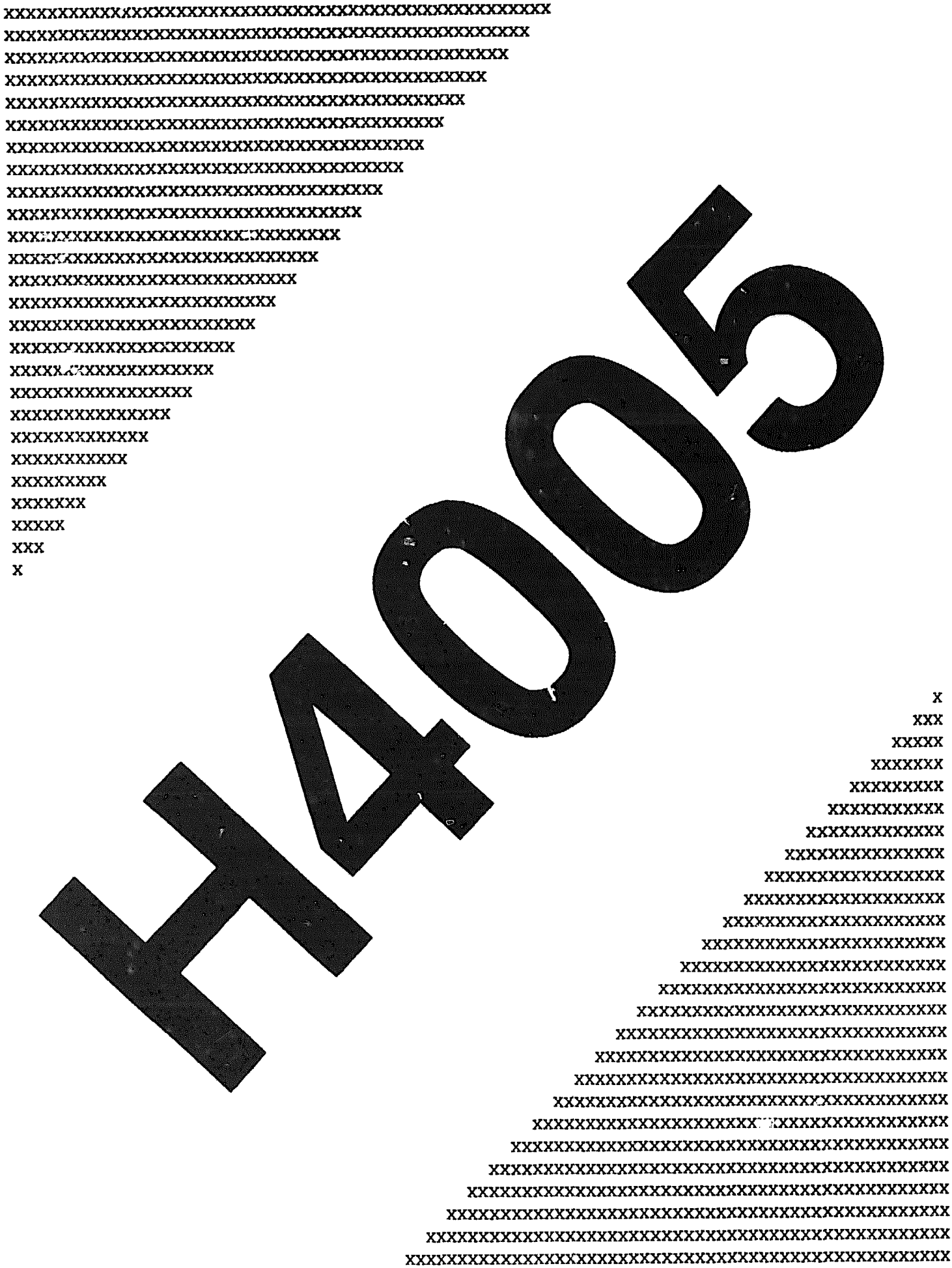
H4005

H4005 802.3 Transceiver
Technical Manual
EK-H4005-TM-002

Digital Equipment Corporation
Maynard, Massachusetts

July 1990

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About This Manual

This manual provides operational and servicing information for the Ethernet H4005 transceiver. The information in this manual is directed toward the customer and Digital Customer Services personnel.

This manual consists of the following chapters.

OVERVIEW

- Chapter 1 provides a general overview that includes a brief description of the hardware and operational requirements for the H4005 transceiver.

FUNCTIONAL DESCRIPTION

- Chapter 2 summarizes the major functional components that make up the H4005 transceiver.

INSTALLATION

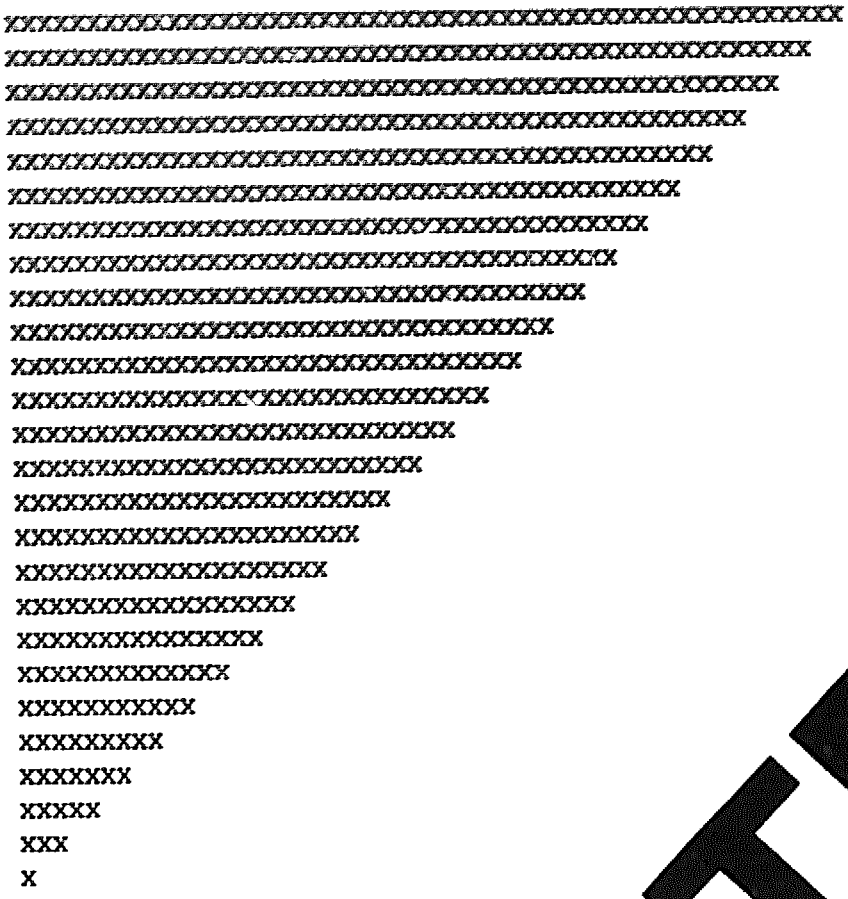
- Chapter 3 contains information on installing the H4005 transceiver to the 802.3 network.

FAULT ISOLATION PROCEDURES

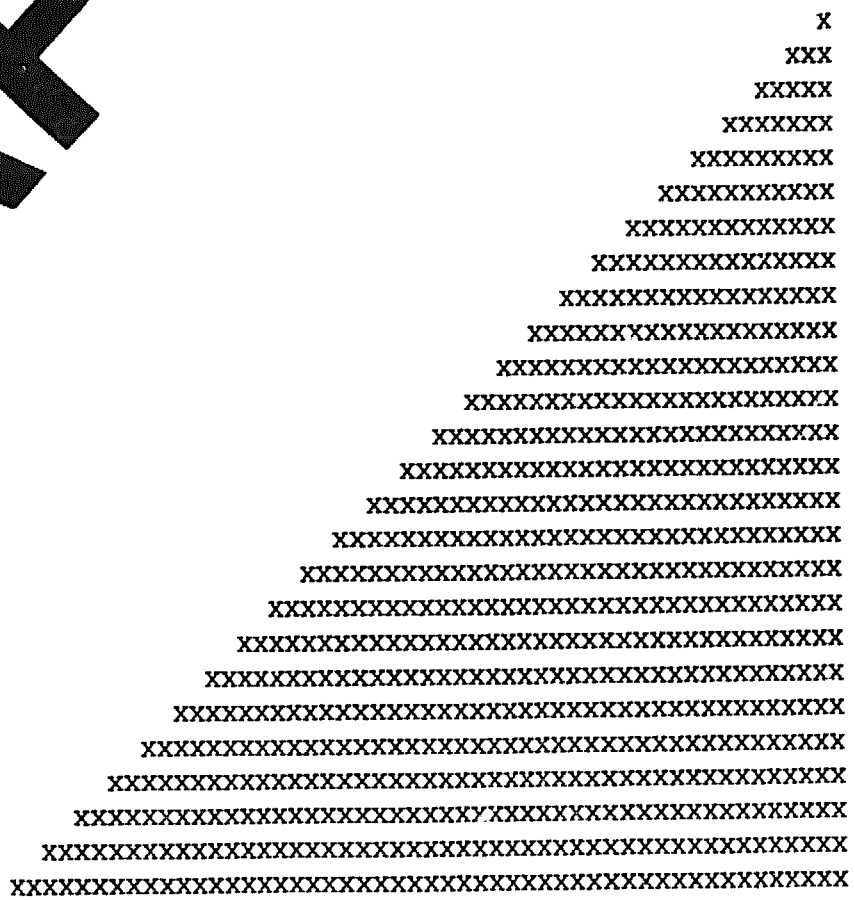
- Chapter 4 provides information on maintenance strategy, troubleshooting, and testing.

TIMING DIAGRAMS

- Appendix A provides timing diagrams of all the H4005 connector signals.



CHAPTER 1



1
OVERVIEW

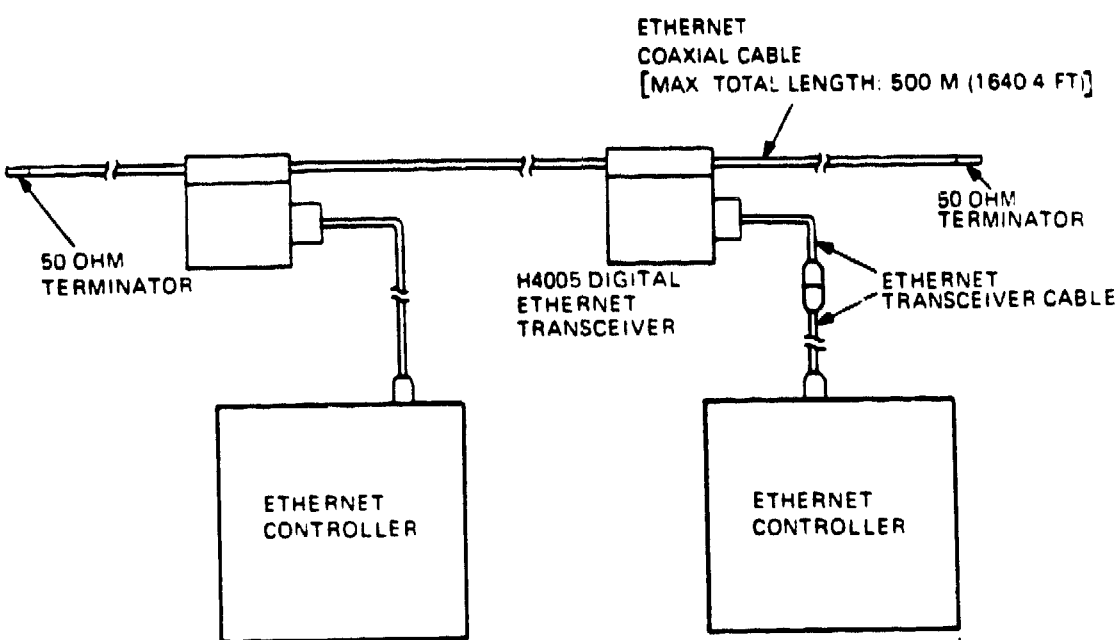
1.1 GENERAL DESCRIPTION

The H4005 Ethernet transceiver provides a physical and electrical interface between an Ethernet coaxial cable and other Ethernet devices such as controllers, repeaters, network interconnect devices, and terminals via the transceiver cable.

The transceiver clamps directly onto the coaxial cable and has a 15-pin male D-connector for connection to a transceiver cable. Power to drive the transceiver (+11.28 to +15.75 Vdc) is provided by the connected device.

The H4005 transceiver is transparent to the user. It is not addressable or programmable.

Figure 1–1 illustrates a typical H4005 transceiver configuration.



*N ≤ 100 PER 500 M (1640.4 FT) COAXIAL CABLE SEGMENT

MKV86 0572

Figure 1–1 Typical H4005 Transceiver Configuration

1.2 H4005 TRANSCEIVER COMPONENTS

The following parts are supplied with the H4005 transceiver.

- H4005 transceiver
- Tap assembly
- *H4005 DIGITAL Ethernet Transceiver with Removable Tap Assembly Installation Card* (EK-H4005-IN)

1.3 RELATED DOCUMENTS

Refer to the following documents for more Ethernet information regarding the H4005 Ethernet transceiver.

TITLE	PART NUMBER
H4005 DIGITAL Ethernet Transceiver with Removable Tap Assembly Installation Card	EK-H4005-IN
DECconnect Documentation Set	EK-DECSY-DK
Etherjack Installation Guide	ED-DEXJK-IN
H4000-T Ethernet Transceiver Tester User Guide	EK-ETHTT-UG
DECconnect System, Requirements Evaluation Workbook	EK-DECSY-EG
Communications Options Minireference Manual, Vol. 7	EK-CMIV7-RM
DEC Standard 134, Ethernet Specification	A-DS-EL00134 (For Internal Use Only)

1.4 DEVICE PLACEMENT

The H4005 transceiver clamps directly onto an Ethernet coaxial cable. Observe the following constraints.

- A maximum of 100 transceivers may be placed on a single 500 m (1640.4 ft) Ethernet coaxial cable segment.
- Transceivers must be positioned 5 cm (1.97 inches) on the annular rings marked every 2.5 m (8.2 ft) on the coaxial cable.
- Spacing between transceivers may not be less than 2.5 m (8.2 ft).

NOTE
If annular rings are not marked on the coaxial cable, transceivers must be spaced in multiples of 2.5 m (8.2 ft) only.

1.5 REQUIRED EQUIPMENT

The following equipment is required for the proper installation and testing of an H4005 Ethernet transceiver.

- H4000-TA (or -TB for non-US versions) transceiver tester (must be IEEE 802.3 compatible)
- CD kit (Part Number: A2-W1100-10)
- Installation tool (Part Number: 12-24664-02)

1.6 POWER REQUIREMENTS

An H4005 transceiver requires +11.28 to +15.75 Vdc for proper operation. The power must be supplied by the Ethernet device to which the transceiver is connected.

1.7 FIELD REPLACEABLE UNITS (FRUs)

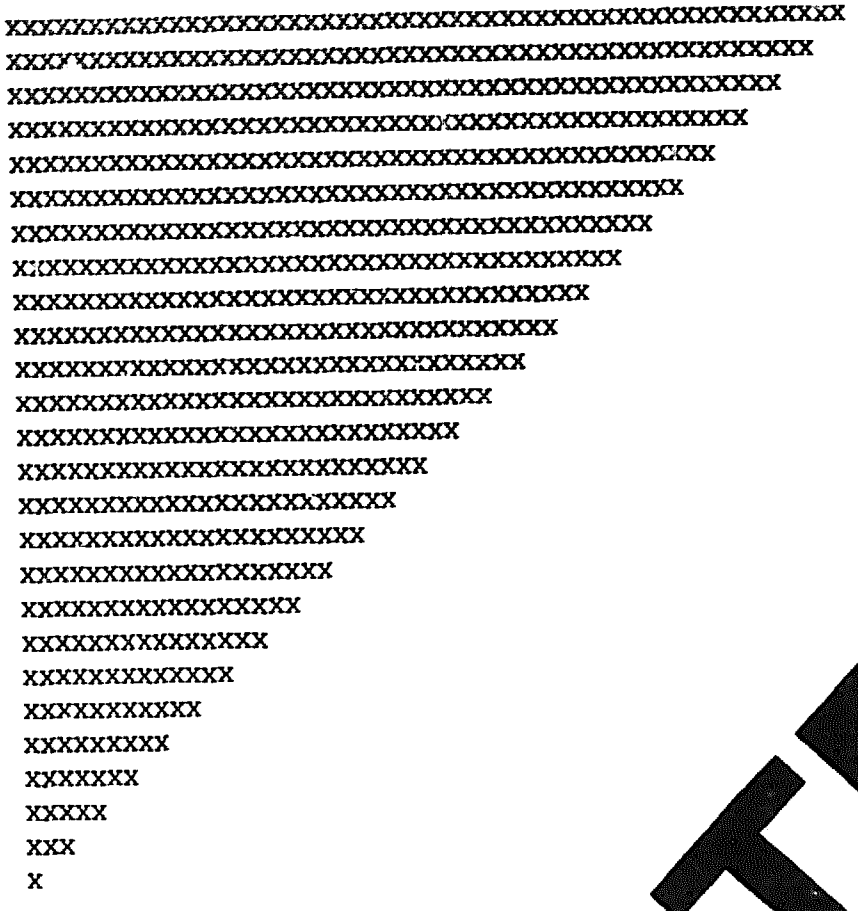
The following items are FRUs for the H4005 transceiver:

Item	Part Number
Braid terminators	12-24664-05 (box of ten)
DIGITAL removable tap	12-24664-01
H4005 transceiver FRU	70-22781-01
Push-pins	74-32789-01
Probe assembly	12-24664-03

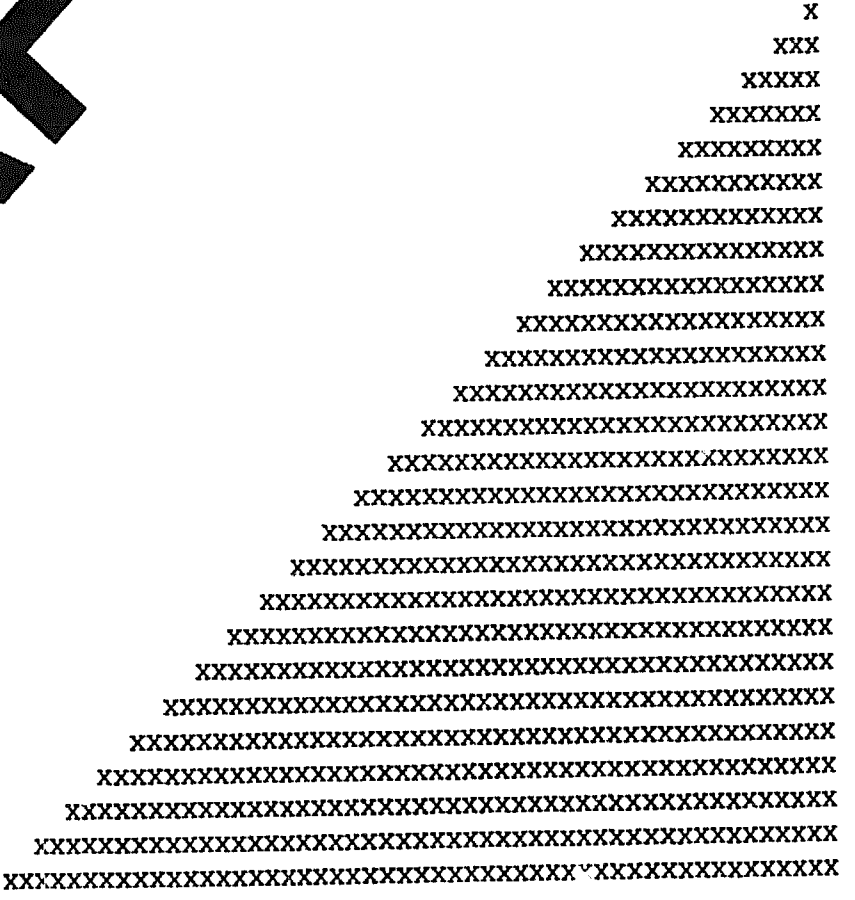
1.8 H4005 CONNECTOR SIGNALS

The following information identifies the signal names to pin numbers. Timing diagrams for these signals are found in Appendix A.

