DMV11
Synchronous Controller
Technical Manual

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PREFACE

This manual describes in detail the installation requirements, programming considerations and techniques, microcode operation, technical functions, and servicing procedures, including diagnostic support, for the DMV11 Synchronous Controller. A variety of appendices are also provided to supplement the above.

Other publications which support the DMV11 Synchronous Controller are:

- *DMV11 Print Set* (MP-00942)

- Electronic Industries Association (EIA) Specifications

- DIGITAL Data Communications Message Protocol (DDCMP) Specifications (AA-D599A-TC)

1.1 INTRODUCTION

The multipoint DDCMP-DMV11 Intelligent Communications Synchronous Line Controller is a device which provides efficient high-speed synchronous communications for distributed networks. The DMV11 uses LSI-11 CPUs as control or tributary stations, while requiring a minimum of main CPU resources. This manual provides detailed information necessary for installing and operating the DMV11.

1.2 INTRODUCTION TO MULTIPOINT

Point-to-point configurations are practical when the message rate of the terminals is high. In many cases, however, the message rate of the terminals is very low even though the bit rate may be quite high. In these cases, sharing a transmission line can significantly reduce the cost and improve the efficiency of a communications network.

Various techniques are used to share transmission lines to improve their utilization. One of these techniques is the use of multipoint lines. In multipoint operation, a single line can be shared among many nodes. Each node is a station and has a unique address. One station in the network is always designated as the control station while the remaining stations are designated as tributary stations. Because all stations are connected to the same line, no two tributary stations may transmit at the same time, and each station must have a means of recognizing which messages it is meant to receive. The address field of the message header identifies the station to receive the message. The control station governs sharing of the line by means of polling in order to authorize transmission to the control station. In a polling operation the tributaries are in effect asked one by one whether they have anything to transmit. To accomplish this, the control station sends a polling message with a unique tributary address down the line. The station which recognizes the address responds by sending data or by sending a positive response.

Tributary stations can only transmit to the control station and only in response to a polling message from the control station. Transmission between tributaries is not allowed as all message traffic must be routed through the control station. Control stations on the other hand may transmit to any tributary at any time if the communicating stations are in full-duplex. In fact, multiple messages for different destinations (tributaries) can be sent serially by the control station. Each tributary station then, in turn, examines the address and accepts only those messages it is meant to receive.

The use of communication lines can be maximized by using full-duplex capabilities at the control station to accommodate many tributary stations on a full-duplex line. In this mode, the control station keeps the lines full by sending to one or more tributary stations, while at the same time receiving from another tributary station.

1.3 DMV11 GENERAL DESCRIPTION

The DMV11 is a high-performance line controller which operates at speeds up to 56K b/s. It accomplishes this by doing DMA transfers.

There are three available options and they are outlined below.

The DMV11-AA consists of:

- An M8053-MA microcontroller/line unit (a quad-high module with multipoint microcode);

- An H3254 (V.35 or integral modem) module test connector;

- An H3255 (RS-423-A/232-C) module test connector;

- A BC55H cable; and

- An H325 and H3251 cable turnaround test connector.

The DMV11-AB consists of:

- An M8053-MA microcontroller/line unit (a quad-high module with multipoint microcode);

- An H3254 (V.35 or integral modem) module test connector;

- An H3255 (RS-423-A/232-C) module test connector;

- A BC05Z-25 cable; and

- An H3250 cable turnaround test connector.

The DMV11-AC consists of:

- An M8064-MA microcontroller/line unit (a quad-high module with multipoint microcode);

- An H3254 (V.35 or integral modem) module test connector;

- A BC55F cable; and

- H3257 and H3258 terminators.

These three options provide coverage of four different types of interfaces (see Table 1-1).

Features of the DMV11 include:

- Support of point-to-point and multipoint operation,

- Support for remote or local, full-duplex, or half-duplex configurations,

- Support for 12 tributaries and one control station in multipoint operation,

- Switch and program selectable operating mode and tributary address,

- Support for multiple addressed tributaries,

- Down-line loading and remote load detect capabilities,

- Go/No-Go diagnostic testing by the microcode,

- Go/No-Go extensive error reporting,

- Modem control.

Table 1-1   DMV11 Options

Option	Interface	Line Speed (DMV11 Limitations)
DMV11-AA	EIA RS-232-C EIA RS-423-A	Up to 19.2K b/s Up to 56K b/s
DMV11-AB	CCITT V.35	Up to 56K b/s
DMV11-AC	Integral modem	56K b/s only

1.4   STANDARD APPLICATIONS

The DMV11 can be used with the integral modem as well as with EIA and CCITT applications. These applications can be configured as either point-to-point or multipoint networks. Figure 1-1 shows a typical point-to-point application and Figure 1-2 shows a typical multipoint application. For local operations through integral modems, stations are interconnected by twinax or triaxial cables. The integral modem can support up to 12 drops in both half- and full-duplex modes. For remote operations, stations are connected through external modems that use common carrier facilities. For specific information on installation of either of the basic DMV11 units and associated options, refer to Chapter 2.

For multipoint applications, the tributary address for each DMV11 in the network is either switch or program assigned. In the case of switch-assigned tributary addresses, specific switches on each DMV11 define the numerical value of the address to which that DMV11 responds. The advantage of a switch-assigned tributary address is that it provides data transfer security since the address cannot be changed by software.

A major advantage of DMV11 multipoint networks is the ability of the main CPU at the control station to down-line load programs to the CPU at each tributary and start those programs without manual intervention. As a result, DMV11-based multipoint networks are particularly suited for installation at remote and generally inaccessible locations. For example, DMV11s may be used in satellites, in hard to reach locations such as weather stations at sea, and in hazardous environments.

1.5   DMV11 SYSTEM OPERATION

Operation of the DMV11 communications line controller is initiated and directed by a user program residing in the main memory. The user program consists of an application program and a device driver that serves as an interface between the DMV11 and the CPU.

Communication between the user program and the DMV11 is accomplished over the LSI-11 bus through four control and status registers (CSRs). These four 16-bit registers serve as a bidirectional port to pass user-program commands to the DMV11, and DMV11 responses to those commands back to the user program. Each of these registers are word and byte addressable by both the user program and the DMV11 microcode.

NOTE
Normally only four CSRs are available to the user program. However, in 22-bit address mode, eight CSRs are available although only one additional 16-bit register is used.

In this group of four CSRs, the first two have a fixed format and in general serve as a handshake control for user-program commands and DMV11 responses. The next two CSRs form a port for the ex-

change of command and responses between the user program and the DMV11. Other control fields provide for initialization, interrupt enabling, reading and execution of maintenance instructions, data transfer setup, and tributary addressing.

A user program issues a command to the DMV11 by first requesting the use of the data port. When the DMV11 grants permission to use the data port, the user program passes the command to the DMV11 in the CSRs. The DMV11 interprets the command and performs the specified actions. If a response is required, the DMV11 stores the appropriate response in the CSRs and then informs the user program that a response is present.

Message data received or to be transmitted by the DMV11 is written into or read from preassigned buffers in main CPU memory. These buffers are accessed by the DMV11 through nonprocessor requests (NPRs) to the associated bus address.
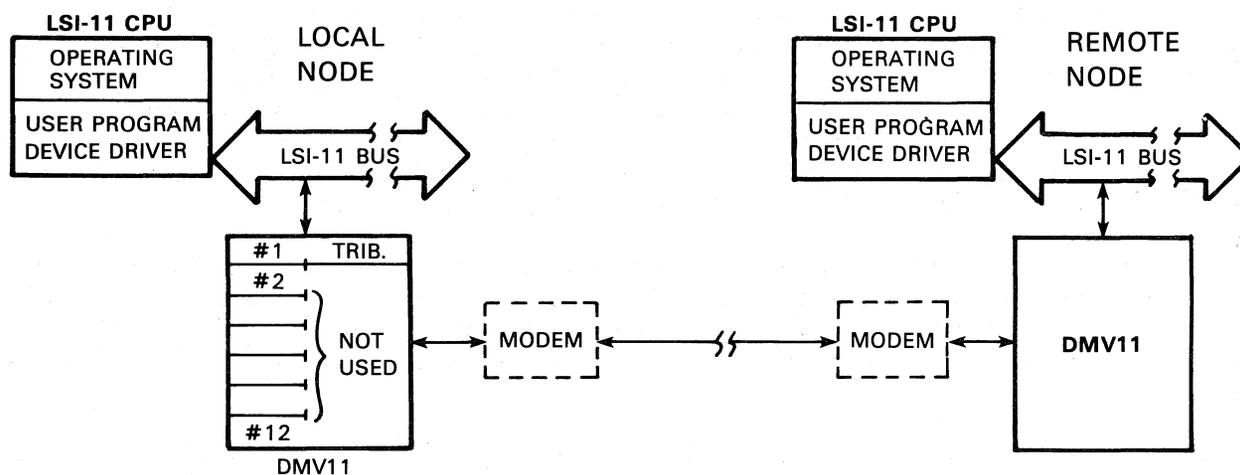
Figure 1-1   DMV11s Used in Point-to-Point Applications

1.6 COMMAND/RESPONSE STRUCTURES
Since the DMV11 is basically an input/output device, it follows that the command/response set for this device be categorized as input commands and output responses. Input commands are commands issued by the user program to the DMV11. Output responses are typically responses to those commands, and are issued by the DMV11 to the user program.

Some responses are unsolicited, and are used to inform the user program of protocol events and line errors.

1.6.1 Input Commands
There are four types of input commands. They are listed below in the usual order of issuance.

1. Microprocessor control/maintenance,
2. Mode definition,
3. Control,
4. Buffer address/character count.

LSI-11 CPU

| OPERATING SYSTEM |
| USER PROGRAM/ DEVICE DRIVER |

LSI-11 BUS

DMV11 CONTROL STATION (INTERNAL DATA STRUCTURE)

| #1 |
| #2 |
| #3 |
| #4 |
| • • |
| #12 |

TRIBUTARY STATUS SLOTS

MODEM

MODEM

MODEM

DMV11 MULTIPOINT NODE A

| #1 |
| STATUS SLOT FOR SWITCH SET TRIB. ADDRESS |

| OPERATING SYSTEM |
| USER PROGRAM/ DEVICE DRIVER |

LSI-11 BUS

| OPERATING SYSTEM |
| USER PROGRAM/ DEVICE DRIVER |

LSI-11 BUS

DMV11 MULTIPOINT NODE B

| #2 |
| #3 |
| #4 |
| • |
| • |
| #n |

TRIB/STATUS SLOTS FOR MULTIADDRESS STATION

MULTIPOINT NODE C

DMV11

MODEM

| OPERATING SYSTEM |
| USER PROGRAM/ DEVICE DRIVER |

LSI-11 BUS

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Figure 1-2   DMV11s Used in Multipoint Applications

1.6.2 Output Responses

Output responses serve to inform the user program of normal or abnormal conditions concerning the data transfer operation. There are three types of output responses:

1. Control response,
2. Information response,
3. Buffer disposition response.

Figure 1-3 is a general summary of the functions performed by the DMV11 command/response structure. These commands and responses are discussed in detail in Chapter 3.

1.7 PROTOCOL SUPPORT

In DMV11 point-to-point and multipoint networks, all message transfers between nodes are under control of the Digital Data Communications Message Protocol (DDCMP). All aspects of DDCMP processing are handled by the DMV11 microcode. Message handling at the user-program level only involves setting up data buffers during transmit operations and accepting data from the DMV11 during receive operations.

There are no file structure constraints on messages transmitted or received over DMV11 networks; however, the maximum data message length allowed is 16,383 bytes. Also, there are no restrictions as to the type of data transmitted or received under DDCMP since all data is transmitted and received in transparent form.

There are basically three types of DDCMP messages: the data message, the control message, and the maintenance message.

1.7.1 Data Messages

DDCMP data messages consist of two parts: the message header and the message body. The header consists of eight bytes of control information necessary for successful transmission of the message. Included in these eight bytes is the block-check count (BCC) for the header, the byte count of the message body, and the tributary address. The header also contains two control bits; one that indicates resynchronization after this message, and one that controls line turnaround. The message body consists of the message and a BCC for the message. Both BCC characters are used by the DMV11 to validate messages as they are received.

The header is assembled by the DMV11 and transmitted with the message body to form the data message. The receiving DMV11 uses the header to verify the address and ensure that the message is received in the correct sequence. The header is also used to determine the number of bytes to transfer to the user program. The header is discarded when the message is successfully passed to the user program.

1.7.2 Control Messages

Control messages are used to manage message traffic. They are eight-byte DDCMP messages which are passed between control and tributary stations under sole control of the DMV11. Two examples of control messages are acknowledge (ACK) and negative acknowledge (NAK). ACKs indicate successful reception of messages while NAKs indicate unsuccessful reception. Control messages in multipoint also contain the address field to identify the tributary to which the message is sent or received from.

1.7.3 Maintenance Messages

Under DDCMP, a DMV11 has two data transfer modes: the DDCMP run state, and the DDCMP maintenance state. In the run state, a DMV11 receives and transmits data messages. In the maintenance state, a DMV11 receives and transmits *only* maintenance messages. A maintenance message is formatted much like a data message. It is formed by an eight-byte header followed by a variable length message body. The content of the body is determined by the user program. Maintenance messages may consist of: 1) operating or diagnostic programs transmitted by the control station for down-line loading into the CPU of a specified tributary, or 2) a portion of the contents of a tributary's CPU memory as requested by the control station. The request of this information is also handled by a maintenance message.

LSI-11
USER PROGRAM

```
                    ┌──────────────────┐     USER PROGRAM ISSUES
                    │    INITIALIZE    │     MICROPROCESSOR CONTROL
                    │    DMV11         │     COMMAND TO MASTER
                    └──────────────────┘     CLEAR DMV11
```

┌──────────┐ FAILURE   USER
│ NOTIFY   │◄────────   PROG. VERIFIES
│ USER   │   INTERNAL
│ PROGRAM │   DIAG.
└──────────┘

SUCCESSFUL,
DMV11 RUNNING

┌──────────────────────┐
│ SET MODE TO HALF   │
│ OF FULL DUPLEX,   │
│ ESTABLISH STATION   │   USER PROGRAM ISSUES
│ AS POINT-TO-POINT   │   MODE DEFINITION
│ NODE OR MULTIPOINT   │   COMMAND
│ CONTROL OR TRIBUTARY │
│ STATION   │
└──────────────────────┘

┌──────────────────────┐
│ ESTABLISH TRIBUTARIES,│
│ SET USER DEFINED   │   USER PROGRAM ISSUES
│ PARAMETERS, INITIATE │   CONTROL COMMANDS
│ PROTOCOL STARTUP   │
└──────────────────────┘

┌──────────────────────┐
│ ASSIGN TRANSMIT   │   USER PROGRAM ISSUES
│ AND.   │   BUFFER ADDRESS /
│ RECEIVE BUFFERS   │   CHARACTER COUNT
└──────────────────────┘   COMMANDS

TRANSMIT   RECEIVE

┌─────────────────────────────────┐   ┌─────────────────────────────────┐
│ THE DMV11 PERFORMS THE FOLLOWING│   │ THE DMV11 PERFORMS THE FOLLOWING│
│ TRANSMIT MESSAGE FUNCTIONS: │   │ RECEIVE MESSAGE FUNCTIONS: │
│ 1. CREATE DDCMP MESSAGE   │   │ 1. PROCESS RECEIVE HEADERS   │
│   HEADERS   │   │ 2. CHECK CRC's   │
│ 2. GENERATE MESSAGE AND   │   │ 3. ACKNOWLEDGE (ACK) PROPERLY │
│   HEADER CRCs   │   │   RECEIVED MESSAGES   │
│ 3. TRANSMIT MESSAGES   │   │ 4. NEGATIVE ACKNOWLEDGE (NAK) │
│   │   │   ERRONEOUSLY RECEIVED MESSAGES│
└─────────────────────────────────┘   └─────────────────────────────────┘

┌──────────────────────────────────────┐
│ THE DMV11 PERFORMS THE FOLLOWING   │   DMV11 ISSUES BUFFER
│ MESSAGE TRAFFIC CONTROL FUNCTIONS: │   DISPOSITION RESPONSES,
│   1. MESSAGE SEQUENCING   │   CONTROL RESPONSES AND
│   2. ERROR RECORDING AND REPORTING   │   INFORMATION RESPONSES
│   3. PROTOCOL SUPPORT   │
│   4. LINK MANAGEMENT   │
└──────────────────────────────────────┘

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Figure 1-3   General Summary of DMV11 Command/Response Structure

1.8 GENERAL SPECIFICATIONS

Environmental, electrical, and performance specifications for all DMV11 configurations are listed in Sections 1.8.1 through 1.8.3.

