DECOM

BROADBAND ETHERNET TRANSCEIVER TECHNICAL MANUAL

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DECOM
Broadband Ethernet Transceiver

Technical Manual

Digital Equipment Corporation

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- Class A Computing Devices:

Notice: This equipment generates, uses, and may emit radio frequency energy. The equipment has been type tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such radio frequency interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference in which case the user at his own expense may be required to take measures to correct the interference.

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PREFACE

The *DECOM Broadband Ethernet Transceiver Technical Manual* allows a technician with a minimum of four years of formal training and work experience on telecommunications equipment to install, operate, and troubleshoot the broadband Ethernet transceiver. This technical manual contains the following sections:

Chapter 1: **Introduction** – Contains a functional and physical description of the broadband Ethernet transceiver. The chapter also contains illustrations of the unit, the indicator panel, and the connections to the DECOM transceiver. A complete set of performance specifications for the transceiver are also found in Chapter 1.

Chapter 2: **Interface Description** – Describes the interface between the host controller and the transceiver, and also between the transceiver and the broadband Ethernet network.

Chapter 3: **Technical Description** – Contains the functional description of the DECOM transceiver, referring to various functional block diagrams and timing diagrams for the transceiver.

Chapter 4: **Maintenance** – Explains troubleshooting procedures that allow the technician to determine the status of the transceiver and its operation in the Ethernet network.

Appendix A: **Broadband Cable Specifications** – Lists the single- and double-cable specifications.

Related Documents

Title	Document Number
DECOM Broadband Ethernet Transceiver Owner's Manual	EK-OOBET-OM
Ethernet Specifications	AA-K759X*-TK
H4000-T Ethernet Transceiver Tester User Guide	EK-ETHTT-UG
Broadband Ethernet Channel and Certification Guide	EK-00BEC-SM
Ethernet Communications Server Site Preparation and Planning Guide	EK-DECSA-SP
Ethernet Communications Server Installation Guide	EK-DECSA-IN
Ethernet Communications Server Operations and Maintenance Guide	EK-DECSA-OP

*The X is a letter designation indicating the version of the document.

VAX Diagnostic Supervisor User's Guide	EK-VXDSU-UG
Ethernet Controllers:	
DEUNA User's Guide	EK-DEUNA-UG
DELUA User's Guide	EK-DELUA-UG
DEQNA User's Guide	EK-DEQNA-UG
DECNA User's Guide	EK-DECNA-UG
DELNI Installation/Owner's Manual	EK-DELNI-IN
DEFTR Broadband Ethernet Frequency Translator Owner's Manual	EK-FRETR-OM
DEFTR Broadband Ethernet Frequency Translator Technical Description	EK-FRETR-TD

CHAPTER 1

CHAPTER 1
INTRODUCTION

1.1 GENERAL DESCRIPTION

The broadband Ethernet transceiver (DECOM) allows a controller installed in data terminal equipment (DTE) conforming to Version 2.0 of the Ethernet local area network (LAN) specification to send and receive data over a single- or dual-cable broadband network.

Protocol

The DECOM transceiver converts the Manchester-encoded Ethernet packets from its controller into differentially-encoded binary phase shift keyed (DBPSK) RF bursts, and transmits these bursts to other DECOM transceivers in the network. The DECOM also demodulates, decodes, and converts DBPSK bursts from other DECOM transceivers into Manchester-encoded Ethernet packets for its controller.

Collisions

Simultaneous transmissions from two or more controllers and their DECOM transceivers are referred to as collisions. After a collision, all controllers stop sending packets for a random time interval. This clears the Ethernet channel used by the DECOM transceivers so that one of the controllers can successfully send a packet over the network.

An Ethernet local area network uses carrier sense multiple access/collision detection, or CSMA/CD. When a collision is detected, the DECOM transceiver sends a collision enforcement signal over a collision enforcement channel adjacent to the Ethernet data channel. The enforcement signal causes the other DECOM transceivers in the broadband Ethernet network to send collision presence signals to their controllers.

Each time a DECOM transceiver successfully transmits a packet without encountering a collision, it transmits a collision enforcement signal over the broadband Ethernet collision enforcement channel network. This transmission is called a heartbeat. When the DECOM transceiver detects its own heartbeat signal, it sends a collision presence signal to its controller, indicating that it has successfully sent the packet over the Ethernet channel.

Guard Circuits

Guard circuits in the DECOM transceiver inhibit continuous transmissions onto the coaxial cable of more than 150 ms. When the cause of the continuous transmission has been removed, transmissions shall be re-enabled within 100 ms. This redundant circuitry ensures that a failure in a single DECOM transceiver does not jam the network by causing the DECOM to continuously transmit a carrier.

Downconverter

If the transceiver is installed in a single-cable network, a downconverter module is used on the DECOM transceiver and a DEFTR frequency translator is used in the cable facility at the headend. The DEFTR frequency translator receives transmissions from the DECOM transceivers on the reverse channel, shifts them up to the forward channel frequency, and transmits them on the cable facility. The downconverter installed on the DECOM transceiver converts the forward Ethernet channel frequency (output of the DEFTR frequency translator) to the DECOM demodulator frequency.

Loopback Testing
The DECOM transceiver has two loopback test modes:

- DIGITAL LOOPBACK – Tests the DECOM digital logic by routing the output of the transmit data logic (normally intended for the RF modulator) to the input of the receive data logic. Digital loopback is internal to the DECOM transceiver and is activated by the rear panel toggle switch.
- RF LOOPBACK – Tests the DECOM transceiver's RF dynamic range. RF loopback is performed by connecting the RF input to the RF output, external to the DECOM, utilizing a loopback attenuator.

Power Supply
A switching power supply provides regulated power supply voltages to the modem and logic circuits in the DECOM transceiver, and allows the DECOM to operate at either 115 V or 230 Vac, depending on the setting of the rear panel line voltage select switch.

Indicators
Table 1-1 lists the indicators on the front panel light that represent transceiver status.

Table 1-1 DECOM Indicators

Indicator	Color	Condition
READY	Green	AC power ON
		NORMAL/LOOPBACK switch in NORMAL position
		Overlength packets have not been sent
		Guard circuits not active
TRANSMIT	Green	Transmit carrier ON. Logic board transmitting data to modulator
RECEIVE	Green	Data carrier detect from demodulator is high. Indicates presence of receive data on receive data output from demodulator, or decoded transmit data from output transmit logic circuits when LOOPBACK/NORMAL switch is in the LOOPBACK position
COLLISION	Amber	Collision has been detected and the controller has been signaled
		Does not light during collision detect self-test (heartbeat) signals
IN RANGE	Green	Lights each time the transceiver receives its own transmission within the maximum round trip delay allowed by Ethernet specification
		Indicates the transceiver is within the proper distance from the headend
LOOPBACK	Amber	The transmit data logic output (encoded TX DATA) from the input of the modulator circuitry is connected to the input of the receive data logic circuitry

1.2 FUNCTIONAL DESCRIPTION

1.2.1 Broadband Ethernet Channel
The broadband Ethernet channel provides a communications link through which stations may communicate using the Ethernet carrier sense multiple access/collision detect (CSMA/CD) protocol.

Broadband Ethernet transceivers operate on three contiguous 6 MHz channels of dual-cable broadband telecommunications networks and within two groups of three contiguous 6 MHz channels of single-cable broadband telecommunications networks. These 18 MHz segments of the frequency bandpass are referred to as the Ethernet channel.

The broadband Ethernet transceivers perform the following functions:

- Accept Manchester-encoded data from CSMA/CD data terminal equipment (DTE), normally called the Ethernet controller, which resides in each applicable station.
- Decode the Manchester-encoded data to produce non-return-to-zero (NRZ) encoded data.
- Scramble and reformat the NRZ data.
- Differentially encode the data.
- Generate a modulated (binary phase shift keyed) waveform from the differentially encoded data.
- Filter and transmit the modulated waveform.
- Transmit a separate (distinct from data) frequency modulated signal to provide a test collision enforcement signal at the end of each transmission interval.
- Receive the differentially encoded binary phase shift keyed modulated RF data signal.
- Demodulate and differentially decode the received RF data signal.
- Descramble the received bit stream.
- Manchester encode the descrambled bit stream.
- Send the Manchester-encoded and descrambled bit stream to the DTE.
- Detect the end of receive message frame.
- Receive the frequency modulated collision signal.
- Detect data collision conditions.
- Transmit a separate (distinct from data) frequency modulated waveform output to provide a collision enforcement signal if a data collision is detected.

The 18 MHz bandwidth of the Ethernet channel is subdivided into two segments:

- 14 MHz for data transmission
- 4 MHz for collision enforcement signaling.

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The binary phase shift keyed modulated data carrier is at the center of the 14 MHz data segment. The frequency modulated collision enforcement carrier is at the center of the 4 MHz collision enforcement segment.

The 4 MHz collision enforcement segment of the 18 MHz Ethernet channel bandwidth allows a collision enforcement signal to be sent to other transceivers at a frequency that does not interfere with the data signal. Collision enforcement signaling is also performed at the end of each transmission interval to test the collision detect circuitry of the transmitting modem. This signal is referred to as the heartbeat.

During its transmission interval, the transmitting transceiver monitors data collision conditions by comparing the source and destination address bits of the data packet being transmitted with the source and destination address bits of the data packet being received. If the received bits do not match the transmitted bits, the transmitting transceiver transmits a collision enforcement signal.

Digital Equipment Corporation's Single-Cable Broadband Ethernet Channel

The single-cable version of Digital Equipment Corporation's broadband Ethernet channel products is intended for use on mid-split broadband cable facilities. Digital Equipment Corporation's broadband Ethernet products use three adjacent channels (54 to 72 MHz) of the reverse bandpass and three adjacent channels (210.25 to 228.25 MHz) of the forward bandpass. Collectively, these channels are referred to as the DIGITAL Ethernet channel of a single-cable broadband facility.

The DIGITAL Ethernet channel of the single-cable broadband facility (Figure 1-1) is implemented using data terminal equipment (DIGITAL Ethernet controllers), broadband communication modems (DIGITAL broadband Ethernet transceivers, DECOM, equipped with a downconverter), and a headend processor (DIGITAL Ethernet frequency translator, DEFTR).

Digital Equipment Corporation's single-cable broadband Ethernet transceiver is the DECOM equipped with a downconverter. As shown in Figure 1-1, the DECOM transceiver connects to the single-cable facility through an RF drop cable, which attaches to a cable facility tap or outlet. The DECOM interfaces to an Ethernet controller located in the associated station through an Ethernet transceiver cable. The DECOM transmits in the 54 to 72 MHz bandpass and receives in the 210.25 to 228.25 MHz bandpass.

Table 1-2 DECOM Model Designations

Model	Topology	Power Input
DECOM-AA	Dual-Cable	115 Vac
DECOM-AB	Dual-Cable	230 Vac
DECOM-BA	Single-Cable*	115 Vac
DECOM-BB	Single-Cable*	230 Vac

*A downconverter is installed on the back of the DECOM transceiver.

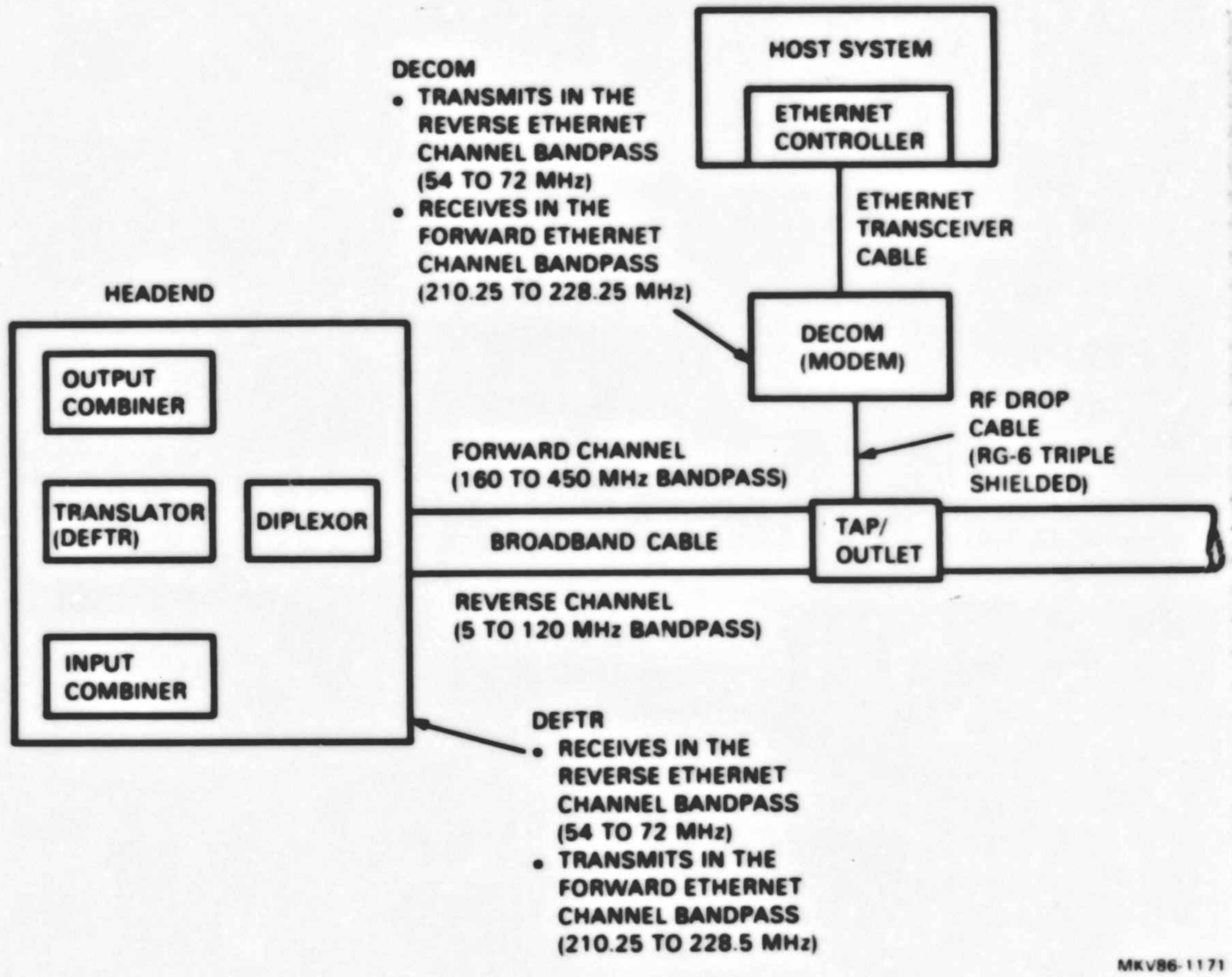

Figure 1-1 Single-Cable Broadband Ethernet Channel Implementation

In the single-cable topology (Figure 1-1), the binary phase shift keyed modulated data and frequency modulated collision enforcement signal outputs of the transceiver are transmitted on the coaxial cable at the reverse Ethernet channel frequencies. These signals propagate through the coaxial cable facility to the frequency translator.

Digital Equipment Corporation's single-cable broadband Ethernet frequency translator is the DEFTR. As shown in Figure 1-1, the DEFTR is located within the cable facility headend. The DEFTR frequency translator filters the incoming reverse channel signals to accept only reverse Ethernet channel frequencies. The DEFTR translates the reverse Ethernet channel bandpass signals to forward channel Ethernet signals (210.25 to 228.25 MHz). The translation is performed using a 282.25 MHz local oscillator and mixing circuits. The DEFTR frequency translator also amplifies the translated signals.

During the frequency translation process, the frequency allocation format of the received reverse bandpass signals is inverted by the translator. The signal received at the lowest frequency in the reverse Ethernet channel bandpass is transmitted at the highest frequency of the forward Ethernet channel bandpass; therefore, the highest frequency output of the DECOM transceiver becomes the lowest frequency output of the DEFTR frequency translator.

The receiver portion of the DIGITAL broadband Ethernet transceiver, DECOM, contains an external downconverter that uses a 282.25 MHz local oscillator and mixer circuitry to convert the 210.25 to 228.25 MHz forward direction bandpass signals to 54 to 72 MHz signals acceptable by the DECOM receiver. During this conversion, the frequency allocation format of the received signals is inverted. The signal received at the highest frequency in the forward Ethernet channel bandpass is converted to the lowest frequency of the reverse Ethernet channel bandpass; therefore, the inversion performed at the headend by the translator is reversed. Thus, the format of the received information sent to the Ethernet controller is in the same frequency format as that transmitted from the controller to the DECOM transceiver and the same as that transmitted on the reverse Ethernet channel bandpass.

The received Ethernet channel signals are then converted to Manchester-encoded information, which is passed to the station Ethernet controller.

Digital Equipment Corporation's Dual-Cable Broadband Ethernet Channel

Digital Equipment Corporation's broadband Ethernet products use three adjacent 6 MHz channels (54 to 72 MHz) of the available dual-cable facility bandpass. Collectively, these channels are referred to as the DIGITAL Ethernet channel of a dual-cable broadband facility.

The DIGITAL Ethernet channel of a dual-cable broadband facility (Figure 1-2) is implemented using data terminal equipment (DIGITAL Ethernet controllers) and broadband communication modems (DIGITAL Ethernet transceivers, DECOM).

Digital Equipment Corporation's dual-cable broadband Ethernet transceiver is the DECOM. As shown in Figure 1-2, the DECOM transceiver connects to the dual-cable facility through two RF drop cables:

- The first RF drop cable attaches the DECOM transceiver to a tap/outlet on the transmit cable of the dual-cable facility
- The second RF drop cable attaches the DECOM transceiver to a tap/outlet on the receive cable of the dual-cable facility.

The DECOM transceiver is connected through an Ethernet transceiver cable to an Ethernet controller located in the station.

The binary phase shift keyed modulated data is transmitted and received on the cable facility in the 54 to 68 MHz bandpass. The frequency modulated collision enforcement signal is transmitted and received in the 68 to 72 MHz bandpass.

In the dual-cable broadband topology (Figure 1-2), the broadband Ethernet transceiver transmits phase shift modulated data and frequency modulated collision enforcement signals on the transmit cable. The transmitted signals propagate through the transmit cable, the headend, the receive cable, and back to the receiver section of all broadband Ethernet transceivers. The transceivers receive the signals, convert the received signals to Manchester-encoded information, and pass the information to the Ethernet controller.

Digital Equipment Corporation's dual-cable broadband Ethernet channel and related product specifications are provided in Sections 1.4 through 1.4.7.

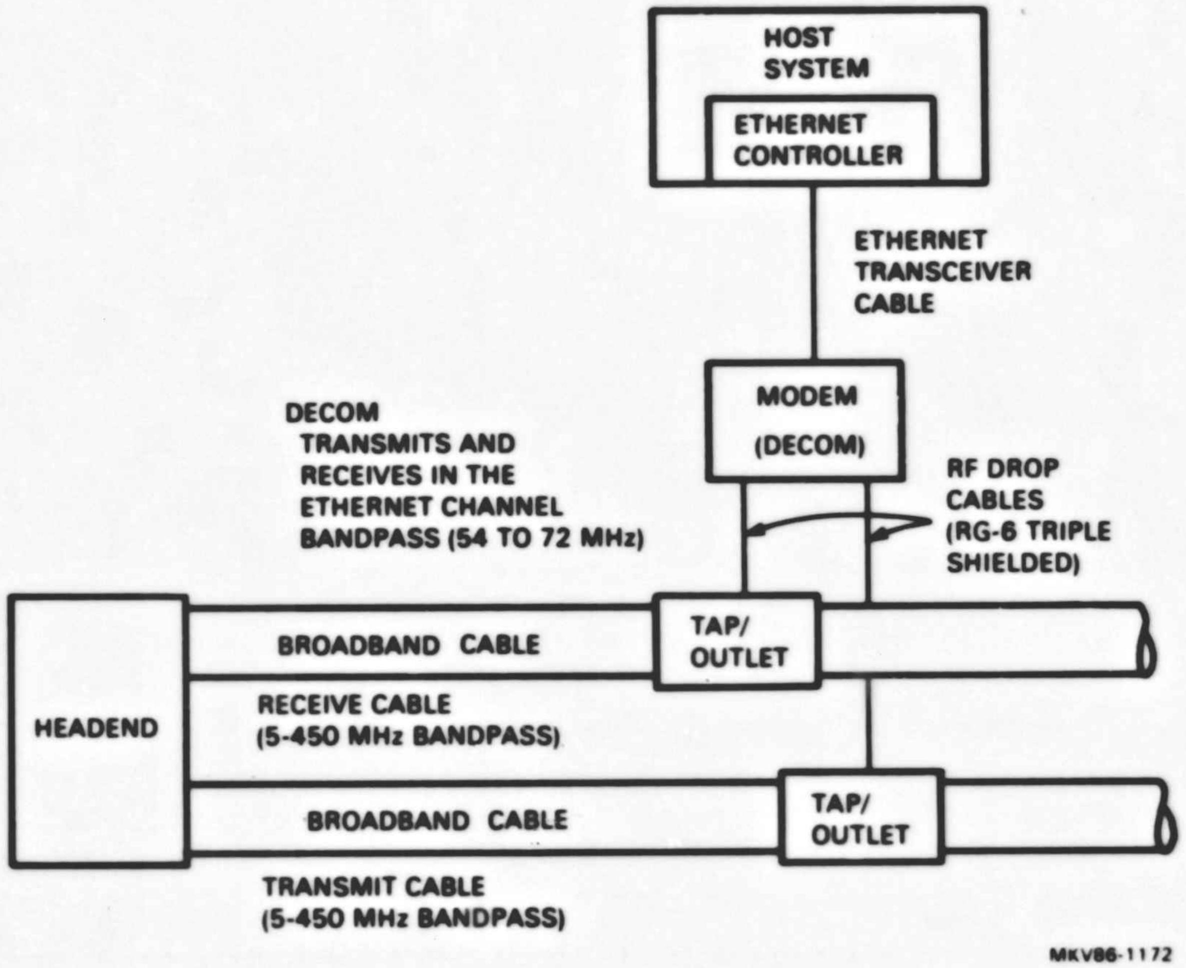

Figure 1-2 Dual-Cable Broadband Ethernet Channel Implementation

1.2.2 Controller to DECOM Packet Format

The DECOM broadband Ethernet transceiver formats the Manchester-encoded data received from the Ethernet controller in the host system. The packet structure of the controller output is shown in Figure 1-3.

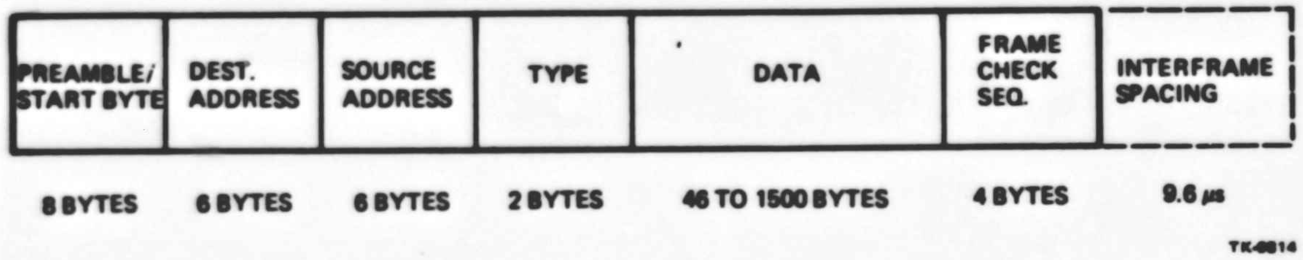

Figure 1-3 Example Format of the Ethernet Packet (From Controller to DECOM)

Table 1-3 Controller to DECOM Packet Format

Segment	Source	Length	Function
Preamble/ start byte	Controller	8 bytes	Synchronizes the DECOM
Destination address	Controller	6 bytes	Indicates which node receives the packet
Source address	Controller	6 bytes	Indicates the origin of the packet
Type	Controller	2 bytes	High-level network protocol use
Data	Host system	46-1500 bytes	Message data
Frame check sequence (FCS)	Controller	4 bytes	32-bit CRC value
Interframe spacing	Controller	9.6 µs	Interframe recovery

Packet Processing

The Ethernet packet sent from the host computer's Ethernet controller to the transceiver contains a preamble of alternate ones and zeros, terminated by a double 1 (end of preamble). End of preamble is followed by a destination address (identifying the controller to which the data is to be sent), a source address (identifying the controller originating the data), and the data itself. The frame check sequence follows the data and contains a 32-bit CRC value. See Figure 1-3.

To make up for preamble bits that are lost during the clock timing recovery sequence in the transmitting transceiver, the transmitting transceiver adds eight bits to the start of the preamble. These eight bits are followed by the preamble bits from the controller.

A unique word, consisting of two zeros, is added to the packet by the transmitting DECOM transceiver. The unique word signals the beginning of a scrambler code sequence. The unique word is generated by forcing bits 24 and 25 of the preamble to zero. The 23 to 39 bit scrambler code sequence is created by scrambling the rest of the controller preamble with the contents of the scrambler shift register.

The destination address, source address, and data are transferred by the DECOM transceiver to differentially encoded and scrambled form, but without being altered as is the preamble.

The postamble is generated by the DECOM transceiver and consists of a zero followed by 22 ones (differential encoding inverts the bits). The postamble signals the end of the data to the receiving transceivers and does not appear at the receiving controller.

A heartbeat signal follows the end of the postamble by six bit times, and is sent over the collision enforcement portion of the Ethernet channel by the transmitting transceiver. This checks the integrity of the DECOM transceiver's collision enforcement and detection circuitry after each packet is received. After the heartbeat is successfully detected, the transmitting transceiver sends a 10 MHz signal to its controller over its collision presence pair on the transceiver cable.

Data passing between a controller and a transceiver is Manchester-encoded, while packets passing between transceivers are differentially encoded and scrambled (except for the preamble that occurs before the unique word, and the postamble that is differentially encoded, but not scrambled).

The transceiver sends the Ethernet packet (Figure 1-4) over the Ethernet channel. The data packets returning to the transceiver are delayed, depending on the size of the cable facility.

1.2.3 Broadband Ethernet Packet Format

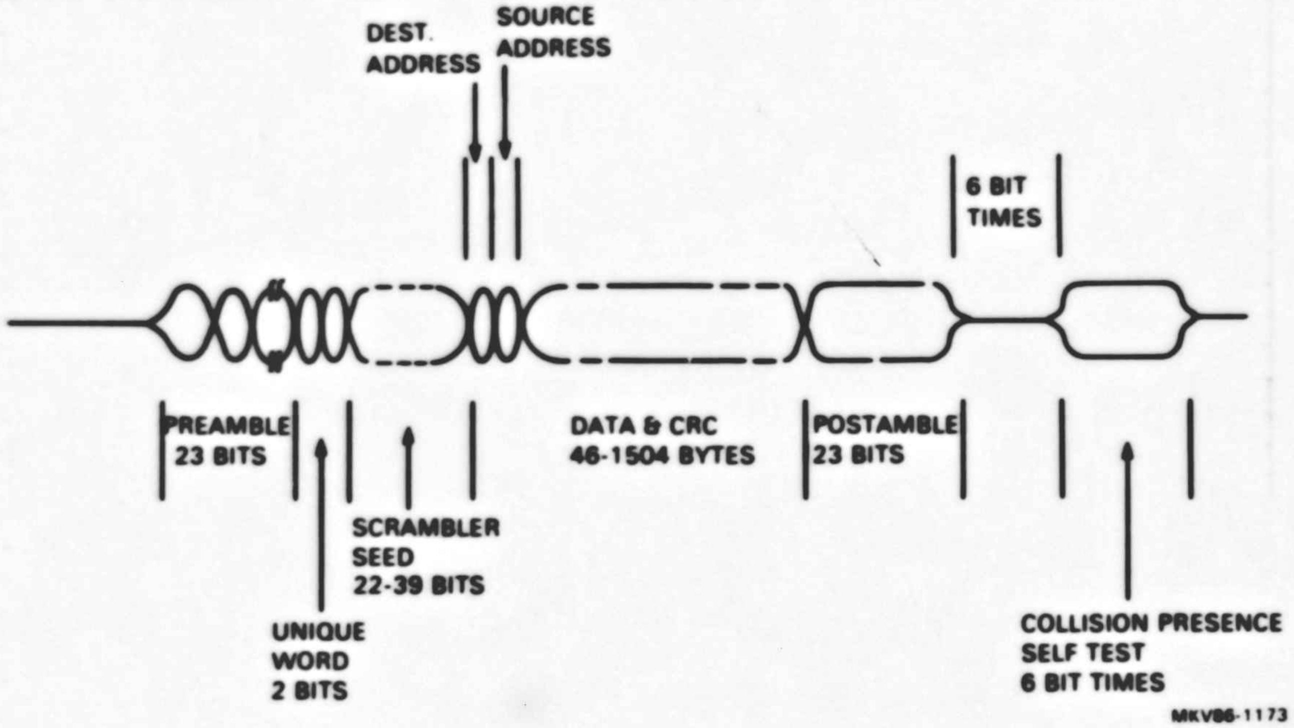

Figure 1-4 Example Format of the Ethernet Data Packet (From DECOM to DECOM)

Table 1-4 Broadband Ethernet Packet Format

Segment	Source	Length	Function
Preamble	Controller & transceiver	23 bits	Synchronizing
Unique word	Transceiver	2 bits	Delimiter for descrambling
Scrambler seed	Transceiver	23-39 bits	Prevents repetitive phase cancellation on the coaxial cable
Destination address	Controller	6 bytes	Indicates which node receives the packet
Source address	Controller	6 bytes	Indicates the origin of the packet
Data	Host system	46-1504 bytes	Data packet plus CRC
Postamble	Transceiver	23 bits	Indicates end of transmission
Collision presence self-test (heartbeat)	Transceiver	32 bits	Checks integrity of the network collision enforcement

1.2.4 DECOM to Controller Packet Format (Figure 1-5)

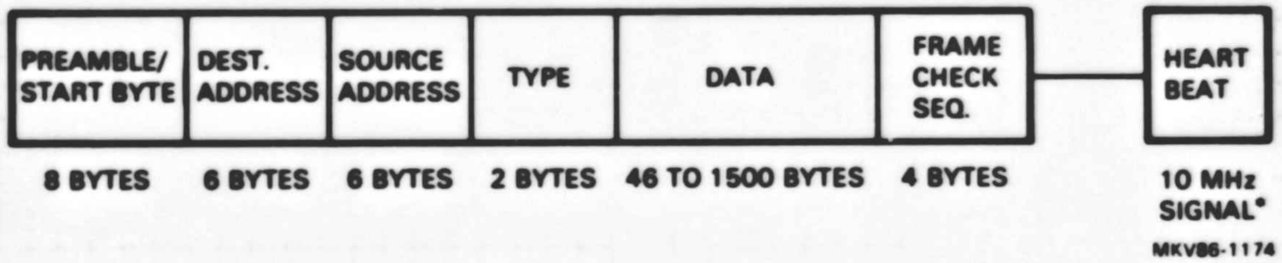

Figure 1-5 Example Format of the Ethernet Data Packet (From DECOM to Controller)

Table 1-5 DECOM to Controller Packet Format

Segment	Source	Length	Function
Preamble	Originating controller	6 bytes	Synchronizes the DECOM
Destination address	Originating controller	6 bytes	Indicates which node is to receive the packet
Source address	Originating controller	6 bytes	Indicates origin of the packet
Data	Originating system	46-1500 bytes	Message
Frame check sequence	Originating controller	4 bytes	32-bit CRC value
*Collision presence self-test (heartbeat)	Originating transceiver	700 ns nominal	Indicates successful transmission of data packet

*Transmitting controller only

1.3 PHYSICAL DESCRIPTION

The DECOM broadband Ethernet transceiver is packaged in a sheet metal chassis surrounded on five sides by an injection-molded plastic shell (Figure 1-6).