Pin	Signal Name
Pin 2	Collision +
Pin 9	Collision –
Pin 3	Transmit +
Pin 10	Transmit –
Pin 5	Receive +
Pin 12	Receive –
Pin 13	Power
Pin 6	Power return
Pins 1, 4, 8, 11, 14	GND
Pin 7	No connection
Pin 15	No connection



CHAPTER 2



2
FUNCTIONAL DESCRIPTION

2.1 H4005 BLOCK DIAGRAM

Figure 2–1 is a block diagram which shows the four basic blocks that make up an H4005 transceiver. Functions of the blocks are as follows:

1. DC to DC Converter—Converts voltage (+11.28 Vdc to +15.75 Vdc) supplied by the Ethernet device to -9 Vdc for the Coaxial Transceiver Interface (CTI) chip set.
2. Isolation Transformer—Isolates noise signals generated by the Ethernet device from the CTI chip.
3. CTI Chip—Contains the receive, transmit, and collision detect functions.
4. Short Detect Circuit—Prevents the Carrier signal from being asserted in the event the coax medium is shorted.

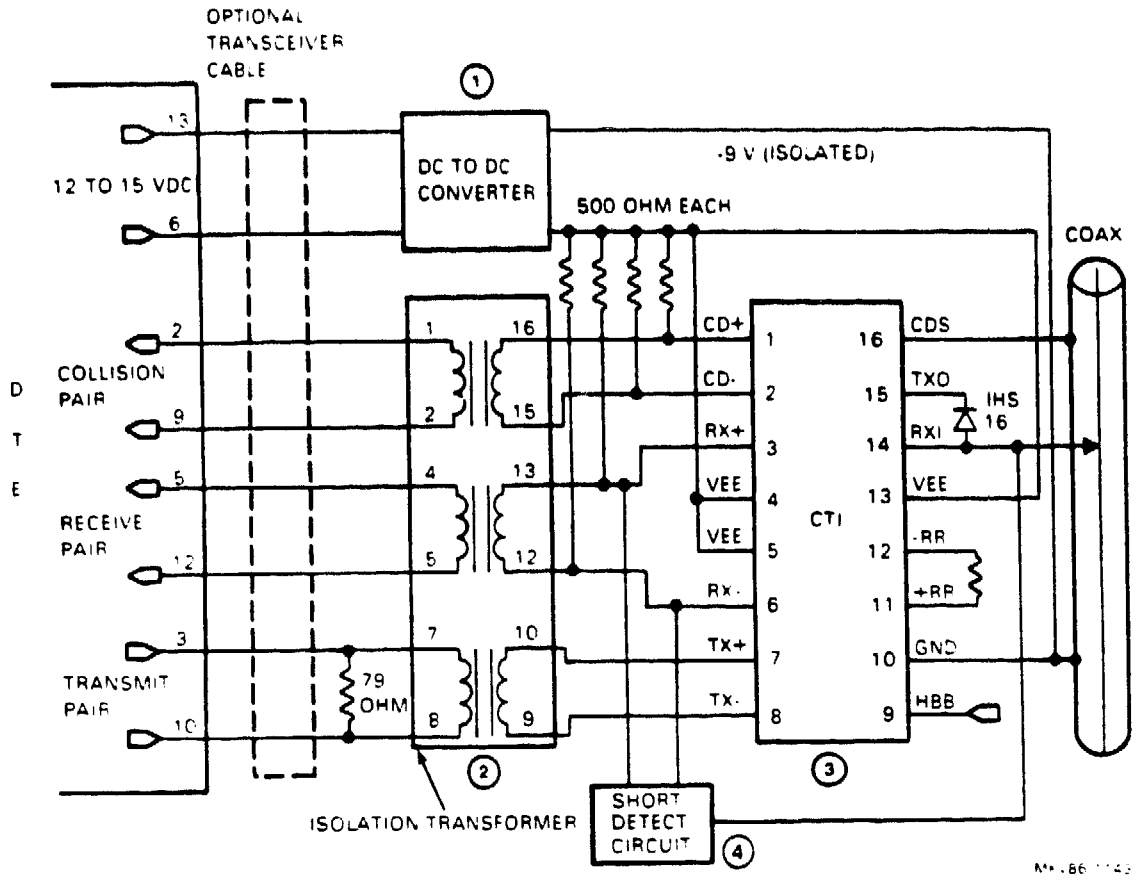


Figure 2-1 H4005 Block Diagram

2.2 CTI CHIP

The CTI chip is the heart of the H4005 transceiver. Figure 2–2 is a block diagram of the CTI chip. Functions of the blocks are as follows:

1. Receiver—Receives data from the Ethernet coaxial cable and passes it to the Ethernet device.
2. Transmitter—Accepts data from the Ethernet device and passes it to the Ethernet coaxial cable.
3. Collision Detect—Indicates to the Ethernet device any collision conditions on the Ethernet coaxial cable.
4. Jabber Timer—Disables the transmitter in the event of illegal packets.

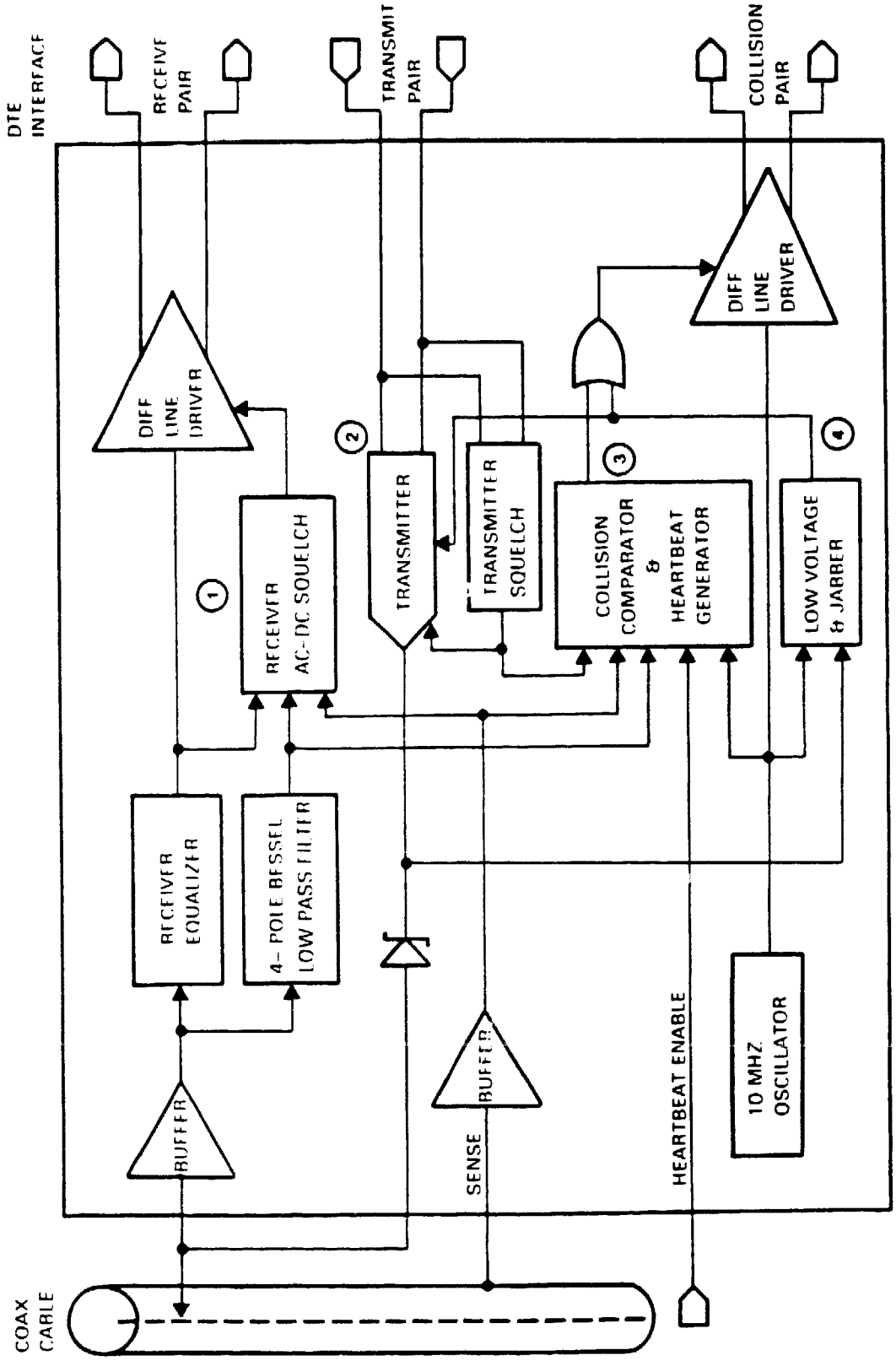


Figure 2–2 CTI Block Diagram

2.2.1 Receiver Functions

The receiver buffer provides high-input impedance and low-input capacitance, which helps to minimize reflections on the Ethernet coaxial cable. High input-impedance provides for low-input current.

The receiver equalizer is a high-pass filter that compensates for the low-pass effect of the Ethernet cable.

A 4-pole low-pass Bessel filter extracts the dc level from the Ethernet signal. The dc level is used by both the receiver squelch and the collision detection circuits.

The receiver squelch circuit gates the receiver's differential line driver ON and OFF. It uses both the dc level and the ac component of the Ethernet signal. Noise and dribble bits are rejected.

The differential line driver provides Emitter Coupler Logic (ECL) signals to the serial chip in the Ethernet device. Signals from the differential line driver have 5 ns or less rise and fall times. In the idle state, the outputs of the differential line driver are driven to the differential zero level to prevent dc standing current in the isolation transformer.

2.2.2 Transmitter Functions

The transmitter has a differential input and an open collector output current driver. The driver controls rise and fall times (5 ns - 25 ns) to minimize higher harmonic components. The rise and fall times are matched to within 1 ns to minimize the impact of signal jitter. The driver also has an internal isolation diode to minimize capacitive loading on the Ethernet coaxial cable when the H4005 is in the idle state.

The transmitter squelch circuit rejects signals with pulse widths less than 10 ns (negative), greater than 150 ns (positive), or levels less than -175 mV.

2.2.3 Collision Functions

The collision comparator monitors the dc level from the Bessel filter. When the level is more negative than the collision threshold, the collision output is enabled. At the end of EVERY transmission, the heartbeat generator, if enabled, creates a pseudo collision for a short time to ensure that the collision circuitry is functioning properly.

The 10 MHz oscillator generates timing signals for the collision and heartbeat functions.

2.2.4 Jabber Functions

The jabber timer monitors the transmitter and inhibits transmission if the transmitter is active longer than 26 ms (a fault condition). It also enables the collision output for the fault duration. After the fault is removed, the timer counts the unjab time for a period of 500 ms before enabling the transmitter.

2.3 SHORT DETECT CIRCUIT FUNCTIONAL DESCRIPTION

The Short Detect circuit bypasses the squelch circuitry on the CTI transceiver chip. The squelch function performs differently than that of the CTI chip. The CTI chip squelch activates on ac line activity and some dc level sensing. The Short Detect circuit, however, is based solely on the average dc component of the transmission medium. The squelch also activates and deactivates much faster than the CTI chip to allow the paralleling of the two functions.

Figure 2–3 shows a block diagram of the Short Detect circuit. At the beginning of each coaxial transmission, the coaxial driver drives the center conductor negative. By filtering the coaxial signal, an average dc voltage value can be obtained. If the average dc voltage exceeds outputs (570 mv - 100 mv), unlock the receive pair leads of the transceiver so that receive data can be passed to the host Ethernet device. The circuit outputs are wire ORd with the receive output pair of the transceiver chip. The receive pair is locked by clamping it near ground and unlocked by holding it negative.

2.3.1 Coaxial Interface Technical Description

The Short Detect circuit interfaces to the transmission medium through the input pin 14 (RXI). This coaxial interface extracts the average dc coaxial voltage value for the level comparator. This is accomplished via a filter (following an input buffer isolation stage) to prevent interaction between the coaxial channel and the filter.

A resistor connects the RXI input to the transmission medium. This resistor increases the Mean Time Network Failure (MTNF) of the H4005 product. The MTNF isolates the H4005 short detect failure from the rest of the network.

2.3.2 Reference Generator Functional Description

The Reference Generator creates a fixed negative voltage threshold used by the comparator. It is important that the reference generator be independent of the supply tolerance and ripple, impulse noise, and temperature variations.

The threshold levels are set by a set of resistors. The value of the resistance creates the threshold levels used internally.

2.3.3 Receive Pair Interface Functional Description

RX+ and RX- are open emitter outputs that are wire ORd to the transceiver pair chip. Their function is to unlock the receive pair when the coaxial dc level is more negative than the threshold level; otherwise, the receive pair must be held at 0 to -1.2 volts.

In addition, hysterisis of the Short Detect circuit is used to prevent noise from affecting the transition of RX+ and RX- from the locked to unlocked regions and vice versa.

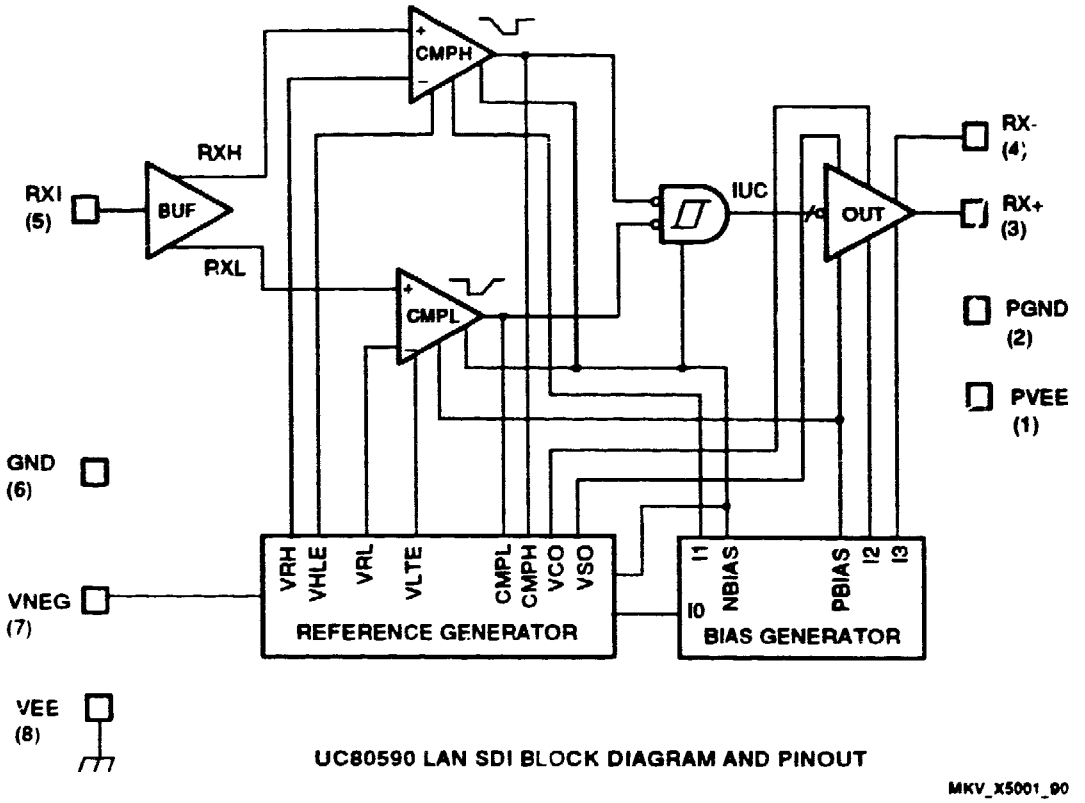
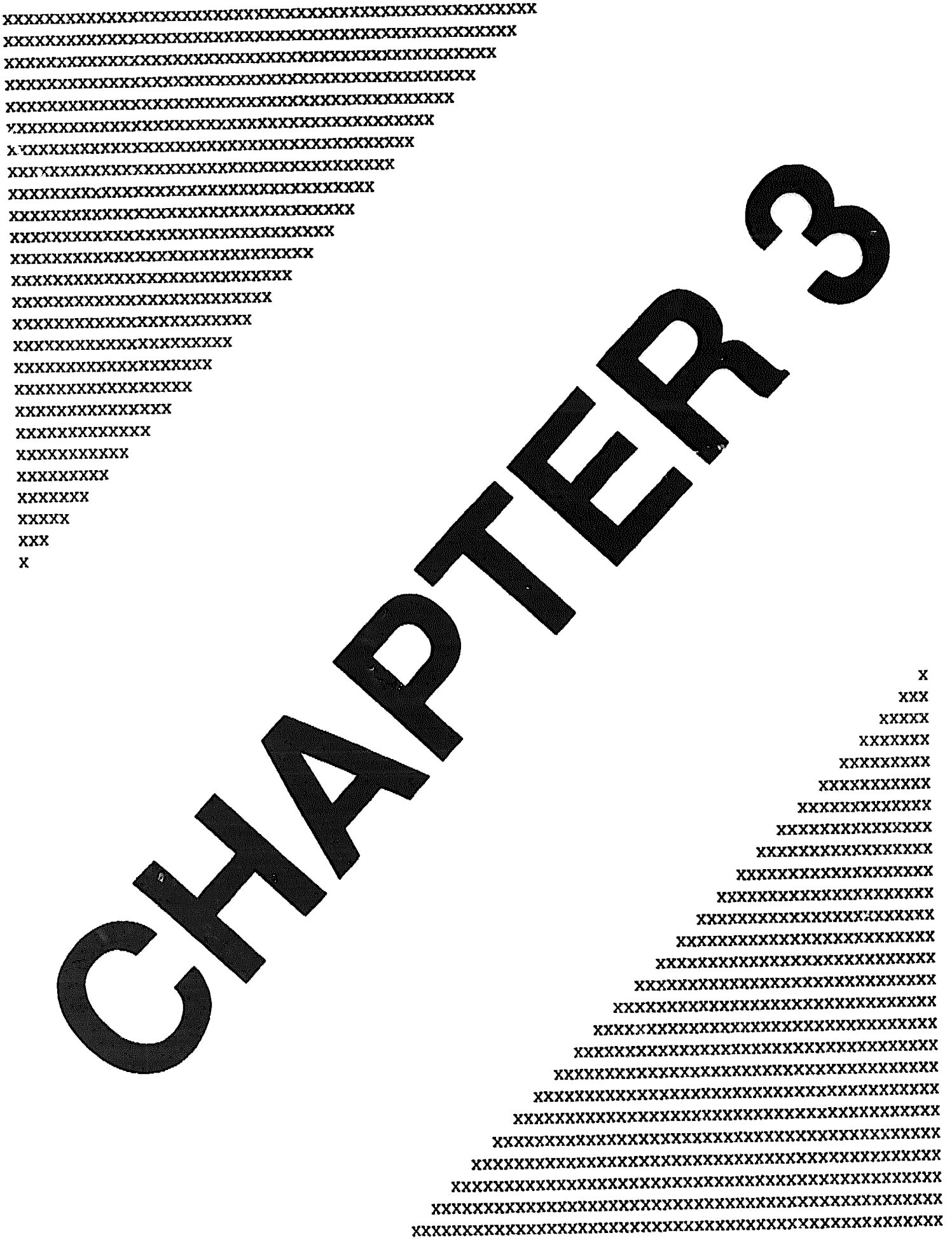


Figure 2–3 Short Detect Circuit


CHAPTER 3

3
INSTALLATION

3.1 H4005 INSTALLATION

This chapter provides H4005 installation guidelines. An *H4005 DIGITAL Ethernet Transceiver with Removable Tap Assembly Installation Card* is shipped with each unit.