1.8.1 Environmental Specifications

The DMV11 is designed to operate in a class C environment as specified by DEC STD 102 (extended).

– Operating Temperature	5°C (41°F) to 50°C (122°F)
– Relative Humidity	10% to 90% with a maximum wet bulb temperature of 28°C (82°F) and a minimum dew point of 2°C (36°F).

1.8.2 Electrical Specifications

The DMV11 requires the following voltages from the LSI-11 bus for proper operation.

Option	Voltage
DMV11-AA,AB	+5 V @ 3.4 A +12 V @ 0.380 A
DMV11-AC	+5 V @ 3.35 A +12 V @ 0.260 A

A − 12 V @ 250 mA required by the level conversion logic for both versions is generated off the + 12 V by a switching inverter.

1.8.3 Performance Specifications

Performance parameters are as follows:

– Operating mode	Full- or half-duplex
– Data format	Synchronous DDCMP
– Data rates	Up to 56K b/s
– Tributaries supported	Up to 12

DMV11s may be connected to DMP11s/DMV11s, DMR11s, DMC11s, and any other synchronous controller running DDCMP protocol.

CHAPTER 2
INSTALLATION

2.1 INTRODUCTION
This chapter provides all the information necessary for a successful installation and subsequent check-out of the DMV11. Included are instructions for unpacking and inspection, preinstallation, installation, and verification of operation.

2.2 UNPACKING AND INSPECTION
The DMV11 is packaged according to commercial packing practices. When unpacking, remove all packing material and check the equipment against the packing list (Table 2-1 contains a list of supplied items for each configuration). Inspect all parts and carefully inspect the module for cracks, loose components, and separations in the etched paths. Report damages or shortages to the shipper and notify the DIGITAL representative.

2.3 INSTALLATION CONSIDERATIONS
Installation of the DMV11 microcontroller/line unit subsystem should be done in three phases:

- Phase I – Preinstallation considerations

  Verify system requirements, system placement, and configuration requirements.

  Network topology chart

  For multipoint networks it is absolutely necessary to know the configuration of the DMV11 (that is; control, tributary, HDX, FDX, and so on) locations of tributaries (w/address), and where in network they are connected (control, Trib 187, Trib 98, Trib 208) or else trouble-shooting will be extremely difficult.

- Phase II – Microcontroller/line unit installation

  Configure, install, and verify the microcontroller/line unit module via the appropriate diagnostics.

- Phase III – DMV11 system testing

  Verify the DMV11 microprocessor subsystem operation with the functional diagnostics and system exerciser programs.

2-1

Table 2-1 DMV11 Option Packing List

Option	Parts List	Description
DMV11-AA		RS-232-C/RS-423-A interface containing:
	M8053-MA	Basic remote DMV11 unit
	BC55H	EIA RS-232-C/RS-423-A panel assembly
	H3254, H3255	Module test connectors
	H3251, H325	Cable turnaround test connector
	EK-DMV11-UG	*DMV11 User's Guide*
	MP-00942	*Field Maintenance Print Set*
	ZJ328-RB	LIB kit
DMV11-AB		CCITT V.35 interface containing:
	M8053-MA	Basic remote DMV11 unit
	BC05Z-25	CCITT V.35 cable
	H3250	Cable turnaround test connector
	H3254, H3255	Module test connectors
	EK-DMV11-UG	*DMV11 User's Guide*
	MP-00942	*Field Maintenance Print Set*
	ZJ328-RB	LIB kit
DMV11-AC		Integral modem interface containing:
	M8064-MA	Basic local DMV11 unit
	BC55F-10	Integral modem cable
	H3254	Module test connector
	H3257/H3258	BC55A terminators
	EK-DMV11-UG	*DMV11 User's Guide*
	MP-00942	*Field Maintenance Print Set*
	ZJ328-RB	LIB kit

2.4 PREINSTALLATION CONSIDERATIONS

Table 2-1 and the following should be considered prior to ordering a DMV11 communications interface to ensure that the system can accept the DMV11 and that it can be installed correctly. The steps should also be verified at installation time.

It is strongly recommended that a topology diagram be drawn at installation time and maintained throughout the life of the installation. Figure 2-1 shows a local network topology and Figure 2-2 shows a remote network topology. The topology diagram should provide the following information.

Cable routing –	Show the actual physical location of the cable trough and indicate any equipment which might cause interference such as an X-ray room.
Machine type –	Indicate whether the CPU is a PDP-11/23, PDP-11/70, PDP-11/34, VAX-11/780, and so forth. (The network could consist of a mixture of DMP11s and DMV11s).
Type of station –	Indicate if the station is a control or tributary station.
Physical address –	DDCMP address can range from 1-255.

Location –	Indicate by room number or other appropriate means, the actual physical location of the equipment.
Node name –	The name given to the tributary if applicable.
Operating system and version –	The name of the software operating system such as RSX-11M V3.2.
DECnet version –	DECnet software version such as DECnet-11M V3.0.
Transmit and receive –	Show transmit and receive lines. Depict end nodes and show termination. If a patch panel is used, indicate the line numbers between patch panels.

NOTE
The use of patch panels and numbering of the lines is recommended.

ELEVATOR SHAFT

SUSPENDED CEILING

| RX | TX |
DELTA
11/70
DMP11
TRIB 3
RSTS XX.X
DE - XX.X
ROOM 515

| RX | TX |
BETA
11/34
DMP 11
TRIB 1
RSX11 M
DM - XX.X
ROOM 412

| RX | TX |
GAMA
11/23
DMV 11
TRIB 2
RSX 11M
DM - XX.X
ROOM 430

| RX | TX |
ALPHA
VAX 11/780
DMP 11
CONTROL
VMS XX.X
DV - XX.X
ROOM 111
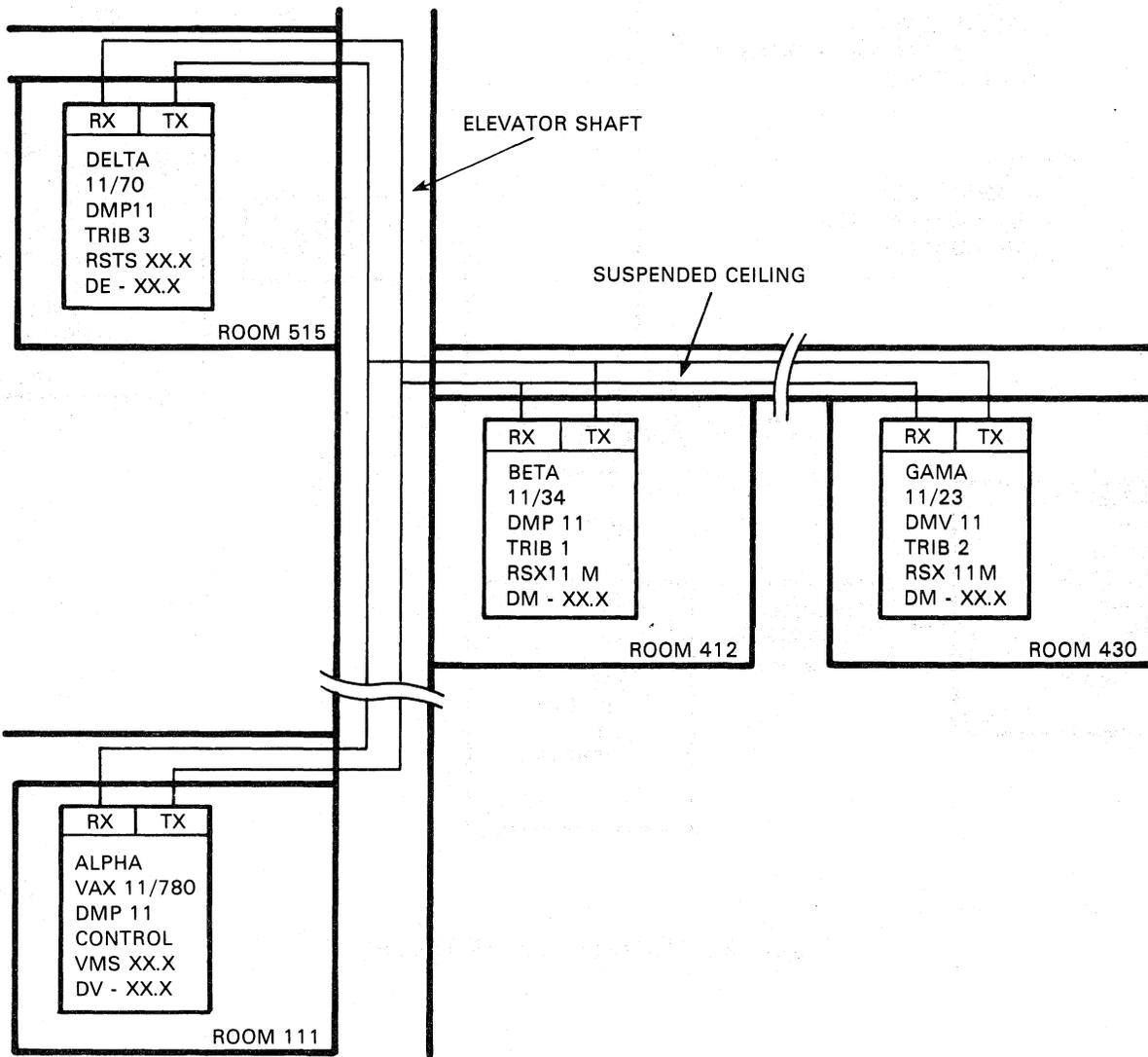
MK-2502

Figure 2-1   Local Network Topology

MERRIMACK
MK1-1/K37
  VAX 11/780
  VAX VMS XX.X
  DV-XX.X
    *NOTE 1
    *NOTE 3
                CONTROL
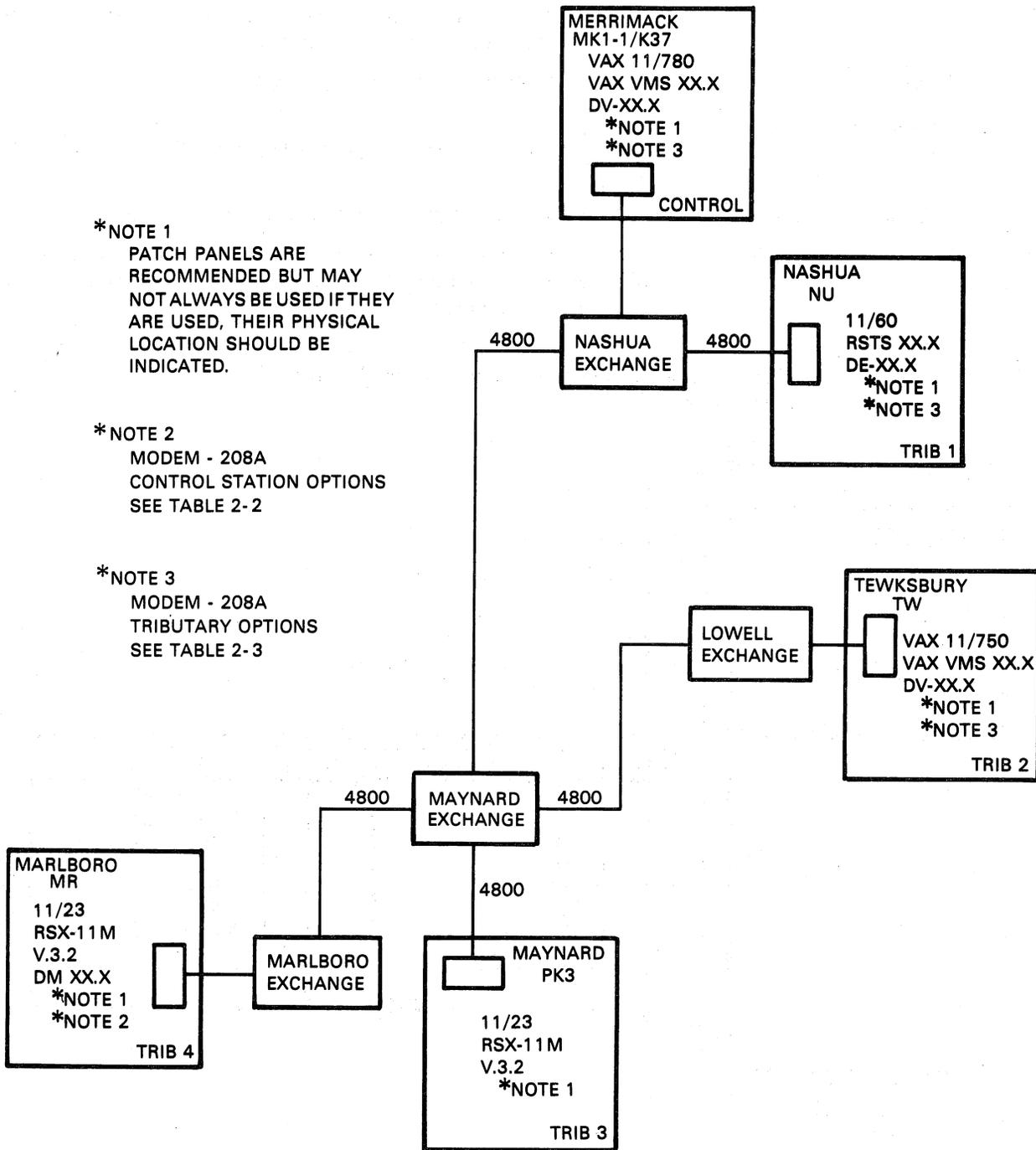
*NOTE 1
  PATCH PANELS ARE
  RECOMMENDED BUT MAY
  NOT ALWAYS BE USED IF THEY
  ARE USED, THEIR PHYSICAL
  LOCATION SHOULD BE
  INDICATED.

*NOTE 2
  MODEM - 208A
  CONTROL STATION OPTIONS
  SEE TABLE 2-2

*NOTE 3
  MODEM - 208A
  TRIBUTARY OPTIONS
  SEE TABLE 2-3

NASHUA
  NU

  11/60
  RSTS XX.X
  DE-XX.X
    *NOTE 1
    *NOTE 3
                TRIB 1

4800   NASHUA
        EXCHANGE   4800

TEWKSBURY
  TW

  VAX 11/750
  VAX VMS XX.X
  DV-XX.X
    *NOTE 1
    *NOTE 3
                TRIB 2

LOWELL
EXCHANGE

4800   MAYNARD
        EXCHANGE   4800

4800

MARLBORO
  MR

  11/23
  RSX-11M
  V.3.2
  DM XX.X
    *NOTE 1
    *NOTE 2
                TRIB 4

MARLBORO
EXCHANGE

MAYNARD
  PK3

  11/23
  RSX-11M
  V.3.2
    *NOTE 1
                TRIB 3

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Figure 2-2   Remote Network Topology

Table 2-2   Typical Host Options of a Bell 208A Data Set (4800 b/s)
Full-Duplex Operation

Data Set Options	DEC Recommended Settings
Transmitter timing	Data set (internal)
Carrier control	Continuous
Request-to-send operation in continuous carrier mode	Continuous (CB constantly ON)
One second holdover at receiver on line dropouts	Not provided
New sync-option to squelch receiver clock	Not used – NS is strapped OFF within the data set
Data set ready lead option for analog loopback testing by data terminal	CC is ON when the AL button (only) is depressed
Grounding option	AB connected to AA

Table 2-3   Typical Tributary Options of a Bell 208A Data Set (4800 b/s)
Full-Duplex Operation

Data Set Options	DEC Recommended Settings
Transmitter timing	Data set (internal)
Carrier control	Switched (48.5 ms CA-CB delay)
Request-to-send operation in continuous carrier mode	Continuous (CB constantly ON) N/A Switched (8 ms ±.5 CA-CB delay) N/A
One second holdover at receiver on line dropouts	Not provided
New sync-option to squelch receiver clock	Not used – NS is strapped OFF within the data set
Data set ready lead option for analog loopback testing by data terminal	CC is ON when the AL button (only) is depressed
Grounding option	AB connected to AA

2.4.1 Device Placement

The DMV11 can be installed in any LSI-11 bus-compatible backplane such as H9276. On systems that contain many high-speed direct memory access (DMA) devices, there is a probability of adverse bus latency. To help prevent against this occurrence, the DMV11 should be placed physically close to the processor. As a result, this gives the DMV11 a high DMA priority.

