futura.

3. Todas las advertencias en el aparato eléctrico y en sus instrucciones de operación deben ser respetadas.

4. Todas las instrucciones de operación y uso deben ser seguidas.

5. El aparato eléctrico no deberá ser usado cerca del agua—por ejemplo, cerca de la tina de baño, lavabo, sótano mojado o cerca de una alberca, etc..

6. El aparato eléctrico debe ser usado únicamente con carritos o pedestales que sean recomendados por el fabricante.

7. El aparato eléctrico debe ser montado a la pared o al techo sólo como sea recomendado por el fabricante.

8. Servicio—El usuario no debe intentar dar servicio al equipo eléctrico más allá a lo descrito en las instrucciones de operación. Todo otro servicio deberá ser referido a personal de servicio calificado.

9. El aparato eléctrico debe ser situado de tal manera que su posición no interfiera su uso. La colocación del aparato eléctrico sobre una cama, sofá, alfombra o superficie similar puede bloquea la ventilación, no se debe colocar en libreros o gabinetes que impidan el flujo de aire por los orificios de ventilación.

10. El equipo eléctrico deber ser situado fuera del alcance de fuentes de calor como radiadores, registros de calor, estufas u otros aparatos (incluyendo amplificadores) que producen calor.

11. El aparato eléctrico deberá ser connectado a una fuente de poder sólo del tipo descrito en el instructivo de operación, o como se indique en el aparato.

12. Precaución debe ser tomada de tal manera que la tierra fisica y la polarización del equipo no sea eliminada.

13. Los cables de la fuente de poder deben ser guiados de tal manera que no sean pisados ni pellizcados por objetos colocados sobre o contra ellos, poniendo particular atención a los contactos y receptáculos donde salen del aparato.

14. El equipo eléctrico debe ser limpiado únicamente de acuerdo a las recomendaciones del fabricante.

15. En caso de existir, una antena externa deberá ser localizada lejos de las lineas de energia.

16. El cable de corriente deberá ser desconectado del cuando el equipo no sea usado por un largo periodo de tiempo.

17. Cuidado debe ser tomado de tal manera que objectos liquidos no sean derramados sobre la cubierta u orificios de ventilación.

18. Servicio por personal calificado deberá ser provisto cuando:

    A: El cable de poder o el contacto ha sido dañado; u

    B: Objectos han caído o líquido ha sido derramado dentro del aparato; o

    C: El aparato ha sido expuesto a la lluvia; o

    D: El aparato parece no operar normalmente o muestra un cambio en su desempeño; o

    E: El aparato ha sido tirado o su cubierta ha sido dañada.

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1. Specifications

Protocol—Protocol-independent (Ethernet V2, IEEE 802.3)

Indicators—LZ1500A-R2: (2) LEDs: (1) BNC (Thin Ethernet), (1) RJ (UTP port) to indicate status; LZ1502A-R2: (4) LEDs: (2) BNC (Thin Ethernet), (2) RJ (UTP port) to indicate status; LZ1503A-R4: (3) LEDs: (1) BNC (Thin Ethernet), (1) RJ (UTP port), (1) 10BASE-T port to indicate status; LZ1504A-R2: (9) LEDs: (4) BNC (Thin Ethernet), (4) RJ (UTP port), (1) AUI to indicate status

Connectors—LZ1500A-R2: (1) BNC female, (1) RJ-12 female, (1) 5-pin DIN female for Power; LZ1502A-R2: (2) BNC female, (2) RJ-12 female, (1) 5-pin DIN female for Power; LZ1503-R4: (1) BNC female, (1) RJ-12 female, (1) RJ-45, (1) 5-pin DIN female for Power; LZ1504A-R2: (4) BNC female, (4) RJ-12 female, (1) AUI, (1) 5-pin DIN female for Power

Power—100-250 VAC, autosensing wallmount power supply, 47-63 Hz, 9 V at 1 Amp

Size—LZ1500A-R2, LZ1502A-R2: 1.5"H x 6.2"W x 9.5"D (3.8 x 15.7 x 24.1 cm); LZ1503A-R4, LZ1504A-R2: 1.7"H x 9"W x 12.3"D (4.3 x 22.8 x 31.2 cm)

2. Introduction

2.1 Overview

The UTP and Thin Ethernet Repeaters are high-performance Ethernet repeaters that operate over the spare pair of telephone wires already in the walls or buried in the ground. They work with any IEEE 802.3 compatible Ethernet system.

2.2 What's in the Box

All the Repeaters come in kits. The contents of each kit are listed below.

LZ1500A-R3:

- (1) LZ1500A-R2 Repeater
- (1) SP528A surge protector
- A mounting kit with Velcro® strips for wall mounting and rubber feet for table mounting.
- 100-250 VAC, autosensing wallmount power supply, 47-63 Hz, 9 V at 1 Amp
- This user's manual

LZ1502A-R3:

- (1) LZ1502A-R2 Repeater
- (2) SP528A surge protectors
- A mounting kit with Velcro® strips for wall mounting and rubber feet for table mounting.
- 100-250 VAC, autosensing wallmount power supply, 47-63 Hz, 9 V at 1 Amp
- This user's manual

LZ1503A-R4:

- (1) LZ1503A-R4 Repeater.
- (1) SP528A surge protector

- A mounting kit with Velcro® strips for wall mounting and rubber feet for table mounting.
- 100-250 VAC, autosensing wallmount power supply, 47-63 Hz, 9 V at 1 Amp
- This user's manual

LZ1504A-R3:

- (1) LZ1504A-R2 Repeater.
- (4) SP528A surge protectors
- (1) LE2110A transceiver
- A mounting kit with brackets and screws for wall mounting, and rubber feet for table mounting.
- 100-250 VAC, autosensing wallmount power supply, 47-63 Hz, 9 V at 1 Amp
- This user's manual

If you do not find all of these components in the box, please call Black Box at 724-746-5500.

2.3 Networking Terminology

The world of computer networking is full of unique terminology. You will come across some of that terminology in this manual. If you are new to networking and do not understand a term used here, please refer to the glossary in **Chapter 7**.

2.4 Customer Support

If you have problems when you read this manual or install a Repeater, contact Technical Support.

3. Quick Start Installation Guide for UTP Repeaters and Hubs

If you are an experienced network installer and would like to install your long distance connection immediately, follow these steps. For more detailed installation instructions, turn to **Chapter 5**.

3.1 Equipment Protection

You must be extremely careful to ensure the safety of persons and equipment whenever using wires that run between buildings. Both underground cable runs that are near the surface and overhead runs are at risk of damage from lightning strikes and must be suitably protected.

This protection must be in place or there will be risk of serious injury or death. The service entrance at each end of the wires should be protected in strict accordance with local safety codes.

In addition, to further reduce the risk of injury or damage to equipment due to lightning strikes or accidental connection to hazardous AC line voltages, secondary circuit protection should be installed at the service entrance.

Outdoor cabling installed by the phone company is typically installed with gas discharge protection devices, carbon blocks or no protection devices at all. If cabling has protection, DO NOT BYPASS these devices—they will help protect both your equipment and all those who work with it. If the cable run you will be using is not protected, DO NOT continue with the installation. STOP. Install suitable protection devices before proceeding and be sure that the manufacturer's instructions are followed fully (including connecting the ground strap)!