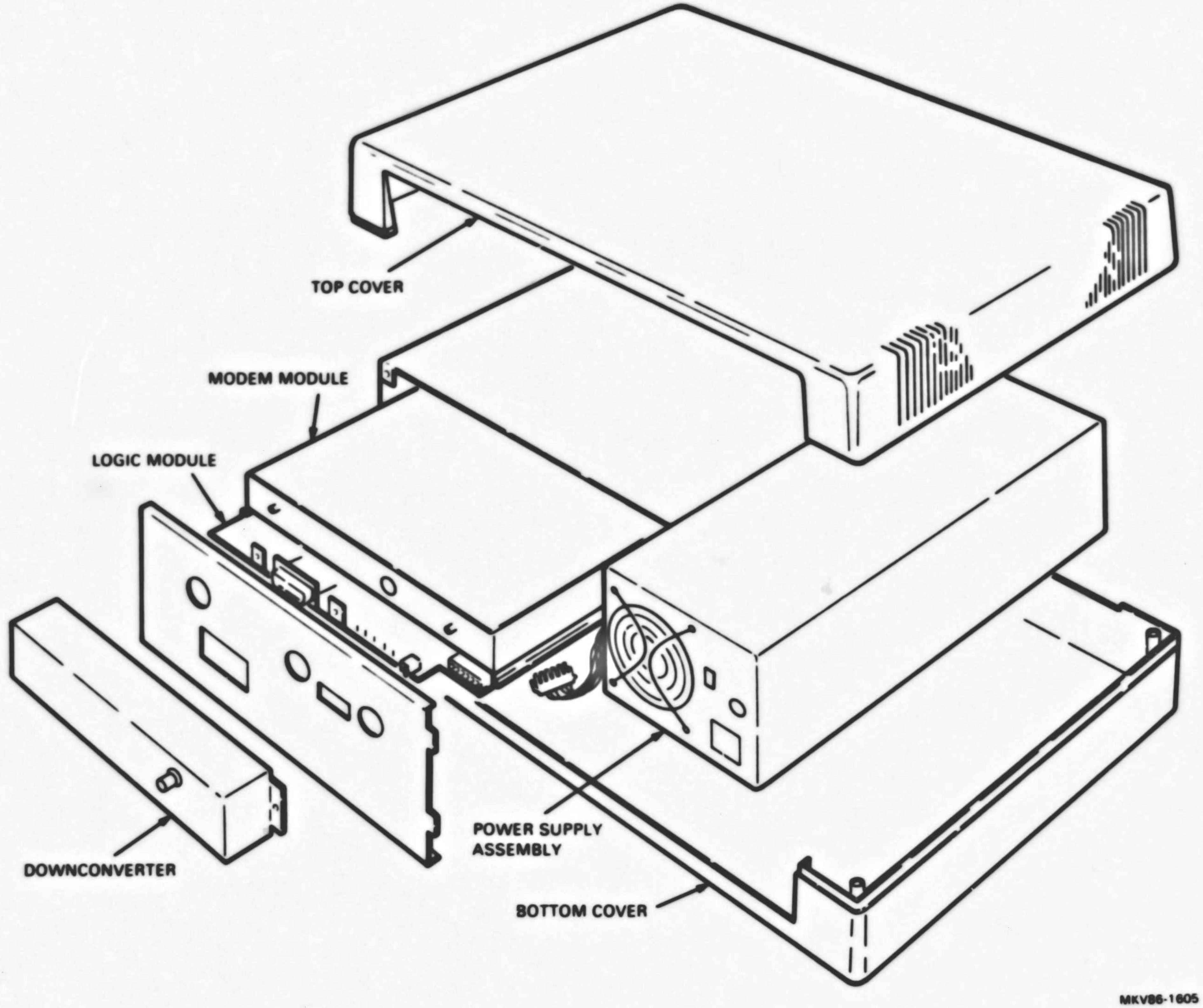

Figure 1-6 DECOM Broadband Ethernet Transceiver

The rear of the chassis (Figure 1-7) is not enclosed by the plastic shell, which allows access to the connectors on its rear panel. Ventilation holes along the sides of the plastic shell and the sides of the chassis, and an opening for the cooling fan at the rear of the chassis provide paths for the flow of cooling air.

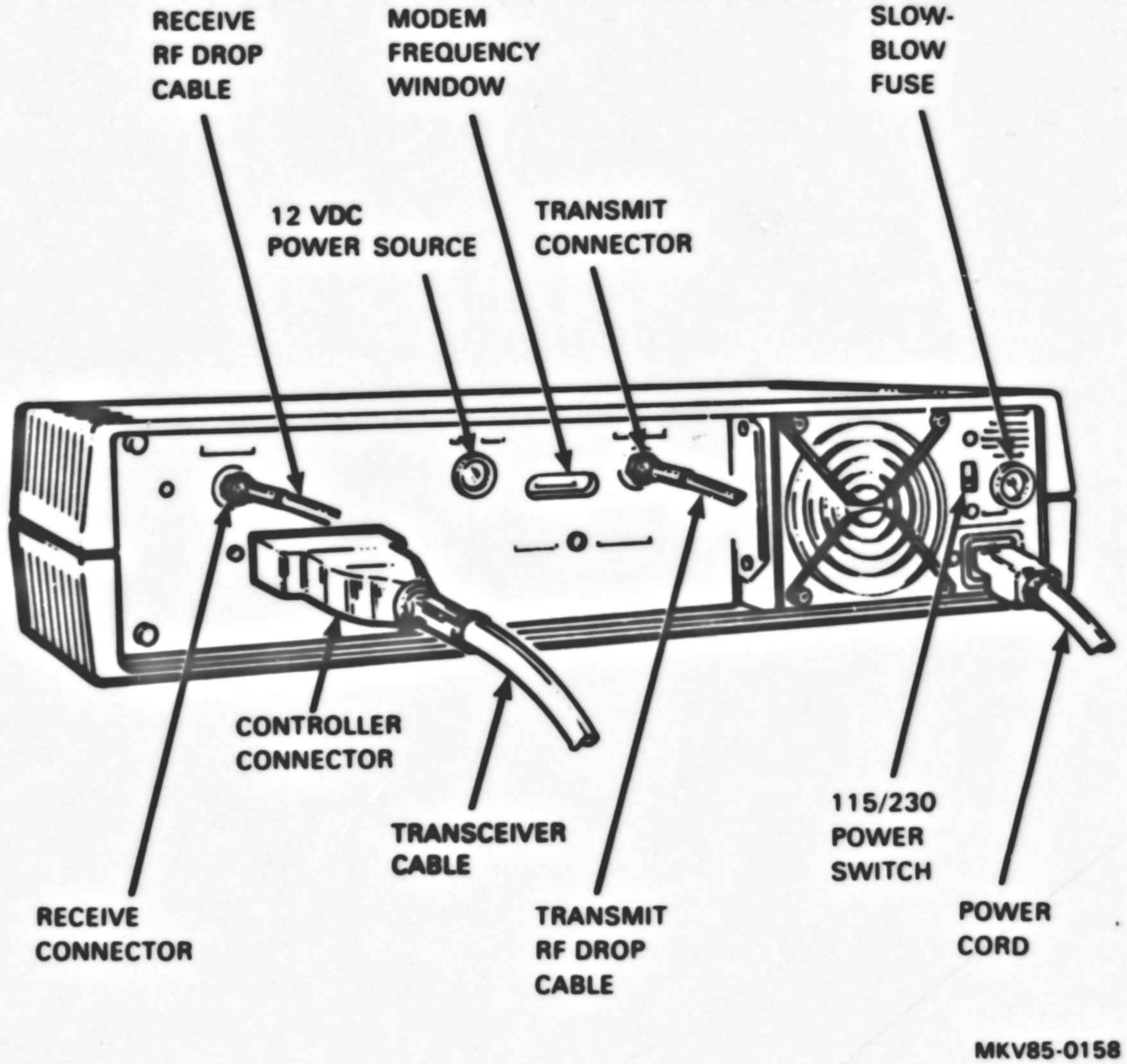

Figure 1-7 Dual-Cable DECOM (Back View)

The downconverter module (Figure 1-8) connects to and is mounted over the TRANSMIT and RECEIVE type F connectors and the +12 Vdc power connector. A rectangular opening in the rear panel allows users to see the frequency range marked on the side of the sheet metal box enclosing the modem module.

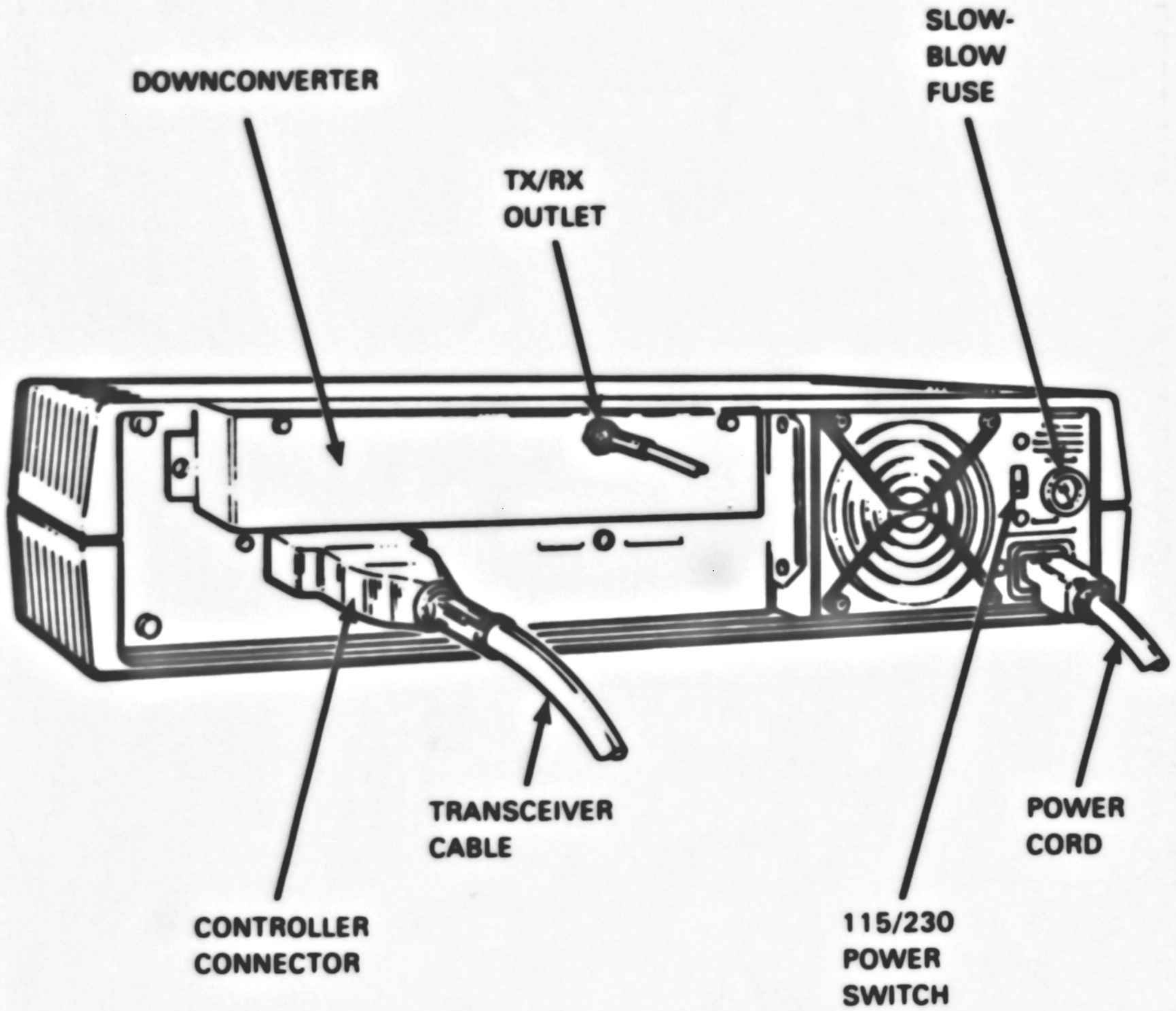

Figure 1-8 Downconverter - Single-Cable DECOM

The operating status of the transceiver is displayed by light-emitting diode (LED) indicators on the front panel, and are visible through a plastic window on the front panel of the injection molded plastic shell. Labels on the window in the front panel indicate the functions of each of the LED lights (Table 1-1).

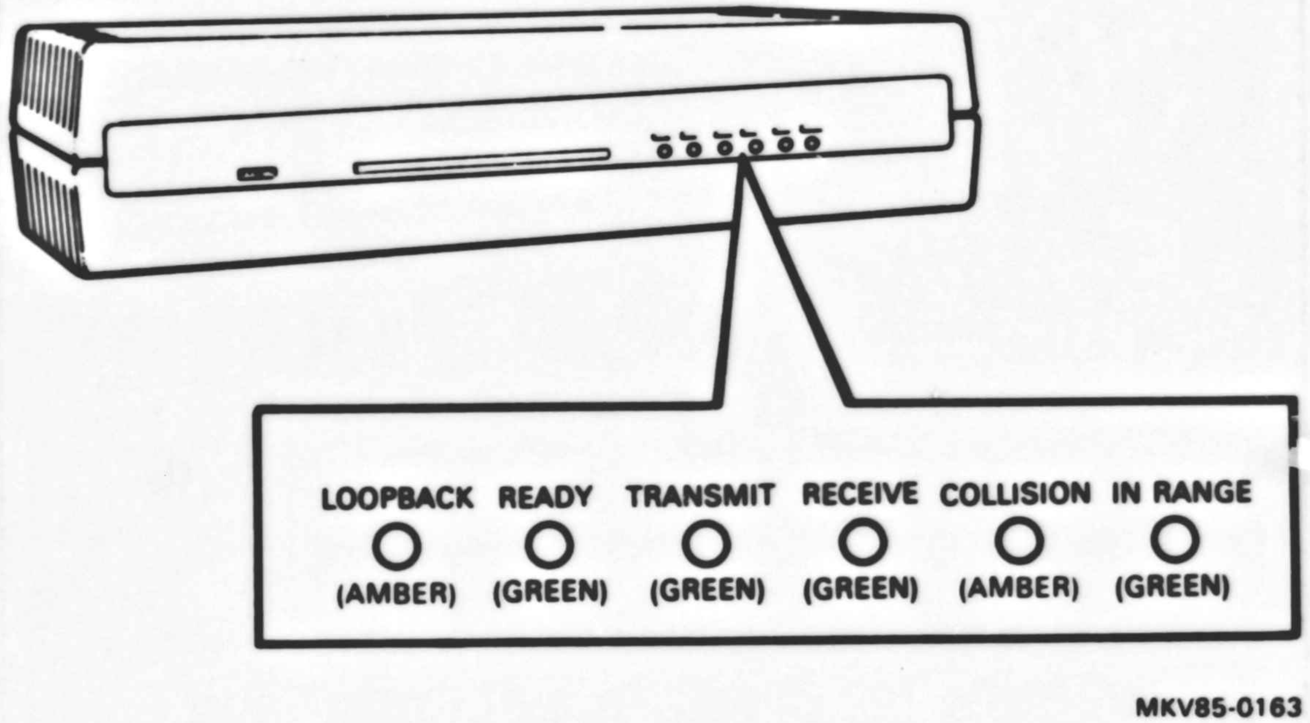

Figure 1-9 Front Panel

1.4 DECOM SPECIFICATIONS

1.4.1 Physical Specifications:

Height:	10.7 cm (4.2 in)
Width:	48.9 cm (19.3 in)
Depth:	32.1 cm (12.6 in)
Weight:	
• Single-Cable Transceiver	6.5 kg (14.2 lb), approximately
• Dual-Cable Transceiver	6.2 kg (13.7 lb), approximately

1.4.2 Environmental Specifications

Operating Temperature Range:	5° to 40°C (41° to 122°F)
Storage Temperature Range:	−20° to +70°C (−4° to +167°F)
Operating Humidity Range:	10% to 90% noncondensing
Max. Operating Altitude:	2348 m (8,000 ft) above sea level
Max. Nonoperating Altitude:	9144 m (30,000 ft) above sea level
Electromagnetic Environment:	2 V/m from 10 KHz to 30 MHz
	5 V/m from 30 MHz to 1 GHz
	.1 V/m from 54 MHz to 72 MHz
Susceptibility to EMI:	Meets FCC Part 15, Subpart J, Class A and VDE 0871
AC Power Line Conducted Susceptibility:	Operates properly with 3 Vrms superimposed on the power line inputs between 10 KHz and 30 MHz (hot, neutral, and ground)
Resistance to AC Power Line Transients:	Operates with 2.5 WS transients superimposed on the power line (hot, neutral, and ground)
Electrical Isolation:	250 kilohms between any transceiver cable conductor and the shield or the center conductor of the coaxial drop cable, at 60 Hz, with a breakdown voltage of 250 Vac
Resistance to Static Discharges:	Withstands static discharges of 15 kV at 25 A without requiring operator intervention
AC Power:	115 V Configuration – 89 Vac to 128 Vac at 59 to 61 Hz
	230 V Configuration – 179 Vac to 256 Vac at 49 to 51 Hz

1.4.3 Transmit Pair Specifications (Transceiver Cable Interface)

Data Rate:	10M bits/s (±.01%)
TX Squelch:	Turns off after the first negative transition below −400 mV
	Turns on after the last positive transition above −175 mV
Impedance:	78 ±5 ohms

1.4.4 Receive Pair Specifications (Transceiver Cable Interface)

Signal Level: (Into a 78 [±5] ohms differential load and an 18.5 ohm common mode load over a frequency of 3 to 30 MHz)	±630 mV p-to-p typical drive ±550 mV p-to-p minimum drive ±1200 mV p-to-p maximum drive
Data Rate:	10M bits/s ±.01%

1.4.5 RF Coaxial Cable Interface Specifications (Input)

Receive Frequencies:	
• Data Band	
– Single-Cable	214.25 to 228.25 MHz
– Dual-Cable	54 to 68 MHz
• Collision Enforcement Band	
– Single-Cable	210.25 to 214.25 MHz
– Dual-Cable	68 to 72 MHz

Sensitivity (min. receive level):

• Data Band	−3 dBmV
• Collision Enforcement Band	−3 dBmV

Squelch On (with −34 dBmV white noise/6 MHz bandpass):

• Data Band	−8 dBmV
• Collision Enforcement Band	−8 dBmV

Squelch Off (with −34 dBmV white noise/6 MHz bandpass):

• Data Band (w/CW)	−18 dBmV
• Data Band (with data signal)	−22 dBmV
• Collision Enforcement Band	−12 dBmV

Dynamic Range:

• Data Band	−3 to +15 dBmV
• Collision Enforcement Band	−3 to +15 dBmV

Bit Error Rate (−34 dBmV white noise/6 MHz bandpass, −3 dBmV signal): 10^{-9}

Return Loss (minimum, within Ethernet band, power applied): 14 dB

Maximum Level of Adjacent NTSC TV Channels for Rejection (Adjacent channels are the 6 MHz bands on either side of the 18 MHz Ethernet bands):

• Audio Carrier	0 dBmV
• Peak Video Sync	+12 dBmV

1.4.6 RF Coaxial Cable Interface Specifications (Output)

Transmit Frequencies:

• Data Band

– Single-Cable	214.25 to 228.25 MHz
– Dual-Cable	54 to 68 MHz

• Collision Enforcement Band

– Single-Cable	210.25 to 214.25 MHz
– Dual-Cable	68 to 72 MHz

Transmit Power (75 ohm load):

• Data Band	50 (±2) dBmV
• Collision Enforcement Band	50 (±2) dBmV

Postamble Level (75 ohm load)
Nominal: 1000 mV peak-to-peak

Collision Detect Self-Test Signal Level (75 ohm load): 1000 mV peak-to-peak

Carrier On/Off Ratio: ≥65 dB

Bandwidth (see mask):

• Data Band	54 to 68 MHz
• Collision Enforcement Band	68 to 72 MHz

Return Loss (min. within Ethernet channel, power applied): 14 dB

Guard Circuitry:

• 2 RF Guard Circuits • 1 Digital Guard Circuit (in logic subassembly)	Ensure that transmissions longer than 150 ms never occur (shall not inhibit continuous transmissions of fewer than 20 ms)
• Reset (normal operation)	Operator-initiated, ac power down and powerup

1.4.7 Signal Processing Specifications

Scrambling Technique (for data for RF transmission): CCITT V.29 type with seed changing for each transmitted packet

Encoding:

• RF Transmission Transceiver Cable	Differential
• Transmission	Manchester

Decoding:

• RF Received Data Signal	Differential (Delay and multiply technique in combination with demodulation at IF)
• Transceiver Cable Received Data Signal	Manchester

Modulation:

• Differentially Encoded Data	Binary phase shift keying (BPSK)
Collision Enforcement	frequency modulation of random data

Demodulation:

• RF Data Band	Delay and multiply at IF
• RF Collision Enforcement	Level detect

CHAPTER 2

CHAPTER 2
INTERFACE DESCRIPTION

2.1 INTERFACE OVERVIEW

The DECOM transceiver provides the functional interface between the broadband coaxial cable facility and the transceiver cable. Figure 2-1 shows a sample configuration of an Ethernet physical channel of which the broadband Ethernet transceiver is a part.

2.2 CONTROLLER TO TRANSCEIVER INTERFACE

2.2.1 Transceiver Cable

The transceiver cable interface is used to provide a communications link between the DECOM transceiver and an Ethernet controller, local network interconnect (DELNI), or communications server. The physical interface between the broadband Ethernet transceiver and the transceiver cable is provided by a 15-pin D subminiature connector on the DECOM rear chassis.

A chart on page 2-3 shows the electrical connections for the transceiver cable.

2.2.2 Electrical Parameters (Transceiver Cable)

The transceiver cable conforms to the following parameters:

Characteristic Impedance:	78 (±5 ohms)
Transfer Impedance (Common Mode):	Shall not exceed the values shown in Figure 2-2 as a function of frequency
Transfer Impedance (Differential Mode):	20 dB lower than that specified for common mode with respect to any signal pair
DC Resistance (Pair):	Less than 40 milliohms/m
Attenuation:	Less than 3 dB (measured at 10 MHz) for the total length between the transceiver and the controller
Propagation Velocity:	0.65 c minimum (5.13 ns/m)

2.2.3 Grounding and Shielding Parameters (Transceiver Cable)

The shield of the transceiver cable must be connected to the chassis of the device housing the controller, local network interconnect, or communications server. The connection must be a direct, low inductance (not to exceed 50 nH) connection.

Both pin 1 of the bulkhead connector and the backshell of the mating transceiver cable connector must be connected to the chassis. Connecting pin 1 of the bulkhead connector only is not adequate; a direct connection between the transceiver cable connector backshell and the chassis must be provided, also. Grounding is provided by the mating D connectors.

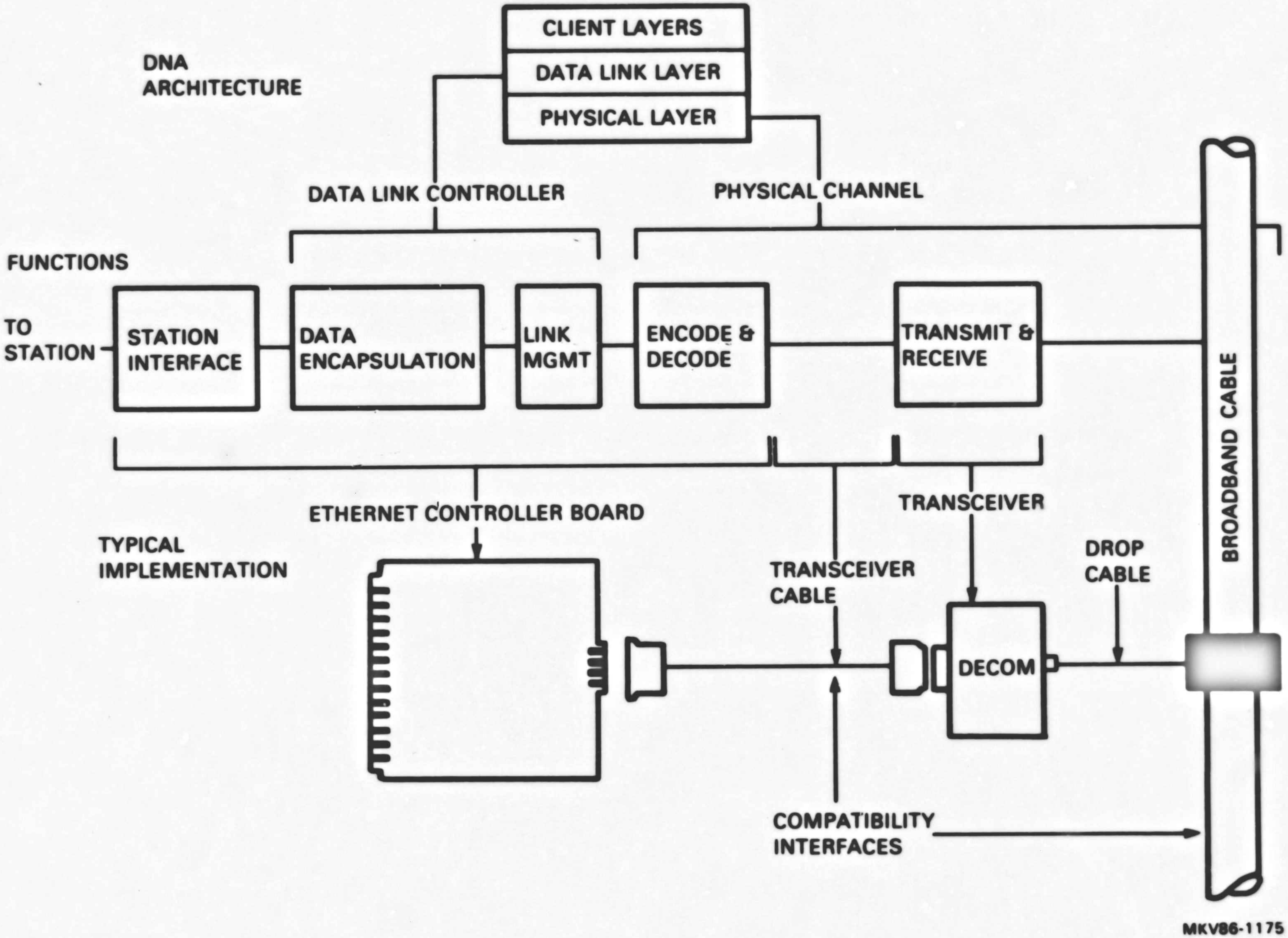

Figure 2-1 Ethernet Architecture and Typical Implementation

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Transceiver Cable Connections

DECOM Connection	Function	Controller Connection
Connector Backshell	Shield	Connector Backshell
Pin 1	Shield	Pin 1
Pin 2	Collision Presence(+)	Pin 2
Pin 3	Transmit(+)	Pin 3
Pin 4	– No Connection –	Pin 4
Pin 5	Receive(+)	Pin 5
Pin 6	Power Return*	Pin 6
Pin 7	– No Connection –	Pin 7
Pin 8	– No Connection –	Pin 8
Pin 9	Collision Presence(–)	Pin 9
Pin 10	Transmit(–)	Pin 10
Pin 11	– No Connection –	Pin 11
Pin 12	Receive(–)	Pin 12
Pin 13	Power*	Pin 13
Pin 14	– No Connection –	Pin 14
Pin 15	– No Connection –	Pin 15

* The DECOM transceiver does not utilize power from the controller. Pins 6 and 13 are terminated to a 78 (±5) ohm ac load within the DECOM transceiver.

2.2.4 Transmit Pair (Transceiver Cable)

To transmit, the transmit pair of the transceiver cable must be driven as follows:

Pins:	TRANSMIT (+) = Pin 3 TRANSMIT (–) = Pin 10
Drive Levels:	±550 mV minimum ±1.2 V maximum
Source Impedance of Driver:	Greater than 415 ohms

2.2.5 Receive Pair (Transceiver Cable)

The receive pair output of the transceiver has the following characteristics:

Pins:	RECEIVE (+) = Pin 5 RECEIVE (–) = Pin 12
Signal Levels:	±550 mV minimum ±1.2 V maximum
Transformer Coupling:	The magnetizing inductance of the coupling transformer is 30 μH (±10%)
Time Constant:	Inductive-resistive time constant is 335 to 600 ns with cable impedance of 78 (±5) ohms

2.2.6 Collision Presence Pair (Transceiver Cable)

The collision presence pair output of the transceiver has the following characteristics:

Pins:	COLLISION PRESENCE (+) = Pin 2 COLLISION PRESENCE (−) = Pin 9
Signal Levels:	±550 mV minimum ±1.2 V maximum
Transformer Coupling:	The magnetizing inductance of the coupling transformer is 30 μH (±10%)
Time Constant:	Inductive-resistive time constant is 335 to 600 ns with cable impedance of 78 (±5) ohms

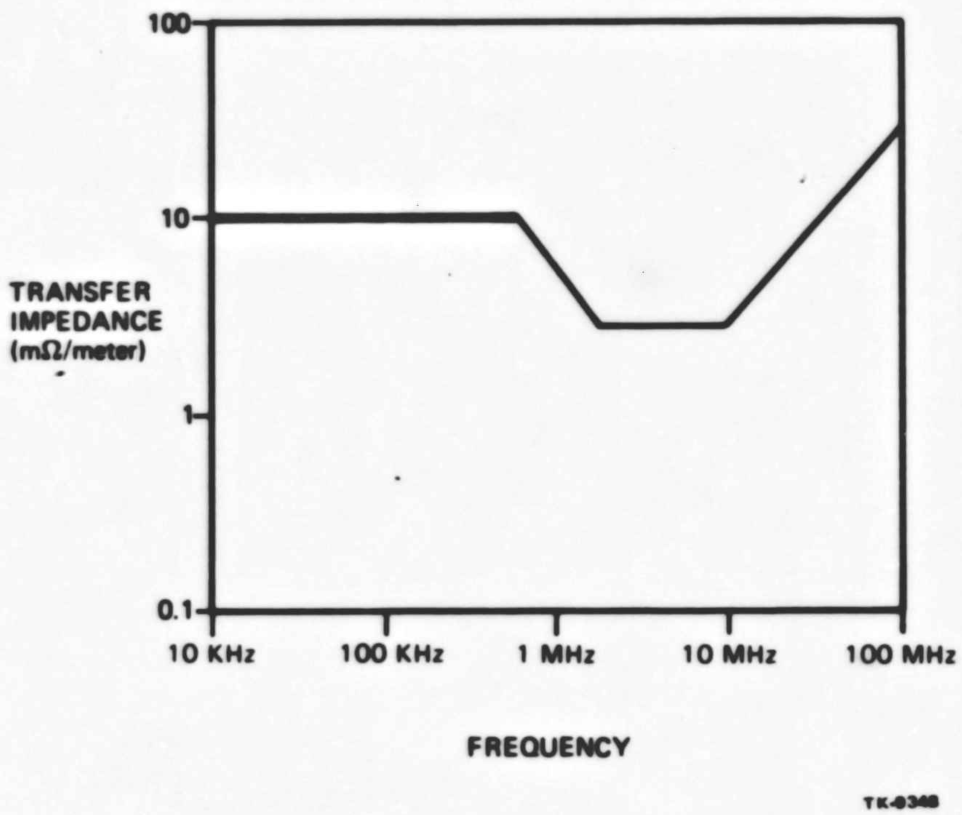


Figure 2-2 Transfer Impedance (Transceiver Cable)

2.2.7 Transceiver Input Response Characteristics

During the idle state, the output of the differential line driver must be high. Because of transformer coupling, however, the idle state output voltage will decay to zero on the transceiver cable during the idle state. The first transition of the signal sent to the transceiver on the transmit pair must be negative going; the last transition must be positive going.

Transformer Coupling:	Magnetizing inductance of the coupling transformer = 30 μH (±10%)
Time Constant:	Inductive-resistive time constant is 335 to 600 ns with cable impedance of 78 (±5) ohms
Input Thresholds:	The transceiver uses a squelch circuit with hysteresis to provide noise immunity. The squelch thresholds are as follows:

- TRANSMIT TURN-ON – The differential input signal must be more negative than −350 mV, nominal (−400 mV, minimum), for a period between 50 and 100 ns to turn off the transmitter squelch.
- TRANSMIT STAY-ON – The differential input signal must be more negative than −150 mV, nominal, to keep the transmitter squelch turned off.

