

# **DEREP ETHERNET REPEATER**

**Technical Manual**  
EK-DEREP-TM.001



# Networks • Communication

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## DEREP Ethernet Repeater

### Technical Manual

Digital Equipment Corporation

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## PREFACE

This manual describes in detail the installation requirements, theory of operation, and servicing procedures for the DEREPEthernet Repeater.

Other publications that support the DEREPEthernet Repeater are:

- *Ethernet Installation Guide* (EK-ETHER-IN)
- *DEREP-AA Local Ethernet Repeater  
Installation/Owner's Manual* (EK-DEREP-IN)
- *DEREP-RA Remote Ethernet Repeater  
Installation/Owner's Manual* (EK-DERRP-IN)
- *Ethernet Transceiver Tester  
User's Manual* (EK-ETHTT-UG)
- *H4080 User's Manual* (EK-H4080-UG)



## CHAPTER 1 INTRODUCTION

### 1.1 FUNCTIONAL DESCRIPTION

The Ethernet repeater (hereafter referred to as the repeater) provides a means of extending Ethernet networks beyond the 500 m (1640 ft) limit of a single Ethernet coaxial cable segment. The repeater resides between two Ethernet cable segments and is connected to them via transceiver cables and Ethernet transceivers. The repeater's main function is to transmit Ethernet signals from one cable segment to another while maintaining synchronization across the network.

Two types of repeaters are presently available: the local repeater and the remote repeater. Both types of repeater perform the same basic function. However, the applications of the two repeaters vary.

#### 1.1.1 Local Repeater

The local repeater is designed to link Ethernet segments separated by not more than 100 m (328 ft). Two 50 m (164 ft) transceiver drop cable lengths make up this distance.

#### 1.1.2 Remote Repeater

The remote repeater links segments separated by not more than 1100 m (3609 ft). This distance is achieved through the use of a fiber-optic link and two 50 m (164 ft) transceiver cables. The fiber-optics cable provides electrical isolation between cable segments and is resistant to electrical interference.

#### 1.1.3 Operator Interface

Operation of the repeater is fully automatic. Once the repeater has been installed and turned ON, no further adjustments are required. The repeater is totally transparent to all Ethernet users.

### 1.2 PHYSICAL DESCRIPTION

This section describes the physical characteristics of the local repeater and the remote repeater.

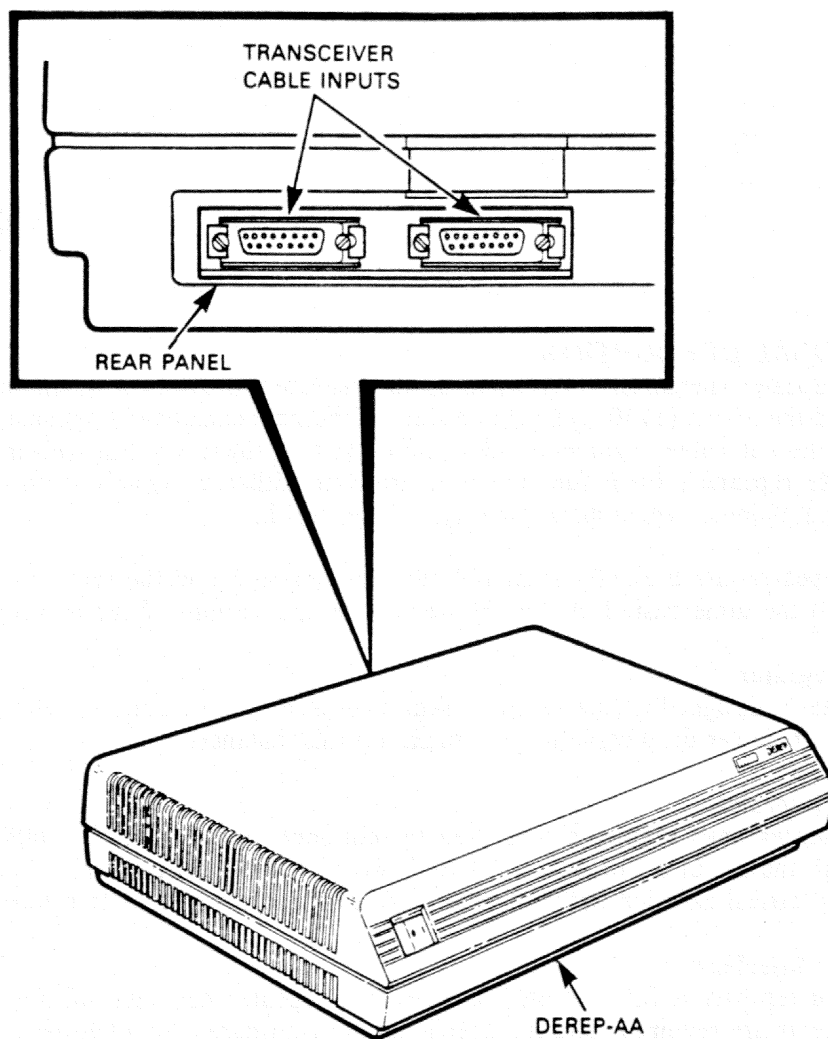
#### 1.2.1 Local Repeater

The local repeater (see Figure 1-1) is made up of a single ac-powered standalone package, and includes the following components.

- Two identical transceiver cable interfaces with each cable interface containing a 15-pin female D-connector with slide latches for locking cables in place.
- Four switches for controlling voltage selection, power ON/OFF, self-test, and standby mode enable. The power ON/OFF switch is located on the front panel. The remaining switches are located on the rear panel of the repeater.
- Sixteen LED indicators that assist in diagnosing repeater and network malfunctions. The indicators are located on the rear panel of the repeater.

#### 1.2.2 Remote Repeater

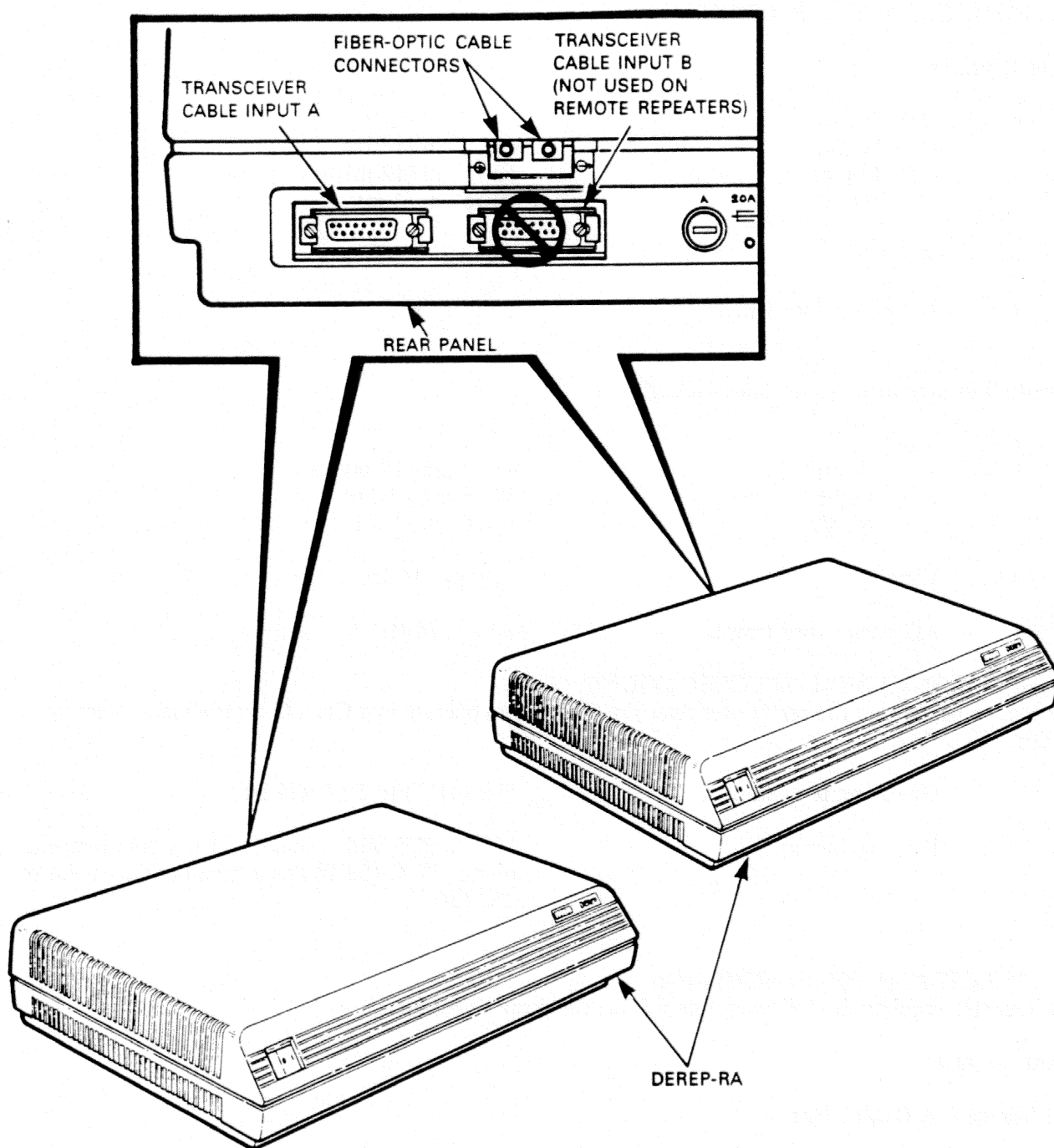
The remote repeater (see Figure 1-2) is made up of two ac-powered standalone packages connected by up to 1000 m (3281 ft) of duplex fiber-optic cable. Each standalone package is identical to that of the local repeater except that a fiber-optic interface is installed inside the repeater unit. This fiber-optic interface overrides the B transceiver cable interface.



MKV84-0049

Figure 1-1 Local Ethernet Repeater





MKV84-0048

Figure 1-2 Remote Ethernet Repeater

### 1.3 PHYSICAL SPECIFICATIONS

#### Local Repeater

- Size
  - Width 45.72 cm (18 in)
  - Depth 30.48 cm (12 in)
  - Height 10.16 cm (4 in)
- Weight 7.26 kg (16 lbs)
- AC power cord length 1.83 m (6 ft)

#### Remote Repeater (each standalone package)

- Size
  - Width 45.72 cm (18 in)
  - Depth 30.48 cm (12 in)
  - Height 10.26 cm (4 in)
- Weight 7.26 kg (16 lbs)
- AC power cord length 1.83 m (6 ft)

### 1.4 ENVIRONMENTAL SPECIFICATIONS

The local repeater and the remote repeater are designed to operate in a Class C environment as specified by DEC STD 102.

- Operating temperature 5°C (41°F) to 50°C (122°F)
- Relative humidity 10% to 90% with a maximum wet bulb temperature of 28°C (82°F) and a minimum dewpoint of 2°C (36°F).

### 1.5 ELECTRICAL SPECIFICATIONS

The repeater requires the following line voltage for proper operation.

#### Local repeater

115 Vac @ 1 A (50/60 Hz)  
or  
230 Vac @ 0.5 A (50/60 Hz)

#### Remote repeater (each standalone package)

115 Vac @ 2.5 A (50/60 Hz)  
or  
230 Vac @ 1.25 A (50/60 Hz)

### 1.6 PERFORMANCE SPECIFICATIONS

Performance specifications are outlined in Table 1-1.

**Table 1-1 Performance Specifications**

Parameter	Minimum	Typical	Maximum	Units
Transmitted preamble	64	64	2500	bits
Transmit clock error	—	—	.01%	—
First transition in to first out	400	500	750	ns
Collision propagation time	400	500	750	ns
Data bit 1 in to bit 1 out delay	5	10*	32†	bits
Last bit in to last bit out delay	2	6	32†	bits
Heartbeat detection window‡	0	—	32000	ns
Packet length	512	—	14144	bits

\*Dependent on preamble length.

†If delay exceeds this value, data is invalid.

‡Measured from the end of data transitions on the “transmit to” side.



## **CHAPTER 2 INSTALLATION**

### **2.1 INTRODUCTION**

This chapter provides the following information.

- Unpacking and installing both the local and remote repeaters
- Procedures for testing the repeater
- Installing and testing standby repeaters

Installation of the repeater is addressed in four basic procedures.

- Preinstallation Considerations
- Unpacking and Inspection
- Installation
- System Testing

### **2.2 TYPICAL INSTALLATIONS**

Under most circumstances, a single local or remote repeater is used to join one Ethernet segment to another. Figure 2-1 illustrates some typical Ethernet repeater installations.

When network reliability is critical, it may be enhanced by installing a standby repeater. Information on installing standby repeaters is included in Section 2.7.

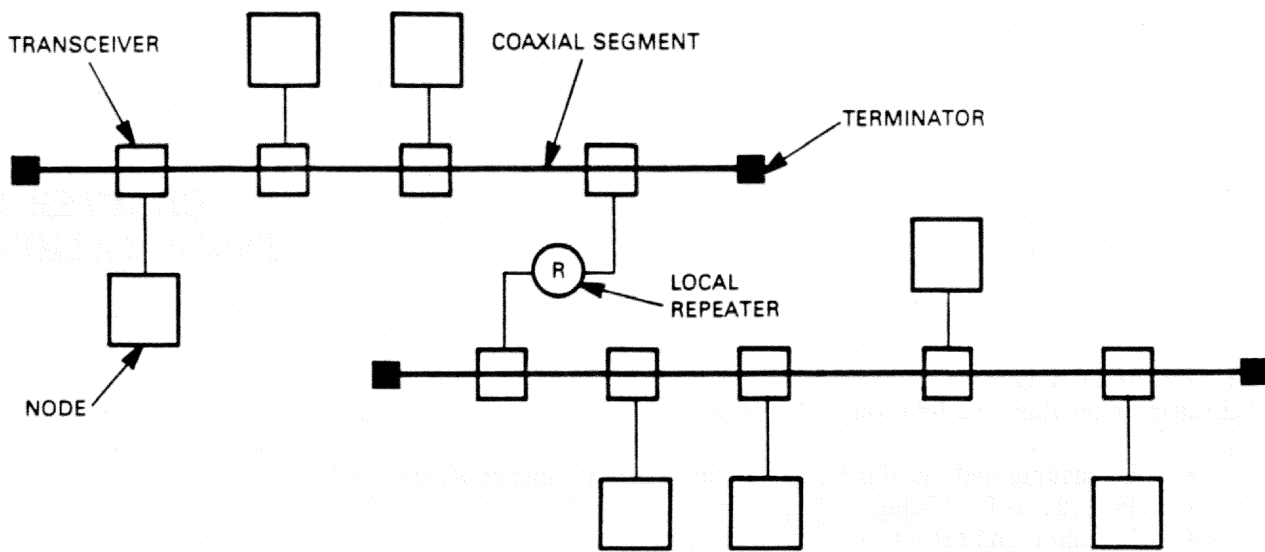
### **2.3 PREINSTALLATION CONSIDERATIONS**

The following should be considered prior to installing the repeater.

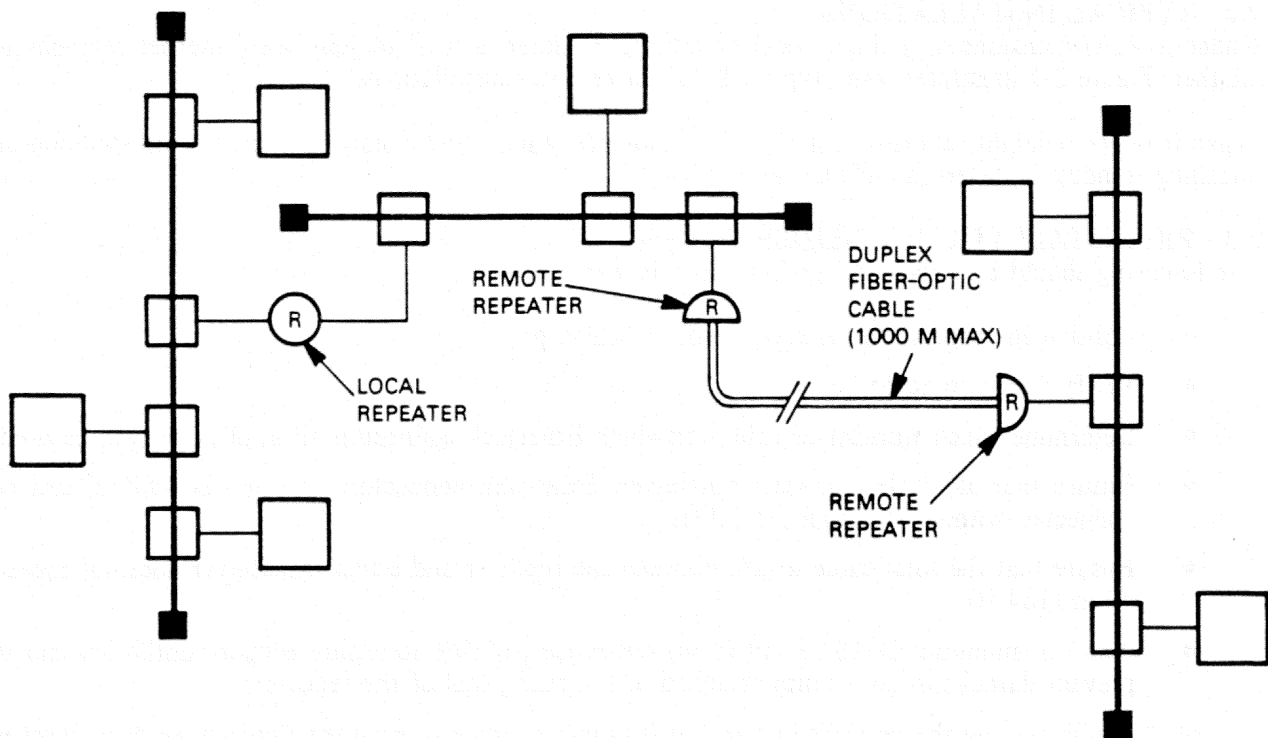
- Position the repeater on a desk, shelf, or tabletop.
- Verify access to ac power.
- Determine which transceiver cables or which Etherjack connectors (if applicable) will be used.
- Ensure that all cables (power, transceiver, Etherjack connector, and/or fiber-optics) can be connected without straining the cables.
- Ensure that the total cable length between the repeater and either transceiver does not exceed 50 m (164 ft).
- Allow a minimum of 10.16 cm (4 in) clearance per side to ensure proper ventilation and to prevent damage to any cables attached to the rear panel of the repeater.
- Avoid locating the repeater in areas such as cable trenches or on the floor where dust or other material is likely to interfere with proper fan ventilation.

#### **NOTE**

**BNE3-\*\* cables for connecting to transceivers or to Etherjack connectors are not supplied.**



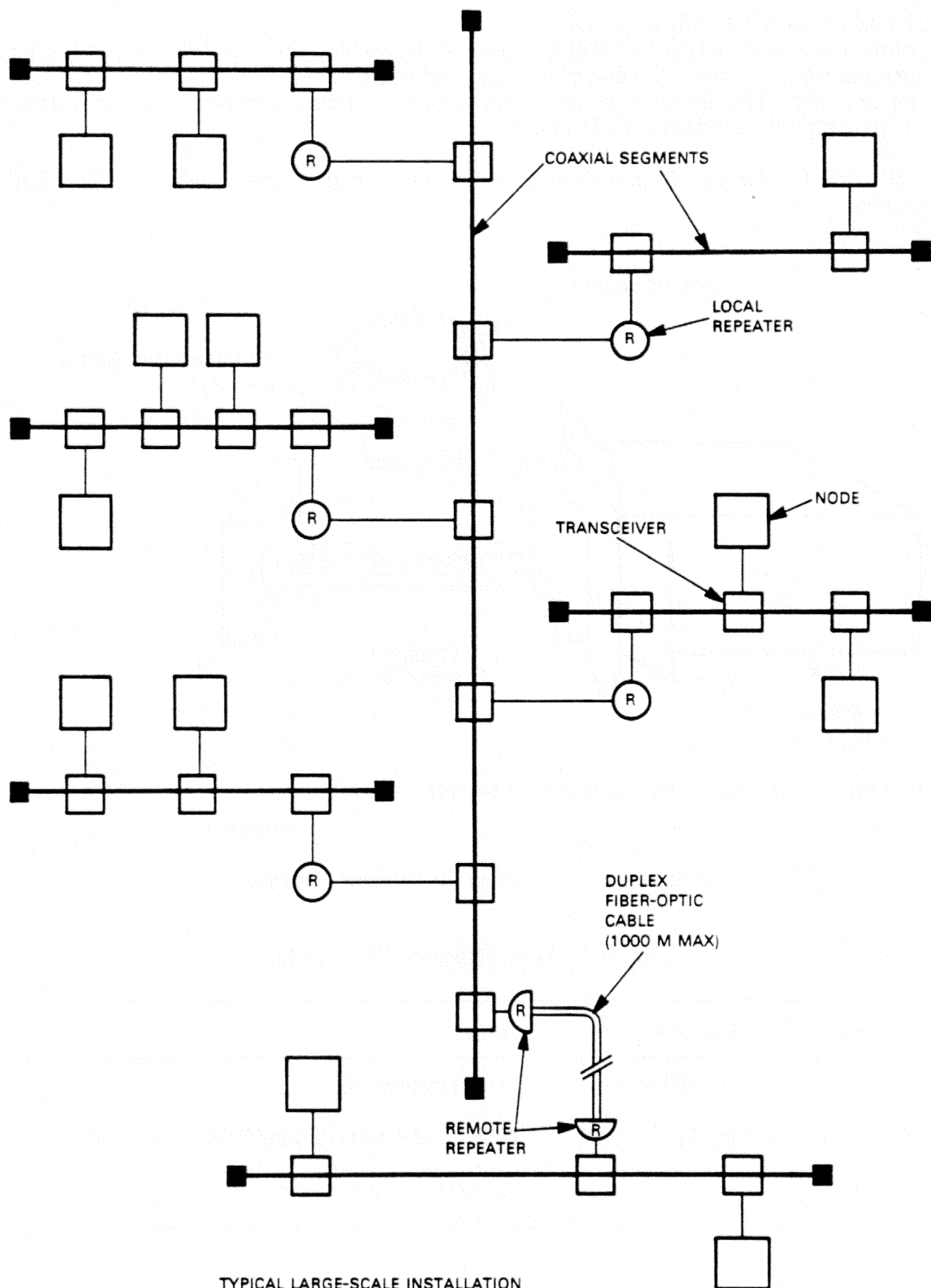
TYPICAL SMALL-SCALE INSTALLATION



TYPICAL MEDIUM-SCALE INSTALLATION

TK-10908

Figure 2-1 Typical Repeater Installations (Sheet 1 of 2)



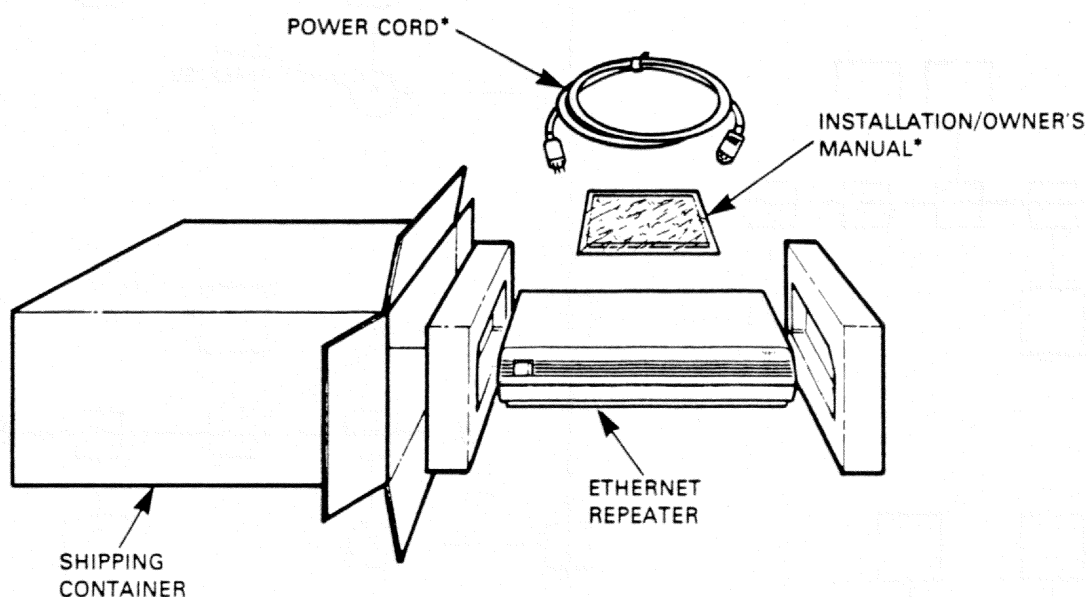
TK-10909

Figure 2-1 Typical Repeater Installations (Sheet 2 of 2)

## 2.4 UNPACKING AND INSPECTION

The Ethernet repeater is packaged according to commercial packing practices. When unpacking, remove all packing material and check the equipment against the shipment list. Figure 2-2 illustrates the correct unpacking procedure. The shipment list for the local repeater is provided in Table 2-1. The shipment list for the remote repeater is provided in Table 2-2.

Inspect all parts for damage. Report damages or shortages to the shipper and notify the DIGITAL representative.



\*IN NON-U.S. VERSIONS, THESE ITEMS MAY BE SHIPPED SEPARATELY

MKV84-0083

Figure 2-2 Unpacking the Ethernet Repeater

Table 2-1 Local Repeater Shipment List

Qty	Part No.	Description
1	DEREP-AA	Local repeater unit
1	EK-DEREP-IN	<i>DEREP-AA Installation/Owner's Manual</i>
1		AC power cord – 1.83 m (6 ft)



**Table 2-2 Remote Repeater Shipment List**

Qty	Part No.	Description
2	DEREP-RA	Remote repeater unit
2	EK-DERRP-IN	<i>DEREP-RA Installation/Owner's Manual</i>
2		AC power cord – 1.83 m (6 ft)

## **2.5 INSTALLATION**

This section provides detailed instructions for installing both the local and remote repeaters.

The instructions in this section assume that the following conditions are met.

- An ac power outlet is within 1.83 m (6 ft) of the location where the repeater is to be installed.
- All necessary cables can be connected to the repeater without straining the cables. Necessary cables may include:
  - Power cord,
  - Transceiver cable(s), and
  - Fiber-optic cables (for remote repeaters only).
- If Etherjack connectors are being used, the total cable distance between the repeater and either transceiver may not exceed 50 m (164 ft).
- The network being configured with the repeater is within allowable limits.
- A duplex fiber-optic cable (applicable to remote repeaters only) has been properly installed. If installed by an external vendor, the cable should be certified (refer to Appendix A of this manual). Also, the cable ends must be properly marked.

### **NOTE**

**Fiber-optic cable is not shipped with the remote repeater.**

### **2.5.1 Local Repeater Installation**

This section describes the installation of a single local repeater.

The power switch is located on the front panel of the repeater. All other connectors, switches, and indicators are on the rear panel (see Figure 2-3).

All cable connections to the local repeater are made on the rear panel of the repeater. Figure 2-4 shows the final cable connections.

Install the local repeater by performing the following steps.

1. Verify that the power switch (on the front panel) is in the OFF position.
2. Verify that the standby mode enable switch is in the "0" (disabled) position.
3. Ensure that the voltage selector switch is set for the correct line voltage.