2.4.2 System Requirements

- LSI-11 bus loading

  The M8053-MA or M8064-MA present two ac loads and one dc load to the LSI-11 bus.

- Power requirements

  Check the power supply before and after installing the microcontroller/line unit to ensure against overloading. Power requirements are listed in Table 2-4.

- Interrupt priority

  The interrupt priority is preset to level four.

- Device address assignment

  The DMV11 address resides in the floating address space of the LSI-11 bus addresses. The ranking assignment of the DMV11 for bus address is 24.

  The selection of the device address is accomplished by switch packs on the microcontroller/line unit module. Refer to Figures 2-3 and 2-4.

- Device vector address assignment

  The DMV11 vectors reside in the floating vector space of the LSI-11 bus addresses. The ranking assignment of the DMV11 for vector assignments is 46.

  The selection of the vector address is accomplished by a switchpack on the microcontroller/line unit module. Refer to Figures 2-3 and 2-4.

Table 2-4   DMV11 Voltage Chart

Module	Voltage Rating	Maximum Voltage	Minimum Voltage	Backplane Pin
M8053-MA	+5 V @ 3.4 A +12 V @ 0.380 A	+5.25 +12.60	+5.0 +11.40	AA2 AD2
M8064-MA	+5 V @ 3.35 A +12 V @ 0.260 A	+5.25 +12.60	+5.0 +11.40	AA2 AD2
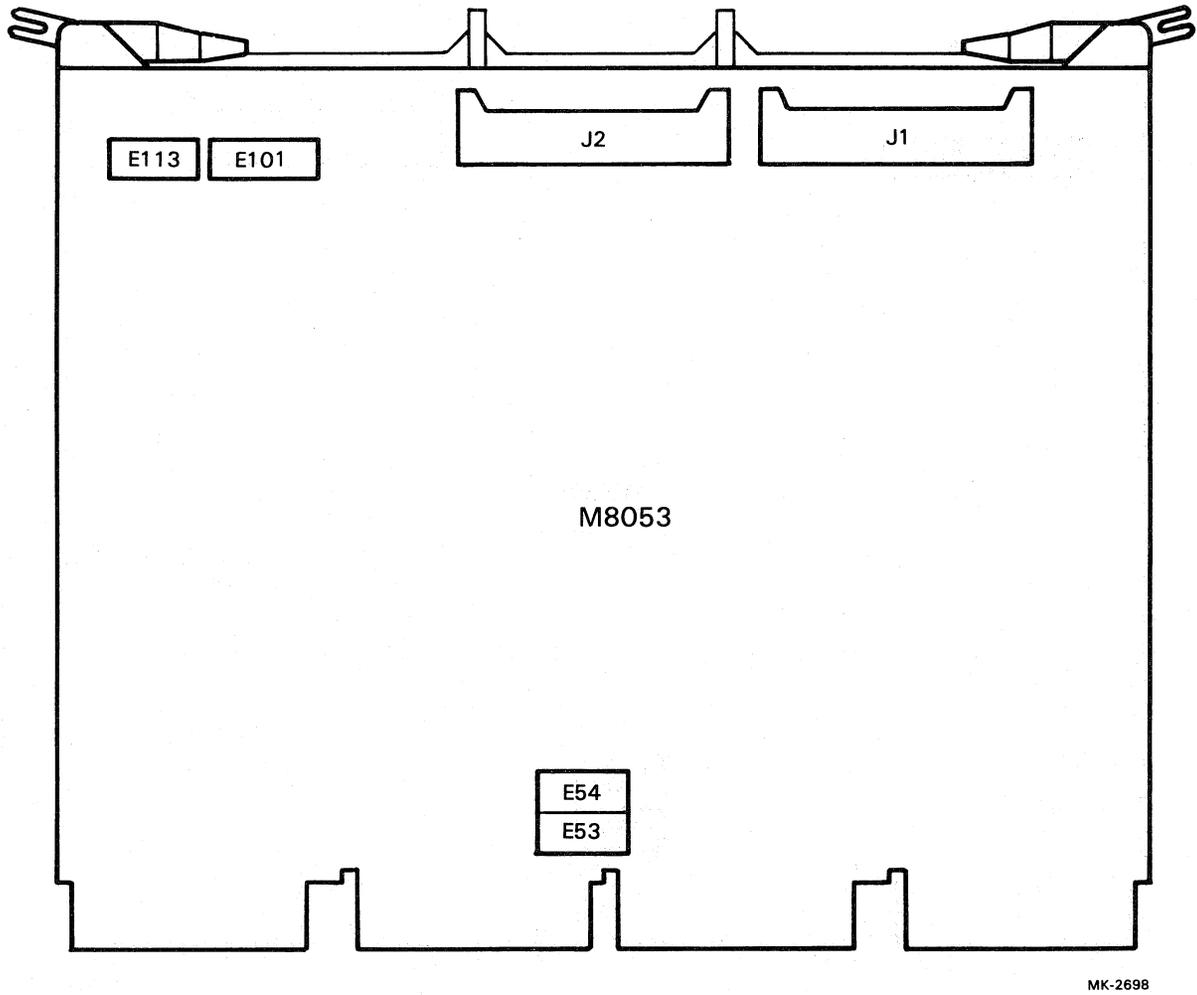
Figure 2-3   M8053 Switch Locations

MK-2698

E119   E107

J1

M8064

E59
E58
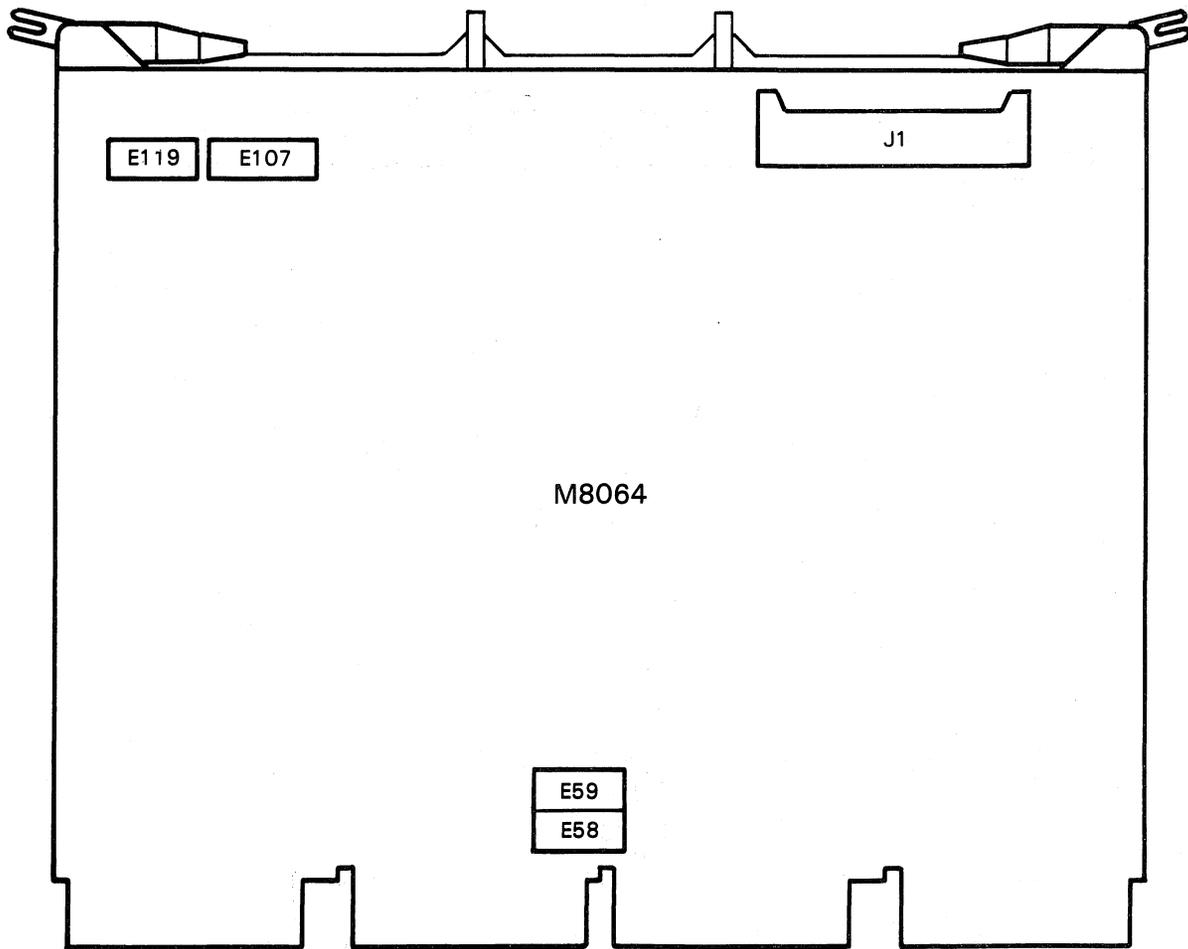
MK-2521

Figure 2-4   M8064 Switch Locations

2.5 INSTALLATION

When installing the DMV11 in the LSI-11 bus-compatible backplane, LSI-11 configuring rules *must* be followed.

Proceed with the installation as follows by performing the following on the slot that will contain the DMV11.

1. Verify that the backplane voltages are within the tolerances specified in Table 2-4.

2. Turn system power OFF and perform resistance checks on the backplane voltage sources to ground. This ensures that no short circuits exist. Refer to Table 2-4 for backplane pin assignments.

3. Configure the correct device address using switchpack settings from Table 2-5.

4. Configure the correct vector address using switchpack settings from Table 2-6.

5. Verify that the switch selectable features of the DMV11 are configured for the station being installed. See Figure 2-5.

6. Insert the appropriate module test connector into the correct microcontroller/line unit connector as specified in Table 2-7. Be sure to insert the test connector with "SIDE 1" (etched on the test connector) visible from the component side of the module. Refer to Figure 2-6 and 2-7.

   Schematics and outline drawings of each test connector used with the DMV11 are provided in Figure 2-8.

7. Turn system power ON.

8. Load and execute the DMV11 static diagnostics. Five error-free passes of each part is the minimum for successful operation.

   (C)VDMA** – DMV11 static logic test part 1
   (C)VDMB** – DMV11 static logic test part 2
   (C)VDMC** – DMV11 static logic test part 3
   (C)VDMD** – DMV11 static logic test part 4
   (C)VDME** – DMV11 static logic test part 5

9. Remove the module turnaround test connector and connect the appropriate cable (see Table 2-7 and Figure 2-9) to the proper Berg connector for the DMV11 option selected. Refer to Table 2-7 for detailed information on cable requirements and to Figures 2-10 through 2-14 for system cabling configurations.

NOTE
When installing panel cables BC55F or BC55H, it is important that the panel be properly mounted to the rear-mounting bulkhead to ensure adequate grounding.

When connecting the BC55H connector panel, verify that the appropriate modem jumpers on the panel are properly configured for the option selected. Table 2-8 lists each of these options and required jumper configurations.

Integral modem options require that a 75 ohms terminator be connected to each receive line (BC55F panel) at each end of a full-duplex and a half-duplex network. These terminators are available in both male (H3257) and female (H3258) types to accommodate different integral modem cabling. Selection of the appropriate terminator type is dependent upon which type of unused panel connector is available on the receive line at the BC55F panel. Refer to Figure 2-10 for DMV11 remote cabling and to Figure 2-11 for DMV11 to DMV11 local cabling.

10.   Insert the appropriate cable turnaround test connector in the end of the cable. Refer to Table 2-7 for the specific test connector. Load and execute the static diagnostics specified in Step 8 using the external maintenance mode selected to verify the module and cable. Upon obtaining a minimum of five error-free passes, proceed to the DMV11 system test procedures, Section 2.6. Figure 2-8 illustrates the various test connectors used in the DMV11.

2.6   DMV11 SYSTEM TESTING
The final step in the installation of a DMV11 subsystem is to exercise the DMV11 as: 1) a unit on the LSI-11 bus; and 2) a link in a communications network.

2.6.1   Functional Diagnostic Testing
Ensure that the specific cable turnaround test connector for the selected DMV11 option is still installed at the end of the cable. Load and execute the DMV11 functional diagnostics with the external mode selected. Upon obtaining a minimum of five error-free end passes, proceed to Section 2.6.2.

2.6.2   DEC/X11 System Exerciser
The DEC/X11 system exerciser for the DMV11 can be run in two different operating modes, internal and external. The internal mode selects faster LSI-11 bus activity. The external mode requires that the specific modem test connector be installed at the end of the cable. This is the preferred mode of operation. There are two DEC/X11 modules for the DMV11; DMD* and DME*.

2.6.3   Final Cable Connections
The final step in the installation process is to return the DMV11 to its normal cable connections, either to the appropriate modem or to the distribution panel. The DMV11 system cabling diagrams in Figures 2-10 through 2-14 have been included to help show overall cabling for the various DMV11-XX options. References to specified locations of the various test connectors during diagnostic testing are also included. After the cables are connected to the appropriate modem or distribution panel, it is suggested that the data communications link test program (DCLT) be exercised.

2.6.4   DMV11 Link Testing
The DMV11 can be exercised over a communications link by the data communications link test (DCLT). It is suggested that DCLT be configured to run first on a cable test connector and then on a modem with the modem analog loopback test feature selected (if the modem includes this feature). Next, the overall communications link should be exercised with the remote computer system that contains a DMV11.

2-10

Table 2-5 Device Address Selection

MSB / LSB bit map:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	1	← M8053 E53 M8064 E58 →								M8053 E54 / M8064 E59		0	0	0

SWITCH NUMBER	S8	S7	S6	S5	S4	S3	S2	S1	S2	S1	DEVICE ADDRESS
									ON		760020
								ON			760040
								ON	ON		760060
							ON				760100

						ON					760200

						ON	ON				760300

					ON						760400

					ON		ON				760500

					ON	ON					760600

					ON	ON	ON				760700

				ON							761000

			ON								762000

			ON	ON							763000

		ON									764000

NOTE: SWITCH ON RESPONDS TO LOGICAL ONE ON THE BUS

MK-2564

Table 2-6 Vector Address Selection

MSB															LSB
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	M8053 E54 M8064 E59						1/0	0	0

SWITCH NUMBER	S8	S7	S6	S5	S4	S3	VECTOR ADDRESS
		ON	ON				300
		ON	ON			ON	310
		ON	ON		ON		320
		ON	ON		ON	ON	330
		ON	ON	ON			340
		ON	ON	ON		ON	350
		ON	ON	ON	ON		360
		ON	ON	ON	ON	ON	370
	ON						400

	ON		ON				500

	ON	ON					600

	ON	ON	ON				700

NOTE: SWITCH ON PRODUCES LOGICAL ONE ON BUS

MK-2563

2-12

```
 8   7   6   5   4   3   2   1
┌───────────────────────────────┐
│      DDCMP ADDRESS REGISTER   │
│       TRIBUTARY/PASSWORD      │
└───────────────────────────────┘
E 119 (M8064)                  ZERO = "ON"
E 113 (M8053)
```

```
 8   7   6   5   4   3   2   1
┌───┬───┬───┬───┬───┬───┬───┬───┐
│   │   │   │   │   │   │   │   │
└───┴───┴───┴───┴───┴───┴───┴───┘
```

MODE WHEN SWITCH   REMOTE   AUTO   UNIT   MODE
    ONE IS SET   LOAD   ANSWER   NUMBER   ENABLE
                    DETECT   FOR
                    ENABLE   POWER   BOOTING
                              ON
                              BOOT
                              ENABLE