2.3 SINGLE-CABLE ETHERNET SYSTEMS' RF SIGNAL INTERFACE

2.3.1 DECOM Signal Frequency (Single-Cable)

The channel frequencies for a single- versus dual-cable broadband Ethernet network are different; however, the basic RF section internal to the DECOM transceiver always operates on the same frequencies whether installed in a single- or dual-cable system. The DECOM frequencies are:

- DATA CARRIER – At 61 MHz, which is phase-modulated. The data carrier band or frequency spectrum is 14 MHz wide around the 61 MHz carrier (from 54 to 68 MHz).
- COLLISION ENFORCEMENT CARRIER – At 70 MHz, which is frequency-modulated. The collision enforcement band is 4 MHz wide around the collision enforcement carrier (from 68 to 72 MHz).

A frequency translator (DEFTR) shifts the transmit frequencies up for transmission on the cable facility while the downconverter installed on the DECOM transceiver shifts the cable facility frequencies down for the DECOM receiver. See Figures 2-3, 2-4, and Table 2-1 for more details on the frequency bands.

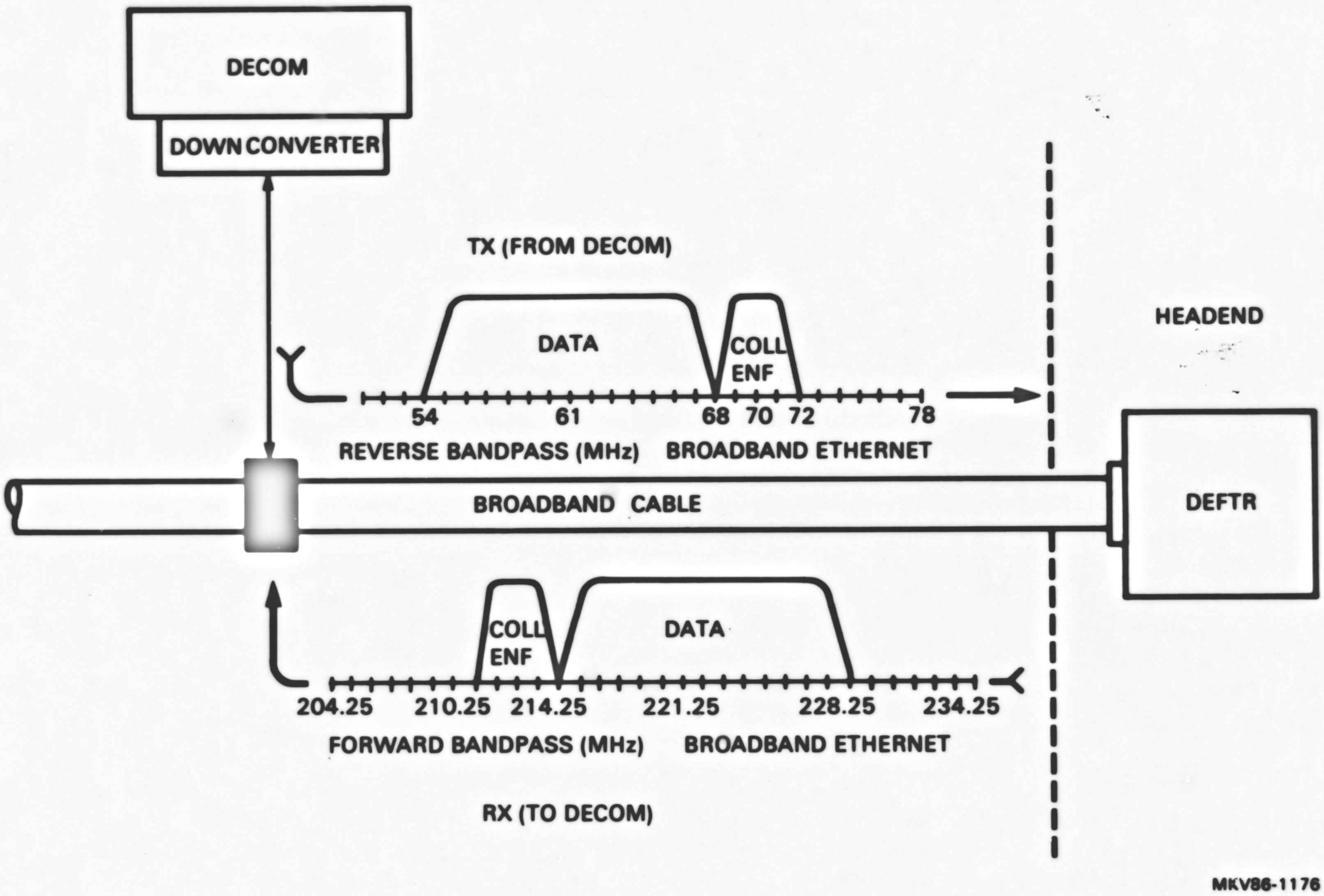
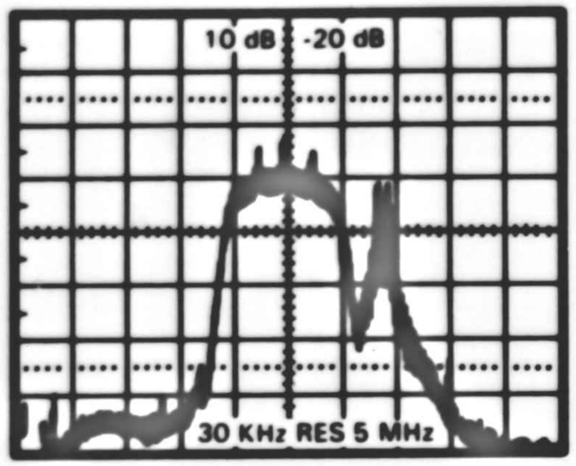


Figure 2-3 Single-Cable DECOM Frequencies

Table 2-1 The DIGITAL Broadband Ethernet Frequency Assignments

Signal Name	From	To	Center Frequency	Bandpass	Modulation/ Encoding	Comments
Single-Cable System						
Data Carrier	DECOM	DEFTR	61 MHz	54-68 MHz	Diff/BPSK	Reverse Chan
Data Carrier	DEFTR	Cable Facility	221.25 MHz	214.25-228.25 MHz	Diff/BPSK	Forward Chan
Data Carrier	Cable Facility	DECOM	221.25 MHz	214.25-228.25 MHz	Diff/BPSK	Forward Chan
Data Carrier	Downcon	DECOM Rec	61 MHz	54-68 MHz	BPSK	Inverted
Col Enf Car	DECOM	DEFTR	70 MHz	68-72 MHz	FM	Reverse Chan
Col Enf Car	DEFTR	Cable Facility	212.25 MHz	210.25-214.25 MHz	FM	Forward Chan
Col Enf Car	Cable Facility	DECOM	212.25 MHz	210.25-214.25 MHz	FM	Forward Chan
Col Enf Car	Downcon	DECOM Rec	70 MHz	68-72 MHz	FM	Inverted
Dual-Cable System						
Data Carrier	DECOM	Cable Facility	61 MHz	54-68 MHz	BPSK	
Data Carrier	Cable Facility	DECOM	61 MHz	54-68 MHz	BPSK	
Col Enf Car	DECOM	Cable Facility	70 MHz	68-72 MHz	FM	
Col Enf Car	Cable Facility	DECOM	70 MHz	68-72 MHz	FM	



SETTINGS
HORIZONTAL = 5 MHz/DIV
BANDPASS FILTER = 30 KHz
VERTICAL = 10 dB/DIV
REFERENCE = 20 dBm

MKV86-1177

Figure 2-4 Actual Transmitted DECOM Signal Frequency Spectrum

2.3.2 DECOM RF Signal Levels (Single-Cable)

DECOM Signal Levels

Receiver Minimum Dynamic Range:	18 dB within the 54-72 MHz bandpass
Absolute Receive Levels:	−3 to +15 dBmV
Transmit Level:	50 dBmV of ±2 dB

Summing the distribution of the 18 dB DECOM receiver dynamic range, in a DEFTR environment of 15° to 32°C (59° to 90°F):

Variation	Allocated To
±2 dB	DECOM transmitter
±3 dB	Reverse Ethernet channel cable facility
±1 dB	DEFTR gain variations
±3 dB	Forward Ethernet channel cable facility
Total = ±9 dB	DECOM receiver dynamic range

In summary, of the DECOM receiver's 18 dB dynamic range, the transmitted signal uses 4 dB, and 1 dB is utilized by the DEFTR frequency translator due to gain variations. This leaves 12 dB to be distributed to the cable facility; 6 dB on the reverse cable facility and 6 dB on the forward cable facility Ethernet channel (±3 dB on each).

DEFTR Signal Levels

Operating Range:	15° to 32°C
Gain:	56 (±1) dB.

Summing the distribution of the 18 dB DECOM receiver dynamic range, in a DEFTR environment of 10° to 40°C (50° to 104°F):

Variation	Allocated To
±2 dB	DECOM transmitter
±3 dB	Reverse Ethernet channel cable facility
±2 dB	DEFTR gain variations
±2 dB	Forward Ethernet channel cable facility
Total = ±9 dB	DECOM receiver dynamic range

In the headend environment [10° to 40°C (50° to 104°F)], of the DECOM receiver's 18 dB dynamic range, the DECOM transmitted signal uses 4 dB, and 2 dB is utilized by the DEFTR frequency translator due to gain variations. This leaves 10 dB to be distributed to the cable facility; 6 dB on the reverse cable facility and 4 dB on the forward Ethernet channel.

2.3.3 DECOM RF Signal and Path Loss (Single-Cable)

From any DECOM transmit point to any receive point there are signal level and path loss restrictions. The signal level restrictions and losses are traced from the point of DECOM transmit, through the reverse channel path, through the DEFTR frequency translator (including input and output attenuators), through the forward channel path, and into the DECOM receiver.

The signal levels and path losses are as follows:

DECOM Transmit Level:	48 to 52 dBmV
Reverse Channel Cable Loss:	37 to 53 dB (6 dB variance of path loss within this range: DECOM signals may vary 10 dB)
Input Level to DEFTR (before input attenuator):	−5 to +15 dBmV (10 dB variance of DECOM signal levels within this range)
Input Attenuator Settings:	0 to 10 dB, in 1 dB increments
Input Level to DEFTR:	−5 to +5 dBmV, after input attenuator
DEFTR Gain:	55 to 57 dB, 15° to 32°C (59° to 90°F)
Output Level of DEFTR:	50 to 62 dBmV, before output attenuator
Output Level of DEFTR (after output attenuator):	40 to 62 dBmV (12 dB variance of DECOM signals within this range)
Forward Channel Cable Loss:	37 to 53 dB (6 dB variance of path loss within this range; DECOM signals may vary 18 dB)
DECOM Signal Level Range:	−3 to +15 dBmV

2.3.4 DECOM Adjacent Channel Parameters (Single-Cable)

Single-cable Ethernet adjacent channel parameters are a function of the DECOM receiver and the input filtering of the DEFTR frequency translator (Figure 2-5).

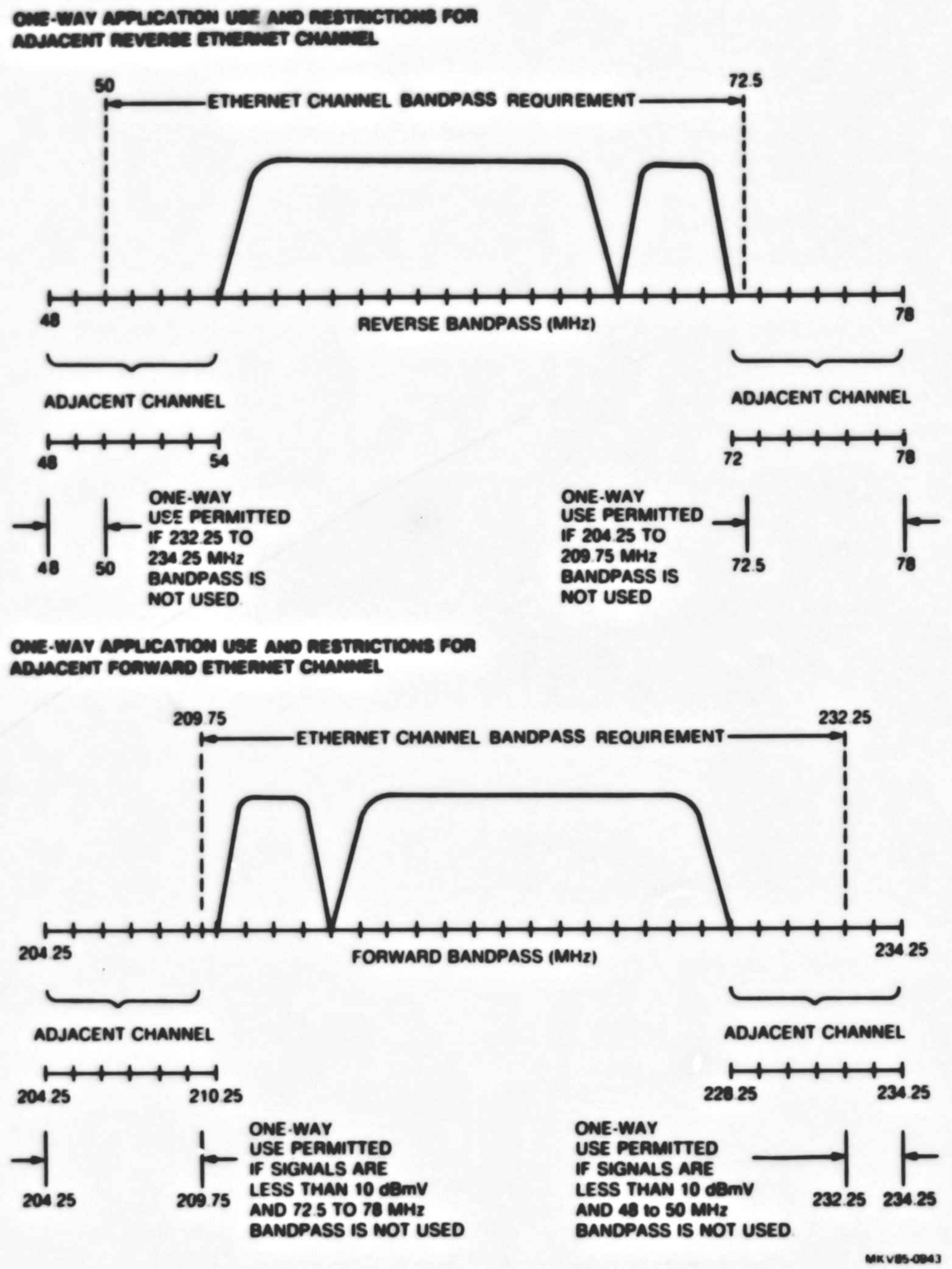


Figure 2-5 DECOM Adjacent Channel Parameters (Single-Cable)

2.4 DUAL-CABLE Ethernet SYSTEMS' RF SIGNAL INTERFACE

The frequency diagrams in this section show smooth and rounded curves, and are for reference purposes only. The actual DECOM signal appears similar to the signal in Figure 2-4.

2.4.1 DECOM Signal Frequency (Dual-Cable)

The DECOM RF signal transmitted and received on a dual-cable broadband coaxial system utilizes modulation around two carrier frequencies (Figure 2-6):

- DATA CARRIER – At 61 MHz, which is phase modulated. The data carrier band or frequency spectrum is 14 MHz wide around the 61 MHz carrier and goes from 54 to 68 MHz.
- COLLISION ENFORCEMENT CARRIER – At 70 MHz, which is frequency-modulated. The collision enforcement band is 4 MHz wide around the collision enforcement carrier (from 68 to 72 MHz).

2.4.2 DECOM RF Signal Levels (Dual-Cable)

Dynamic Range:	18 dB
Absolute Receive Levels:	–3 to +15 dBmV
Transmit Signal Level:	50 dBmV ±2 dB

Summing the distribution of the 18 dB DECOM receiver dynamic range, in the dual-cable environment:

Variation	Allocated To
±2 dB	DECOM transmitter
±7 dB	Dual-cable facility
Total = ±9 dB	DECOM dynamic range

Of the 18 dB DECOM receiver dynamic range, the DECOM transmitted signal uses 4 dB. This leaves 14 dB of signal variation to be utilized by the dual-cable facility Ethernet channel. From any outlet utilized for transmitting DECOM signals to any outlet utilized to receive DECOM signals, there is a specified loss with a variation of 14 dB (±7 dB).

2.4.3 DECOM RF Signal and Path Loss (Dual-Cable)

Path loss for dual-cable DECOM applications is a function of the DECOM transmit level and DECOM receive level. The DECOM transmits nominally at 50 dBmV and receives at 6 dBmV. Therefore, the nominal path loss for dual cable DECOM applications is 44 dB (50 dBmV - 6 dBmV).

Section 2.4.2 shows the variation in path loss based on the DECOM transmit level variation and the DECOM dynamic range as ±7 dB. Therefore, the absolute (outlet-to-outlet) path loss for the dual-cable Ethernet channel is 44 dB, ±7 dB.

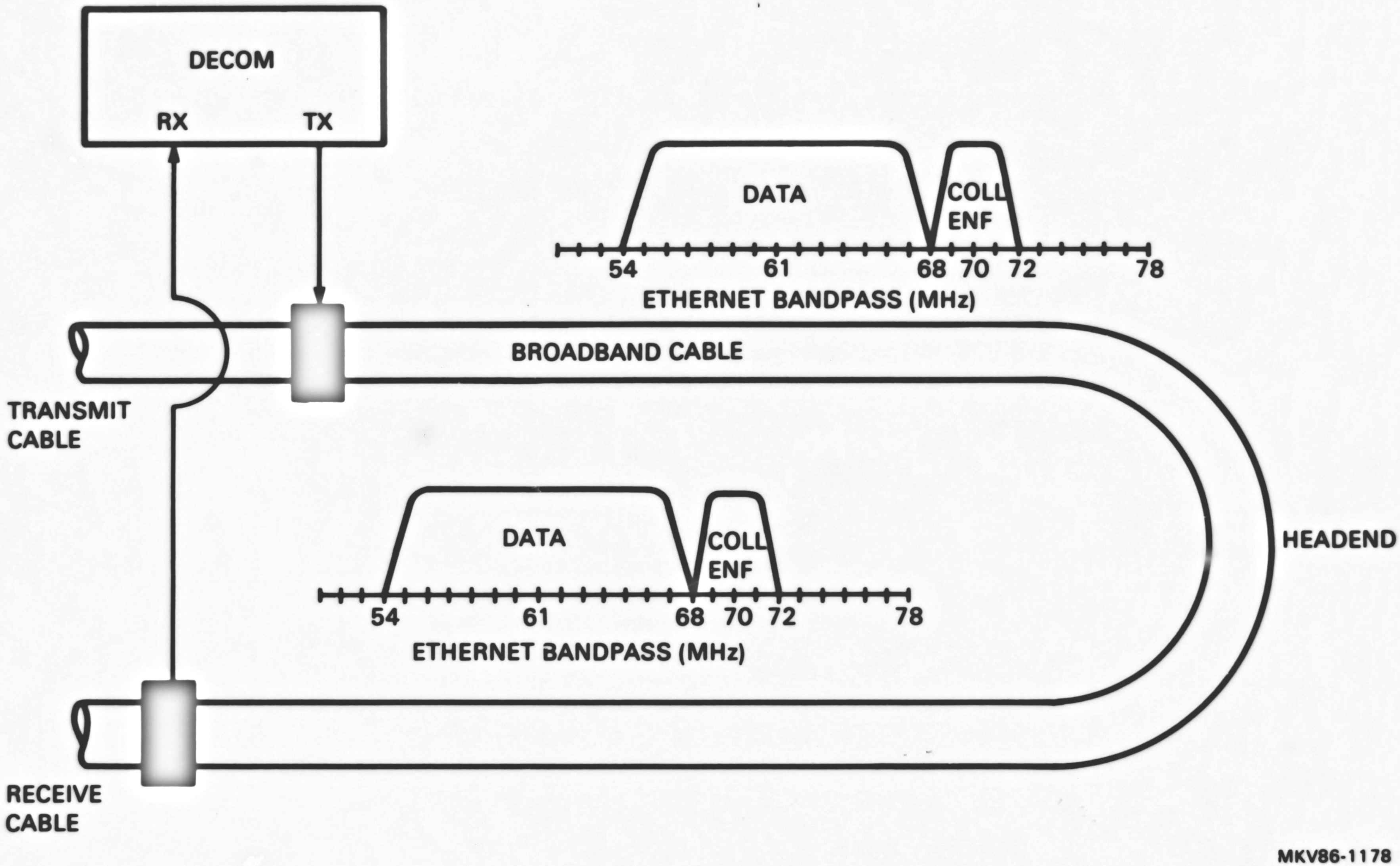


Figure 2-6 Dual-Cable DECOM Frequency Utilization

2.4.4 DECOM Adjacent Channel Parameters (Dual-Cable)

The DECOM (broadband Ethernet) adjacent channels are defined as the 6 MHz bandpass (48-54 MHz and/or 72-78 MHz) on either side of the dual-cable Ethernet bandpass of 54-72 MHz (Figure 2-7).

Nonsignals on the adjacent channels must be 10 dBmV or less in signal strength and are only allowed in the 48-50 MHz and 72.5-78 MHz bandpasses to prevent being received by the DECOM transceiver and being perceived as DECOM signals. The data or collision enforcement circuitry in the receiving DECOM transceiver could be activated.

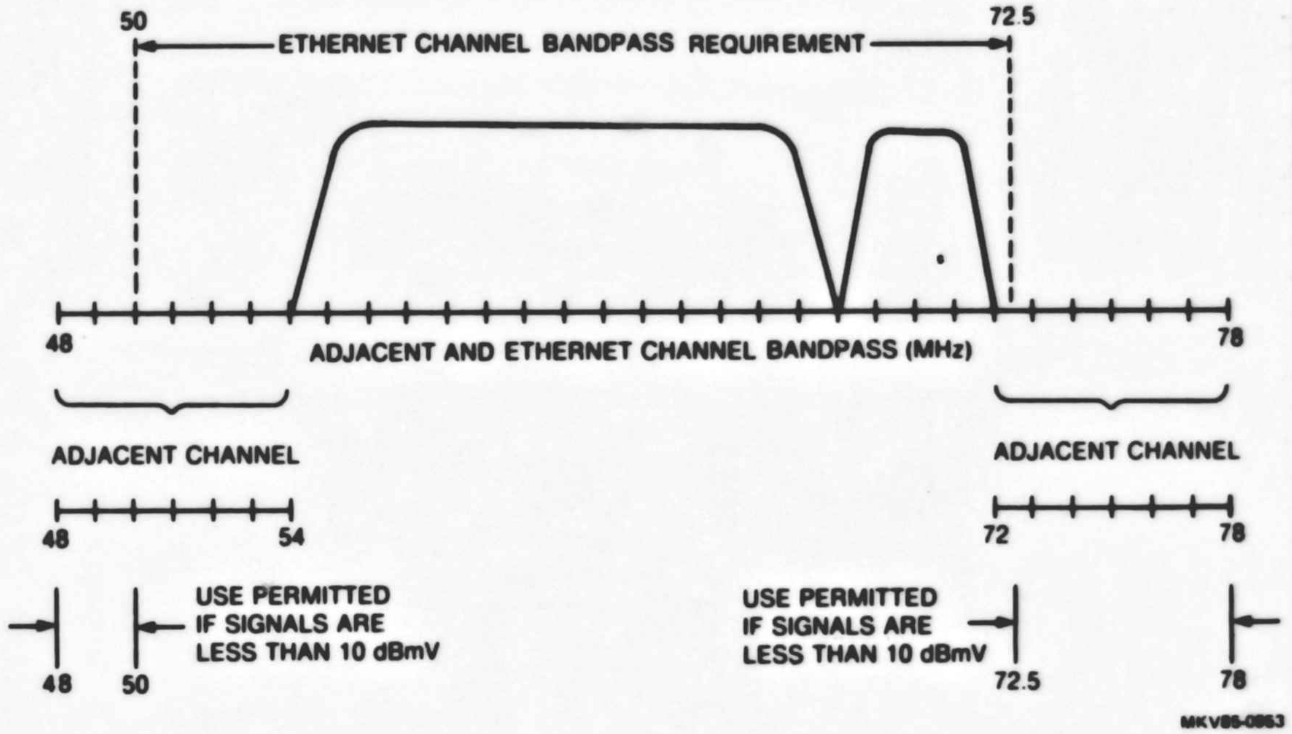


Figure 2-7 DECOM Adjacent Channel Parameters (Dual-Cable)

2.5 DECOM RF SIGNAL MASK

To utilize a broadband cable system's multiple bandpasses and assure concurrent applications, the DECOM transmitted signal adheres to the following mask relative to frequency and relative signal levels (Figure 2-8).

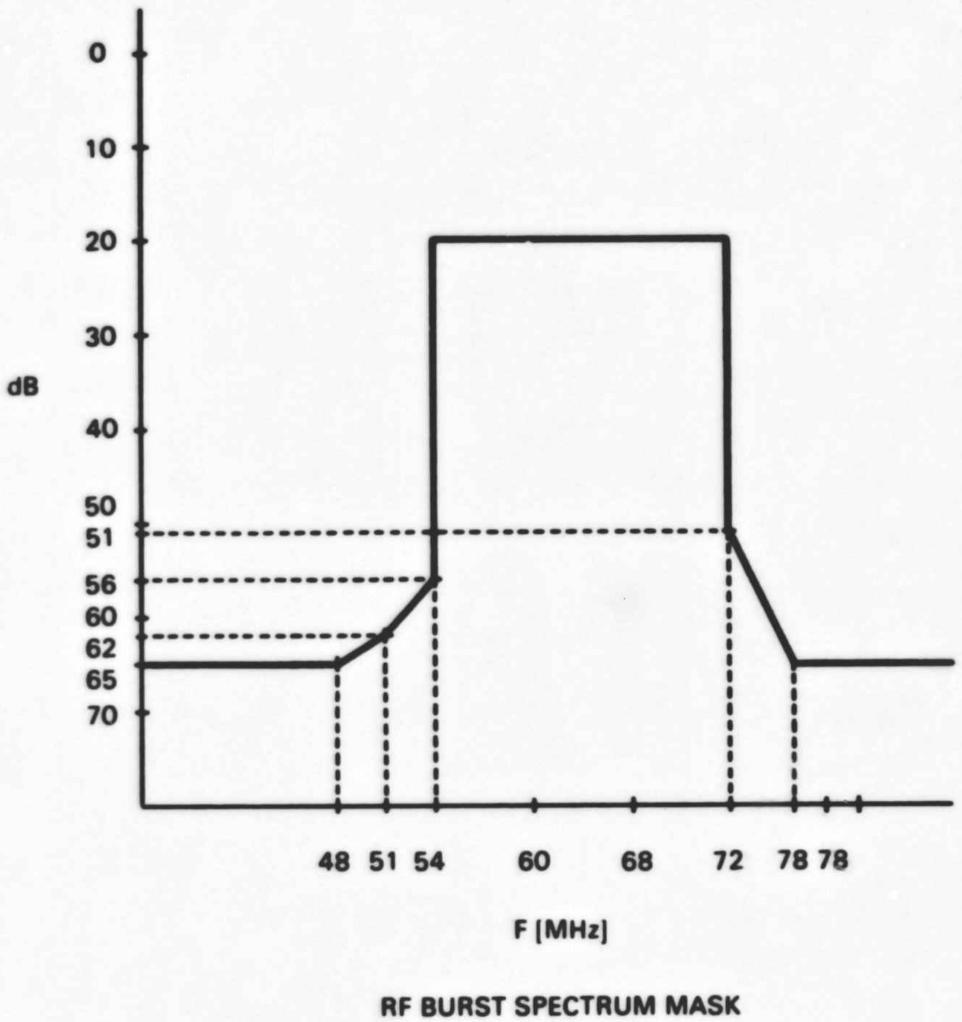


Figure 2-8 DECOM RF Signal Burst Spectrum Mask

2.6 DECOM RECEIVER FREQUENCY RESPONSE PARAMETERS

The frequency response refers to the level of the signals received within the DECOM receiver's frequency range. The dynamic range of the DECOM receiver is 18 dB (6 dBmV ±9 dB). The acceptable limit for the 18 MHz Ethernet bandpass (54-72 MHz) is ±1 dB.

Example: An 8 dBmV signal received at 54 MHz would be received at any other frequency within the bandpass at 8 dBmV within a range of ±1 dB. The 8 dBmV signal received at 54 MHz would be received at 7 to 9 dBmV at any other DECOM receive frequency, 54-72 MHz.

2.7 DECOM RECEIVER NOISE LEVELS

Any non-Ethernet energy received by the DECOM receiver within the 54-72 MHz bandpass is considered to be noise. Most noise in broadband systems is generated by the active devices, mainly amplifiers, that the cable facility utilizes. Other noise sources are signal scatter and distortion products from other broadband applications that appear in the Ethernet bandpass. Ingress of signals external to the cable facility is also a source of noise.

Broadband noise levels should be specified relative to a bandwidth for them to be meaningful. The wider the bandwidth of reference, the more noise will be measured for a given amount of noise power. In broadband Ethernet systems, the standard "reference bandpass" is 4.2 MHz for noise.

Noise levels specified with a reference bandpass other than 4.2 MHz must be converted to the 4.2 MHz reference to be meaningful. The conversion factor is obtained as follows:

$$\text{Noise Bandwidth Conversion Factor} = 10\log\left(\frac{\text{4.2 MHz (bandwidth of industry ref)}}{\text{Bandwidth of noise level for conversion}}\right)$$

To convert the noise level, add the conversion factor to the non-4.2 MHz noise level:

4.2 MHz referenced level = non-4.2 MHz reference level + conversion factor

The acceptable broadband noise strength in the DECOM bandpass is −35.6 dBmV referenced to a 4.2 MHz bandwidth. Noise strength below this level and a signal level of −3 dBmV, at a minimum, ensures an Ethernet error rate of 1 bit in 10^9.

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2.8 DECOM PROPAGATION DELAY PARAMETERS

The propagation delay specification for DECOM Ethernet channels is expressed as RF "user outlet" to RF "user outlet" distance in microseconds.

- Dual-Cable Applications - 15.53 µs, and
- Single-Cable Applications - 15.03 plus .50 µs allotted to the DEFTR headend translator.

The propagation delay specification for the broadband Ethernet channel is derived from the Ethernet controller budget relative to the Ethernet "slot time."

Slot time budget (maximum) = 512 bit times + preamble(576 bit) time

Of this bit time distribution, portions are allocated to various hardware/firmware functions. In the worst case, the functions include the Ethernet path from an Ethernet controller output including Ethernet transceiver cable, transceiver, cable medium, collision detection and enforcement, and back to transmitting Ethernet controller.

Much of this bit time allocation is preset by hardware, CSMA/CD, and Ethernet requirements. The balance of the budget is attributable to the broadband Ethernet channel delay budget or propagation delay of the cable medium. In the single-cable case, this cable medium delay considers the headend translator delay allocation.

Sections 2.8.1 and 2.8.2 detail Ethernet budgets relative to the DECOM product in dual- and single-cable applications. It is assumed that electrical signaling has velocity as follows:

- 4.27 ns/m in broadband drop cable, and
- 3.83 ns/m in broadband semi-rigid trunk cable.

2.8.1 Delay Budget - Single-Cable Broadband Ethernet

Bits Allocated	Element in Communications Path
0.00	Start of first bit from controller
3.00	First bit at transceiver cable
2.57	Transceiver cable controller to DECOM
16.00	Transceiver cable TX pair to DECOM RF out
1.05	RF TX drop cable
73.80	Inbound channel trunk cable
5.00	Headend translator delay
73.80	Outbound channel trunk cable
1.05	RF RX drop cable
160.00	End of bit comparison (at the end of the source address)
20.00	Collision detected to collision enforcement at DECOM RF out
1.05	RF TX drop cable
73.80	Inbound channel trunk cable
.50	Headend translator delay
73.80	Outbound channel trunk cable
1.05	RF RX drop cable
12.00	Receive collision enforcement to signal at transceiver cable collision presence pair
2.57	Transceiver cable DECOM to controller
3.00	Controller detects collision presence
32.00	Controller jams channel
3.86	Cable components (amplifiers, splitters, etc.)
576.00 Bits Total Delay	

Allocating 74.85 bits from user RF outlet to headend results in a radius of 1900 meters, utilizing transmissi speed of 10M bits, cable delay of 3.83 ns/m, and accounting for DEFTR delay.