**NOTE**

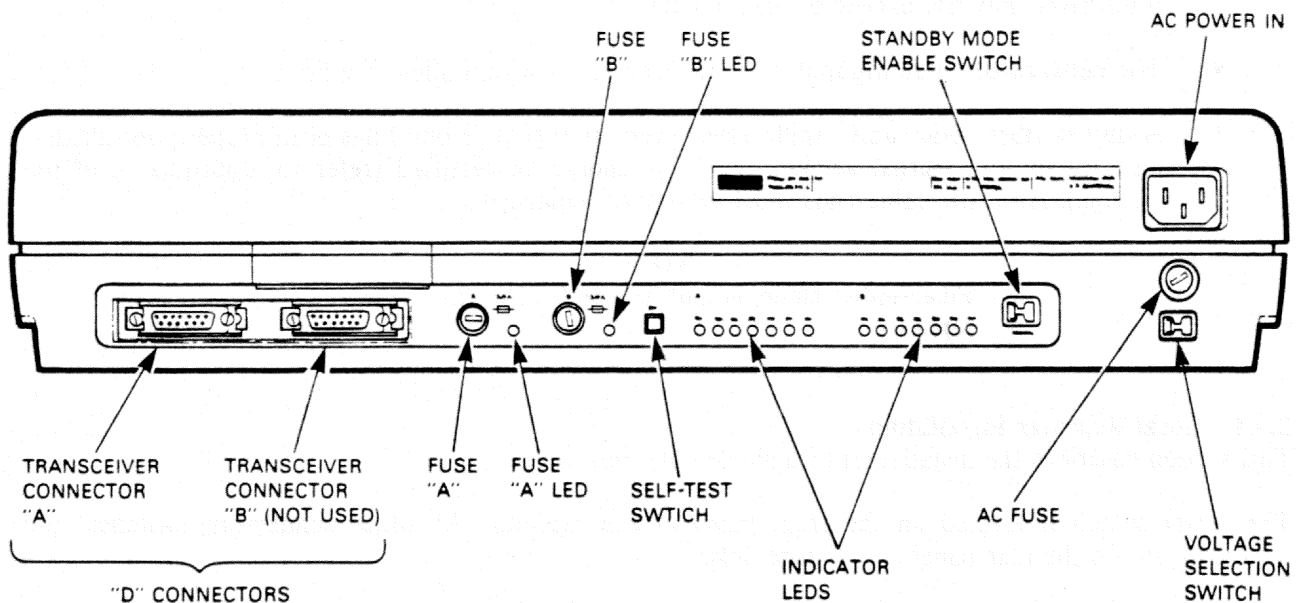
**Units are shipped with 115 Vac selected.**

4. Connect the transceiver cables (or cables from the Etherjack connection boxes) to the repeater as shown in Figure 2-4.
5. Lock the cables in place by sliding the connector latches to the locking position.

**NOTE**

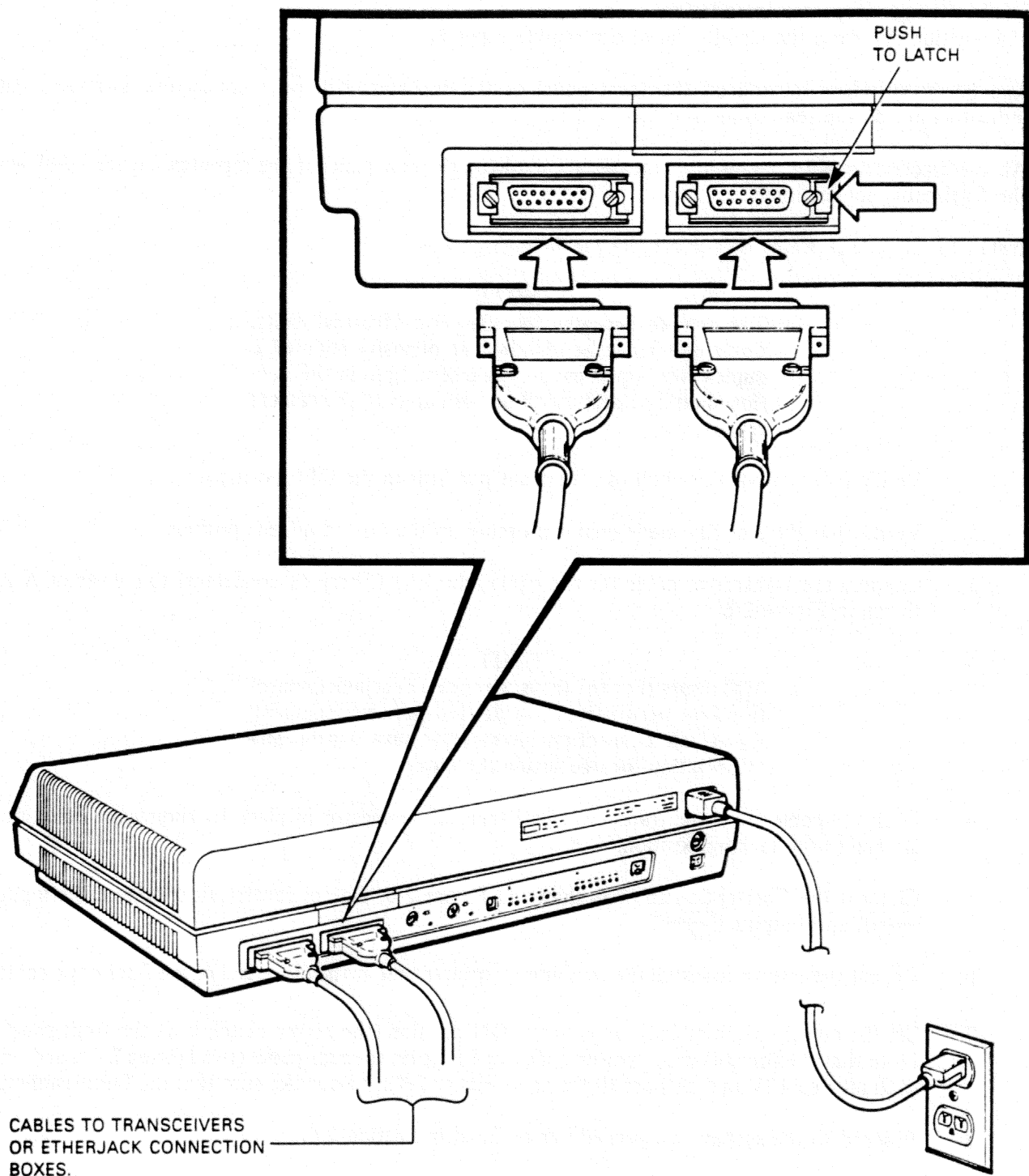
**Make sure that the transceiver or Etherjack connection box used serves the desired network segment. Etherjack connection boxes may have appropriate information located inside the cover.**

6. Set the power switch to the ON position. Note that the four (4) green power indicator LEDs on the rear panel (two labeled 2.0A and one each labeled 12V and 5V) are lit (refer to Figure 2-7). Also make sure that the fan is running.
7. Proceed to the system test procedures outlined in Section 2.6.



TK-10930

Figure 2-3 Local Repeater Rear Panel



CABLES TO TRANSCEIVERS  
OR ETHERJACK CONNECTION  
BOXES.

**NOTE**  
MAKE SURE THAT TRANSCEIVERS  
OR ETHERJACK CONNECTION BOXES  
USED SERVE DIFFERENT NETWORK  
SEGMENTS.

TK-10929

Figure 2-4 Typical Local Repeater Cabling

### 2.5.2 Remote Repeater Installation

This section describes the installation of the remote repeater.

The power switch is located on the front panel of the repeater. All other connectors, switches, and indicators are on the rear panel (see Figure 2-5).

All cable connections to the remote repeater are made on the rear panel of the repeater. Figure 2-6 shows the final cable connections.

Install the remote repeater by performing the following steps.

#### NOTE

**The remote repeater includes two identical units. Each unit must be installed at opposite ends of a duplex fiber-optic cable. The instructions in this section should be performed on both units of the remote repeater.**

1. Verify that the power switch (on the front panel) is in the OFF position.
2. Verify that the standby mode enable switch is in the "0" (disabled) position.
3. Connect the transceiver cable (or the cable from the Etherjack connector) to connector A as shown in Figure 2-6.

#### NOTE

**Make sure that the transceiver or Etherjack connection box used serves the desired network segment. Etherjack connection boxes may have appropriate information located inside the cover.**

4. Lock the cable from the transceiver or Etherjack connector in place by sliding the connector latches to the locking position.
5. Connect the fiber-optic cables as shown in Figure 2-6. Do not reverse fiber-optic cable inputs (→⊗) and outputs (⊗→).
6. Repeat these steps to install the remaining repeater unit at the other end of the fiber-optic cable.
7. Set the power switch of both units to the ON position (the power switch is on the front panel). Note that the four (4) green power indicator LEDs on the rear panel (two labeled 2.0A and one each labeled 12V and 5V) are lit (refer to Figure 2-7). Also make sure that the fan is running.
8. Proceed to the system test procedures outlined in Section 2.6.

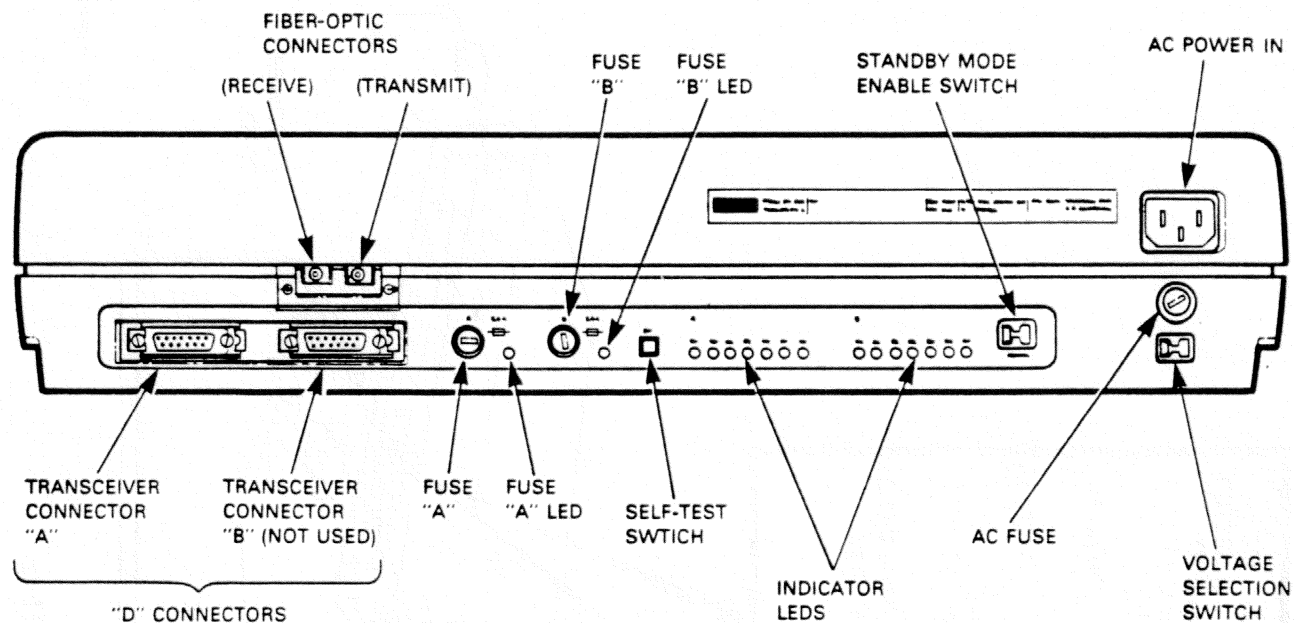


Figure 2-5 Remote Repeater Rear Panel

## 2.6 INSTALLATION TESTING

Installation testing consists of running the repeater self-test.

### NOTE

**No special test equipment is required to verify repeater operation.**

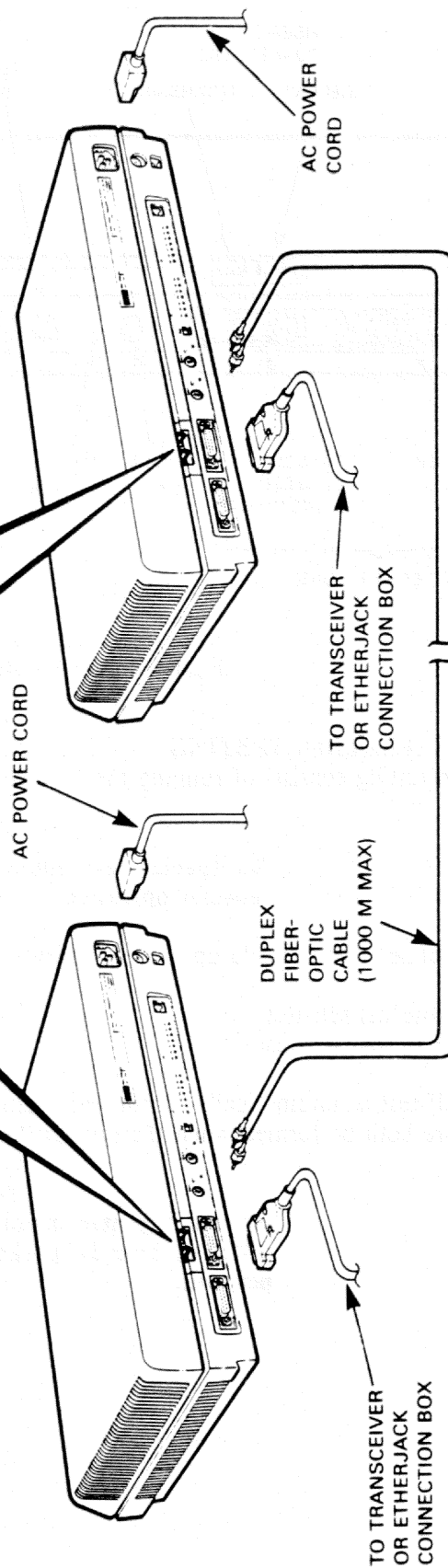
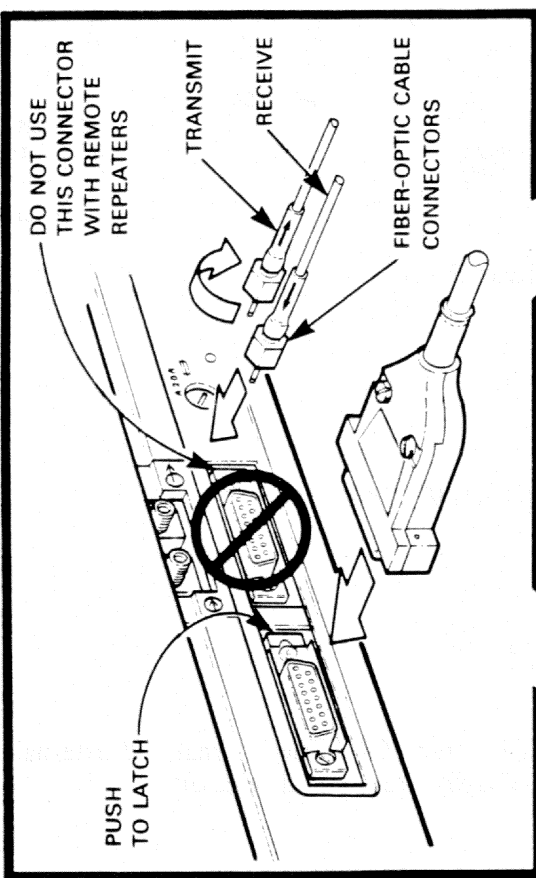
The repeater self-test is made up of two separate tests.

- Internal self-test
- External self-test

Internal self-test is automatically performed when the repeater is turned ON. The internal and external self-tests are both performed when the self-test button is momentarily pressed and released.

### NOTE

**Normal repeater operations are suspended during self-test. That is, packets are not repeated on the network.**



MKV84-0040

Figure 2-6 Typical Remote Repeater Cabling

### 2.6.1 Internal Self-Test

The internal self-test generates *internal* loopback of encoded data to both side A and B of the repeater\*. This test exercises the logic module up to, but not including, the transceiver cable interface and/or fiber-optic cable interface.

### 2.6.2 External Self-Test

The external self-test generates *external* loopback of encoded data to both side A and B of the repeater\*. For local repeaters, signal turnaround occurs in the transceivers. In remote repeaters, signal turnaround occurs in the local transceiver and in the remote half of the repeater.

For local repeaters, the external self-test exercises the following elements.

- Logic module
- Both transceiver interfaces (side A and side B)
- Both transceiver cables and transceivers

For remote repeaters, the external self-test exercises the following elements.

- Logic module
- Transceiver cable interface and fiber-optic interface
- Transceiver cable and transceiver (on side A)
- Fiber-optic cable (on side B)

A detailed description of the self-test is provided in Chapter 5.

### 2.6.3 Executing the Repeater Self-Test

To initiate the repeater self-test, perform the following.

1. To run internal self-test only, press the power switch to "0" (OFF). Wait five seconds and press the power switch to "1" (ON).

Observe the LEDs on the rear of the repeater. No error LEDs should remain lit (TST, FLT, INT, or ERR). If any of these LEDs remain lit, follow the recommended procedures in Chapter 5.

2. To run internal and external self-test, momentarily press and release the self-test button (see Figure 2-7) on the rear of the repeater.

#### NOTES

1. **All LEDs should light when the self-test button is pressed and held down.**
2. **Remote repeaters do not pass external self-test unless both repeater units are fully connected and operating.**

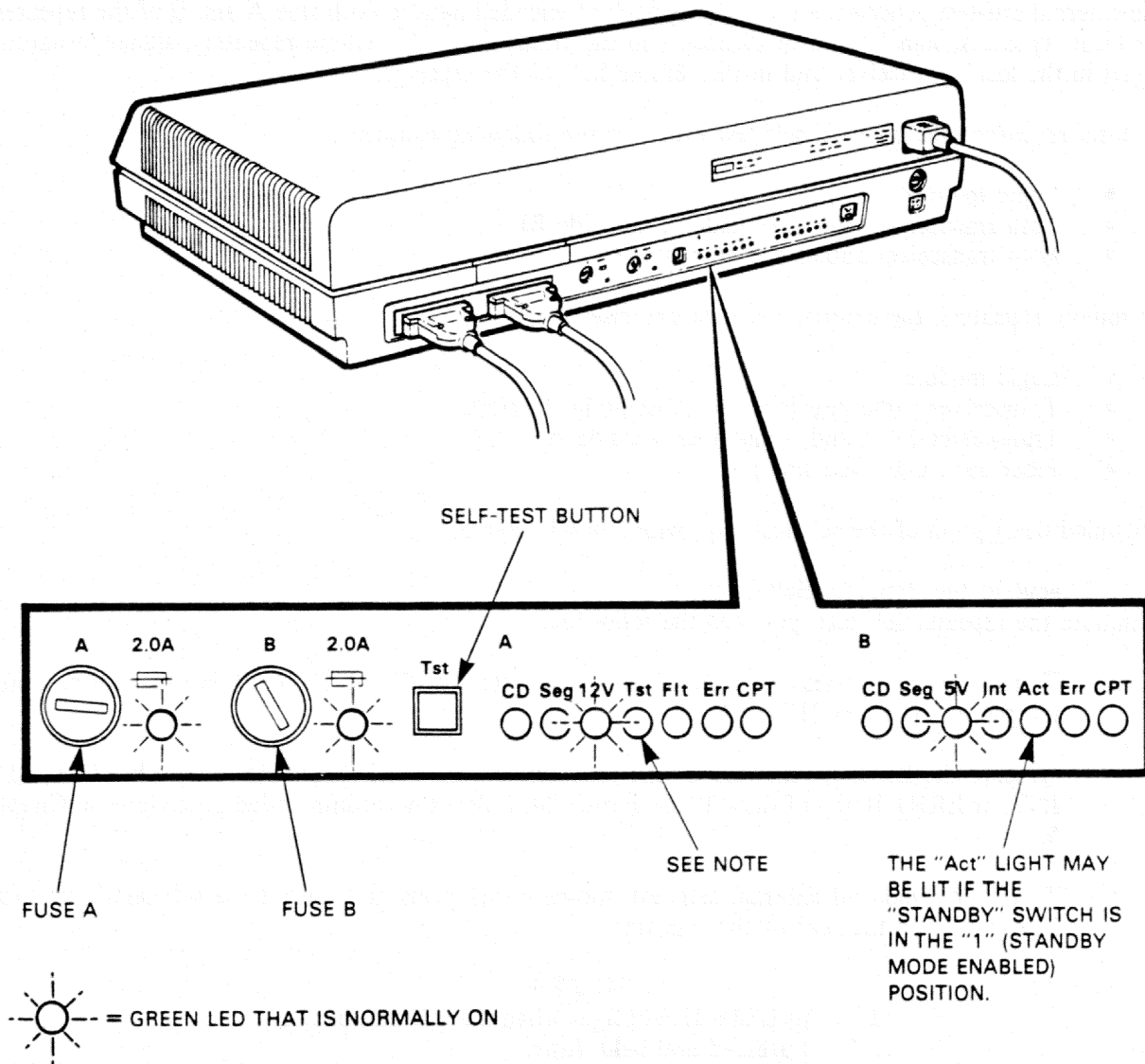
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\* Side A of the repeater refers to the transceiver interface and circuitry associated with transceiver connector A on the rear of the repeater.

For local repeaters, side B refers to the circuitry associated with transceiver connector B (on the rear of the repeater).

For remote repeaters, side B refers to the circuitry associated with the fiber-optic interface.

3. Observe the LEDs on the rear of the repeater unit being tested. A successful pass is indicated when no self-test error LEDs (labeled TST, ERR, or INT) remain lit. Note that the self-test LED (labeled TST) remains lit until the self-test has successfully executed (typically .3 seconds). Figure 2-7 illustrates a successful pass.



#### NOTE

THE "TST" LED LIGHTS WHEN THE SELF-TEST SWITCH IS PRESSED AND STAYS ON UNTIL THE SELF-TEST SUCCESSFULLY EXECUTES (TYPICALLY .3 SECONDS). IF THE TST LED REMAINS STEADILY LIT, A FAILURE IS INDICATED. CHAPTER 5 CONTAINS INFORMATION ON RECOMMENDED PROCEDURES TO BE FOLLOWED IN THE EVENT A FAILURE IS INDICATED.

MKV84-0068

Figure 2-7 LED Indications After a Successful Self-Test



If the self-test LED remains steadily lit (typically for more than .5 seconds), a failure mode is indicated. In this case, the specific failure mode may be determined by observing the conditions of the other LEDs. Chapter 5 contains information on recommended procedures to be followed in the event that a failure mode occurs.

#### **CAUTION**

**If the repeater fails the self-test, remove it IMMEDIATELY from service in the network.**

#### **NOTE**

**When testing remote repeater installations, self-test must be performed individually on each repeater unit.**

If no more repeaters are to be tested, the installation is now complete. If standby repeaters are to be installed, proceed to Section 2.7.

## **2.7 INSTALLING STANDBY REPEATERS**

This section provides instructions for installing local standby repeaters. Instructions for testing the standby functions are also included.

#### **CAUTION**

**Only local repeaters may be used in standby mode. Do not attempt to use remote repeaters in standby mode as network performance may be impaired.**

When network availability is critical, it may be enhanced by installing a standby repeater. In most repeater installations, one repeater is used to join two Ethernet segments. When two repeaters are used, one is designated as the *primary* repeater and the other as the *standby*. Figure 2-8 illustrates a typical installation using a standby repeater.

The standby repeater is typically installed in parallel with one primary repeater but has standby mode enabled. In this mode, the standby repeater verifies the operation of the primary repeater by monitoring the communications between segments. If the data on one segment is not repeated onto the other segment, the standby repeater assumes that the primary unit has failed. The standby repeater automatically switches to the active mode reestablishing communications between the segments.

#### **NOTE**

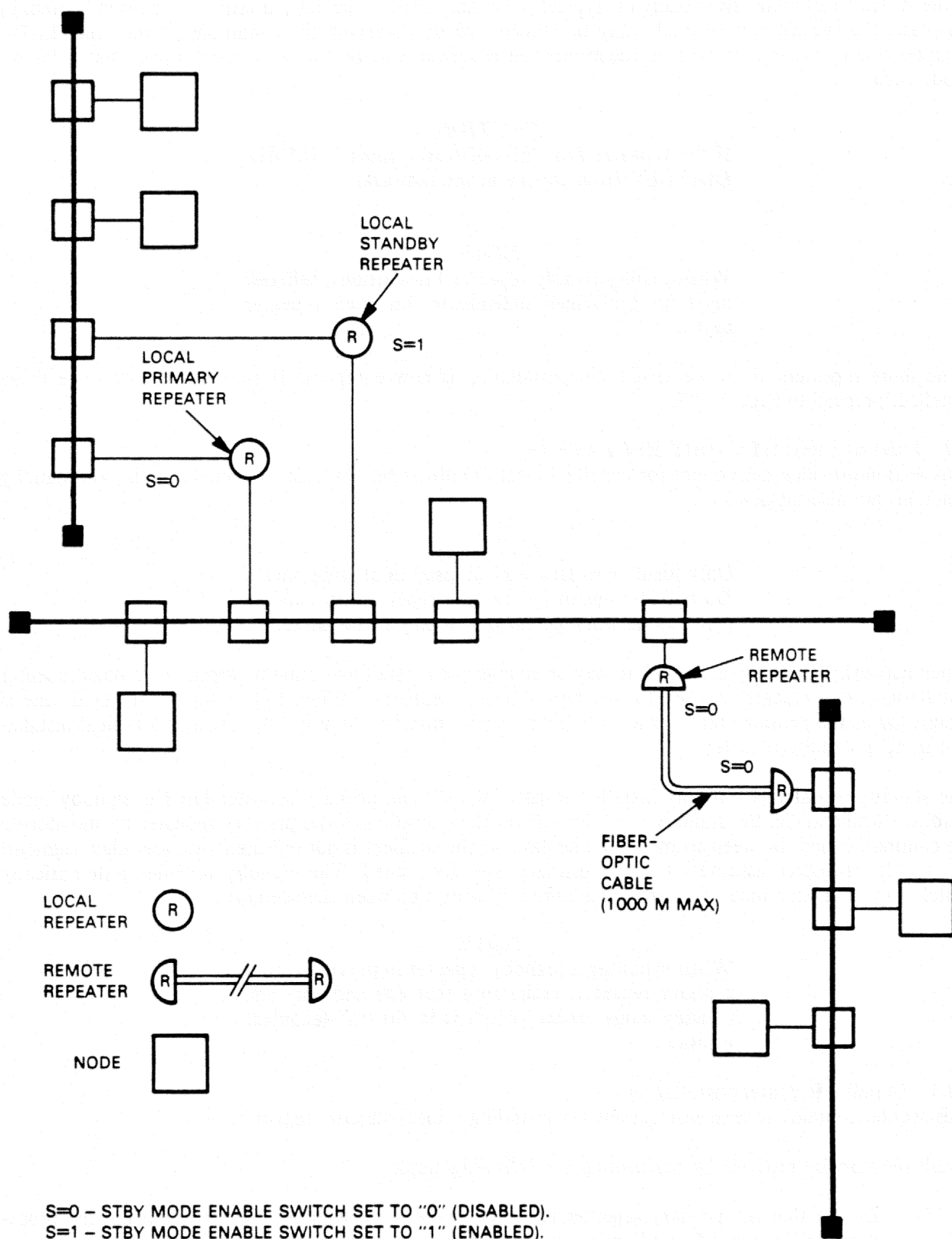
**When installing a standby repeater in parallel with a primary repeater, make sure that one and only one standby mode enable switch is in the "1" (enabled) position.**

### **2.7.1 Standby Repeater Installation**

This section contains general instructions for installing a local standby repeater.

Install the standby repeater by performing the following steps.

1. Ensure that the primary repeater has been properly installed and tested following the procedures in Section 2.5 and Section 2.6.
2. Remove the primary repeater from network service by turning the repeater power OFF.



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Figure 2-8 Typical Installation with a Standby Repeater

3. Install and test the standby repeater following the procedures in Section 2.5 and 2.6.
4. Set the standby mode enable switch of the standby repeater to "1" as shown in Figure 2-8.