E 107 (M8064)   ZERO = "ON"
E 101 (M8053)
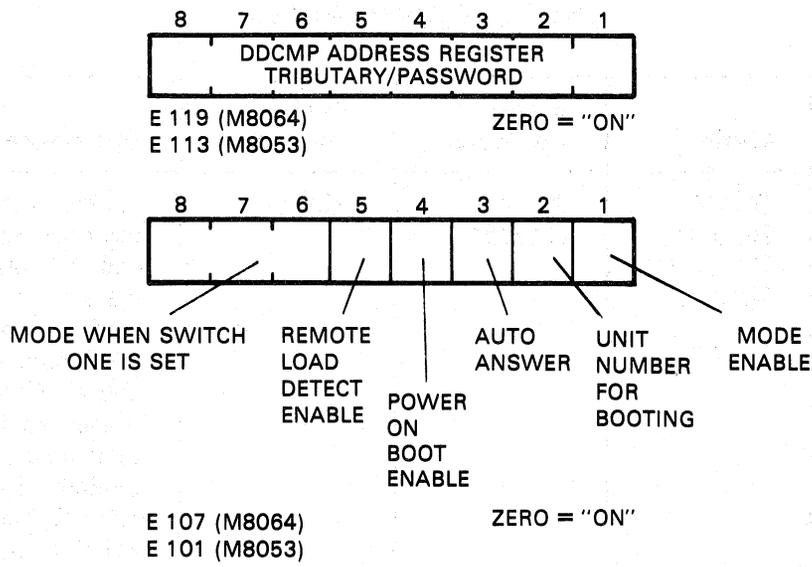
8	7	6	SWITCH SETTING FOR THE MODE OF OPERATION.
ON	ON	ON	HDX PT TO PT DMC COMPATIBLE
ON	ON	OFF	FDX PT TO PT DMC COMPATIBLE
ON	OFF	ON	HDX POINT TO POINT
ON	OFF	OFF	FDX POINT TO POINT
OFF	ON	ON	HDX CONTROL STATION
OFF	ON	OFF	FDX CONTROL STATION
OFF	OFF	ON	HDX TRIBUTARY STATION
OFF	OFF	OFF	FDX TRIBUTARY STATION

```
 10   9
┌────┬────┐
│ *  │    │
└────┴────┘
```

"ON" = V.35   HIGH
"OFF" = EIA   SPEED
   M8053

E 107 (M8064)
E 101 (M8053)
OFF = "LOGIC ONE"
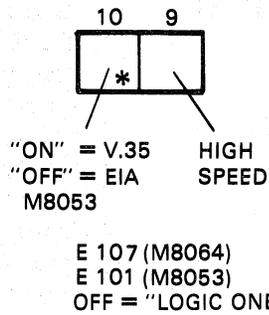
HIGH SPEED SWITCH
MUST BE SET
FOR INTEGRAL
MODEM OR WHEN
RUNNING ABOVE 19.2KB

* UNUSED
  ON
  M8064

ZERO = "ON"

MK-2493

Figure 2-5   DMV11 Switch Selectable Features

2-13

Table 2-7 Cable Description

Interface	Cable	Module Connector	Test Connector	Description
RS-232-C	BC55H Refer to Figure 2-9 View A	J2 (M8053)	H325	A cable with a 40-pin Berg connector at one end. The other end has a panel that includes two different cinch connectors, J1 and J2. Connector J2 is used for RS-232-C to connect to the modem with external cable BC05D-25. The panel is mounted to a rear-mounted bulkhead to ensure proper grounding and ease of access to external cable connections.
	BC05D-25 Refer to Figure 2-9 View B		H325	A 7.6 m (25 feet) external cable that connects to J2 of the BC55C panel and an RS-232-C modem.
RS-423-A	BC55H-03 Refer to Figure 2-9 View A	J2 (M8053)	H3251	Same cable as used for RS-232-C except that panel connector J1 is used with external cable BC55D-33 for connection to the modem. The panel is mounted to a rear-mounted bulkhead to ensure proper grounding and ease of access for external cable connections.
	BC55D-33 Refer to Figure 2-9 View C		H3251	A 10.1 m (33 feet) cable that connects to J1 of the BC55H panel and an RS-449 modem.

Table 2-7 Cable Description (Cont)

Interface	Cable	Module Connector	Test Connector	Description
V.35	BC05Z-25 Refer to Figure 2-9 View D	J1 (M8053)	H3250	A 7.6 m (25 feet) modem cable with a 40-pin Berg connector at one end that connects to J1 of the M8053. A 34-pin Data-Phone DIGITAL Service (DDS) connector is installed at the other end and connects to the modem.
Integral Modem	BC55F Refer to Figure 2-9 View F	J1 (M8064)	Panel switch to HDX position	A 0.9 m (3 feet) cable with a 40-pin Berg connector at one end that plugs into J1 of the M8064. The panel assembly is installed at the rear-mounted bulkhead for ease of external connections and to ensure proper grounding. Appropriate terminator connectors H3257 or H3258 must be used. See Figures 2-9 and View F.
Integral Modem	BC55N-98 Refer to Figure 2-9 View E	Local link BC55F panel	None	A 29.9 m (98 feet) external twinax cable used to interconnect a DMP11 or a DMR11 to a DMV11 system for a selected data rate of 56K b/s.
	BC55M-98 Refer to Figure 2-9 View E	None	None	A 29.9 m (98 feet) external triaxial cable used for the same purpose as the BC55N, but for data rates above 56K b/s. The DMV11-AC supports data rates of 56K b/s.

CONNECT CABLE BC05Z FOR V.35 INTERFACE

H3254
TEST CONNECTOR

SIDE 1

J1

H3255
TEST CONNECTOR

SIDE 1

J2

CONNECT CABLE BC55H
FOR RS-232-C OR RS-423-A
INTERFACE.
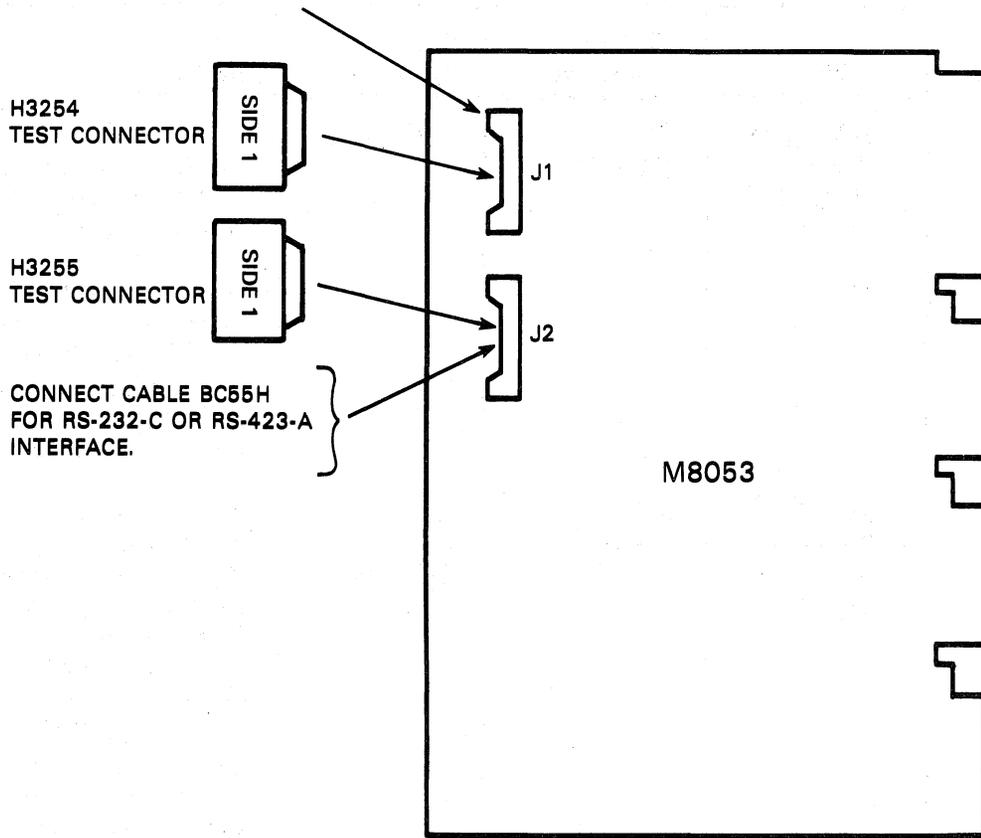
M8053

MK-2508

Figure 2-6   Test Connector Insertion for the M8053

CONNECT BC55F
FOR INTEGRAL MODEM

H3254
TEST CONNECTOR

SIDE 1

J1
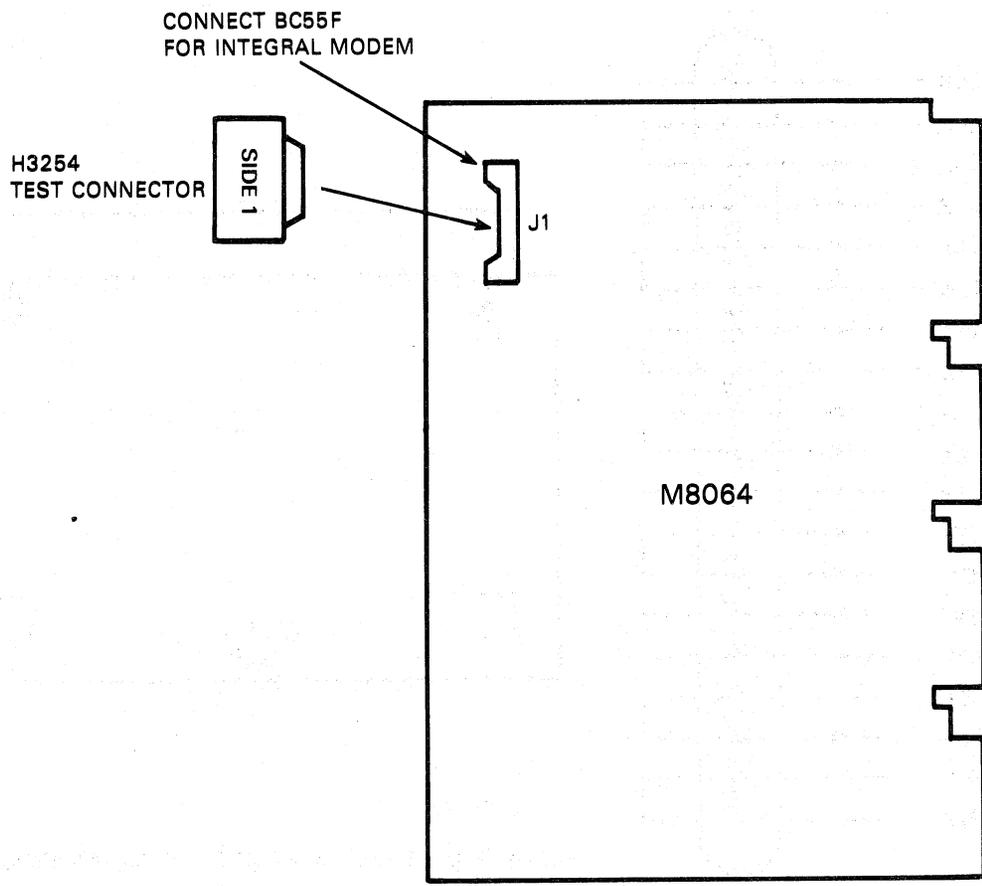
M8064

MK-2699

Figure 2-7   Test Connector Insertion for the M8064
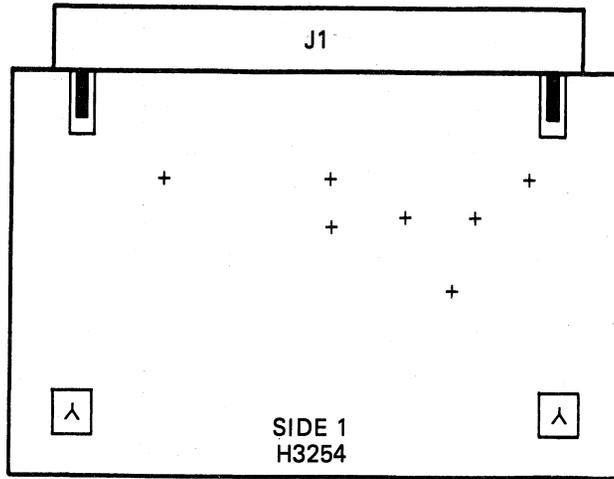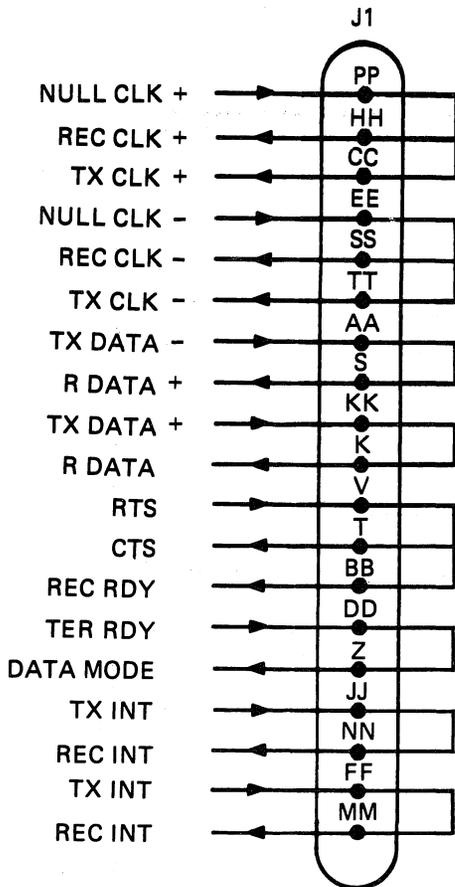
VIEW A

H3254 MODULE TEST CONNECTOR (J1 ON M8053/M8064)

MK-2645
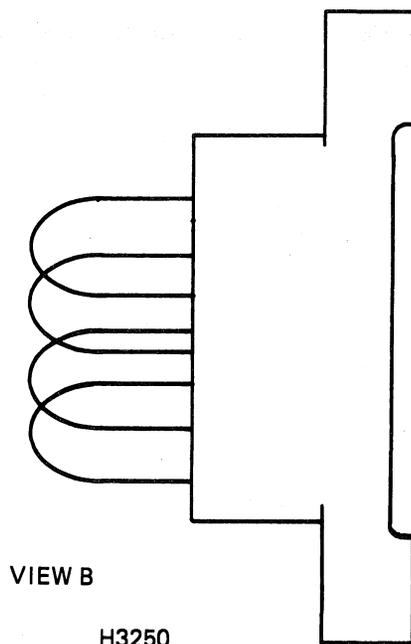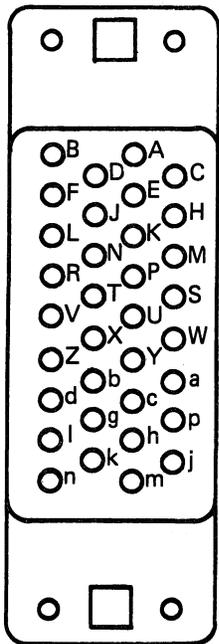
VIEW B

