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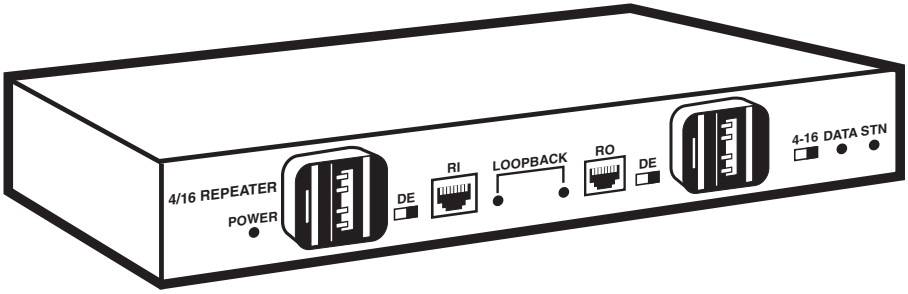
FEBRUARY 1998
LT0010A

4/16 TR Repeater (Copper)



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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 parato 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 equio 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.

Contents

1. Specifications

Standards — IEEE 802.5

Indicators — (5) LEDs: Power, RI Loopback, RO Loopback, Data, Station

Connectors — (2) RJ-45 female, (2) data connectors

Fuse — 1/2 Amp, 250 V slo-blo

Power — Universal 115-230 VAC, 50-60 Hz power supply

Size — 1.7"H x 11.4"W x 9"D (4.3 x 28.9 x 22.9 cm)

Weight — 3.5 lb. (1.6 kg)

2. Introduction

The 4/16 TR Repeater (Copper) lets you expand the geographic distance of a Token Ring network, using either inexpensive Type 3 (unshielded twisted pair) cable or Type 1 or Type 2 cable.

You can use the Repeater to increase the size of the main ring, to lengthen individual station lobes, or both.

2.1 Main Ring Applications

For maximum distances, the Repeaters must be used in pairs. A 4/16 TR Repeater (Copper) regenerates the signals of both the primary and the backup paths of the network, requiring only one repeater in the place of two IBM® repeaters.

A typical Token Ring network using Type 3 cable without repeaters is shown in **Fig. 2-1**. The maximum geographical size of the network is determined according to rules given in Token Ring network planning documents.

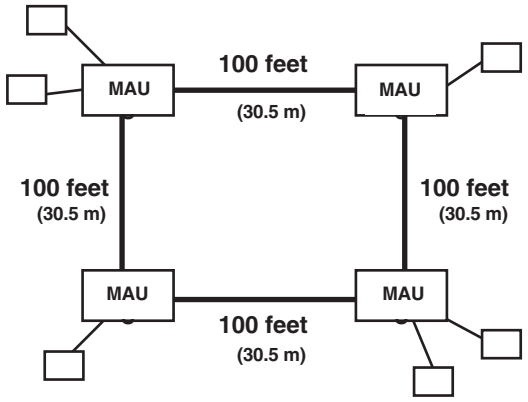

Fig. 2-1. Typical Token Ring Without Repeaters.

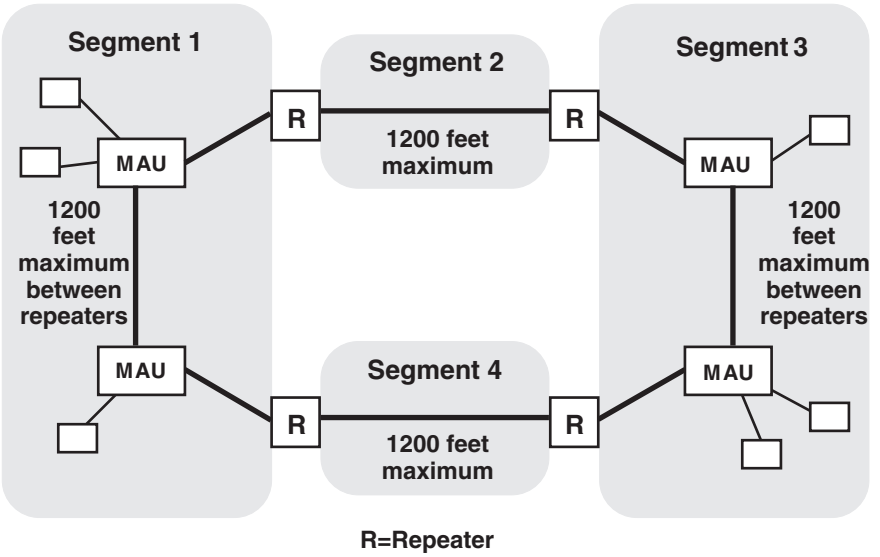

Fig. 2-2. Typical Token Ring Network With Repeaters.