**CAUTION**

**If the standby mode enable switch of both repeaters (the primary and standby repeater) are set to the same position, network performance may be seriously impaired.**

5. Return the primary repeater to active service by turning the repeater power ON.

**NOTE**

**A standby repeater is in the active standby mode (the Act LED is lit) on power-up. The repeater returns to the inactive state when the network is used.**

### **2.7.2 Testing the Standby Function of the Standby Repeater**

Once the network is fully operational, test the standby function by removing the primary repeater from service in the network. Turn the power switch of the primary repeater to the OFF position.

**NOTE**

**A standby repeater becomes active after eight full packets have not been repeated by the primary repeater.**

Note that the active standby LED (labeled Act) on the rear of the standby repeater turns ON. Following the particular network protocol, verify communication between nodes that normally communicate via the primary repeater(s).

When the test is complete, return the primary repeater to active service in the network by turning the primary repeater power ON. With the primary and standby repeaters both attempting transmission of data, the unit with standby mode enabled returns to an inactive state. The active standby LED (labeled Act) on the rear of the standby repeater should turn OFF.



## CHAPTER 3

### THEORY OF OPERATION

#### 3.1 SCOPE

This chapter discusses the theory of operation of the Ethernet repeater. Included in this chapter are:

- Special definitions,
- Repeater states, and
- Repeater operation.

#### 3.2 DEFINITIONS

The following terms have special definitions that should be understood before proceeding to the descriptions of repeater operation.

**Carrier** – Data transitions in the physical channel.

**Coaxial cable** – A shielded PVC or Teflon™ type constant-impedance (50  $\Omega$ ) cable used to make Ethernet cable segments.

**Collision** – The result of simultaneous multiple transmissions overlapping in the physical channel resulting in garbled data. This condition requires retransmission of the entire packet.

**Collision enforcement** – The transmission of a jam after a collision is detected. Collision enforcement ensures that all transmitting nodes can detect the collision.

**CPT (Collision Presence Test)** – A signal sent by the transceiver via the collision presence pair of the transceiver cable. The CPT signal duration is approximately 1  $\mu$ s (microsecond) in length and is sent within 2  $\mu$ s of the carrier going away following a transmission. This signal is used by the repeater to verify that the collision detect circuitry in the transceiver is functioning.

**Interpacket gap** – A time period of about 9.6  $\mu$ s that precedes packets. This gap is used for controller recovery.

**Jam** – A series of transitions (32-bits minimum – 48-bits maximum) used to ensure that the duration of a collision is sufficient to guarantee its detection by all transmitting nodes.

**Manchester encoded data** – A data stream that includes a self-synchronizing clock signal. The first half of each bit cell contains *inverse* data while the second half contains *true* data. The clock signal and data are recovered from the mid-bit transition of each bit cell.

**Node** – A network component having a network controller. The system and controller support networking software. Nodes are connected to segments via transceivers.

---

Teflon is a trademark of Dupont de Nemours & Co., Inc.

**Packet** – The basic Ethernet network message unit that is made up of a preamble and data stream. The data stream is preceded by the preamble. The minimum packet length is 512 bits. The maximum packet length is 1708 bits. Packets must be separated by at least 9.6  $\mu$ s (the interpacket gap).

**Physical channel** – The transmission medium connecting all nodes in an Ethernet network. The transmission medium includes coaxial cable segments, repeaters, transceivers, and transceiver cables.

**Preamble** – A 64-bit series of alternating 1s and 0s (ending in a 1 that precedes the actual message or data string). The preamble is used by the repeater (and other Ethernet receiving devices) for stabilization and synchronization of the decoder.

**Runt packet** – A packet that is less than 512 bits in length (512 bits is the minimum packet length). Runt packets generally result when collisions cause the transmitting nodes to stop transmitting. Runt packets are disregarded by receiving nodes.

**Segment (coaxial segment)** – A section of coaxial cable made up of one or more coaxial cable lengths and coaxial connectors. The segment is terminated at each end in its characteristic impedance (50  $\Omega$ ). A segment may contain up to 500 m (1640 ft) of coaxial cable. Transceivers and terminators are the only devices allowed to physically attach to the segment. Other devices such as nodes, local network interconnects, and repeaters must connect through transceivers.

**Slot time** – The time required for data transitions to propagate from one end of a maximal (largest allowable) Ethernet configuration to the other end, and for collision information to propagate back. Specifically, the slot time for Ethernet networks is 51.2  $\mu$ s (round-trip propagation time + maximum jam time).

**Transceiver** – A transceiver is the physical interface between Ethernet coaxial segments and other network devices such as nodes, repeaters, and so on. Transceivers provide dc isolation, transmission and reception impedance matching, and collision detection for those devices to which they are connected.

### 3.3 REPEATER STATES

The repeater responds to network conditions such as carrier or collision presence by implementing specified machine states. When the repeater detects one of the specified conditions or a combination of conditions, the repeater's state machine responds by selecting the appropriate path to the next machine state. Typically, the repeater must implement a series of states before returning to the initial (idle) state.

Figure 3-1 shows the state machine flow from one state to another.

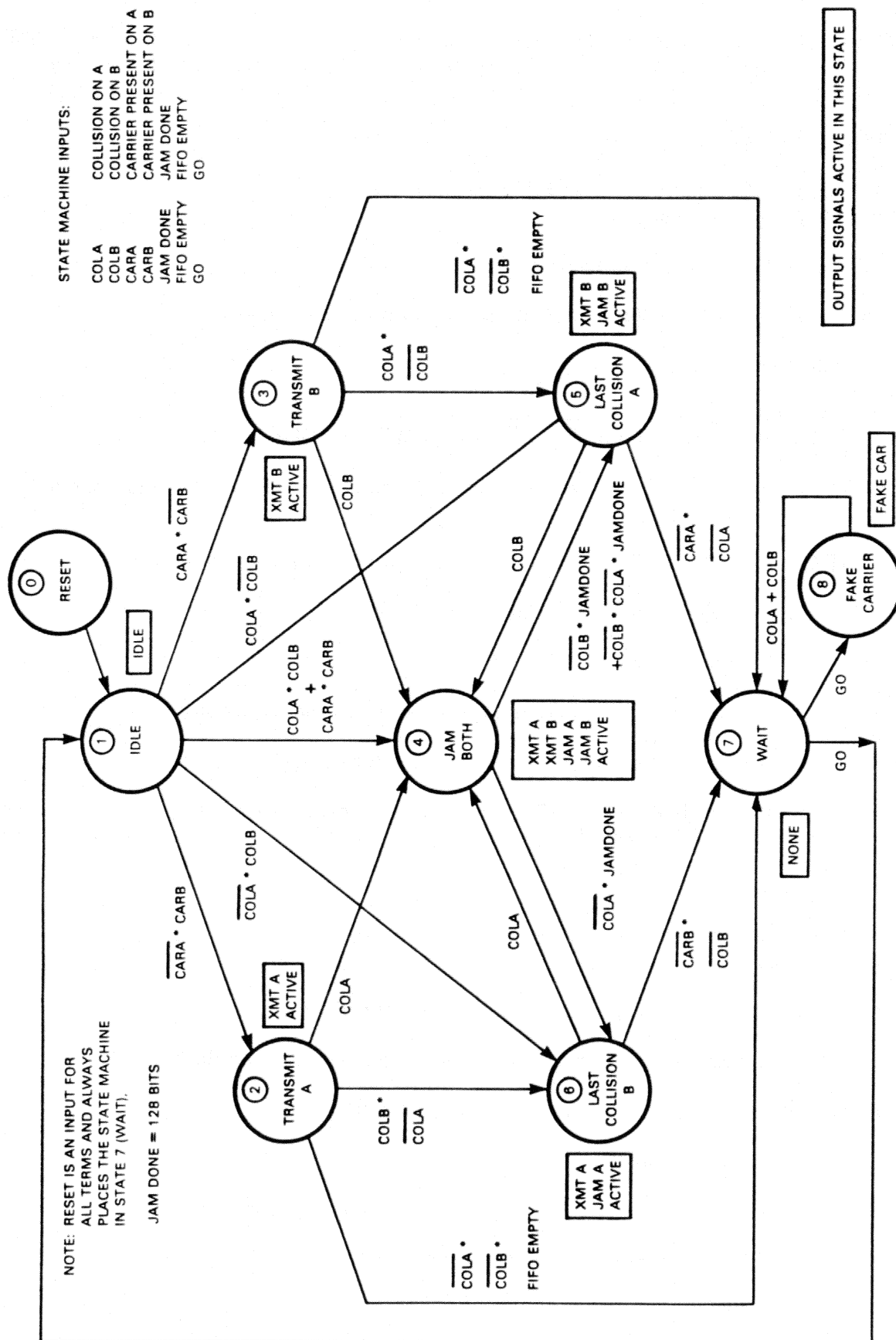
The repeater can be in only one of nine operational states at any given time. The operational states are described below. Inputs to the state machine determine the repeater's operational state. The design of the state machine ensures that the repeater is not in more than one state at any given time.

The following states make up the outputs of the state machine.

1. **RESET** – This is the initial state of the repeater that is entered on power-up.

The RESET state exits immediately to the IDLE state.

2. **IDLE** – In this state the repeater is monitoring inputs from the fiber-optic or transceiver interfaces. This state ends when carrier or collision is detected.



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Figure 3-1 State Machine Flow Diagram

3. **TRANSMIT A** – Entered when carrier has been detected on the B side of the repeater. This state starts the slot-time counter and routes encoded transmit data to the A transceiver interface.

This state ends when:

- Carrier B goes away and the FIFO is empty, and
- Any collision is detected.

4. **TRANSMIT B** – Similar to TRANSMIT A.
5. **JAM BOTH** – In this state the repeater is transmitting a jam to both sides.

This state is entered when:

- A collision occurs on the side which is being transmitted to, and
- Simultaneous collisions or carriers occur when in the IDLE state.

This state ends when 128 jam bits have been sent (jam done) and a collision presence signal on one side goes away.

6. **LAST COLLISION B** – The current (or most recent) collision is on the B side.

In this state the repeater is transmitting a jam to side A.

This state is entered from:

- The TRANSMIT A state when a collision occurs on the receive side (side B),
- The IDLE state when a collision occurs on the B side, and
- The JAM BOTH state when 128 jam bits are sent to both sides and the collision presence signal on side A has ended.

This state exits to:

- The JAM BOTH state if a new collision occurs on the A side while side A is being jammed, and
- The WAIT state when carrier B and collision B both end.

7. **LAST COLLISION A** – The current (or most recent) collision is on the A side.

In this state the repeater is transmitting a jam to side B.

This state is entered from:

- The TRANSMIT B state when a collision occurs on the receive side (side A),
- The IDLE state when a collision occurs on the A side, and
- The JAM BOTH state when 128 jam bits are sent to both sides and the collision presence signal on side B has ended.



This state exits to:

- The JAM BOTH state if a new collision occurs on the B side while side B is being jammed, and
  - The WAIT state when carrier A and collision A both end.
8. WAIT – There are no outputs during this state. The duration of the WAIT state varies depending on the state of the repeater.

In normal operation, the duration of the WAIT state is 3.2  $\mu$ s. This allows time (called the collision presence test jumpover period) for the cables to go idle before they are again monitored for carrier and collision.

In self-test, the duration of the WAIT state defines an interpacket gap of 12.6  $\mu$ s.

9. FAKE CARRIER – This state causes one of the carrier inputs to the state machine to become active for self-test.

This state is entered when the self-test is performed.

This state is exited to the WAIT state when there is a collision on side A or a collision on side B.

### 3.4 REPEATER OPERATION

The repeater utilizes a carrier-sense circuit to monitor the physical channel for traffic. When the repeater detects carrier on one segment, the repeater automatically generates and transmits a new preamble to the other segment. The remaining message is then retimed, amplified, and retransmitted to the other segment.

In addition, the repeater maintains network synchronization during collisions.

The repeater responds to the following network conditions.

- Carrier on either side
- Absence of CPT from either side
- Collisions on either side
- Excessive collisions on either side
- Inactivity on one segment if in standby mode

#### 3.4.1 Carrier

As soon as carrier is detected on the receive lines from a transceiver, the repeater begins generating and sending a new preamble. The repeater continues to generate preamble until at least 63 bits have been generated. Then the message portion of the packet is retimed, amplified, and transmitted to the other side of the repeater.

#### 3.4.2 CPT (Collision Presence Test)

After each transmission of data onto a coaxial segment by a transceiver, the transceiver generates a CPT signal. CPT is a signal (about 1  $\mu$ s in length) that is coupled to the collision presence signal line pair of the transceiver cable. The CPT signal is used by the repeater for verification of the collision detection circuitry in the transceiver.

After transmission, when return data transitions have ceased on the repeater's receive line pair, the repeater looks for the CPT signal from the transceiver. If no CPT signal is detected within 3.2  $\mu$ s (32 bit times) after data transitions have stopped, the repeater assumes that there is a fault in the transceiver's collision detection circuitry. The CPT LED is then latched ON to indicate the apparent fault.

### 3.4.3 Collisions

Collisions occur when two or more nodes transmit at the same time. Their respective data packets run into each other as they propagate throughout the network resulting in garbled data.

Once a node has begun to transmit, it takes a certain amount of time for the signal or carrier to propagate to all parts of the network. As each node in turn senses carrier in the channel, it may defer (delay) its own transmission until the carrier goes away and the interpacket gap (9.6  $\mu$ s) has expired.

It is possible for a node to transmit before the carrier of a currently transmitting node has been sensed. This is the time during which collisions typically occur.

If the collision occurred at the opposite end of the network from the node which first transmitted, then the first node must wait for the collision to propagate back to it. Once the slot time (round-trip propagation time + minimum jam time) has passed with no collisions detected (51.2  $\mu$ s), the node is said to have "acquired" the channel.

### COLLISION HANDLING

The repeater's role during a collision is to enforce the collisions between both network segments. The repeater does this by transmitting jam bits to one or both sides of the repeater. Consider the following examples.

#### *Example 1 – Collisions on the "Transmit To" Side*

Assume the repeater is transmitting a packet to side B. A collision on side B is detected by all transceivers and their respective nodes on that side. The remaining transmission is disregarded by the receiving nodes on side B. The repeater stops sending data and begins transmitting jam bits to side B.

At the same time, the nodes on side A must be made aware of the collision on side B. The repeater forces a collision on side A by transmitting a jam to side A. This forces a collision on side A.

#### *Example 2 – Collisions on the "Receive" Side*

Assume that the repeater is receiving data from side A and transmitting it to side B. A collision on side A is detected by all transceivers and respective nodes on side A including the transmitting node which then stops its own transmission.

As soon as the repeater detects the collision, it stops repeating data to side B and begins transmitting jam bits. This transmission stops when side A goes idle.

Since collisions typically occur during the slot time, the packet never achieves the legal minimum packet length of 512 bits. The result is a shortened or "runt" packet being transmitted to side B by the repeater. Runt packets are disregarded by the receiving nodes.

Note that the repeater continues to transmit jam bits to side B until side A becomes idle. This ensures that the network segments on both sides of the repeater go idle in relative synchronization.

### 3.5 SEGMENTATION

Segmentation is a process in which the repeater partially suspends communication between two network segments. Segmentation results from an excessive number of collisions occurring on a particular segment or from no data loopback during transmission.

### **3.5.1 Autosegmentation**

In the segmented state, the repeater continues to transmit data to, and receive data from, that segment on which the collisions are occurring. However, the received data will not be repeated to the "good" side. Also, collisions on the "bad" side are not enforced on the "good" side while in the segmented mode.

A coaxial segment is considered to be faulty if 64 consecutive collisions have occurred on transmission attempts to a coaxial segment. Even with many active nodes on the network, it is unlikely that 64 consecutive collisions would occur except in cases of equipment failure. Thus, when the repeater counts 64 consecutive collisions on a coaxial segment, the repeater assumes that a failure has occurred and that segment is then cut off or "segmented" from the remaining network.

Once the network is segmented, the FLT (Fault) LED is lit. In addition, the appropriate SEG (A or B) LED is latched ON as an indication that this condition has occurred on a particular segment.

### **3.5.2 Exit from Segmentation**

The repeater exits the segmented mode when a packet of data is transmitted to the segmented side without a collision. The repeater assumes this to indicate that the segment is functioning normally since no collision occurred.

## **3.6 STANDBY MODE**

When a repeater has standby mode enabled, the repeater monitors communications between the two segments to which it is connected. In this configuration, it can monitor and verify the operation of the primary repeater(s). Figure 3-2 illustrates a typical installation using a standby repeater.

### **3.6.1 Active Standby Repeaters**

When the standby repeater detects data on one side that is not repeated on the other side for an entire slot time, the standby repeater assumes that the primary unit has failed. The standby repeater then automatically switches from the passive to the active state.

When active, the standby repeater performs the same functions as a primary repeater except that the segmentation process is slightly different. Primary repeaters enter a segmented mode after 64 consecutive collisions. Active standby repeaters return to a passive state after 56 consecutive collisions.

### **3.6.2 Standby Repeaters Reentering the Passive State**

The standby repeater reenters the passive state when:

- 56 consecutive collisions occur on a segment, and
- A collision exists for a period that exceeds the slot time.

In most cases, these collisions are a result of the primary unit being returned to service in the network. Note that the primary repeater must count 64 collisions before segmenting. Since the standby repeater reenters the passive state after only 56 collisions, the collisions cease, letting the primary repeater assume its original status in the network. The standby repeater also assumes its original status verifying operation of the primary repeater.

## **3.7 SELF-TEST**

Two levels of self-test are possible with the repeater.

- Internal self-test
- External self-test

The repeater automatically performs internal self-test when the system is powered up or when the self-test button is pressed. External self-test is performed only when the self-test button is pressed.

The internal self-test for local and remote repeaters is identical. There are certain differences between the external self-test for local and remote repeaters. These differences are described in Sections 3.7.2 and 3.7.3.

Figure 3-3 describes the internal self-test flow. Figure 3-4 describes the external self-test flow.

### **3.7.1 Internal Self-Test**

During internal self-test, the repeater generates 256 preamble bits followed by a pack of 1792 ones. This data stream is encoded, looped back through the decoder, and then clocked into the FIFO and checked. This results in an extensive internal self-test of most counters and other internal circuitry.

#### **NOTE**

**Normal repeater operation is interrupted during internal self-test since outputs and inputs to the transceivers on the A and B side are disabled.**

### **3.7.2 External Self-Test for Local Repeaters**

During external self-test, the repeater generates 256 preamble bits followed by a pack of 1792 zeros. This data stream is encoded and transmitted to side A of the repeater. With the receive lines of the transceiver active, the repeater monitors the transmission. Thus, a loopback is performed that verifies the operation and connection of the transceiver. This same sequence is repeated for the B side of the repeater.

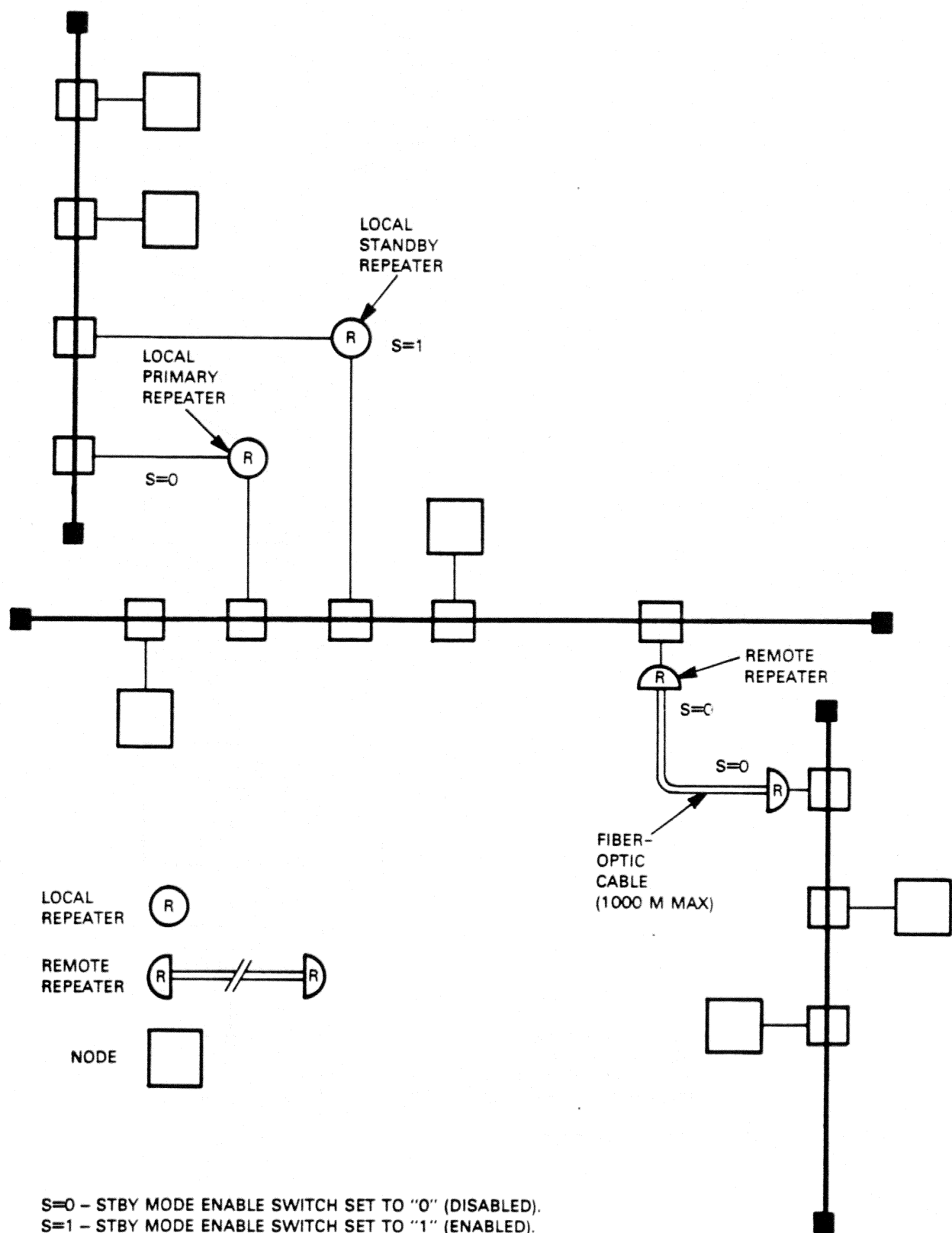
#### **NOTE**

**The external self-test actually transmits a packet to each side of the repeater. If carrier is present on the Ethernet coaxial cable, the transmitted packets result in a collision. If collisions do occur, the repeater makes 64 attempts to complete self-test and then segments if unsuccessful.**

### **3.7.3 External Self-Test for Remote Repeaters**

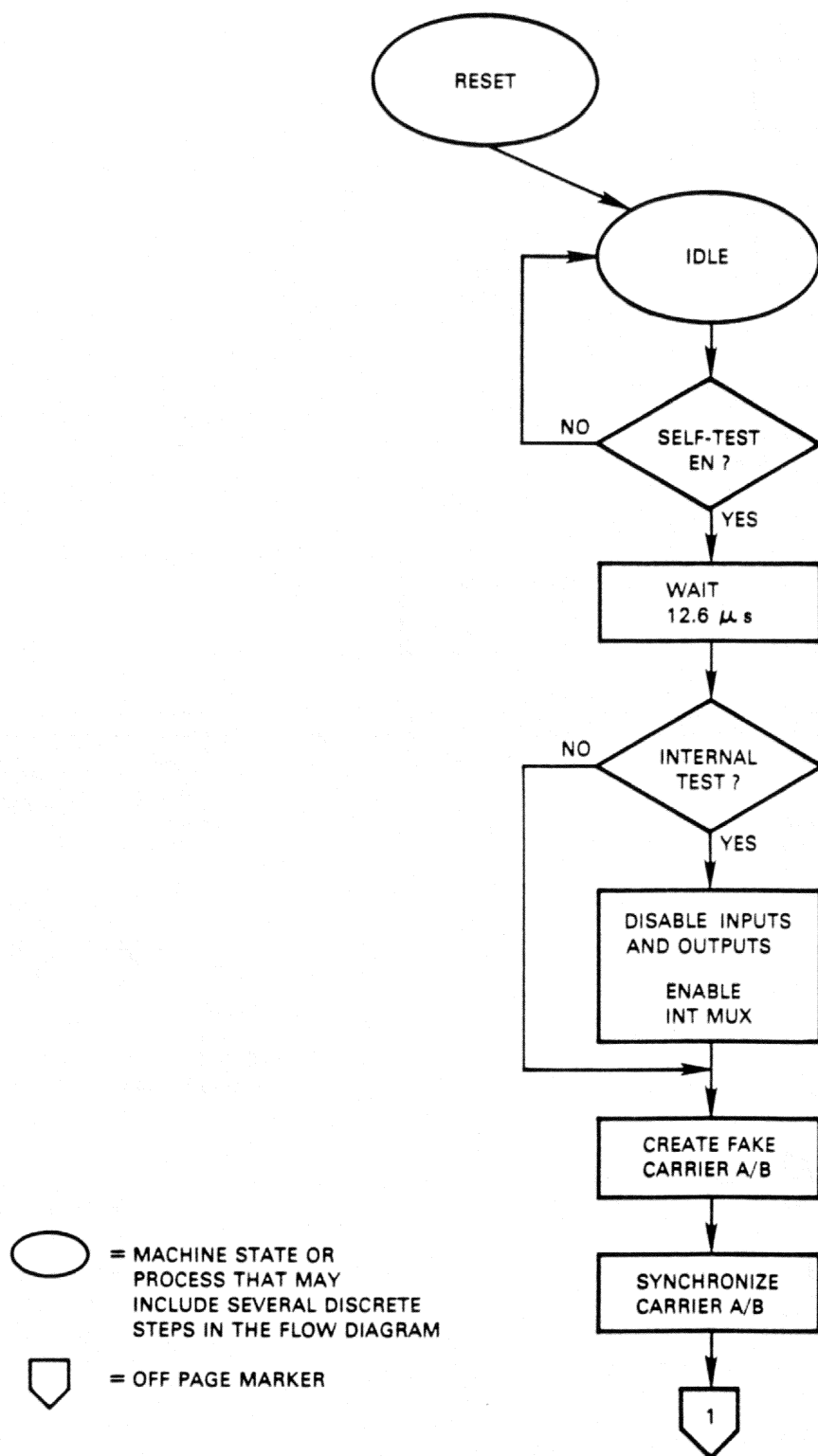
External self-test for remote repeaters is identical to that of local repeaters with the following exceptions.

- The test packet comprises 2048 preamble bits (zeros).
- The test packet to the B side loops back through the fiber-optic cable from the remote half of the repeater.
- The repeater only verifies the presence of data looped back from the B side. The data is not clocked back through the FIFO.