H3250
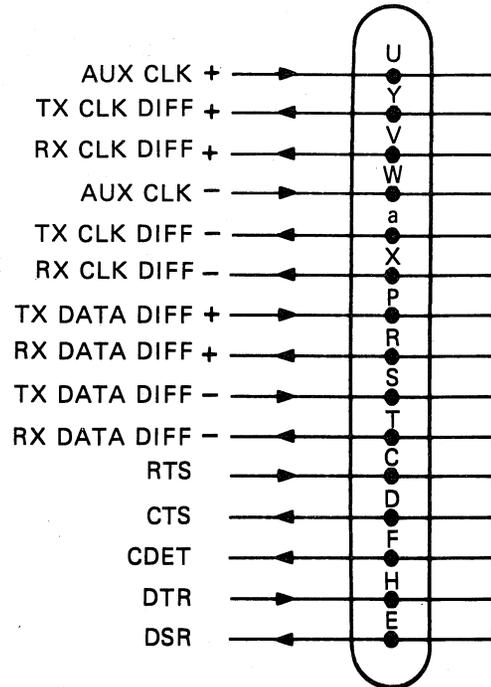
MK-2123

Figure 2-8   DMV11 Test Connectors (Sheet 1 of 4)
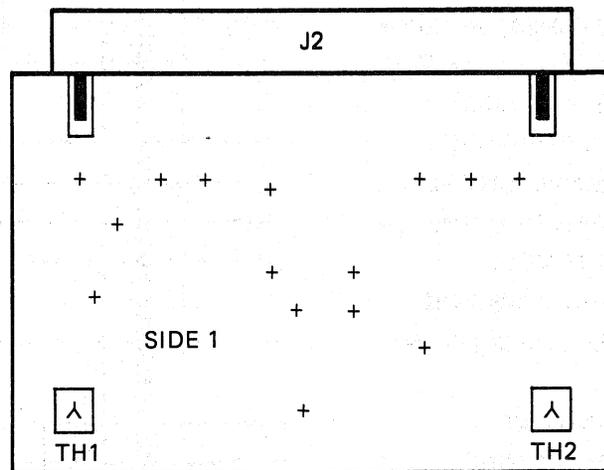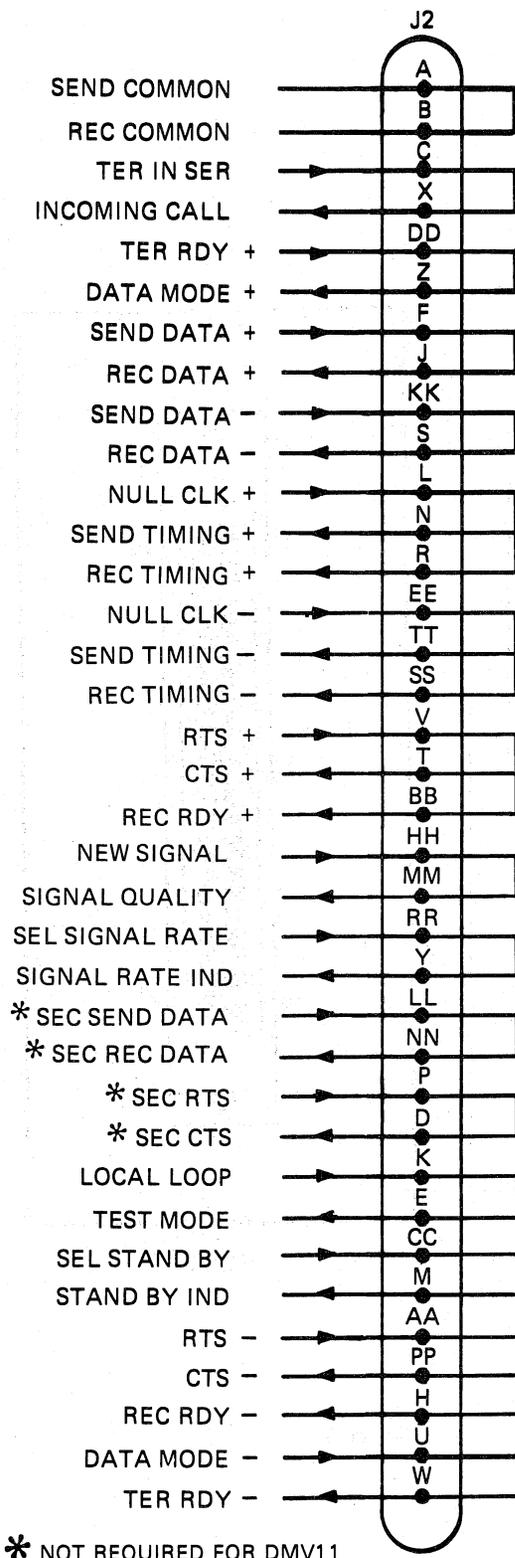
Figure 2-8 DMV11 Test Connectors (Sheet 2 of 4)

Figure 2-8   DMV11 Test Connectors (Sheet 3 of 4)

H325

SCE → 24
SCT ← 15
SCR ← 17

SEC XMIT → 11
SEC RCV ← 12

XMIT DATA → 2
RCV DATA ← 3

RS → 4
CS ← 5
CO ← 8

NEW SYNC → 14
DATA SET RDY ← 6

CUT TO TEST*
NEW SYNC

DTR → 20
RI ← 22

CUT TO TEST
NEW SYNC
SIDE 1

H325

VIEW E

H325 CABLE TEST CONNECTOR (BC55C AND BC05D)
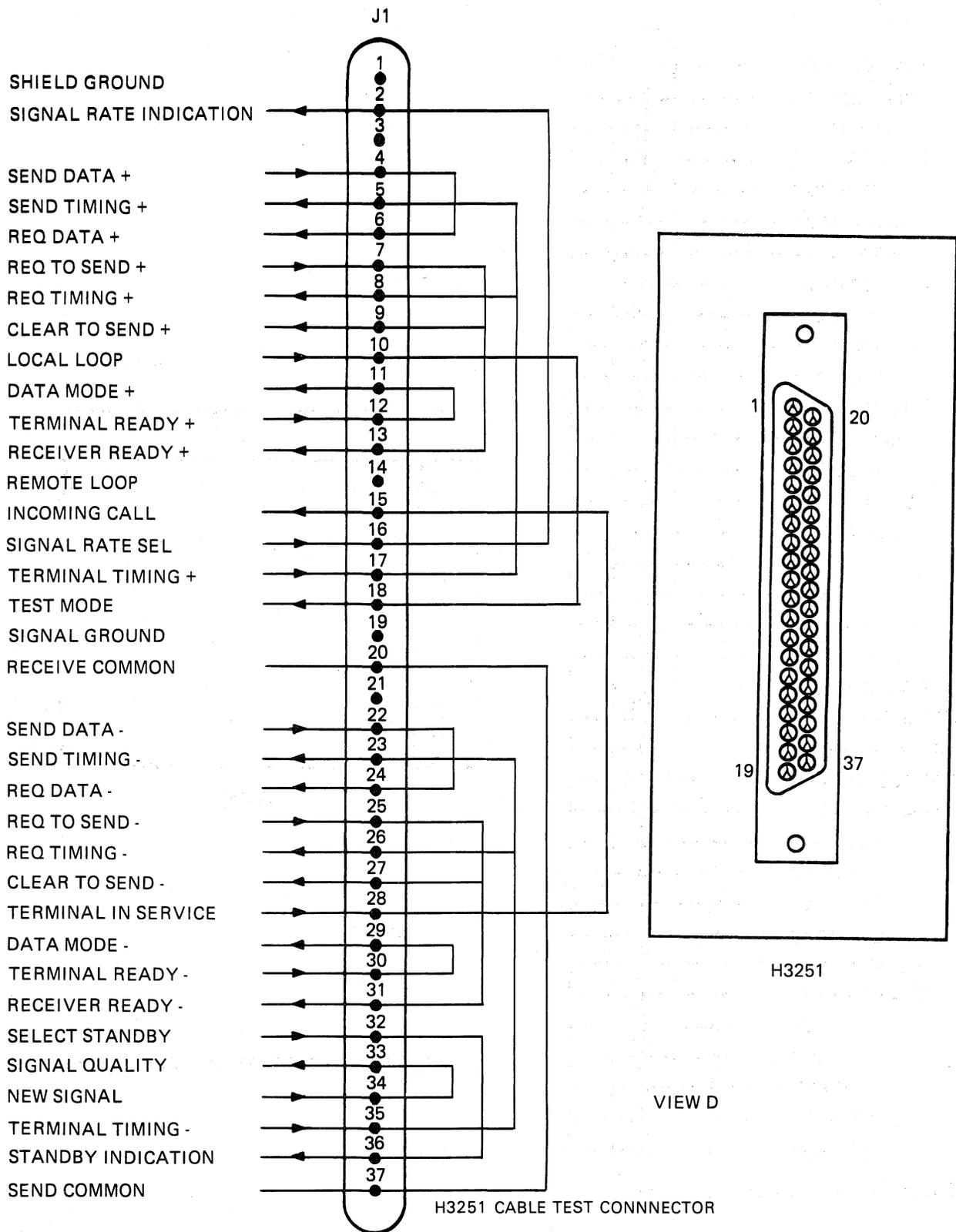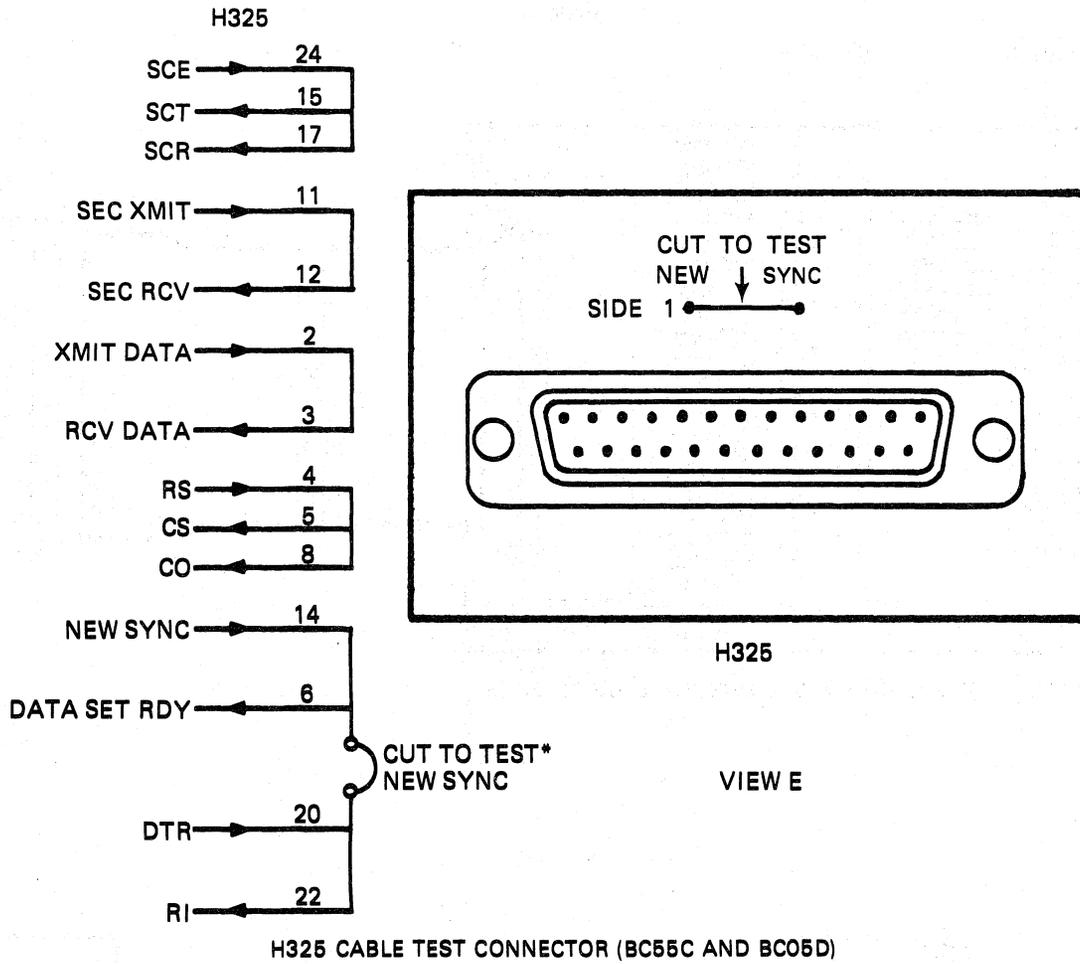
MK-2124

Figure 2-8   DMV11 Test Connectors (Sheet 4 of 4)

2-21

VIEW A

RS-232-C   RS-423-A

J1   J3

J2

W15
W16
W17
W18
W19
W20

W1
W2
W3
W4
W5
W6
W7
W8
W9

C5
C6
C4
C3
C1
C2

W10
W11
W12
W13
W14

R1
W21

A

VV
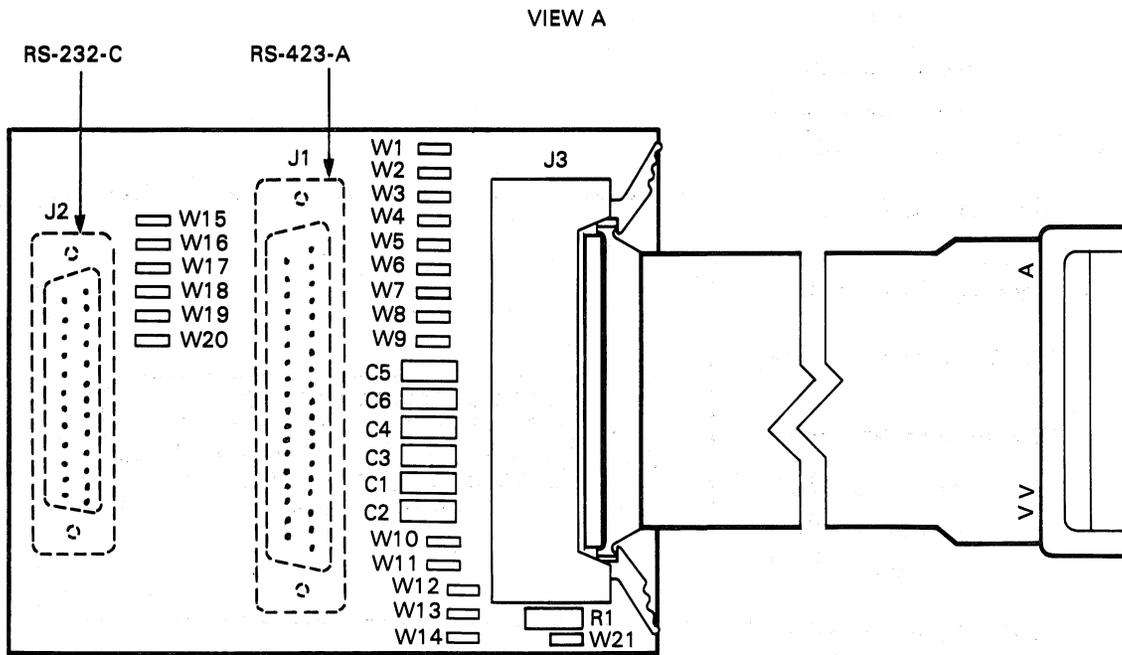
BC55H-3 (RS-232-C/RS-423-A) INTERFACE PANEL CABLE

MK-2656

VIEW B

25 PIN
CINCH

BC05D-25 (RS-232-C INTERFACE) MODEM CABLE

25 PIN
CINCH

MK-2745

VIEW C

37 PIN
CINCH

BC55D-33 (RS-422-A/RS423-A INTERFACE) MODEM CABLE

37 PIN
CINCH
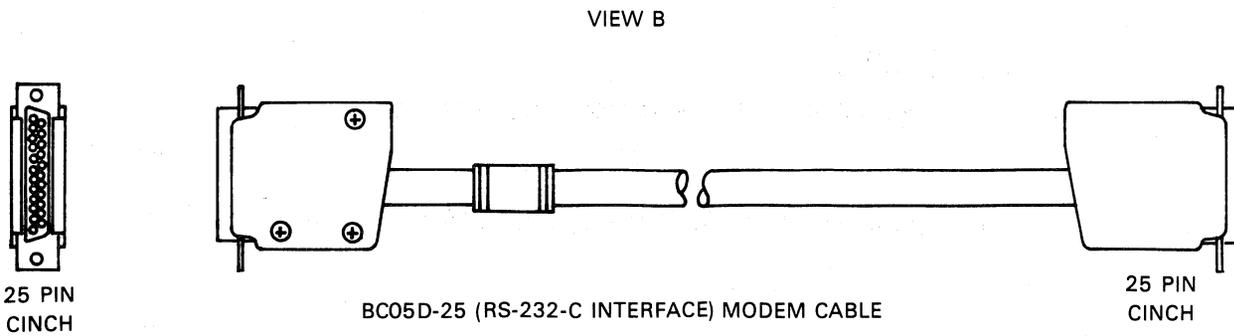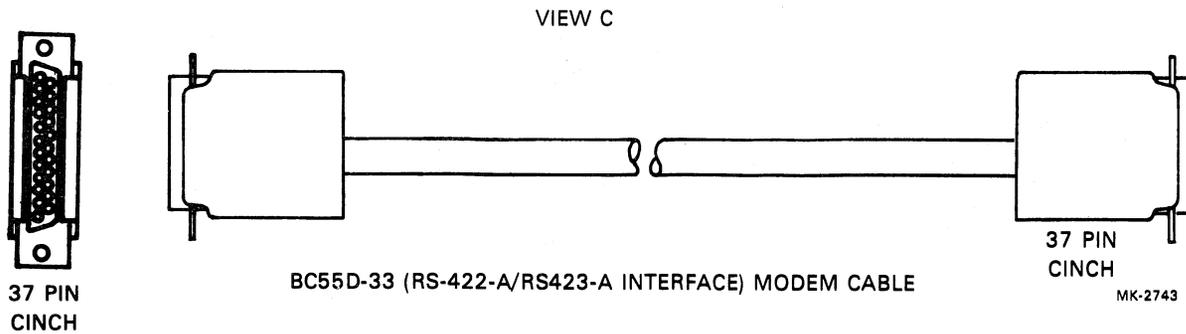
MK-2743

Figure 2-9   DMV11 Cable Drawings (Sheet 1 of 3)
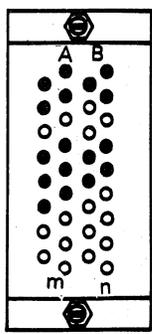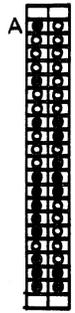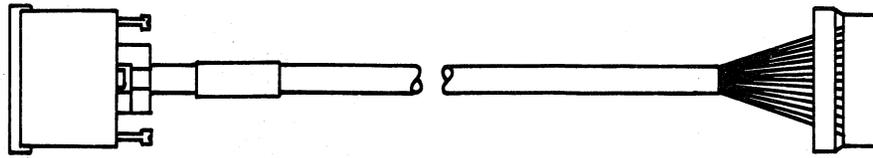
BC05Z-25 (V.35 INTERFACE) MODEM CABLE