CAUTION

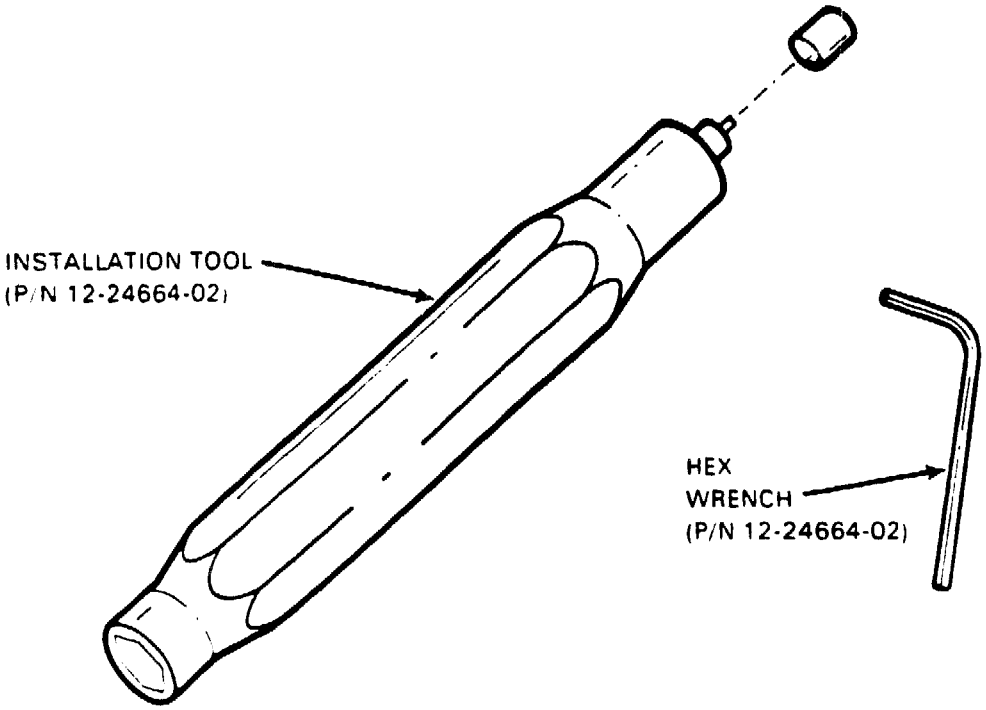
Not for installation in air ducts or plenums. For installation in other environmental air handling spaces, use only with UL classified cable as to fire and smoke characteristics in accordance with Section 725-2(B) of the National Electrical Code.

3.2 INSTALLATION GUIDELINES

This section illustrates H4005 installation procedures.

IMPORTANT

- **May require installation by Qualified Service Personnel.**
- **Not to be used in environmental air ducts or plenums.**
- **Input voltage must be within a range of 11.28 to 15.75 Vdc.**
- **Voltage source is current limited to a maximum of 2 A.**
- **To be used with UL Classified Ethernet cables or IEEE 802.3 local area networks.**



NOTE
TAP INSTALLATION TOOLS ARE NOT INCLUDED (TYPICALLY GOOD FOR 10-15 INSTALLATIONS)

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Figure 3–1 Tap Installation Tools

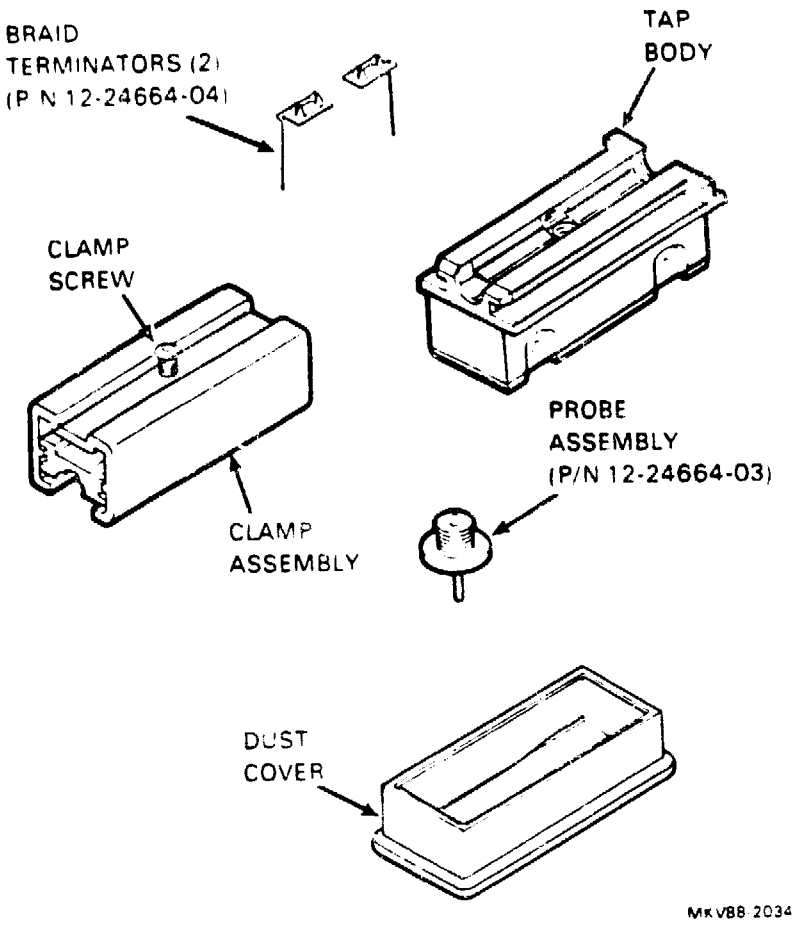


Figure 3–2 Tap Assembly

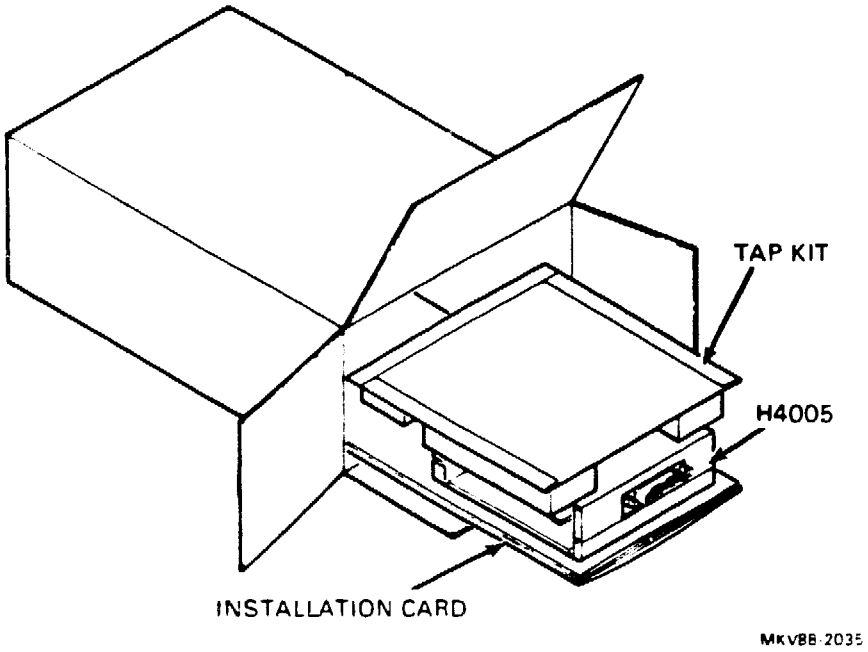
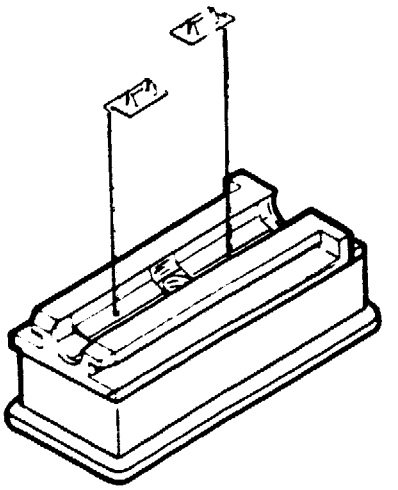


Figure 3–3 Unpacking the Transceiver



INSTALL BRAID TERMINATORS INTO TAP BODY

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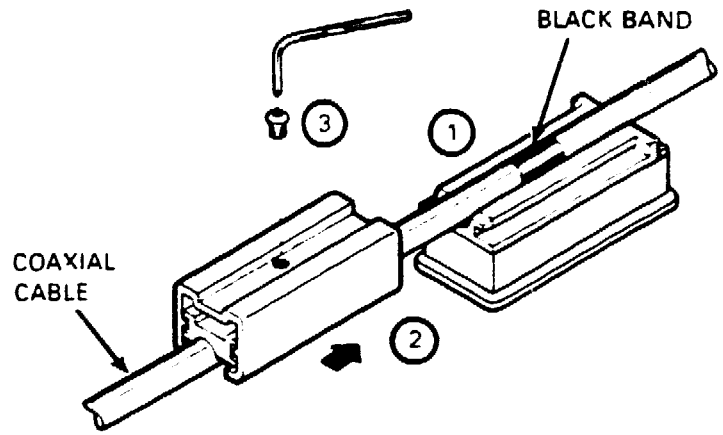
Figure 3–4 Preparing the Tap Body



1. POSITION TAP BODY ON BLACK BAND THAT IS ON COAXIAL CABLE
2. SLIDE CLAMP ASSEMBLY ONTO TAP BODY
3. INSTALL CLAMP SCREW AND TIGHTEN WITH HEX WRENCH

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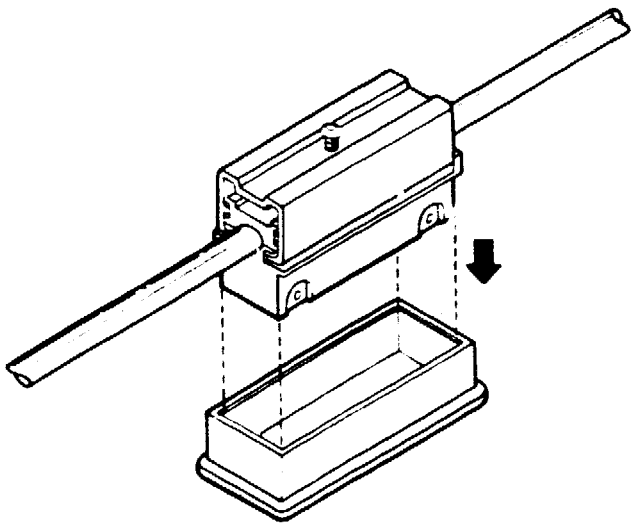
Figure 3–5 Positioning the Coaxial Cable and Assembling Tap



PULL DUST COVER OFF TAP ASSEMBLY

CAUTION
PINS INSIDE THE TAP BODY
ARE EASILY BENT.

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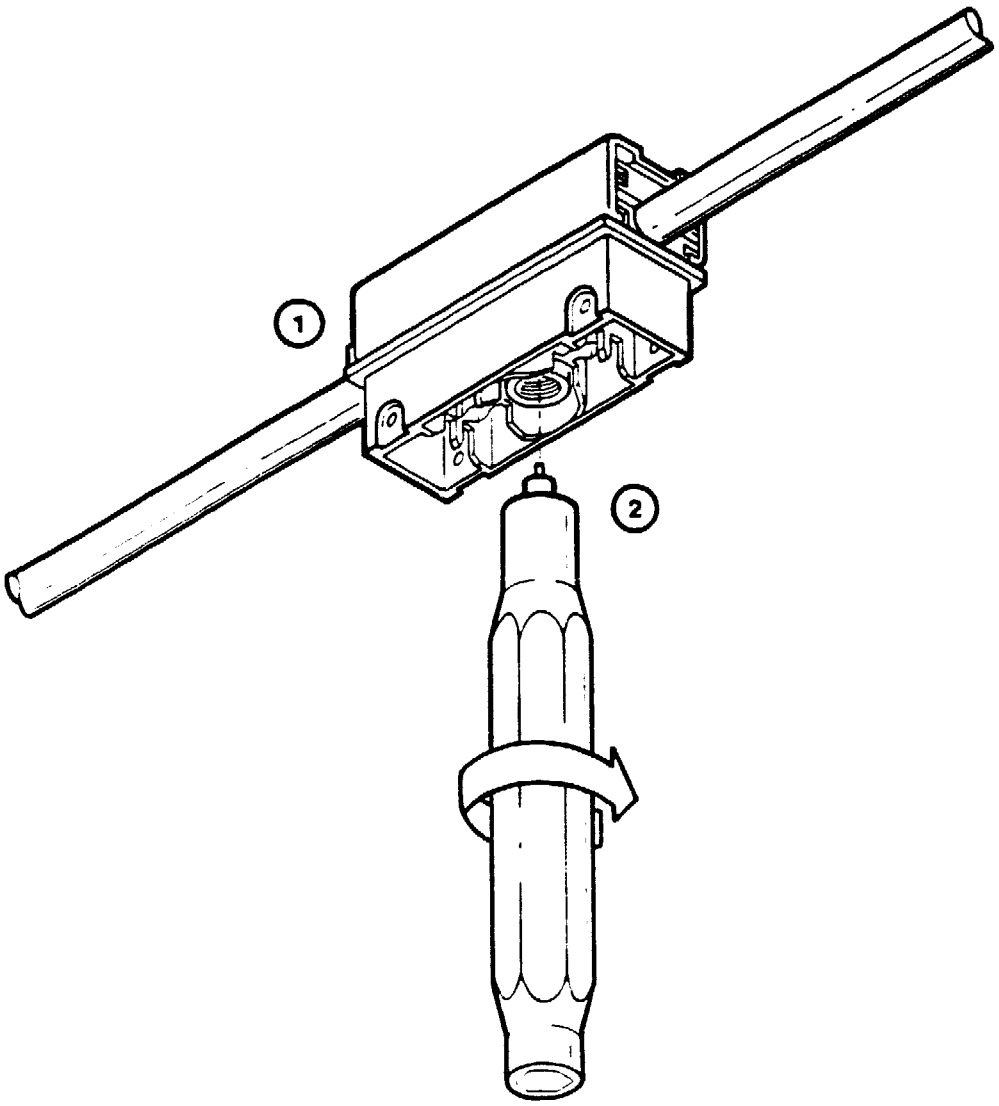
Figure 3–6 Removing the Tap Assembly Dust Cover



(1) POSITION TAP ASSEMBLY FOR DRILLING.

(2) USING DRILL END OF INSTALLATION TOOL, INSERT TOOL INTO PROBE HOLE IN TAP ASSEMBLY AND ROTATE TOOL CLOCKWISE. DRILLING THROUGH CABLE S OUTER JACKET AND SHIELD. DRILLING SHOULD NOT EXPOSE CENTER CONDUCTOR

NOTE
THE DRILL MUST BOTTOM ON THE TAP BODY.

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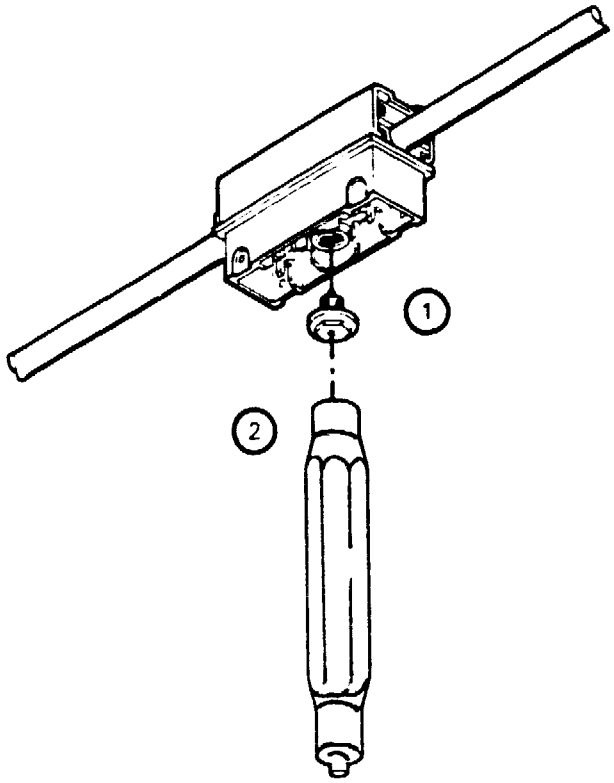
Figure 3–7 Drilling the Coaxial Cable



(1) REMOVE ANY SHIELD PARTICLES FROM HOLE IN CABLE.

(2) USING WRENCH END OF INSTALLATION TOOL, THREAD PROBE ASSEMBLY INTO TAP ASSEMBLY UNTIL PROBE ASSEMBLY BOTTOMS.

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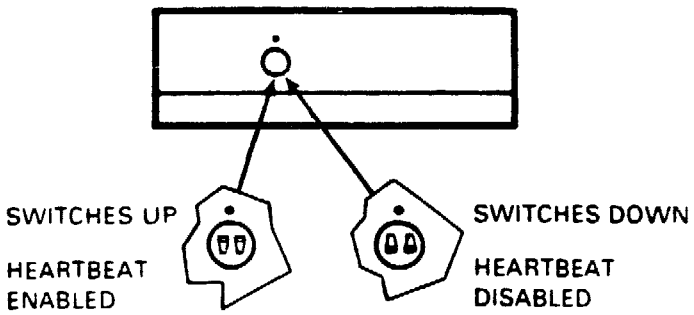
Figure 3–8 Inserting Probe Assembly into Tap/Cable Assembly

THE H4005 IS NORMALLY SHIPPED IN HEARTBEAT ENABLED CONFIGURATION.



NOTES

1. SWITCHES TOWARD DIMPLE ENABLE HEARTBEAT.
2. SWITCHES AWAY FROM DIMPLE DISABLE HEARTBEAT.
3. CONSULT ETHERNET INSTALLATION GUIDE FOR HEARTBEAT SELECTION.

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Figure 3–9 Heartbeat Selection

H4005 CANNOT BE USED WITH DEREP.

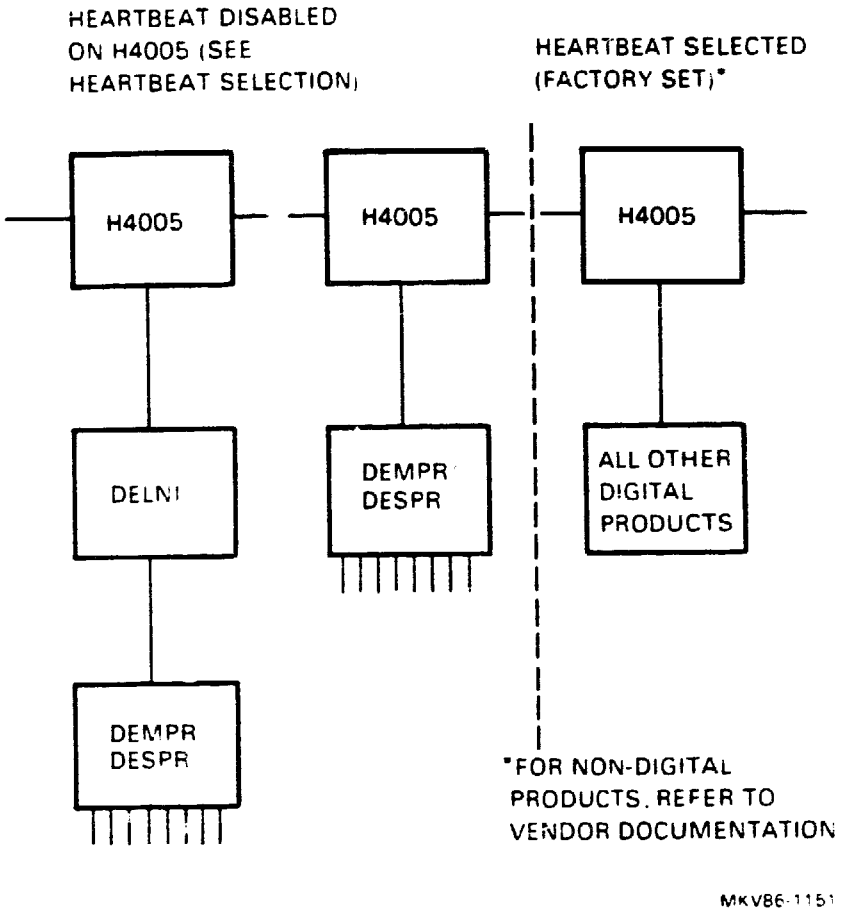
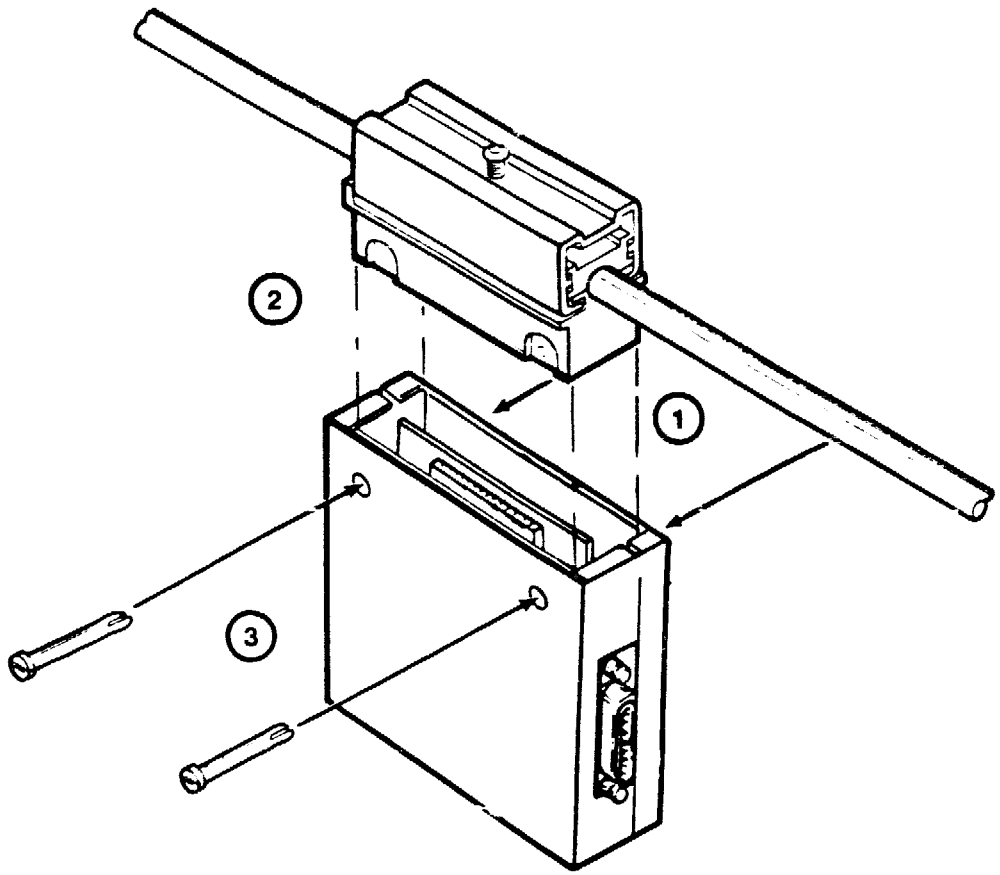