This protection is commercially available from a number of telecommunications distributors and from networking catalog companies. Before purchasing, make sure that the protective devices are specifically for use with high-speed data-transmission lines, as some are only for use with telephone systems and will degrade the quality of the Ethernet signals.

Note that many carbon-block-type protection devices add a significant load to the line and will not work with our devices. These must be removed and replaced with suitable protection devices.

Units designed for use with punchdown blocks ("66" blocks) are available from telecommunications wholesalers as well as through your telecom installer. A device with RJ-11 or RJ-45 connections, part number ST512A, is available from your dealer.

If you have any questions about which protection devices to use, call Black Box Technical Support at 724-746-5500.

3.2 UTP Repeaters Quick Start Installation

1. Install the repeaters in the wiring closet, near the central punch down block or patch panel.

2. Repeaters can be placed on a shelf (attach adhesive feet), or wall-mounted with Velcro strips (LZ1500A-R2, LZ1502A-R2, LZ1503A-R4) or mounting brackets (LZ1504A).

3. Inspect existing telephone wire to locate the two end points of an unused pair.

4. Measure the lengths of the phone wire that will connect the repeater ports to be certain that the distance is less than 1500 ft (457.2 m). To do so, short-circuit one end of the phone-wire pair and measure the resistance between the two wires at the other end. Multiply the resistance by 20 to find the length of the wire in feet. For example, a reading of 54.6 ohms indicates roughly 1,100 feet of cable (54.6 x 20 = 1092). For a maximum of 1,500 ft., the resistance must measure 75 ohms or less. This formula works for standard 24 gauge phone wire.

5. Check that the wires are properly protected against hazardous voltages (see **Section 6.1**).

6. Make patch cables with RJ-11 plugs. Wire the RJ-11 plugs using the two center pins, 3 and 4. Connect them straight through, pin 3 to 3, pin 4 to 4 (do not reverse polarity).

7. Plug in the power supply and attach it to the repeater. The LEDs on the repeater will alternate between red and green.

8. Attach patch cables to the repeater ports and phone block. When repeaters have been interconnected, the LEDs will remain constant; one Repeater will show a steady red LED, the other will show a steady green LED.

9. Now connect your existing LAN to the repeater using the appropriate ports, BNC or AUI.

NOTE

For safety, IEEE 802.3 10BASE2 Ethernet specifications call for each segment to be connected at one point to an earth ground such as a cold water pipe. To simplify your system's installation, we have internally connected the ports' grounds in our repeaters together and recommend that the earth ground connection be made from only one of the ports on the repeater. Grounding one segment in this manner will properly ground all the 10BASE2 segments connected to the repeater.

- Connect 10BASE2 segment(s) directly to the Repeater as if each port is a 50 ohm terminator. (Do not connect in the middle of a segment or use a BNC "T" connector.)
- When a segment is properly attached and the far end of the segment is properly terminated, the LEDs will cease alternating.
- Be sure to connect the shield of one (only one) of the segments to an earth ground.

Each 10BASE2 port of the Repeaters acts like one terminator on the 10BASE2 segment to which it is connected. Therefore, each segment must have one (and only one) additional terminator at the far end of the run. If the terminator is not attached, or there are two or more terminators in addition to the termination provided by the repeater, that segment of the network will not operate properly.

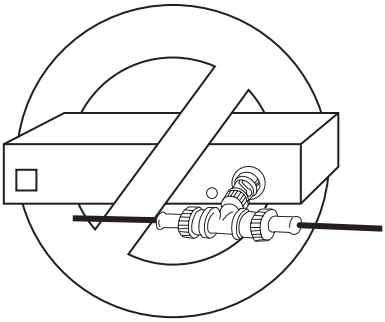


Fig. 3-1. 10BASE2 Thin Ethernet Segment Must End at the Repeater.

Some Network Interface Cards (NICs), hubs, and adapters have terminators built in that may be enabled or disabled via jumpers. Make sure that only the NIC at the end of the segment farthest from the Repeater has its termination enabled and that all the rest are disabled. (If an external terminator is used, then all the NICs should have their termination disabled.)

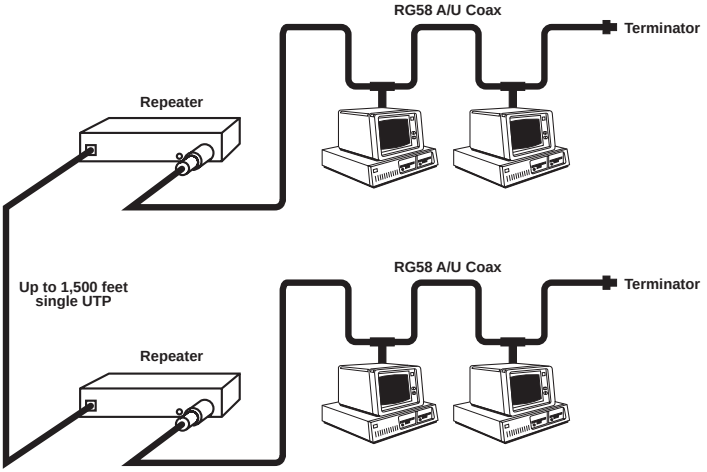


Fig. 3-2. NIC Termination Enabled.

10. There can be no more than two connections in line in the network without reclocking. This means that any point in the network must be able to be connected to any other point in the network through a maximum of two links (3 hubs). In most, but not all, cases (depending on the configuration of the rest of the network) it is permissible to have three connections in a line. If your network layout requires more than two connections, call for technical support.

4. Installing Long Distance Repeaters

This chapter explains how to install Long Distance Repeaters. The installation consists of 5 major steps:

1. Creating a site plan and marking the location of network connections and wiring closets.
2. Measuring the lengths of phone wire and preparing the interconnections.
3. Installing the Repeaters and connecting them with patch cables to the phone punch down block or patch panel.
4. Interconnecting with 10BASE2 coax, 10BASE-T, or AUI Ethernet segments, as applicable.
5. Starting the system.

4.1 The Tools and Parts You Need

Installing Repeaters is fast and simple, but does require tools and parts you may not normally have around the office. Before you begin installation, be sure you have these tools and parts on hand:

- A site plan for your office showing the locations of the wiring closets in all locations (a rough sketch will do)
- A punchdown tool (sometimes called an impact tool)

Fig. 4-1. Punchdown Tool.

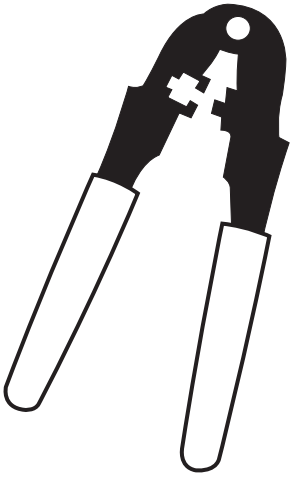


Fig. 4-2. RJ-11 Crimping Tool.

- An RJ-11 crimping tool
- A Phillips head screwdriver
- An ohmmeter

You can obtain tools and parts from your dealer.