MK-2744

VIEW E
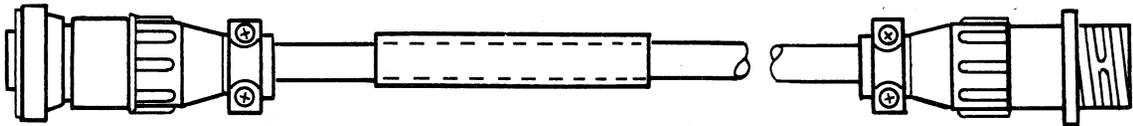
BC55N TWINAX CABLE
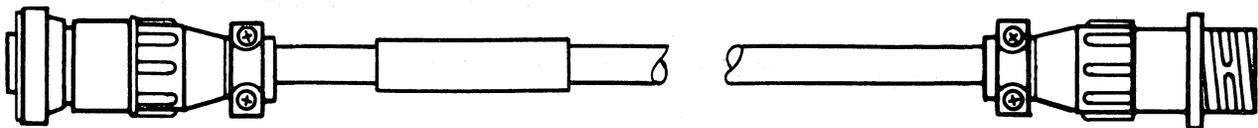
BC55M TRIAX CABLE

MK-2742

Figure 2-9   DMV11 Cable Drawings (Sheet 2 of 3)
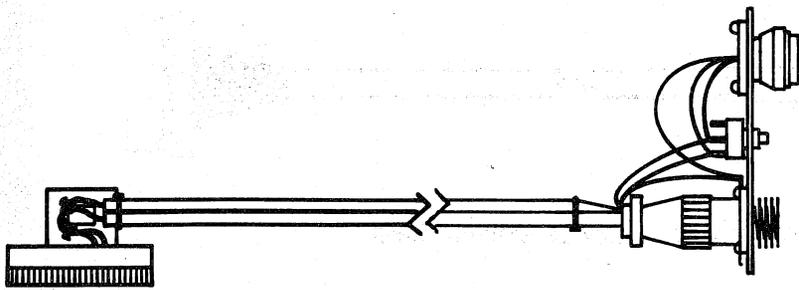
BC55F (INTEGRAL MODEM) PANEL CABLE

FEMALE CONNECTORS

OUT   OUT

P4   P3

HDX

RECEIVE   TRANSMIT

FDX

IN   IN

P1   P2
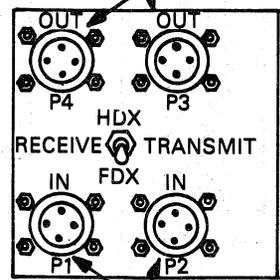
MALE CONNECTORS

CONNECTOR PANEL
(FRONT VIEW)

MK-2646
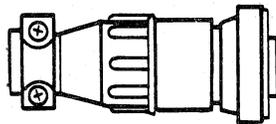
H3258
TERMINATOR
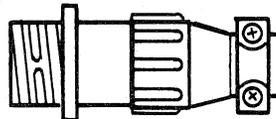
H3257
TERMINATOR

MK-2244

Figure 2-9   DMV11 Cable Drawings (Sheet 3 of 3)
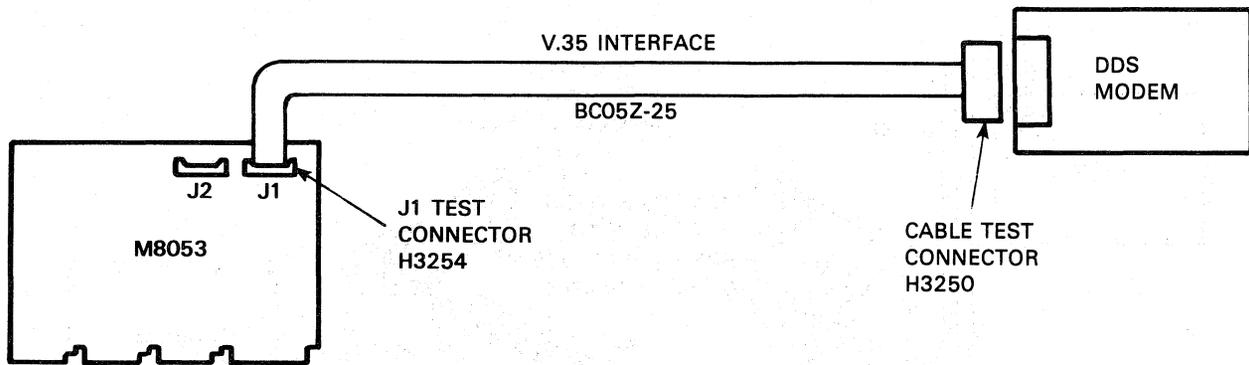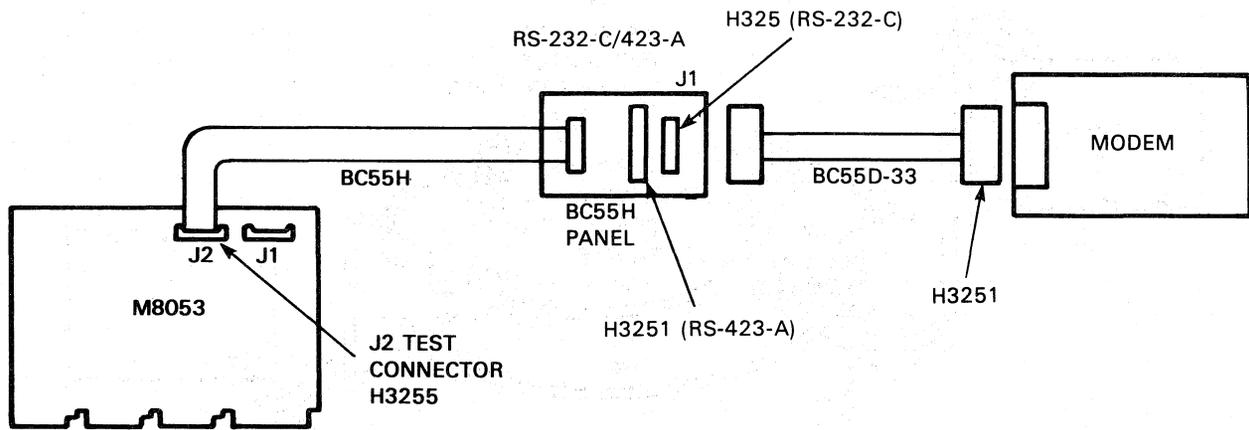
Figure 2-10   DMV11 Remote System Cabling Diagram

FULL-DUPLEX

INSTALL 75Ω
TERMINATOR
CONNECTOR (H3257)

M8064

J1

BC55F

RCV
XMIT
HDX
FDX

HDX/FDX SWITCH
MUST BE IN THE FDX
(down) POSITION ON
BOTH PANELS

RCV
XMIT
HDX
FDX

*

*

F

F

M8064

J1

BC55F

INSTALL 75Ω
TERMINATOR
CONNECTOR
(H3258)

* FOR 56K bps USE CABLE BC55N-98

MK-2491

HALF-DUPLEX

INSTALL 75Ω
TERMINATOR
CONNECTOR (H3257)

M8064

J1

BC55F

RCV
XMIT
HDX
FDX

HDX/FDX SWITCH
MUST BE IN THE
HDX (up) POSITION
ON BOTH PANELS

RCV
XMIT
HDX
FDX

*

F

M8064

J1

BC55F

INSTALL 75Ω
TERMINATOR
CONNECTOR
(H3258)

* FOR 56K bps USE CABLE BC55N-98

MK-2492

Figure 2-11   DMV11 to DMV11 Integral (Local) Modem Cabling Diagram (Point-to-Point)

HDX NETWORK
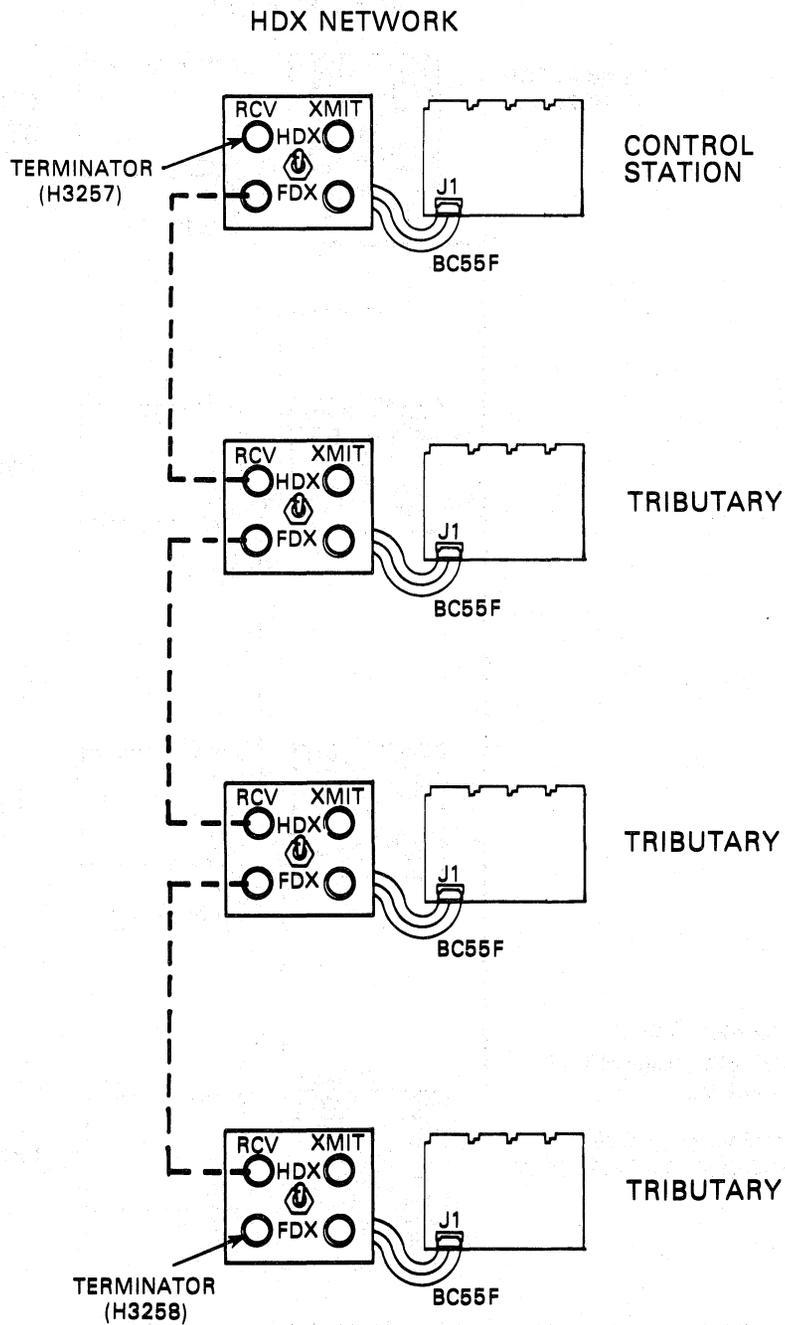
Figure 2-12   Half-Duplex Multipoint Network (Control Station End Node)

FDX NETWORK

TERMINATOR
(H3257)

RCV   XMIT
HDX

FDX

BC55F

CONTROL
STATION

J1

RCV   XMIT
HDX

FDX

BC55F

TRIBUTARY

J1

RCV   XMIT
HDX

FDX

BC55F

TRIBUTARY

J1

NOTES:

SOLID LINE REPRESENTS
CONTROL STATION TRANSMIT TO
TRIBUTARY RECEIVE.

DASH LINE REPRESENTS CONTROL
STATION RECEIVE FROM TRIBUTARY
TRANSMIT.

H3257

RCV   XMIT
HDX

FDX

BC55F

TRIBUTARY

J1

H3258
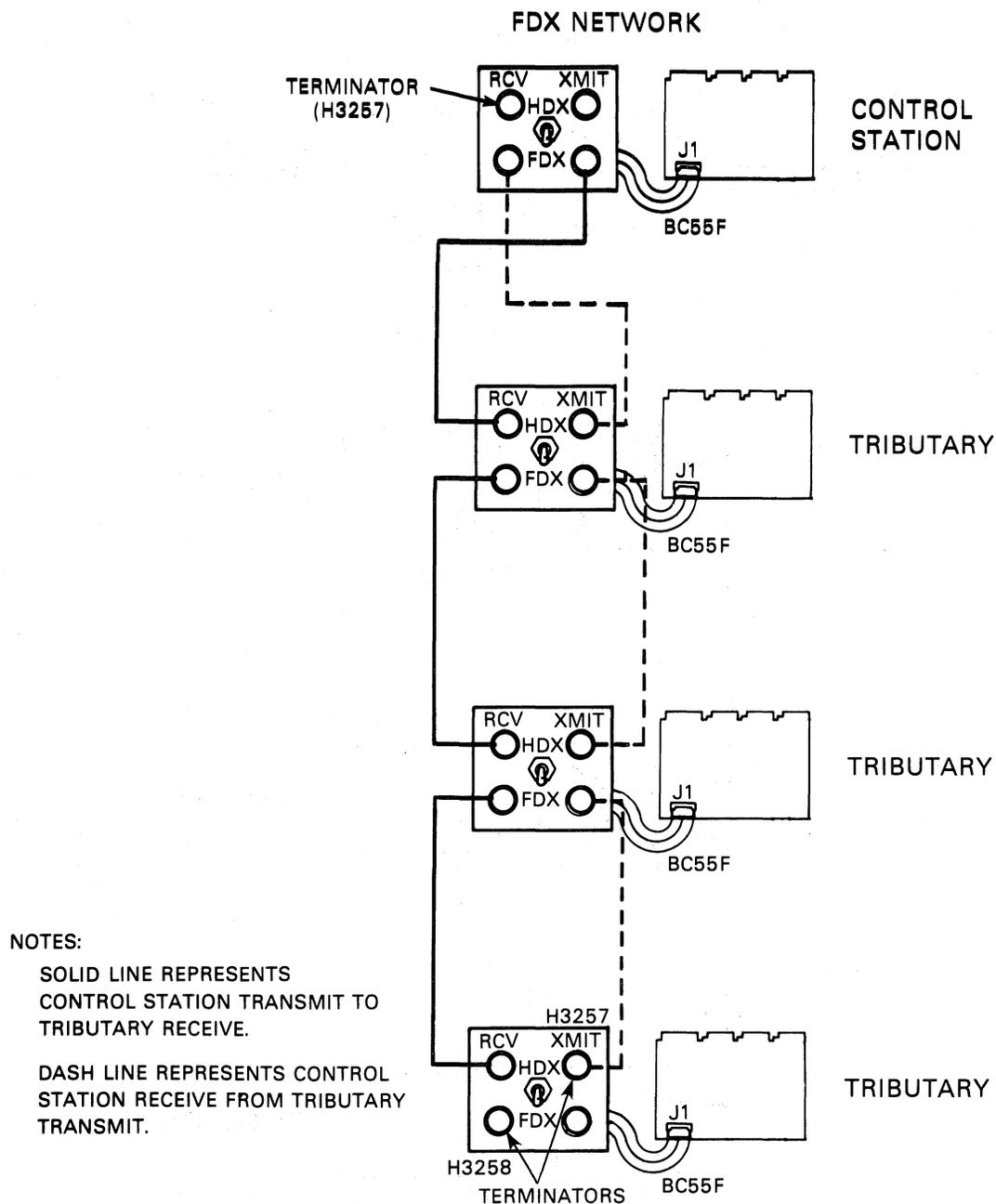
TERMINATORS

BOTH ENDS OF THE TRANSMIT LINE FROM THE TRIBUTARIES NEED TERMINATION
IN ADDITION TO THE ONE TRANSMIT LINE FROM THE CONTROL STATION

MK-2506

Figure 2-13   Full-Duplex Multipoint Network (Control Station End Node)

2-28

FDX NETWORK

NOTES:
   SOLID LINE REPRESENTS
   CONTROL STATION TRANSMIT TO
   TRIBUTARY RECEIVE.