Figure 3–10 H4005 Network Configuration



(1) REMOVE PUSH-PINS FROM CASE

(2) ALIGN TAP BRAID AND PROBE POSTS WITH THE CONTACTS ON THE TRANSCEIVER AND INSERT TAP/CABLE ASSEMBLY INTO THE TRANSCEIVER

(3) INSTALL TWO PUSH-PINS (P/N 74-32789-01) INTO CASE AND THROUGH TAP UNTIL FULLY INSERTED

NOTE
THE TRANSCEIVER MAY BE ROTATED 180 DEGREES SO THAT THE TRANSCEIVER CABLE CAN BE CONNECTED AT THE OPPOSITE END

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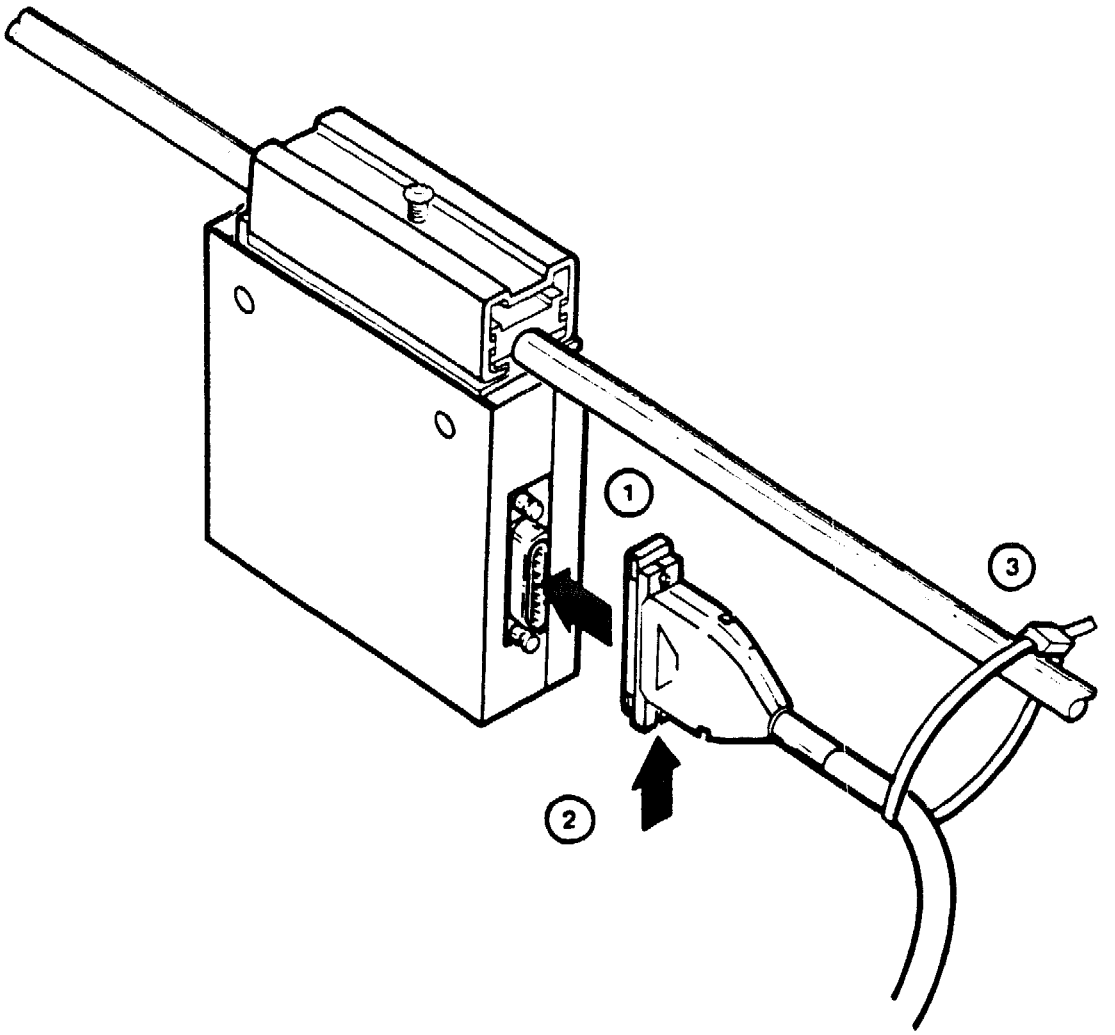
Figure 3–11 Connecting Tap/Cable Assembly to Transceiver



(1) ATTACH TRANSCEIVER CABLE TO TRANSCEIVER CABLE CONNECTOR

(2) SLIDE CABLE CONNECTOR LATCH TO CLOSE POSITION AND CHECK THAT CONNECTOR IS SECURE

(3) TIE WRAP TRANSCEIVER CABLE TO COAXIAL CABLE

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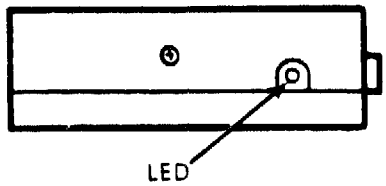
Figure 3–12 Attaching the Transceiver Cable



WHEN FULLY INSTALLED AND OPERATIONAL, POWER LED (GREEN) SHOULD BE ON

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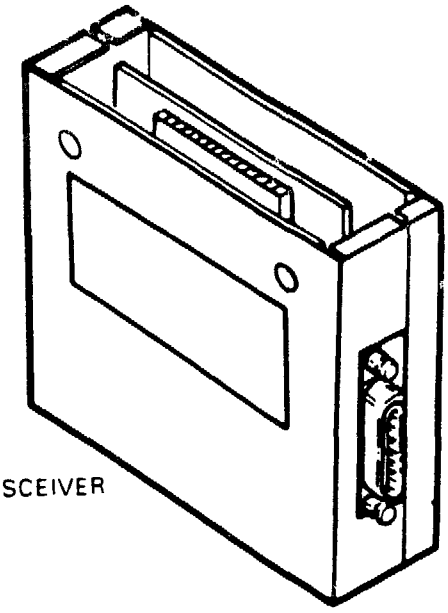
Figure 3–13 Power LED



USE BLANK LABEL TO INDICATE ADDITIONAL INFORMATION ABOUT TRANSCEIVER. CUSTOMER MAY ADD INFORMATION IN THE SPACE PROVIDED

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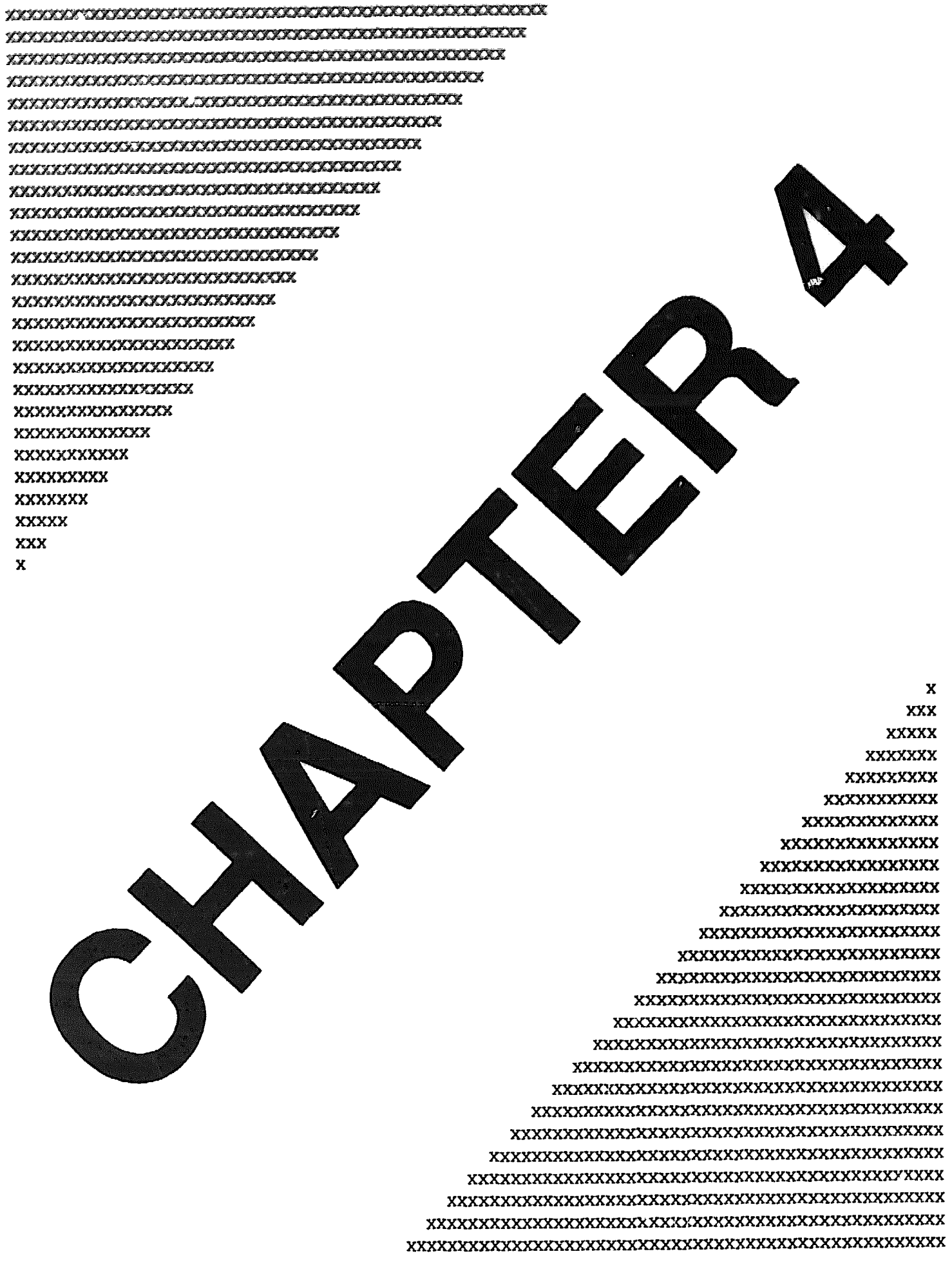
Figure 3–14 Labeling Transceiver Information


CHAPTER 4

4
FAULT ISOLATION PROCEDURES

4.1 REPLACEMENT STRATEGY

The H4005 Ethernet transceiver is a field replaceable unit (FRU). It is not repairable in the field. Replace the H4005 transceiver if it is deemed defective after testing. Discard the failed unit.

4.2 DIAGNOSTICS

There are no diagnostics designed specifically for the H4005 Ethernet transceiver. The following diagnostics may be helpful for isolating faults to the transceiver.

- Functional diagnostics for the device connected to the transceiver. Refer to the specific device for applicable diagnostics.
- Network Interconnect Exerciser (NIE)
- Network Control Program (NCP)
- Any form of Network connectivity test (such as, SET HOST)

4.3 TROUBLESHOOTING FLOW DIAGRAM

Figure 4–1 illustrates the procedure for locating a defective H4005 Ethernet transceiver.

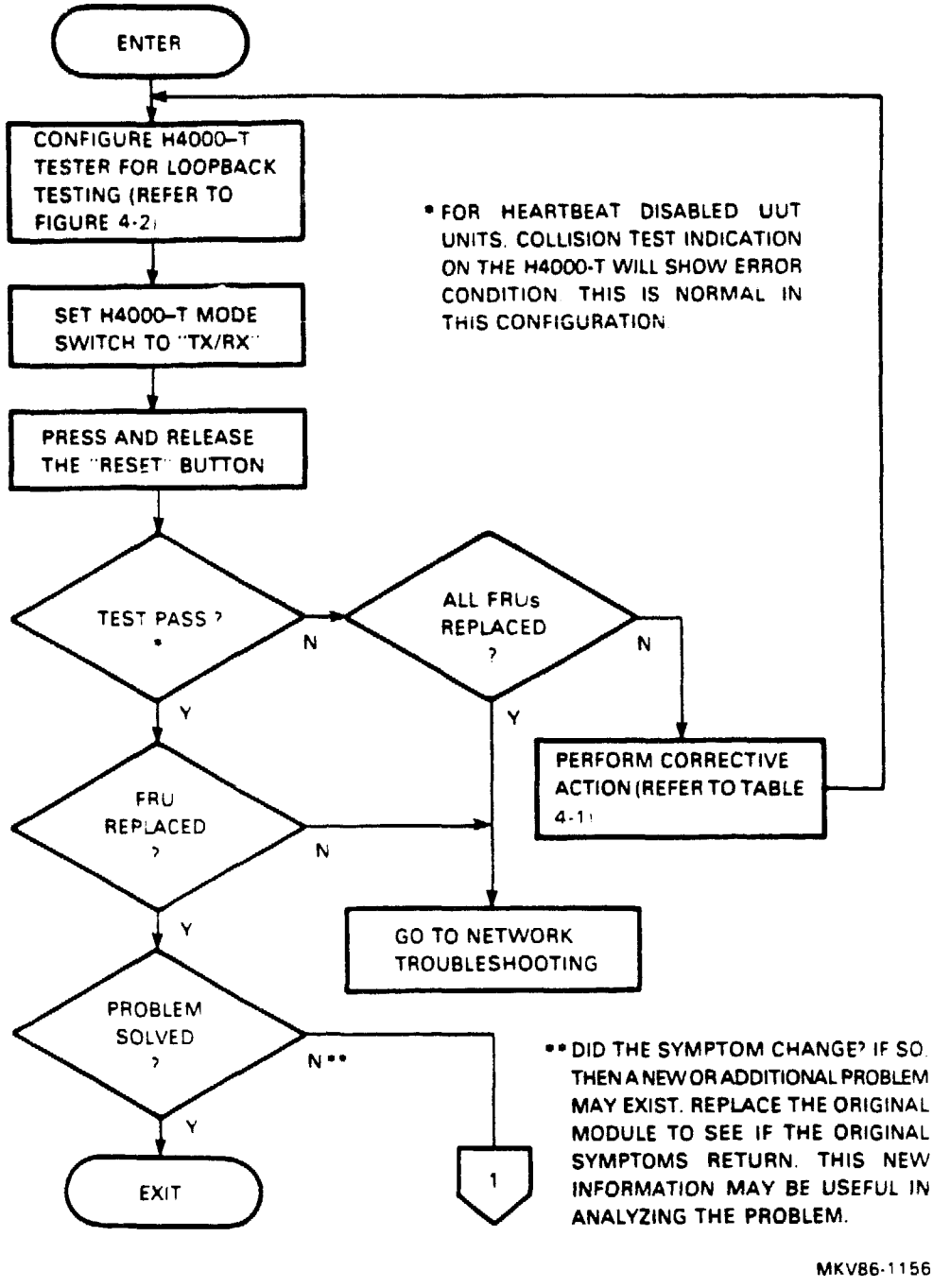


Figure 4–1 Troubleshooting Flow Diagram (Sheet 1 of 4)

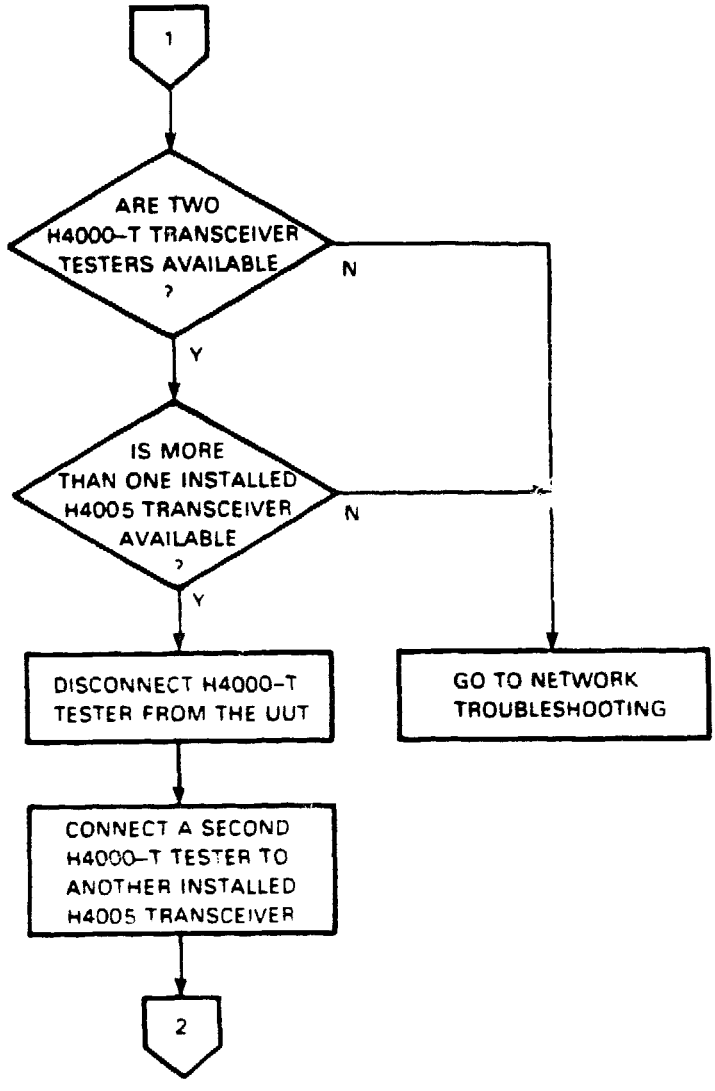
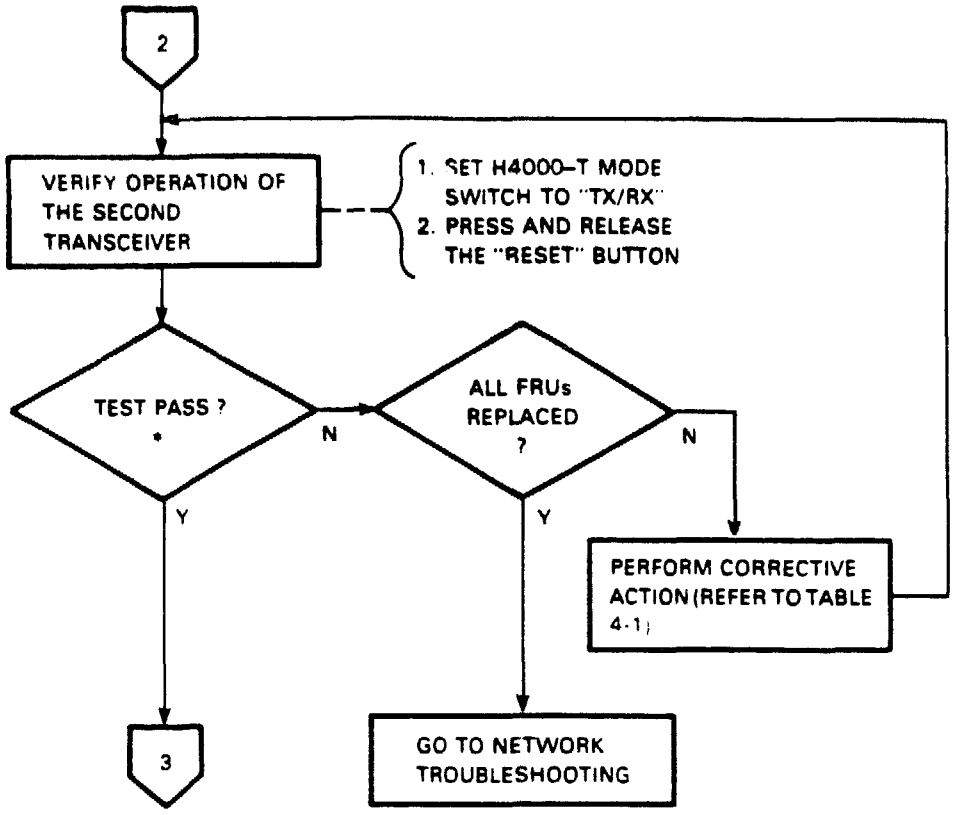