4.2 About the Wiring Closet

A Repeater is typically installed in a wiring closet to make it possible to connect the phone wires carrying network signals to the repeater with short patch cables. While the wiring closet may seem like an intimidating and confusing place, installing and wiring a Repeater there will be surprisingly easy.

4.3 UTP Phone Wire

Repeaters are intended for use with 100-ohm unshielded twisted-pair telephone wire (UTP) already installed in and between buildings. Buildings, individual floors and wings of a building are often interconnected with 25-, 50-, or 100-pair Level 2 UTP cables. One pair in these is usually available for long-distance LAN connections.

4.4 Patch Cables

A patch cable connects each phone-wire pair to a Repeater port. Each patch cable extends from the port to the phone punchdown block containing the phone-wire connection. You must make your own patch cables for an installation, or obtain them from your dealer. They are not included with your Repeaters.

Cables, plugs, and the tools to make patch cables can be purchased from your dealer. When making patch cables to connect punchdown blocks to repeaters, use only the two center pins 3 and 4 by joining one wire to pin 3 on both plugs and the other to pin 4 on both plugs with a crimping tool. If you are making patch cords for connecting the repeaters directly to the punchdown blocks, make sure the wire used is compatible with the punchdown block. Most blocks do not work properly with stranded wires. These cables will typically have a connector on only one end, with the other end connected directly to the punchdown block.

NOTE

Because standard telephone patch cords contain a crossover in their wiring, they will not function in a network. Neither will flat "Silver Satin" telephone patch cords since they are not made of twisted-pair wires.

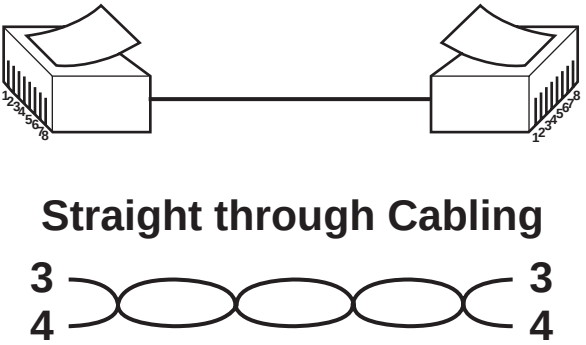


Fig. 4-3. Straight-Through Cabling.

4.5 About Cable Connections and Lengths

Long Distance Repeaters are capable of operating over cable spans up to 1500 feet (457.2 m) in length. You can have up to three Repeaters (2 links) connected in a row. Refer to **Fig. 4-4**.

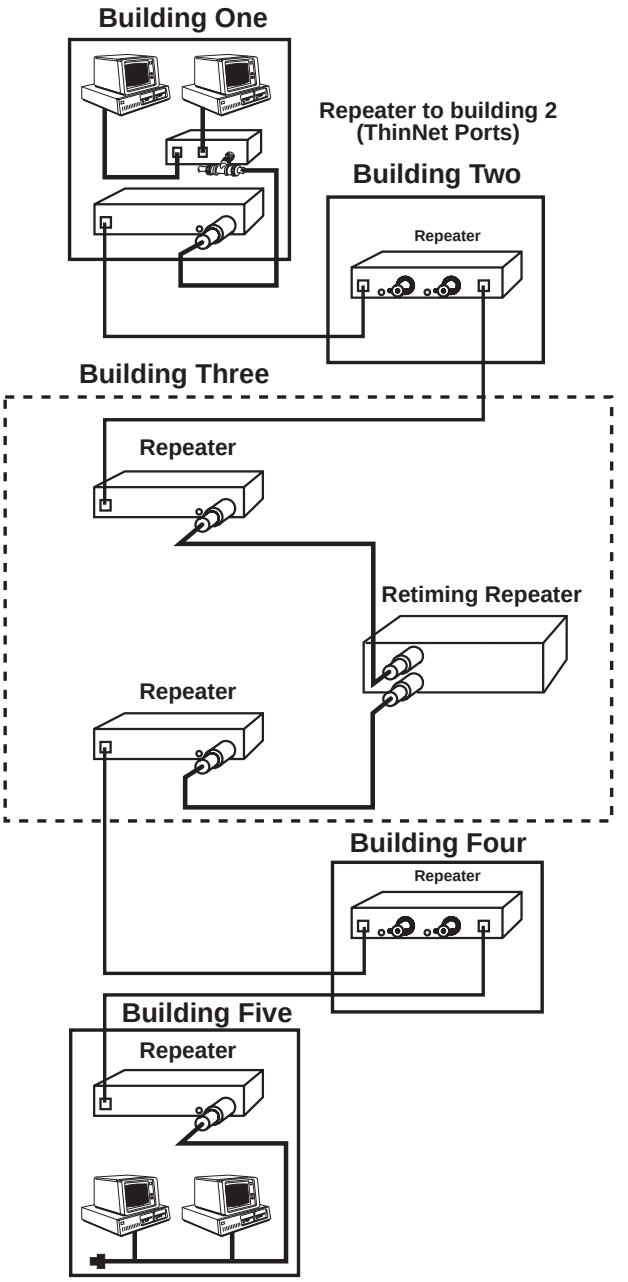


Fig. 4-4. Connecting Multiple Links.

4.6 Installation Steps

Before attempting to install your Repeaters, you must have the tools and parts on hand to complete the operation. Please read **Section 5.1**.

4.6.1 EQUIPMENT PROTECTION

NOTE

You must be extremely careful to ensure the safety of persons and equipment whenever using wires that run between buildings. Both underground cable runs that are near the surface and overhead runs are at risk of damage from lightning strikes and must be suitably protected. This protection must be in place or there will be risk of serious injury or death.

The service entrance at each end of the wires should be protected in strict accordance with local safety codes. In addition, to further reduce the risk of injury or damage to equipment due to lightning strikes or accidental connection to hazardous AC line voltages, secondary circuit protection should be installed at the service entrance.

Outdoor cabling installed by the phone company is typically installed with gas-discharge protection devices, carbon blocks, or no protection devices at all. If cabling has protection, DO NOT BYPASS these devices—they will help protect both your equipment and all those who work with it. If the cable run you will be using is not protected, DO NOT continue with the installation, STOP. Install suitable protection devices before proceeding and be sure that the manufacturer's instructions are followed fully (including connecting the ground strap)!

This protection is commercially available from a number of telecommunications distributors and from networking catalog companies. Before purchasing, make sure that the protective devices are specifically for use with high-speed data-transmission lines, since some are only for use with telephone systems and will degrade the quality of the Ethernet signals.

Note that many carbon-block-type protection devices add a significant load to the line and will not work with our devices. These must be removed and replaced with suitable protection devices. Units designed for use with punchdown blocks ("66" blocks) are available from telecommunications wholesalers as well as through your telecom installer. Devices with RJ-11 or RJ-45 connections, such as part number ST512A, are available from your dealer.

If you have any questions regarding which protection devices to use, call Technical Support.

4.6.2 PREPARE THE SITE PLAN

1. Find or create a site plan. It must show the location of one or more phone closets where the Repeaters will be installed.