   DASH LINE REPRESENTS CONTROL
   STATION RECEIVE FROM TRIBUTARY
   TRANSMIT.
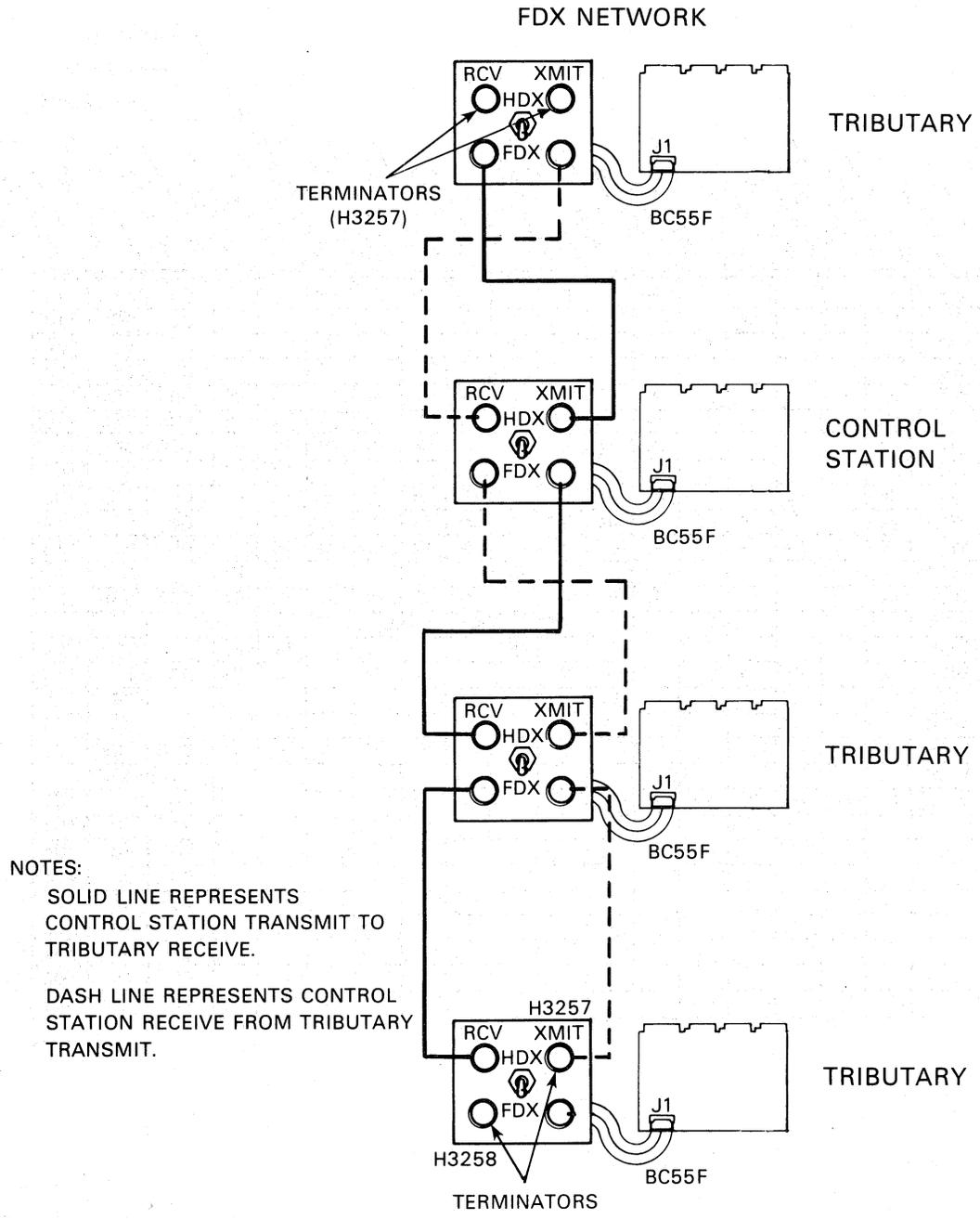
SINCE THE CONTROL STATION IS NOT AN END MODE, THERE IS NEED TO TERMINATE TWO SETS OF
TRANSMIT LINES FROM THE CONTROL STATION, ADDITIONALLY BOTH ENDS OF THE TRANSMIT LINE FROM
THE TRIBUTARIES

MK-2505

Figure 2-14   Full-Duplex Multipoint Network (Control Station Inner Node)

2-29

Table 2-8   Modem Option Jumper Functions

Column groups at upper right — leader labels: FUTURE D, X.21BIS, X.20BIS (pointing to the ISO2110.2 / related columns).

J2 PIN	JUMPER	RS-232-C	BELL 103J	BELL 208B	BELL 209	DATEL 200	DATEL 600	DATEL 2400	DATEL 4800	CCITT V.21	CCITT V.23	CCITT V.26B	CCITT V.27T	ISO2110-1972	ISO2110.2	ISO2110.2	EIA RS-232-C	EIA RS-449	CCITT V.24
23	W1	IN					IN	IN	IN		IN	IN	IN	IN	IN		CH	SR	111
21	W2	IN			IN												CG	SQ	110
11	W3				IN			IN					IN					SF	126
23	W4																CI	SF	112
16	W5	IN				IN	IN	IN		IN	IN	IN	IN	IN	IN	IN	SBB	SRD	119
14	W6	IN				IN	IN	IN		IN	IN	IN	IN	IN	IN	IN	SBA	SSD	118
12	W7	IN				IN	IN	IN		IN	IN	IN	IN	IN	IN	IN	SCF	SRR	122
21	W8								IN					IN	IN			RL	140
4	W9	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	IN	CA	RS	105
15	W10	IN	IN	IN			IN	IN		IN	IN	IN	IN	IN			DB	ST	114
17	W11	IN	IN	IN			IN	IN		IN	IN	IN	IN	IN			DD	RT	115
18	W12							IN					IN	IN				LL	141
19	W13	IN				IN	IN	IN		IN	IN	IN	IN	IN	IN	IN	SCA	SRS	121
	W14	NOT NORMALLY INSTALLED																	
25	W15								IN					IN	IN			TM	142
24	W16	IN		IN	IN			IN			IN	IN		IN	IN		DA	TT	113
25	W17						IN											SB	117
24	W18						IN											SS	116
13	W19	IN				IN	IN	IN		IN	IN	IN	IN	IN	IN	IN	SCB	SCS	121
25	W20	MAKE BUSY																	
1	W21	IN	IN	IN	IN	IN	IN	IN	IN						IN		AA		101
2																	BA	SD	103
3																	BB	RD	104
5																	CB	CS	106
6																	CC	DM	107
7																	AB	SG	102
8																	CF	RR	109
20																	CD	TR	108
22																	CE	IC	125

MK-2725

CHAPTER 3
COMMAND AND RESPONSE STRUCTURES

3.1 INTRODUCTION
This chapter defines DMV11 command and response formats in all necessary detail, and describes all programming sequences relevant to DMV11 operation in the network environment. The CSR command structure and format of input commands and output responses, as well as data port descriptions, are described in detail. Discussions include special programming techniques, user access to maintenance mode, and user interpretation of status/error reporting.

3.2 COMMAND STRUCTURE
The DMV11 command set is structured into two categories; input commands and output responses. Brief overviews of input commands and output responses, including command codes and the hand-shaking requirements, are provided in this section.

Transfer of control and status information between the main CPU resident user program and the DMV11 is accomplished through four 16-bit control and status registers (CSRs). Input commands are issued to the DMV11 by the user program, and output responses are issued to the user program by the DMV11.

NOTE
Normally only four CSRs are used, but in the 22-bit
address mode, eight CSRs are available.

3.2.1 Control and Status Registers
Four 16-bit CSRs are used to transfer control and status information. These registers are both byte and word addressable. The eight bytes are assigned addresses in the floating address space in the I/O page as follows:

16XXX0, 16XXX1, 16XXX2, 16XXX3, 16XXX4, 16XXX5, 16XXX6, and 16XXX7.

For discussion, these byte addresses are designated byte select 0 through 7 (BSEL0 through BSEL7). BSEL10 and BSEL11 are only used in 22-bit address mode. BSEL12 through BSEL17 are not used by the user/DMV11-command structure and are not referred to in this document.

The four word addresses are the even numbered locations and are designated select 0, 2, 4, and 6 (SEL0, SEL2, SEL4, and SEL6). The CSR addresses are assigned to the floating address space. The floating address ranking for the DMV11 is 24 (See Appendix B). The relationship between the symbolic byte and word addresses for DMV11 CSRs, and the actual CSR layout, is shown in Figure 3-1. Figure 3-2 illustrates the fields in CSR bytes BSEL0, BSEL2, and BSEL3 that comprise the fixed format portion of both user-program commands and DMV11 responses. This fixed format portion serves to identify the command/response type, address of the tributary that the command/response applies to, and coordinate ownership of the CSRs between the DMV11 and the user program. Detailed bit descriptions of SEL0 and BSEL2 are provided in Tables 3-1 and 3-2 respectively.

The four bytes comprising SEL4 and SEL6 contain the fields pertinent to each user-program command and DMV11 response. Detailed descriptions of the SEL4 and SEL6 fields are presented in Sections 3.3 through 3.4.
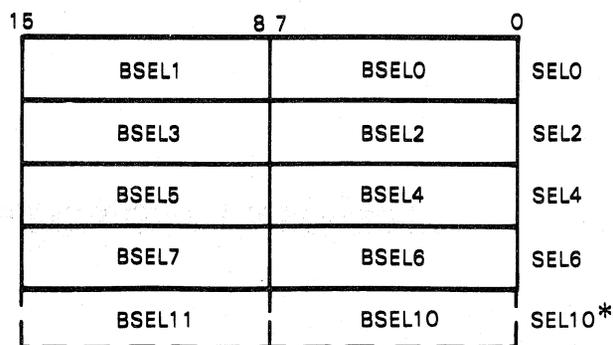
*SEL10 IS ONLY USED IN 22 BIT ADDRESS MODE

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Figure 3-1   DMV11 CSRs Byte and Word
Symbolic Addresses
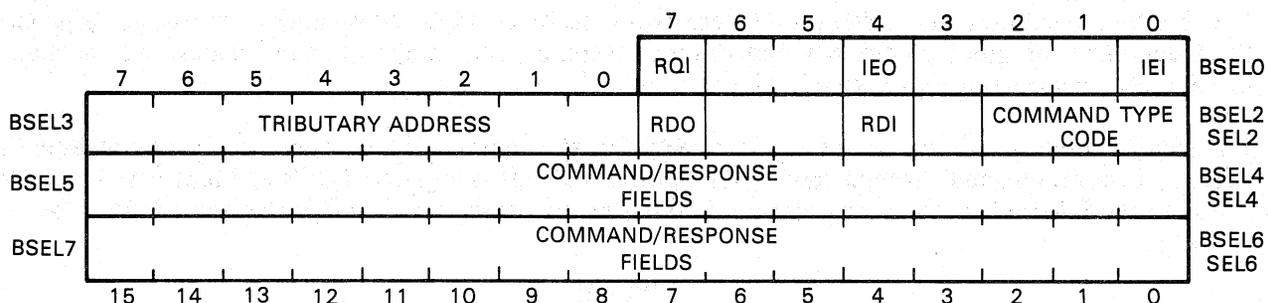
MK-1636

Figure 3-2   Fixed and Variable Formats for Commands and Responses

Table 3-1   SEL0 Bit Functions

Bits	Name	Description
BSEL0		
0	Interrupt Enable In (IEI)	When set, this bit enables the DMV11, upon asserting RDI (bit 4 of BSEL2), to generate an interrupt to vector address XX0.
1-3	Reserved	
4	Interrupt Enable Out (IEO)	When set, this bit enables the DMV11, upon asserting RDO (bit 7 of BSEL2), to generate an interrupt to vector address XX4.
5-6	Reserved	

Table 3-1 SEL0 Bit Functions (Cont)

Bits	Name	Description
7	Request In (RQI)	This bit is set by the user program to request access to the data port. It is cleared by the user program when the data port is not required for further issuing of commands. The user program may leave RQI set if successive requests for the data port are pending.
BSEL1 8	Maintenance Request	When set, along with master clear (bit 14 of SEL4), this bit causes the DMV11 to enter the maintenance register emulation section of the microcode.

NOTE
Detailed discussion of maintenance register emula-
tion is presented in Section 4.8.

Bits	Name	Description
9-10	Reserved	
11	Diagnostic Mode	When set, this bit allows diagnostic programs to change the mode of operation of the DMV11 using the mode definition command to override the mode switches.
12	Reserved	
13	Invoke P/MOP Boot	Invoke primary MOP mode. When set to one, this bit causes the DMV11 at this multipoint station to request that the control station initiate the primary MOP (maintenance operation protocol) boot procedure. In point-to-point networks, a DMV11 having this bit set requests the other station to initiate the primary MOP boot procedure.

NOTE
The master clear bit (bit 14) must also be asserted
to use invoke P/MOP.

Bits	Name	Description
14	Master Clear	When set, this bit initializes the DMV11. The clock is enabled and the RUN flip-flop is set. Master clear is self-clearing.
15	Run	This bit controls running of the microprocessor. It is set by bus initialization or master clear. When run is cleared the microprocessor halts.

Table 3-2 BSEL2 Bit Functions

Bits	Name	Description
0-2	Control/Response Code	These bits define the type of input command or output response as follows.

Bits			Description
2	1	0	
0	0	0	Buffer address/character count (RCV) command or buffer disposition (RCV complete) response
0	0	1	Control command or control response
0	1	0	Mode definition command or information response
0	1	1	Buffer disposition (RCV unused) response
1	0	0	Buffer address/character count (XMIT) command or buffer disposition (XMIT complete) response
1	0	1	Reserved
1	1	0	Buffer disposition (sent but not acknowledged) response
1	1	1	Buffer disposition (not sent) response

Bits	Name	Description
3	22-Bit Mode	This bit when set indicates to the DMV11 that the buffer address is in the 22-bit format.
4	Ready In (RDI)	RDI is the DMV11 response to RQI, indicating to the user program that it has control of the CSRs to issue a command. It is cleared by the user program when the data port contains the input command. Clearing RDI returns control back to the DMV11.
5-6	Reserved	
7	Ready Out (RDO)	RDO is asserted by the DMV11 to indicate that the data ports (SEL4 and SEL6) contain an output response for the user program. The user program must clear RDO after it has read this information. Clearing RDO returns the CSRs to the DMV11.

3.2.2 Input Commands Overview

In general, input commands provide the means for the user program to assign, receive, or transmit buffers to the DMV11. Detailed field descriptions and formats of each input command are provided in Section 3.3

There are four types of input commands that can be issued to the DMV11 for execution.

- Microprocessor control/maintenance command;
- Mode definition;
- Control;
- Buffer address/character count.

With the exception of the microprocessor control/maintenance command, input commands require an identification code in the first three bits of BSEL2 (see Figure 3-2). These codes, which define each command and variations of specific commands within the command set, are defined in Table 3-2 and listed in Table 3-3.

NOTE
CSR addresses are expressed in octal.

Table 3-3   Input Command Codes

Input Command Type	Binary Code(BSEL2)		
	Bit	Bit	Bit
	2	1	0
Mode definition	0	1	0
Control	0	0	1
Buffer address/character count (receive)	0	0	0
Buffer address/character count (transmit)	1	0	0

3.2.3 Output Responses Overview

Output responses provide a means for the DMV11 to report various normal and abnormal (error) conditions concerning the data transfer operation. Three basic responses are provided:

- Buffer disposition;
- Control;
- Information.

The buffer disposition response is used to return both used and unused buffers to the user program.