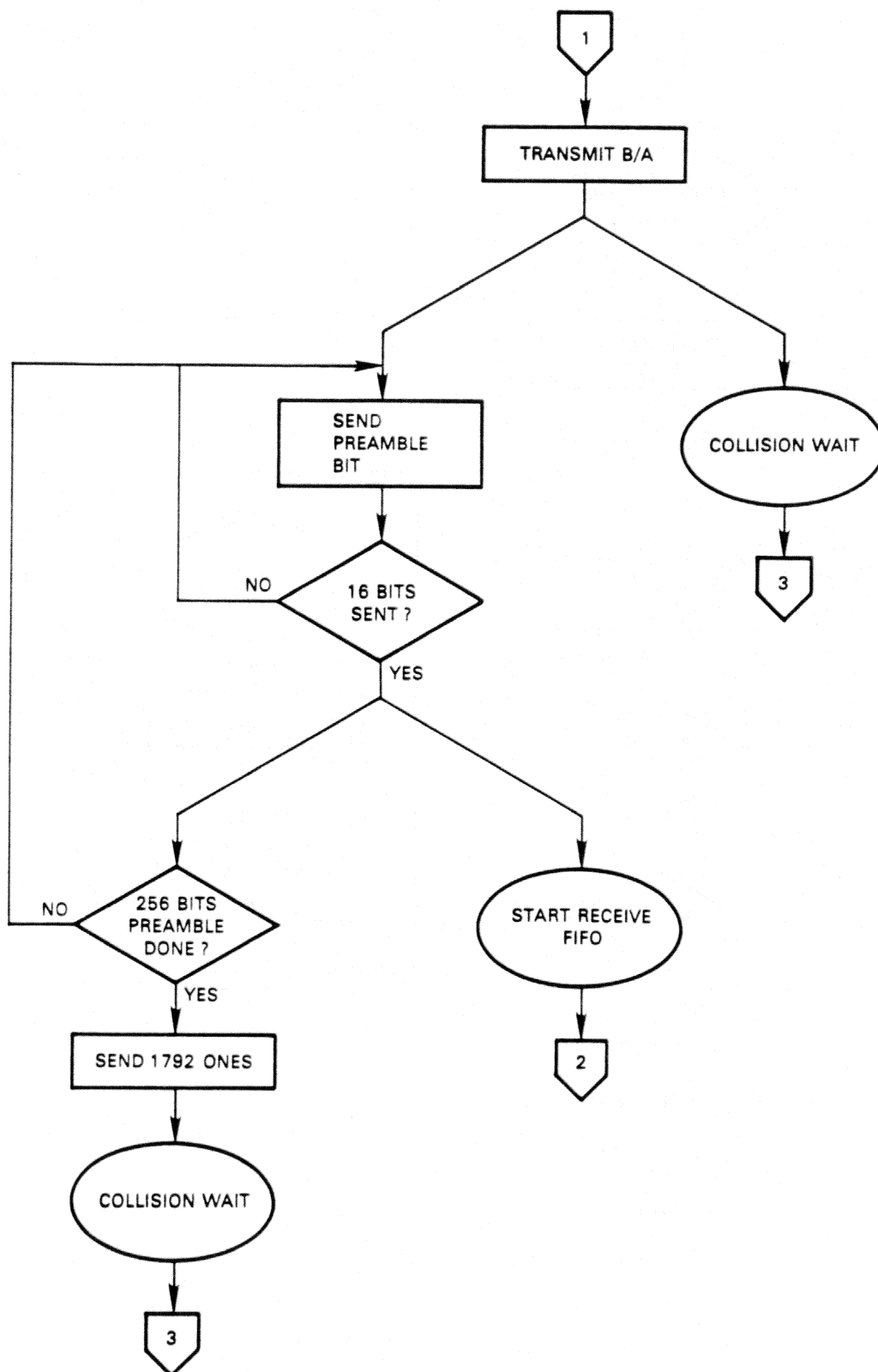
TK-10925

Figure 3-2 Typical Installation with a Standby Repeater



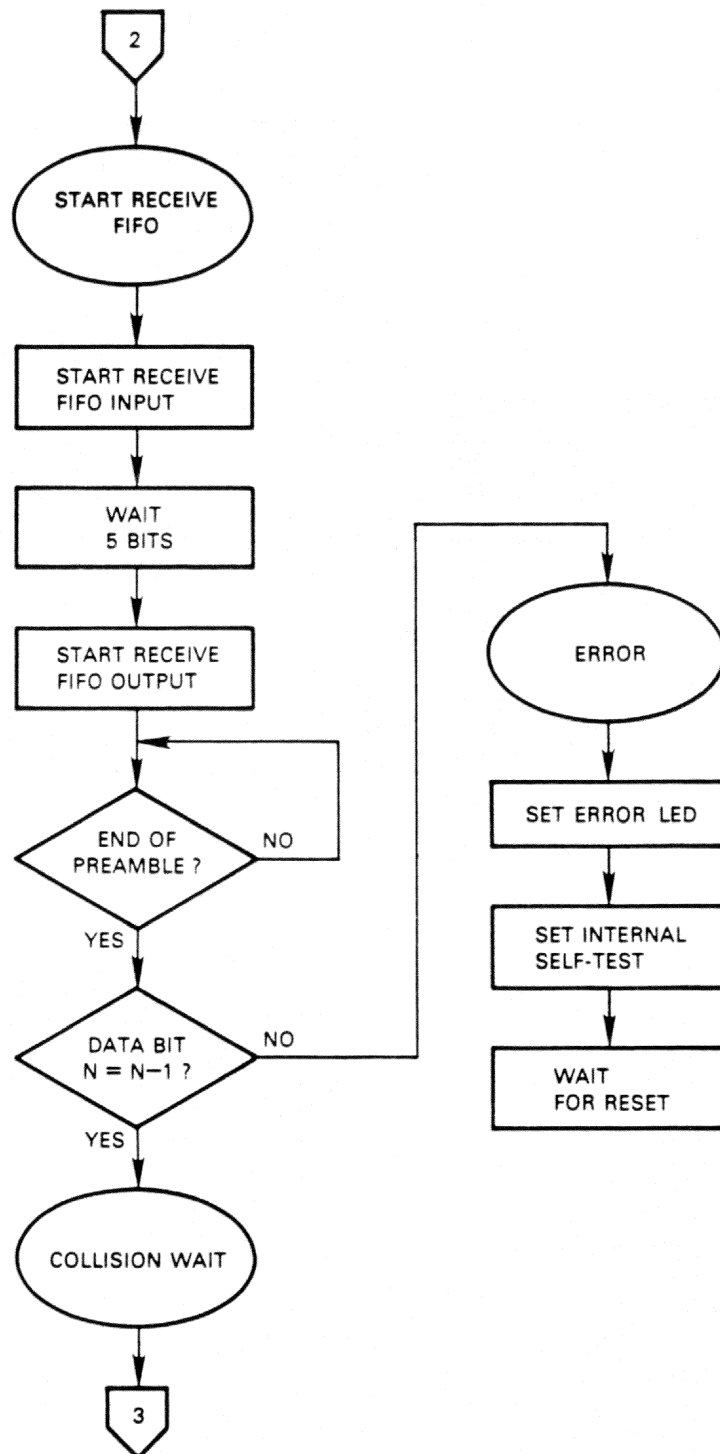
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Figure 3-3 Internal Self-Test Flow Diagram (Sheet 1 of 5)



MKV84-0101

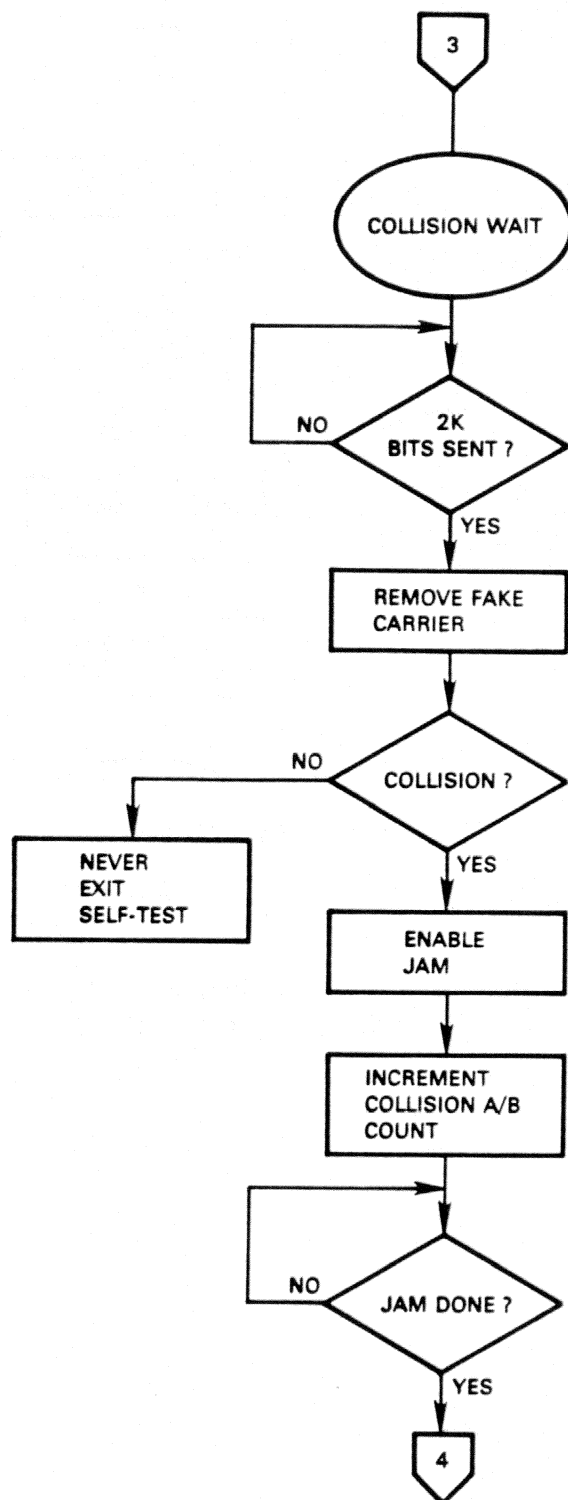
Figure 3-3 Internal Self-Test Flow Diagram (Sheet 2 of 5)



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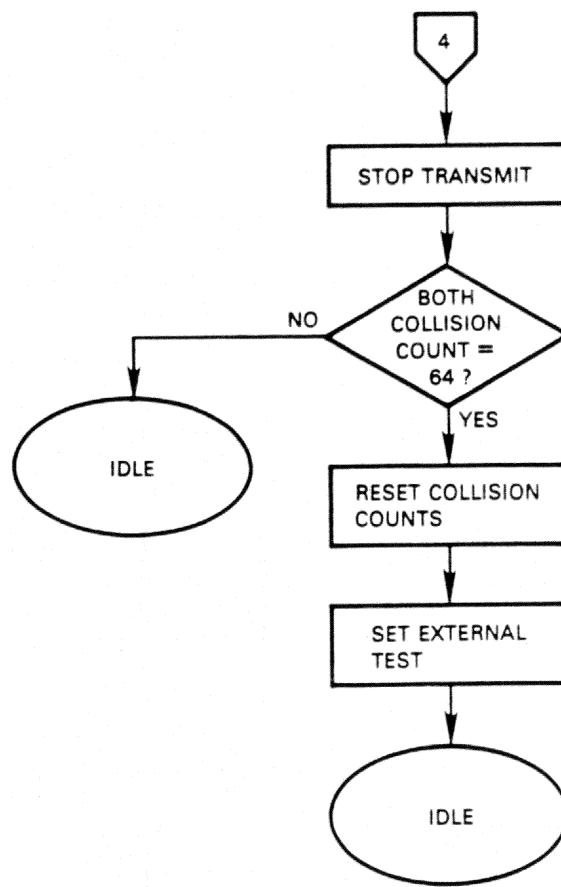
Figure 3-3 Internal Self-Test Flow Diagram (Sheet 3 of 5)





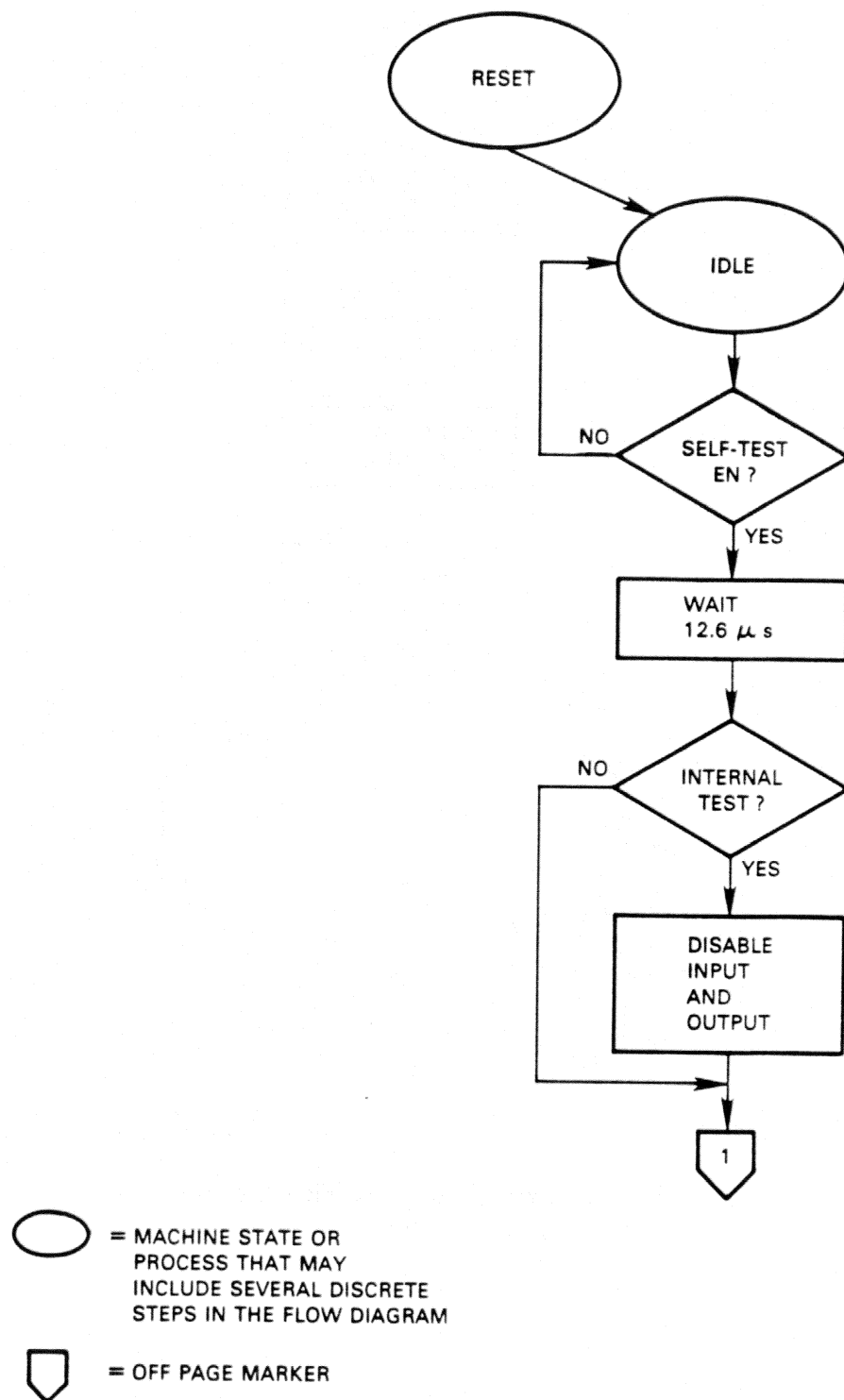
MKV84-0103

Figure 3-3 Internal Self-Test Flow Diagram  
(Sheet 4 of 5)



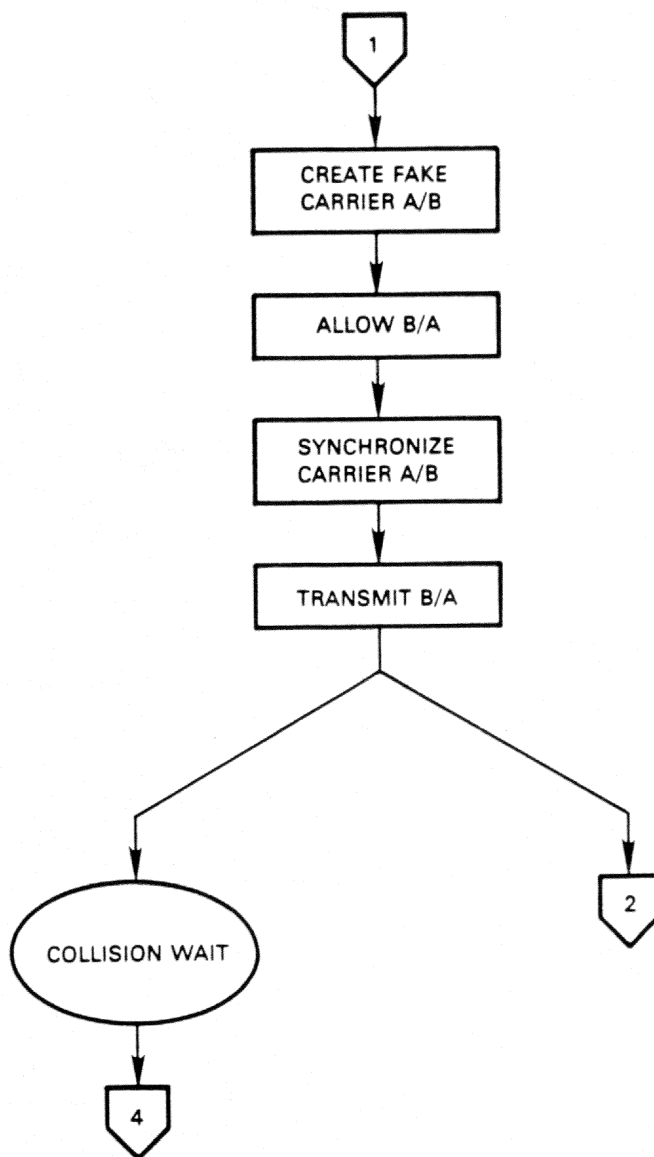
MKV84-0104

Figure 3-3 Internal Self-Test Flow Diagram  
(Sheet 5 of 5)



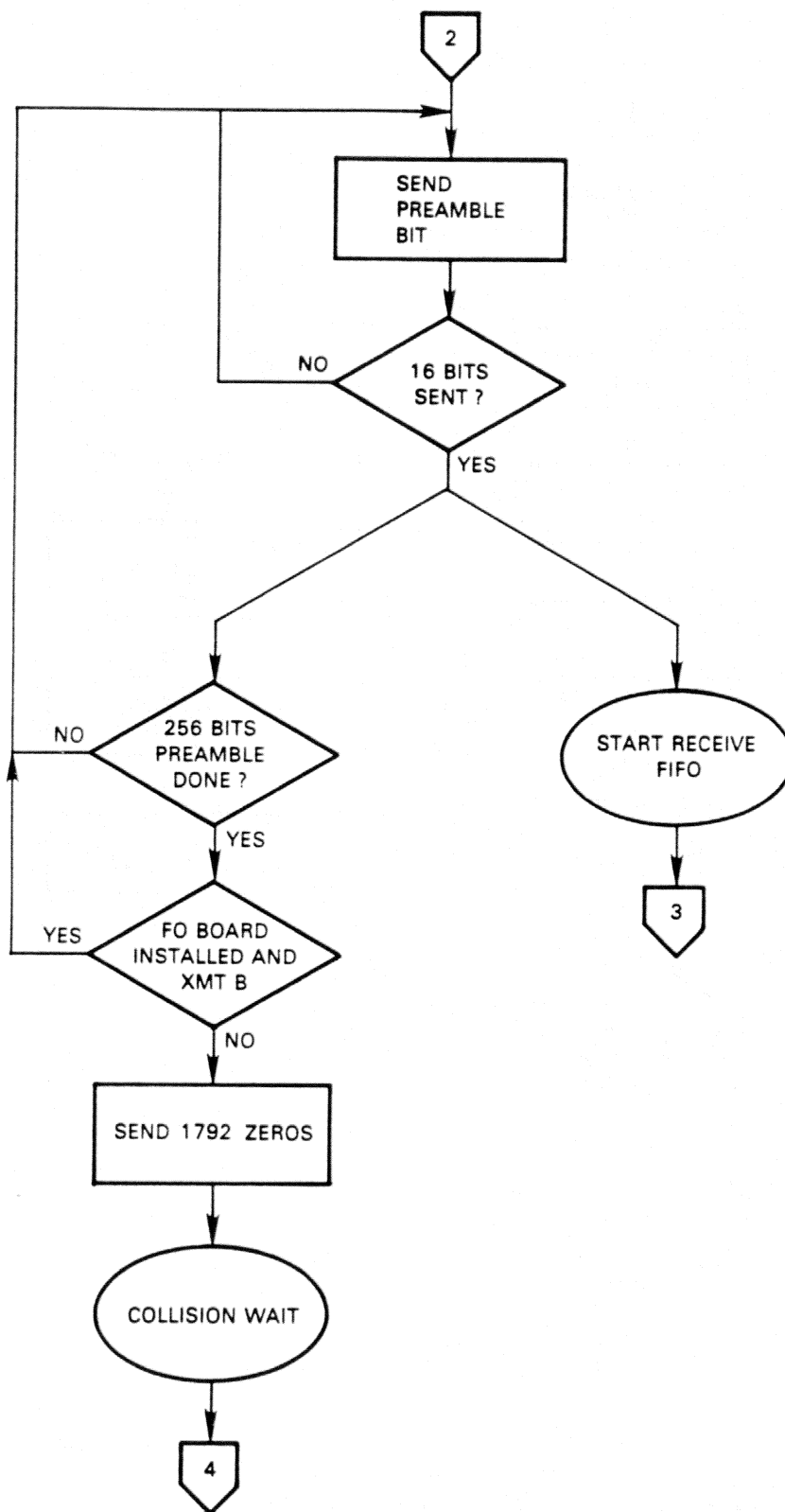
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Figure 3-4 External Self-Test Flow Diagram (Sheet 1 of 6)



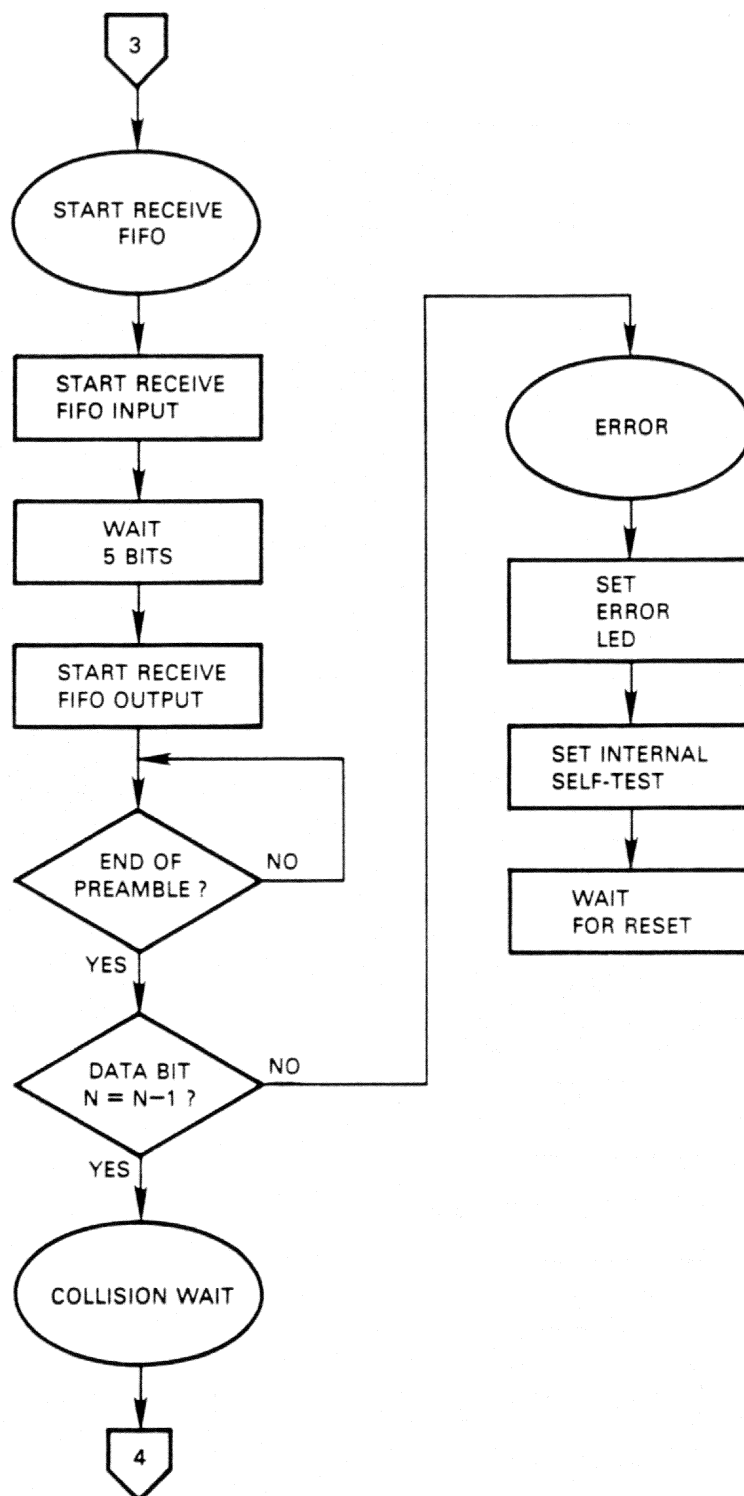
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Figure 3-4 External Self-Test Flow Diagram  
(Sheet 2 of 6)



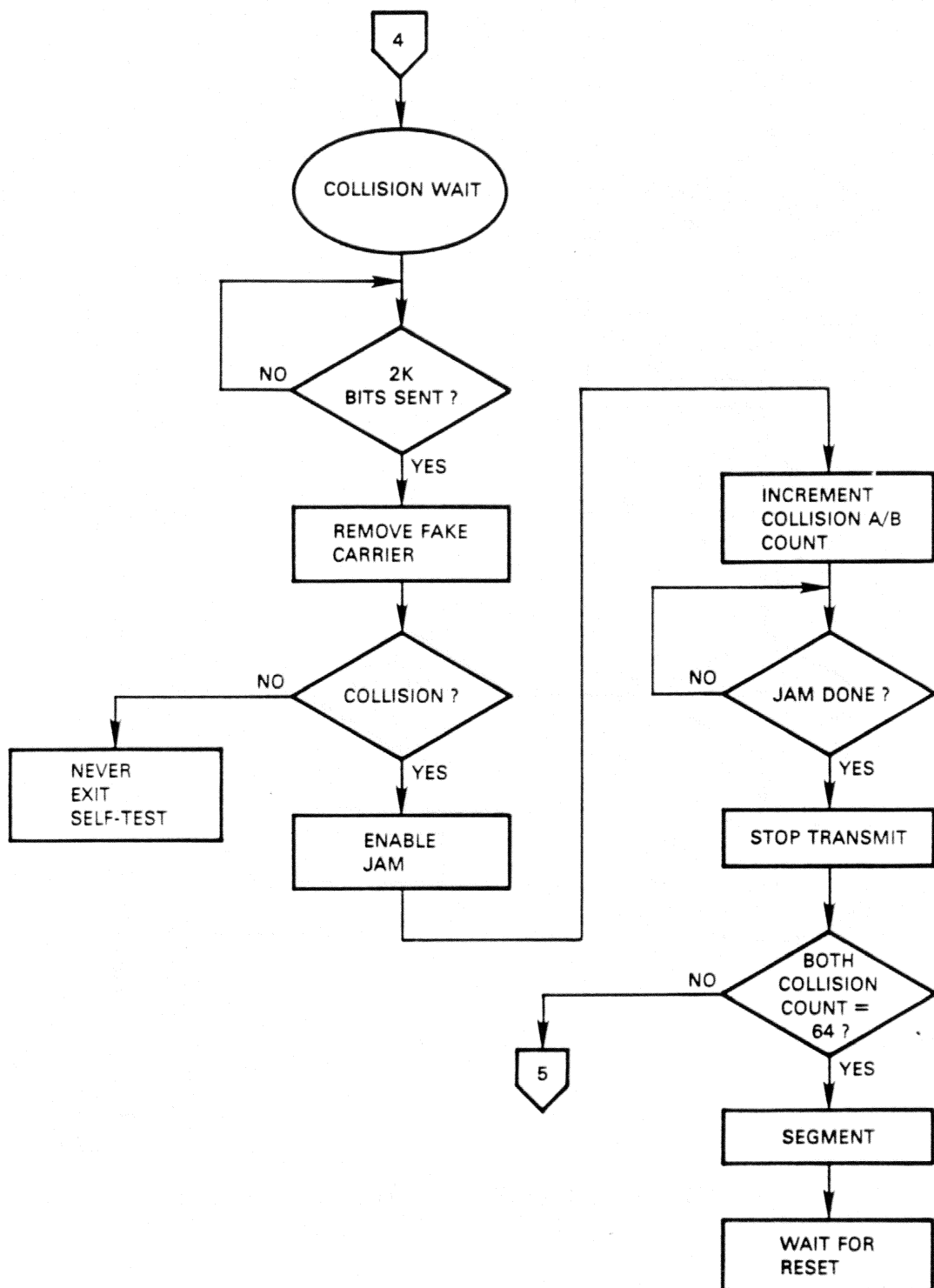
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Figure 3-4 External Self-Test Flow Diagram (Sheet 3 of 6)