The repeaters have divided the network into four segments. A segment is any part of the network that is between two repeaters.

Generally, each segment of the network may be considered as a ring by itself for distance purposes. For example, in **Fig. 2-1**, the main ring size without repeaters is 400 feet (121.9 m); in **Fig. 2-2**, the same main ring using repeaters is 4800 feet (1463 m). Distances will vary depending on network configuration and cable type.

2.2 Auto Loopback Fault Tolerance

If cable A, B, or C in **Fig. 2-3** breaks, the devices on either side of the cable would wrap the network signal to the backup path, thereby allowing the network to continue operation. Conventional repeaters would not provide this level of fault tolerance.

Fig. 2-3 shows the Repeaters being used with satellite MAUs.

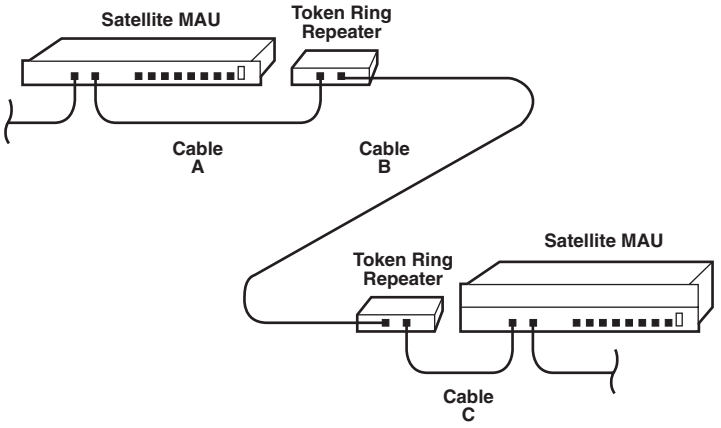

Fig. 2-3. Repeaters Used with Satellite MAUs.

2.3 Lobe Applications

You can use the Repeaters to extend the length of individual station lobes. Extending an individual lobe can be more economical than extending the main ring. In the top example in **Fig. 2-4**, the main ring has been extended using a MAU and two repeaters. In the bottom example, an individual lobe has been extended using one repeater.

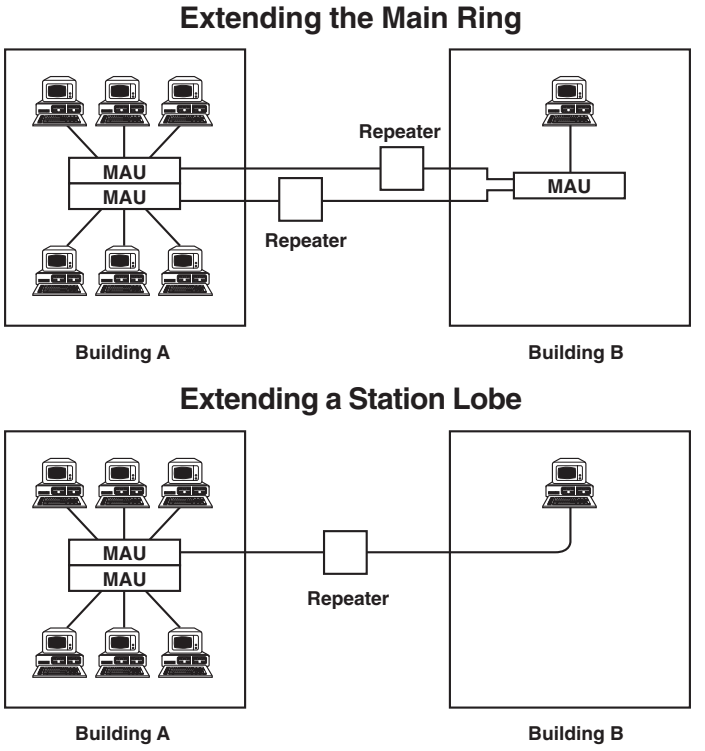

Fig. 2-4. Extending the Main Ring Versus Extending an Individual Lobe.

3. Hardware

The front view of the 4/16 TR Repeater (Copper) is shown in **Fig. 3-1**.

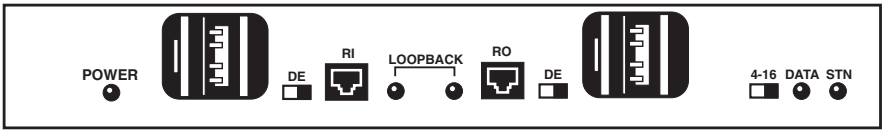

Fig. 3-1. Front View of the 4/16 TR Repeater (Copper).

3.1 RI and RO Ports

The 4/16 TR Repeater (Copper) has two RJ-45 connectors and two data connectors on the front panel labeled RI and RO. For individual pin functions, see **Section 3.4, Connectors**.