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2.8.2 Delay Budget – Dual-Cable Broadband Ethernet

Bits Allocated	Delay Element in Communications Path
0.00	Start of first bit from controller
3.00	First bit at transceiver cable
2.57	Transceiver cable controller to DECOM
16.00	Transceiver cable TX pair to DECOM RF out
1.05	RF TX drop cable
74.05	Inbound channel trunk cable
74.05	Outbound channel trunk cable
1.05	RF RX drop cable
160.00	End of bit comparison (at the end of the source address)
20.00	Collision detected to collision enforcement at DECOM RF out
1.05	RF TX drop cable
74.05	Inbound channel trunk cable
74.05	Outbound channel trunk cable
1.05	RF RX drop cable
12.00	Receive collision enforcement to signal at transceiver cable collision presence pair
2.57	Transceiver cable DECOM to controller
3.00	Controller detects collision presence
32.00	Controller jams channel
24.46	Cable components (amplifiers, splitters, etc.)
576.00 Bits Total Delay	

Allocating 75.1 bits from user RF outlet to headend results in a radius of approximately 2000 meters, utilizing transmission speed of 10M bits, and cable delay of 3.83 ns/m.

CHAPTER 3

CHAPTER 3
TECHNICAL DESCRIPTION

3.1 OVERVIEW (Figure 3-1)

The DECOM broadband Ethernet transceiver is a standalone device that connects the host computer's Ethernet controller to the broadband Ethernet cable facility. The DECOM transceiver uses TTL and ECL series logic and RF technology to convert the Manchester-encoded Ethernet packets from the controller into differentially-encoded binary phase shift keyed (DBPSK) RF bursts and transmits these bursts to other DECOM transceivers in the network. The DECOM demodulates, decodes, and converts DBPSK bursts from other DECOM transceivers into Manchester-encoded Ethernet packets for its controller.

3.1.1 Connection to the Controller (Host)

The Ethernet controller connects to the DECOM broadband Ethernet transceiver by a BNE3X-XX or BNE4X-XX tranceiver cable. The maximum length for the BNE3X-XX cable is 50 meters (163 feet) and the BNE4X-XX cable is 12 meters (40 feet) maximum. The pin out is shown in Table 2-1.

3.1.2 Logic Module

The logic module processes transmit and receive data as it passes between the controller in the host and the modem module. The logic module detects the presence of a collision and sends the appropriate control signals to the controller and the modem module. The collision detection and enforcement logic compares the TX DATA from the transmit data logic with the RX DATA from the receive data logic, which has passed over the cable facility and returned to the transceiver. The logic module also provides scrambling, encoding and decoding, and the addition of the preamble.

3.1.3 Modem Module

The modem module changes the data from digital format to an RF format for transmission and from RF format to digital format for reception. The RF format is differentially-encoded binary phase shift keyed (BPSK).

The modulator in the modem module binary phase shift keys a 61 MHz carrier in response to the encoded TX DATA from the transmit data logic circuit. The modulator outputs this carrier directly to the transmit cable in a dual-cable facility, or through the downconverter module to the cable in a single-cable facility.

The demodulator converts the differentially-encoded BPSK signal from the cable or downconverter into RX DATA and an RX CLOCK for the receive data logic.

3.1.4 Downconverter Module

In a single-cable installation, the BPSK modulated carrier from the modulator passes through a diplexer in the downconverter module. The diplexer allows the transmit signal to pass into the cable facility, but keeps the transmit signal from overloading the input to the downconverter for the demodulator.

The downconverter also converts the 221.25 MHz BPSK receive signal from the cable facility into a 61 MHz receive signal for the demodulator. In a dual-cable network, the demodulator connects directly to the receive cable in the cable facility.

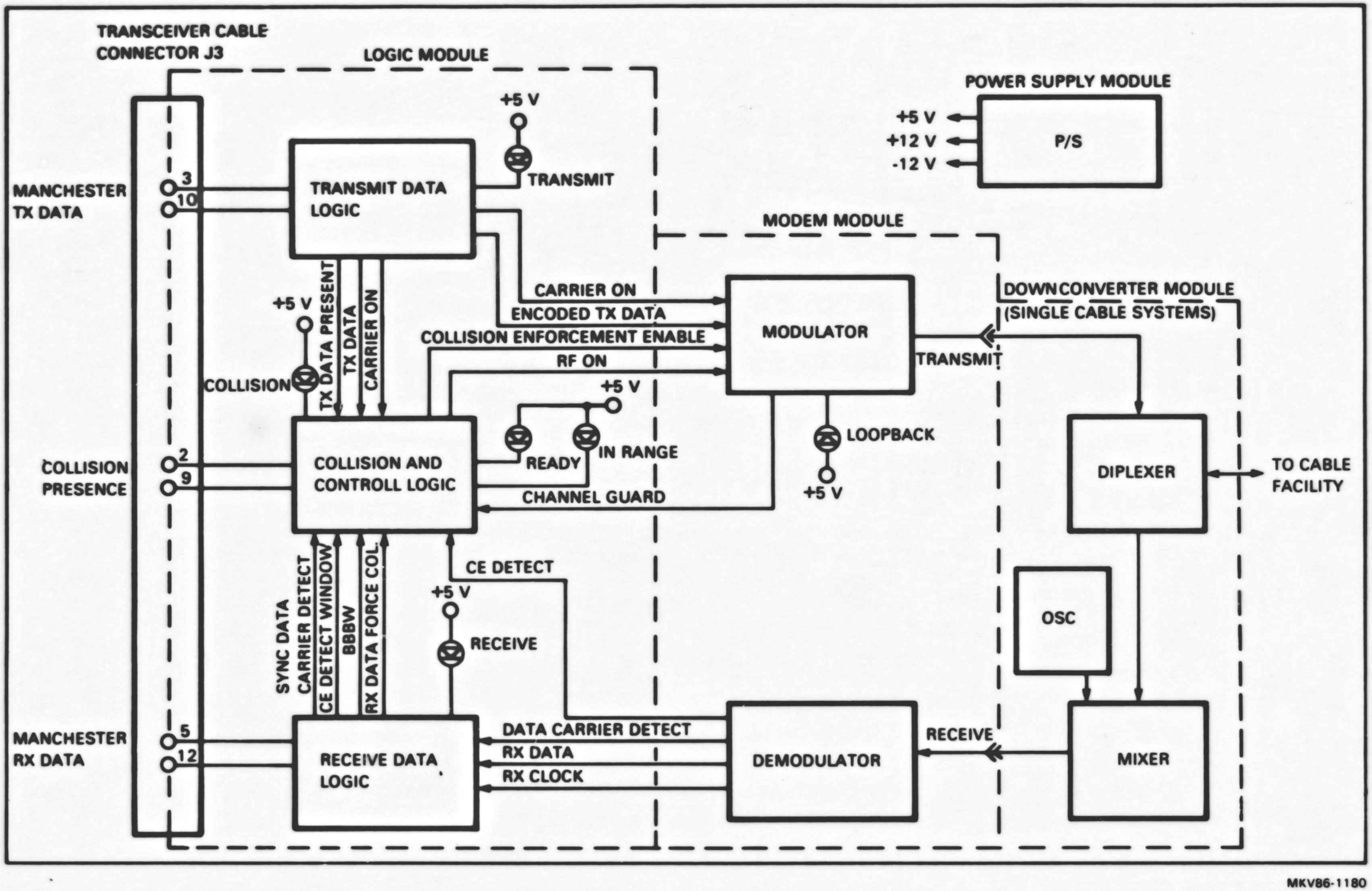

Figure 3-1 DECOM Broadband Ethernet Transceiver Block Diagram

3.1.5 Connection to the Network

The DECOM transceiver and the cable facility are connected by a 75 ohm coaxial cable. The broadband drop cable connects to the cable facility by a broadband cable tap.

3.1.6 Power Supply

The DECOM transceiver can be configured to operate on 120 or 230 Vac, at either 50 or 60 Hz. The 90 W switching supply generates voltages at +5 V, +12 V, and −12 V dc. A cooling fan is connected to the ac input.

3.2 LOGIC MODULE

3.2.1 Transmit Data Logic (Figure 3-2)

As the functional block diagram in Figure 3-2 shows, the transmit data logic reformats packets of transmit data from the controller module for transmission by the modulator in the modem.

TRANSMIT DATA INTERFACE [1]

Manchester-encoded transmit data from the controller enters the DECOM transceiver at J3, pins 3 and 10. The outer shell of the connector on the cable from the controller connects to the chassis of the transceiver by two parallel capacitors. This arrangement provides an RF ground that keeps the cable between the DECOM transceiver and its controller from radiating EMI.

The transmit data interface converts the input from the transmit data pair from ECL to TTL levels, and provides balanced Manchester data to the Manchester decoder.

MANCHESTER DECODER [2]

The data from the controller is Manchester-encoded so that a transition occurs in the middle of each bit. A low-to-high transition encodes a 1 bit and a high-to-low transition encodes a 0 bit. Manchester encoding allows the controller to send data and the clock over the same twisted pair.

The Manchester decoder recovers the clock from the Manchester data input to the transceiver, and outputs separate non-return-to-zero (NRZ) data and derived clock outputs for the NRZ data FIFO.

TRANSMIT SQUELCH CIRCUIT [3]

The transmit squelch circuit generates an output that allows transitions to appear at the output of the Manchester decoder only when data transitions are present on the transmit data interface. When data transitions are not present, the transmit squelch circuit holds Manchester data high.

NRZ DATA FIFO [4]

The NRZ data FIFO provides a buffer to compensate for the difference in phase between the clock derived from the Manchester data and the clock on the logic module. Data is written into and read from the FIFO at slightly different rates. This allows the transmit logic circuits to process data from the controller using a locally generated continuously running clock.

The NRZ data FIFO also adds eight bits in an alternating one/zero pattern to the front of the preamble sent by the controller. These eight preamble bits compensate for the preamble bits (up to nine)lost by the preceding circuitry. This allows the bit timing recovery circuits at the receiving transceivers time to lock onto the clock before the start of the data.

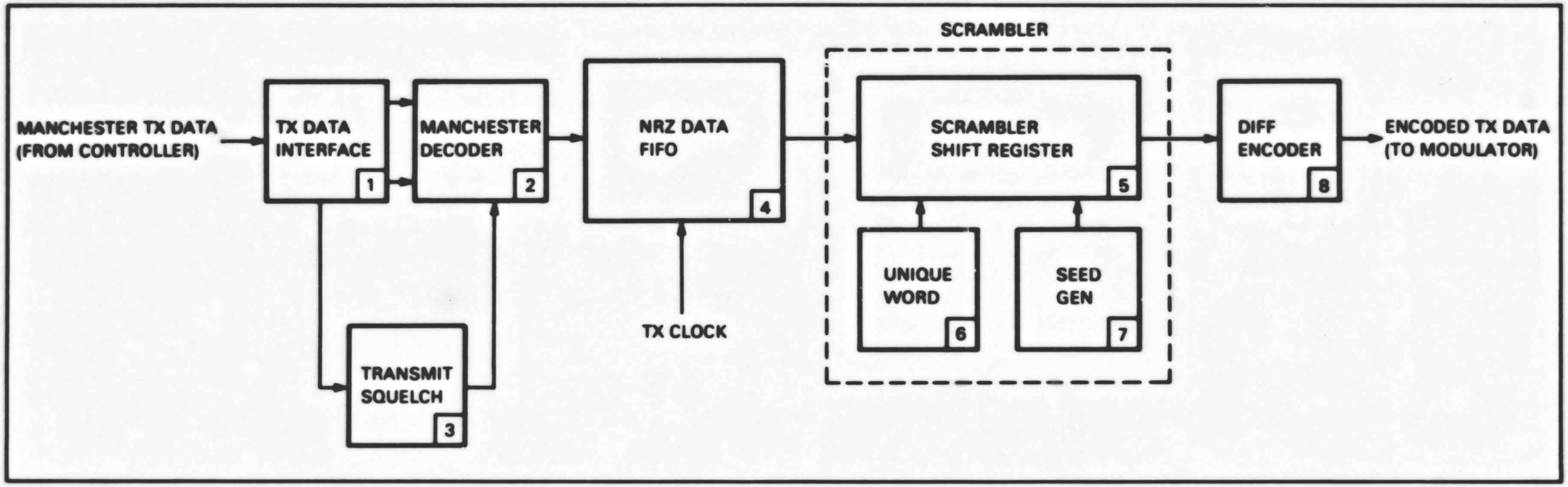

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Figure 3-2 Transmit Logic Block Diagram

SCRAMBLER
The scrambler scrambles the packets that are sent over the network to keep them from having long strings of zeros or ones. The long strings can keep the clock recovery circuits in other transceivers from recovering the clock from the data after it is differentially encoded. The scrambler circuit also adds a 23-bit postamble to the end of each packet, consisting of a one followed by 22 zeros.

SCRAMBLER SHIFT REGISTER 5
The 23-bit scrambler shift register provides a pattern used to scramble the data and conforms to the CCITT V.29 standard, except that it is preloaded with a 24-bit seed from the scrambler seed generator.

UNIQUE WORD GENERATOR 6
The scrambler also inserts a unique word into the preamble just before the scrambler sequence by changing one of the ones in the preamble to a zero. (Refer to Figure 3-2.)

SEED GENERATOR 7
The scrambler seed generator keeps a packet with a sequence that cannot be scrambled from jamming the network. All scramblers have a sequence that they cannot scramble. The sequence is the same as the data sequence that is being used to scramble the data, resulting in a continuous strings of ones or zeros.

If this sequence occurred in data sent over the broadband Ethernet network, the clock recovery circuits in the receiving transceivers would be unable to recover the clock. There would not be any transitions for the circuit to synchronize itself with. The result is a bit error in the packet and the controller would send it again, resulting in a condition in which the same packet would be sent over and over, jamming the network. The probability is a 10^{-27} that this would happen.

DIFFERENTIAL ENCODER 8
The differential encoder encodes scrambler shift register output so that the data and clock are superimposed, making it possible to separate the clock and data on the receiving end. The differential encoder takes the bit at its input and compares it with the bit it has just sent. The encoder sends a one if the previous bit and the next bit are the same, and it sends a zero if the previous bit and the next bit are different.

Thus, the differential encoder encodes the data in terms of changes and no changes, avoiding the need for a common clock at the transmitting and receiving transceivers.

3.2.2 Collision and Control Logic (Figure 3-3)

If the transmit and receive source and destination address fields do not match, a collision has occurred. The collision and control logic sends a 10 MHz COLLISION PRESENT signal to the controller and illuminates the COLLISION LED on the front panel of the DECOM transceiver.

The collision and control logic causes the collision enforcement transmitter to send a 70 MHz frequency modulated carrier to the demodulators in the other transceivers in the rest of the network.

The collision enforcement carrier also causes the collision detection and enforcement logic in the rest of the transceivers in the network to send a COLLISION PRESENT signal to their respective controllers so that they will stop sending data.

COLLISION CONTROL AND HEARTBEAT CIRCUITS [1]

The collision control and heartbeat circuits cause the collision detector and collision present interface to send collision enforcement and heartbeat tones to the controller after a collision has been detected and when the transceiver successfully receives its own transmission back from the cable, respectively.

Since the transceivers use phase shift keying to transmit data, the transceiver with the strongest signal often will not detect errors in its transmission, while the transceiver with the weakest signal will see errors in its received transmission.

Any transceiver that detects a collision turns on a collision enforcement carrier in a band next to the data carrier, signaling the other transceivers that there has been a collision. The collision control circuits detect such collisions. The modems send a collision enforcement signal to their controller.

The heartbeat circuits generate a heartbeat signal about six bit times after the end of each successful transmission from the transceiver, indicating to the controller that the transceiver has successfully received its own transmission.

TRANSMIT DATA SHIFT REGISTER [2]

The transmit data shift register buffers the data that is being transmitted over the network so that the collision and control circuits can compare the transmitted data with the data that is being received over the cable after the propagation delay introduced by the cable.

COLLISION DETECTOR [3]

The collision detector compares the data that has been transmitted from the output of the transmit data FIFO with the scrambled RX data output of the descrambler, starting at the unique word. When the two sets of data differ, a collision or a transmission error has occurred.

The collision detector compares through the last bit of the source address for a maximum of 143 bits and a minimum of 128 bits. Two transmitters can start transmitting simultaneously, and their source addresses will differ by at least one bit. By the 143rd bit, one of the transceivers will detect a difference between the packet it is transmitting and the packet it is receiving.

The collision detector looks at the preamble bits from the transmit data FIFO RAM until it detects a transmit unique word (two zeros in a row). It then disables its read output, which stops the read counter, and holds it at whatever state it was in.

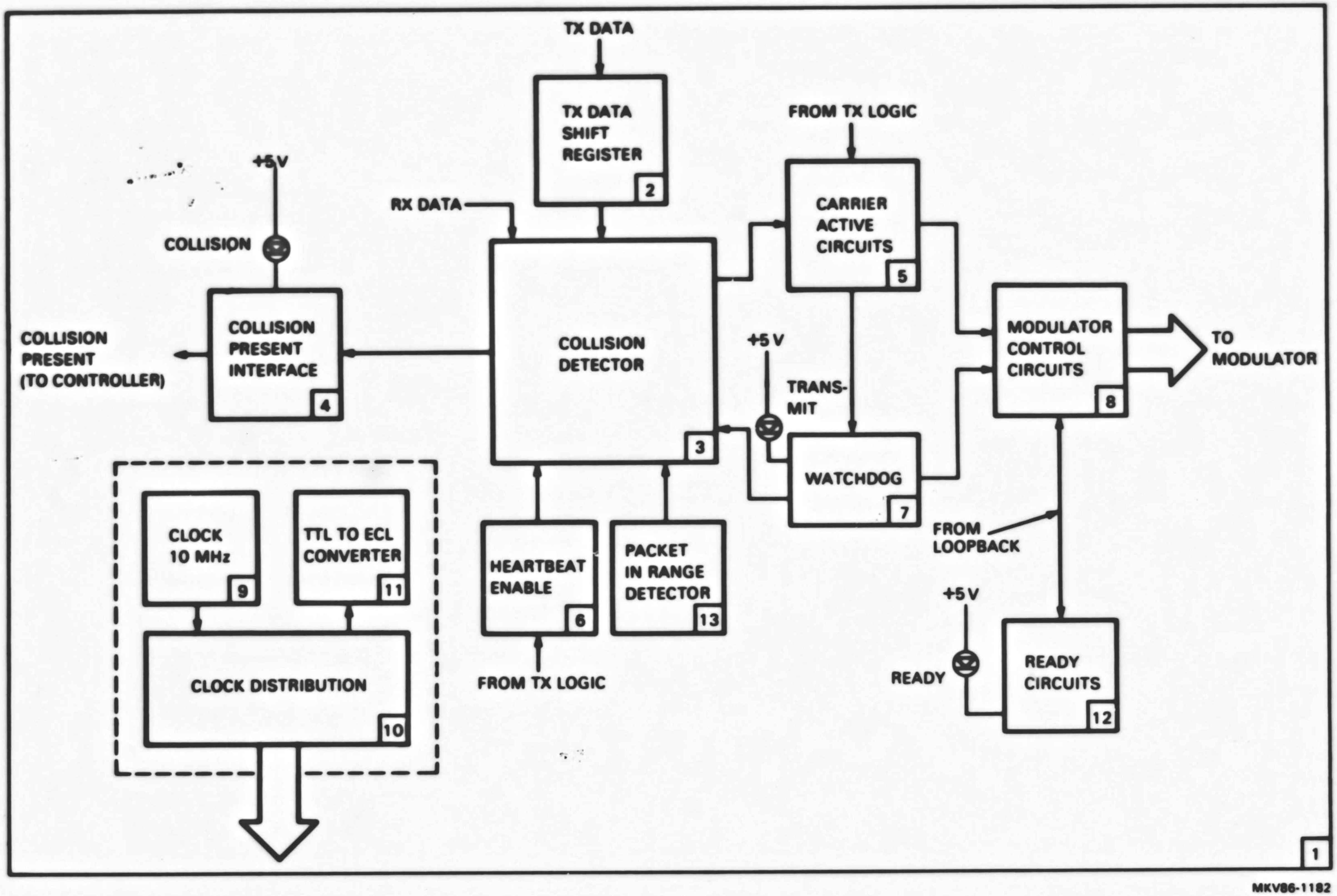

Figure 3-3 Collision and Control Logic Block Diagram

COLLISION PRESENT INTERFACE [4]
The collision present interface sends out a 10 MHz signal generated from the ECL receive clock to the collision present circuits when the collision present output from the collision detector becomes active.

At the same time, the collision present interface lights the COLLISION LED on the front panel.

CARRIER ACTIVE CIRCUITS [5]
The heartbeat and carrier active generator produces control signals that turn on the data and collision enforcement oscillators in the modem during the time that data is being transmitted and just after a successful transmission from the transceiver, respectively.

The carrier active generator outputs a carrier active signal 1 bit after the transmit data present signal becomes active, and lowers the carrier active signal 23 bits after the transmit data present signal becomes inactive. This allows the scrambler enough time after data stops coming out of the NRZ data FIFO memory to generate a postamble that is 23 bits long.

The heartbeat circuit generates a heartbeat signal on the coaxial cable for 32 bits after it inactivates the CARRIER ACTIVE signal, creating a heartbeat signal after the end of the transmission.

HEARTBEAT ENABLE [6]
The heartbeat enable generator sends a heartbeat enable signal to the collision detector, which gates the collision enforcement detect signal.

The heartbeat enable generator sends a signal to the collision detector after the receive data unique word detector disables the receive data present signal at the end of a successful transmission. The heartbeat enable generator outputs its heartbeatenable signal for two milliseconds after the disappearance of receive data present. The collision detector enables its collision present, collision enforcement, and collision detect outputs for the same time period.

WATCHDOG [7]
The CARRIER ON output from the watchdog timer remains active as long as its carrier active and heartbeat signal inputs stay active fewer than 100 ms. The watchdog timer keeps the controller from a transmission longer than that called for in the Ethernet specification, thus jamming the network. The watchdog timer backs up the guard circuits, and keeps a transmission that is too long from tripping the guard circuits. Resetting the guard circuits requires that the power to the transceiver be cycled on and off before it can be used again.

MODULATOR CONTROL CIRCUIT [8]
The modulator control circuits control the RF switches in the modem module. The RF switches enable the collision enforcement and data carriers, and enable the modem's RF output. The modulator control circuit controls the RF output, collision enforcement oscillator, and BPSK oscillator in the modulator in response to the collision enforcement enable output from the collision detector and the carrier on output from the loopback multiplexer. Since turning the collision enforcement and data carriers on and off too quickly would introduce unwanted frequency spurs, these switches are turned on and off through shaping filters.

The modulator control circuit introduces a delay between the time that CARRIER ON is disabled and RF ON and the CE enable signals are enabled. Whenever the CE enable input to the modulator control circuit is enabled, it immediately disables CARRIER ON and then waits four bit times before turning CE enable on.

The modulator control circuit also disables CARRIER ON if the CARRIER ON input from the watchdog timer indicates that the transmission is too long.

The modulator control circuit enables its RF ON output whenever its collision enforcement enable or the CARRIER ON inputs are enabled. Whenever the NORMAL/LOOPBACK switch is in the LOOPBACK position, the modulator control circuit disables all its control outputs to the modem modulator.

CLOCK [9]
The clock circuit supplies a 10 MHz, crystal controlled, local clock to the rest of the circuits on the logic module. The clock signals have the same phase, except for the TX CLOCK signal, which is 180 degrees out of phase from the rest of the clock outputs.

CLOCK DISTRIBUTION [10]
The clock distribution drivers buffer the output from the 10 MHz clock and provide TTL clock signals to the rest of the circuits on the logic module.

TTL TO ECL CONVERTER [11]
The TTL to ECL Converter converts the TTL output from one of the clock distribution drivers to ECL levels that can be used by the Manchester encoder and receiver squelch circuits, which contain ECL logic.

READY CIRCUIT [12]
The ready circuit lights the READY LED, indicating that the transceiver is not in loopback, the watchdog timer has not timed out, the data carrier is enabled, and the length of the transmissions from the transceiver have not exceeded 100 ms.

PACKET IN RANGE DETECTOR [13]
The packet in range detector activates the IN RANGE LED when the transceiver has sent a packet over the cable facility without encountering differences between the bits it has transmitted and the bits it has received within the maximum time delay allowed by the broadband Ethernet network specification. IN RANGE also indicates that the transceiver is not too far away from the headend (DEFTR).

3.2.3 Receive Data Logic (Figure 3-4)

The receive data logic converts the bursts of data into a 10 MHz Manchester-encoded receive data stream for the controller. The RECEIVE LED on the front panel of the transceiver illuminates as data passes from the receive data logic circuits to the controller in the host.

LOOPBACK MULTIPLEXER [1]

The loopback circuits allow the DECOM transceiver to be tested without messages being sent onto the network. The loopback multiplexer selects signals from the demodulator when the NORMAL/LOOPBACK toggle switch is in the NORMAL position, and it selects signals from the output of the transmit logic circuit that simulate the signals from the demodulator when the NORMAL/LOOPBACK toggle switch is in the LOOPBACK position.

Table 3-1 lists the outputs from the demodulator and the signals that the loopback multiplexer uses to simulate them.

Table 3-1 Loopback Simulation Signal

Demodulator Signal	Loopback Signal
RX Clock Bar	TX Clock
RX Data Bar	Decoded TX Data
Collision Enforcement	Collision Enforcement (CE) Enable Detect
Data Carrier Detect	Carrier On

DIFFERENTIAL DECODER [2]

When in loopback mode, the differential decoder decodes the output of the differential encoder in the transmit logic circuit to simulate the demodulator receive data from the demodulator. The decoder uses the local receive clock to decode the data.

RECEIVE DATA FIFO [3]

The receive data FIFO synchronizes the data from the modem's demodulator with the local clock. The receive data FIFO provides a data buffer that makes up for frequency differences between the receive clock from the demodulator and the local clock. The receive clock clocks data into the FIFO and the local receive clock clocks data out of the FIFO. The buffering effect provided by the memory in the FIFO allows data to be read into and out of the FIFO at slightly different speeds, making up for any frequency differences between the two clocks.

MEMORY [4]

The receive data FIFO memory is a one by eight bit circular buffer with memory locations that are independently addressable by the read and write counters.

WRITE COUNTER [5]

The output from the memory write counter sequentially addresses locations in the receive data FIFO memory so that they can be written to, in response to the DEMOD RX CLOCK.

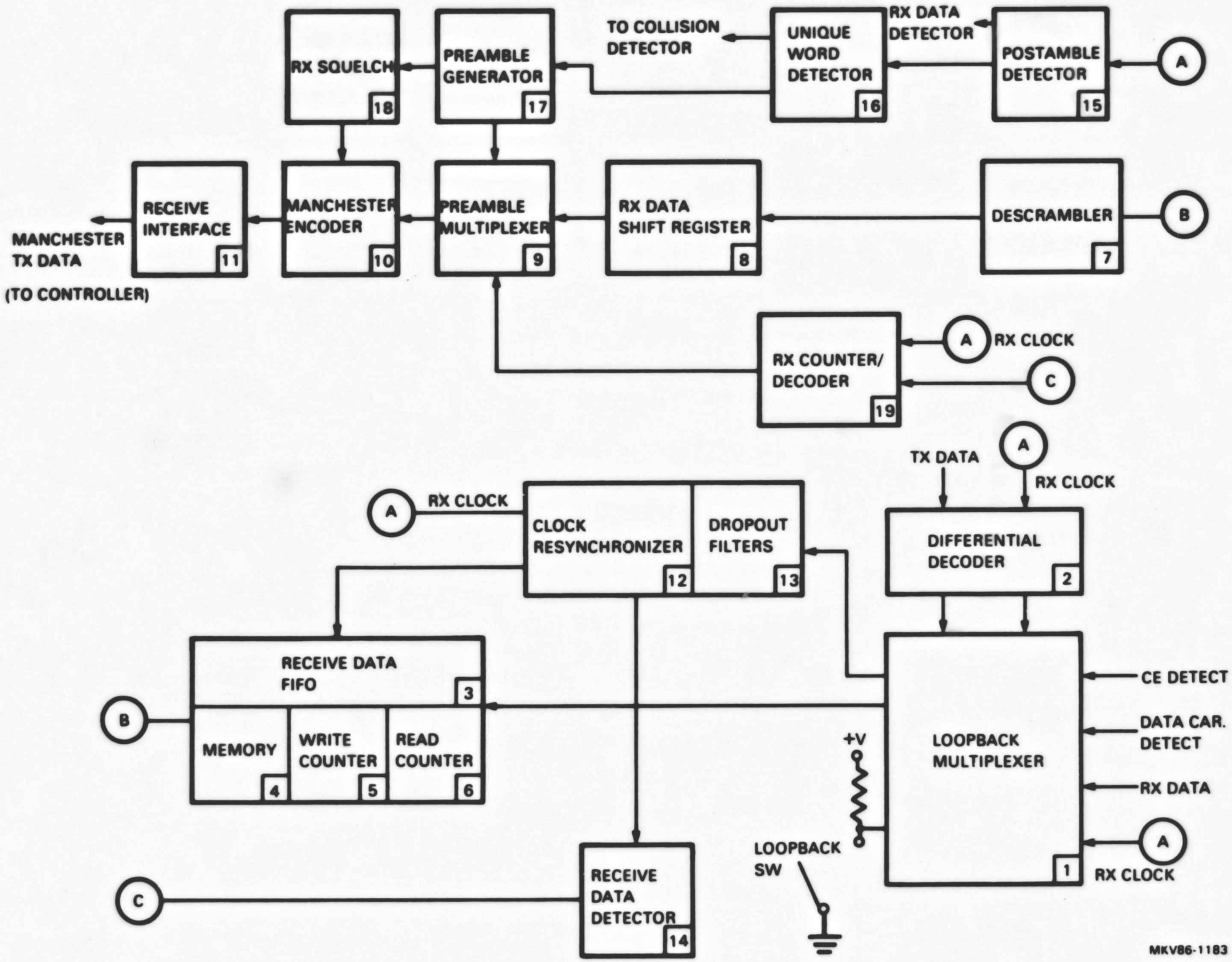

Figure 3-4 Receive Data Logic Block Diagram

READ COUNTER [6]

The output from the memory read counter sequentially addresses locations in the receive data FIFO memory and outputs the data in response to the local receive clock.

DESCRAMBLER [7]

The descrambler descrambles the data that was scrambled by the transmit logic circuits. The first 23 bits of scrambled preamble after the unique word set the descrambler to the same state that the scrambler was in when it started to scramble the packet. The descrambler can use the same seed, used by the scrambler, to descramble the data.

RECEIVE DATA SHIFT REGISTER [8]

The receive data shift register delays the data from the output of the descrambler to give the unique word detector time to detect the unique word and to give the preamble generator enough time to add the 26 extra preamble bits to the start of the burst, which were lost during the time it took the unique word detector to detect the unique word. The shift register also allows the postamble to be detected without actually transmitting the postamble to the controller.

PREAMBLE MULTIPLEXER [9]

The preamble multiplexer adds the preamble bits that were lost during the time it took to detect the unique word (26 bits lost) and the 23 bits of the preamble that were lost during the time it took to synchronize the descrambler.

The preamble multiplexer adds back these lost bits by selecting the synchronized I/O output from the preamble generator for the first 48 bits of the received packet and then switching to the RX data shift register, which is now outputting descrambled delayed RX DATA bit number 49. The RX counter/decoder determines when the preamble multiplexer switches.