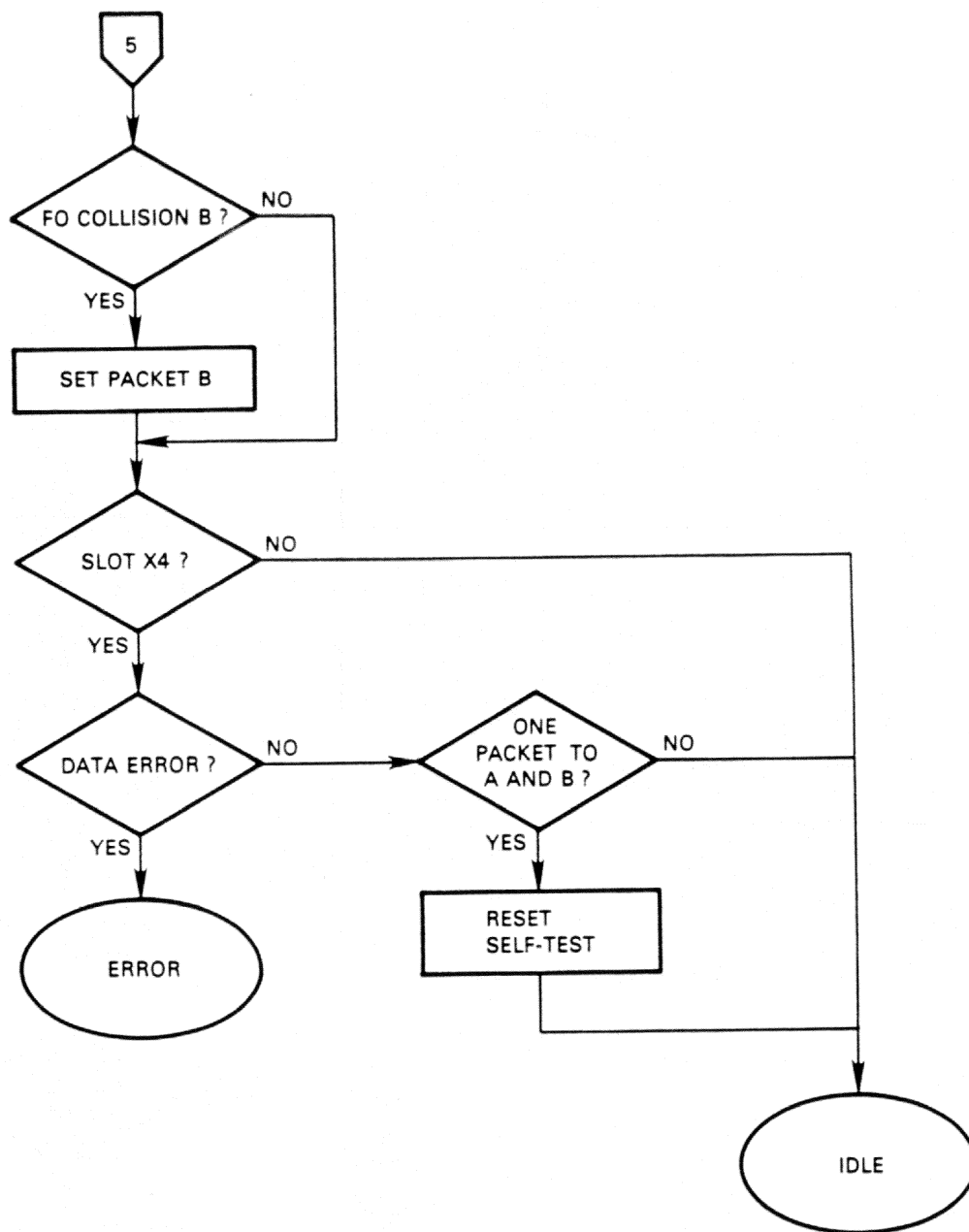
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Figure 3-4 External Self-Test Flow Diagram (Sheet 4 of 6)



MKV84-0109

Figure 3-4 External Self-Test Flow Diagram (Sheet 5 of 6)



MKV84-0110

Figure 3-4 External Self-Test Flow Diagram (Sheet 6 of 6)



## CHAPTER 4

### TECHNICAL DESCRIPTION

#### 4.1 SCOPE

This chapter provides a technical description of the Ethernet repeater. Included in this chapter are discussions on:

- The data structure,
- The functional block diagram, and
- The circuit descriptions.

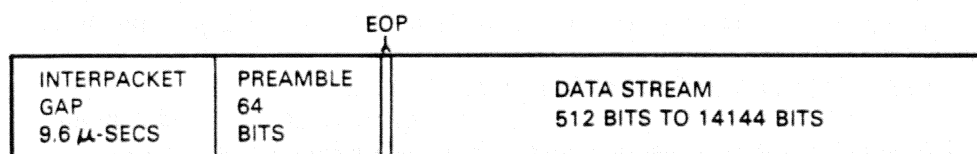
Only the local repeater and the fiber-optics interface are discussed.

#### 4.2 THE DATA STRUCTURE

The repeater is largely controlled by the received data transitions. Thus, an understanding of the nature of valid transitions is helpful in understanding the operation of the repeater.

The repeater is designed to distinguish valid data from non-data and to respond accordingly. A valid data frame or "packet" has certain characteristics such as bit rate, signal level, and duration that set it apart from other transitions. The incoming data must possess these characteristics before it can be processed by the repeater.

From the standpoint of a repeater, a packet is made up of two main parts: a preamble and a data stream (see Figure 4-1). Note that the packet is preceded by the interpacket gap of 9.6  $\mu$ s. This ensures that the nodes are ready to process the incoming transitions.



TK-10922

Figure 4-1 Typical Packet

The preamble is a 64-bit series of alternating 1s and 0s (ending in a 1) that precedes the actual message or data string. The preamble is used by the repeater (and other Ethernet receiving devices) for stabilization and synchronization of the decoder. The pattern is:

10101010 10101010 10101010 10101010 10101010 10101010 10101010 10101011

The preamble is transmitted from left to right. Notice that the last bit pair is identical (two 1s instead of a 1 and a 0). This bit pair is used to signal the end-of-preamble (EOP). The repeater recognizes this bit pair and all successive bits are treated as the data string.

The data string is the actual message being transmitted. The data string includes different data fields. However, the repeater treats the data string solely as a bit stream and does not recognize the different fields.

### 4.3 FUNCTIONAL BLOCK DESCRIPTION

This section describes a typical data flow as a packet is processed by the repeater.

#### 4.3.1 Assumptions

This discussion of functional blocks assumes the following conditions.

- The data flow is from receive B to transmit A. Signals coming from or going to a specific side are typically identified as A or B. For example, B DATA is data from the B side.
- The repeater is a local repeater (the operation of the fiber-optic interface is described in Section 4.4.1.2).
- The "packet" is made up of a 64-bit preamble (including the EOP) and the data string.

All signals from the transceiver must pass through the transceiver interface before they may be processed by the repeater.

The outputs of the transceiver interface are used to control the repeater's state machine. They are:

- CAR B (carrier B) – The CAR B signal is a steady voltage level (high or low) indicating the presence or absence of data on the receive pair of the transceiver cable. The active (high) level begins as soon as carrier is detected and ends when data transitions cease. Carrier B informs the state machine that there are data transitions on B.
- COL B (collision B) – COL B is a steady voltage level (high or low) indicating the presence or absence of the collision presence signal. The active (high) level begins as soon as the collision presence signal is detected on the collision pair of the transceiver cable. The active level ends when collision presence transitions cease.
- CPT B (collision presence test B) – A CPT signal is sent by the transceiver via the collision presence pair of the transceiver cable and should occur within 2  $\mu$ s after the carrier goes away.
- B DATA – B DATA includes all buffered transitions from transceiver B. When CAR B (from the carrier detect circuit) is active, the transitions are treated as valid data unless COL B is also active. When CAR B is inactive, any transitions are ignored by the repeater.

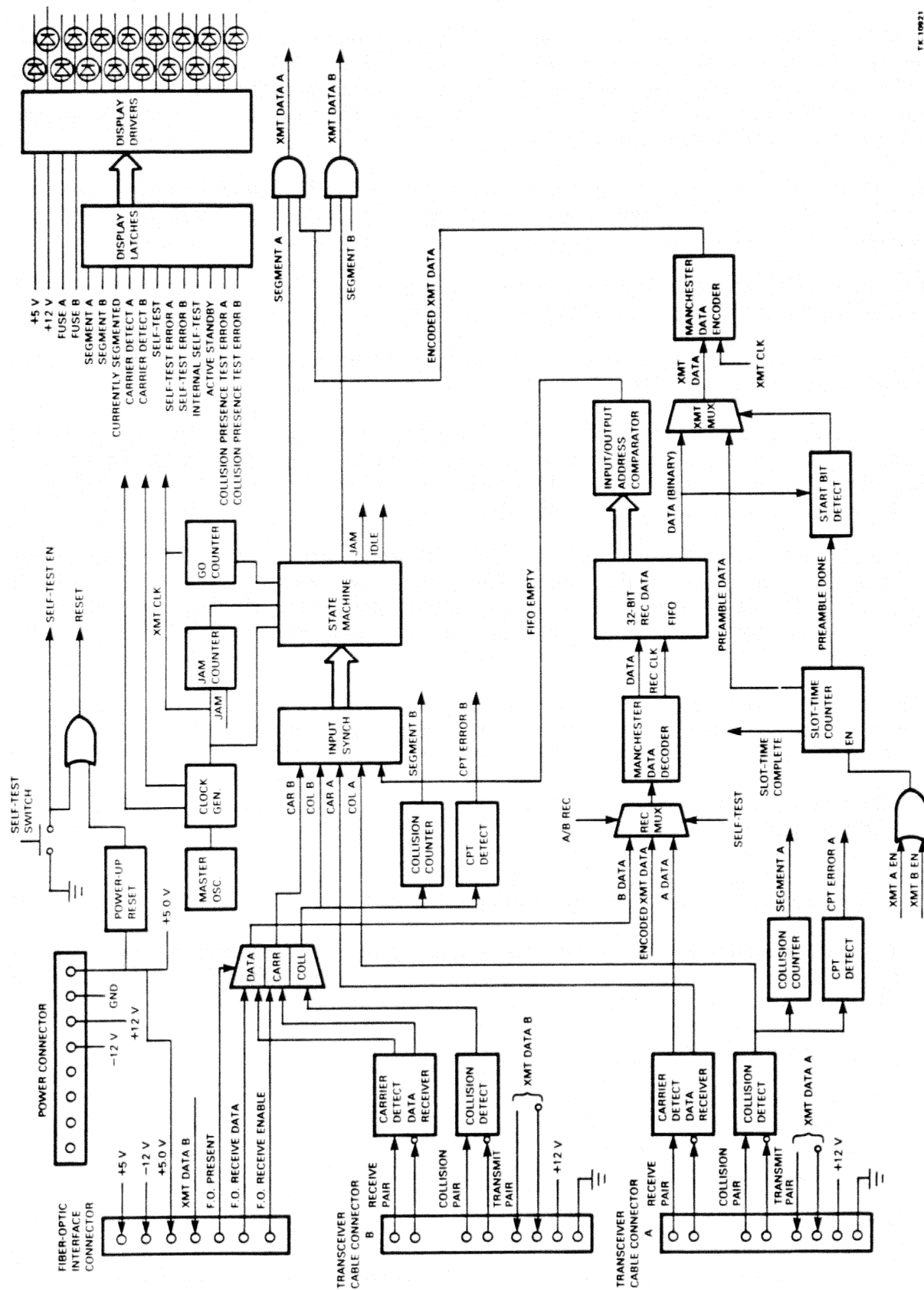
#### NOTE

**Similar signals are generated when transitions enter the transceiver interface on the A side of the repeater.**

#### 4.3.2 Typical Data Flow

This section describes a typical data flow. Refer to the repeater block diagram in Figure 4-2 as you read through this section.

All signals from the B transceiver interface and fiber-optic interface pass through the select multiplexer. The multiplexer selects data from the fiber-optic interface or transceiver connector B to be processed by the repeater. In this example, no fiber-optic board is present, so the multiplexer selects data from transceiver connector B.



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Figure 4-2 Repeater Functional Block Diagram

The CAR B signal goes to the state machine via the input synchronizer. The synchronizer synchronizes inputs to the state machine. When the state machine detects CAR B, XMT A EN (transmit A enable) goes active. This enables transceiver interface A to transmit encoded data. The slot-time counter begins generating a new preamble that is sent to the transmit multiplexer. The preamble is then encoded and sent to the cable drivers of the A transceiver interface.

COL B results from CPT on the collision pair of the transceiver cable. COL B is channeled to the collision counter and CPT detect circuits. The collision counter and CPT detect circuits are gated at the proper times to look for a signal on the collision presence pair.

B DATA passes to the receive multiplexer that selects the incoming data stream or ENCODED XMT DATA (from self-test) to be decoded and loaded into the FIFO.

The Manchester decoder recovers the clock and the data from the incoming data stream. The data is then clocked into the 32-bit circular FIFO.

After a delay that allows the decoder to stabilize, the FIFO begins clocking decoded data through itself to the transmit multiplexer. Note that the first data from the FIFO is the old preamble. The transmit multiplexer ignores the old preamble from the FIFO and selects the new preamble being generated by the slot-time counter. The new preamble is then Manchester encoded.

When the EOP (end-of-preamble) is detected by the EOP detect circuit, and a minimum of 63 new preamble bits have been generated, the transmit multiplexer begins selecting data from the FIFO. If necessary, an EOP bit is also added. Thus, a new preamble is generated which precedes a retimed data string. All transitions from the transmit multiplexer are then Manchester encoded and gated to the transmit connector.

#### **4.4 CIRCUIT DESCRIPTIONS**

This section describes individual circuits of the Ethernet repeater. For clarity, this section is divided into the following subsections.

- Data path circuits
- Control circuits

##### **4.4.1 Data Path Circuits**

The following sections describe individual circuits in the data path.

**4.4.1.1 Transceiver Interfaces** – The repeater has two identical transceiver interfaces. One interface is for the transceiver connected to the A side of the repeater, and the other interface is for the transceiver connected to the B side of the repeater.

Each transceiver interface is made up of:

- A transceiver connector,
- A carrier detect circuit,
- A receive data preamplifier, and
- A collision detect circuit.

#### **TRANSCEIVER CONNECTOR**

The transceiver connector is a 15-pin female D-connector with a slide latch for connecting and locking to a transceiver cable. The transceiver connectors are physically located on the rear of the repeater.

### **CARRIER DETECT**

Input to the carrier detect circuit is from the receive pair (+ receive and – receive) of the transceiver. The input is through pins 5 and 12 of the transceiver connector. Signals on these lines are typically 1.2 V data transitions from the transceiver.

The output of carrier detect is a steady voltage level (high or low) indicating the presence or absence of valid data. This output is used to drive the state machine.

### **RECEIVE DATA PREAMPLIFIER**

Input to the preamplifier is from the receive pair of the transceiver cable (pins 5 and 12 of the transceiver connector). The receive preamplifier buffers incoming data levels for processing by the repeater.

### **COLLISION DETECT**

When a collision occurs, it should be detected by each transceiver installed on the segment on which the collision occurs. Each transceiver then generates a 10 MHz collision presence signal that is coupled to the collision presence (+) and collision presence (–) signal line pair of the transceiver cable.

Input to the repeater's collision detection circuit is the 10 MHz collision presence signal from the transceiver. The collision signal is generated by the transceiver when:

- A collision is occurring, and
- A CPT signal is sent (see Section 4.4.1.4).

The collision presence signal enters the repeater via pins 2 and 9 of the transceiver connector. The collision presence pair of the transceiver cable is normally inactive except during the above conditions.

The output of the collision detection circuits is a steady voltage level (high or low) indicating the presence or absence of collision.

This output, called collision A (or collision B if from transceiver connector B), is used to drive the state machine and to increment the collision counter.

**4.4.1.2 Fiber-Optic Interface** – The fiber-optic interface is included only in remote repeaters using a fiber-optic cable.

The fiber-optic interface converts ECL data levels to optical signals for transmission via a fiber-optic cable. Conversely, the fiber-optic transceiver receives optical signals from a fiber-optic cable and converts them to ECL data levels. The ECL levels can be used by the repeater.

A block diagram of the fiber-optic interface is shown in Figure 4-3.

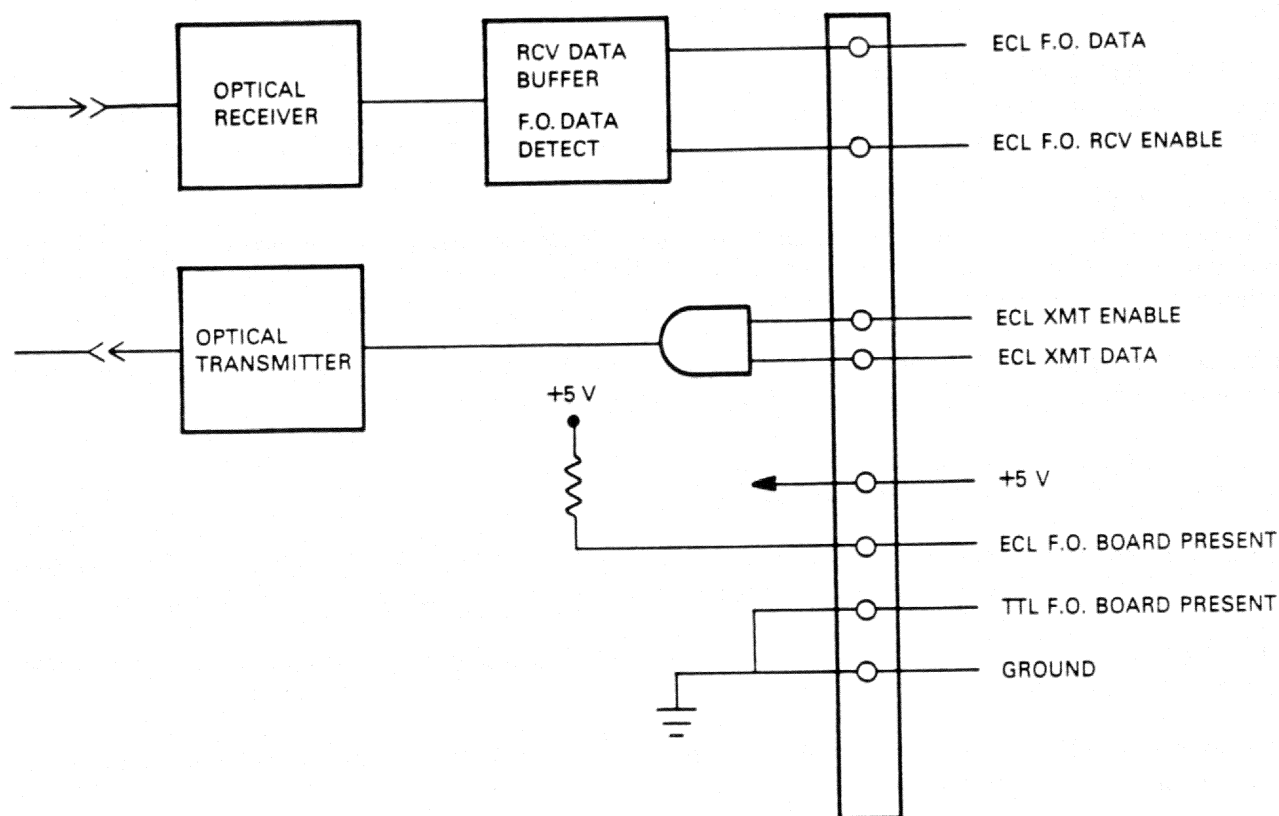
**4.4.1.3 Collision Counters** – Each side (A and B) of the repeater has its own collision counter.

The collision counter (for side A) increments when the collision presence pair on side A goes active while a packet is being transmitted to side A.

The collision counter (for side A) resets to 0 when 512 consecutive bits have been transmitted to side A with no collision presence being detected (512 bits = 51.2  $\mu$ s = slot time).

The collision counter for side B behaves in a like manner when similar conditions occur on side B.

When the repeater has the "Standby" switch in the "1" (enabled) position, the STANDBY H signal is set. The presence of this signal causes both the A and B counters to start counting from 8 instead of 1. This means that SEGMENT B (or A) is set after 56 consecutive collisions. When a standby repeater is active, SEGMENT B (or A) results in the repeater reentering the passive standby mode.



TK-10915

Figure 4-3 Fiber-Optic Interface Block Diagram

**4.4.1.4 CPT Detect** – A CPT signal is sent by the transceiver via the collision pair of the transceiver cable. The signal is sent within 2  $\mu$ s after the receive pair of the transceiver cable goes idle (after transmission by the repeater).

The CPT signal is a collision signal typically about 1  $\mu$ s in duration. CPT is used to verify the operation of the collision detect circuitry of the transceiver.

The repeater has two CPT detect circuits; one for each side (A and B) of the repeater.

Be aware that side B of local and remote repeaters has an identical circuit. However, in remote repeaters, the side B CPT detect circuit is disabled.

Input to the CPT detect circuit on side A is a synchronized collision presence signal from the collision detect circuit on side A. The CPT detect circuit is gated to look for the collision presence signal in a 3.2  $\mu$ s search window. The search window begins after a valid packet has been sent to side A with no collisions being detected.

If no CPT signal is detected, COLLISION ERROR (A or B) H is set signaling a malfunction in the collision detect circuitry. The appropriate rear panel LED(s) is latched ON indicating that a failure occurred. This latch is reset by any collision (or CPT) signal from the transceiver.

The CPT search window is terminated by RESET HOLDOFF which goes inactive 32 bit times (3.2  $\mu$ s) after carrier goes away.

**4.4.1.5 B Interface Select Multiplexer** – The select multiplexer is a quad 2 line-to-1 line multiplexer. This device selects data from the B transceiver connector or the fiber-optic interface if one is present.

Inputs to the select multiplexer are from the following sources.

- Transceiver interface B and its associated carrier detect, collision detect, and preamplifier circuits.
- The fiber-optic interface.

When no fiber-optic interface is present, the FO BOARD PRESENT line is inactive. This causes the multiplexer to select inputs from transceiver interface B for processing by the repeater.

When a fiber-optic interface is present, the FO BOARD PRESENT line is active. This causes the multiplexer to select inputs from the fiber-optic interface for processing by the repeater. FO BOARD PRESENT also disables the B transceiver interface.

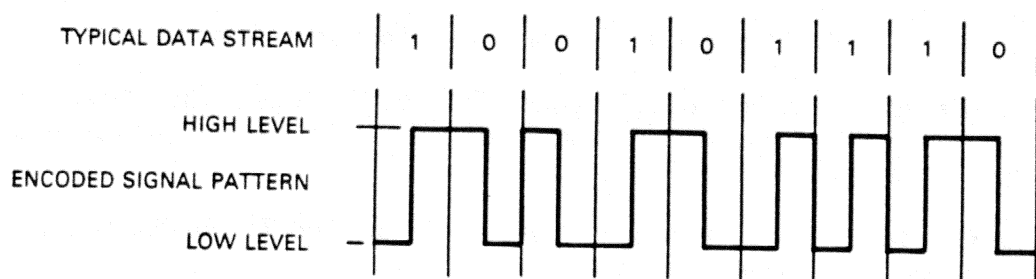
The outputs of the select multiplexer are CAR B, REC DATA B, and COL B.

**4.4.1.6 Receive Multiplexer** – The receive multiplexer acts as a 3 line-to-1 line multiplexer. The multiplexer is used to transfer one of three inputs to the Manchester decoder. The three inputs are:

- Encoded data from the B side of the repeater,
- Encoded data from transceiver connector A, and
- Encoded transmit data (for internal self-test loopback).

The receive multiplexer is controlled by the state machine and self-test circuit.

**4.4.1.7 Manchester Data Decoder** – Manchester encoded data from the receive multiplexer is decoded and the 10 MHz clock is recovered from the data stream. Manchester encoded data includes a self-synchronizing clock signal. Since the first half of each bit cell contains *inverse* data, and the second half contains *true* data, a clock signal can be recovered from the mid-bit transition of each bit cell. Figure 4-4 illustrates data that has been Manchester encoded.



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Figure 4-4 Manchester Encoded Data

The flip-flop that reads the incoming data is clocked by mid-cell transitions that have been delayed 75 ns (nanoseconds) by a delay line. Thus, the output of the flip-flop is always 25 ns into the next sequential bit cell and, therefore, always contains inverse data.

The clock signal is recovered by the same decoder.

Translators are used to convert decoded serial data (REC DATA) and clock (REC CLK) from ECL to TTL levels. The decoded TTL data levels are sent to the FIFO with the clock.

**4.4.1.8 FIFO** – The FIFO is a 32-bit circular register made up of four 8-bit latches and four 8-to-1 line multiplexers. A decoder, driven by counters, enables each 8-bit latch, in turn, to load and latch its outputs with eight consecutive data bits.

The multiplexers act as parallel-to-serial converters. Each multiplexer in succession is enabled by a binary counter and decoder to serially select each of its eight lines for transfer to the common output. The output is sent to the transmit multiplexer.

A block diagram of the FIFO register is shown in Figure 4-5.

**4.4.1.9 FIFO I/O Address Comparator** – The FIFO address comparator is made up of a 74LS85 comparator. This device compares the input address to the output address from the FIFO register. The comparator output (input = output) is used for FIFO control and to signal the state machine when the FIFO is empty.

**4.4.1.10 Slot-Time Counter** – The slot-time counter is made up of three 4-bit binary counters. The slot time is 51.2  $\mu$ s (512 bit times) and is the window in which collisions can legally occur. The slot-time counter begins as soon as the state machine exits the IDLE state and increments with the 10 MHz clock. Outputs of the slot-time counter are used for FIFO control, self-test control, and preamble generation.

**4.4.1.11 Preamble Generator** – The preamble generator uses the first bit of the slot-time counter. As soon as carrier is detected by the state machine, the slot-time counter begins counting. The generated preamble is used as an input to the transmit multiplexer.

The preamble count is incremented by each positive transition of the 10 MHz clock. When 63 positive clock transitions have occurred, the 63 BITS DONE signal is set. The 63 BITS DONE signal is used as one of several steering inputs to the transmit multiplexer.