Figure 4–1 Troubleshooting Flow Diagram (Sheet 2 of 4)



* FOR HEARTBEAT DISABLED UUT UNITS COLLISION TEST INDICATION ON THE H4000-T WILL SHOW ERROR CONDITION THIS IS NORMAL IN THIS CONFIGURATION

MKV86-1157

Figure 4–1 Troubleshooting Flow Diagram (Sheet 3 of 4)

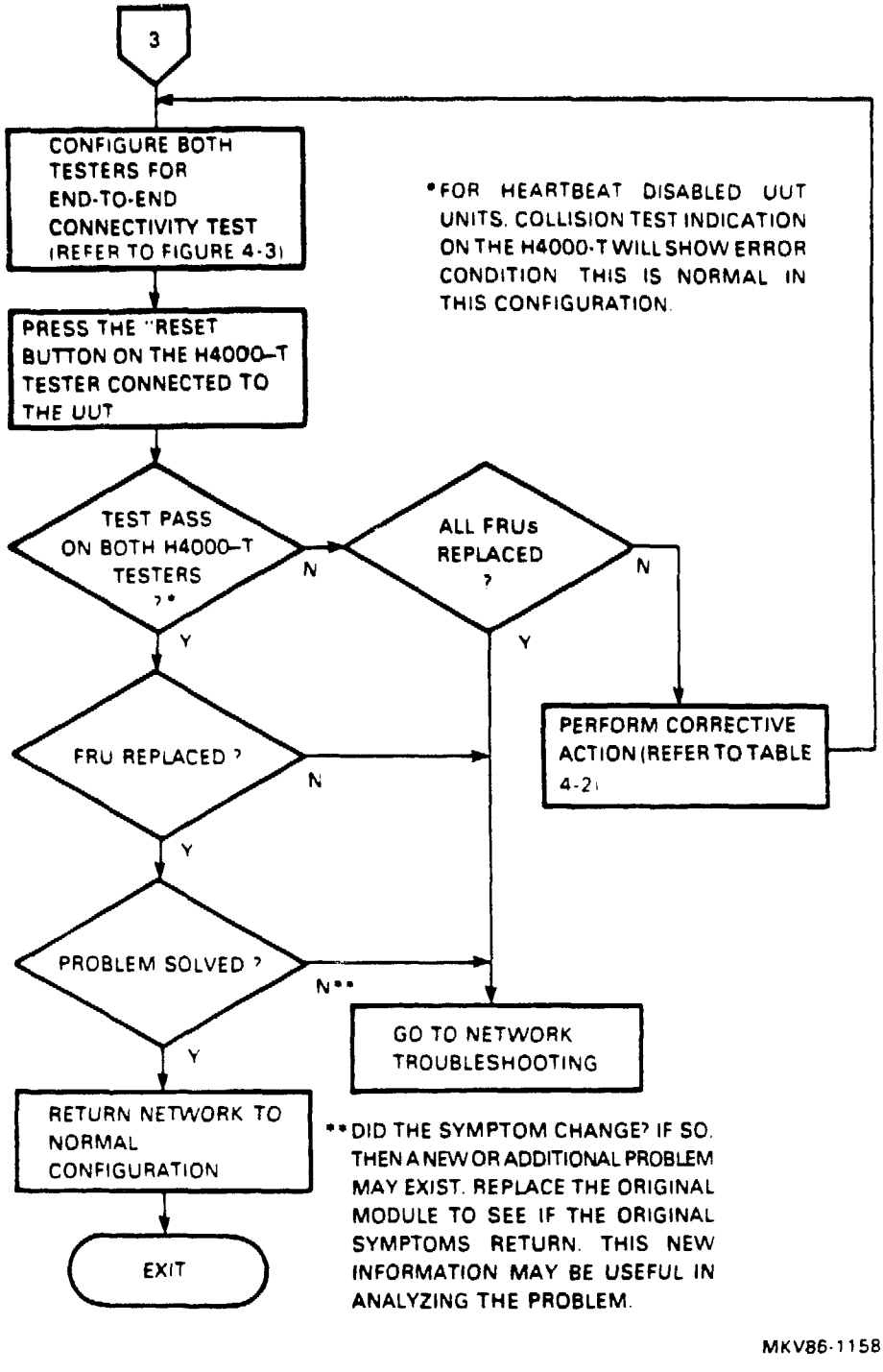


Figure 4–1 Troubleshooting Flow Diagram (Sheet 4 of 4)

4.4 TESTING CONFIGURATIONS

Figure 4–2 shows the configuration for a single H4000-T transceiver tester connected to an H4005 unit under test.

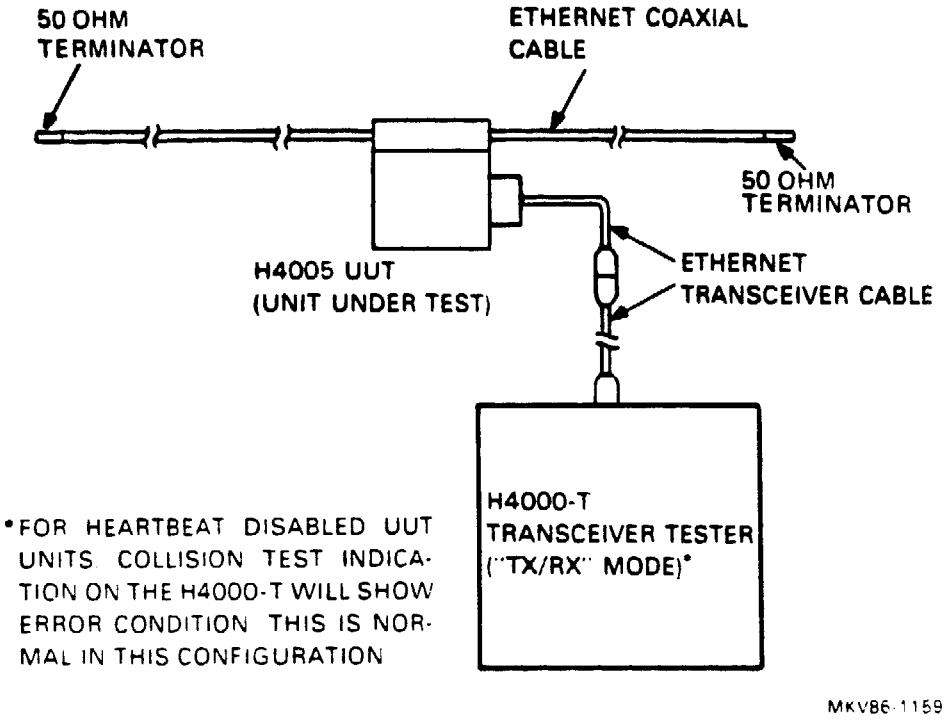
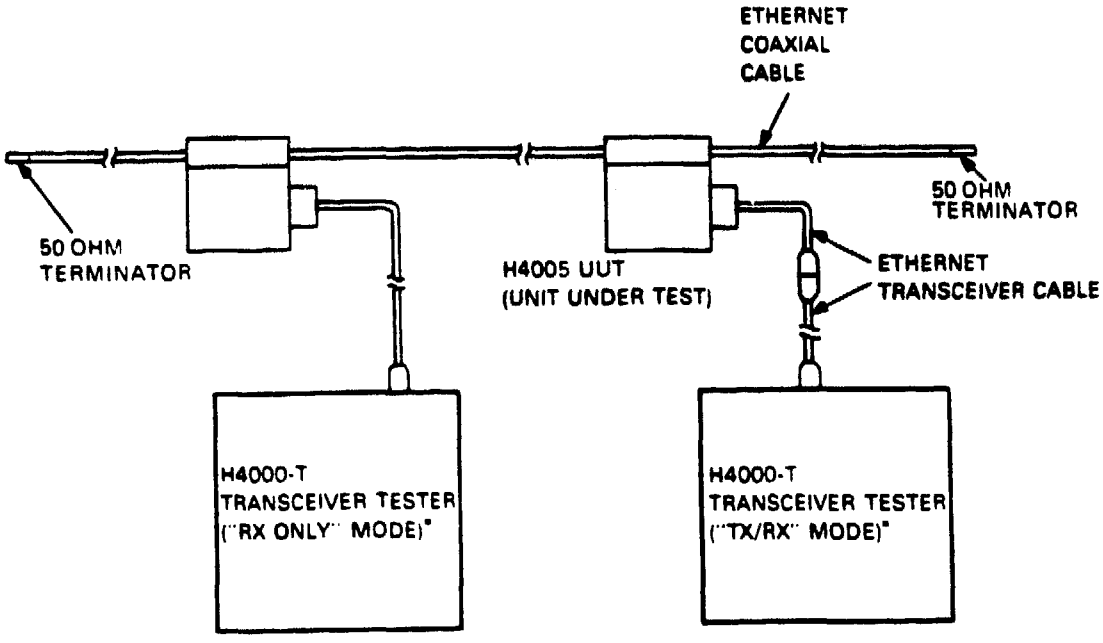


Figure 4–2 Typical H4000-T Configuration for Loopback Testing

Figure 4–3 shows a configuration for two H4000-T transceiver testers connected for end-to-end connectivity testing. One tester is set in TX/RX mode, the other tester is set in RX ONLY mode.



*FOR HEARTBEAT DISABLED UUT UNITS COLLISION TEST INDICATION ON THE H4000-T WILL SHOW ERROR CONDITION. THIS IS NORMAL IN THIS CONFIGURATION.

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Figure 4–3 Typical H4000-T Configuration for End-to-End Testing

Table 4–1 lists the lamps, indications, and corrective actions for an H4000-T testing in TX/RX mode.

Table 4–1 H4000-T Lamps and Corrective Actions (TX/RX Mode)

Lamp	Indication	Corrective Actions*
DATA PASS	Data packet transmitted and received correctly	None
DATA FAIL	Data packet not received correctly	Repair/replace: • Transceiver • Bent or broken contacts • Transceiver cable** • Connection (retap)
COLLISION TEST	Collision test signal not received after sending data packet	Repair/Replace: • Transceiver cable** • Transceiver
	If heartbeat is disabled, collision test failure is normal.	None
COLLISION	Intermittent light:	
	COLLISION ON and TIMEOUT ON	Check for shorted coax
	Steady light:	
	COLLISION ON and SELF-TEST flashing	Check for: • Missing terminators • Defective controller • Improperly configured network • Open cable

Table 4–1 (Cont.) H4000–T Lamps and Corrective Actions (TX/RX Mode)

Lamp	Indication	Corrective Actions*
TIMEOUT	Carrier signal not received within 19 microseconds	Repair/Replace:
		• Transceiver cable**
		• Transceiver
	TIMEOUT ON and COLLISION ON	Check for shorted coax
SELF TEST PASS	SELF–TEST flashing every 3–4 seconds	None

* When several FRUs are listed, begin by replacing the first of the listed items before trying the others.

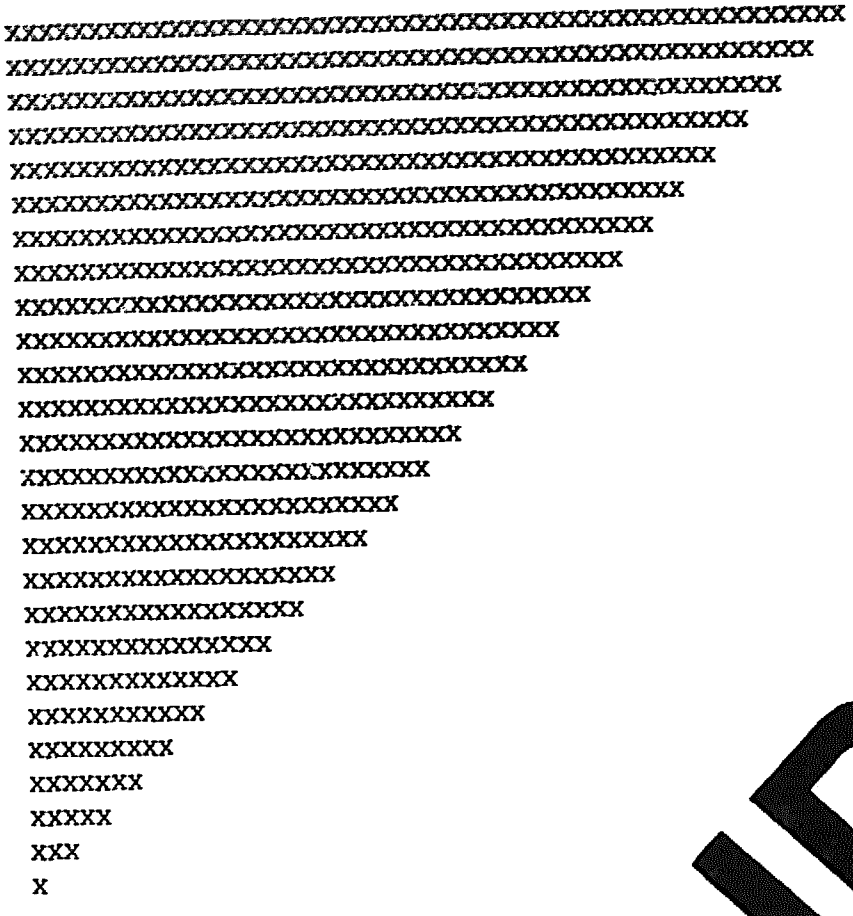
**Ensure that the transceiver cable is properly assembled and is an 802.3 Ethernet transceiver cable.

Table 4–2 lists the lamps, indications, and corrective actions for an H4000-T testing in RX ONLY mode.

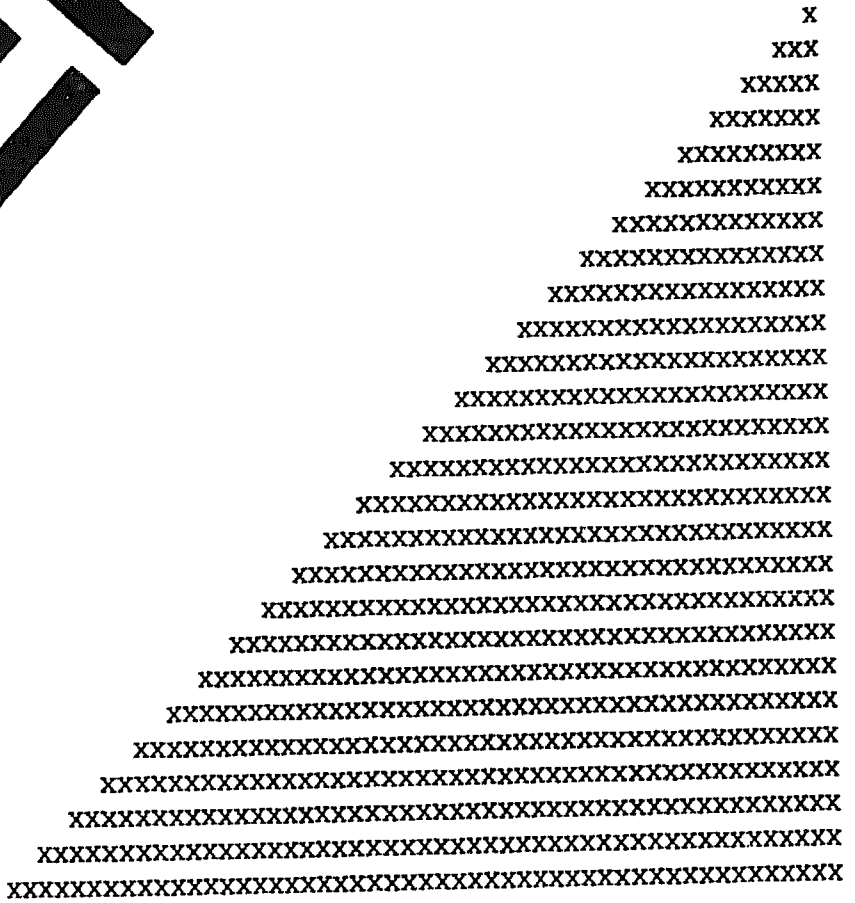
Table 4–2 H4000-T Lamps and Corrective Actions (RX ONLY Mode)

Lamp	Indication	Corrective Actions*
DATA PASS	Data packet received correctly	None
DATA FAIL	Data packet not received correctly (DATA PASS lamp lit on TX/RX tester)	Perform the following: • Replace transceiver • Check tap (ohm out) • Troubleshoot cable plant
COLLISION TEST	Not used	
COLLISION	Steady light: If COLLISION lamp is also lit on TX/RX tester	Check for: • Missing terminators • Defective controller • Improperly configured network
TIMEOUT	Not used	
SELF TEST PASS	Steady ON indicates the signal self-test was successful	None

* When several FRUs are listed, begin by replacing the first of the listed items before trying the others.



APPENDIX A



A
H4005 TIMING DIAGRAMS

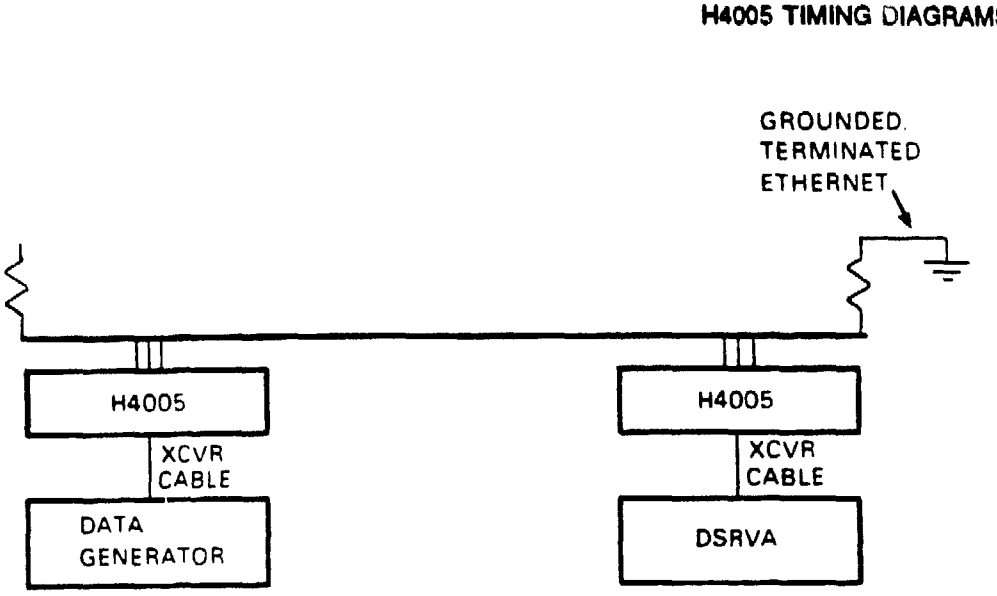
This appendix provides timing diagrams of all the H4005 connector signals. Table A–1 is a cross-reference that lists the signal and its associated figure number. All signals involving collisions were generated by biasing the coaxial cable to -1.4 V as shown in Figure A–1. Timing references are made to the Beginning of Packet (BOP), Middle of Packet (MOP) and End of Packet (EOP).