MANCHESTER ENCODER [10]

The Manchester encoder encodes the data from the output of the preamble multiplexer with the ECL receive clock so that a line transition occurs in the middle of each bit period, with a low-to-high transition encoding a 1 bit and a high-to-low transition encoding a 0 bit.

RECEIVE INTERFACE [11]

The receive interface converts the ECL output of the Manchester encoder to a differential output that can drive the receive data pair output to the controller. The interface isolates the circuits in the transceiver from the receive data pair connection.

CLOCK RESYNCHRONIZER [12]

The receive clock synchronizer synchronizes the data carrier detect and collision enforcement detect outputs from the demodulator with the local receive clock. Erroneous transitions on the outputs from the demodulator are suppressed. A receive data output from the clock resynchronizer and dropout filter indicates when energy is present on the cable, and goes low 80 bit times after energy has not been detected on the cable.

The circuits also keep data from entering the receive data FIFO memory until 12 bits after the carrier detect signal from the demodulator appears, to make sure that the clock recovery circuit in the demodulator has locked onto the receive clock before using the receive clock to clock data into the FIFO.

DROPOUT FILTERS [13]

The dropout filters kegp rapid transitions from the demodulator that occur when the data carriers from collision transceivers momentarily cancel each other out from entering the receive logic.

The transitions also occur when the collision enforcement carriers from two transceivers momentarily cancel each other out.

RECEIVE DATA DETECTOR [14]

The receive data detector keeps the receive data counter running for 80 bit times after a collision, so that the receive counter decoder stays in its collision detect state until data on the cable completely dies out. This keeps the receive data logic from sending the controller receive data, then collision presence, and then receive data again. The controller will interpret the second set of receive data as the start of another packet that has violated the interpacket gap specification of 9.6 ms.

POSTAMBLE DETECTOR [15]

The postamble detector looks for a one followed by 22 zeros at the output of the descrambler. If a carrier has been detected before this pattern occurs, the postamble detector sends a POSTAMBLE DETECT to the receive data detector.

Since the delayed DATA CARRIER DETECT signal does not become active any earlier than 15 bits after the end of the data, and since the postamble detector looks at the data 15 bits after it actually occurs, only the preamble bits, and not a random bit pattern in the data can activate the POSTAMBLE DETECT.

UNIQUE WORD DETECTOR [16]

The unique word detector detects the unique word in the preamble bits, and produces a UNIQUE WORD DETECT, which is an output to the RX data present detector.

When the preamble is detected, the unique word detector forces UNIQUE WORD DETECT active. If the unique word has not been detected within 32 bits after the beginning of the burst, the collision detect circuit will report a collision, since only a collision could prevent a unique word detection within 32 bits.

PREAMBLE GENERATOR [17]

The preamble generator supplies preamble bits to replace the preamble bits lost during the time it takes to reliably detect the unique word so that the controller receives a preamble that conforms with the Ethernet standard.

The unique word detector turns on the preamble generator – at the end of the unique word – when the preamble is about to go to a one. The preamble generator generates about 48 bits after receive data is detected, which the preamble multiplexer outputs to the Manchester encoder.

RECEIVE SQUELCH [18]

The preamble generator turns on the squelch circuit only when RX DATA is present. The receive squelch signal activates the Manchester encoder only when data is present at the output of the preamble multiplexer. The Manchester encoder thus sends transitions to the controller only when valid data is present.

RECEIVE DATA COUNTER/DECODER [19]

The receive data counter/decoder generates control signals for the receive logic circuits and the collision and control circuits. The counter starts incrementing in response to the local receive clock after it receives a receive data present signal from the clock resynchronizer. Six bit times later, the receive counter/decoder enables the receive data FIFO.

The receive counter/decoder generates control signals for the receive logic and for the collision and control circuits in response to a 10-bit count from the RX data counter/decoder and unique word detect circuits.

3.3 MODEM MODULE

The modem module modulates the transmit carrier with the data and removes the carrier from incoming Ethernet packets. The modem module also generates the collision carrier.

3.3.1 Modulator Circuits (Figure 3-5)

The modulator portion of the modem module produces a 61 MHz BPSK carrier, and a 70 MHz FM carrier that is modulated by the digital-encoded TX data input. The CARRIER ENFORCEMENT ENABLE, CARRIER ON, and RF ON inputs to the modulator determine whether the 70 MHz collision enforcement carrier or the 61 MHz data carrier will appear at RF output.

BALANCED DRIVER [1]

The balanced driver converts the TTL levels on its encoded TX data signal input into a precisely balanced bipolar signal that swings symmetrically about dc ground, thus avoiding intersymbol interference in the mixer and equalized data filter. The current/voltage regulator provides a precisely regulated bipolar power supply for the balanced driver to increase the symmetry of its output.

EQUALIZED DATA FILTER [2]

The equalized data filter removes high frequency energy and shapes the spectrum sent to the BPSK modulator to keep it from producing adjacent channel interference. Group delay variations through the filter have been kept within 20 ns to reduce intersymbol interference.

BPSK MODULATOR [3]

The BPSK modulator is a double-balanced mixer that BPSK modulates the carrier from the BPSK oscillator with the data output from the equalized data filter.

BPSK OSCILLATOR [4]

The BPSK oscillator produces a 61 MHz carrier that drives the input of the BPSK modulator via the BPSK oscillator switch.

RF SWITCH AND BPSK SHAPING FILTER [5]

The BPSK oscillator switch keeps the output of the BPSK oscillator from appearing at the input to the BPSK modulator when encoded TX data is not present, in response to the CARRIER ON signal from the logic module. The BPSK shaping filter gives the CARRIER ON signal a fast attach and slow decay, so that the BPSK oscillator switch goes on almost immediately after CARRIER ON goes active, and then stays on for about 300 ns after CARRIER ON goes off, keeping the BPSK oscillator from turning off too quickly and putting a transient on the cable that would create interference on other channels.

LOW PASS FILTER [6]

The low-pass BPSK filter removes any harmonics introduced into the output of the BPSK modulator by the data at the output of the equalized data filter.

SUMMER [7]

The summer combines the 61 MHz BPSK carrier with the FM carrier produced by the collision enforcement modulator.

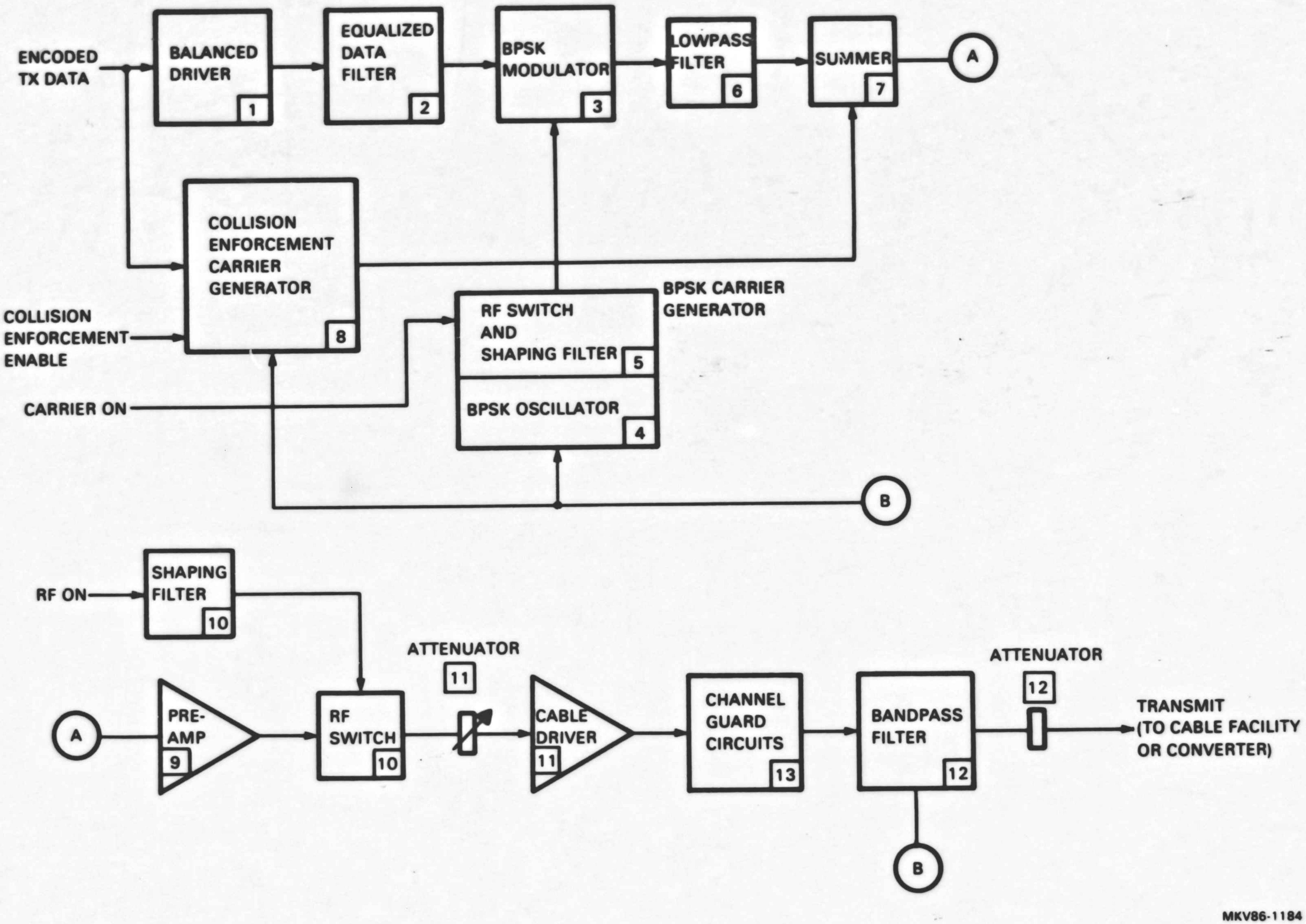

Figure 3-5 Modulator Block Diagram

COLLISION ENFORCEMENT CARRIER GENERATOR [8]
The collision enforcement carrier generator produces a 70 MHz FM carrier that is combined with the 61 MHz BPSK carrier by the summer. The encoded TX data modulates the output of the 70 MHz carrier enforcement oscillator, producing an output to the collision enforcement oscillator with a random phase across a 2 MHz bandwidth. This signal randomly modulates the collision enforcement signal from the collision enforcement oscillator so that collision enforcement carriers from two transceivers do not cancel when they are summed in the collision enforcement detector of a third transceiver (if they are 180 degrees out of phase).

The collision enforcement enable signal allows the output from the collision enforcement oscillator to appear at the input to the summer only when a collision or a heartbeat signal has been detected, or at the end of a complete data burst.

The collision enforcement carrier only appears at the input to the summer when a carrier enforcement signal or the heartbeat is not being sent.

PRE-AMP [9]
The pre-amplifier increases the level of the signal appearing at the input to the RF switch.

RF SWITCH [10]
The RF switch and shaping filter switch the output of the modulator on and off in response to the RF ON signal from the collision detection and enforcement logic.

The shaping filter and RF switch slow down the rise and fall times of bursts (data bursts, collision enforcement bursts, and heartbeat bursts) from the collision enforcement and BPSK oscillators so that the modulator does not produce switching transients that could spill over into other channels on the cable. RF ON from the logic module is the input to the shaping filter. The shaping filter controls the rise time of the RF ON signal so that the outputs of the BPSK oscillator and collision enforcement oscillators do not create abrupt transients at the output of the modulator.

CABLE DRIVER AMPLIFIER AND ATTENUATOR [11]
The cable driver amplifier and level adjust attenuator set the level of the RF output to the cable facility or downconverter module.

BANDPASS FILTER AND ATTENUATOR [12]
The 54-to-72 MHz bandpass filter attenuates unwanted harmonics (second and higher order) from the BPSK oscillator, BPSK modulator, and the collision enforcement oscillator. The filter also attenuates encoded TX data that has leaked to the output of the BPSK modulator.

The attenuator at the output of the bandpass filter maintains a constant load on the output of the bandpass filter, improving the VSWR at the RF output of the modulator.

CHANNEL GUARD CIRCUITS [13]
The channel guard circuits ensure that a single or a double failure in the transceiver will not jam communications between other transceivers on the network. The channel guard power detectors and channel guard logic circuits are fully redundant, and remove the +12 V power supply inputs to the BPSK and collision enforcement oscillators if a transmission of longer than 100 ms appears at the channel guard taps.

If the channel guard logic circuits are activated, power must be cycled off and on to reset the circuits.

The channel guard circuits extinguish the READY light on the front panel if the modulator becomes disabled.

3.3.2 Demodulator Circuits (Figure 3-6)
The demodulator in the modem recovers data and the clock from a DBPSK modulated signal from the cable facility. The demodulator output signals indicate the presence of a DBPSK carrier and the presence of a collision enforcement carrier at its input.

61 MHZ BANDPASS FILTER AND WIDEBAND RF AMPLIFIER [1]
The 61 MHz bandpass filter increases the image rejection of the demodulator and reduces the composite signal level appearing at the wide-band amplifier that drives the input to the mixer. The wideband RF amplifier matches the output of the bandpass filter to the input of the mixer.

91 MHZ CRYSTAL OSCILLATOR AND MIXER [2]
The 91 MHz crystal oscillator and mixer shift the spectrum at the output of the RF amplifier down to 30 MHz.

PRODUCT FILTER AND IF AMPLIFIER [3]
The elliptic product filter removes the 120 MHz high side product at the output of the mixer, while the IF amplifier provides 25 dB of gain to make up for losses in the mixer and filter.

COLLISION ENFORCEMENT SPLITTER [4]
The collision enforcement detection circuit and its associated splitter detect the presence of a 70 MHz FM collision enforcement carrier at the input to the demodulator, and produces a collision enforcement detect signal when the level of this signal exceeds a preset threshold.

The splitter is a resistive network that samples the composite signal at the input of the collision detector.

The bandpass filter in the input to the collision detector passes signals only at the frequency of the collision enforcement carrier. An IF amplifier drives the input of the bandpass filter and makes up for signal losses in the collision enforcement splitter and the bandpass filter.

30 MHZ BANDPASS FILTER [5]
The 30 MHz bandpass filter establishes the correct carrier-to- white noise signal ratio at the input of the DBPSK detector.

CARRIER DETECT SPLITTER AND CARRIER DETECTOR [6]
The carrier detector and splitter detect the presence of a BPSK carrier at the input to the demodulator and output DATA CARRIER DETECT signal when the level of the BPSK carrier exceeds a preset threshold.

The carrier detect splitter is a resistive network that taps off the signal at the output of the second IF amplifier. Another IF amplifier at the output of the splitter drives the limiter preceding the detector.

The limiter prevents amplitude variations in the signal from appearing at the input to the detector so that the output level from the detector does not change in response to amplitude modulation on the data carrier signal.

DBPSK DEMODULATOR [7]
The differentially-encoded binary phase shift keyed (DBPSK) detector recovers the data from the BPSK modulated carrier using a noncoherent binary phase comparison detector. An analog delay line introduces a one-symbol (100 ns) delay to the incoming signal so that the present and previous data transitions can be compared at the intermediate frequency. This allows the differential coding to be removed and the baseband data to be reconstructed.

BIT TIME RECOVERY CIRCUIT [8]
The bit time recovery (BTR) circuit recovers the data clock from the differentially-encoded output of the DBPSK detector.

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The bit time recovery circuit is in the wide bandwidth mode in the absence of a data carrier detect signal from the carrier detector so that it can acquire the clock within 15 symbols at the beginning of a data burst. The BTR then switches to the narrow bandwidth mode when the data carrier detect signal is present so that it can stay locked onto the clock during the burst. In the narrowband mode, the BTR circuit maintains the phase of the clock if it is momentarily unable to recover signal transitions, maintaining a low bit error rate in the presence of noise.

The data carrier detect signal switches the bit timing recovery circuit to narrow bandwidth mode by opening the bandwidth switch, which pulls the output of the injection lock amplifier high. Opening the bandwidth switch thus allows the injection lock amplifier to amplify the signal across the ringing tank, increasing the Q and decreasing the bandwidth.

The ECL to TTL converter changes the ECL output of the phase shifter to TTL levels for the DEMOD RX CLOCK output from the demodulator.

BTR PULSE SHAPER 9

The pulse shaper generates narrow pulses at each transition of the recovered data from the DBPSK detector. Pulse widths have a nominal width of 20 ns.

BTR 10 MHZ RINGING TANK AND BANDWIDTH SWITCH 10

At the start of the burst preamble, the pulses from the pulse shaper circuit build up oscillations in the tank circuit, which become large enough to drive the input of the phase shifter. About 12 bit times later, the bandwidth switch enables the injection lock amplifier, which reinforces the oscillations in the 10 MHz ringing tank, increasing its Q from 15 to about 50. This allows the oscillations in the tank to get quickly into phase with transitions on the recovered data at the start of the burst. The ringing tank stays in phase with the transitions on the recovered data when transitions on the data are lost because of noise.

At the end of the transmit burst, the bandwidth switch turns off and the oscillations in the tank quickly subside.

BTR PHASE SHIFTER 11

An injection lock oscillator and ringing tank delay the recovered clock so that the rising edges no longer appear in the middle of the output from the DBPSK detector. The phase shifter again delays the recovered clock (about 36 degrees) so that its rising edges again appear in the middle of the output.

BTR ECL TO TTL CONVERTER 12

The ECL to TTL converter changes the ECL output of the phase shifter to TTL levels to produce the demodulator receive clock output for the receive logic circuits in the logic module.

MID-BIT SAMPLER 13

The mid-bit sampler samples the transitions from the DBPSK detector on the rising edges of the recovered clock and outputs these samples to the ECL to TTL converter. The mid-bit sampler increases the signal to noise ratio of the demodulated data, and eliminates jitter due to ISI distortion introduced during demodulation.

ECL TO TTL CONVERTER 14

The ECL to TTL converter converts the ECL levels at the output of the mid-bit sampler to TTL levels for the RX data output to the receive logic circuits in the logic module.

POWER INPUT FILTER AND REGULATOR 15

The power input filter keeps noise from appearing on the power supply inputs to the circuits in the demodulator. The regulator supplies −5 V to the ECL logic circuits in the demodulator.

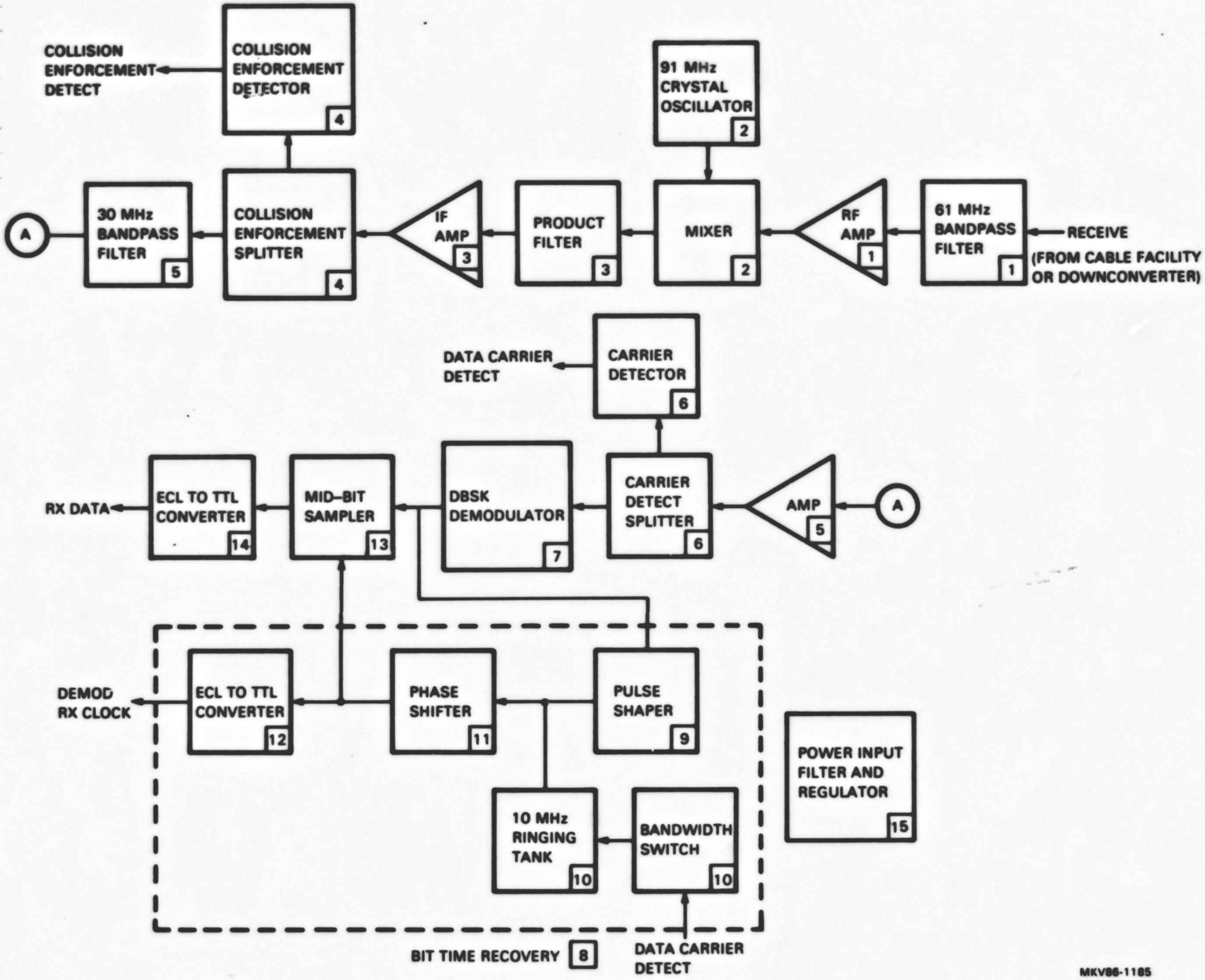

Figure 3-6 Demodulator Block Diagram

3.4 DOWNCONVERTER MODULE (SINGLE-CABLE ONLY) (FIGURE 3-7)

The frequency converter downconverts a spectrum centered on 221.25 MHz to a spectrum centered on 61 MHz for the demodulator of a transceiver when the DECOM transceiver is installed in a single cable network.

3.4.1 Diplexer

DIPLEXER [1]
The diplexer allows the 61 MHz output from the modulator and the input to the demodulator to be simultaneously connected to a single cable, while maintaining isolation between the modulator output and the demodulator input.

The diplexer splits the bandwidth of the cable facility into a low- and a high-frequency segment. The low-frequency segment (54 to 72 MHz) is used by the modulator to transmit to the cable headend (DEFTR), and the high-frequency segment (210.25 to 228.25 MHz) is received by the downconverter module.

BANDPASS FILTER [1]
Filtering in the diplexer isolates the modulator output from the demodulator input while allowing signals to pass from the modulator output to the cable facility and from the cable facility to the input of the demodulator.

3.4.2 Downconverter

4 dB PAD [2]
The 4 dB pad reduces the gain from the cable input to the demodulator output of the downconverter module to 0 dBm, eliminates a small mismatch between the output impedance of the bandpass filter and the input to the wideband amplifier, and improves the return loss at the input to the amplifier. The testpoint at the output of the 4 dB pad provides a test output that can be used to align the 221 MHz bandpass filter.

AMPLIFIER [3]
The broadband amplifier makes up for losses in the 221 MHz bandpass filter and the mixer, and provides a broadband 50 ohm match for the mixer.

MIXER [4]
The mixer beats the 221.25 MHz carrier from the network with the 282.25 MHz output from the oscillator and tripler to produce a difference frequency of 61 MHz at the demodulator output of the downconverter. Since high side injection is used, the mixer reinverts the frequency spectrum, originally inverted in the headend (DEFTR), so that the collision enforcement carrier again appears on the high frequency side of the DBPSK data carrier.

OSCILLATOR [5]
The grounded base overtone oscillator produces a 94.0833 MHz crystal-controlled output for the tripler.

TRIPLER [6]
The tripler is an amplifier biased to operate in the Class C mode with its output tank tuned to the 282.25 MHz (third harmonic) that is produced by the oscillator.

TUNED AMPLIFIER [7]
The tuned amplifier rejects the fundamental output frequency of the crystal oscillator at 94.0833 MHz, the second harmonic, and other unwanted products at the output of the tripler. The unwanted signals are 60 dB below the desired 282.25 signal from the tripler.

BUFFER AMPLIFIER [8]
The buffer amplifier isolates the output of the tuned amplifier from the input of the mixer, keeping the relatively low input impedance of the mixer from reducing the selectivity of the tuned amplifier.

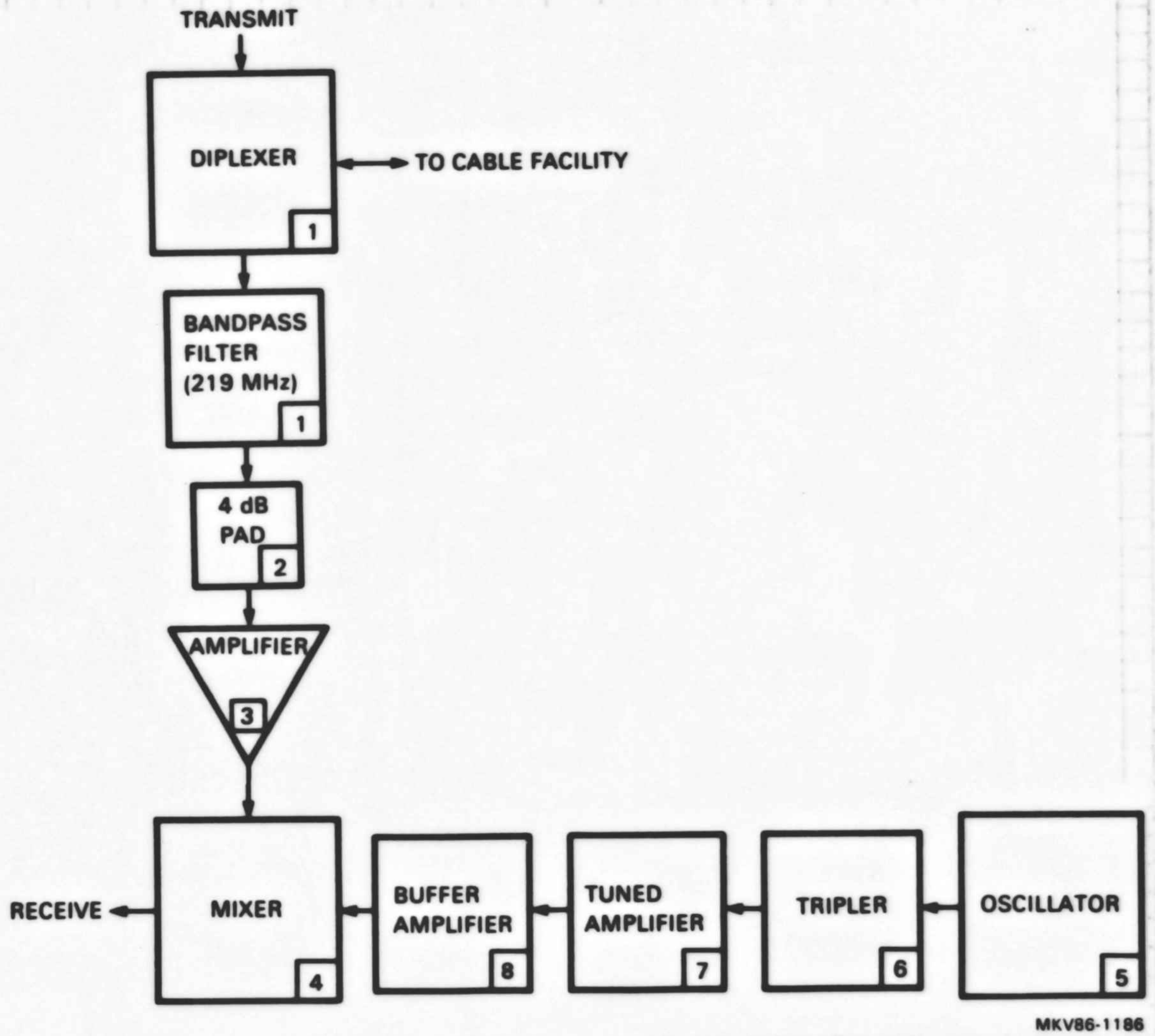

Figure 3-7 Downconverter Module Block Diagram

3.5 POWER SUPPLY CIRCUITS (FIGURE 3-8)

The power supply circuits connect the outputs from the switching power supply module to the circuits on the logic module, the modem module, and the downconverter module.

POWER SUPPLY VOLTAGE DISTRIBUTION

Power supply voltages from the switching power supply module enter the logic board by connector J1, and connect to the power supply inputs on the modem module by connector J2.

A −5 V regulator in the modem module develops −5 V for the ECL logic.

The ground of the power supply connects directly to earth ground. The ground from the logic module, the modem module, and the downconverter, if installed, connect directly to the ground of the power supply.

POWER FILTER

The power filter isolates the −12 V, +12 V, and +5 V inputs to the logic card from noise on the output of the switching power supply. At the same time it isolates the power supply inputs to the logic circuits and the power supply inputs to the modem so that switching noise from the logic circuits cannot enter the modem, and EMI from the modem cannot enter the logic circuits. The power filter starts to roll off at about 10 MHz.

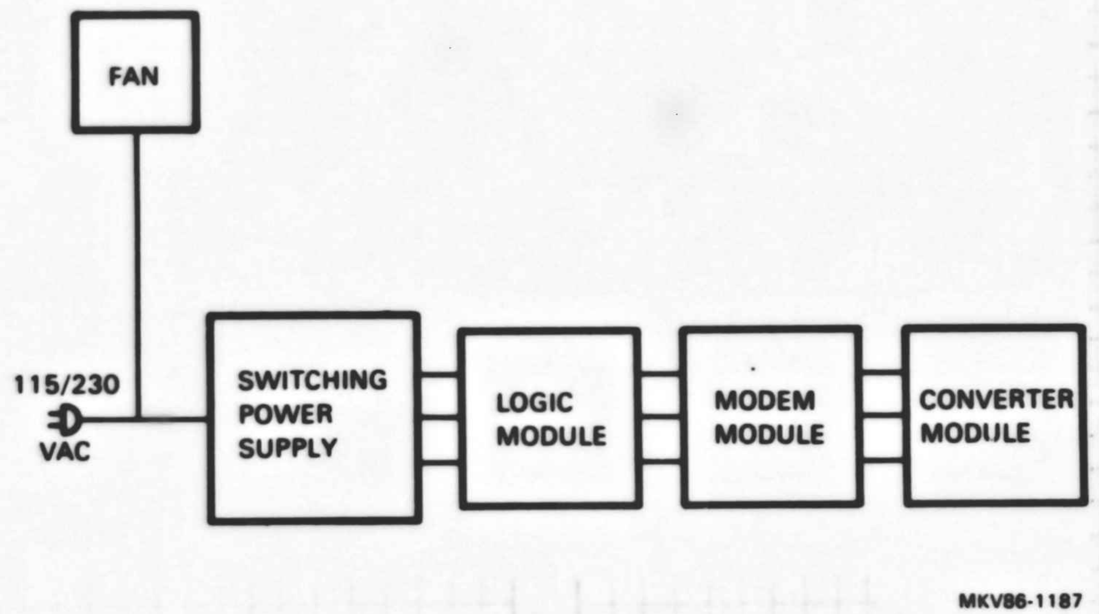

Figure 3-8 Power Supply Block Diagram

CHAPTER 4

CHAPTER 4
MAINTENANCE

4.1 GENERAL

There are no diagnostics designed specifically for the DECOM broadband Ethernet transceiver. The Ethernet controller diagnostics (for the controller being utilized) and the NIE (Network Interconnect Exerciser) are used to isolate problems with the DECOM transceiver.

4.1.1 Maintenance Philosophy

The maintenance philosophy for the DECOM transceiver is to replace the complete unit and return the failed unit to Digital Equipment Corporation for repair.

Cable facility problems should be referred to the organization responsible for the cable facility.