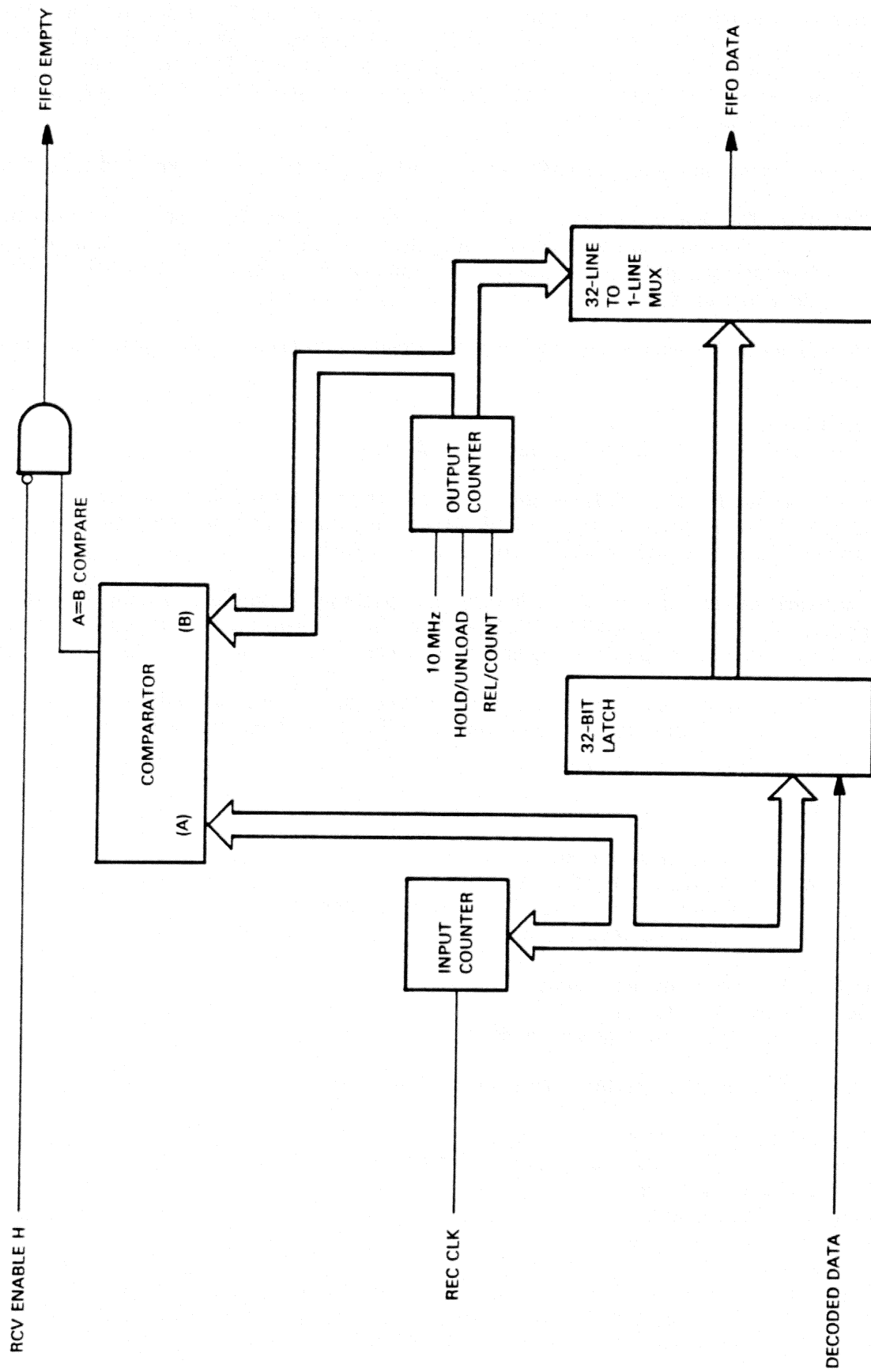
**4.4.1.12 EOP (End-of-Preamble) Detect** – The EOP detect circuit is made up of an EXCLUSIVE OR gate and a D flip-flop. Inputs to the EXCLUSIVE OR gate are:

- FIFO DATA, and
- DELAYED FIFO DATA (this is FIFO data that has been delayed one bit time).

Thus, two consecutive bits become the two inputs to the EXCLUSIVE OR gate. The EOP is made up of two consecutive like bits at the end of the preamble. Thus the EXCLUSIVE OR gate output goes low because both inputs are momentarily the same.

The output of the OR gate drives a D flip-flop that latches in the low state. The flip-flop output, EOP L, and EOP H are used as steering inputs to the transmit multiplexer.





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Figure 4-5 FIFO Block Diagram

**4.4.1.13 Transmit Multiplexer** – The transmit multiplexer selects retimed FIFO DATA or new PREAMBLE DATA (from the slot-time counter) for encoding and transmission. When the 63 BITS DONE signal from the preamble generator goes active, the multiplexer deselects PREAMBLE DATA and selects FIFO DATA. The transmit multiplexer ensures that the last two bits of the preamble are like bits; changing the last bit if needed.

The output of the transmit multiplexer is XMT DATA H which is Manchester encoded and transmitted.

**4.4.1.14 XMT Data Encoder (Manchester Encoder)** – The XMT (transmit) data encoder circuit is made up of four D flip-flops and an EXCLUSIVE OR gate. As XMT DATA H is clocked through the flip-flops, the leading edge of a 20 MHz clock causes the outputs to change states in the middle of each bit cell. This causes the first half of the output bit cell to contain inverse data.

**4.4.1.15 XMT (Transmit) Enable** – The XMT enable circuit routes encoded XMT data to the proper transceiver interface.

#### **4.4.2 Control Circuits**

The following sections describe individual repeater control circuits.

**4.4.2.1 Master Oscillator and Clock Generator** – The master oscillator is a 40 MHz crystal oscillator. Clock outputs of 20 MHz, 10 MHz, 5 MHz, and 2.5 MHz are tapped from a binary counter to control the repeater. Translated clocks are also provided to run the ECL encoder.

**4.4.2.2 Input Synchronizer** – The input synchronizer is a dual-ranked flip-flop. This flip-flop synchronizes asynchronous inputs (COL A, COL B, CAR A, and CAR B) with the repeater's 10 MHz clock. Synchronized inputs are used to run the repeater state machine.

**4.4.2.3 State Machine** – The state machine is a 16R8 PAL (programmed array logic). Synchronized inputs from the transceiver interfaces and inputs from the FIFO, go counter, and power-up reset circuits control the state machine.

These signals include:

- CAR A from transceiver interface A,
- COL A from transceiver interface A,
- CAR B from transceiver connector B or fiber-optic interface,
- COL B from transceiver interface B,
- FIFO EMPTY from the FIFO I/O comparator,
- JAM DONE from the jam counter,
- GO from the go counter, and
- SYNCH RESET H from power-up reset.

The outputs of the state machine perform the following functions:

- Start the slot-time counter,
- Route encoded XMT data to the proper transceiver interface,
- Control the jam counter,
- Control the go counter, and
- Control the self-test process.

**4.4.2.4 Jam Counter** – The jam counter is made up of two cascaded binary counters. The counter is controlled by JAM WAIT from the state machine and increments with each positive transition of the 10 MHz clock. When the jam counter reaches 128, JAM DONE H signals the state machine.

**4.4.2.5 Go Counter** – The go counter is an 8-bit binary counter that is enabled by the state machine.

During normal operation, the go counter defines a CPT detection window of 3.2  $\mu$ s.

During self-test, the go counter defines an interpacket gap of 12.6  $\mu$ s.

**4.4.2.6 Display Indicators and Drivers** – Power indicators for +5 V, +12 V, transceiver fuse A, and transceiver fuse B are LEDs that are visible from the rear of the repeater unit. These indicators are turned ON when the associated voltage levels are present at the LED.

Remaining indicator LEDs are turned ON when the appropriate error or status conditions enable the associated gate.

**4.4.2.7 Power-up Reset** – After power-up, two pulses (RESET L and RESET H) are generated. These pulses perform the following repeater functions.

- Initiates the internal self-test (after synchronizing with the internal clock through a dual-ranked flip flop).
- Generates SYNCH RESET L that resets the collision counters to 0.
- Turns ON (momentarily) all LEDs and then resets latched error LED indications.

RESET L and RESET H are also generated when the self-test button is pressed. In this case, RESET L and RESET H work in conjunction with SELF TEST L and EXTERNAL TEST L to initiate the external self-test.

**4.4.2.8 Power Supply** – The power supply can operate from either 115 Vac or 230 Vac (50 Hz – 60 Hz). A switch on the repeater's rear panel must be set for the appropriate input voltage.

The following output voltages are available.

- +5 volts
- +12 volts (for transceiver power)
- Ground
- Separate +12 volt supply lead for the fan



## **CHAPTER 5 MAINTENANCE**

### **5.1 SCOPE**

This chapter provides information for maintaining the local repeater and the remote repeater. Included in this chapter are:

- Maintenance philosophy,
- Preventive maintenance,
- Corrective maintenance, and
- Repeater disassembly.

### **5.2 MAINTENANCE PHILOSOPHY**

Maintenance of the Ethernet repeater consists of preventive and corrective maintenance procedures. Instructions for replacing faulty FRUs are provided as part of the corrective maintenance procedures.

The local repeater FRUs are:

- Logic module,
- Power supply chassis, and
- AC power cable.

The remote repeater FRUs are:

- Logic module,
- Power supply chassis,
- Fiber-optic interface, and
- AC power cable.

#### **5.2.1 Required Equipment**

For local repeaters, fault isolation to the FRU may be achieved by using the state indicator LEDs on the rear of the repeater. No special equipment is required to isolate faults to this level.

For remote repeaters, a fiber-optic turnaround test connector may be required for some fault isolation procedures.

The fiber-optic turnaround test connector is a 19.05 cm (7.5 in) fiber-optic cable loop. This test connector replaces the fiber-optic cable for off-line testing of a remote repeater.

#### **5.2.2 Optional Equipment**

The following two test devices may be helpful in performing some corrective maintenance procedures. Note that the test devices are not supplied.

- H4080 turnaround test connector

This connector is a modified transceiver. The H4080 test connector can replace an on-line transceiver for off-line self-testing of the repeater. For more information, consult the *H4080 User's Manual*.

- H4000-TA (or TB) Ethernet transceiver tester

This tester transmits a packet onto an Ethernet coaxial segment (via a transceiver). The tester then monitors the transmission via a second transceiver and verifies network operation. For further information consult the *Ethernet Transceiver Tester User's Manual*.

### 5.3 PREVENTIVE MAINTENANCE (PM)

Preventive maintenance involves a periodic exercise of the repeater self-test. There is no specific PM schedule, however, the self-test should be exercised when network PM is performed.

PM is especially important in installations that use primary and backup repeaters. In these cases, it is possible for a repeater failure to go unnoticed until either both repeaters fail or until the failure is detected during PM.

The repeater self-test is performed on two levels.

- Internal loopback is automatically performed when the repeater is turned ON. See Figures 5-1 and 5-2 for diagrams of the internal loopback tests.
- Internal and external loopback are both performed when the self-test button is momentarily pressed and released. See Figures 5-1 and 5-2 for diagrams of the loopback tests.

#### NOTE

**Repeater operations are suspended during the time that the self-test button is depressed, and while the self-test is executing. Normal repeater operations are resumed after the self test successfully completes.**

#### 5.3.1 Internal Self-Test

The internal self-test generates an internal loopback of encoded data to side A and to side B of the repeater\*. This test exercises the logic module only. The transceiver cable interface and/or fiber-optic cable interface are not exercised. See Figures 5-1 and 5-2 for block diagrams of the internal self-test.

The internal self-test for the local and remote repeaters is *identical*.

#### 5.3.2 External Self-Test

The external self-test generates external loopback of encoded data to side A and then to side B of the repeater\*.

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\* Side A of the repeater refers to the transceiver interface and circuitry associated with transceiver connector A on the rear of the repeater.

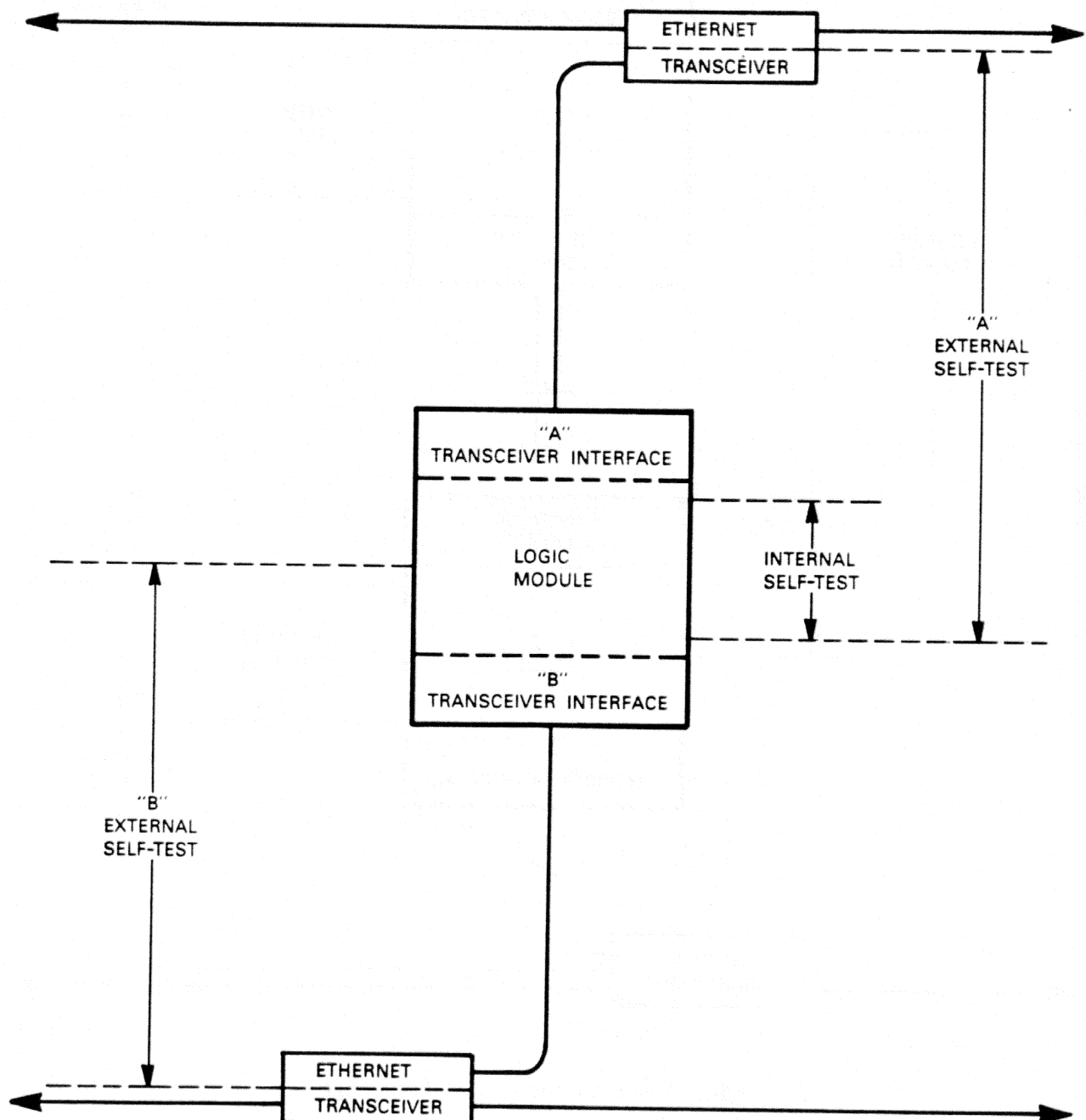
Side B of the repeater (for local repeaters) refers to the transceiver interface and circuitry associated with transceiver connector B on the rear of the repeater.

Side B of the repeater (for remote repeaters) refers to the circuitry associated with the fiber-optic interface on the rear of the repeater.

In local repeaters, signal turnaround occurs in the transceivers (see Figure 5-1). In remote repeaters, signal turnaround occurs in the local transceiver and in the remote half of the repeater (see Figure 5-2).

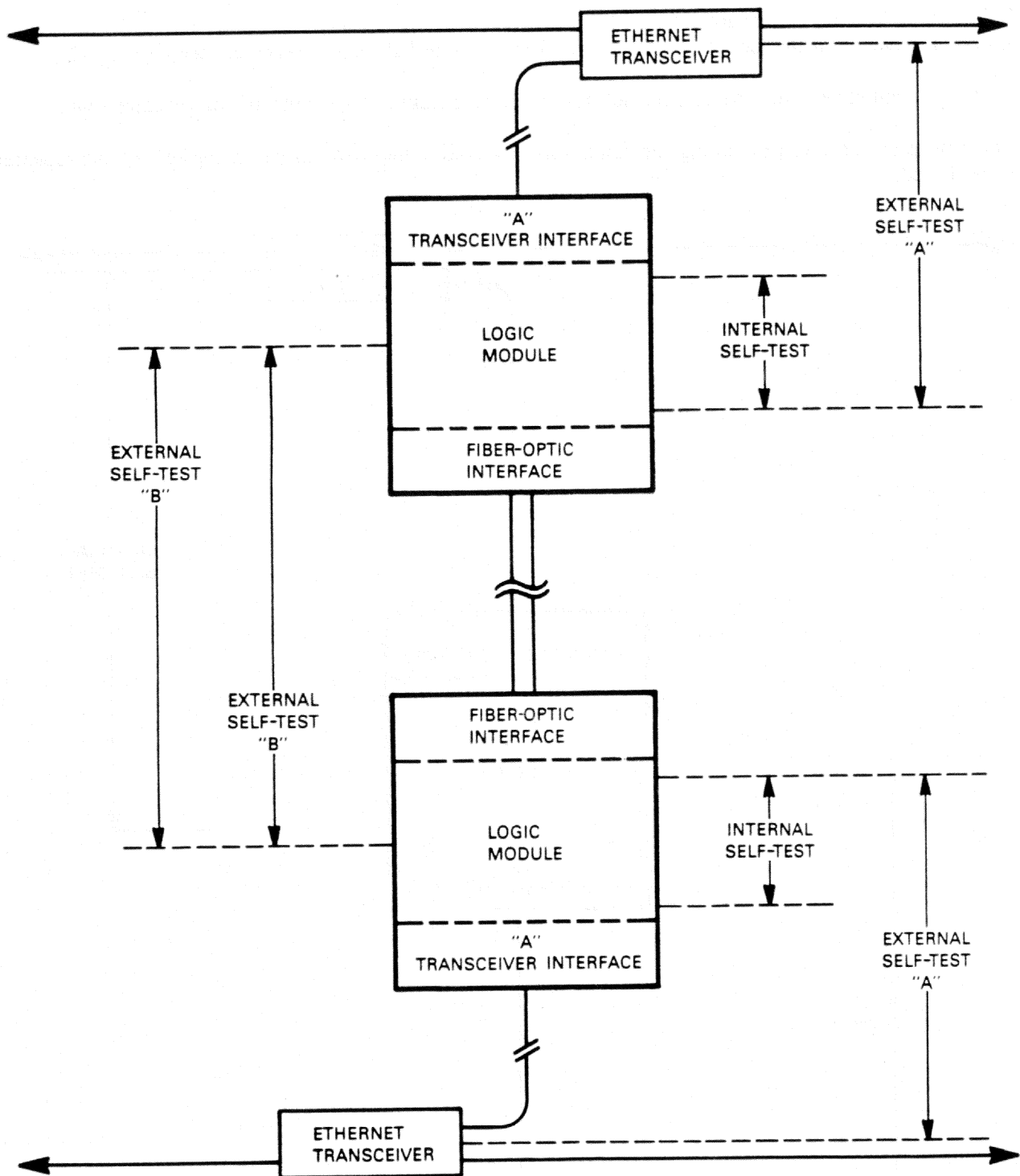
To test the entire remote repeater, the self-test must be executed from both of the repeater units.

Test results are observed by noting the conditions of the state indicator LEDs on the rear of the repeater being tested.



TK-10911

Figure 5-1 Local Repeater Self-Test Diagram



TK-10912

Figure 5-2 Remote Repeater Self-Test Diagram



### 5.3.3 Executing the Repeater Self-Test

To initiate the repeater self-test, perform the following.

1. To run internal self-test only, press the power switch to "0" (OFF). Wait five seconds and press the power switch to "1" (ON).

Observe the LEDs on the rear of the repeater. No error LEDs should remain lit (TST, FLT, INT, or ERR). If any of these LEDs remain lit, follow the recommended procedures in this chapter.

2. To run internal and external self-test, momentarily press and release the self-test button on the rear of the repeater. All LEDs should light while the self-test button is pressed and held down.

#### NOTES

1. Normal repeater operations are suspended during the self-test.
  2. All LEDs should light when the "TST" button is held in.
  3. Remote repeaters do not pass external self-test unless both repeater units are fully connected and turned ON.
3. Observe the LEDs on the rear of the repeater being tested. A successful pass is indicated when no self-test error LEDs remain lit. Figure 5-3 shows a typical LED status after self-test has successfully completed.

If the self-test LED remains steadily lit (typically for more than .5 seconds), a failure mode is indicated. In this case, the specific failure mode may be determined by observing the conditions of the other LEDs. Specific failure modes are identified in Section 5.4.

### 5.4 CORRECTIVE MAINTENANCE

Corrective maintenance should be performed once it has been determined that a faulty repeater exists. Corrective maintenance comprises fault isolation to, and replacement of, the faulty FRU. Fault isolation is accomplished by running the self-test and analyzing the results indicated by the LEDs on the rear of the repeater.

It is possible that a fault will exist in the transceiver or other equipment electrically close to the repeater. In some cases, this type of fault may initially appear to be in the repeater. However, careful exercise of the troubleshooting procedures in this section should isolate the fault to the repeater FRU or point to other possible sources of malfunction.

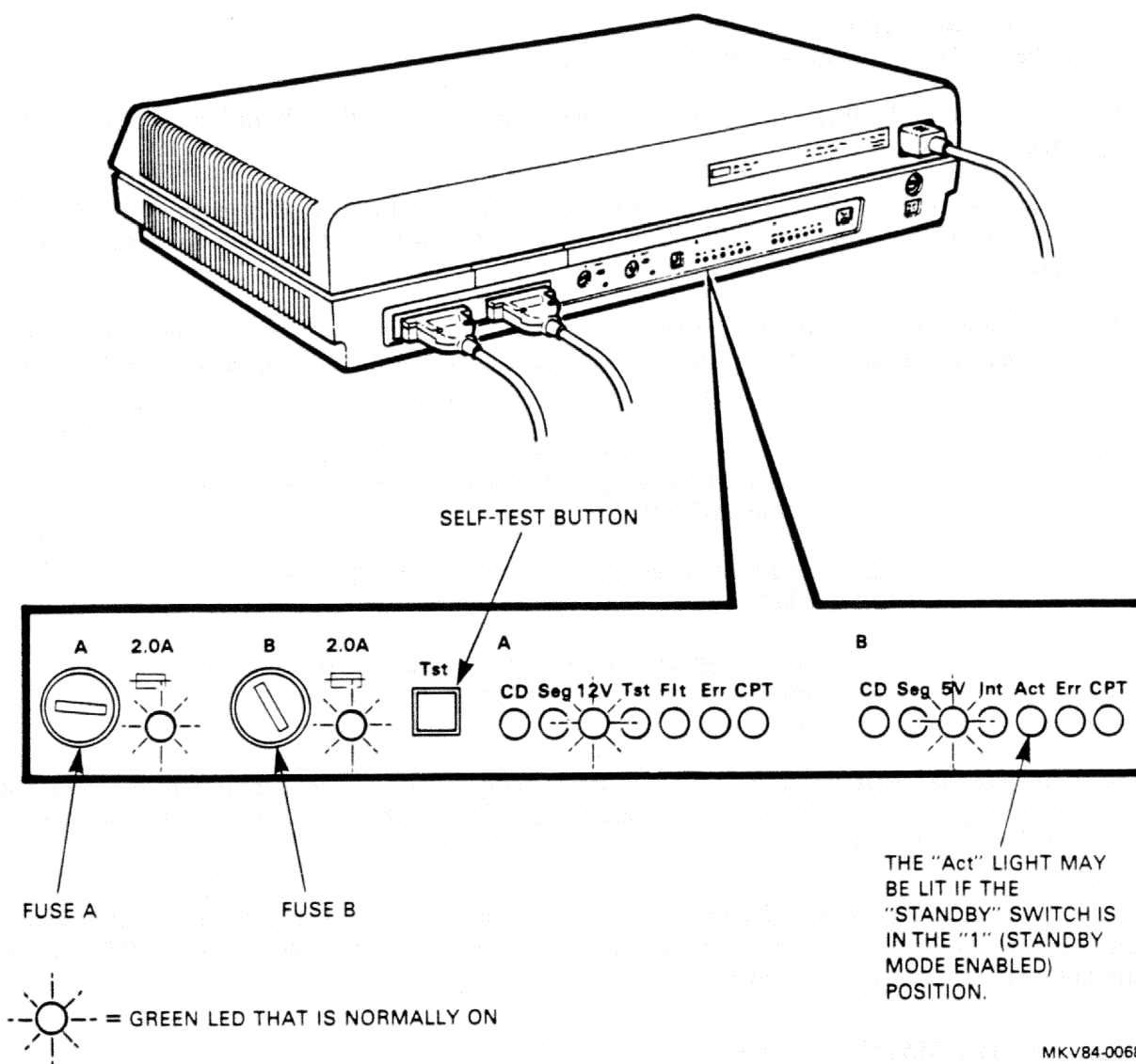


Figure 5-3 Typical LED Status

#### 5.4.1 Troubleshooting Tips

The following tips are suggested as aids to troubleshooting.

- When problems are suspected, always ensure that the repeater is receiving the correct voltage and that all cables are properly connected.
- When interchanging local repeater inputs:

Note that the A and B inputs to local repeaters are identical, and reversing the transceiver cable inputs should have no effect on the functions of the repeater. Intentionally reversing transceiver cable inputs is a routine troubleshooting procedure for local repeaters.

For example, when transceiver cables are reversed, malfunctions existing outside the repeater appear to move to the repeater's other side (from side A to side B or vice-versa). In contrast, malfunctions existing within the repeater generally remain with the repeater's same side even when transceiver cables are reversed.

#### 5.4.2 Repeater LED Indications

This section describes each of the LEDs on the repeater rear panel and suggests procedures to be followed in the event that an abnormal indication is present.

When a repeater is suspected of a malfunction, first examine the LEDs to determine if the repeater is functioning.

The following chart provides a quick reference to normal LED conditions. Numbers in parentheses reflect non-U.S. LED designations.

ON	Occasionally Flickering (see note)	OFF
5V (12) 12V (5) FUSE A FUSE B	CD A (3) CD B (10)	All others

#### NOTE

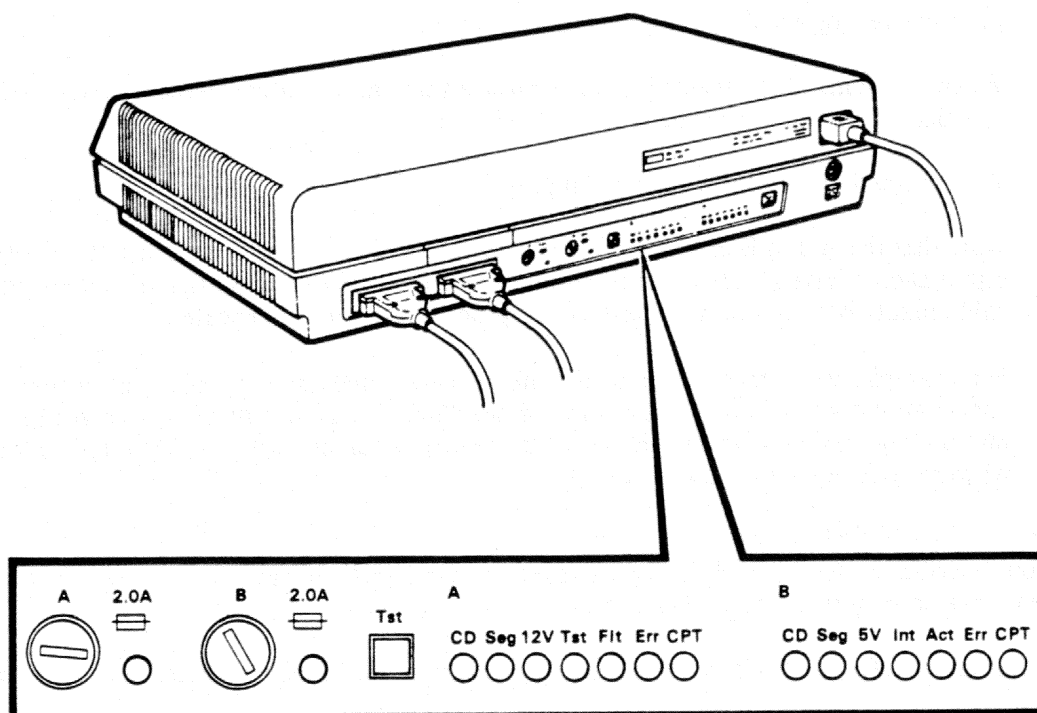
These lights turn ON indicating when activity on the associated coaxial segment has been transmitted to the repeater's other side. During heavy network traffic, these LEDs may appear to be steadily ON.