Table A–1 H4005 Timing Diagram Cross-Reference

SIGNAL	Part of Signal	SITUATION	Figure #
RCV±	BOP, MOP	Normal RCV	A-2
RCV±	BOP, MOP	RCV with COLLISION	A-2
RCV±	EOP	Normal RCV	A-3
RCV±	EOP	RCV with COLLISION	A-3
COAX	BOP	Normal RCV	A-4
COAX	BOP	XMIT with or without HEARTBEAT	A-4
COAX	MOP, EOP	Normal RCV	A-5
COAX	MOP, EOP	XMIT with or without HEARTBEAT	A-5
RCV±	BOP	XMIT with or without HEARTBEAT	A-6
RCV±	BOP	XMIT into OPEN (3 or 500 meters away)	A-6
RCV±	MOP, EOP	XMIT with or without HEARTBEAT	A-7
RCV±	MOP, EOP	XMIT into OPEN (3 or 500 meters away)	A-7
XMIT±	BOP	XMIT with or without HEARTBEAT	A-8
XMIT±	BOP	XMIT into OPEN or SHORT (3 meters away)	A-8
XMIT±	MOP	XMIT with or without HEARTBEAT	A-9
XMIT±	MOP	XMIT into OPEN or SHORT (3 meters away)	A-9
XMIT±	EOP	XMIT with or without HEARTBEAT	A-10
XMIT±	EOP	XMIT into OPEN or SHORT (3 meters away)	A-10
COLL±	EOP	XMIT with HEARTBEAT	A-11
COAX	BOP	XMIT into SHORT (3 meters away)	A-12
COAX	MOP, EOP	XMIT into SHORT (3 meters away)	A-13

Table A–1 (Cont.) H4005 Timing Diagram Cross-Reference

SIGNAL	Part of Signal	SITUATION	Figure #
COAX	BOP	XMIT into SHORT (500 meters away)	A-14
COAX	MOP	XMIT into SHORT (500 meters away)	A-15
COAX	LATE MOP	XMIT into SHORT (500 meters away)	A-16
COAX	EOP	XMIT into SHORT (500 meters away)	A-17
RCV±	All	XMIT into SHORT (500 meters away)	A-18
COAX	BOP	XMIT with COLLISION	A-19
COAX	MOP, EOP	XMIT with COLLISION	A-20
COAX	BOP	RCV with COLLISION	A-21
COAX	MOP, EOP	RCV with COLLISION	A-22
COLL±	All	RCV with COLLISION	A-23
COLL±	All	Normal RCV	A-24
XMIT±	All	Normal RCV	A-24
COLL±	All	XMIT without HEARTBEAT	A-24
COLL±	BOP, MOP	XMIT with HEARTBEAT	A-24
RCV±	All	XMIT into SHORT (3 meters away)	A-24
XMIT±	All	RCV with COLLISION	A-24
COAX	All	XMIT into OPEN (3 meters away). Signal amplitude is 0 V to -4 V instead of 0 V to -1.8 V	A-3 and A-4
COLL±	All	XMIT into OPEN (3 or 500 meters away). Signal is active continuously, not just at EOP	A-10
COLL±	All	XMIT into SHORT (3 or 500 meters away)	A-10
XMIT±	All	XMIT into OPEN or SHORT (500 meters away)	A-7 and A-8
COAX	All	XMIT into OPEN (500 meters away)	A-3 and A-4
RCV±	All	XMIT with COLLISION	A-5 and A-6
XMIT±	All	XMIT with COLLISION	A-7 and A-8
COLL±	All	XMIT with COLLISION	A10



NOTE
SIGNALS INVOLVING COLLISIONS WERE GENERATED BY BIASING THE COAX -1.4 V.

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Figure A–1 Biasing the Coaxial Cable

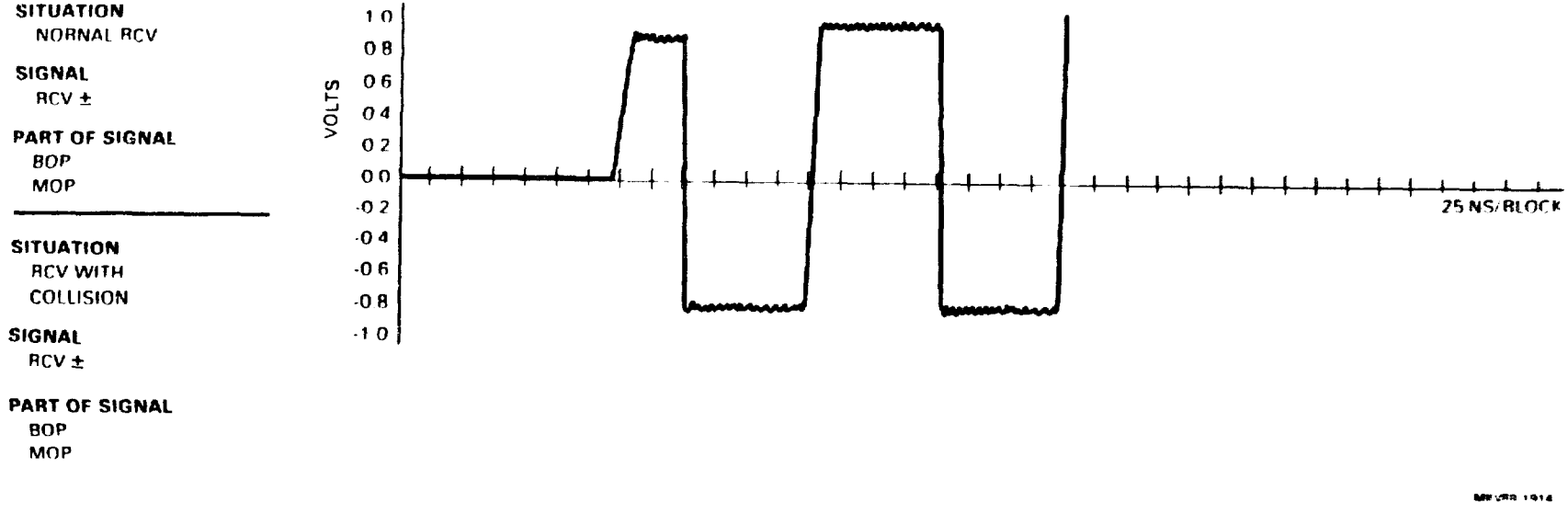

Figure A–2 RCV± BOP, MOP (Normal RCV and RCV With COLLISION)

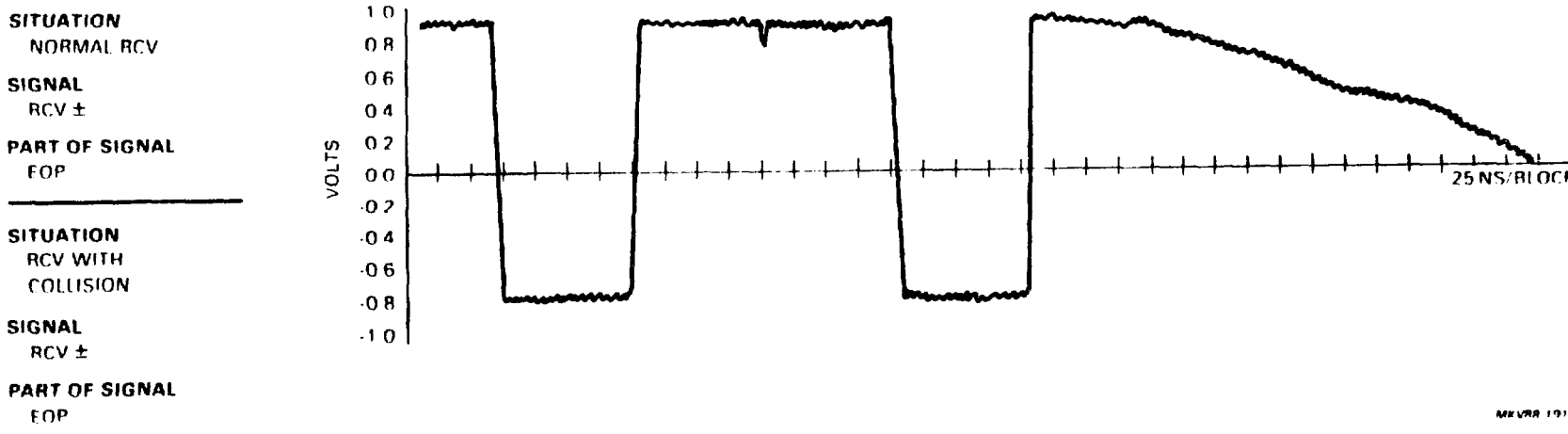

Figure A–3 RCV± EOP (Normal RCV and RCV With COLLISION)

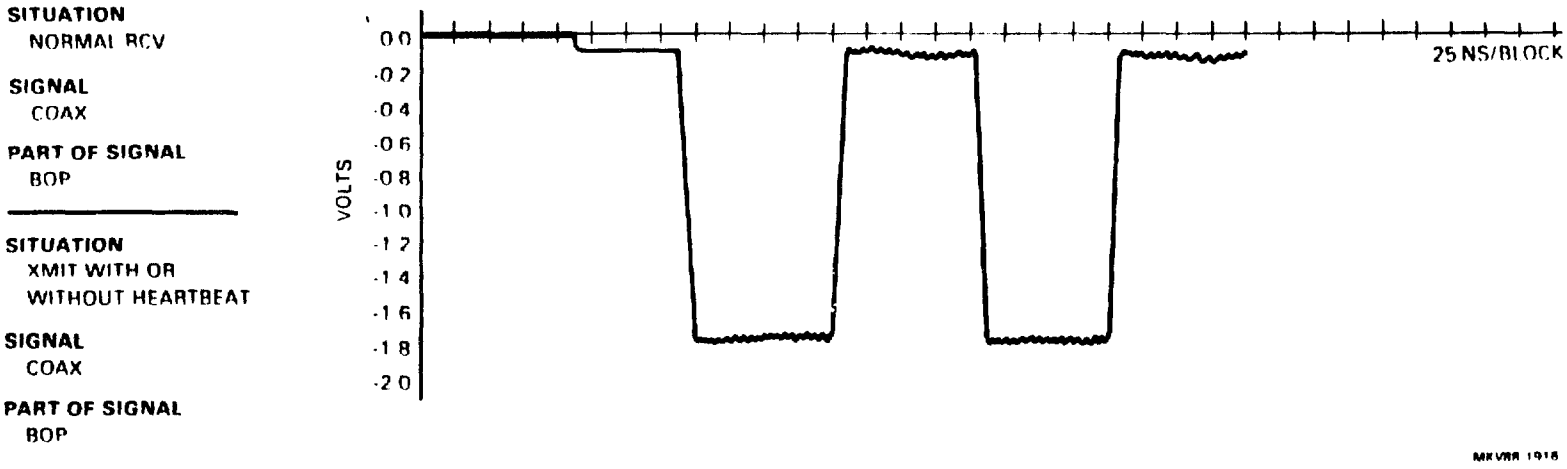

Figure A–4 COAX BOP (Normal RCV and XMIT With or Without HEARTBEAT)

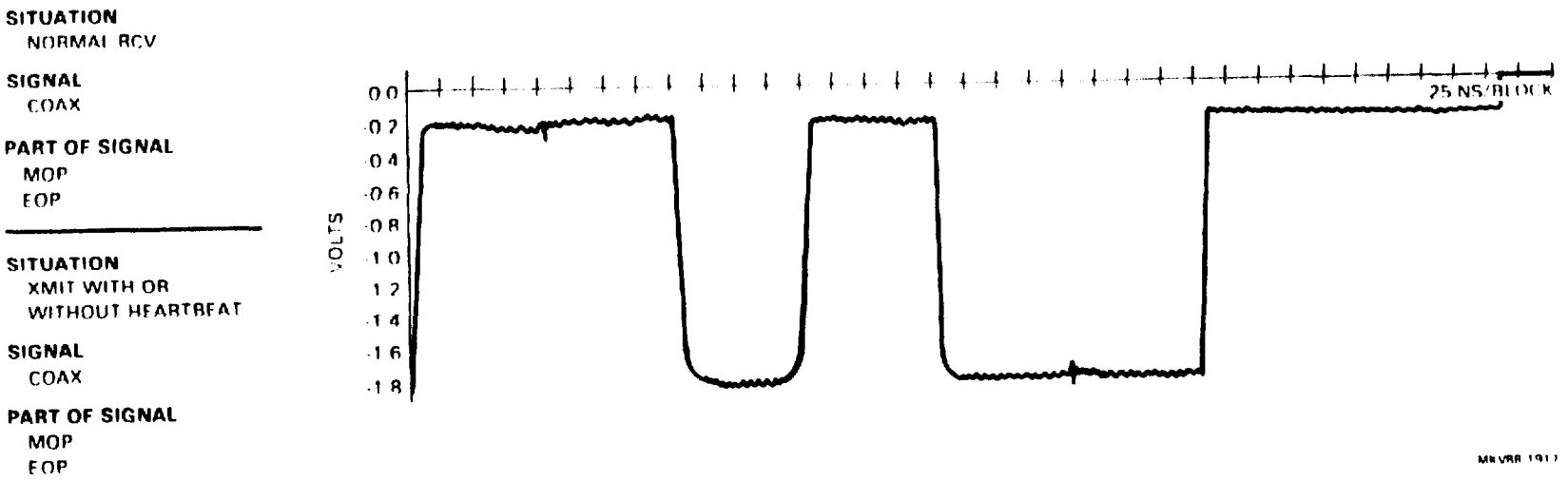

Figure A–5 COAX MOP, EOP (Normal RCV and XMIT With or Without HEARTBEAT)

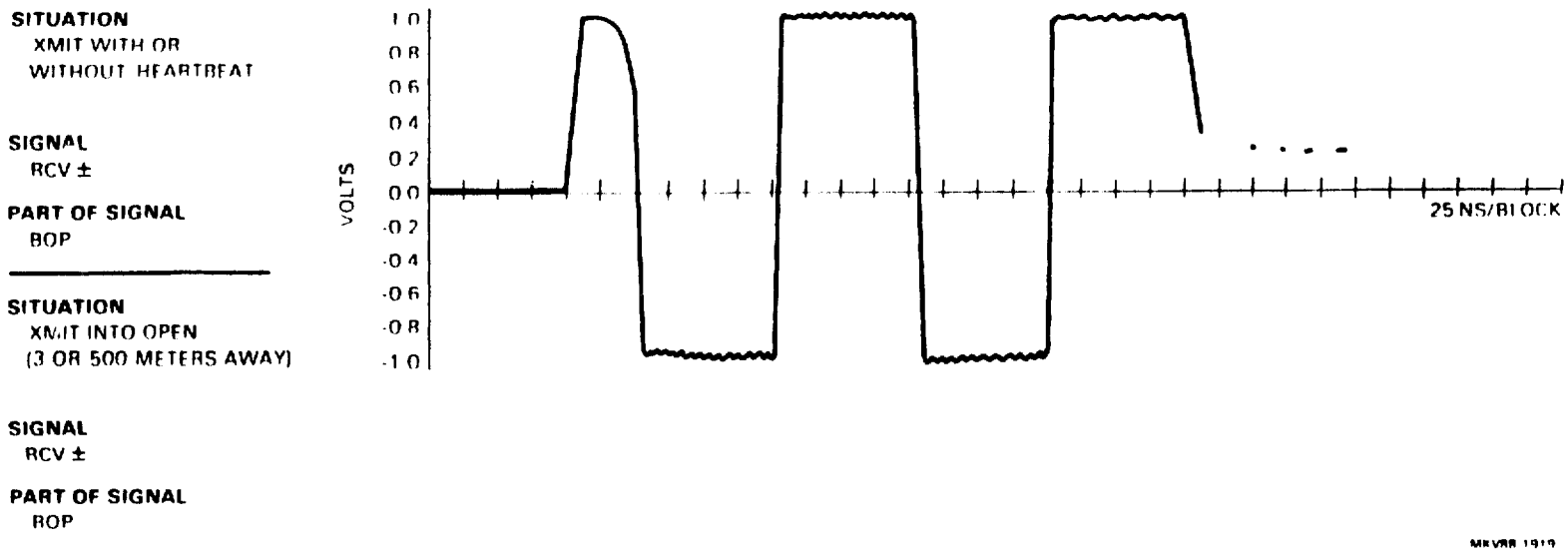

Figure A–6 RCV± BOP (XMIT With or Without HEARTBEAT and XMIT Into OPEN 3 or 500 Meters Away)

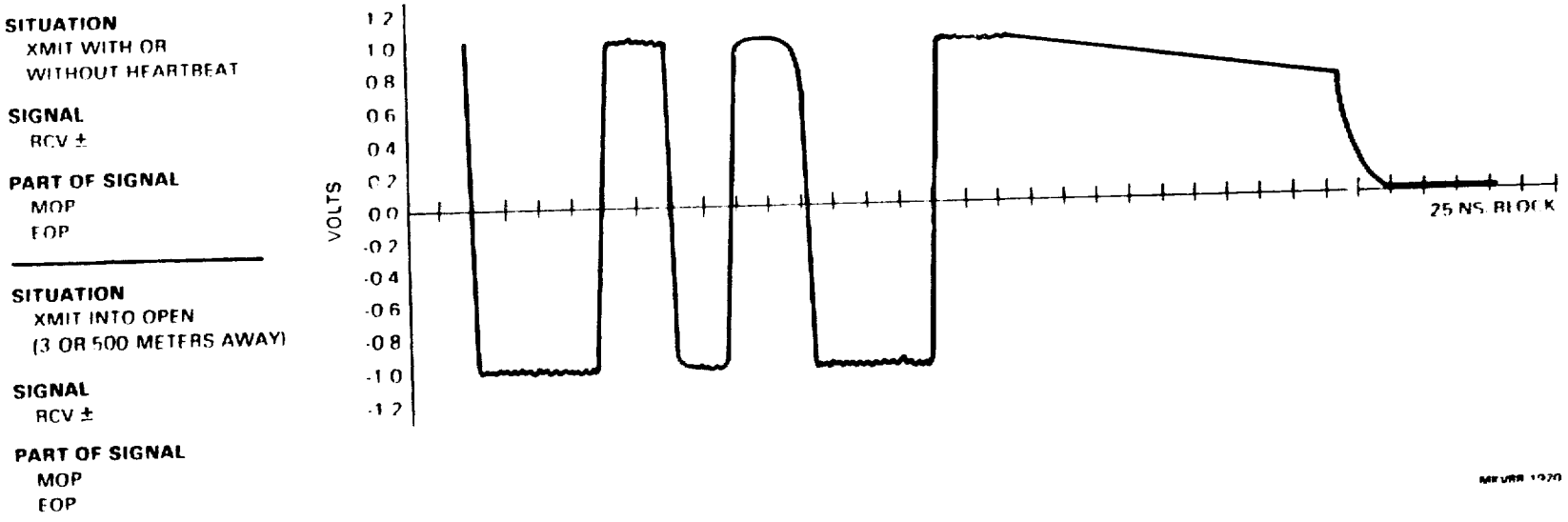

Figure A–7 RCV± MOP, EOP (XMIT With or Without HEARTBEAT and XMIT Into OPEN 3 or 500 Meters Away)

SITUATION
XMIT WITH OR
WITHOUT HEARTBEAT

SIGNAL
XMIT ±

PART OF SIGNAL
BOP

SITUATION
XMIT INTO OPEN OR
SHORT
(3 METERS AWAY)