When the repeaters are used in a main ring application, the RI (ring in) connector will be attached to a cable from the ring out port of an MAU or of another repeater.

3.2 D E Switches (Auto Loopback)

There are two slide switches on the Repeater's front panel labeled (RI/RO) D E, one located to the left of the RI port and the other located to the right of the RO port. These switches control the automatic loopback feature.

The slide switch should be in the **D** (disabled) position when its associated RI or RO port is connected to one of the following:

- a conventional MAU's RI or RO port (in a lobe installation)
- a MAU or satellite MAU station port (in a lobe installation)
- a PC or other network station, or additional Repeaters (in a lobe installation)

The slide switch should be in the **E** (enabled) position when the Repeater's RI or RO port is connected to the RI or RO port of another device that supports its automatic loopback feature. This could be another Repeater (except in a lobe application, where the switch must be in the **D** position), a MAU controller, or a satellite MAU. Setting the switch in the **E** position enables the loopback feature, so if the cable into that port breaks or if no cable is inserted, the Repeater will automatically loop back the port to use the backup path, thereby allowing the network to continue operation.

3.3 4/16 Switch

The 4/16 switch matches the speed of the Repeater to the Token Ring speed, either 4 Mbps or 16 Mbps.

NOTE

The unshielded twisted-pair cable used with the Repeaters must have at least two twisted pairs of wire. This means a minimum of four separate wires, whether or not all four will be used. The cable must be wired straight through, as shown in Fig. 3-3**. Do not connect transmit and receive wires in the same twisted pair;** Fig. 3-3 **shows how to avoid this.**

If the repeaters will be used between a MAU controller and a MAU satellite MAU, two extra conductors (one extra twisted pair) must also be provided. See the next page.

A, B, C, and D represent the four center pins of an RJ45 or RJ11 connector.

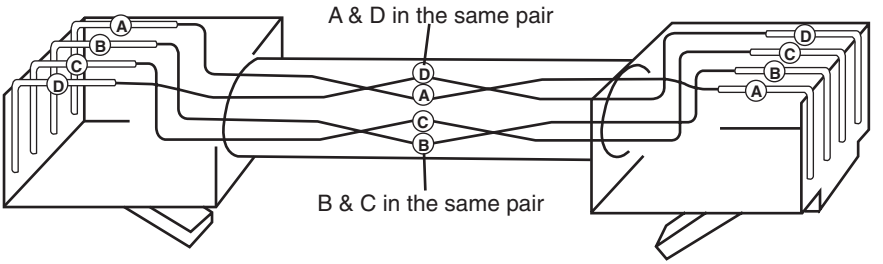

Fig. 3-3. Straight-Through Wiring for Type 3 Cable and Modular Connectors.

3.4 Connectors

3.4.1 RJ-45 Connectors

Fig. 3-2 shows the transmit and receive pin in the female RJ-45 connectors on the Repeater front panels.

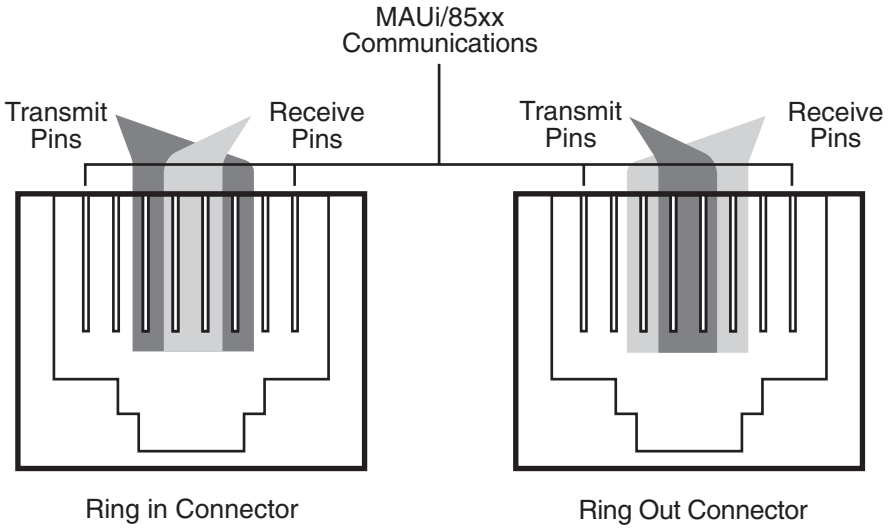

Fig. 3-2. RJ-45 Connectors.

We recommend using Type 3 cable that conforms to the specification listed below.

Number of Pairs — 2, twisted

Shield — Longitudinal polyester-aluminum foil overshield

Wire — 24 AWG

Mutual Capacitance — 14.5 pF/ft.
DC Resistance — 25.7 ohms/1000 ft.