Figure 5-4 shows the repeater LEDs and associated definitions.

Table 5-1 contains a more complete description of LEDs and recommended corrective procedures.

#### 5.4.3 Self-Test Errors and Troubleshooting

Table 5-2 describes self-test error indications and outlines recommended procedures to be followed when self-test errors occur.



LED #	LED NAME	COLOR	DEFINITION
1	2.0A	GREEN	FUSE A FUNCTIONING
2	2.0A	GREEN	FUSE B FUNCTIONING
1	CD	GREEN	CARRIER RECEIVED ON B AND TRANSMITTED TO A
2	SEG	YELLOW	REPEATER WAS SEGMENTED ON SIDE A
3	12V	GREEN	+12 VOLT SUPPLY FUNCTIONING
4	TST	RED	EXECUTING SELF-TEST
5	FLT	RED	CURRENTLY SEGMENTED
6	ERR	RED	EXTERNAL SELF-TEST ERROR ON SIDE A
7	CPT	RED	CPT ERROR ON SIDE A
1	CD	GREEN	CARRIER RECEIVED ON A AND TRANSMITTED TO B
2	SEG	YELLOW	REPEATER WAS SEGMENTED ON SIDE B
3	5V	GREEN	+5 VOLT SUPPLY FUNCTIONING
4	INT	RED	EXECUTING INTERNAL SELF-TEST
5	ACT	RED	STANDBY ACTIVE
6	ERR	RED	EXTERNAL SELF-TEST ERROR ON SIDE B
7	CPT	RED	CPT ERROR ON SIDE B

MKV84-0050

Figure 5-4 LED Definitions

**Table 5-1 LEDs and Troubleshooting**

LED Name	LED Definition	Normal State	Indications/ <i>Corrective Action</i>
2.0A	FUSE A	ON	<p>This (green) LED indicates that the +12 V transceiver power fuse on side A is good.</p> <p>When OFF, this indicates that either the fuse is blown or that +12 V is not reaching the fuseholder.</p> <ol style="list-style-type: none"> <li>1. <i>Check the fuse. If blown, replace it with correct fuse</i>  <i>(2 A - Digital Equipment Corporation part number 90-07215-00).</i></li> <li>2. <i>If the fuse continues to blow, try connecting to a different transceiver or transceiver cable.</i></li> <li>3. <i>Check other indicators (5V and 12V LEDs) to determine that the repeater is properly powered.</i></li> <li>4. <i>Verify that the power switch is ON, and that the power cord is connected to the proper voltage source. Check the line fuse (refer to Note 1 at the end of this table).</i></li> </ol>
2.0A	FUSE B	ON	Similar to 2.0A (side A)
5V	+5 volts	ON	<p>This (green) LED indicates that the +5 V circuit of the power supply is functioning.</p> <p>When OFF, this may indicate that the +5 V circuit is not functioning.</p> <ol style="list-style-type: none"> <li>1. <i>Check the 12V LED to determine whether the power supply is functioning.</i></li> <li>2. <i>Check the FUSE A and FUSE B LEDs. These LEDs indicate that +12 V is being supplied to the transceivers.</i></li> <li>3. <i>Verify that the power switch is ON and that the power cord is connected to the proper voltage source. Check the line fuse (refer to Note 1 at the end of this table).</i></li> </ol>

**Table 5-1 LEDs and Troubleshooting (Cont)**

<b>LED Name</b>	<b>LED Definition</b>	<b>Normal State</b>	<b>Indications/Corrective Action</b>
			<ol style="list-style-type: none"> <li>4. <i>Press the self-test button. All LEDs should light while the button is pressed. If all LEDs (with the exception of the 5V LED) turn ON, the 5V LED is defective. Replace the logic module.</i></li> <li>5. <i>If the above procedures do not correct the problem, replace the power supply.</i></li> </ol>
12V	+12 volts	ON	<p>This (green) LED indicates that the +12 V circuit of the power supply is functioning.</p> <p>When OFF, this indicates that the +12 V circuit is not functioning.</p> <ol style="list-style-type: none"> <li>1. <i>Check the 5V LED to determine that ac power is reaching the power supply.</i></li> <li>2. <i>Check the FUSE A and FUSE B LEDs. These LEDs indicate that +12 V is being supplied to the transceivers.</i></li> <li>3. <i>Verify that the power switch is ON and that the power cord is connected to the proper voltage source. Check the line fuse (refer to Note 1 at the end of this table).</i></li> <li>4. <i>Note whether the fan is running. The fan operates on +12 V and indicates that part of the +12 V section of the power supply is functioning.</i></li> <li>5. <i>Press the self-test button. All LEDs should light while the button is pressed. If all LEDs (with the exception of the 12V LED) turn ON, the 12V LED is defective. Replace the logic module.</i></li> <li>6. <i>If the above procedures do not correct the problem, replace the power supply.</i></li> </ol>

**Table 5-1 LEDs and Troubleshooting (Cont)**

LED Name	LED Definition	Normal State	Indications/ <i>Corrective Action</i>
CD (A)	Carrier Detect A	Should Flicker	<p>This (green) LED flickers when data packets are received from side B AND transmitted to side A. During heavy network traffic, this LED may appear to be steadily lit.</p> <p>When continuously OFF, this may indicate that:</p> <ul style="list-style-type: none"> <li>• There is no traffic on side B.</li> <li>• The transceiver on side B is not functioning.</li> <li>• The carrier detect circuit on side B is not functioning.</li> <li>• The carrier A LED is not functioning.</li> </ul> <ol style="list-style-type: none"> <li>1. <i>Check other indicators (FUSE A, FUSE B, 5V, and 12V LEDs) to determine that the repeater is properly powered and whether the transceiver is getting power.</i></li> <li>2. <i>Press the self-test button. All LEDs should light while the button is pressed. If the Carrier A LED fails to turn ON, the LED is defective. Replace the logic module. If the LED lights, note the results of the self-test (see Table 5-2).</i></li> <li>3. <i>For local repeaters, interchange transceiver cable inputs.</i> <ol style="list-style-type: none"> <li>a. <i>Try swapping transceiver cable inputs to see if the inactive indications shift to side B of the repeater (refer to Note 2 at the end of this table).</i></li> <li>b. <i>If the indication does shift to the other side of the repeater, suspect inactivity on that segment, or a problem with the transceiver and/or transceiver cable.</i></li> <li>c. <i>If the indication stays with side A, check FUSE B. If FUSE B is good, change the logic module.</i></li> </ol> </li> </ol>

**Table 5-1 LEDs and Troubleshooting (Cont)**

LED Name	LED Definition	Normal State	Indications/Corrective Action
			<ol style="list-style-type: none"> <li>4. <i>For remote repeaters, try using a different transceiver or transceiver cable (refer to Note 2 at the end of this table).</i> <ol style="list-style-type: none"> <li>a. <i>If the CD indication improves, suspect a problem in the transceiver or transceiver cable.</i></li> <li>b. <i>If the CD indication does not improve, suspect inactivity (no traffic) on side B or a faulty logic module.</i></li> </ol> </li> </ol>
CD (B)	Carrier Detect B	Should Flicker	Similar to CD (A)
CPT Error A	Collision Presence Test Error (Side A)	OFF	<p>This (red) LED latches ON to indicate that a CPT signal was not detected on side A following a previous data transmission to side A. The CPT signal is sent from the transceiver via the collision pair to indicate that the collision detect circuitry is functional.</p> <p>The absence of CPT suggests:</p> <ul style="list-style-type: none"> <li>• A malfunction in the collision detect circuitry.</li> <li>• A malfunction in the transceiver or transceiver cable.</li> <li>• Excessive transceiver cable length (over 50 m [164 ft]).</li> </ul> <ol style="list-style-type: none"> <li>1. <i>Press the self-test button to reset the error indication. Note that CPT detect is turned OFF during self-test. Monitor the LED for reoccurrence of CPT error.</i></li> <li>2. <i>For local repeaters, interchange transceiver cable inputs.</i> <ol style="list-style-type: none"> <li>a. <i>Try swapping transceiver cable inputs to see if the CPT error indication shifts to side B of the repeater (refer to Note 2 at the end of this table).</i></li> <li>b. <i>If the indication does shift to the other side of the repeater, suspect a problem with the transceiver and/or transceiver cable.</i></li> </ol> </li> </ol>



**Table 5-1 LEDs and Troubleshooting (Cont)**

LED Name	LED Definition	Normal State	Indications/Corrective Action
			<p>c. <i>If the indication stays with side A, suspect a problem in the CPT detect circuitry. Replace the logic module.</i></p> <p>3. <i>For remote repeaters, try using a different transceiver or transceiver cable (refer to Note 2 at the end of this table).</i></p> <p>a. <i>If the CPT error indication goes away, suspect a problem in the transceiver or transceiver cable.</i></p> <p>b. <i>If the CPT error indication remains, suspect inactivity (no traffic) on side B or a faulty logic module.</i></p>
CPT Error B	Collision Presence Test Error (Side B)	OFF	<p>For local repeaters this indication is similar to CPT Error A.</p> <p>For remote repeaters, the CPT circuit on side B is disabled.</p>
FLT	Fault	OFF	<p>When ON, this (red) LED indicates that one of the transceivers and its associated coaxial segments is currently segmented or faulty (refer to Note 3 at the end of this table).</p> <p>1. <i>Observe the SEG A and SEG B LEDs. At least one of these should be latched ON to indicate which side is segmented.</i></p> <p>2. <i>Be aware that the conditions which resulted in segmentation could cease to exist appearing possibly as an intermittent malfunction.</i></p> <p>3. <i>Run the self-test and note the results (refer to Table 5-2).</i></p> <p>4. <i>For local repeaters only, interchange transceiver cable inputs (refer to Note 2 at the end of this table).</i></p> <p>a. <i>Swap transceiver cable inputs to see if the segmented indication shifts to side B of the repeater.</i></p>

Table 5-1 LEDs and Troubleshooting (Cont)

LED Name	LED Definition	Normal State	Indications/Corrective Action
			<ul style="list-style-type: none"> <li>b. <i>If the indication does shift to the other side of the repeater, suspect a problem outside the repeater such as a transceiver, transceiver cable, or coaxial segment.</i></li> <li>c. <i>If the indication stays with side A, suspect a problem in the collision detect circuitry. Replace the logic module.</i></li> </ul>
Act	Standby Active	OFF	<p>When ON, this (red) LED indicates that the repeater is in the active standby mode. The standby mode becomes active when the primary repeater has failed or when no primary repeater exists.</p> <p><i>Check the LEDs on the rear of the primary repeater. Follow the suggested corrective procedures.</i></p>
SEG (A)	Segmented A	OFF	<p>This (yellow) LED indicates that side A was segmented at least once since the last self-test or power-up was performed (refer to Note 3 at the end of this table).</p> <ul style="list-style-type: none"> <li>1. <i>Note whether side A is currently segmented (the FLT LED would be ON). Press the self-test button to reset the segmented LEDs and to run the self-test. Note the self-test results in Table 5-2.</i></li> <li>2. <i>For local repeaters, try interchanging transceiver cable inputs:</i> <ul style="list-style-type: none"> <li>a. <i>Swap transceiver cable inputs to see if the segmented indication shifts to side B of the repeater (refer to Note 2 at the end of this table).</i></li> <li>b. <i>If the indication does shift to the other side of the repeater, suspect a problem outside the repeater such as a transceiver, transceiver cable, or coaxial segment.</i></li> <li>c. <i>If the indication stays with side A, suspect a problem in the collision detect circuitry. Replace the logic module.</i></li> </ul> </li> </ul>

**Table 5-1 LEDs and Troubleshooting (Cont)**

LED Name	LED Definition	Normal State	Indications/Corrective Action
			<p>3. <i>For remote repeaters:</i></p> <p>a. <i>If side A is not currently segmented (the FLT LED is OFF), press the self-test button to reset the SEG LED and to run the self-test. Note the self-test results in Table 5-2.</i></p> <p>b. <i>If side A is currently segmented (the FLT LED is ON), try using a different transceiver or transceiver cable (refer to Note 2 at the end of this table).</i></p> <p><i>If the segmented condition ends, suspect a faulty transceiver or transceiver cable.</i></p> <p><i>If the condition persists, suspect the coaxial cable or its associated equipment.</i></p>
SEG (B)	Segmented B	OFF	Similar to SEG (A)

**NOTES**

1. Turn OFF the repeater and unplug the power cord before checking the line fuse.
2. Turn the repeater OFF before unplugging any cables.
3. Segmentation is an unusual condition resulting from loss of data loopback or from 64 consecutive unsuccessful attempts to transmit a packet. If the A or B segmented indicator is frequently found "ON", it may indicate intermittent problems on the coaxial segment or its associated equipment.

Table 5-2 Self-Test Error LEDs

LED Name	LED Definition	Normal State	Indications/ <i>Corrective Action</i>
TST	Self-Test Executing	OFF	<p>This (red) LED lights briefly (typically .3 seconds) on power-up and on pressing the "TST" (self-test) button. This indicates that the repeater self-test is executing.</p> <p>If the "TST" LED remains lit, the self-test has failed (the repeater never exits self-test).</p> <ol style="list-style-type: none"> <li>1. <i>A remote repeater unit which is failing self-test (the "TST" LED is ON) causes the remaining unit to fail (external) self-test. This problem can be minimized by resetting both units.</i> <ol style="list-style-type: none"> <li>a. <i>Turn each unit OFF for five seconds and then back ON.</i></li> <li>b. <i>Observe the LEDs at this point.</i></li> <li>c. <i>Run self-test on the "good" unit to verify its operation.</i></li> </ol> </li> <li>2. <i>Note the condition of the other self-test LEDs (for both local and remote repeaters):</i> <ol style="list-style-type: none"> <li>a. <i>"INT" (internal self-test)</i></li> <li>b. <i>"ERR" (self-test error A)</i></li> <li>c. <i>"ERR" (self-test error B)</i></li> </ol> </li> </ol>
INT	Internal Self-Test	OFF	<p>When ON, this (red) LED indicates that the repeater is in the internal self-test state. If a data error is found during internal or external self-test, the repeater locks itself into the internal self-test state. This state is maintained until the repeater is reset (turned OFF for five seconds and then turned back ON).</p> <ol style="list-style-type: none"> <li>1. <i>Turn the repeater OFF, wait five seconds, and turn the repeater ON. Only the internal test is performed on power-up (the internal test executes with or without transceiver cables and/or fiber-optic cables being connected).</i></li> <li>2. <i>If the "INT" LED still remains lit, a malfunction exists in the logic module.</i></li> </ol>

**Table 5-2 Self-Test Error LEDs (Cont)**

LED Name	LED Definition	Normal State	Indications/Corrective Action
			<p>3. <i>If the "INT" LED does not remain lit after power-up, press and release the "TST" button. The transceiver cable and/or fiber-optic cable must be connected (for remote repeaters both units must be ON). This runs both the internal and external self-test. Note the conditions of the "ERR" LEDs for the A and B sides.</i></p>
ERR (A)	Self-Test Error A	OFF	<p>This (red) LED lights when the self-test has detected an internal or external data loopback error on side A.</p> <p>If the ERR (A) LED remains ON after the internal test, a malfunction exists in the logic module of the repeater.</p> <p>If this LED remains ON after the external self-test only, a malfunction may exist in:</p> <ul style="list-style-type: none"> <li>• The transceiver cable interface.</li> <li>• The transceiver cable.</li> <li>• The transceiver connected to side A.</li> <li>• The coaxial segment on side A.</li> </ul> <p>1. <i>For local repeaters:</i></p> <ol style="list-style-type: none"> <li>a. <i>Try swapping transceiver cable inputs to see if the error indication shifts to side B of the repeater. Refer to the note at the end of this table.</i></li> <li>b. <i>If the indication does shift to side B, suspect a problem outside the repeater. Typically, such a problem might be the transceiver, transceiver cable, or other equipment on the associated coaxial segment.</i></li> <li>c. <i>If the problem remains on side A after swapping transceiver cable inputs, the logic module should be changed.</i></li> </ol>

**Table 5-2 Self-Test Error LEDs (Cont)**

<b>LED Name</b>	<b>LED Definition</b>	<b>Normal State</b>	<b>Indications/Corrective Action</b>
			<p>2. <i>For remote repeaters:</i></p> <p>a. <i>Try using a different transceiver or transceiver cable (see the note at the end of this table).</i></p> <p>b. <i>Turn the repeater power ON and rerun the external self-test (press and release the "TST" button).</i></p> <p><i>If the "ERR" (A) indication goes away, suspect a problem in the transceiver cable, the transceiver, or associated coaxial segment.</i></p> <p><i>If the "ERR" (A) indication remains, replace the logic module.</i></p>
<b>ERR (B)</b>	<b>Self-Test Error B</b>	<b>OFF</b>	<p>This (red) LED lights when the self-test has detected an internal or external data loopback error on side B.</p> <p>1. <i>For local repeaters, indications and procedures are similar to "ERR" (A).</i></p> <p>2. <i>For remote repeaters, use the following procedures when the "ERR" (B) LED remains lit following the external self-test.</i></p> <p>a. <i>Turn the repeater OFF.</i></p>

**Table 5-2 Self-Test Error LEDs (Cont)**

LED Name	LED Definition	Normal State	Indications/ <i>Corrective Action</i>
			<p>b. <i>Disconnect the fiber-optic cable and install a fiber-optic turnaround connector in its place (see the note at the end of this table).</i></p> <p>c. <i>Press and release the "TST" button.</i></p> <p><i>If the "ERR" (B) indication remains, suspect the fiber-optic interface or the logic module.</i></p> <p><i>If the "ERR" (B) indication goes away, suspect the remote repeater unit or the fiber-optic cable. Perform the self-test on the remote unit.</i></p> <p><b>CAUTION:</b> Fiber-optic turnaround connectors cause collisions while they are connected. <b>ALWAYS</b> remove a fiber-optic turnaround connector after testing is completed.</p>
			<p><b>NOTE</b></p> <p>Turn repeater power OFF before disconnecting any cables. Turning the power OFF resets error indications.</p>

## **5.5 REPEATER DISASSEMBLY**

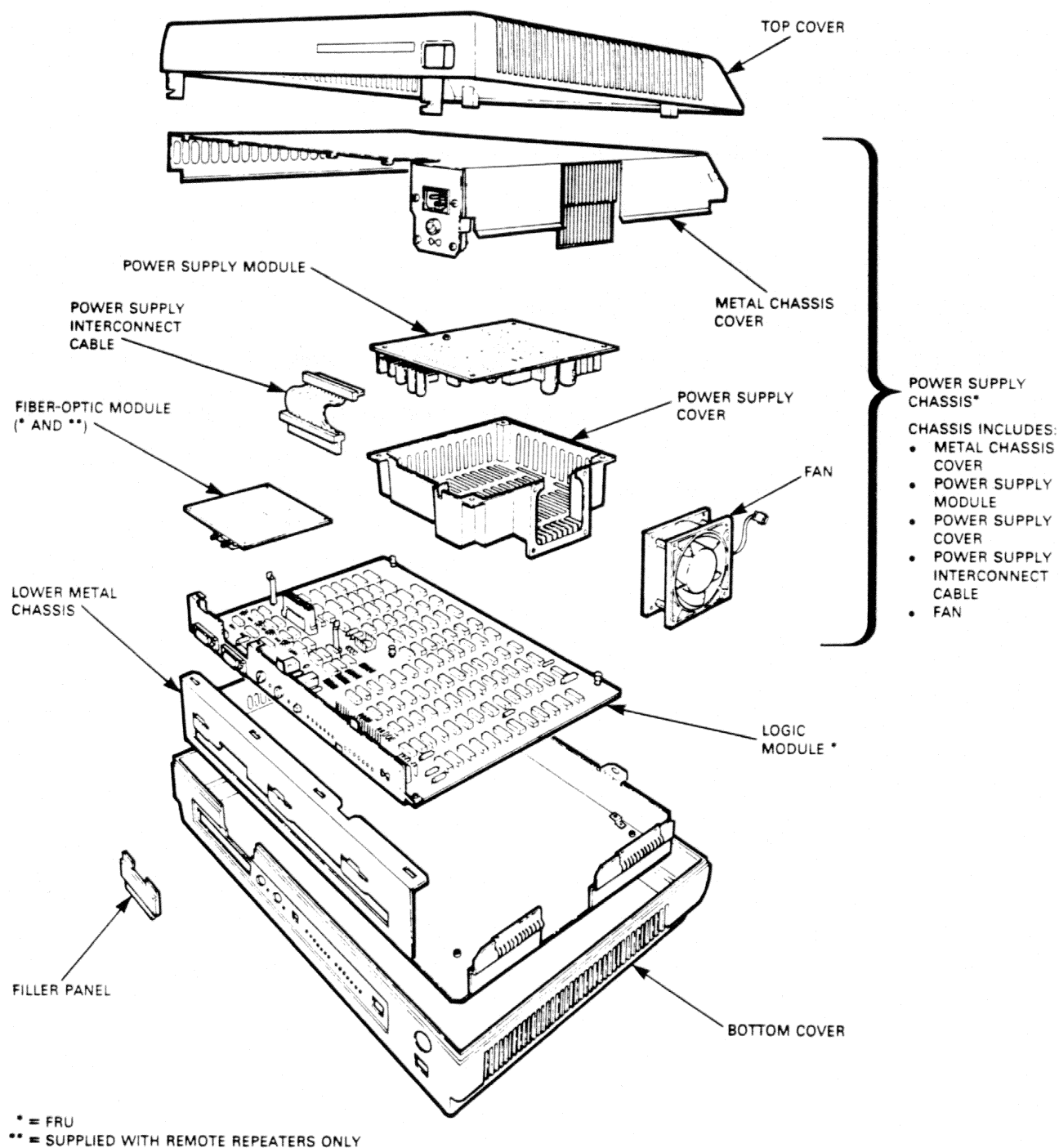
It is necessary to disassemble the repeater to repair or replace a defective FRU. Figure 5-5 shows the location of all FRUs in the repeater.

### **WARNING**

**To prevent electrical shock and damage to components, turn OFF power and disconnect all cables attached to the repeater before opening the chassis.**

The instructions in this section assume that all external cables to the repeater have been removed. When removing cables, be sure that they are properly marked so that they are reconnected in the same locations.



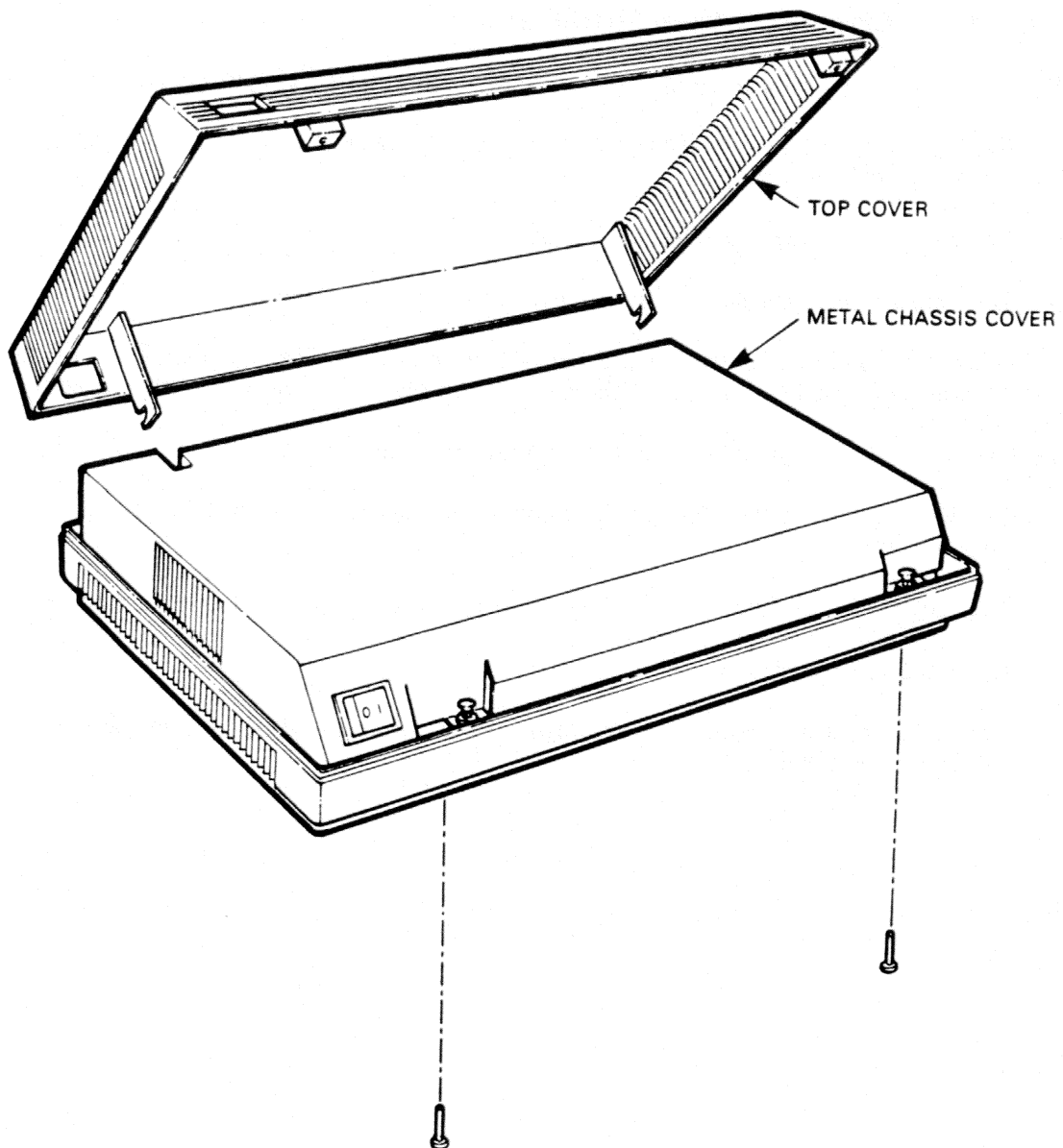


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Figure 5-5 Repeater FRU Locations

### 5.5.1 Opening and Closing the Repeater

- Perform the following steps to open the repeater (refer to Figure 5-6).
  - Remove the two slotted screws from the bottom of the repeater.
  - Lift the front of the top cover up.
  - Completely remove the top cover and set aside.
- Perform the following steps to close the repeater.
  - Align the top and bottom covers holding the front of the top cover in the open position.
  - Carefully close the cover making sure that the tabs on the rear of the top cover fit into the catches in the rear of the bottom cover.
  - Insert the two slotted screws into the two holes in the bottom cover and tighten.