SIGNAL
XMIT ±

PART OF SIGNAL
BOP

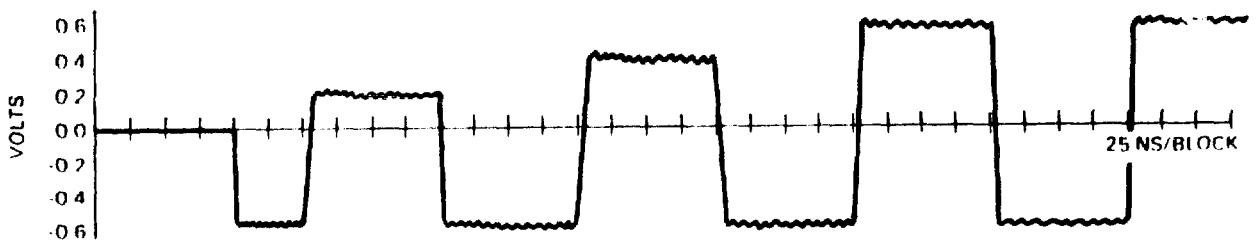

Figure A–8 XMIT± BOP (XMIT With or Without HEARTBEAT and XMIT Into OPEN or SHORT 3 Meters Away)

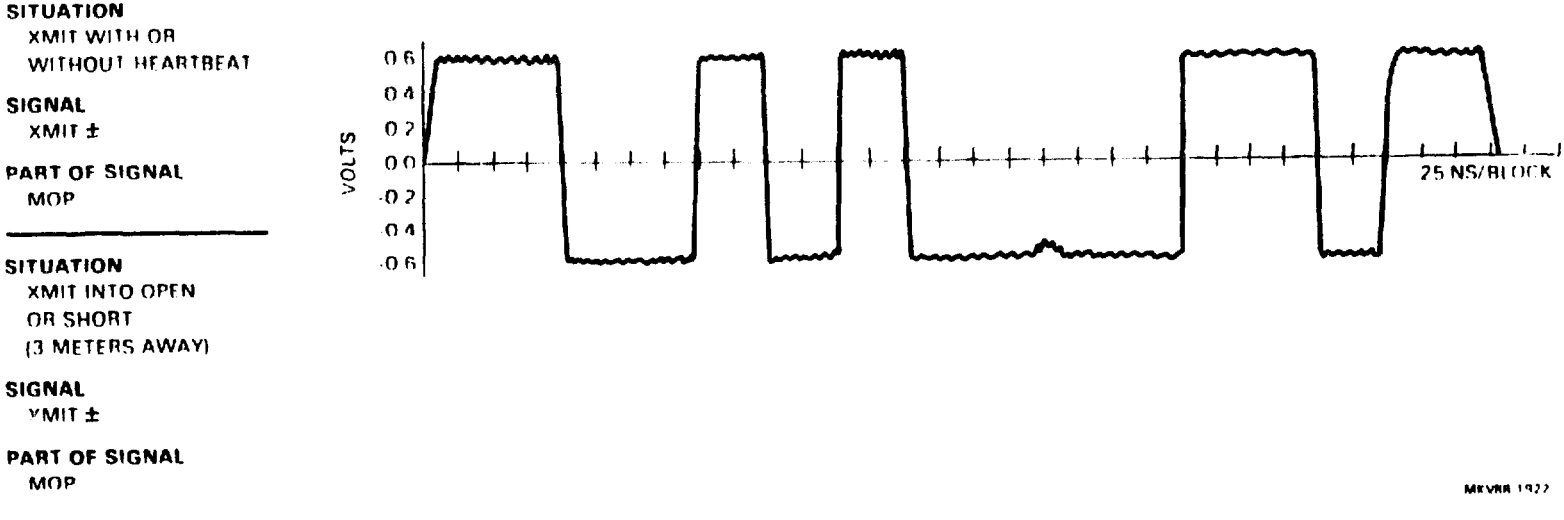

Figure A–9 XMIT± MOP (XMIT With or Without HEARTBEAT and XMIT Into OPEN or SHORT 3 Meters Away)

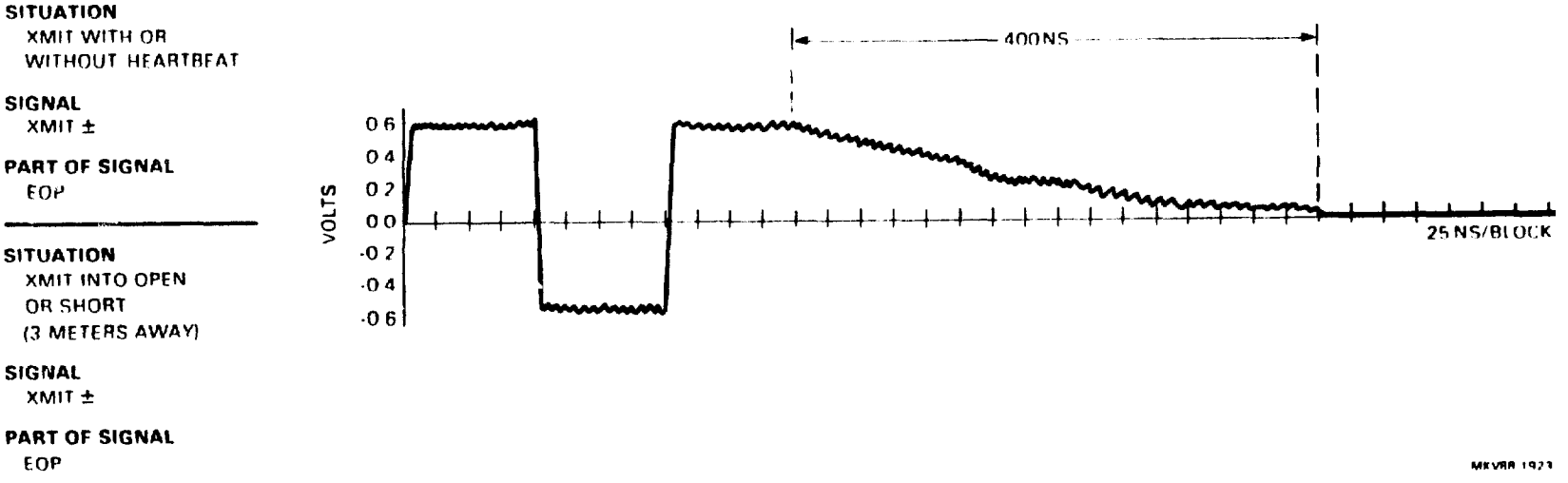

Figure A–10 XMIT± EOP (XMIT With or Without HEARTBEAT and XMIT Into OPEN or SHORT 3 Meters Away)

SITUATION
XMIT WITH HEARTBEAT

SIGNAL
COLL ±

PART OF SIGNAL
EOP

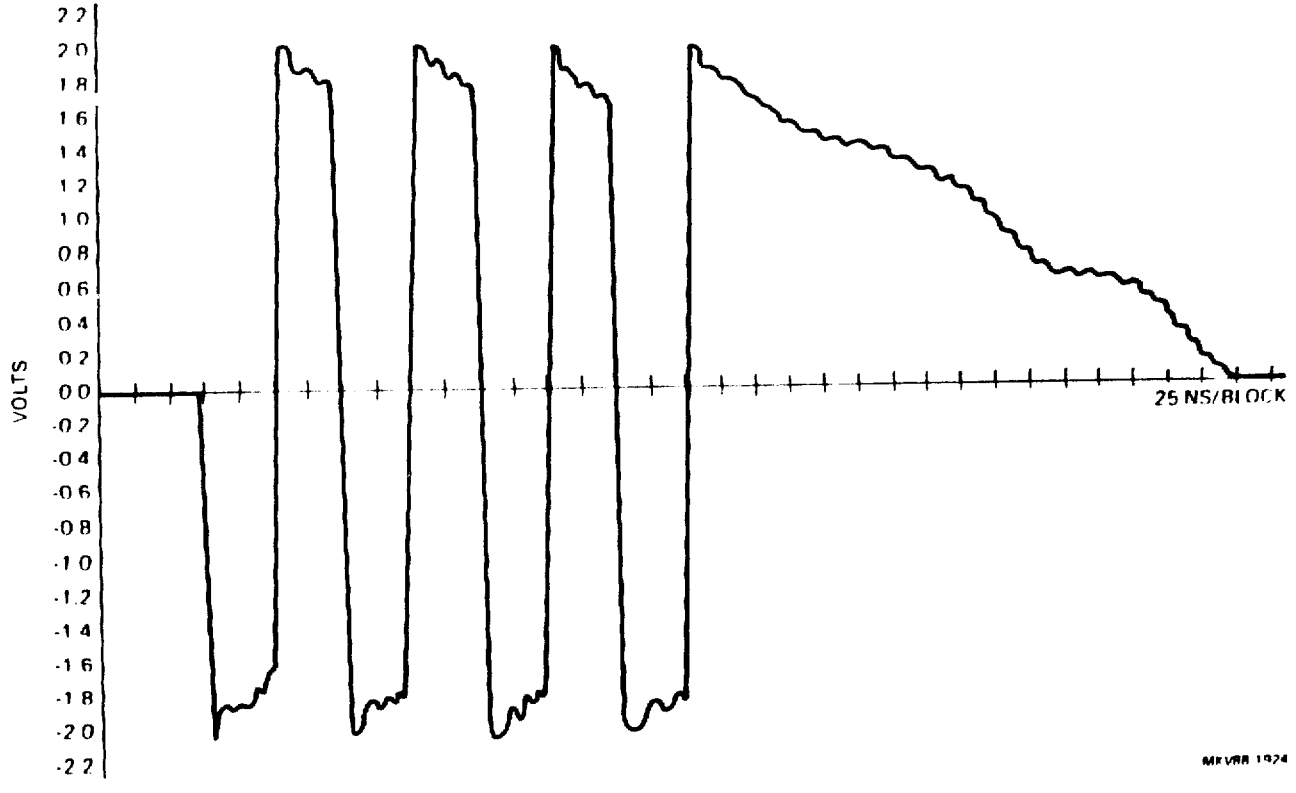

Figure A–11 COLL± EOP (XMIT With HEARTBEAT)

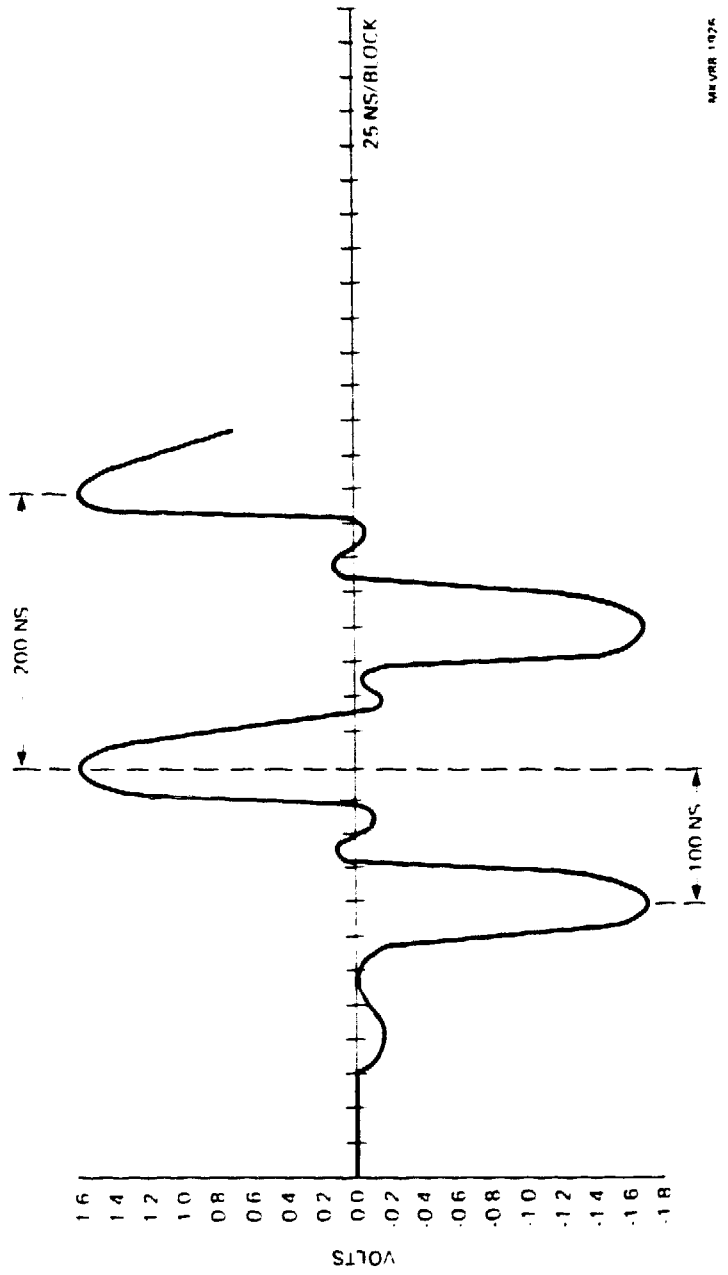

Figure A–12 COAX BOP (XMIT Into SHORT 3 Meters Away)

SITUATION
XMIT INTO
SHORT (3 METERS AWAY)

SIGNAL
COAX

PART OF SIGNAL
MOP
EOP

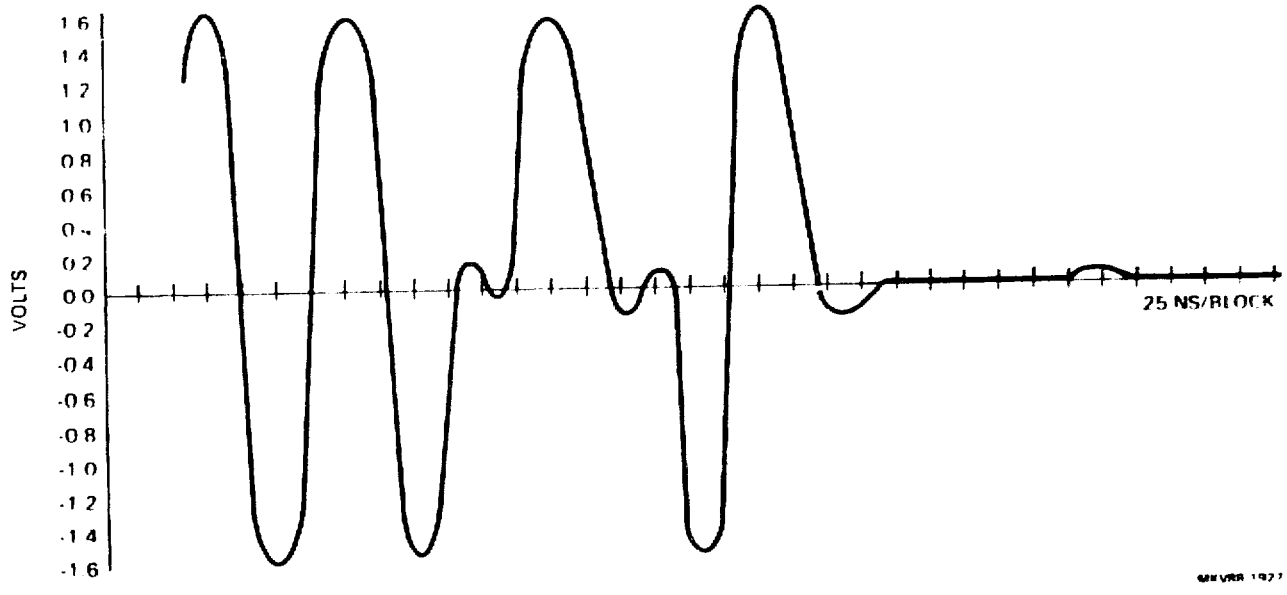

Figure A–13 COAX MOP, EOP (XMIT Into SHORT 3 Meters Away)

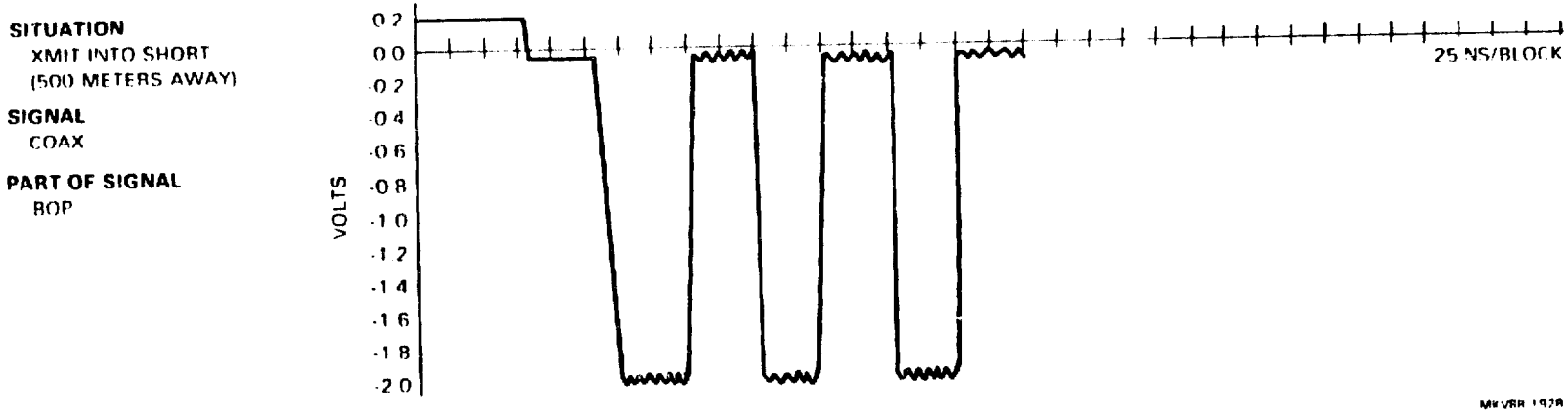

Figure A–14 COAX BOP (XMIT Into SHORT 500 Meters Away)

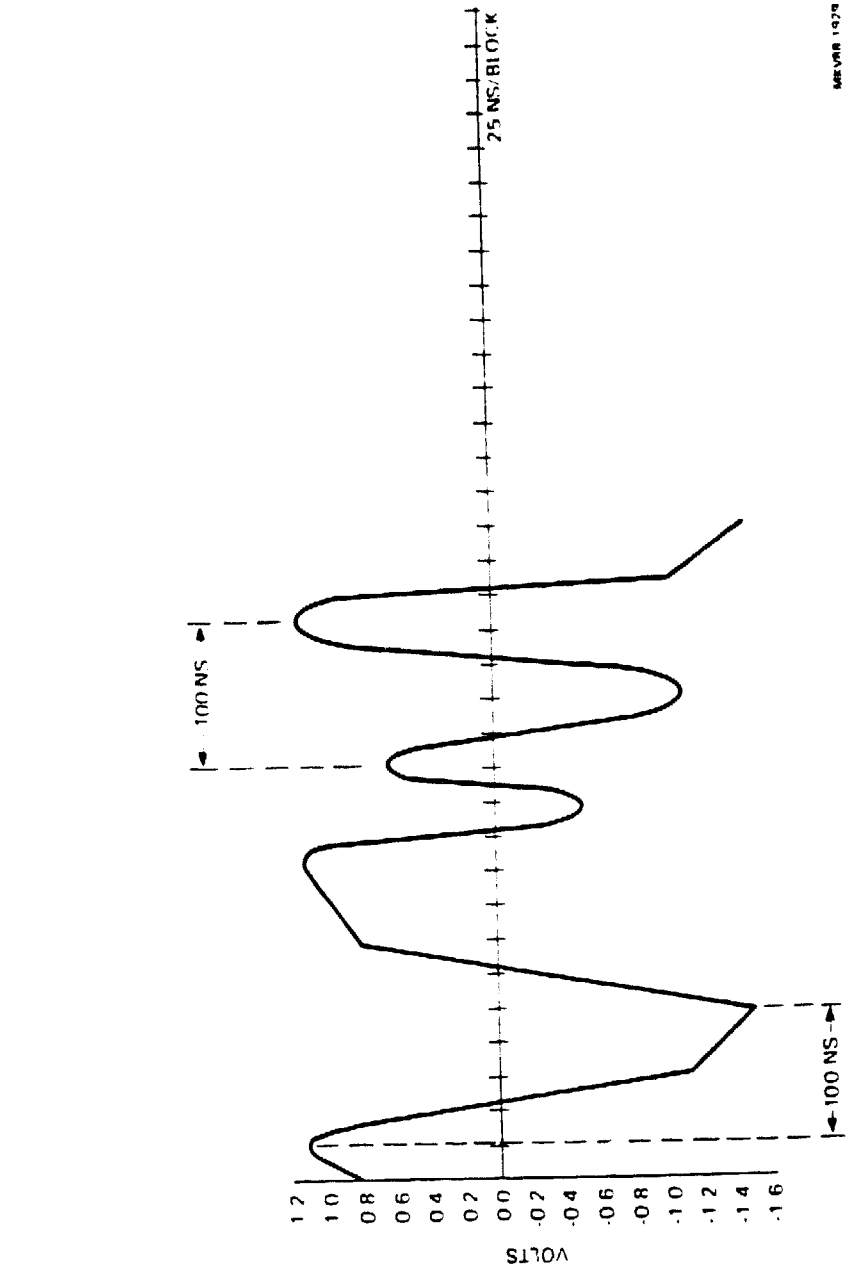

Figure A–15 COAX MOP (XMIT Into SHORT 500 Meters Away)