2. On the plan, mark the location of devices (hubs, concentrators, etc.) to be interconnected.

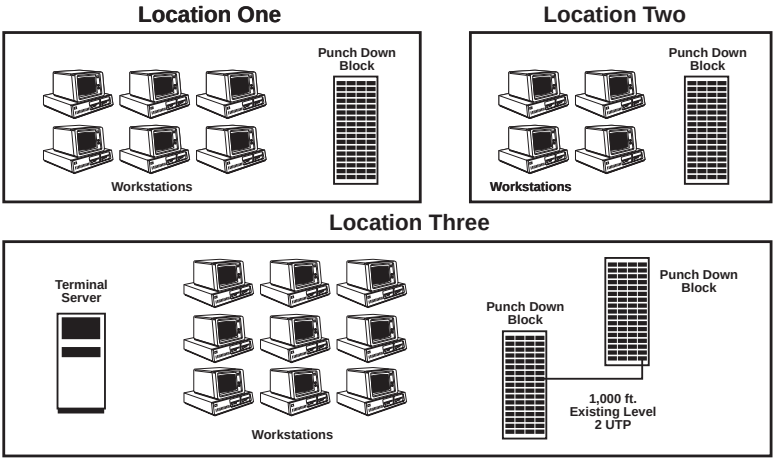


Fig. 4-5. Prepare the Site Plan.

3. Locate and identify each pair of wire that you will use for the long distance interconnection. The wire pairs must run only between the two points to be connected. The link will not connect if there is a bridge tap anywhere on the link.

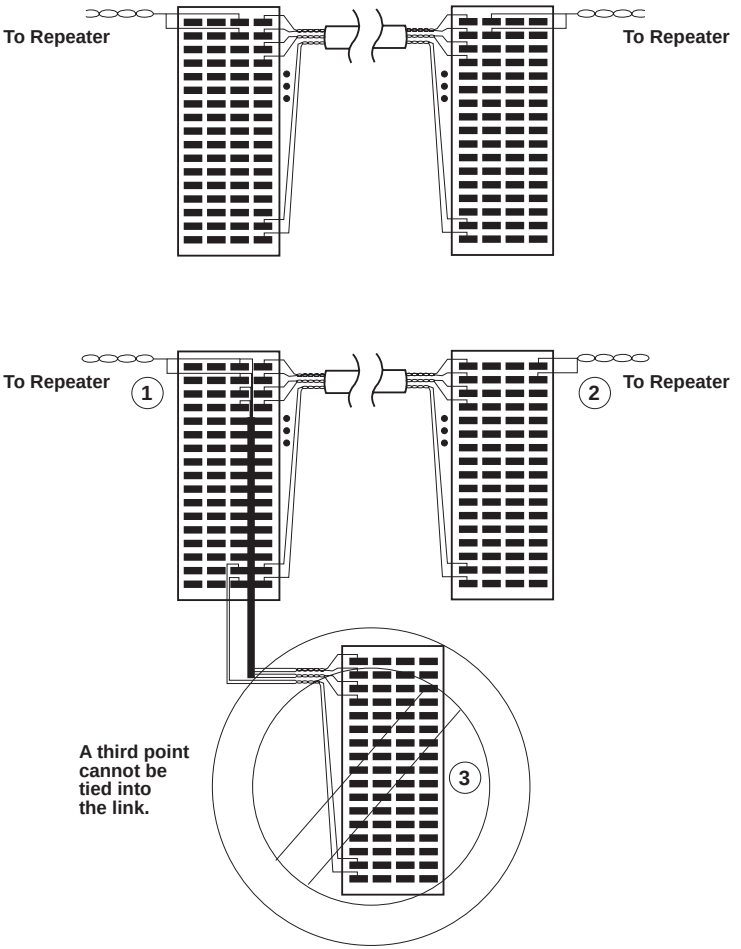


Fig. 4-6. Identifying Wire Pairs.

4.6.3 MEASURE PHONE WIRE

Measure the lengths of phone wire that will connect the Repeaters using an ohmmeter. Short-circuit one end of the phone wire and measure the resistance between the two wires at the other end.

Multiply the resistance by 20 to find the length of the wire in feet. For example, 54.6 ohms would indicate a cable length of about 1100 feet: 54.6 x 20 =1092. This formula works for 24 gauge phone wire. Refer to the chart below for maximum acceptable resistance values of other wire gauges. Attach a label to each pair showing its length. This will be useful later if there is a cable fault.

Table 4-1. Wire Table (for LZ150x Series).

Gauge	Max. Resistance (for 1500 ft.)
24 GA	75 Ω
22	48
20	30
18	20

NOTE: Wire smaller than 24 gauge is not recommended, and any wire used must be 100-ohm impedance unshielded twisted pair.

Telephone wire connected between two Repeaters may span up to 1,500 feet (457.2 m) in length. If a run is longer, you must break it in the middle and add another repeater (such as an LZ1502A) between the two segments.

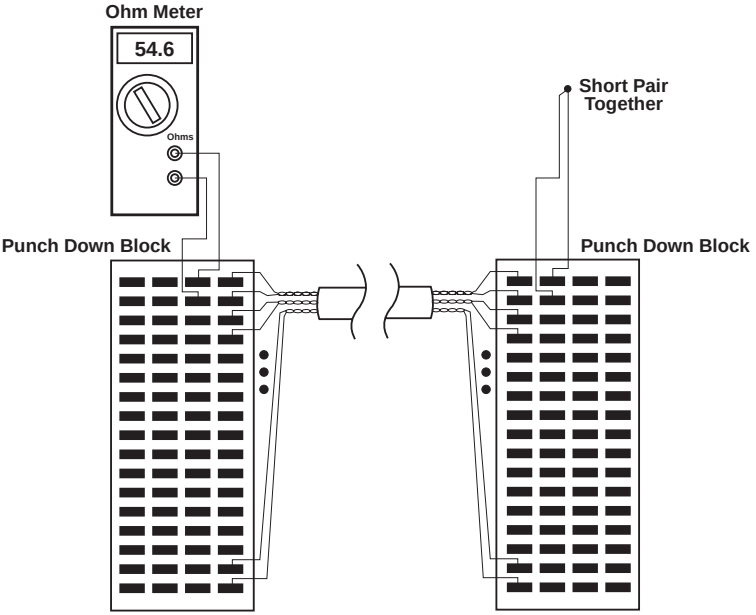


Fig. 4-7. Measuring the Length of the Telephone Wire Connecting Two Repeaters.

4.6.4 Install UTP Repeaters and Attach Patch Cables

1. Install the Repeaters in the wiring closet, near the central punchdown block or patch panel. You can mount them with Velcro strips or screw them to the wall with wall mount brackets. All Repeaters can be shelf- or table-mounted as well. The power supply plugs into a wall socket or is screwed into the wall and plugged into a socket.

2. Plug in the power supply and attach it to the Repeater. All LEDs on the repeater alternate between red and green.

3. Wire the RJ-11 jacks using the two center pins, 3 and 4.

Attaching patch cable wires to the phone block requires the use of a punchdown or impact tool. The wires must be "punched down" on forked pins corresponding to the phone-wire pairs used for each end of the long-distance span.