Characteristic Impedance — 600 ohms at 1 KHz; 100 ohms at 1 MHz

Attenuation — 0.42 dB/1000 ft. at 1 KHz; 7.5 dB/1000 ft. at 1 MHz

Use With Satellite MAUs

If a Repeater will be used between a MAU controller and a satellite MAU, two extra conductors must be provided in the cable and connectors to carry off-LAN communication between the MAU devices. RJ-45 male connectors must be used (not RJ-11 male connectors). The cables must be wired straight through, the same as the network conductors. See **Fig. 3-4**.

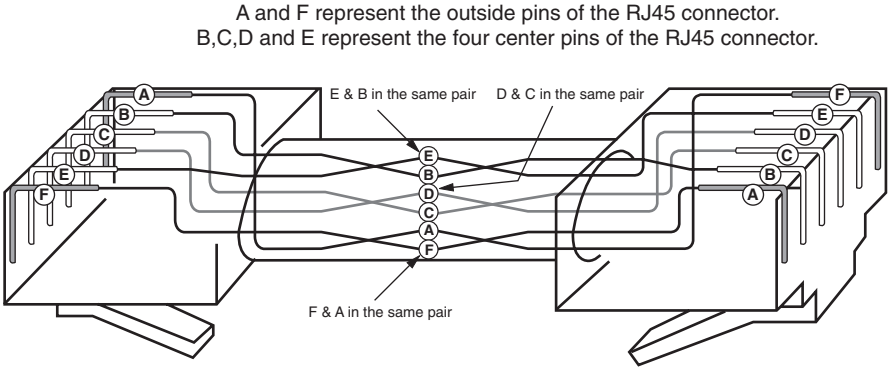

Fig. 3-4. Straight-Through Wiring for Type 3 Cable and Modular Connectors When Used with Satellite MAUs.

3.4.2 Data Connectors

Fig. 3-5 shows the transmit and receive pins of the data connectors on the front panel of the Repeater.

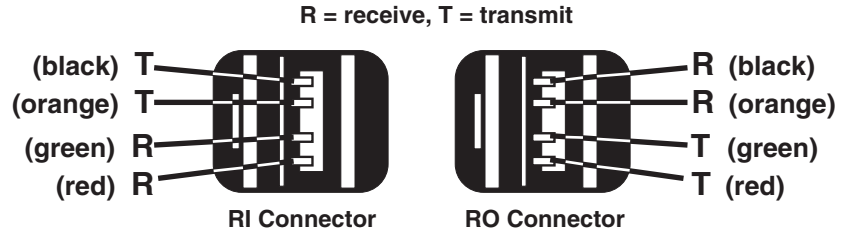

Fig. 3-5. Data Connector Transmit and Receive Pins.

The cables used between repeater and MAU and between repeater and station must be "straight-through," as shown in **Fig. 3-6**.

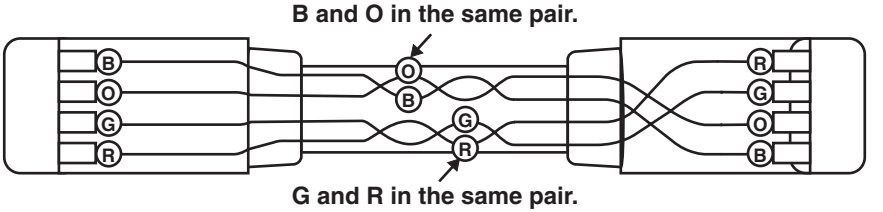

Fig. 3-6. Straight-Through Data Connector and Cable Wiring.

3.5 LEDs

This section covers LED functions for the repeater. **Fig. 3-1** illustrates the LEDs.

The **Power** LED (green) lights when the repeater's power cord is plugged into an electrical outlet.

The **Data** LED will be green under normal conditions. When a network fault (such as a wire break) is sensed, it will be red. If it flickers between red and green it means that a signal is being received, but it is corrupted or invalid.

RI Loopback — If the automatic loopback circuit is enabled for the RI port (this is controlled by the D E switch for that port), a fault condition on the Ring In side will cause the RI port to loop back (wrap), and this red LED will indicate the condition by turning on.

RO Loopback — If the automatic loopback circuit is enabled for the RO port (this is controlled by the D E switch for that port), a fault condition on the Ring Out side will cause the RO port to loop back, and this red LED will indicate the condition by turning on.

The **Station** LED (green) lights only when the repeater is used on a station lobe. The difference between the signal on the main ring and that on a station lobe is that the lobe signal has an additional voltage, known as a phantom voltage, generated by the station. When it is sensed by the MAU, a relay in the MAU is opened to allow the station to insert onto the ring. When a 4/16 TR Repeater (Copper) is installed on a lobe, the Station LED will light when it senses the phantom voltage from the station.