4.1.2 Troubleshooting Aids

The following aids will be used to assist in locating the problem node and troubleshooting the suspect DECOM transceiver:

- NIE – network interconnect exerciser
- Controller diagnostics for the Ethernet controller installed at the suspect node
- Map of the network under test
- Loopback pad.

4.1.3 Troubleshooting Techniques

In many cases, the service personnel responding to a trouble call for the Ethernet system will only know that there is a communications problem on the Ethernet. In these cases, the first task will be to determine which node or Ethernet device attached to the cable facility is causing the problem. By running the NIE and using a map of the Ethernet system, the service personnel can isolate the problem device or area. Using the Ethernet controller diagnostics and various loopbacks, the faulty DECOM transceiver or other device can be identified.

If the problem is located at a known node, the service representative need only locate the faulty device or connection.

See Section 4.2 for detailed troubleshooting instructions.

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4.2 TROUBLESHOOTING

Table 4-1 DECOM Operator Troubleshooting

Problem	Probable Cause	Remedy
READY light is ON and fan is OFF.	Fan is bad	Replace the transceiver.
READY light is OFF and fan is OFF.	Blown fuse	Check fuse (Figure 4-1).
	No power at the socket	IF fuse is good, check main power circuit breaker and make sure that there is power at the socket.
		IF power is at the socket and through the power cord to the transceiver, call service for the transceiver.
LOOPBACK light is ON.	Loopback switch in LOOPBACK mode	Switch to NORMAL mode.
	Transceiver faulty	Call service for the transceiver.
READY light turns OFF when transceiver cable is connected to the transceiver.	Controller faulty	Disconnect and reconnect the power cord.
		IF the READY light still does not turn ON, disconnect the transceiver cable.
		IF the READY light turns ON, call service for the controller.
	Transceiver faulty	IF the READY light still does not turn ON, call service for the transceiver.

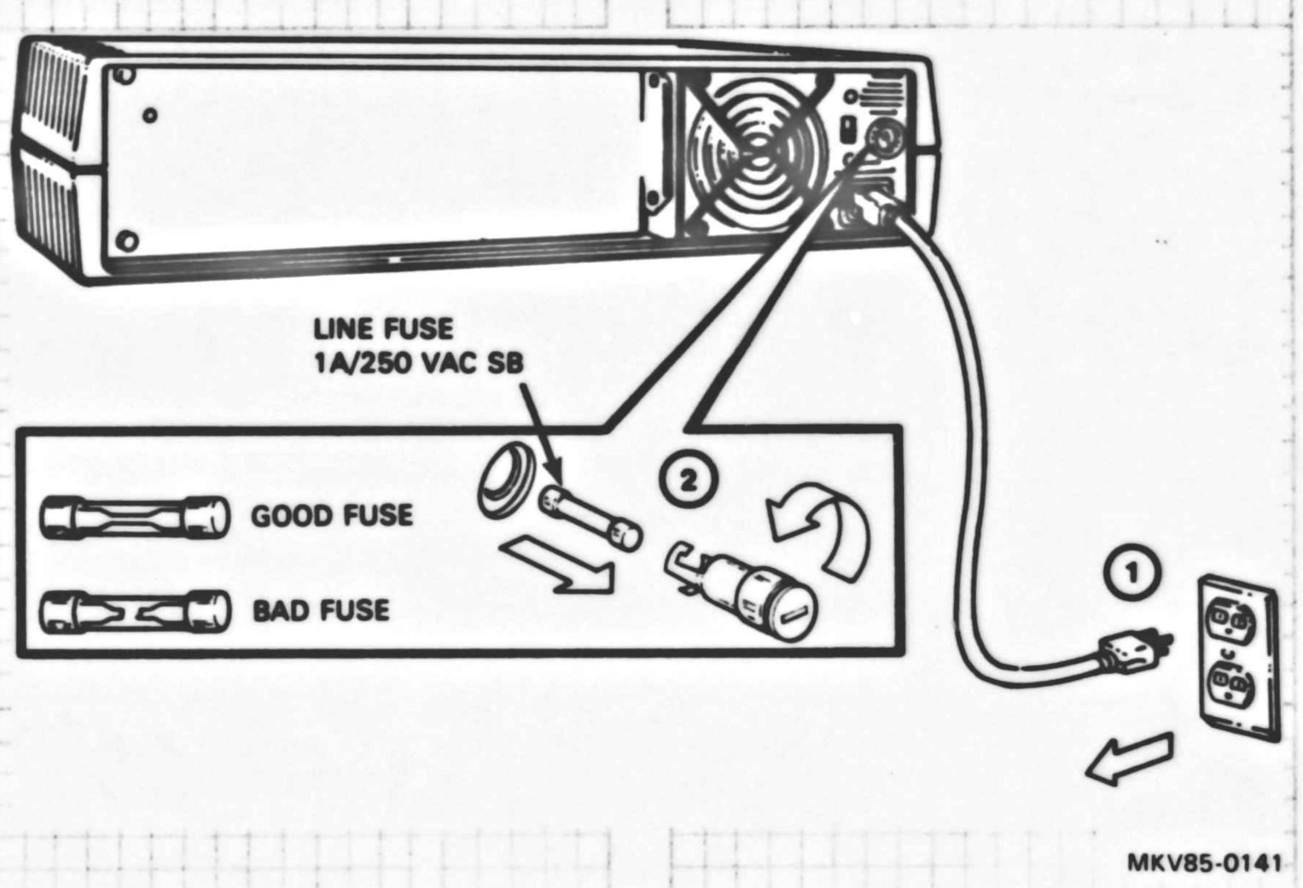


Figure 4-1 Checking the DECOM Fuse

Table 4-2 Network Troubleshooting for the Operator

Problem	Probable Cause	Remedy
All DECOM transceivers are NOT working and other applications* are NOT working.	Network cable facility.	Get service for network cable facility.
All DECOM transceivers are NOT working and other applications* ARE working.	Frequency translator (DEFTR) – single-cable only	Get service for DEFTR frequency translator.
Some DECOM transceivers are NOT working.	Network cable facility	Get service for network cable facility.
One DECOM transceiver is NOT working.	DECOM transceiver	Get service for the DECOM transceiver.

* "Other applications" means other data modems, video equipment, T1 type modems, and so forth that use the network cable facility as their transmission medium.

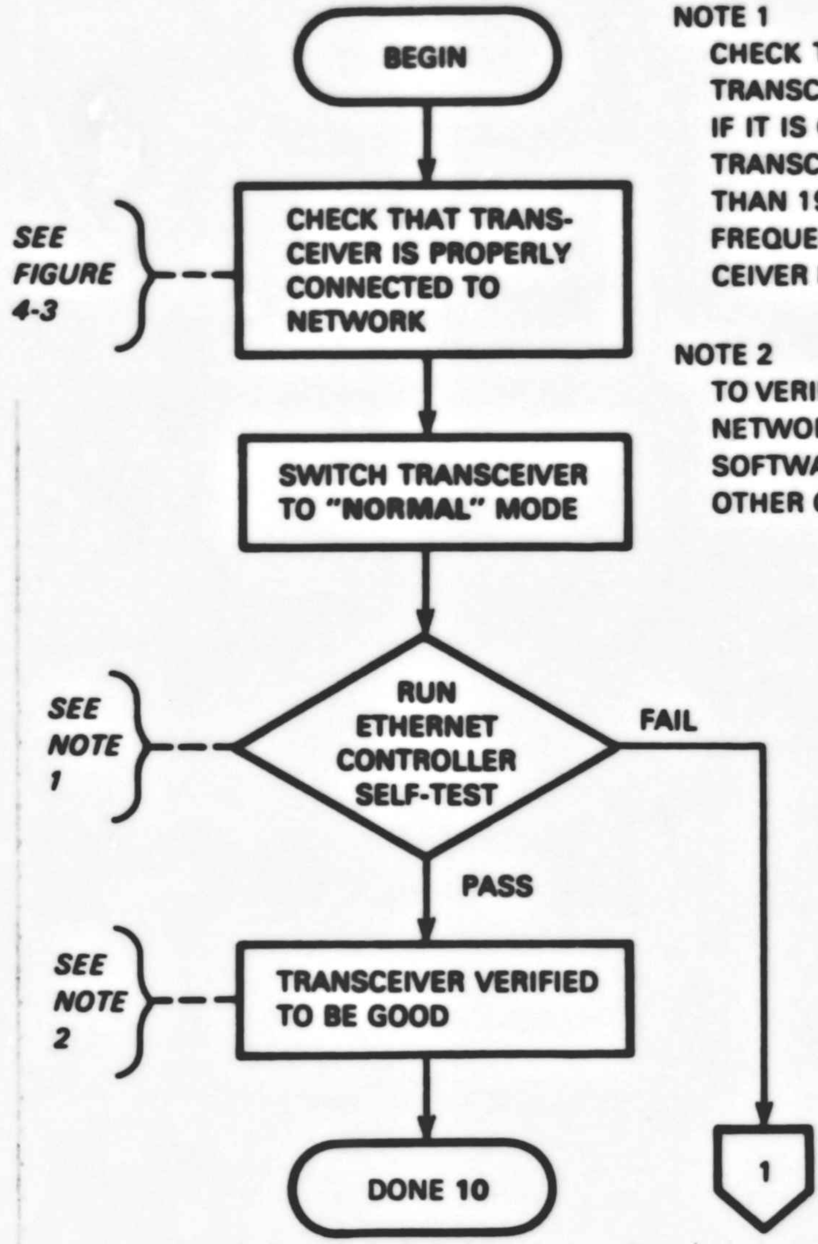
4.2.1 Single-Cable Systems

The flowchart (Figure 4-2) assumes that the Ethernet controller has loopback test capability (that is, NI Exerciser), which can be used to test the transceiver. When the flowchart indicates "RUN ETHERNET CONTROLLER SELF-TEST," run this test on the transceiver by using the Ethernet controller self-test or functional level testing software. Refer to the user and software documentation for the Ethernet controller in use.

Instructions in the troubleshooting flowchart requires the use of a variable attenuator referred to as the "loopback pad." The part number for the loopback pad is 29-25203. Two short [0.3 m (1 ft)] cables with male F-type connectors on each of the ends are required to connect the loopback pad to the transceiver. These cables are similar to the cables used to connect the DECOM transceiver to a tap or wall outlet (Figure 4-3).

CAUTION

When asked to remove and replace the downconverter, take extra care to line up the three connectors so that the connector pins are not bent.



NOTE 1
CHECK THAT THE IN RANGE LIGHT ON THE TRANSCEIVER TURNS ON DURING THIS TEST. IF IT IS OFF, THEN THE TAP TO WHICH THE TRANSCEIVER IS CONNECTED MAY BE MORE THAN 1900 METERS (6234 FEET) FROM THE FREQUENCY TRANSLATOR, OR THE TRANSCEIVER MAY REQUIRE SERVICE.

NOTE 2
TO VERIFY COMPLETE NETWORK PATH, RUN NETWORK APPLICATIONS OR DIAGNOSTIC SOFTWARE WITH THIS TRANSCEIVER AND OTHER OPERATIONAL TRANSCEIVERS.

MKV86-1188

Figure 4-2 Single-Cable DECOM Troubleshooting Flow Diagram (Sheet 1 of 6)

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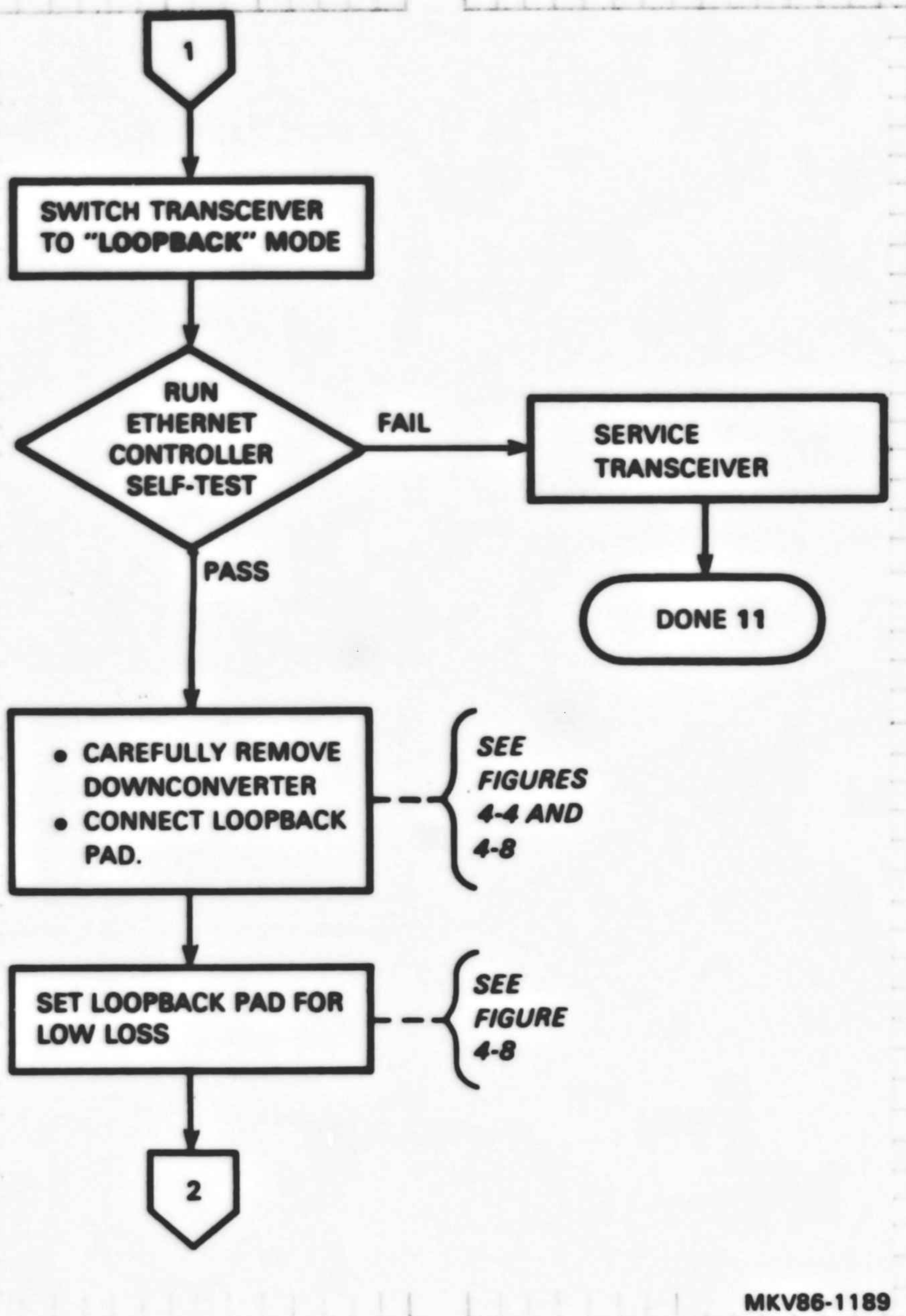

Figure 4-2 Single-Cable DECOM Troubleshooting Flow Diagram (Sheet 2 of 6)

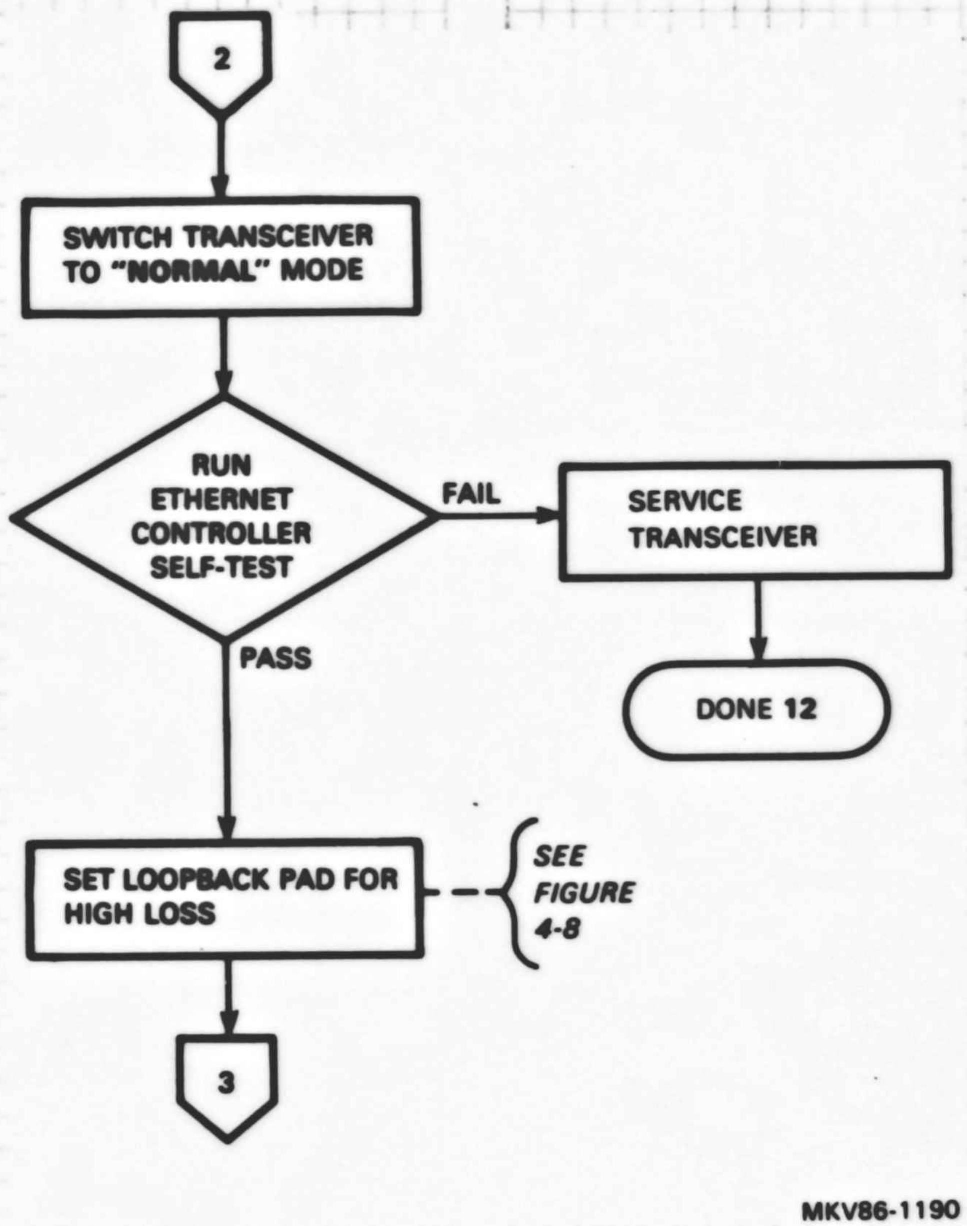

Figure 4-2 Single-Cable DECOM Troubleshooting Flow Diagram (Sheet 3 of 6)

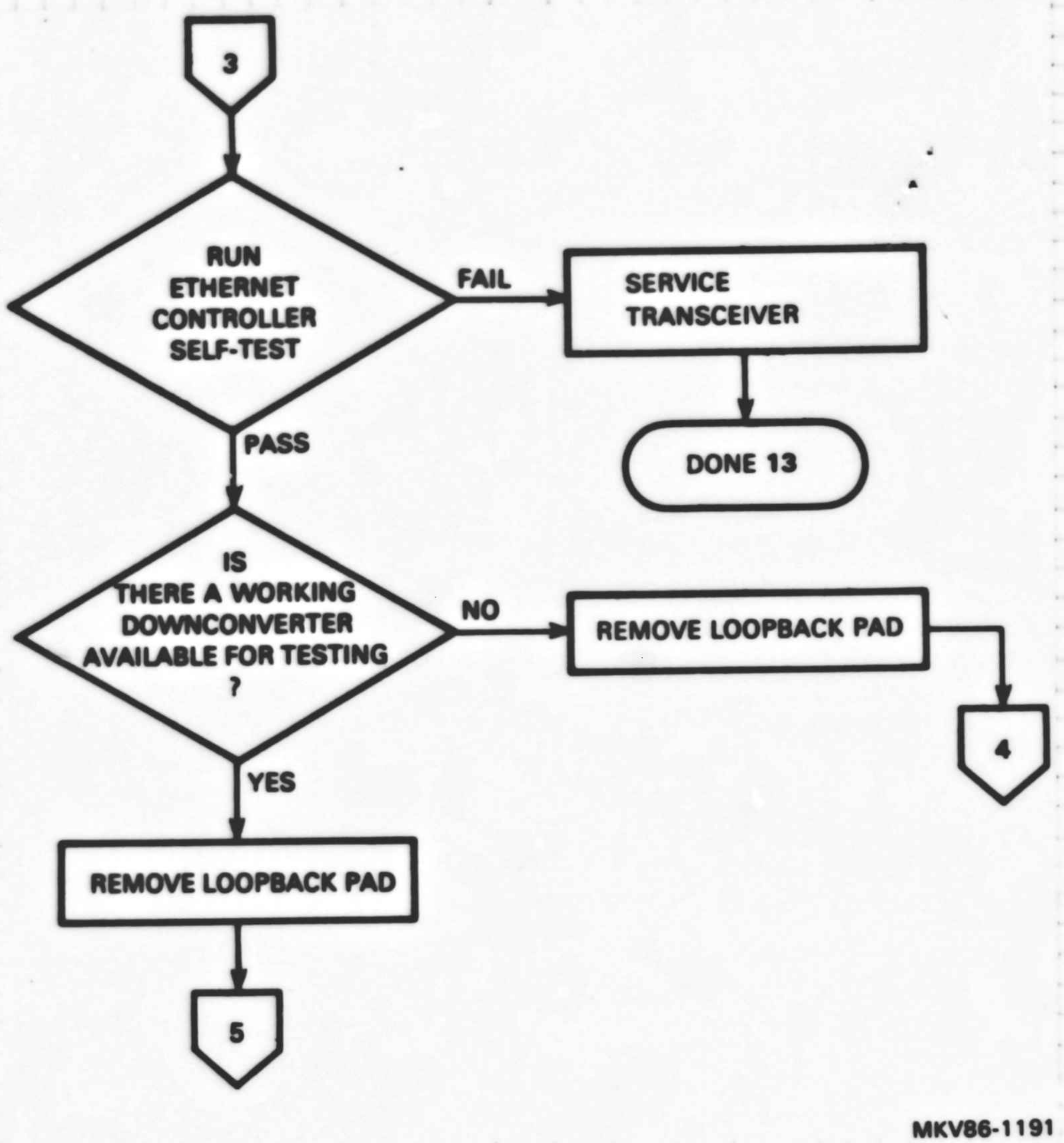

Figure 4-2 Single-Cable DECOM Troubleshooting Flow Diagram (Sheet 4 of 6)

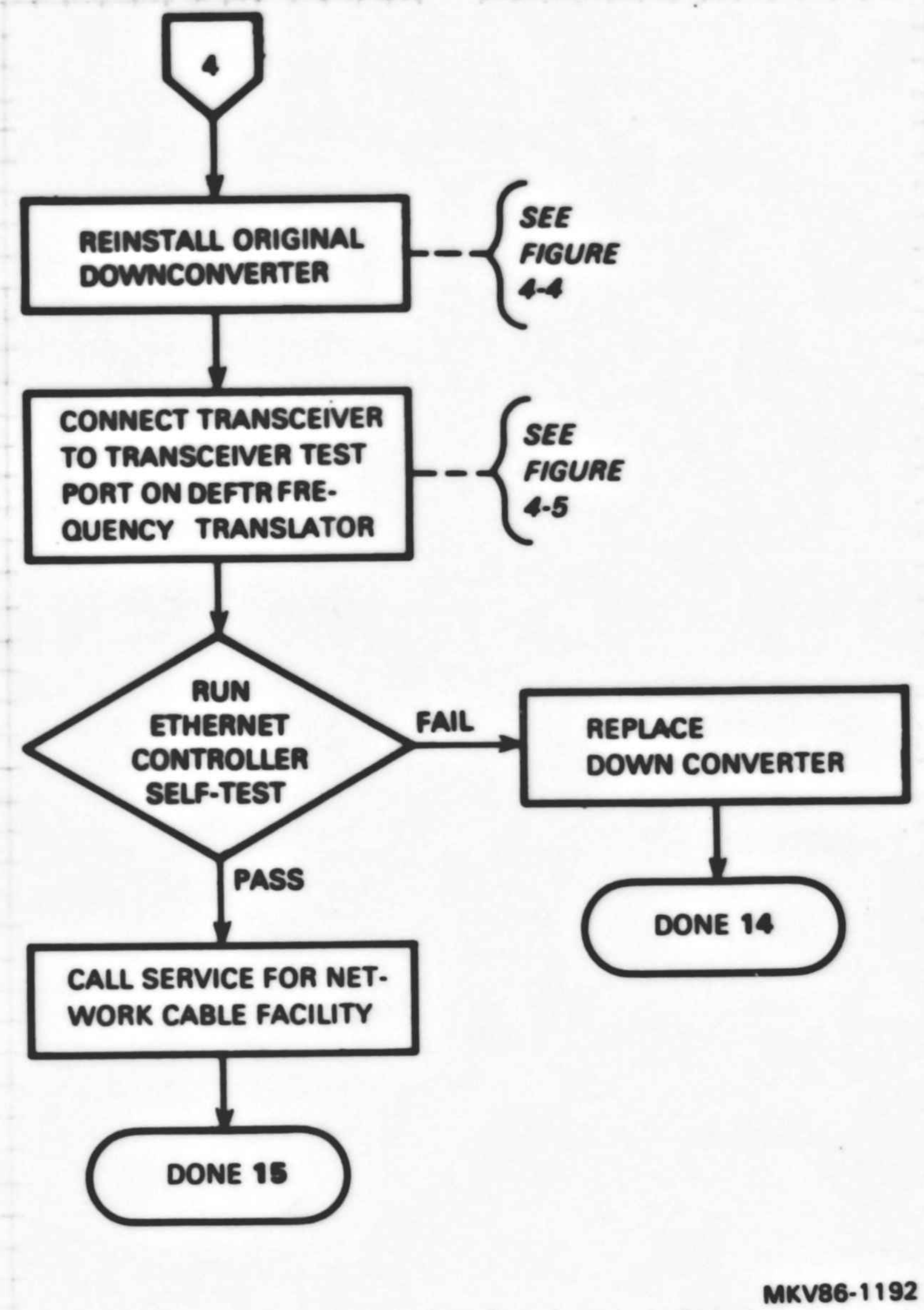

Figure 4-2 Single-Cable DECOM Troubleshooting Flow Diagram (Sheet 5 of 6)

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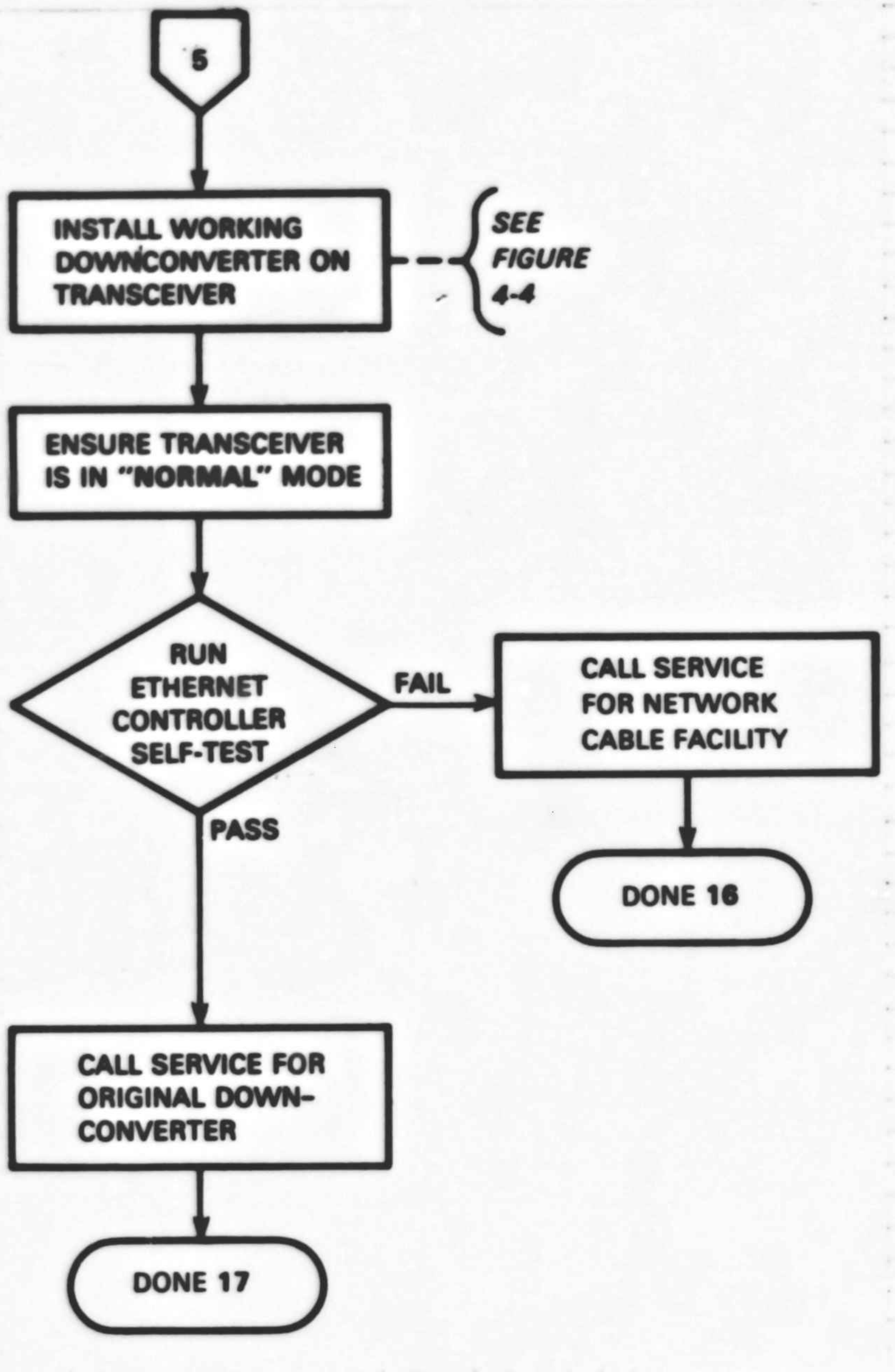

Figure 4-2 Single-Cable DECOM Troubleshooting Flow Diagram (Sheet 6 of 6)

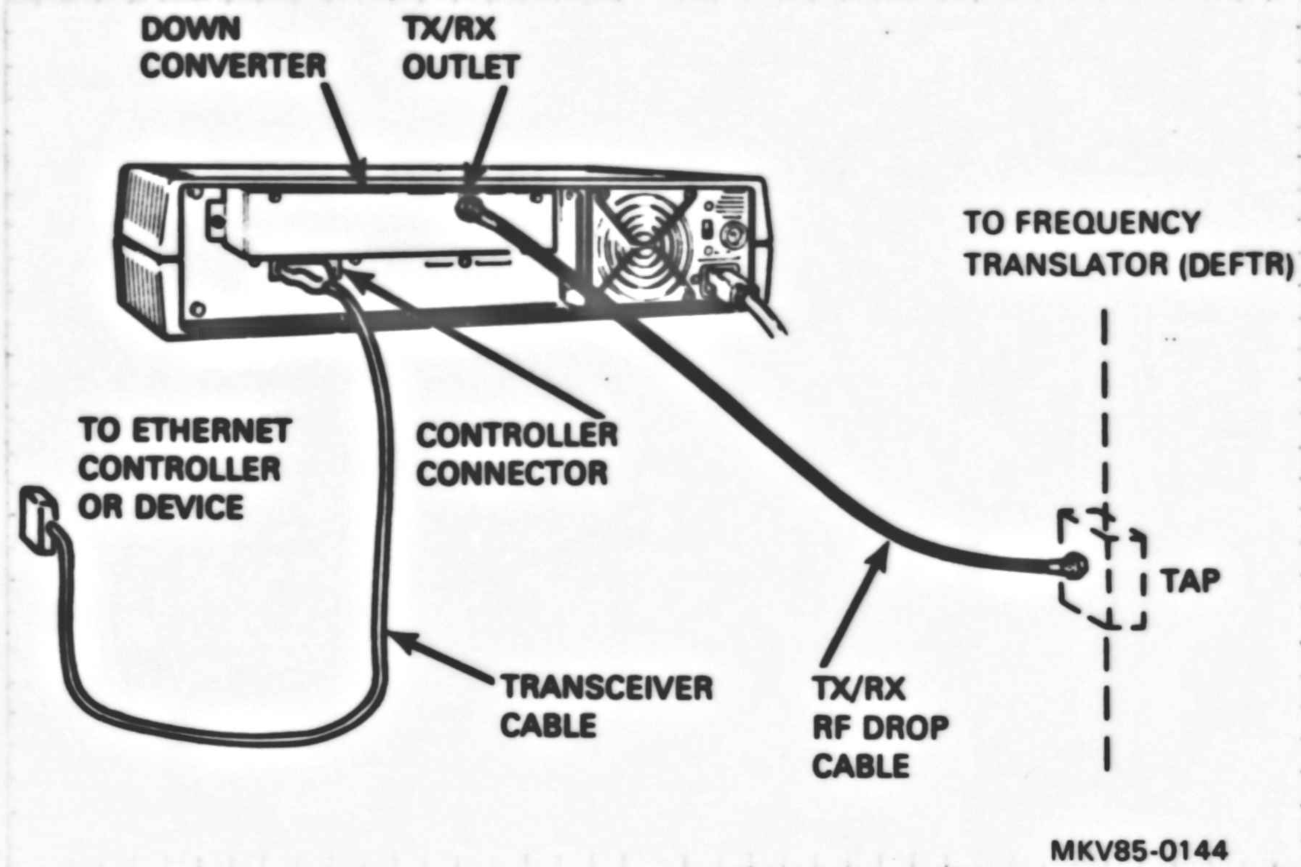

Figure 4-3 Single-Cable Network Connection

4.2.2 Dual-Cable Systems

The flowchart (Figure 4-6) assumes that the Ethernet controller has loopback test capability (that is, NI Exerciser), which can be used to test the transceiver. When the flowchart indicates "RUN ETHERNET CONTROLLER SELF-TEST," run this test on the transceiver by using the Ethernet controller self-test or functional level testing software. Refer to the user and software documentation for the Ethernet controller in use.