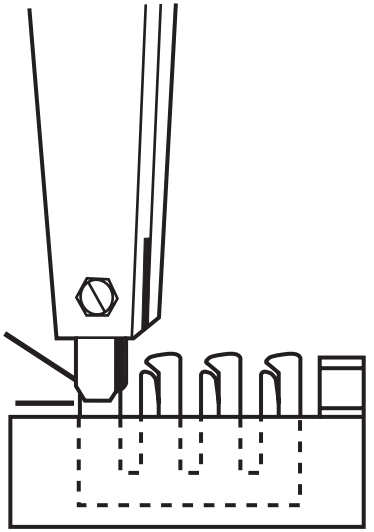


Fig. 4-8. Punching Down Wires.

Form a loop at the end of each patch cable wire and place the loop under the lip of a pin. Position the punchdown tool over the pin, with the cutting edge above the short end of the wire, and press down firmly. The tool forces the wire down between the halves of the forked pin and severs its short end.

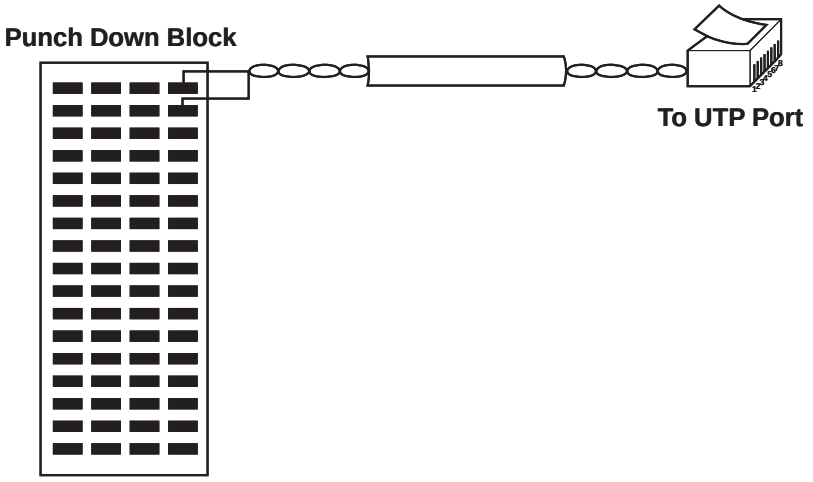


Fig. 4-9. Punchdown Block Connection.

4. Attach all patch cables to the repeater port(s) and phone block onto the spots identified in the previous section. The LEDs will continue to alternate until both ends of the link are powered up and connected together. Once linked together, the LED on one unit will light red and the LED on the other unit will light green. If they do not latch, please see **Chapter 6.0** for help in diagnosing the problem.

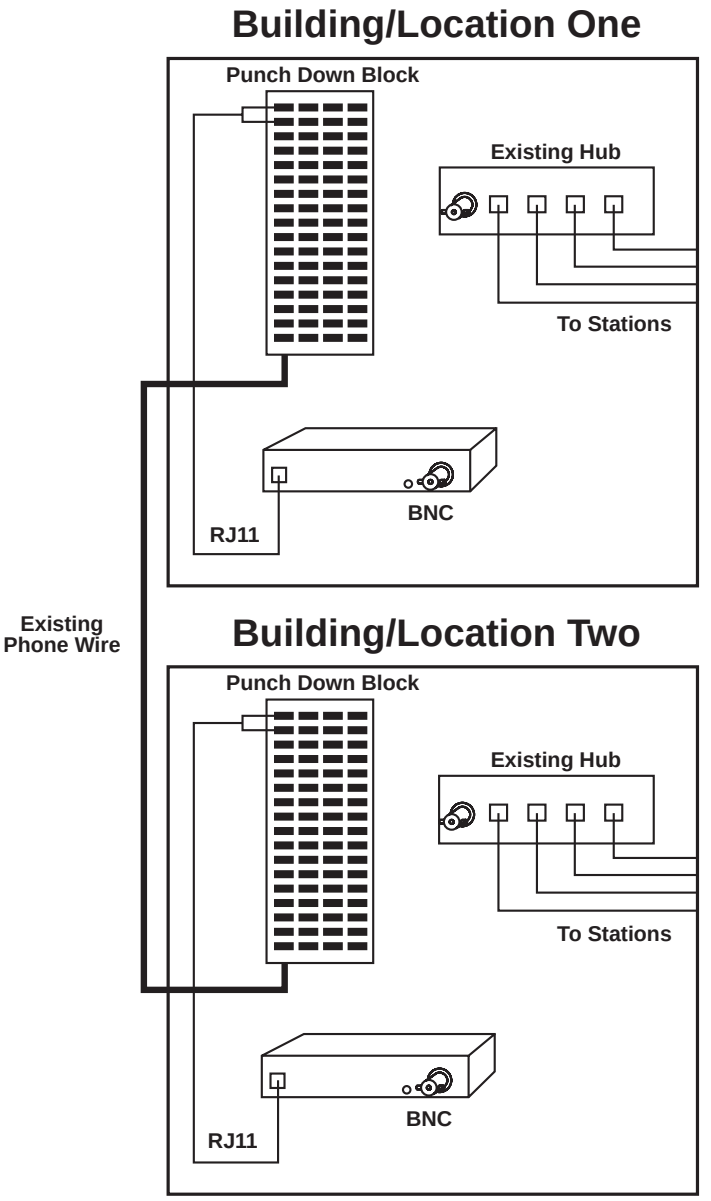


Fig. 4-10. LZ150xA Series Hub-to-Hub Connection.

4.6.5 INSTALL 10BASE2 THIN COAX AND AUI SEGMENTS

NOTE

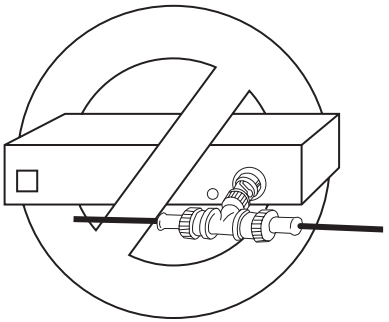
For safety, IEEE 802.3 10BASE2 Ethernet specifications call for each segment to be connected at one point to an earth ground, such as a cold water pipe. To simplify your systems installation, we have internally connected the port grounds in our repeaters, and recommend that the earth ground connection be made from only one of the ports on the repeater. Grounding one segment in this manner will properly ground all the segments connected to the repeater. (Refers to the LZ1502A, LZ1504A, and LZ1508A with two, four, and eight BNC ports respectively.)

Installation Steps

1. Connect 10BASE2 thin coax segments to the Repeater as if each port is a 50 ohm terminator.

2. When a segment is properly attached and the far end of the segment is properly terminated, the adjacent LED will cease alternating.

3. Be sure to connect the shield of one (only one) of the segments to an earth ground.



The segment must end at the repeater. DO NOT use a T-Connector.

Fig. 4-11. The Segment Must End at the Repeater.

Each 10BASE2 port of the Repeaters acts like one terminator on the 10BASE2 thin coax segment it is connected to. Therefore, each segment must have one (and only one) additional terminator at the far end of the run. If the terminator is not attached or there are two or more terminators

in addition to the termination provided by the repeater that segment of the network will not operate properly.

Some Network Interface Cards (NICs), hubs, and adapters have terminators built in that can be enabled or disabled via jumpers. Make sure that only the NIC at the end of the segment farthest from the Repeater has its termination enabled and that all the rest are disabled. If an external terminator is used then all the cards should have their termination disabled.