4. Installation

4.1 Installation on the Main Ring

This section contains installation procedures for the following:

- Networks using only passive MAUs.
- Networks using only extended-distance MAUs.
- Networks with mixed passive and extended-distance MAUs.
- Using 4/16 TR Repeaters with the automatic loopback feature enabled.
- Special applications.

4.1.1 Network Planning

A floor plan of the area in which your network will operate is vital for planning, so draw a detailed map of the installation. You should know where you want all MAUs, attaching devices, and repeaters to be located, and what wire gauge or cable type the main ring and station lobes will use.

The maximum number of attaching devices on a single ring using Category 5 or Type 3 cable is 72, minus the number of repeaters. The maximum number of attaching devices on a ring using Type 1 or Type 2 cable is 260 minus the number of repeaters. A maximum of eight repeaters may be used on a single ring.

You can either rack-mount or wall-mount the repeaters or place them on a shelf or table. Wall-mounting ears and rubber feet for table mounting are included with each repeater.

4.1.2 Non-Mixed Network

The following procedure assumes you do not have a mixture of passive and extended distance MAUs in your network. For mixed networks, see **Section 4.1.3**.

Planning a Non-Mixed Network

1. Place the first repeater at the input to the wiring closet that contains the largest number of MAUs.

2. Place the next repeater as far from the first repeater as possible without exceeding the maximum drive distance. You may also place it at less than the maximum distance from the first repeater for expansion purposes. Then later, if lobes need to be longer or if another MAU needs to be added, it will be possible with a minimum of effort and expense.

   See the following steps to calculate drive distances.

3. Calculate the drive distance of each segment separately (information on segments is given in **Chapter 2, Introduction**). The drive distance must be less than or equal to the distance given for your configuration and cable type in the appropriate chart in **Section 4.3**.

   a. Determine the length of the longest lobe attached to the segment.

   b. Determine the length of the cable between each repeater and its closest MAU.

Situation 1: The longest lobe is longer than each of the cables between the repeaters and their nearest MAU.

The drive distance is the sum of the longest lobe length plus the length of all cables between the first and last MAU in the segment. Exclude the length of patch cables. Compare this sum with the appropriate chart in **Section 4.3**. It must be less than or equal to the distance given for your configuration. When planning is complete, go to **Section 4.2, Completing the Main Ring Installation**.

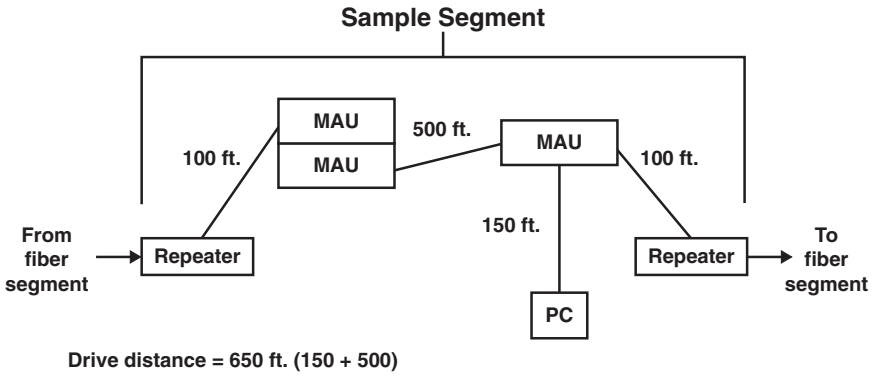

Fig. 4-1. Situation 1.

Situation 2: The longest lobe is shorter than one or both of the cables between the repeaters and the nearest MAU.

The drive distance is the sum of the longer of the two cable lengths between the repeaters and their nearest MAU plus the length of all cables between the first and last MAU in the segment. Exclude patch cable lengths. Compare this sum with the appropriate chart in **Section 4.3**. It must be less than or equal to the distance given for your configuration. When planning is complete, go to **Section 4.2, Completing the Main Ring Installation**.

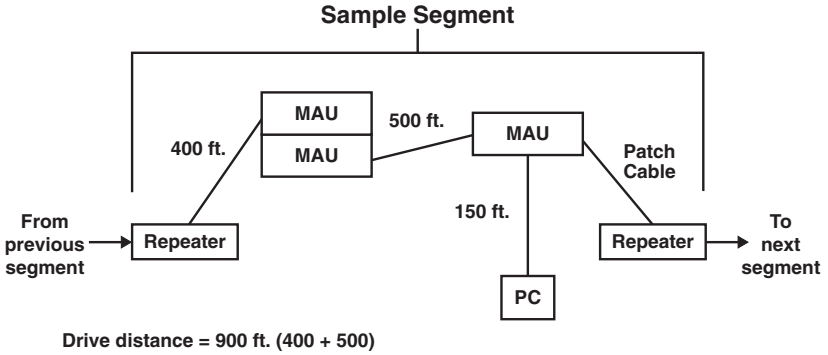

Fig. 4-2. Situation 2.