SITUATION
XMIT INTO SHORT
(500 METERS AWAY)

SIGNAL
COAX

PART OF SIGNAL
LATE MOP

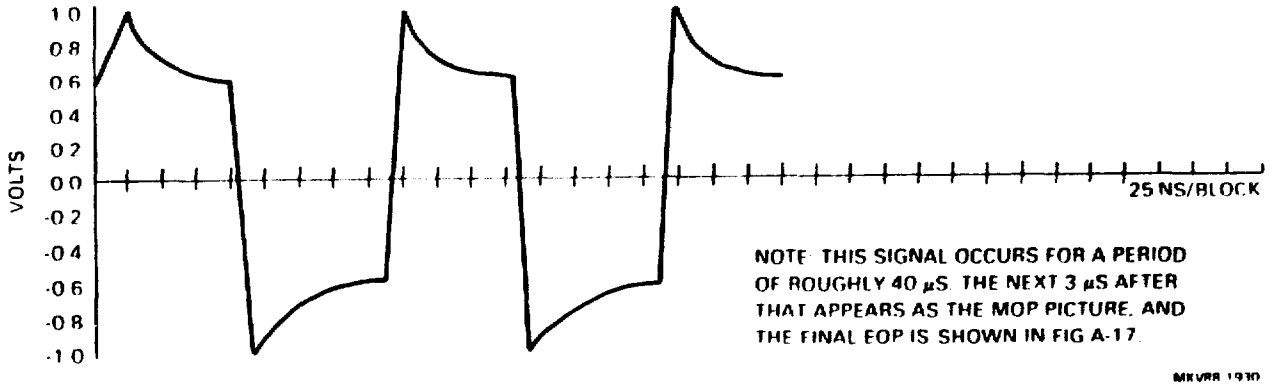

Figure A–16 COAX LATE MOP (XMIT Into SHORT 500 Meters Away)

SITUATION
XMIT INTO SHORT
(500 METERS AWAY)

SIGNAL
COAX

PART OF SIGNAL
EOP

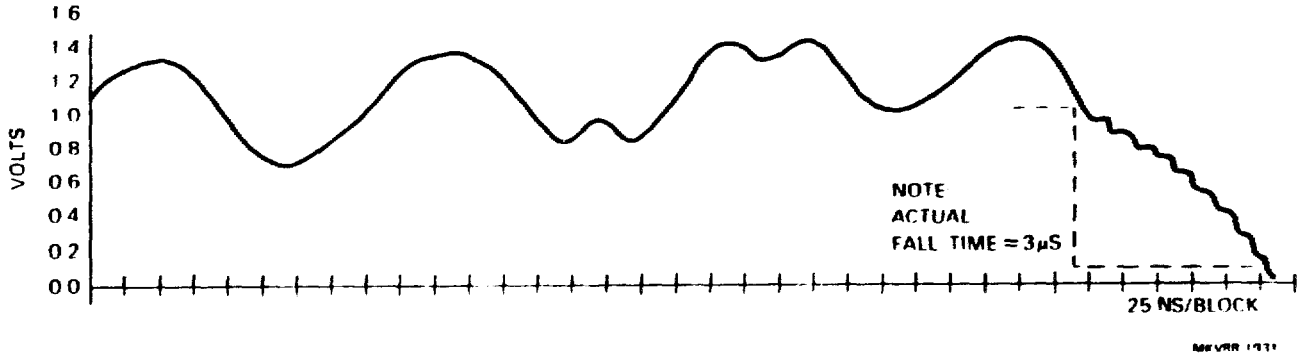

Figure A–17 COAX EOP (XMIT Into SHORT 500 Meters Away)

SITUATION
XMIT INTO SHORT
(500 METERS AWAY)

SIGNAL
RCV ±

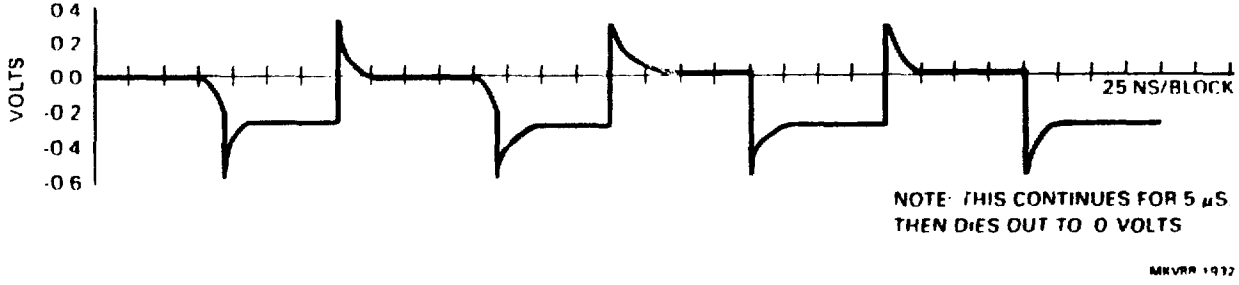

Figure A–18 RCV± (XMIT Into SHORT 500 Meters Away)

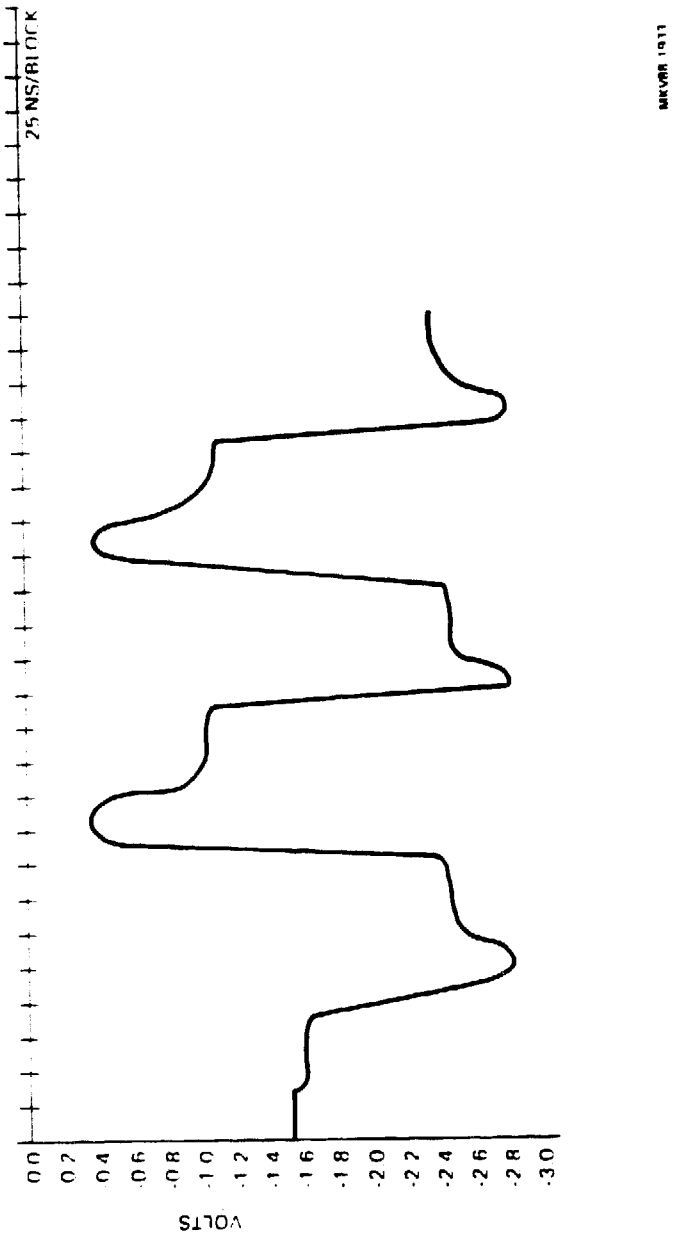

Figure A–19 COAX BOP (XMIT With COLLISION)

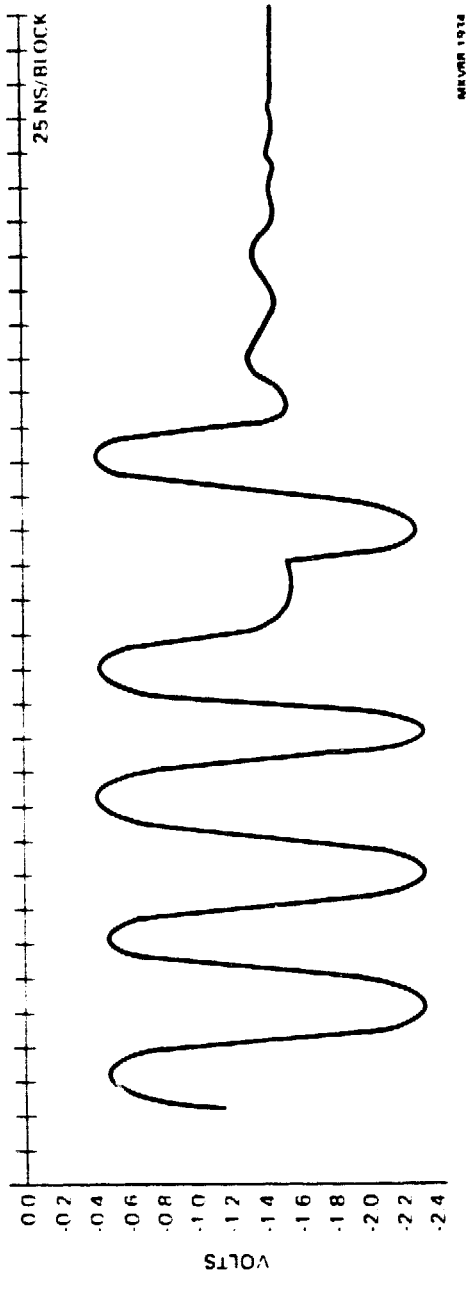

Figure A–20 COAX MOP, EOP (XMIT With COLLISION)

SITUATION
RCV WITH COLLISION

SIGNAL
COAX

PART OF SIGNAL
BOP

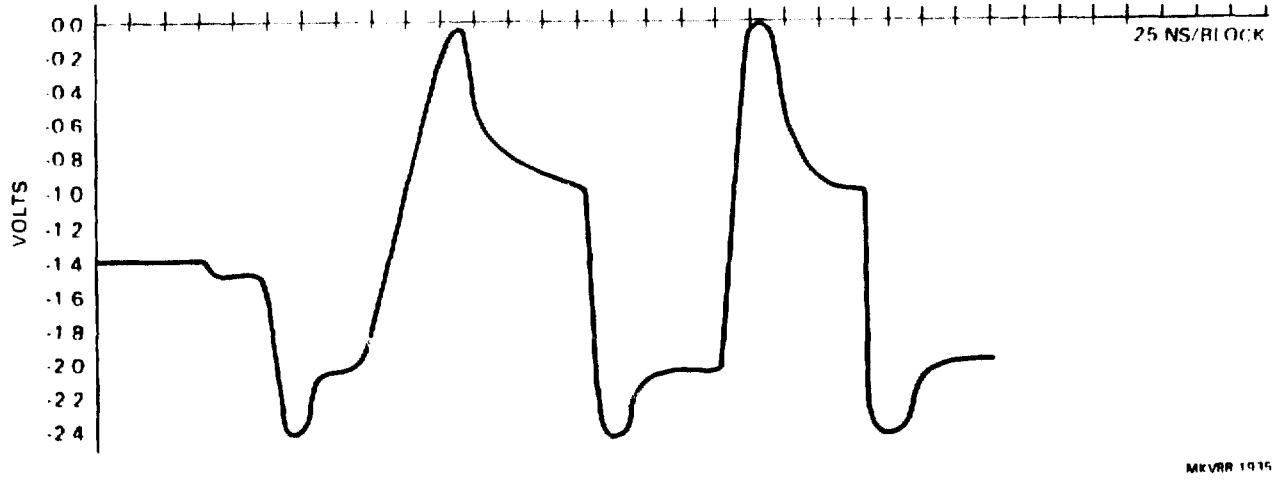

Figure A–21 COAX BOP (RCV With COLLISION)

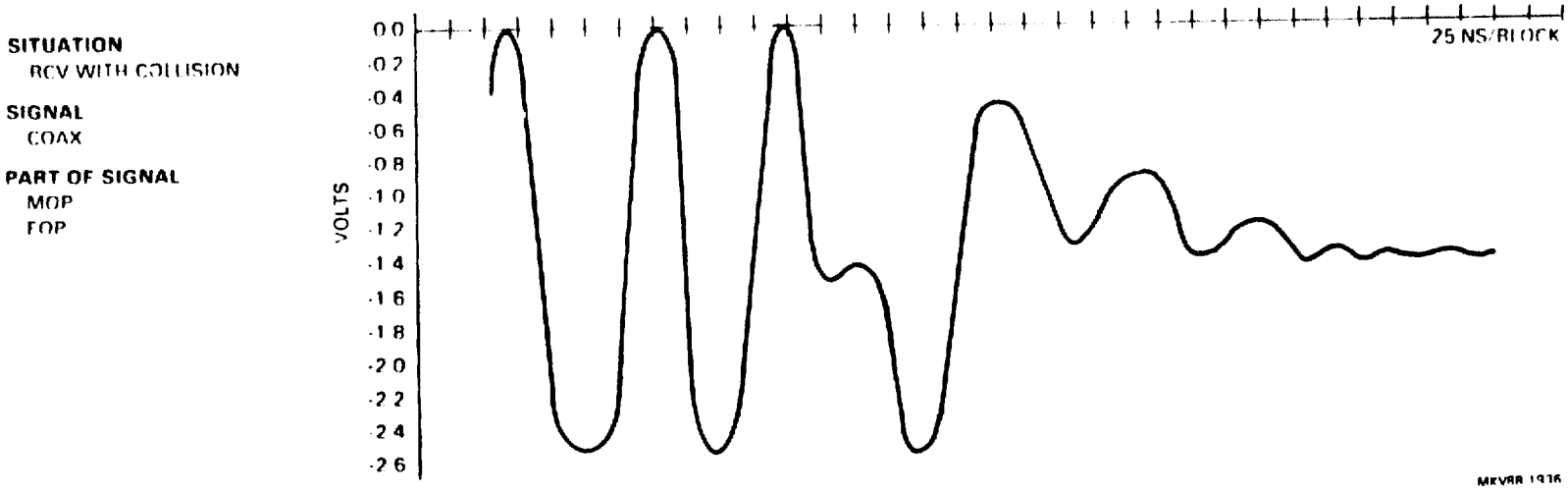

Figure A–22 COAX MOP, EOP (RCV With COLLISION)

SITUATION
RCV WITH COLLISION

SIGNAL
COLL ±

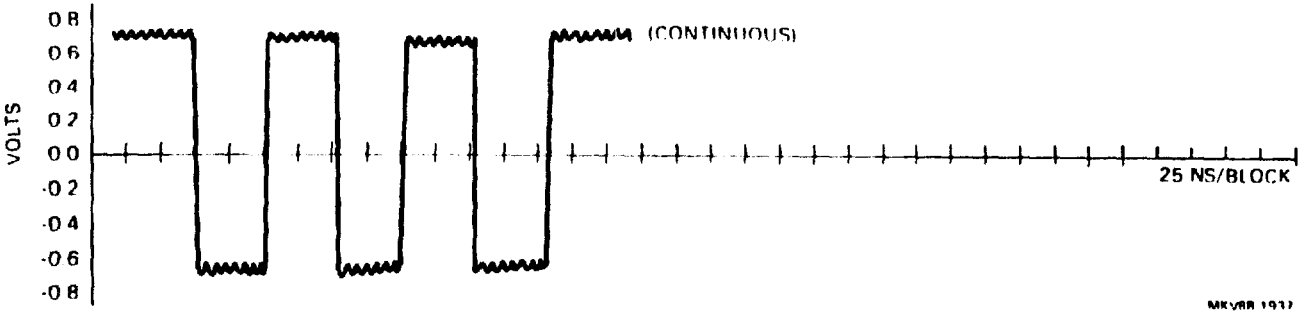

Figure A–23 COLL± (RCV With COLLISION)

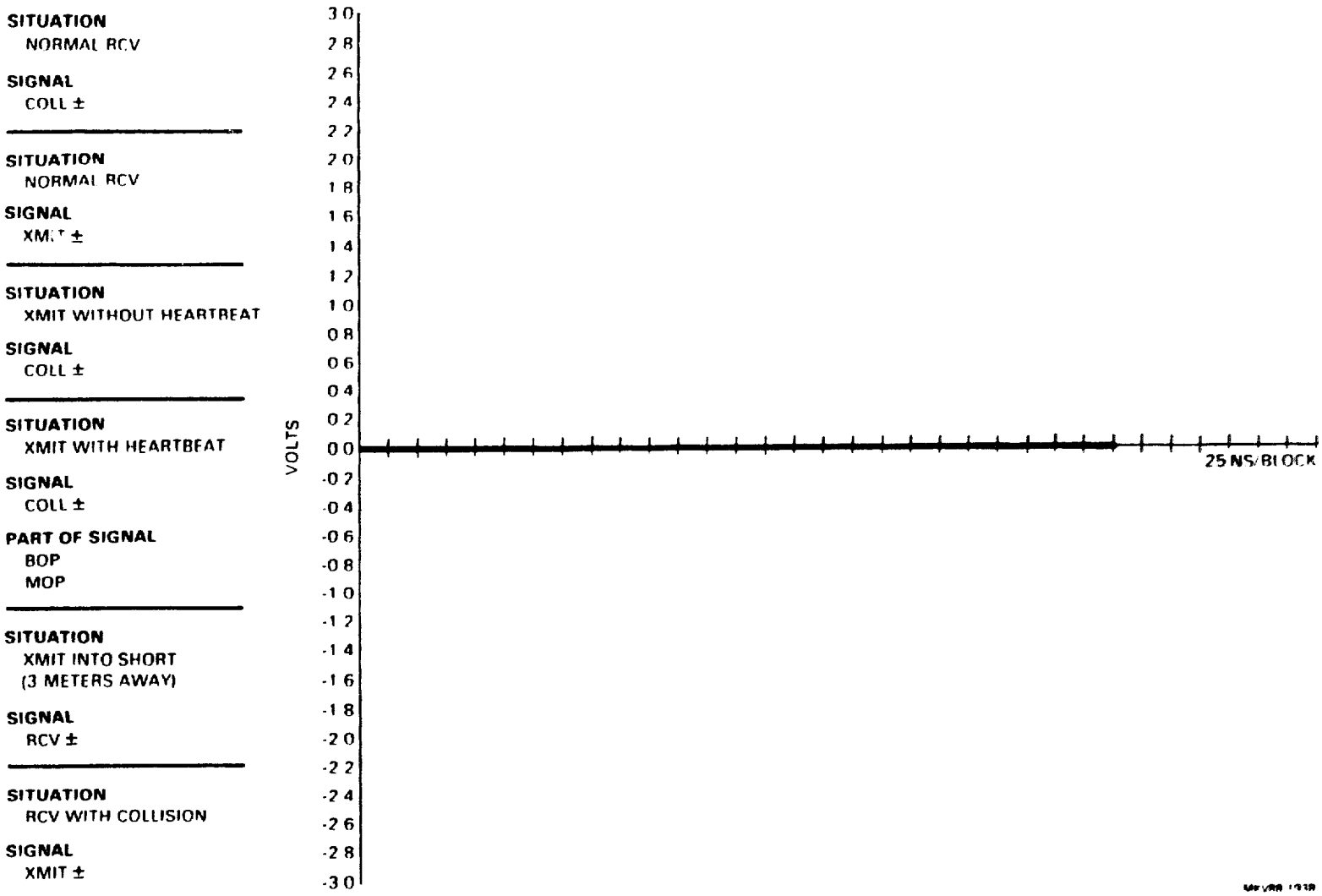

Figure A–24 Various Signals/Situations as Indicated in Table A-1