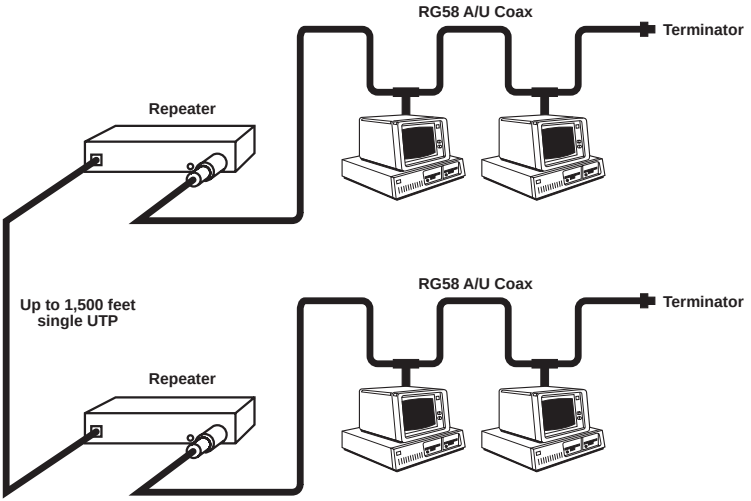


Fig. 4-12. NIC Terminated at the End of the Segment.

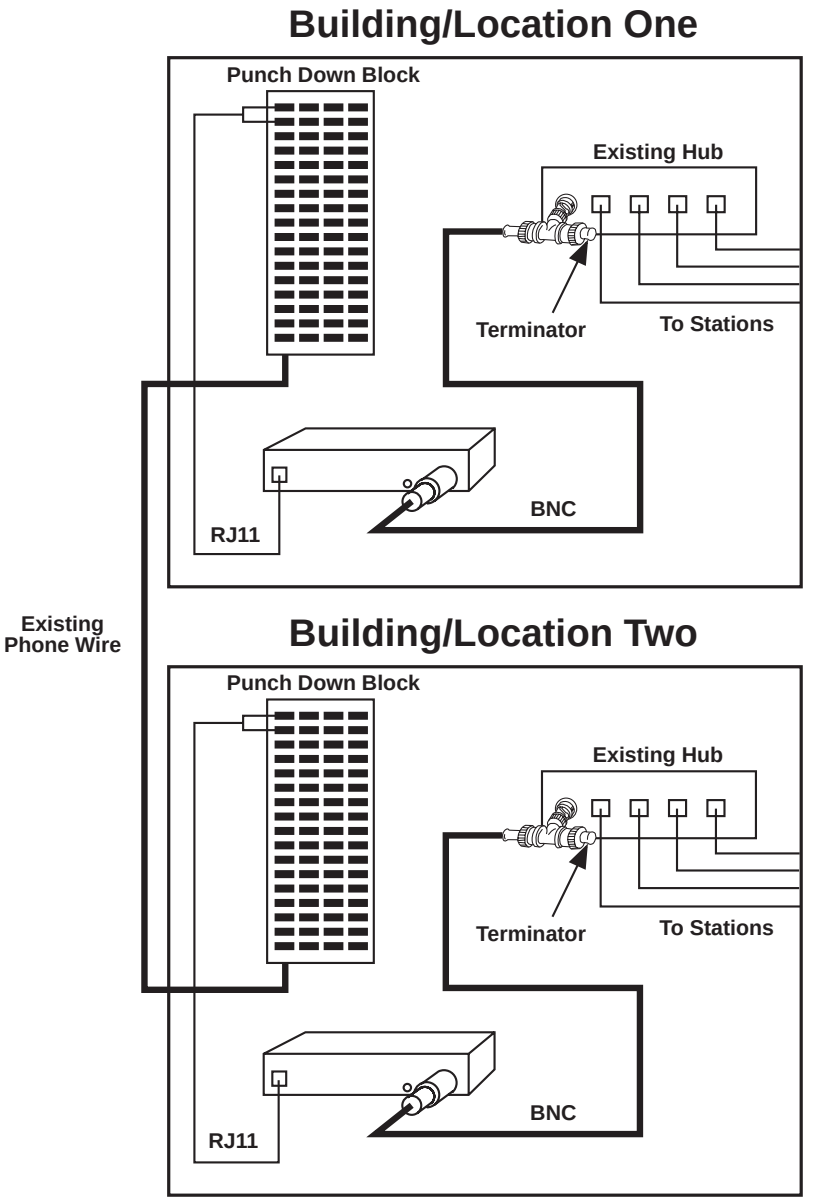


Fig. 4-13. Hub-to-Hub Connection With Termination.

AUI Port Connections

An AUI (Attachment Unit Interface) port is available on the LZ1504A to attach the repeaters to an MAU (Media Attachment Unit) on a 10BASE5 backbone. The AUI port can also be used with a plug-in microtransceiver to attach to other media, such as 10BASE-T or fiber-optic networks.

The red LED indicates that the port is disabled. This will occur when there are errors on the link, such as multiple collisions in a row. The port will be re-enabled automatically once the error is cleared. The green LED indicates the level of network traffic. As network traffic increases, the LED's intensity and blink duration increase.

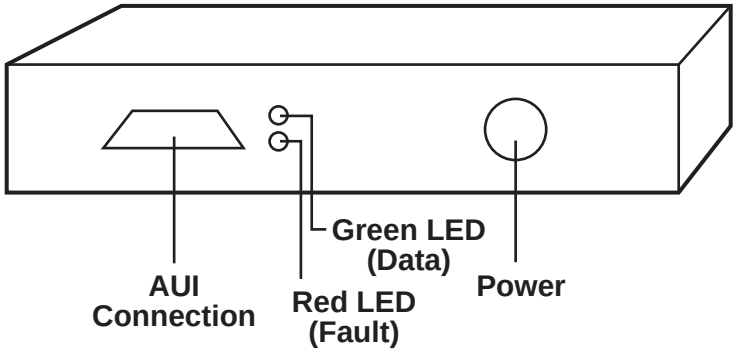


Fig. 4-14. AUI Port Connections.

5. Monitoring and Troubleshooting

Solving network problems is easy once you learn a few basics. If you find that the information in this chapter does not address a problem you are having with your network, call Technical Support. Besides software issues, the most common network problems are cable faults, accounting for over 75% of all network hardware problems. Always suspect the cabling, and always suspect the connections to the cabling first—connectors unplugged, wires not making good contact in the connectors, punch-down block connections faulty, etc.

5.1 Monitoring the UTP Repeater LEDs

1. The LEDs near the ports of the LZ150xA series repeaters show whether the system power is on and the ports are properly connected. If no LEDs are on, the system is not powered. When a 10BASE2 port is properly connected and the power is on, the red LED is on continuously. When two repeater channels are connected together, one will turn on its red LED, the other its green. There are three fault conditions the repeaters cannot distinguish from a proper connection:

• When the phone wire polarity is reversed in a link, both Repeater ports will turn on the same color LED. The only effect is that the crossed link doesn't function. The rest of the network will continue to operate, but messages that must traverse the crossed link won't be received.