Situation 3: There are no MAUs in the ring segment.

The maximum drive distances between repeaters are listed in **Section 4.3, Distance Charts**. A maximum of five repeaters may be placed in a row on the same line with no MAUs in between them. When planning is complete, go to **Section 4.2, Completing the Main Ring Installation**.

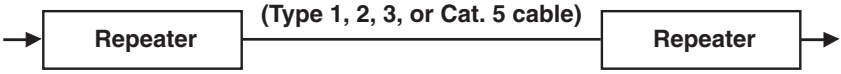

Fig. 4-3. Situation 3.

4.1.3 Mixed Network

A mixed network is one that uses both passive and extended-distance MAUs. This type of configuration requires different calculations for the drive distances of segments.

Planning a Mixed Network

Calculate the drive distance of each mixed segment separately, as follows:

1. Determine the length of the longest lobe attached to a passive MAU in the segment. Don't count lobes attached to extended distance MAUs.
2. Determine the length of the cable between each repeater and its closest MAU. It doesn't matter whether the closest MAU is passive or extended-distance.

Situation 1: The longest lobe is longer than either of the cables between the repeaters and the nearest MAU.

The drive distance is the sum of the longest lobe length plus the length of all cables between the first and last MAU in the segment. Exclude the length of patch cables. The distance must be less than or equal to the distance given for your configuration and cable type in the distance charts for passive MAUs in **Section 4.3**.

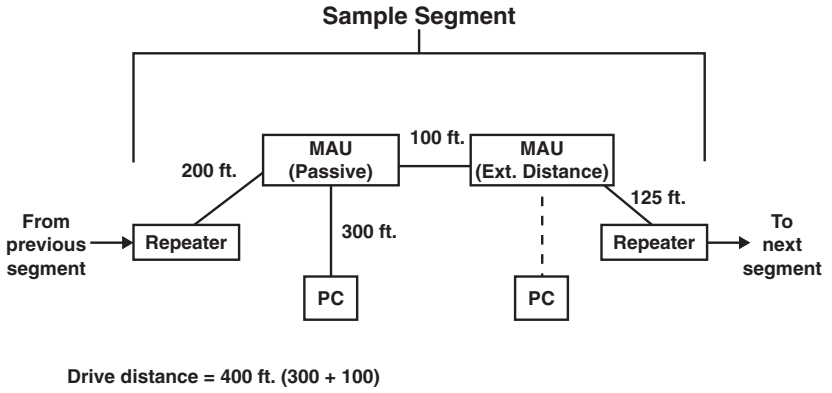

Fig. 4-4. Mixed Network: Situation 1.

Situation 2: The longest lobe is shorter than one or both of the cables between the repeaters and the nearest MAU.

The drive distance is the sum of the longer of the two cable lengths between the repeaters and their nearest MAU plus the length of all cables between the first and last MAU in the segment. Exclude the length of patch cables. The distance must be less than or equal to the distance given for your configuration and cable type in **Section 4.3**.

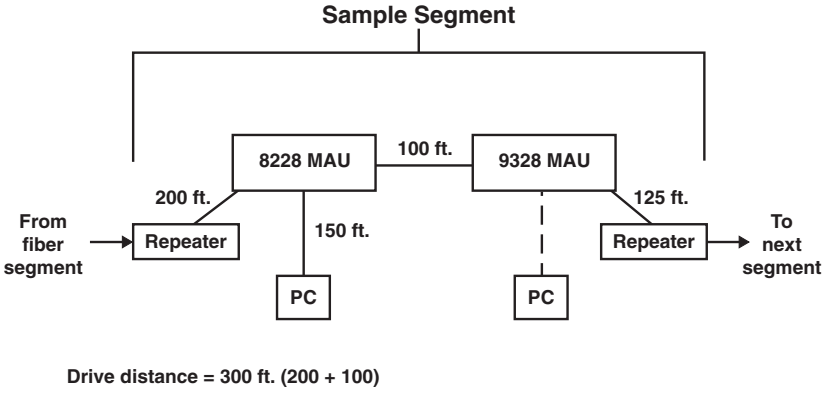

Fig. 4-5. Mixed Network: Situation 2.

3. To find the maximum allowable lobe length for the extended distance MAUs, subtract the drive distance just calculated from the maximum distance for your configuration and cable type in **Section 4.3**. The result is the maximum lobe length as long as it does not exceed the maximum lobe length for your wire gauge or cable type.