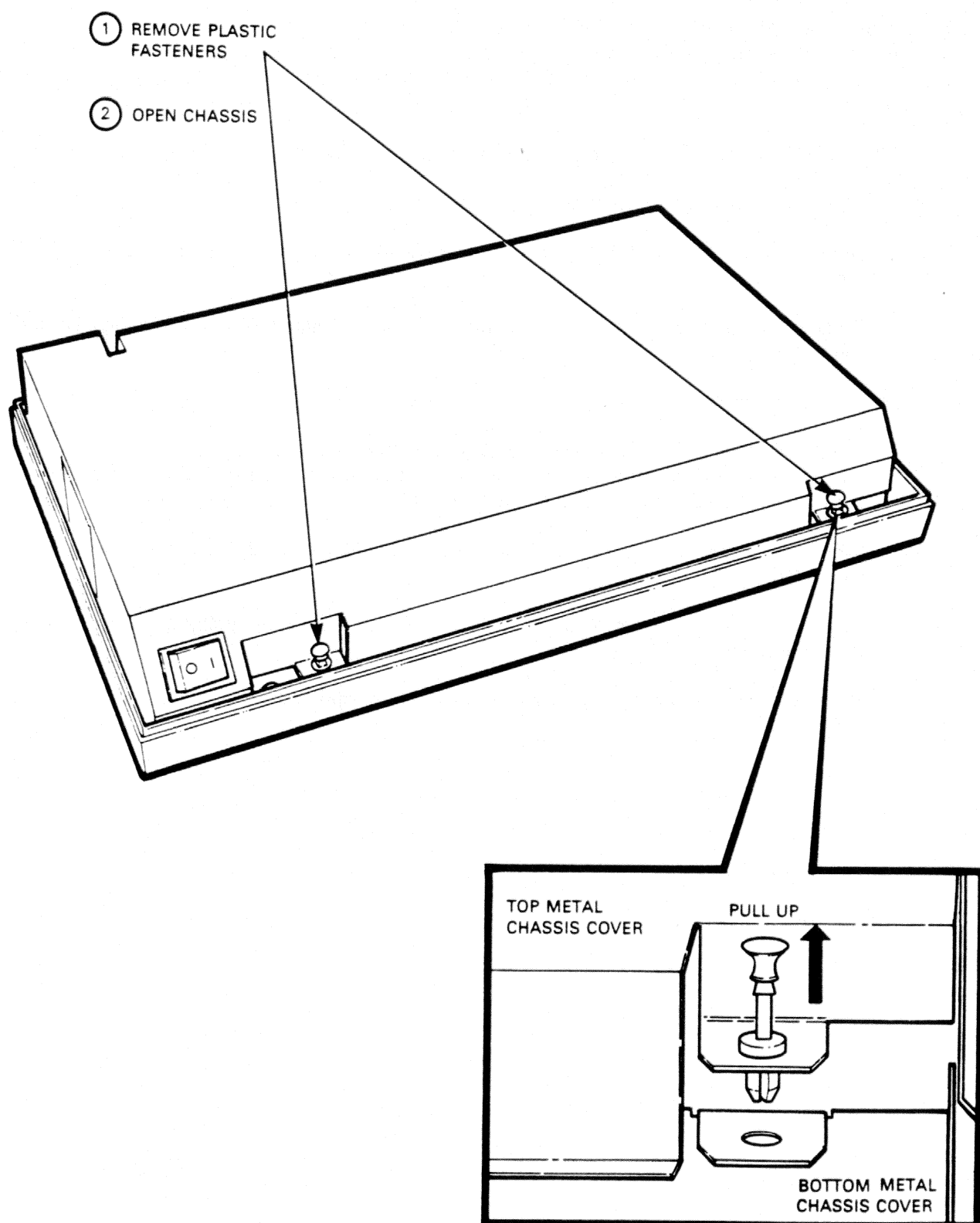


TK-10928

Figure 5-6 Opening and Closing the Repeater

### 5.5.2 Opening and Closing the Internal Metal Chassis

- Perform the following steps to open the internal metal chassis (refer to Figure 5-7).
  - Pull up on the plunger of each plastic fastener (the fasteners are located at the front of the metal chassis).
  - Lift the front of the top chassis cover up.
  - Disconnect the power supply interconnect cable from the logic module.
  - Slide the top chassis cover forward about 1 cm (.394 in). The four metal tabs of the top chassis cover should slide out of the holes in the rear of the bottom chassis cover.
- Perform the following steps to close the internal metal chassis.
  - Fit the four tabs at the rear of the top chassis cover into the slots at the rear of the bottom chassis cover.
  - Connect the power interconnect cable from the power supply to the logic module.
  - Close the top chassis cover.
  - Press the plunger of both fasteners down firmly until they latch, locking the top and bottom chassis covers together.



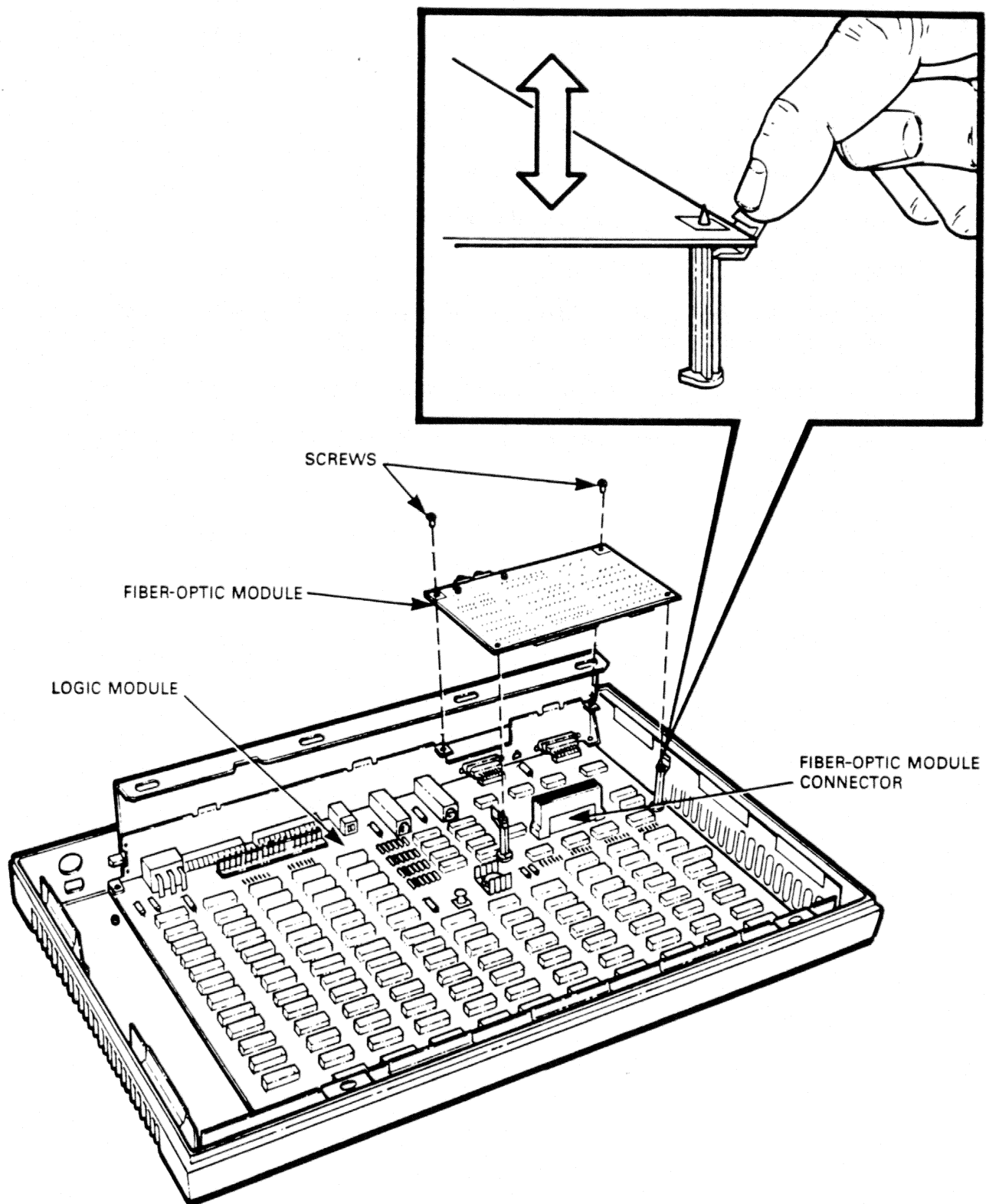
TK-10926

Figure 5-7 Opening and Closing the Internal Metal Chassis

### 5.5.3 Fiber-Optic Module Removal and Replacement

The fiber-optic module is located at the right-rear section of the logic module (see Figure 5-8). The fiber-optic module is mounted on four standoffs (two standoffs with screws and two standoffs that are plastic fasteners).

- Perform the following steps to remove the fiber-optic module.
  - Remove the two screws from the rear standoffs.
  - Gently pull the locking clip of the remaining standoffs away from the module as shown in Figure 5-8.
  - Remove the module by lifting the module up from each standoff and off of the electrical connector.
- Perform the following steps to replace the fiber-optic module.
  - Align the fiber-optic module with the electrical connector and the standoffs at the right-rear section of the logic module (the components should be facing down and the fiber-optic connectors aligned with the hole in the rear panel).
  - Gently push down on the module making sure that the electrical connector is properly connected.
  - Push down on each corner of the module ensuring that the locking clip of each standoff locks the module in place.
  - Replace the two screws in the rear holes of the fiber-optic module.



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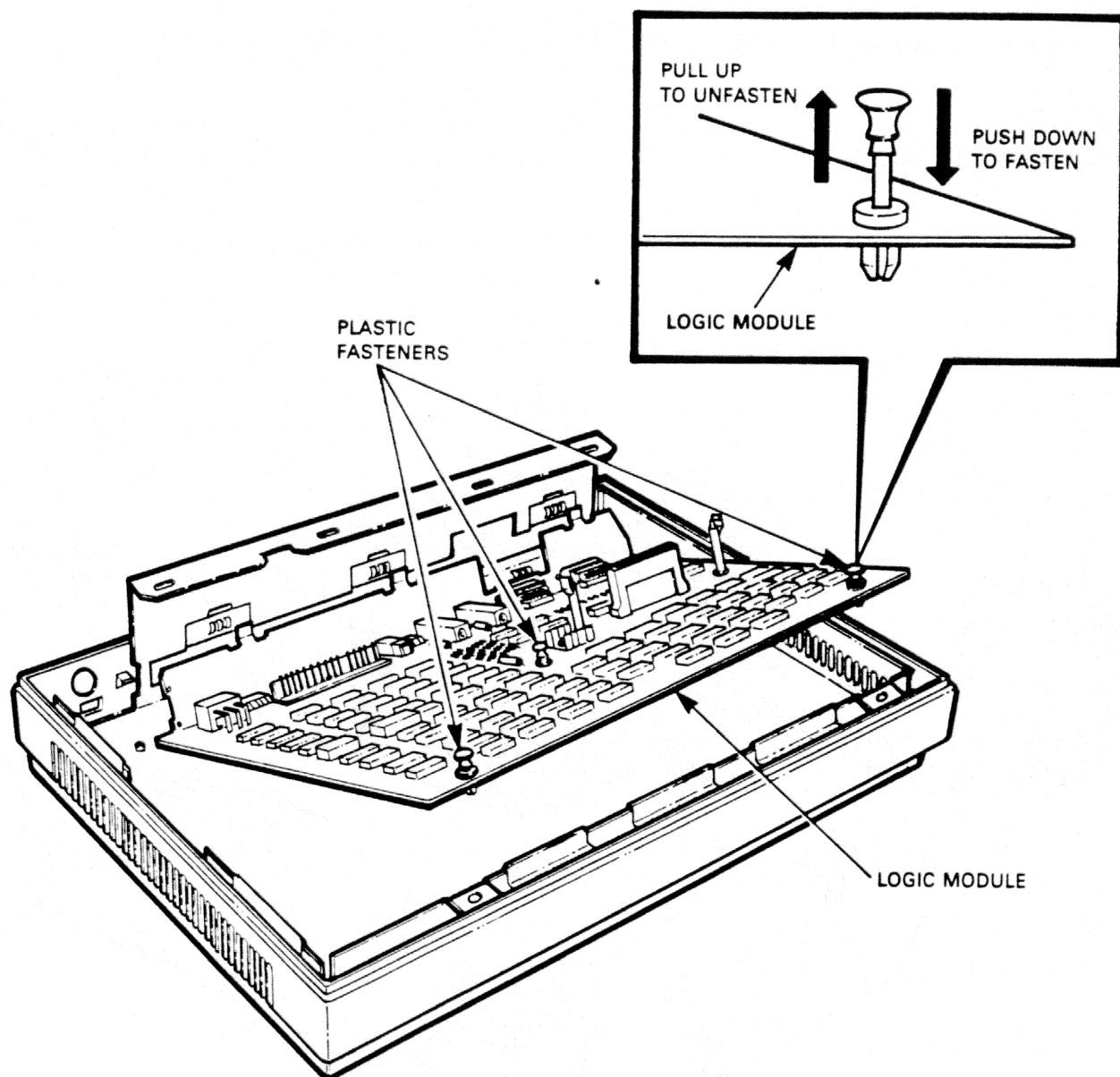
Figure 5-8 Fiber-Optic Module Removal and Replacement

#### **5.5.4 Logic Module Removal and Replacement**

The logic module is held in place by three plastic fasteners. See Figure 5-9 for the locations of these fasteners.

- Perform the following steps to remove the logic module.
  - Pull up the plungers of the three plastic fasteners.
  - Carefully lift the logic module out of the metal chassis.
- Perform the following steps to replace the logic module.
  - Fit the module into the chassis. Make sure that the D-shaped transceiver connectors and other hardware are properly aligned with the access holes in the rear panel of the repeater.
  - Align the three holes in the module with the corresponding holes in the metal chassis.
  - Push down on the plunger of the three plastic fasteners to lock the module in place.





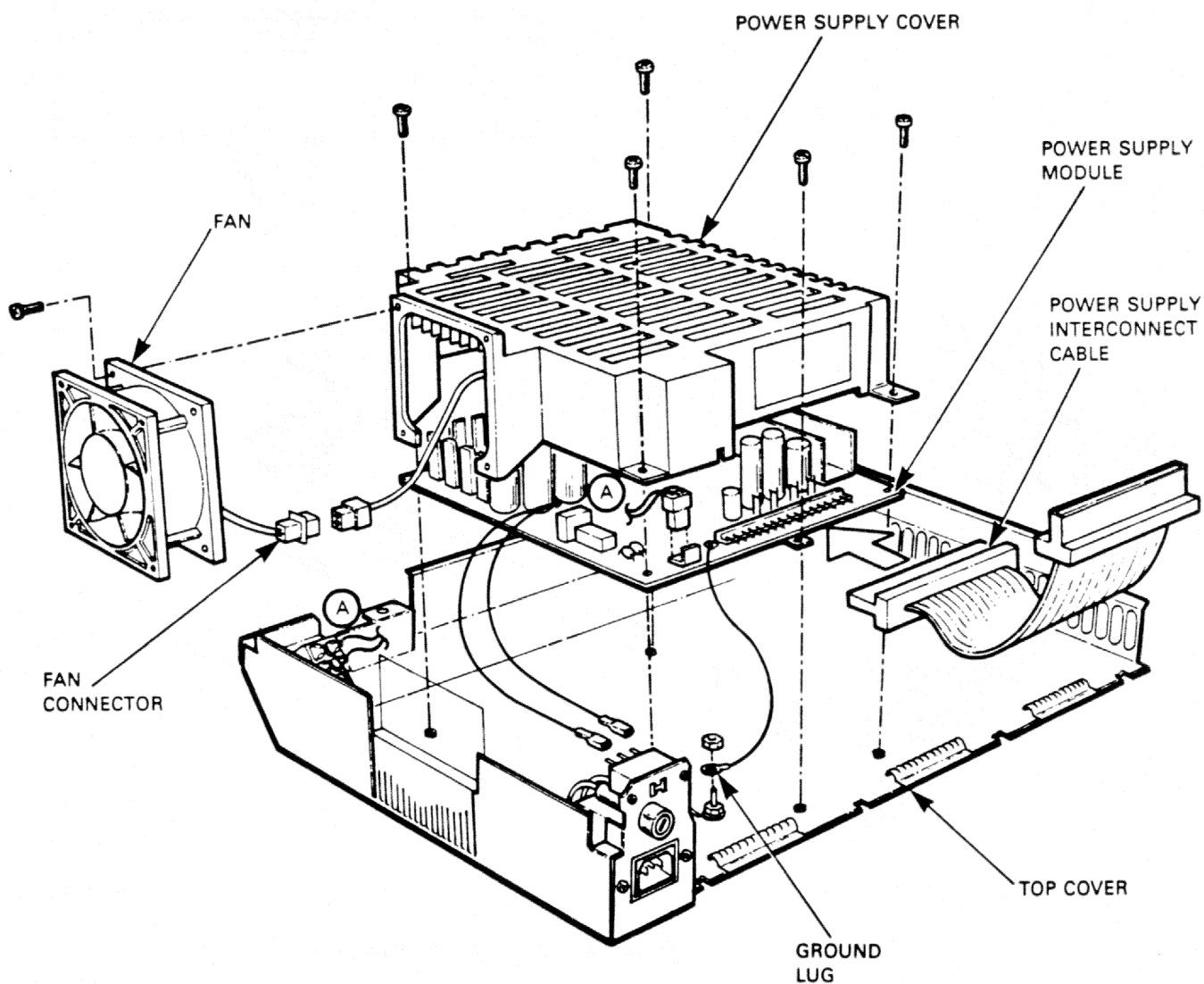
TK-10924

Figure 5-9 Logic Module Removal and Replacement

### 5.5.5 Power Supply/Fan Removal and Replacement

The power supply and fan are located in the top cover of the internal metal chassis as shown in Figure 5-10.

When a power supply or fan is malfunctioning, the entire assembly (the fan, power supply, and metal cover) should be replaced.



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Figure 5-10 Power Supply Chassis

## **APPENDIX A FIBER-OPTIC LINK CERTIFICATION**

### **A.1 INTRODUCTION**

This appendix contains the necessary procedures for certifying fiber-optic link installations for the Remote Ethernet Repeater. The certification should be performed before the Remote Ethernet Repeater is installed.

Link certification ensures the following.

- The correct cable type is used.
- The fiber-optic connectors are properly installed.
- The link (installed cable) is within the specifications required by the repeater.

### **A.2 FIBER-OPTIC LINK CERTIFICATION**

The link certification must be performed by a person skilled in the appropriate equipment and fiber-optic cable testing techniques.

A certified link:

- Is capable of transmitting the optical signals between remote repeater units, and
- Has topology documentation that is accurate and accessible. Topology documentation must include:
  - Link routing,
  - Cable splice locations, and
  - Connector locations.

A certified fiber-optic link must meet the following parameters.

- Signal attenuation
- Link length

### **A.3 REQUIREMENTS**

This section describes cable and equipment requirements for certifying fiber-optic cable.

### A.3.1 Cable Requirements

The fiber-optic cable and connectors used must meet the following constraints.

- The fiber used should be a Corning 1508™ type fiber or equivalent. For any questions regarding specific parameters, refer to the *DIGITAL Fiber-Optic Cable Specification* (number 17-00333).
- Connectors used on these cables must be Amphenol 906™ type SMA style or equivalent. Attenuation per connector must remain under 1.5 dB.

### A.3.2 Required Equipment

To perform the fiber-optic link certification, either of the following fiber-optic time domain reflectometers (FOTDR) are required.

#### NOTE

**The FOTDR needs special instruction in its operation and handling.**

- Photodyne 5500™ FOTDR or equivalent with Amphenol 906 type SMA style connector.

The Photodyne 5500 FOTDR is a district-level tool that requires the following additional equipment.

- Oscilloscope (Tektronics 564™ type or equivalent), and
- Oscilloscope camera (Tektronics C-5C™ type or equivalent).

- Tektronics OF-150™ model FOTDR or equivalent with Amphenol 906 type SMA connector. An oscilloscope and chart recorder are included with the Tektronics OF-150 model FOTDR.

The Tektronics OF-150 model FOTDR is a regional-level tool.

#### NOTE

**The FOTDR must have been calibrated to manufacturer's specifications within the recommended calibration period.**

The FOTDR measures the following parameters of fiber-optic cable.

- Length
- Attenuation

#### NOTE

**It is possible to calculate the fiber propagation delay using length and attenuation parameters.**

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Corning 1508 is a trademark of Corning Glass Works.

Amphenol 906 is a trademark of Amphenol North America, Division of Bunker Ramo Corp.

Photodyne 5500 is a trademark of Photodyne, Inc.

Tektronics 564, C-5C, and OF-150 are trademarks of Tektronix, Inc.

#### A.4 CERTIFICATION PROCEDURE

The certification procedure is made up of the following.

1. Visual inspection of the fiber-optic link (cable, connectors, and all splices). Any damage must be repaired and any stress bends must be removed.
2. Precalculation of expected cable, connector, and splice losses.
3. FOTDR measurement of the fiber-optic link. Discrepancies between the calculated and measured losses should be investigated.

##### A.4.1 Loss Calculation Formula

Calculate what the cable, connector, and splice losses should be (the total loss for the system must be less than 10.0 dB).

$$\begin{array}{rcl} L \times .006 \text{ dB} & = & (L = \text{the length in meters}) \\ C \times 1.50 \text{ dB} & = & (C = \text{the number of barrel connectors}) \\ S \times 0.50 \text{ dB} & = & (S = \text{the number of mechanical fiber-optic splices.}) \\ & + & \\ \hline \text{Total dB loss} & = & \end{array}$$

##### A.4.2 FOTDR Procedure

Measure the fiber-optic link with the FOTDR. Look for indications of breaks or areas of severe attenuation (>.5 dB for splices and >1.5 dB for connectors).

##### WARNING

**Do not look into a fiber-optic connector while the cable is connected to an FOTDR. Laser light may cause damage to eyes.**

##### NOTE

**It is important to perform the FOTDR measurement from each end of both fibers that make up the link. This assures that a broken fiber at the far end of the link is not missed (mistaken for the end of the fiber).**

**A.4.2.1 Equipment Setup** – Use the Photodyne 5500 FOTDR and an oscilloscope (or an equivalent FOTDR). Follow the directions given in the equipment manual for setup and use.

##### NOTE

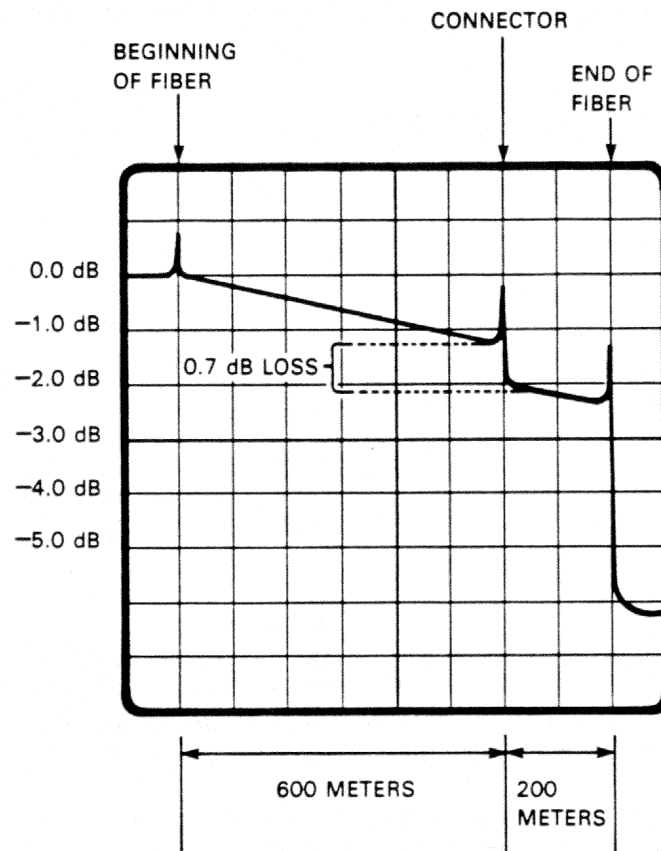
**Be sure that all equipment is disconnected from the fiber-optic link prior to measuring the link.**

When using the Photodyne 5500 FOTDR, select the following settings.

- PULSE WIDTH:
  - 20 ns (for lengths less than 100 m [328 ft])
  - 100 ns (for lengths greater than 100 m [328 ft])
- UNITS IN METERS? = Yes
- CORE INDEX = 1.47

#### A.4.2.2 Cable Measurement –

1. Connect the oscilloscope to the Photodyne 5500 FOTDR as follows.
  - a. TRIGGER-OUT from FOTDR to TRIGGER-IN on oscilloscope
  - b. LOG-OUT from FOTDR to oscilloscope input with a 50  $\Omega$  terminator in the same line.
2. Measure each fiber separately. Look for abnormalities in the slope of the oscilloscope readout (see Figure A-1). Compare the oscilloscope information with the redundant information displayed by the Photodyne 5500 FOTDR unit.



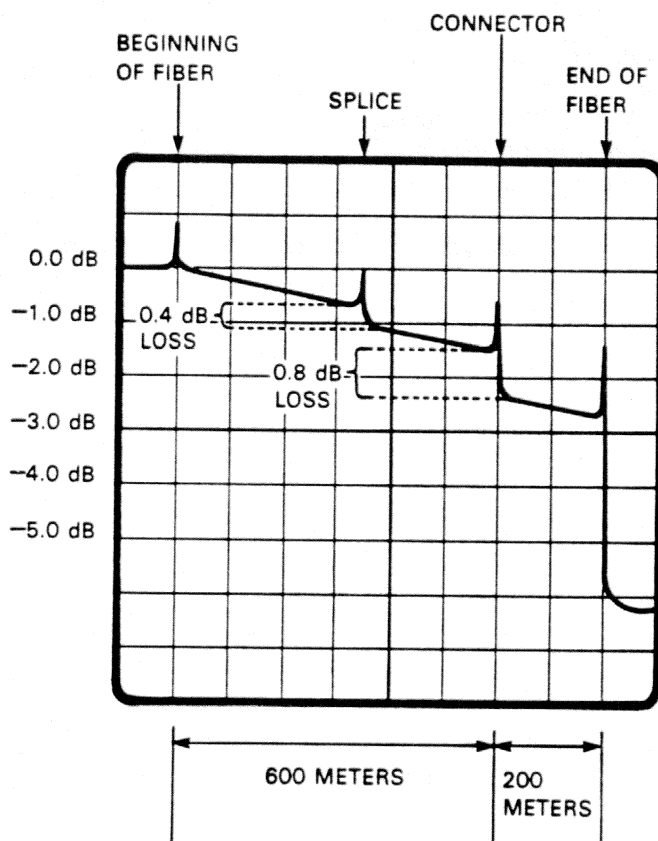
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Figure A-1 Typical FOTDR Trace Showing a Connector

3. Measure the length of each channel of the fiber-optic link in accordance to the procedures outlined in the FOTDR manual. The link length must not exceed 1000 m (3281 ft).
4. Measure the attenuation of each channel of the fiber-optic link. The attenuation for each fiber should be less than 6 dB per km. Total loss including splices, connectors, and cable attenuation must be less than 10 dB.

The attenuation is the distance between the upper portion of the slope to the lower portion of the slope (refer to Figure A-1).

5. Note the connector losses. Individual connectors should not have more than 1.5 dB of loss (see Figure A-1).
6. Note loss through cable splices. Individual splices should not have more than 0.5 dB of loss (see Figure A-2).



MKV84-0117

Figure A-2 Typical FOTDR Trace Showing a Splice and Connector

#### A.5 POSSIBLE PROBLEM SOURCES

If losses recorded exceed 10 dB, check the following.

- Verify all connectors and connections.
- Make sure that the connector ends are clean before remating.
- Remove any stress bends found in the cable.

If the attenuation remains greater than 10 dB, the fiber-optic link cannot be certified. The installer (or customer) should be informed of the problem. Appropriate repairs or modifications must be completed and the link retested before it can be certified.

#### **A.6 RECORDING THE RESULTS**

Once all the measurements have been made, be sure to record the results in the network site guide. It is preferred that the recorded results be placed near the fiber-optic connectors if possible. The following must be recorded.

- Installer's company name and address
- Installer's name
- Date of certification
- Attenuation of each fiber
- Length of link measured by the FOTDR
- Name of the person(s) recording data
- Equipment used to certify the link

If a strip graph recording is taken, it should be included with the above records.