• A short in a cable that is more than 100 feet from a repeater port will not be detected, and that port will have its red LED on; depending on how far the short is from the other repeater, that repeater's port may have its LED either lit red or alternating. The rest of the network will continue to operate, but messages that must traverse the shorted link won't be received.

• There are too many 10BASE2 terminations. The network must have one (only) terminator at the far end. Some repeaters and network interface cards contain an internal 50 ohm terminator that is connected to the 10BASE2 leg by means of an on-board jumper. If this terminator is in place and there is a second external terminator on the coax leg (for a total of 3), the repeater will not allow the connection to become active. Make sure that only one terminator is on the coax and that it is at the far end of the segment. Disable any terminators in the middle of the segment, leaving only one at the far end.

2. When a port's LEDs alternate between red and green, the port is not properly connected. The LEDs on a port alternate when:

• There is nothing connected to the jack.

- A length of phone wire is connected, but there is nothing at the other end of the line.
- A length of phone wire is connected, but there is a short circuit in the cable at or near the repeater.
- The polarity of the phone wire connecting two Repeaters is reversed (pin 3 of one jack is connected to pin 4 of another) and the wire is less than 150 feet (45.7 m) long.
- One repeater is not powered.
- There is a break in the wire.

3. The LEDs on a 10BASE2 port alternate when:

- There is nothing connected to the jack.
- A length of 10BASE2 coax is connected, but there is no terminator at the far end of the segment.
- A length of 10BASE2 coax is connected, but there is a short circuit in the cable at or near the repeater.
- A length of 10BASE2 coax is connected, but there is a break in the wire.

When the LEDs alternate, the corresponding port is automatically disconnected from the network. This enables the remaining portions of the network to keep functioning until the problem is corrected.

5.2 Troubleshooting

Symptom: No LEDs are on, and the network does not operate.

Cause: The repeater is not powered.

Action: Check that the external power supply is plugged into the repeater and into a working wall outlet. Verify that the outlet is functional using another electrical device such as a lamp. If the outlet is OK and the repeater still does not work, call Technical Support.

Symptom: The LEDs continue to flash even when a cable is attached.

Causes: If any of the following causes exist simultaneously, you must correct all of them for the port to work. The repeater automatically disconnects the offending channel, so it is not necessary to shut down the network to repair a problem.

Cause: 1. There is nothing connected to the jack.

Action: 1. Check that the cable is completely plugged in and the modular plug is properly attached.

Cause: 2. A length of phone wire is connected but there is nothing at the far end of the line.

Action: 2. Verify that there is not a break in the cable by measuring the cable length from each end. (Short one end and measure the resistance from the other end. Repeat from the other end as explained in **Chapter 3**.) The resistance should be the same on both readings.

Cause: 3. The repeater at the far end is not powered.

Action: 3. Check the power supply of the other repeater.

Cause: 4. A length of phone wire is connected but there is a short circuit in the cable at or near the repeater.

Action: 4. Breaks and shorts tend to occur at or near connections. A short in the phone wire can be located using an ohmmeter. The distance to the short in feet is approximately the resistance times 20. Note that more often than not the problem will be at a connection; check connections first.

Symptom: A single device in a coaxial run with all the other devices on the run working does not communicate.

Cause: 1. The device is not connected to the coaxial leg.

Action: 1. Verify that the coax loops into the device. It may not have been attached, the connection may have come loose, or the T-connector may be defective.

Cause: 2. There is a problem with the hardware or software in that particular unit.

Action: 2. Swap the device with another known working unit from elsewhere on the leg. If the problem follows the device, have it repaired or replaced.

Symptom: A repeater port connected to another repeater has its red LED on, but there is no communication between the repeaters.

Cause: 1. The wires are crossed.

Action: 1. Check the LED on the other repeater. If it is red, unplug the phone wire at one repeater and reverse the crossed wires.

Cause: 2. The wires are shorted at a point more than 100 feet (30.5 m) from either repeater.

Action: 2. Check the LED on the other repeater. If it is red, unplug the phone wire and using an ohmmeter, check for a short and repair as necessary.

Symptom: The Repeater LEDs flash red and green but no data passes through the line.

Cause: 1. There is a Bridge tap.

Action: 1. Make certain the run extends between two end points only and does not branch off to a third point.

Cause: 2. The connection (or part of it) was made with shielded twisted pair.

Action: 2. Reconnect the units using unshielded twisted pair.

Cause: 3. The connection (or part of it) was made with silver-satin cable.

Action: 3. Make sure no silver-satin patch cables are used. Reconnect the units with unshielded twisted pair.

Cause: 4. Voice-rated (not data-rated) protection devices have been used.

Action: 4. Only data-rated surge-protection devices will work properly. Voice-rated devices typically load the lines preventing high-speed data transmission. Replace any voice-grade surge protectors with data-rated devices.

Cause: 5. The distance of the run exceeds the product specifications.

Action: 5. Break the run into two runs, or reroute the run to a distance within the 1500 ft. (457.2 m) maximum specification.

Symptom: A repeater port connected to another repeater has its green LED on, but there is no communication between the repeaters.

Cause: 1. The wires are crossed.

Action: 1. Check the LED on the other repeater. If it is green, unplug the phone wire at one repeater and reverse the crossed wires.

5.3 Hints and Tips

The following information will help you avoid problems with your Long

Distance Repeaters.

- Some repeaters and network interface cards contain an internal 50-ohm terminator that is connected to the Thin Ethernet leg by means of an on-board jumper. If this terminator is in place and there is a second, external terminator and a coax connection on the coax leg (for a total of 3), the repeater will not allow the connection to become active. Make sure that only one terminator is on the coax and that it is at the far end of the segment. Disable any terminators in the middle of the segment, leaving only one at the far end.

- In networks with 10BASE5 (thick Ethernet) backbones, take care to ensure that the MAU (Media Access Unit) feeding the Repeaters have the SQE (Signal Quality Error) test disabled. If it is enabled, all equipment on the UTP portion of the net will operate very slowly, but the rest of the equipment will be unaffected.

- Do not use flat telephone cables for patch cables or any other network connection for two reasons:

1. Some devices are quite sensitive to EMI and RFI noise. If you use flat untwisted wire—even short patch cables— you may experience very poor performance.

2. Flat telephone cables have their polarity reversed; any device on a leg with the wrong polarity won't communicate with the repeater. Replace all flat cables with twisted ones.

- Be sure the protection devices you are using are compatible with high speed data networks. For further information on precautions and protection devices, refer to **Chapter 3**. If you have any other safety concerns or questions, stop and call Technical Support for assistance.

- Trust and use the Repeater LEDs. They will prevent problems from occurring and greatly reduce troubleshooting time and effort. If you have read this chapter and still cannot solve a problem, please call Technical Support.

6. Glossary

Asynchronous Communication—A data transmission method in which a packet of data is sent, and the receiver stations synchronize their clocks to the timing embedded in the packet.

AUI Port—Attachment Unit Interface port for connecting additional network hardware.

BNC Connectors—The connectors for 10BASE2 thin coax cable are BNC connectors. The BNC connectors on each end of thin coax cable connect to T-connectors, barrel connectors, and other network hardware.

BNC T-Connectors—The top of the T in a BNC T-connector functions as a barrel connector and links two lengths of 10BASE2 cable. The third end is used to connect to network interface cards, etc.