4. When planning is complete, go to **Section 4.2, Completing the Main Ring Installation**.

4.1.4 Using Automatic Loopback with the 4/16 TR Repeater (Copper)

The 4/16 TR Repeater (Copper) incorporates an automatic loopback feature. If the network cable attached to the repeater's RI or RO port breaks when the loopback feature is enabled, the affected port will loop back (wrap) to the backup path, thereby allowing the network to continue operation.

Because conventional MAUs do not support this feature, the feature must be disabled on repeater ports that connect to such devices. Enabling and disabling automatic loopback is done with the D E switches.

However, when there are no intervening conventional MAUs between two 4/16 TR Repeaters, the automatic feature can be enabled.

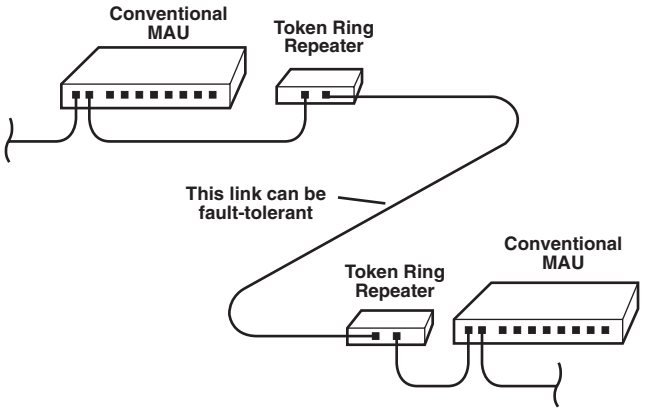

Fig. 4-6. Automatic Loopback Between two 4/16 TR Repeaters.

4.1.5 Special Applications

A small number of applications may require a non-redundant main ring configuration, which is a configuration where the backup path is used during normal operation.

This type of configuration allows MAUs to be great distances apart without having to run an extremely long separate return path that would require additional repeaters.

A maximum of five repeaters may be placed in a row without intervening MAUs.

NOTE

If this type of ring is configured, remember that there will not be a backup path to use if a part of the main ring fails.

Calculate drive distances for the segments in this type of configuration the same as for an ordinary configuration. This includes segments on either end of the ring, such as segments A and E in **Fig. 4-7**.

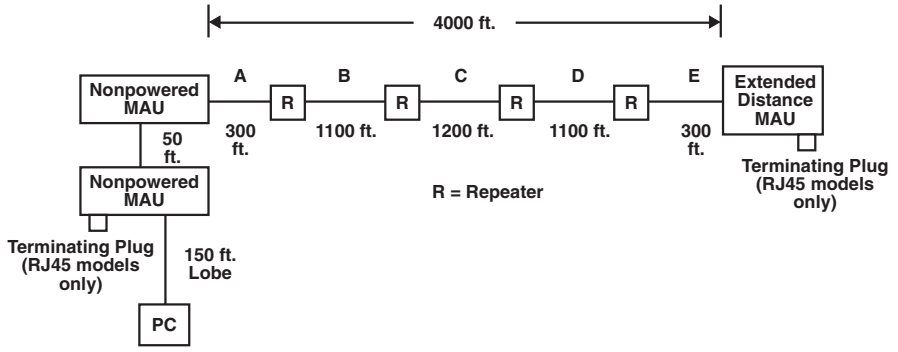

Fig. 4-7. Non-Redundant Example of a Main Ring.

Terminating Plug

On some earlier RJ-45-equipped MAUs, a terminating plug (also called a wrap plug) is required when a redundant main ring is configured.

If a terminating plug is required, it must be inserted into the unused Ring In or Ring Out connector of the MAU on each end of the ring (see **Fig. 4-7**). The plug connects the transmit and receive wires (thus using the backup path) as shown in **Fig. 4-8**.

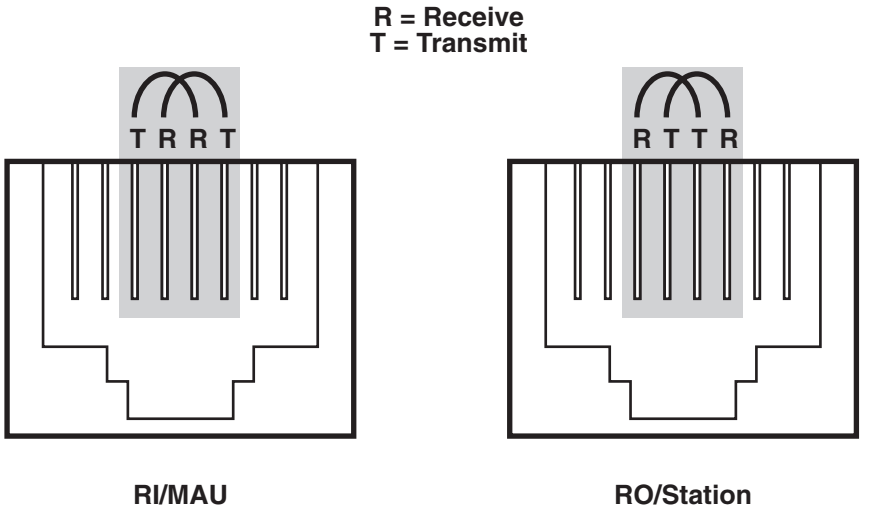

Fig. 4-8. MAU Terminating Plug Function.