Instructions in the troubleshooting flowchart requires the use of a variable attenuator referred to as the "loopback pad." The part number for the loopback pad is 29-25203. Two short [0.3 m (1 ft)] cables with male F-type connectors on each of the ends are required to connect the loopback pad to the transceiver. These cables are similar to the cables used to connect the DECOM transceiver to a tap or wall outlet (Figure 4-7).

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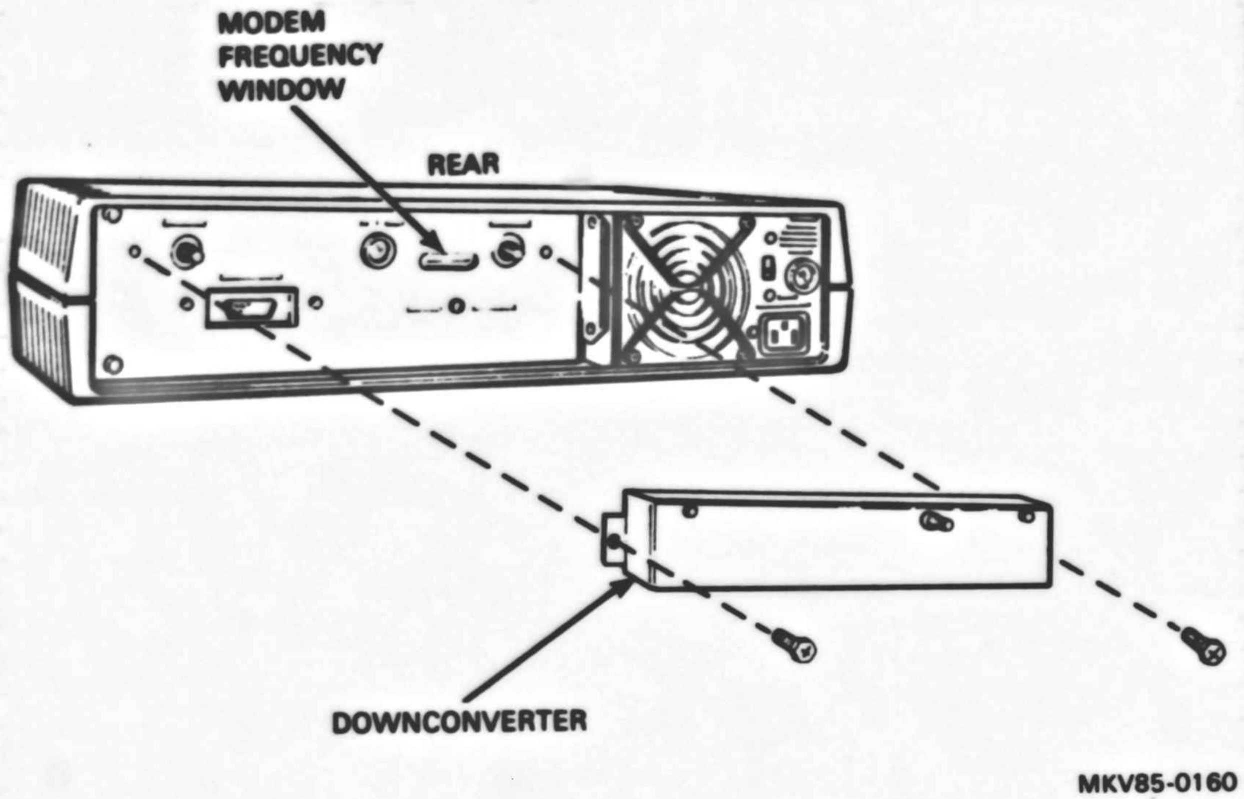

Figure 4-4 Downconverter Removal/Replacement

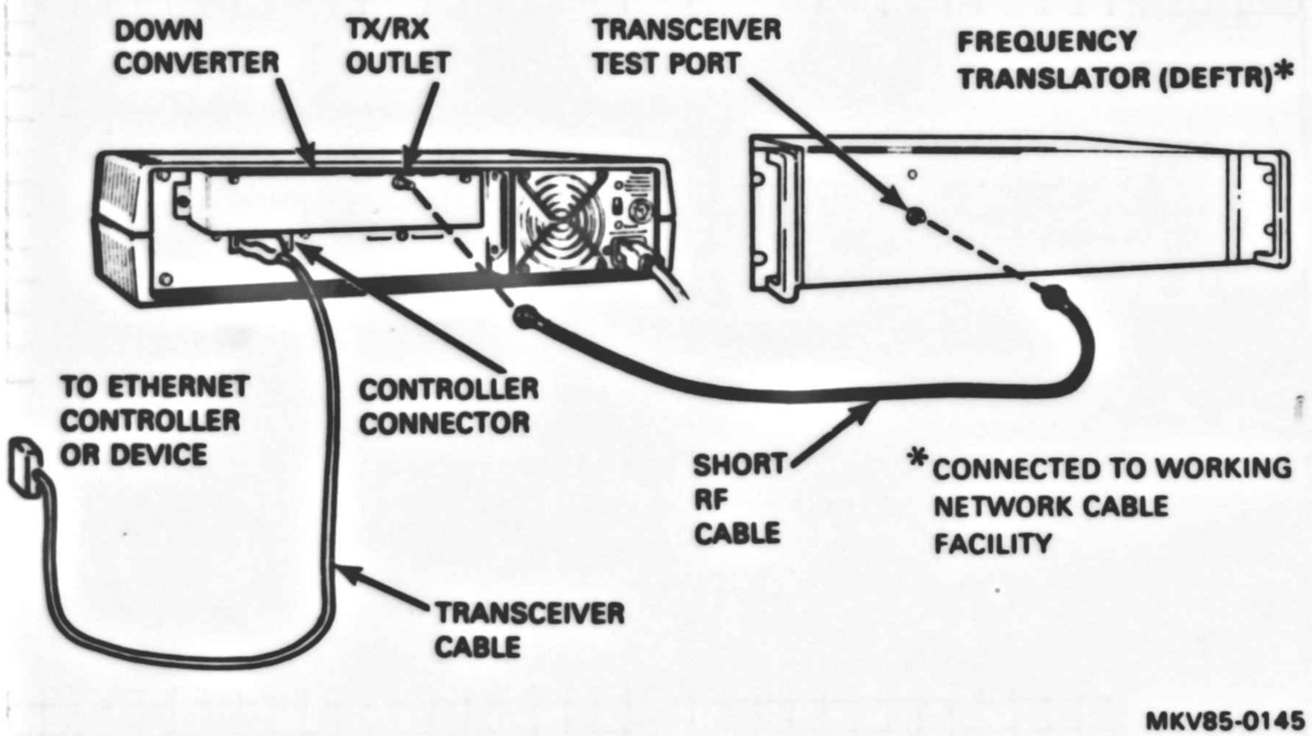

Figure 4-5 DECOM to DEFTR Test Configuration

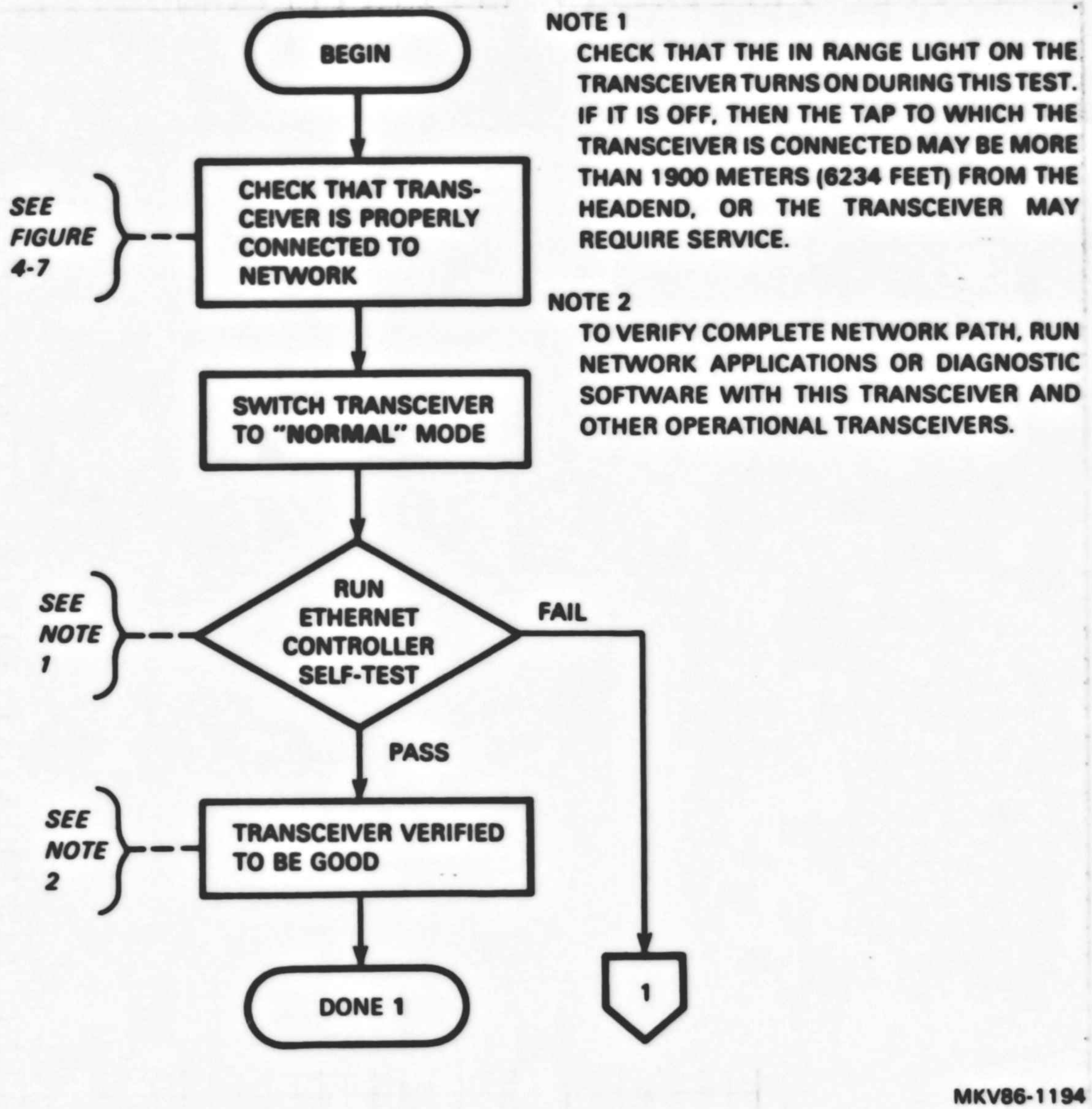

Figure 4-6 Dual-Cable DECOM Troubleshooting Flow Diagram (Sheet 1 of 6)

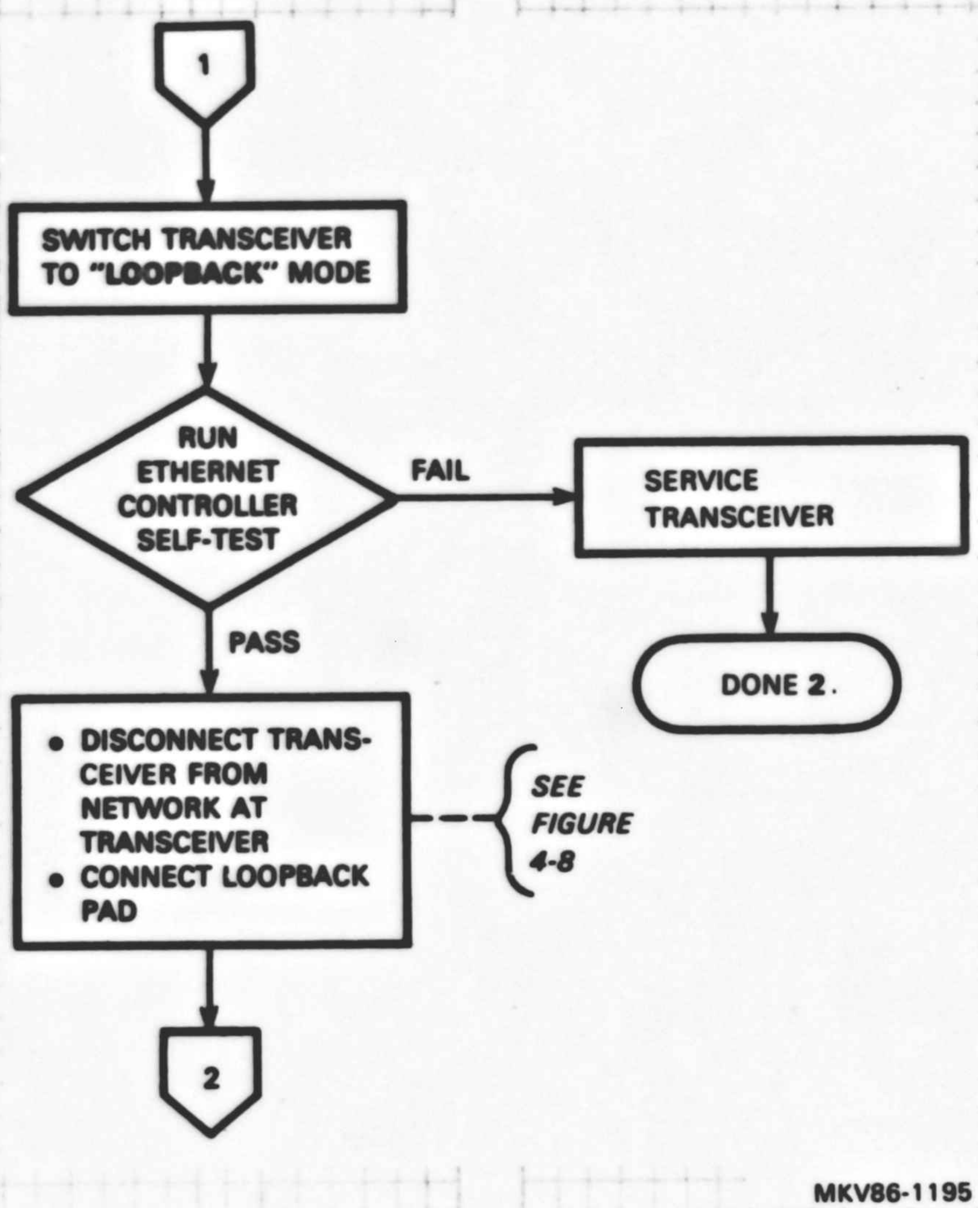

Figure 4-6 Dual-Cable DECOM Troubleshooting Flow Diagram (Sheet 2 of 6)

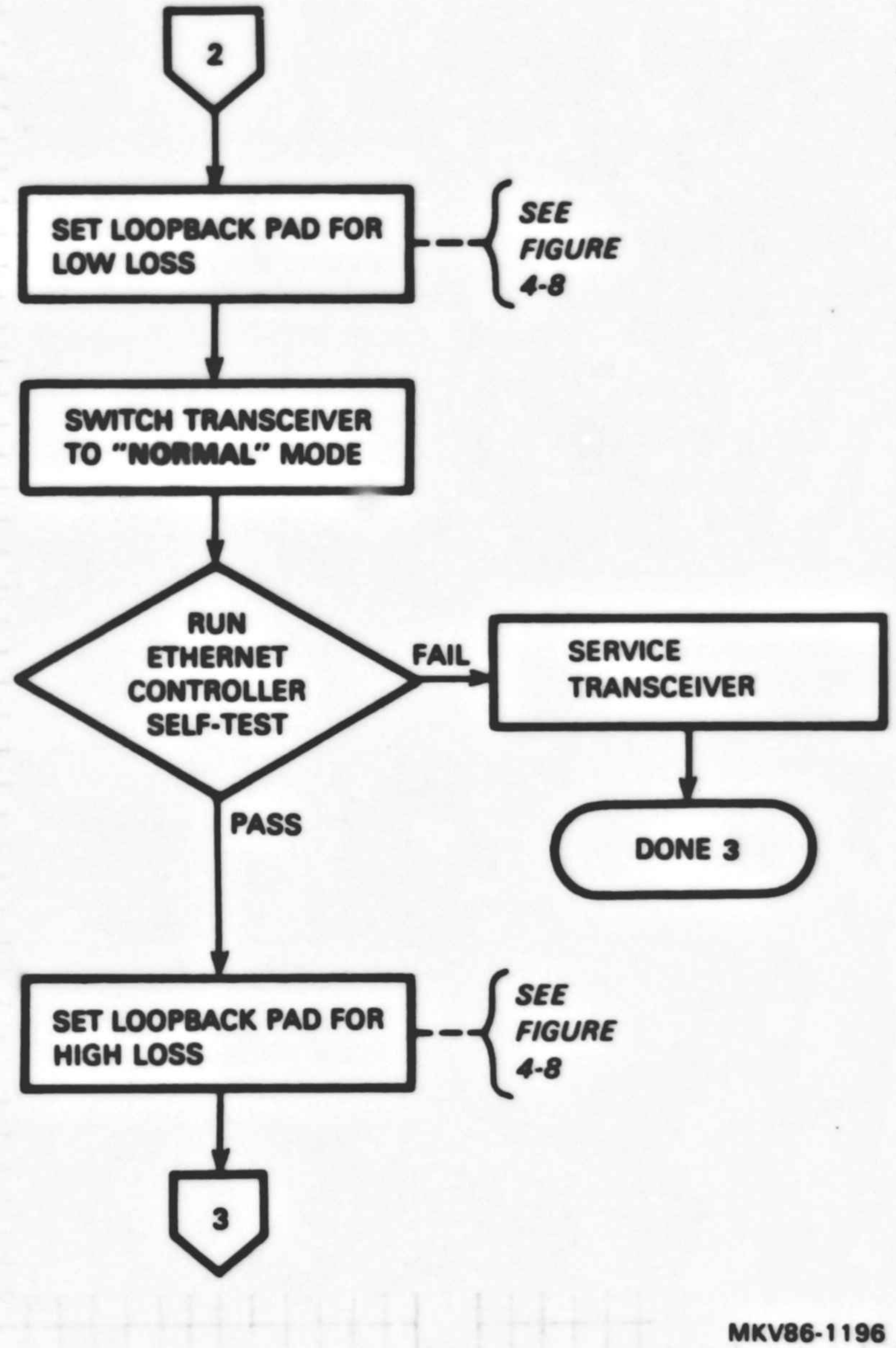

Figure 4-6 Dual-Cable DECOM Troubleshooting Flow Diagram (Sheet 3 of 6)

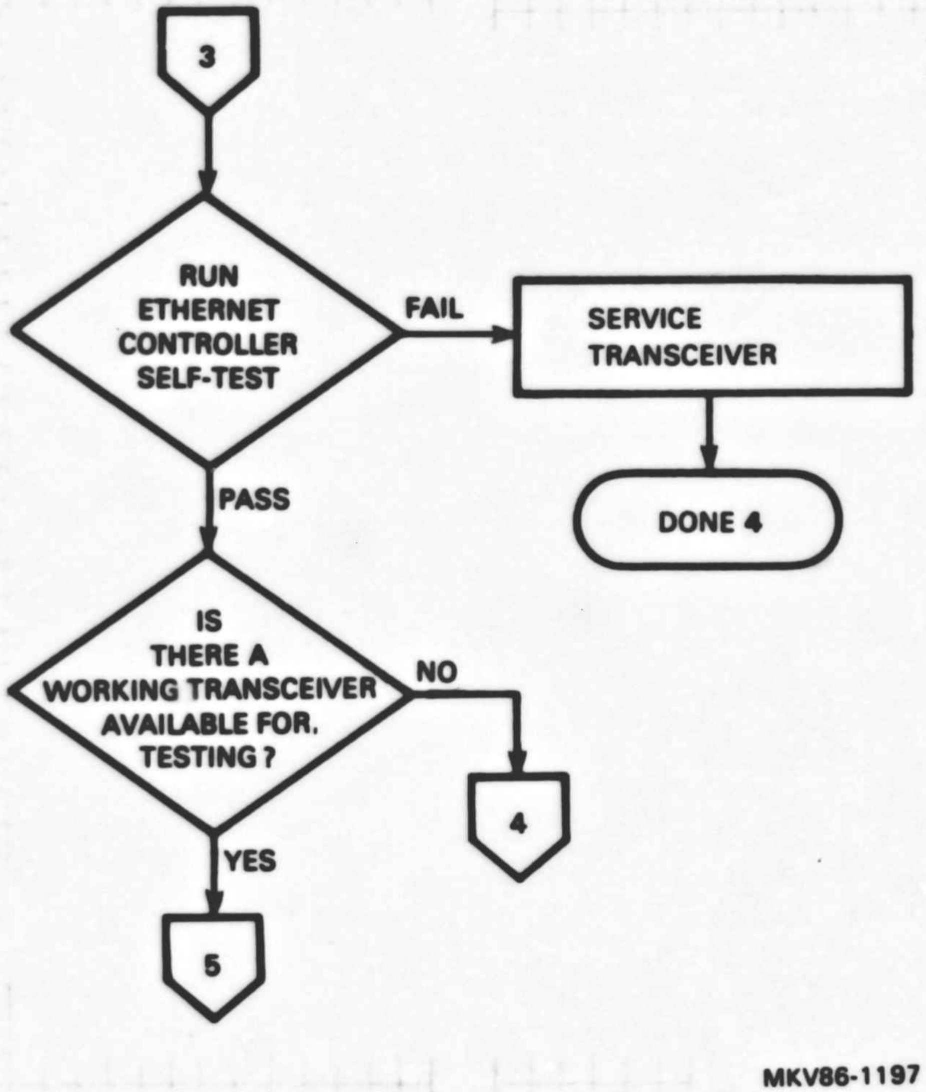

Figure 4-6 Dual-Cable DECOM Troubleshooting Flow Diagram (Sheet 4 of 6)

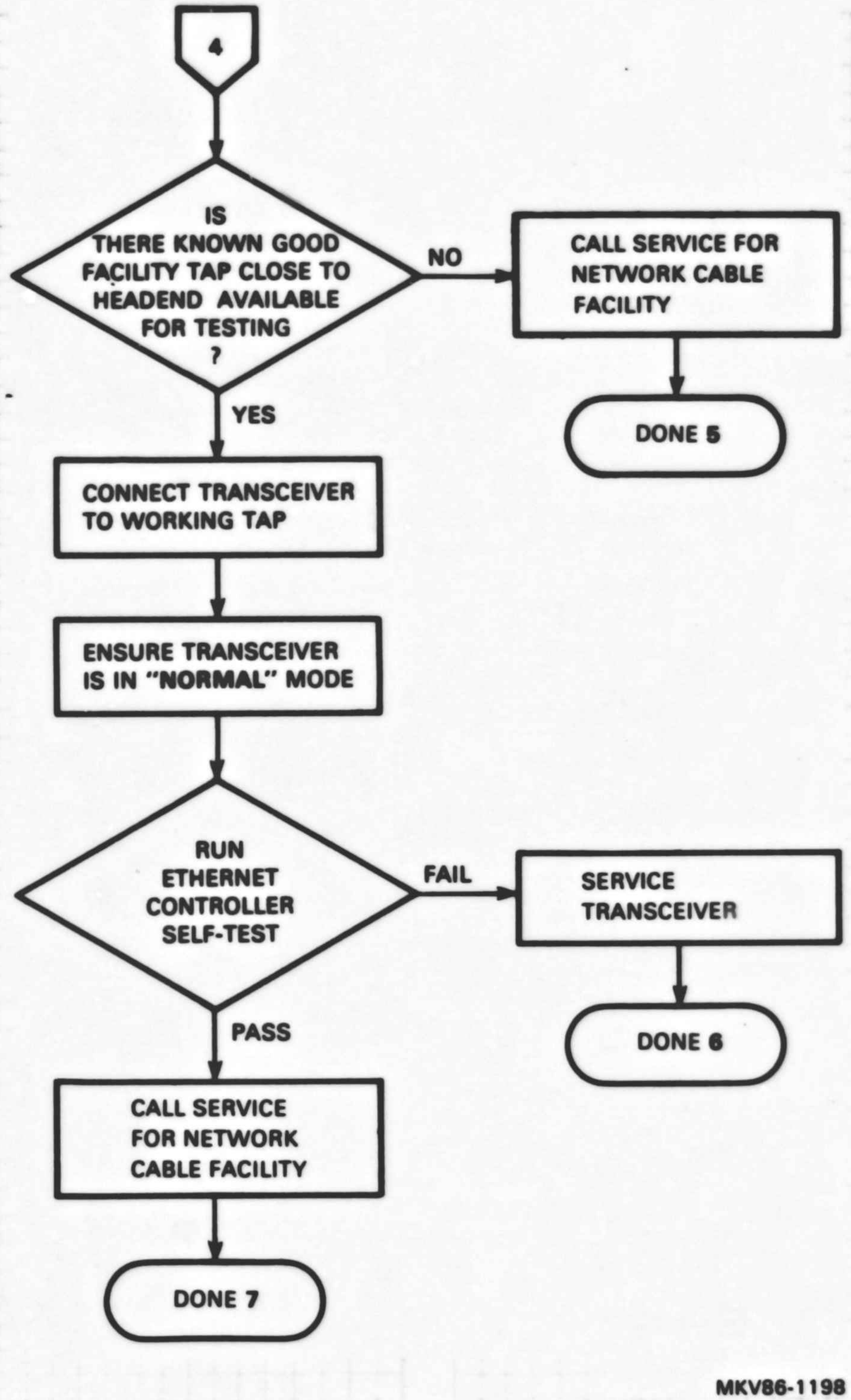

Figure 4-6 Dual-Cable DECOM Troubleshooting Flow Diagram (Sheet 5 of 6)

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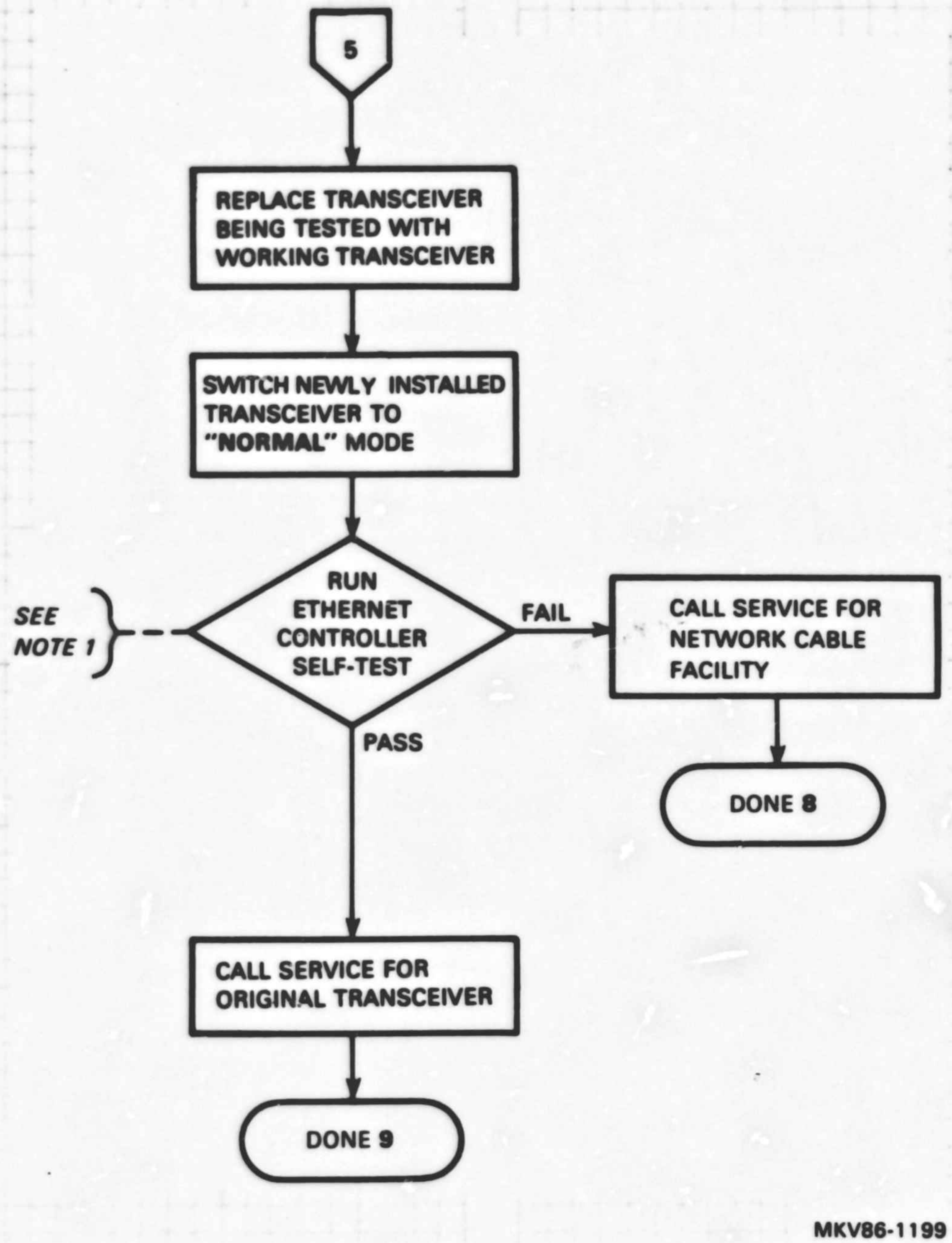

Figure 4-6 Dual-Cable DECOM Troubleshooting Flow Diagram (Sheet 6 of 6)