BNC Terminators—50-ohm terminators are used to terminate the 10BASE2 thin coax network at its ends. You can attach a BNC terminator to one plug on a
T-connector if you will not be attaching a length of cable to that plug; you may also need to use a BNC terminator with a grounding wire to ground the network.

Backbone—A central network that connects several other, usually lower-bandwidth networks, so those networks can pass data to each other.

Balun—A device that connects a BALanced line to an UNbalanced line, for example, a twisted wire pair to coaxial cable. A balanced line is one in which both wires are electrically equal. In an unbalanced line, such as coaxial cable, one line (the central conductor) has different physical properties from the other (the surrounding concentric conductor).

Bandwidth—The information-carrying capacity of a communications system, generally measured in the number of bps (bits per second). The higher the bandwidth of a system, the more information it can carry per second. Ethernet products operate at 10 Mbps (10 million bits per second).

Bridge—A device that connects two or more same protocol networks so that devices on these networks can communicate with each other. The bridge ascertains how to pass packets between networks based on node address information, on filtering criteria established by the network manager, or on both types of information.

Bus—In a network, a single, shared communications link (often a linear run of cable) that connects all nodes. Although all network devices have equal access to messages broadcast along the bus, each device listens for only the messages directed to its unique address.

Crosstalk—The electrical interference between signals transmitted on adjacent wires.

Coaxial Cable—This cable consists of an inner core of wiring that conducts electrical signals, surrounded by an outer conductor that is the return path. An outer covering protects the wiring.
10BASE2 Ethernet systems use
50-ohm RG58A/U coaxial cable.

Concentrator—Some LAN implementations use concentrators, or access units, that allow network devices to be interconnected through a central point. Attaching devices through a central concentrator typically simplifies the maintenance of the LAN. When connecting a 10BASE-T twisted-pair network, refer to the concentrator manual for specific cabling guidelines.

Ethernet—A local are a network (LAN) specification that uses baseband signaling at 10 Mbps, provides multiple access to the transmission medium, and requires that a transceiver be able to detect the presence of another transceiver (or collision detection). These three requirements are abbreviated as Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

Gateway—A device or program that connects two LANs that use different protocols and translates between these protocols, allowing devices on the two networks to communicate with each other.

Hub—A device that extends the maximum physical length of a network by receiving and then retransmitting signals among network segments. A hub provides the central connecting point in a star network topology.

IEEE—Institute of Electrical and Electronics Engineers. Members of the IEEE are drawn from the industry and work together to establish industry standards. The IEEE 802 committee has issued many definitive documents on local area network standards.

Internet—Two or more networks that have similar or dissimilar protocols, connected by gateways or routers.

Interoperability—The ability to exchange information in a network that contains computers and additional devices that have dissimilar operating systems or protocols.

Jabber—When a particular interconnection on a line will not stop transmitting.

Jumper—An electrical conductor that connects two points in a circuit board is called a jumper. Jumpers are used to select different options

(address, enabling and disabling functions, etc.).

LED—Light emitting diode.

Link Integrity Test—A signal sent on a line to verify connection when there is no traffic on the line.

Local Area Network (LAN)—A computer-based communications system confined to a defined local area is a LAN. The network may include a combination of personal computers, terminals, printers, and other attached devices.

MAU—Media Access Unit. A device used to connect a network node to a network segment. Also known as Transceivers.

Network Interface Card (NIC)—An add-in card or external box that connects a computer to a network. The card or box has a connector for attaching the network cable. Sometimes the network interface card/controller (or NIC) is called the interface card. Different types of computers require different interface cards. The connectors are different sizes to accommodate the cables of different networks.
Node—An addressable device on a network, such as a printer, fax, modem or computer.

Ohm—An electrical unit of measurement used to measure the resistance of a transmission medium to the flow of electrons (a current) through the medium.

Ohmmeter—A device that measures the resistance of electrical current flowing through a wire.

Packet—A group of bits, including address, data, and control elements, that are switched and transmitted together.

Peer—A device treated as the equal of another device on the network. Networks that let other nodes communicate with each other as equals are called peer-to-peer networks.

Protocol—A set of rules for exchanging information within a specific type of network, such as Ethernet or Token Ring.

Punchdown Block—A wiring device used by phone companies and network installers for connecting many wires together in one location. A typical punchdown block (type 66 block) has fifty rows of four contacts, or pins. Wires are pushed, or "punched down," onto a pin to make electrical contact using a special tool called a punchdown tool.

Repeater—A network device used to amplify and retransmit LAN packets.

Retiming Repeater—A repeater that reclocks an electrical signal and amplifies the signal for retransmission.

Router—A device that connects two networks of different protocols together and maintains addressing information for each network. Workstations can pass information from one network to another by sending the information through the router.

Segment—Any section of cable that is attached to a port of a repeater, bridge, or router.

Server—A computer, workstation, or similar device that provides service(s) to network users or other devices on the network. The three most common types of servers on local area networks are the print server, file server, and electronic mail server.

Shielded Cable—A wire or circuit enclosed by a grounded metallic material. Shielding serves two purposes. First, it keeps outside electrical disturbances from reaching the wire and disrupting the signals passing over it. Second, shielding keeps the cable from emitting radiation that can disrupt radio and television reception, or that can be captured and interpreted by some unauthorized person.

Star Topology—A centralized network with a hub, concentrator, or star controller in the center and all the nodes connected to it. The hub controls access and transmission along all of the connecting lines. Star networks are simple to control because all control takes place at one point.

10BASE5—The original Ethernet medium, an implementation of the Ethernet IEEE standard on twinaxial cable, a baseband medium, at 10 megabits per second. The maximum segment length is 500 meters (1640 feet).

10BASE-T—An implementation of the Ethernet IEEE standard on data grade unshielded twisted pair wiring, a baseband medium, at 10 megabits per second.

10BASE2—An implementation of the Ethernet IEEE standard on thin coaxial cable, a baseband medium at 10 megabits per second. The maximum segment length is just under 200 meters (656 feet).

Terminator—A device attached to the end of a cable to prevent unwanted signals on the line or link. A terminator matches the characteristic impedance of the line, so that signals arriving at the end of the cable do not find an impedance discontinuity and are thus not reflected.

Thick Ethernet Cable—A large, 50-ohm coaxial cable, typically bright yellow in color. Thick Ethernet cable can be purchased in various pre-cut

lengths, with standard N-series male connectors installed on each end. It also is available in bulk, but bulk cable does not include connectors.

Thin Ethernet Cable—This is a special type of coaxial cable (RG58A/U 50-ohm), available in a variety of lengths, with or without connectors installed.

Topology—The physical layout of a network, including the cables and devices. The topology of a network is its road map and can show which devices can communicate directly and which cannot because they don't share a connection path. Typical topologies used on local area networks are the bus, star, and ring.

Transceiver—A device used to connect a network node to a network segment. Transceivers are also known as MAUs (Media Access Units).

Twisted Pair—Twisted-pair cable consists of two insulated strands of copper wire that have been braided. One of the main reasons that this type of cable is being used for local area networks is that it is already installed in many locations.

UTP—Unshielded Twisted Pair (see *Twisted Pair*).