Data connector-equipped MAUs do not require terminating plugs. They automatically use the backup path when there are no connectors attached to Ring In and Ring Out.

When planning is complete, go to **Section 4.2, Completing the Main Ring Installation**.

4.2 Completing the Main Ring Installation

Once repeater placement has been fully planned and the proper cabling has been routed to all areas where it is needed, use the following procedure to finish the installation.

1. Make sure the D E and 4/16 switches for the 4/16 TR Repeaters are set properly.

2. Plug the power cords into the backs of all repeaters and into electrical outlets. If powered MAUs are used, make sure their power is on as well.

2a. If the network is not activated, connect the repeaters to the main ring using the Ring In and Ring Out connectors. (Ring In receives the cable from the previous device; Ring Out connects to the cable going to the next device.) Bring up the network and make sure it is operating properly.

2b. If the network is already operating, the repeaters may be installed by attaching Ring In and Ring Out cables to the appropriate connectors, as long as the ring is not broken for more than five to ten seconds.

CAUTION

If the main ring is broken for more than five to ten seconds, the network will be completely disabled and will have to be restarted. Data loss may occur.

3. The installation is complete.

   During normal main ring operation, a Repeater's Power LED will be on, its Data LED will be green, and its Station LED will be off.

LED functions are described fully in **Section 3.5**.

4.3 Distance Charts

The distance charts are used with the installation procedures earlier in this chapter.

Table 4-1. 4/16 TR Repeater (Copper) at 4 Mbps.

Cable Type	Distance in Feet (Meters)
Category 5	2250 (685.8)
Type 3	1200 (365.8)
Type 1, 2	2400 (731.5)

Table 4-2. 4/16 TR Repeater (Copper) at 16 Mbps.

Cable Type	Distance in Feet (Meters)
Category 5	800 (243.8)
Type 3	450 (137.2)
Type 1, 2	1000 (304.8)

4.4 Installation on a Lobe

4.4.1 Planning the Lobe Installation

A floor plan of the area in which your network will operate is vital for planning, so draw a detailed map of the installation. You should know where you want all MAUs, bridges, attaching devices, and repeaters to be located, and what wire gauge or cable type the network and lobes will use.

The maximum number of attaching devices on a single ring using Category 5 or Type 3 cable is 72, minus the number of repeaters. The maximum number of attaching devices on a ring using Type 1 or Type 2 cable is 260 minus the number of repeaters.

A maximum of eight repeaters may be used on a single ring.

The repeaters may be either rack-mounted, wall-mounted, or placed on a shelf or table. Wall-mounting ears are included with each repeater.

1. Decide which lobe or lobes will require one or more repeaters.

2. The maximum distance between a MAU and a repeater on a lobe is equal to the maximum lobe length for an ordinary attaching device or station, whatever distance that may be for the specific ring.

3. The maximum distance between a repeater and a station depends on ring speed and cable type. See **Section 4.3, Distance Charts**.

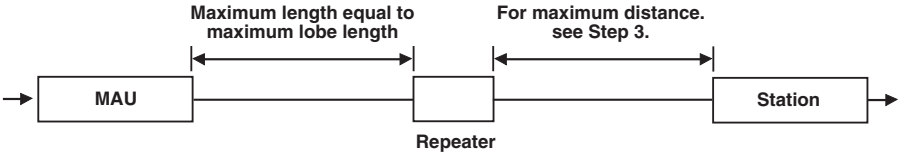

Fig. 4-9. Maximum Distances.

4.4.2 Completing the Lobe Installation

1. Make sure the D E switches are set in the D (disabled) position, and that the 4/16 switches are set to the appropriate network speed.

2. Place all devices in their proper places.

3. Turn off the power to the affected PC or station.

4. Connect all cables, and connect all repeaters to a power source.

5. Turn on the PC or station and make sure that it is set up to request network access.

6. The installation is complete.

During normal lobe operation, a 4/16 TR Repeater's Power LED will be on, its Data LED will be green, and its Loopback LEDs will be off. If the PC is turned on and requesting network access, the station LED will be on.

LED functions are described fully in **Section 3.5**.