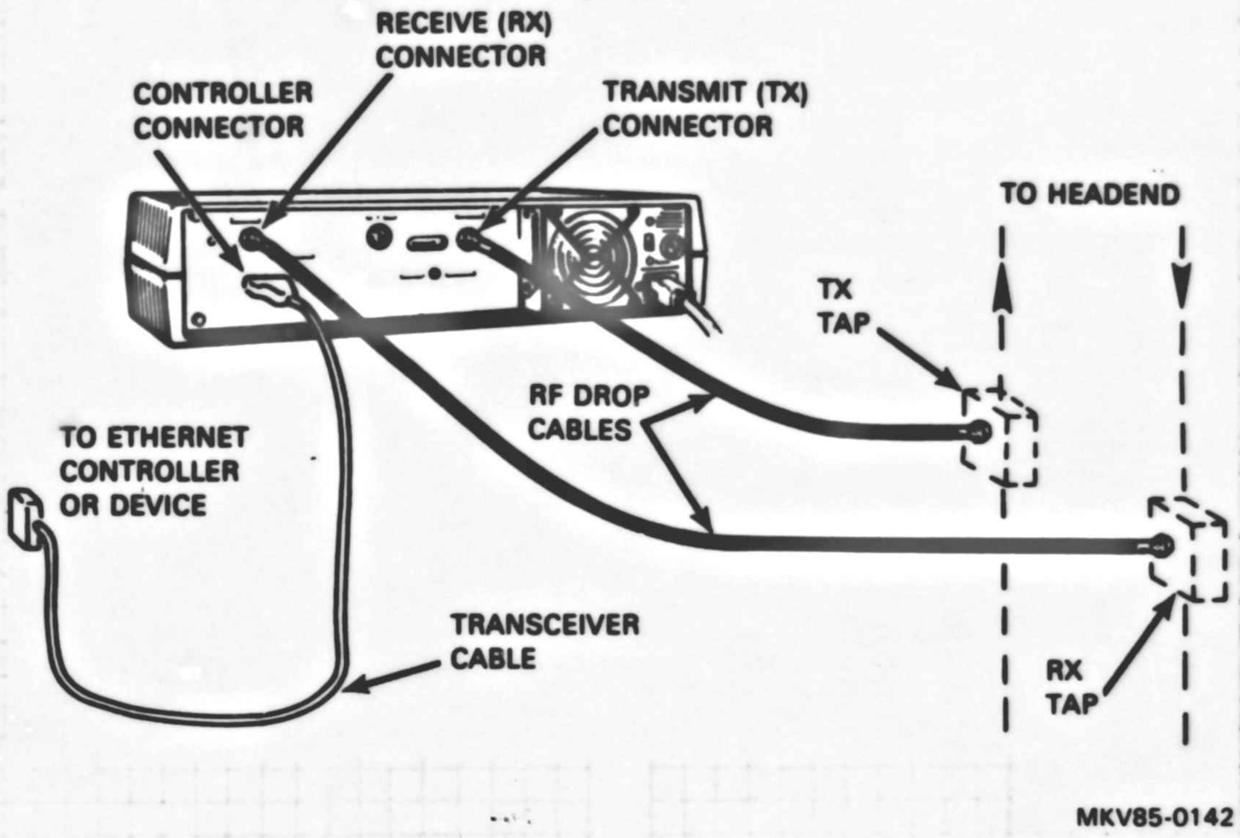

Figure 4-7 Dual-Cable Network Connection

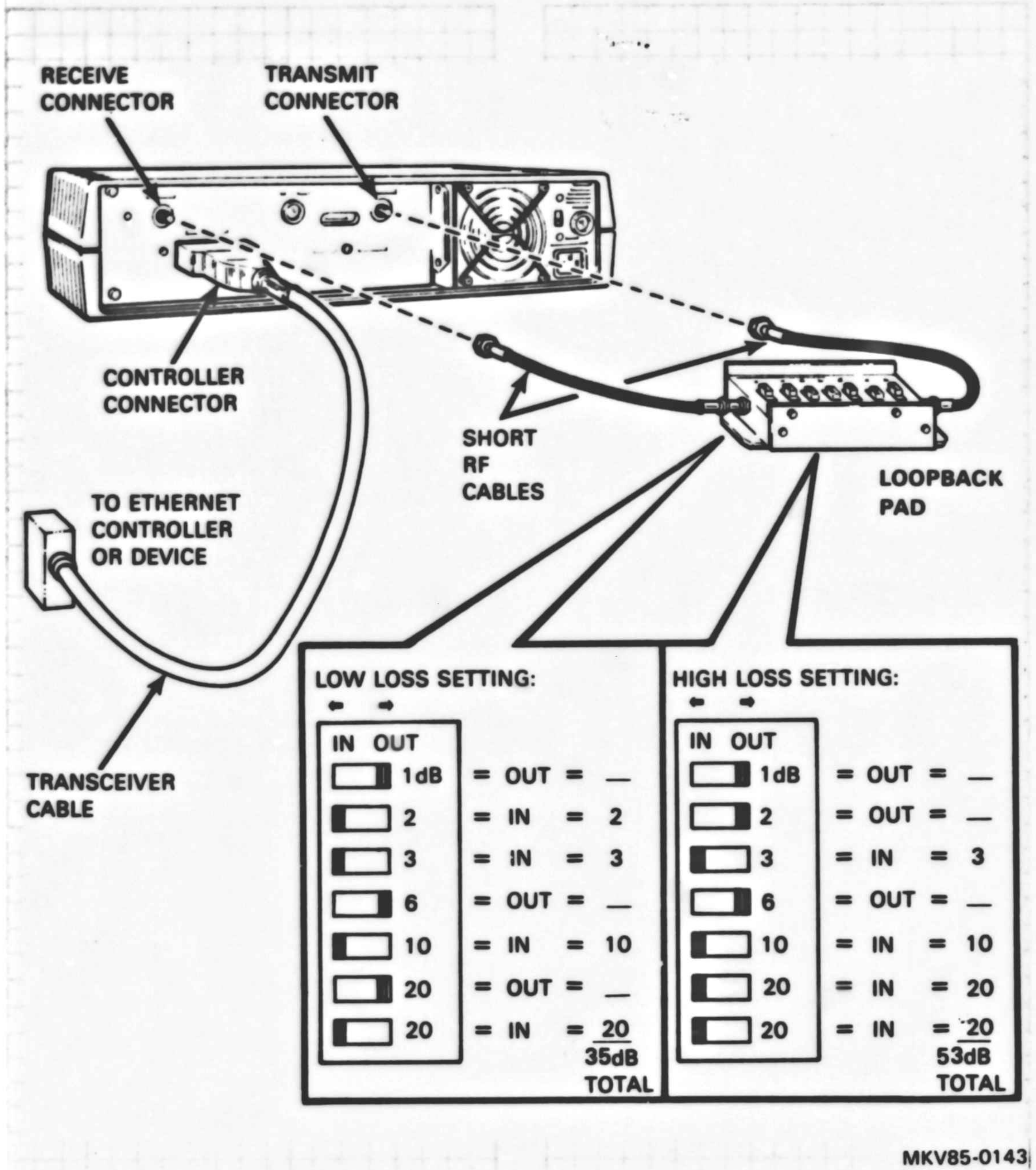

Figure 4-8 Loopback Pad Connection

4.3 CONTROLLER DIAGNOSTICS

Each computer attached to the Ethernet has an Ethernet controller or adapter, which in turn has a diagnostic program. The controller diagnostic is used to test the controller's ability to communicate with other computers on the Ethernet. The Ethernet controller diagnostics also allow testing of the DECOM transceiver with and without the loopback pad.

4.3.1 Matrix

Table 4-3 provides a reference for determining the proper diagnostics for the installed computer/controller.

Table 4-3 Controller Functional Diagnostics

Ethernet Controller	System PDP-11	MicroPDP-11	VAX-11	MicroVAX
DEUNA	CZUAB*	ZQNAE*	EVDWB*.*	NA
DELUA	CZUAD*	ZQNAE*	EVDYB*.*	NA
DEQNA	CZQNA*	ZQNAE*	NA	NAXQA*
DELQA	CZQNA*	ZQNAE*	NA	NAXQA*
DECNA	NA	ZQNAE*	NA	NA

4.3.2 Loading and Running Controller Diagnostics on a VAX System

References: *VAX Diagnostic Supervisor User's Guide*, EK-VXDSU-UG
DEUNA Technical Manual, EK-DEUNA-TM
DELUA User's Guide, EK-DELUA-UG

On the VAX systems, the Ethernet controller functional diagnostics can be run concurrently with VMS. The ability to communicate via the controller under test must be sacrificed while it is being tested.

On systems other than the VAX, the computer must be taken down while the controller diagnostics are operating.

Using the Ethernet controller functional diagnostics for a VAX system:

- Enter the SYSTEM account
- Run the NCP (network control program)
- Notify all system users of maintenance activities and turn off DECnet
- Exit the NCP and log out of the system account
- Log into the FIELD account
- Run VDS (VAX diagnostic supervisor)

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- ATTACH devices - The ATTACH command/procedure specifies device-specific hardware parameters to the VDS. The HELP file contains the device designations that will be required.
- Select the device(s) to be tested, using the SELECT command.
- Run the Ethernet controller functional diagnostics, using the START command.
- The functional diagnostics will now provide a prompt for setting the MAXBUF parameter and the USER BYTLM parameter.
- After the parameters have been changed, the diagnostics will run and the results of the test displayed.

Successful completion of the diagnostics indicate that the controller and the DECOM transceiver being tested have been able to transmit to and receive a message from a remote node. If controller diagnostics are successful, run the NIE.

4.3.3 Loading and Running Controller Diagnostics on a MicroVAX System

References: *MicroVAX Diagnostic Monitor Programmer's Guide*, AC-FE26A-DN
DEQNA Ethernet User's Guide, EK-DEQNA-UG

The MDM (MicroVAX diagnostics monitor) includes the DEQNA Ethernet controller functional diagnostics for the MicroVAX systems. The MDM must be operated in the service mode to test the Ethernet controller.

Using the MDM for the MicroVAX system:

- Boot the MicroVAX with the MDM tape
- Select the service mode
- Select the DEQNA service test
- Run the selected diagnostics:

  MDM>> START

The MDM will prompt the operator to install loopbacks at various points in the communications path (Figure 4-9). Successful completion of the diagnostics indicate that the controller, the transceiver cable, and the DECOM transceiver being tested have been able to transmit to and receive a message in the loopback configuration. If controller diagnostics are successful, run the NIE.

4.3.4 Loading and Running Controller Diagnostics on a PDP-11 System

References: *DEUNA Technical Manual*, EK-DEUNA-TM
DELUA User's Guide, EK-DELUA-UG
DEQNA Ethernet User's Guide, EK-DEQNA-UG

On PDP-11 systems, the Ethernet controller functional diagnostics are run with the system off-line with a loopback connector installed on the system. The diagnostics are run under the extended diagnostics program, XXDP-XM.

To load the functional diagnostics for the PDP-11 system:

- Install the diagnostic media
- Install the loopback connector on transceiver output connector on the back of the PDP-11
- Boot from the appropriate device
- Run the functional diagnostics:

  .RUN ZUABC
- Begin testing:

  DR> START
- Change the hardware and/or software configuration as required.

Successful completion of the diagnostics indicate that the controller installed in the PDP-11 system is operational. If controller diagnostics are successful, run the NIE.

4.3.5 Loading and Running Controller Diagnostics on a MicroPDP-11 System

References: *DEUNA Technical Manual*, EK-DEUNA-TM
DELUA User's Guide, EK-DELUA-UG
DEQNA Ethernet User's Guide, EK-DEQNA-UG
DECNA Controller Installation Guide, EK-DECNA-IN

The MicroPDP-11 systems run the functional diagnostics off-line.The diagnostics are run under the extended diagnostics program, XXDP.

To load the functional diagnostics for the MicroPDP-11 system:

- Install the diagnostic media
- Boot from the device on which the diagnostics are installed
- Run the functional diagnostics:

  .RUN ZQNAE*
- Change the hardware and/or software configuration as required.

Successful completion of the diagnostics indicate that the controller installed in the MicroPDP-11 system is operational. If controller diagnostics are successful, run the NIE.

4.3.6 Troubleshooting with the Controller Diagnostics

The controller diagnostics, with the use of appropriate DECOM loopbacks, can be used to isolate DECOM problems. See Figure 4-9 for loopback techniques.

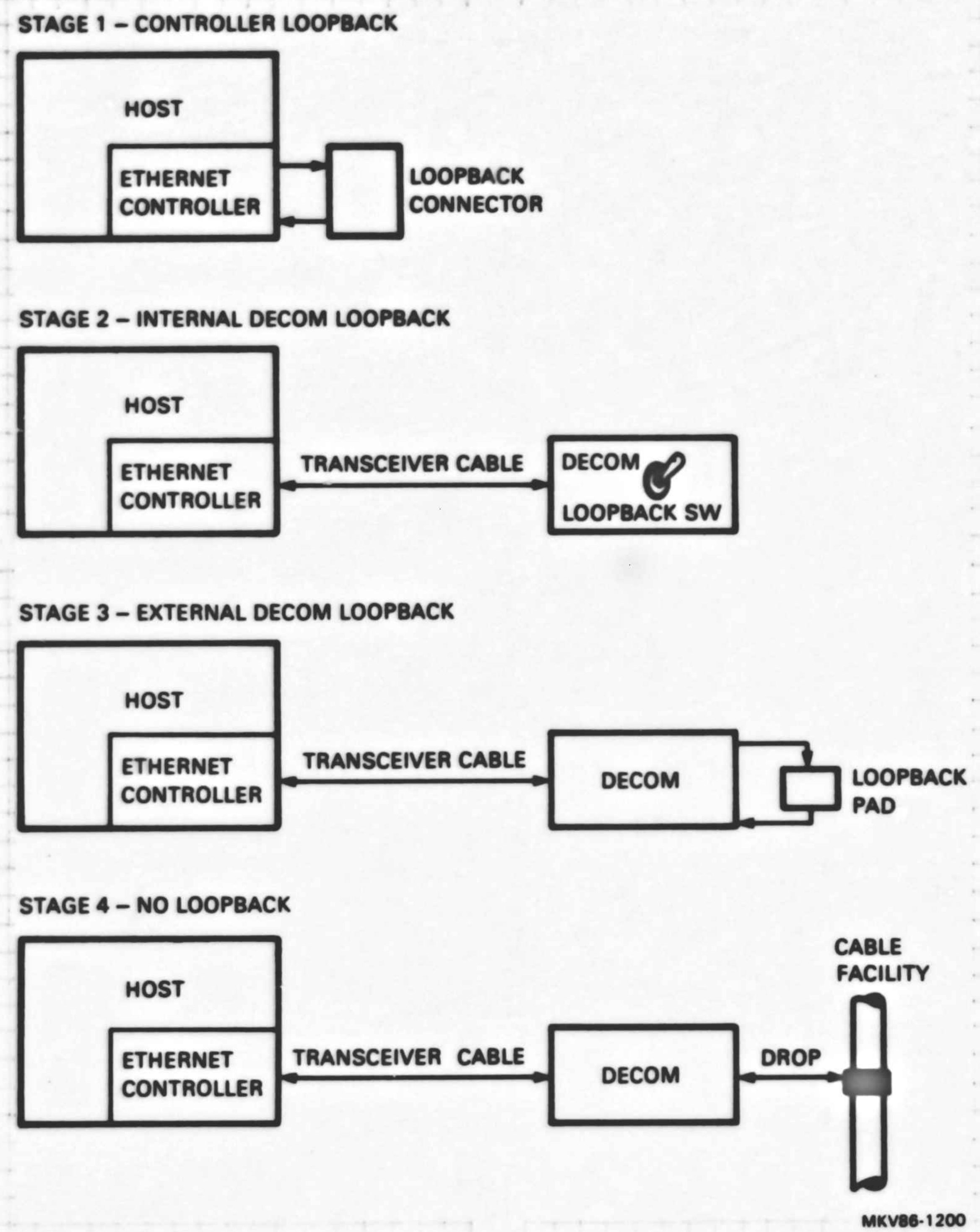

Figure 4-9 Loopback Techniques

Running the controller diagnostics and connecting the loopbacks (if needed) are done in four stages:

Stage 1

CONTROLLER LOOPBACK

A. Install the controller loopback connector.

B. Run the controller diagnostics.

If the test is successful, the controller has been verified as good.

Stage 2

LOOPBACK SWITCH

A. Place the loopback switch on the DECOM transceiver in the LOOPBACK position.

B. Run the controller diagnostics.

If the test is successful, the controller and the transceiver cable and the associated connection are verified as good. Go to Stage 3.

If this test fails, the problem is with the controller, transceiver cable, DECOM transceiver, or the connections. Troubleshoot by checking connections and substituting known good components.

Stage 3

EXTERNAL LOOPBACK

A. Place the loopback switch in the NORMAL position and connect the loopback pad on the DECOM transceiver as shown Figure 4-8.

B. Run the controller diagnostics.

If the test is successful, the controller, the transceiver cable, the DECOM transceiver, and the associated connections are verified as good. Proceed with network troubleshooting procedures.

If the Stage 2 configuration was successful and Stage 3 fails, the problem is with the DECOM transceiver. Replace the DECOM.

Stage 4

NO LOOPBACK

A. Run the controller diagnostics with no loopback.

If the diagnostics run successfully, then the communications path, including all connections and the DECOM transceiver, are verified as good.

If diagnostics fail, see diagnostic documentation for error messages and recommended action. If the problem is not resolved, go to Stage 2.

4.4 NETWORK INTERCONNECT EXERCISER

The network interconnect exerciser (NIE) provides a diagnostic exerciser for Ethernet networks. Node installation, verification, and problem isolation can be performed using the NIE; therefore, it is useful for troubleshooting the DECOM transceiver.

Some of the features that make the NIE useful for troubleshooting DECOM problems are as follows:

- Monitors system ID messages on the network and builds a node table of known nodes
- Tests for connectivity by transmitting loopback packets to individual or sequences of nodes in the node table and checking the response
- Allows the user to specify test loop parameters
- Samples network traffic and display characteristics of packets
- Sends a request ID packet to any node address and displays the responding system's ID message.

The NIE interacts with the network by passively listening to the network traffic and by actively transmitting loopback packets and request ID messages. In order to loop packets, the NIE must have a list of valid node addresses, which is obtained from the node table.

Table 4-4 NIE Diagnostics

Adapter or Controller	System				
	MicroPDP-11	VAX/VMS	PDP-11/DRS	PDP-11/XXX	MicroVAX
DEUNA	NA	EVDWC*.*	CZNID*	CZUAC*	NA
DELUA	NA	EVDWC*.*	CZNID*	CZUAC*	NA
DEQNA	VNIAB*	NA	NA	NA	NANIA*
DELQA	NA	NA	NA	NA	NANIA*

4.4.1 Loading and Running the NIE on a VAX/VMS System

Reference: *Network Interconnect Exerciser (NIE) User's Guide, Book 1: DEUNA/DELUA Under VAX/VMS*, AA-HI06A-TE

On the VAX systems, the NIE diagnostics can be run concurrently with VMS. DECnet must be disabled, thus the ability to communicate on the Ethernet must be sacrificed while the NIE is running. The NIE is used as a maintenance tool for troubleshooting DECOMproblems. The NIE can check a DECOM transceiver remotely and can also locate a problem DECOM on the network.

Using the NIE for a VAX system:

- Enter the SYSTEM account (privilege required)
- Run the NCP (network control program)
- Notify all system users of maintenance activities
- Turn off DECnet
- Exit the NCP and log out of the system account
- Log into the FIELD account
- Run VDS (VAX diagnostic supervisor)
- ATTACH devices – The ATTACH command/procedure specifies device-specific hardware parameters to the VDS. The HELP file contains the device designations that will berequired.
- Select the device to be tested using the SELECT command.

  Example:

  DS> SELECT XEAO
- Load the NIE:

  DS> LOAD EVDWC.EXE
- Run the NIE:

  DS> START
  NIE>

Sections 4.4.5, 4.4.5.1, and 4.4.5.2 describe the NIE commands and procedures.

Successful completion of the NIE indicates that the DECOM transceiver being tested is able to transmit to and receive a message from a remote node.

4.4.2 Loading and Running the NIE on a MicroVAX System

Reference: *MicroVAX Diagnostic Monitor Programmer's Guide*, AC-FE26A-DN

The MDM (MicroVAX diagnostics monitor) includes the NIE (network interconnect exerciser). The NIE can be used as a maintenance tool for troubleshooting DECOM problems. The NIE can check a DECOM transceiver remotely and can also locate a problem DECOM on the network.

The MDM must be operated in the service mode, which means the MicroVAX system must be off-line to test the DECOM transceiver using the NIE.

Using the NIE on the MicroVAX system:

- Boot the MicroVAX with the MDM tape
- Select the service mode
- Select the NIE test
- Run the NIE:

  MDM>> START
  NIE>>

Sections 4.4.5, 4.4.5.1, and 4.4.5.2 describe the NIE commands and procedures.

Successful completion of the NIE indicates that the DECOM transceiver being tested has been able to transmit to and receive a message from a remote node.

4.4.3 Loading and Running the NIE on a PDP-11 System

References: *Network Interconnect Exerciser (NIE) User's Guide,*
Book 2: DEUNA/DELUA Under PDP-11/RSX, AA-HI85A-TE
Book 3: DEUNA/DELUA Under PDP-11/XXDP+, AA-HI86A-TE

The XXDP (extended diagnostic program) includes the NIE (network interconnect exerciser). The NIE can be used as a maintenance tool for troubleshooting DECOM problems. The NIE can check a DECOM transceiver remotely and can also locate a problem DECOM on the network.

The PDP-11 system must be off-line to test the DECOM transceiver using the NIE.

Using the NIE on the PDP-11 system:

- Install the diagnostic media
- Boot from the appropriate device
- Run the NIE for PDP-11:

  .RUN CZUAC

- Begin testing:

  DR> START

- Change the hardware and/or software configuration as required
- At the NIE prompt, enter the desired NIE command (Sections 4.4.5, 4.4.5.1, or 4.4.5.2).

Successful completion of the NIE indicates that the DECOM transceiver being tested has been able to transmit to and receive a message from a remote node.

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4.4.4 Loading and Running the NIE on a MicroPDP-11 System

The XXDP (extended diagnostic program) for the MicroPDP-11 system includes the NIE (network interconnect exerciser). The NIE can be used as a maintenance tool for troubleshooting DECOM problems. The NIE can check a DECOM transceiver remotely and can also locate a problem DECOM on the network.

The MicroPDP-11 system must be off-line to test the DECOM transceiver using the NIE.

Using the NIE on the PDP-11 system:

- Install the diagnostic media
- Boot from the appropriate device
- Run the NIE for MicroPDP-11:

  .RUN VNIAB*

- Begin testing:

  DR> START

- Change the hardware and/or software configuration as required
- At the NIE prompt, enter the desired NIE command (Sections 4.4.5, 4.4.5.1, or 4.4.5.2.)

Successful completion of the NIE indicates that the DECOM transceiver being tested has been able to transmit to and receive a message from a remote node.

4.4.5 Troubleshooting with the NIE

Sections 4.4.5.1 and 4.4.5.2 describe how to use the NIE to troubleshoot suspected DECOM failures from the suspect node and from a remote node.

4.4.5.1 Testing from a Suspect Node

If the suspect node is local, the NIE should be run from that node. Take the following steps:

1. Build a node table of the nodes on the Ethernet

   Example: NIE> BUILD/MINUTES=10

   The node table is constructed in the listen mode, which verifies that the receiver portion of the DECOM transceiver is functioning.

2. Bounce a message off a remote node, which appears on the node table.

   Example: NIE> BOUNCE/N3

   If the test message returns to the node you are on, then both the transmit and receive portions and all connections on the suspect DECOM transceiver have been verified as good.

   See Table 4-5 for NIE error messages and recommended actions. The controller diagnostic with the appropriate loopbacks may now be used as an alternative to isolate the problem.

3. To verify proper operation of the network, check all the nodes on the node table.

   Example: NIE> RUN DIRECT

   Successful completion of this test verifies that all nodes on the table are operating properly.

4. When testing is complete, return to the diagnostic supervisor.

   Example: NIE> EXIT

Refer to Table 4-6 for more NIE commands and test variations.

4.4.5.2 Testing from a Remote Node

If the suspect node is remote, the NIE can be used test the suspect node. Take the following steps:

1. Determine the Ethernet address for the suspect node. This information should be available from the system manager.

   NOTE
   If the suspect node is not transmitting, it will not appear in the node tableconstructed with the BUILD command.

2. Build a node table to see if the suspect node appears.

   Example: NIE> BUILD/MINUTES=20

   If the suspect node appears on the node table, then the transmit portion of the DECOM transceiver is operating.

3. Bounce a message off a suspect node.

   Example: NIE> BOUNCE/<address>

   If the test message returns to the node you are on, then both the transmit and receive portions and all connections on the suspect DECOM transceiver have been verified as good.

   If the bounce test is not successful, go to the suspect node and continue troubleshooting using the controller diagnostics and appropriate loopbacks.

4. To verify proper operation of the network, check all the nodes on the node table.

   Example: NIE> RUN DIRECT

   Successful completion of this test verifies that all nodes on the table are operating properly.

5. When testing is complete, return to the diagnostic supervisor.

   Example: NIE> EXIT

Refer to Table 4-6 for more NIE commands and test variations.

Table 4-5 NIE Error Message Summary

Name	Description
Node Physical Address	The physical address of the node on the NI
Receives Not Complete	The number of packets transmitted without a corresponding reply
Receives Complete	The number of packets transmitted and received successfully. (Note that messages sent do not always equal messages received if there are problems with the node or if traffic is high enough to cause dropped packets)
Data Length Error	Number of packets with the bytes expected not equaling the number of bytes received
Data Comparison Errors	Number of bytes received in error
Bytes Compares	The number of bytes of data compared
Bytes Transferred	The number of bytes transmitted to a node (data and header)

Table 4-6 NIE Command Summary

Command	Function
BUILD	Establishes a remote console channel in promiscuous mode and listens for system ID messages. When a message is received, the default hardware address, the physical address, and the node type of the originating node are extracted and saved in a node table. A node is added to the table the first time a message is monitored from that node
/MINUTES=m	Each node transmits its SYSTEM ID message every 10 minutes. Building for 10 minutes should capture all or nearly all the nodes
/HOURS=h	See above
BOUNCE/<add list>	Loops one packet through the sequence of nodes specified by their physical or logical addresses
RUN DIRECT	Loops a packet to each node listed on the node table and maintains test summary data in the summary data table. A "/PASS" qualifier allows looping of the test
RUN LOOPPAIR	Loops a packet through each logically adjacent pair of nodes on the node table
RUN ALL	Runs one pass of RUN DIRECT test, then loops a packet through all possible node pairs on the node table. This test can be very lengthy
NODES	
/<add list>	Enters the nodes from the address list into the node table
CLEAR NODES <add list>	Clears nodes, specified by their logical or physical addresses, from the node table
CLEAR NODES/ALL	Removes all nodes from the node table
SHOW NODES	Displays/prints the node table
SUMMARY	Displays/prints all summary data since NIE was started (or since the last CLEAR SUMMARY)
CLEAR SUMMARY	Clears the summary table

Table 4-6 NIE Command Summary (Cont)

Command	Function
LISTEN	Starts a diagnostic channel in promiscuous mode and attempts to listen to all NI traffic. A listen characteristic table is constructed with each packet characterized by source address, destination address, protocol type, packet size, and a count of how many times a packet with the same characteristics has appeared. A count of packets with the same source address is also maintained
/SOURCE	Listen and record packets from the specified source address only
/DESTINATION	Listen and record packets from the specified destination address only
/PROTOCOL	Listen and record packets of the specified protocol only
SHOW LISTEN	Displays/prints the listen table
CLEAR LISTEN	Clears all accumulated data in the listen table
MESSAGE	Instructs the NIE to use the default message
/TEXT=<ASCII string>	Changes the message to specified data pattern
/TEXT=%<hex string>	Changes the message to specified data pattern
/TYPE=<msg type>	Selects the message type
/SIZE=<msg size>	Selects the message size in bytes
/COPIES=<msg copies>	Selects the number of copies of the message to be looped
SHOW MESSAGE	Displays/prints the current message parameters
CLEAR MESSAGE	Returns the message to default parameters
IDENTIFY=<node add>	Requests from the specified node its physical address, hardware address, node type, node functions, and ECO numbers
HELP or ?	Displays/prints the HELP file
EXIT	Exits from NIE and returns control to the diagnostic supervisor

Table 4-6 NIE Command Summary (Cont)

Command	Function
PRINT	Instructs NIE to print all data
NOPRINT	Restricts printout to the last three error messages
SAVE <filespec>	Saves the node table in the specified file
UNSAVE <filespec>	Loads the specified node table

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APPENDIX A

APPENDIX A
BROADBAND ETHERNET CHANNEL SPECIFICATION

A.1 SINGLE-CABLE

A.1.1 Signal Level

DECOM Transmit Level	50 dBmV ± 2 dB
DECOM Receive Level	6 dBmV ± 9 dB
DEFTR Input Level	0 dBmV ± 5 dB
DEFTR Input Attenuation	0-10 dB in 1 dB increments
DEFTR Gain	56 dB ± 1 dB; 15-32°C (59 to 90°F) 56 dB ± 2 dB; 10-40°C (50 to 104°F)
DEFTR Output Attenuation	0-10 dB in 1 dB increments
Reverse Channel Loss	37-53 dB with no more than 6 dB variance
Forward Channel Loss	37-53 dB with no more than 6 dB variance; DEFTR at 15-32°C (59 to 90°F) 38-52 dB with no more than 4 dB variance; DEFTR at 10-40°C (50 to 104°F)
Total Loop Loss	44 ±7 dB

A.1.2 Noise Level

Total into Receiver (at minimum signal level)	−35.6 dBmV/4.2 MHz/BER 10^{-9}

A.1.3 Frequency Response (Peak-to-Valley)

Reverse Channel Response	≤1 dB
Forward Channel Response	≤1 dB
Total Frequency Response	≤2 dB

A.1.4 Propagation Delay

Round Trip Delay (outlet-to-outlet)	15.03 μs + 500 ns for DEFTR
Outlet-to-Headend	1900 m, maximum distance
Outlet-to-Outlet	3800 m, maximum distance

A.1.5 Adjacent Channel Requirements
Restrictions to the use of the 6 MHz (48-54 MHz, 72-78 MHz, 204.25-210.25 MHz, and/or 228.25-234.25 MHz) adjacent channels, to the broadband Ethernet channel, are as follows.

One-Way Applications

Signals less than or equal to 10 dBmV, at the outlet, are permitted to be received, only in the 204.25 through 209.75 MHz bandpass and the 232.25 through 234.25 bandpass. Use the following guidelines:

1. If using the 48-50 MHz bandpass, no use is permitted in the 228.25-234.25 MHz bandpass.
2. If using the 72.5-78.0 MHz bandpass, no use is permitted in the 204.25-210.25 MHz bandpass.

Two-Way Applications

Two-way communications are not permitted in the adjacent channels.

Nonbroadband Ethernet translator skirts (40 dB points on the input filters) are not permitted in the adjacent channels.

A.2 DUAL-CABLE

A.2.1 Signal Level

DECOM Transmit Level	50 dBmV ± 2 dB
DECOM Receive Level	6 dBmV ± 9 dB
Total Loop Loss	44 ±7 dB

A.2.2 Noise Level

Total into Receiver (at minimum signal level)	−35.6 dBmV/4.2 MHz/BER 10 EE-9

A.2.3 Frequency Response (Peak-to-Valley)

Reverse Channel Response	≤1 dB
Forward Channel Response	≤1 dB
Total Frequency Response	≤2 dB

A.2.4 Propagation Delay

Round Trip Delay (Outlet to Outlet)	15.53 μs
Outlet-to-Headend	2000 m, maximum distance
Outlet-to-Outlet	4000 m, maximum distance

A.2.5 Adjacent Channel Requirements
Restrictions to the use of the 6 MHz (48-54 MHz and/or 72-78 MHz) adjacent channels to the broadband Ethernet channel, are as follows:

Signals ≤10 dBmV at the outlet are permitted to be received only in the 48.0 through 50.0 MHz bandpass and the 72.5 through 78.0 MHz bandpass.

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