The control response is used to report error conditions concerning the microcontroller/line unit hardware, data link, physical link, or remote station. It also passes protocol information to the user.

The information response provides information requested by a control command from the user program.

3.3 DMV11 INPUT COMMANDS

This section provides detailed descriptions of each input command. Command formats and data port usages are illustrated and defined. User-program execution requirements, command variables, and action taken by the DMV11 in response to commands are discussed.

3.3.1 Microprocessor Control/Maintenance Command

This single byte command has two functions; to initialize and cause the DMV11 to start running, and to cause entry into the microcode maintenance loop when the maintenance request bit is set. At start-up time under normal operating conditions, this is the first command issued by the user program in order to initialize the DMV11.

The format for the DMV11 initialization register (BSEL1) is shown in Figure 3-3. To set the master clear bit and thereby cause entry into the DMV11 running mode, the user program moves a byte with an octal value of 100 to BSEL1. As a result, all condition-sensitive logic in the DMV11 is reset for start-up, and the start-up diagnostic is executed. When the diagnostic completes satisfactorily, the run bit in BSEL1 is set to one. This indicates that the DMV11 is running and the microcode is executing.

Figure 3-4 presents a flow chart describing how to initialize the DMV11. A timeout counter is set to avoid the possibility of the user program being caught in an endless loop in case the internal diagnostic does not complete successfully.
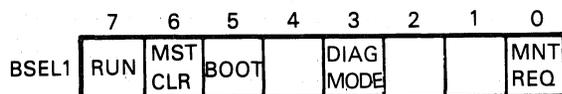
```
          7    6    5    4    3    2    1    0
        ┌────┬────┬────┬────┬────┬────┬────┬────┐
BSEL1   │RUN │MST │BOOT│    │DIAG│    │    │MNT │
        │    │CLR │    │    │MODE│    │    │REQ │
        └────┴────┴────┴────┴────┴────┴────┴────┘

                                      MK-2513
```

Figure 3-3   Microprocessor Control/Maintenance
Command Format

3.3.2 Mode Definition Command

Functionally, the mode definition command is used to establish the hierarchy of a network and the characteristics of the communications line serving that network. As shown in Figure 3-5, the mode definition command contains two fields; the command type code field in BSEL2, and the mode field in BSEL6. The mode field contains a code defining the function to be performed by the command.

With the mode definition command, the user program can designate the DMV11 as a control station, a tributary in a multipoint network, or as a node in a point-to-point network. In addition, the characteristics (half-duplex or full-duplex) of the physical communications line connecting the network can be defined.

The actual mode field codes and the functions implemented by each code are listed in Table 3-4.

Under normal operating conditions, the mode definition command is issued by the user program at start-up time (after the internal microdiagnostics have executed successfully and the run bit is set). Network discipline requires that each DMV11 in a network issue a mode definition command that is appropriate to the network. For example, in a half-duplex multipoint network comprised solely of DMV11s:

1.   The user program at the control station issues a mode definition command with the mode field set at four.

2.   The user program at each tributary station issues a mode definition command with the mode field set to six.

```
                    ┌─────────┐
                    │  ENTER  │
                    └────┬────┘
                         │
              ┌──────────▼──────────┐
              │ SET MASTER          │
              │ CLEAR BIT           │
              │ IN BSEL1            │
              │ (BSEL= 100₈)        │
              └──────────┬──────────┘
                         │
              ┌──────────▼──────────┐
              │ SET                 │
              │ TIME OUT            │
              │ COUNTER             │
              │ TO                  │
              │ ≥ 0.5 SEC           │
              └──────────┬──────────┘
```
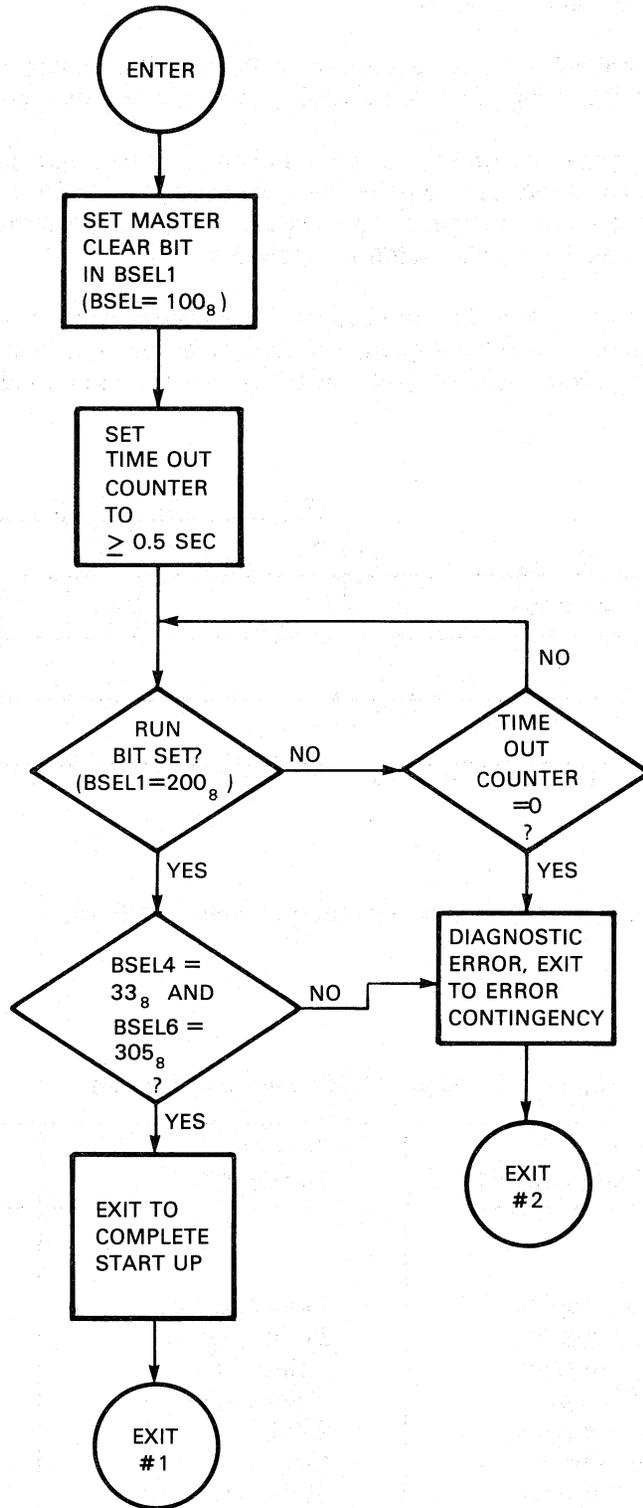
Figure 3-4   Initialization of the DMV11

This network discipline also applies to DMV11s operating in point-to-point networks with other DMV11s, DMP11s, DMC11s, and DMR11s.

When tributary addresses are software assigned, the mode definition command must be used at the control and tributary stations to configure the network and assign line characteristics.

The functions performed by the mode definition command can also be implemented by the mode selection switches on the DMV11 module. The switches must be used to establish mode definition functions when tributary addresses are switch assigned. The switch setting for performing the mode definition functions corresponds to the BSEL6 codes listed in Table 3-4.

Once the type of station is set, it can only be changed by a master clear or a physical change in the switches. If the type of station is switch assigned, a master clear has no affect. However, the switches are overridden when the diagnostic mode bit (bit 3 of BSEL1) is set and a mode definition command is issued.
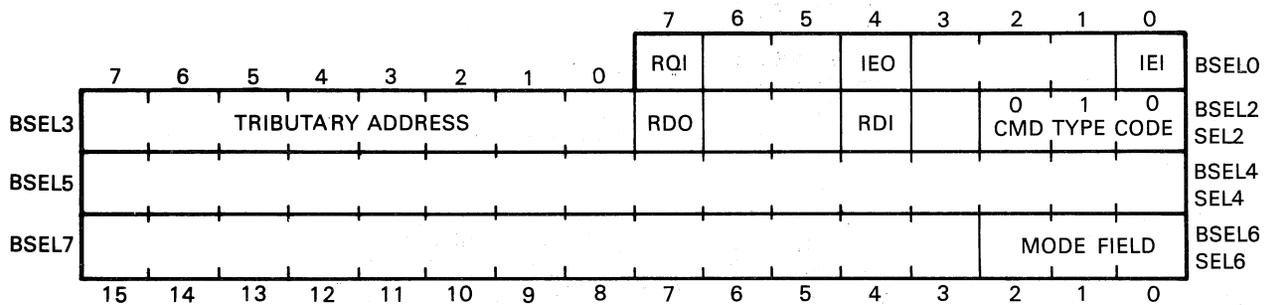
Figure 3-5   Mode Definition Command Format

Table 3-4   Mode Field Codes and Functions

BSEL6 Bit Positions			Line Characteristics	Network Configuration	DMC11-Line Compatibility?
2	1	0			
0	0	0	Half-duplex	Point-to-point	Yes
0	0	1	Full-duplex	Point-to-point	Yes
0	1	0	Half-duplex	Point-to-point	No
0	1	1	Full-duplex	Point-to-point	No
1	0	0	Half-duplex	Control station	N/A
1	0	1	Full-duplex	Control station	N/A
1	1	0	Half-duplex	Tributary station	N/A
1	1	1	Full-duplex	Tributary station	N/A

3.3.3 Control Command

This command is the primary means of controlling the operation of DMV11-implemented networks. The format of the control command is illustrated in Figure 3-6.

At start-up time, the user program at the DMV11 control station must issue one control command (establish tributary) for each tributary address supported in the multipoint network. This must be done after issuing the microprocessor control and mode definition commands. This causes the microcode to create a tributary status slot (TSS) in the DMV11 data memory for each tributary in the network.

Similarly, the user program at each tributary must issue a control command (establish tributary) for each tributary to be established at that station. This causes a TSS to be created at that station for each tributary it establishes.

In point-to-point networks, a control command (establish tributary) must be issued at both stations. The tributary address field in this case must be a one. This results in the creation of a single TSS structure at each station.

The DMV11 microcode at the control station and at all tributary stations uses these TSS structures to coordinate protocol operation over the network between the control/tributary pair. User programs, at the control station and at the established tributaries, access these structures to obtain operational information such as:

- The number of messages transmitted and received;
- The number of selection intervals and timeouts;
- The number of reply timeouts; and
- The number of various types of errors.
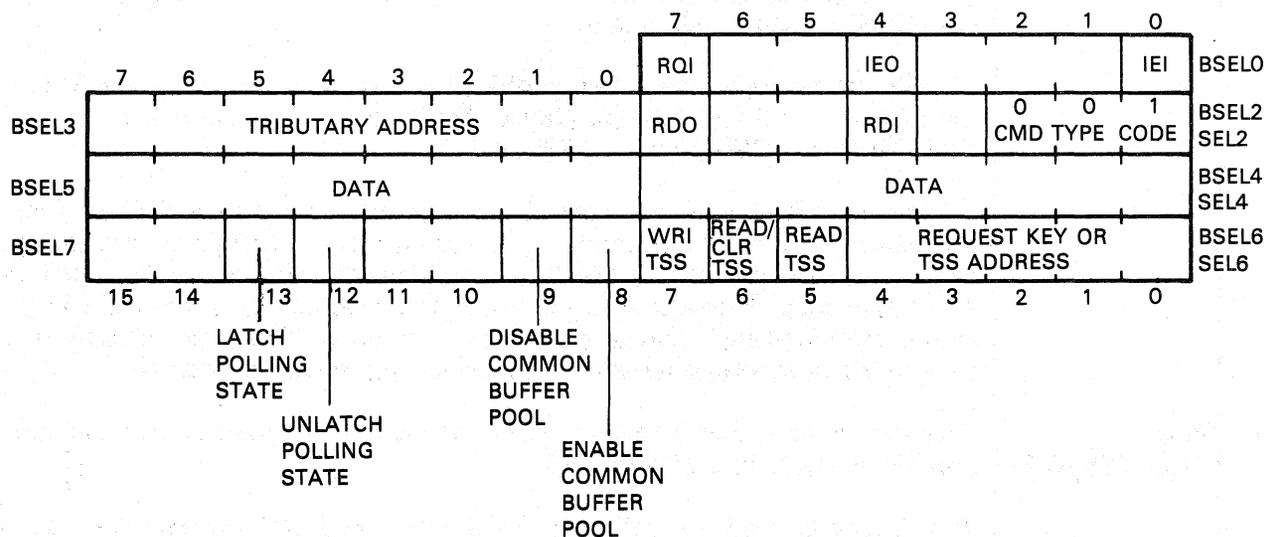
Figure 3-6 Control Command Format

At the start-up of tributary stations having multiple software assigned tributary addresses, the user program at each station issues as many control commands as there are established tributaries at that node. However, in networks where tributary addresses are switch assigned, only one control command specifying the switch assigned address is required as part of the start-up sequence. Any other nonzero tributary address in a control command is overridden by the switches.

The control command is also used by the user program at the control station to specify a unique set of polling parameters for each tributary in the network.

During normal operation, the control station microcode can determine the polling level of any tributary in the network and adjust the polling frequency of that tributary as necessary (see Section 5.2).

The control command permits the user program to perform a number of control functions using the same command format. In general, each function implemented by this command requires issuing of a single appropriately formatted control command. SEL6 is used to define the various functions of the control command (see Figure 3-6). Table 3-5 provides a detailed description of each bit or field.

Table 3-5   SEL6 Control Command Functions

Bit	Name	Description
0-4	Request Key	These five bits are encoded requests from the user program. When this field is used, bits 5 through 7 must be cleared. Request keys are encoded as shown in Table 3-6.
5	Read TSS/GSS	A control command with this bit set, allows the user program to read two consecutive locations (two bytes) of a tributary status slot (TSS) or global status slot (GSS) without modifying it.
		The TSS to be read is specified in BSEL3 and the location within the TSS is specified in bits 0-4 of BSEL6. Notice that bit 5 is also set to indicate a read GSS. To read a GSS location, BSEL3 is zero.
		When the DMV11 receives a control command to read a TSS or GSS location, it passes the requested information to the user program through an information response (see Section 3.4.3). However, the requested information is placed on an internal queue before it is passed to the user program. As a result, the information requested may change before the user gets it. This is particularly true for number of messages transmitted/received and selection intervals.
6	Read and Clear TSS/GSS	A control command with this bit set, allows the user program to read and clear specific locations in a TSS or GSS.
		The TSS to be read is specified in BSEL3 and the location within the TSS is specified in bits 0-4 of BSEL6. Notice that a read and clear command bit 6 of BSEL6 is also set. This gives a base octal value of 100 to which the specific TSS address is added. To read and clear a GSS location, BSEL3 is zero.
		Only the error counter sections of the TSS (7-17 octal) and GSS (15-17 octal) can be accessed with a read and clear command.

Table 3-5 SEL6 Control Command Functions (Cont)

Bit	Name	Description
		Accessing any other locations results in a procedural error.
		Valid octal values for BSEL6 for the read and clear function are listed below:

Octal Value	TSS Location
107	Data messages transmitted
110	Data messages received
111	Selection intervals
112	Data errors outbound
113	Data errors inbound
114	Local buffer errors
115	Remote buffer errors
116	Selection timeouts
117	Local and remote reply timeouts

Octal Value	GSS Location
115	Remote station errors
116	Local station errors
117	Global header blockcheck and maintenance data blockcheck errors

These errors are covered in detail Section 5.3.

When the DMV11 receives a control command to read and clear a TSS or GSS location, it passes the requested information to the user program through an information response, and then clears the location.

As in the case of the read TSS/GSS, the information is placed on an internal queue and is subject to change before the user gets it. However, by reading and clearing, the user can keep a cumulative total.

Bit	Name	Description
7	Write TSS	A control command with this bit set, enables the user program to write into specific locations in an associated TSS or GSS.
		The TSS to be written into is specified in BSEL3 and the specific location within the TSS or GSS is specified in bits 0-4 of BSEL6. To write to a GSS location, BSEL3 is zero.
		Notice that bit 7 of BSEL6 is also set to indicate a write TSS. This gives a base octal value of 200 to which the specific TSS address is added.

Table 3-5 SEL6 Control Command Functions (Cont)

Bit	Name	Description
		The data to be written is contained in BSEL4 and BSEL5. There are eight TSS and five GSS parameters that can be written:

TSS PARAMETER		BSEL6
1.	Transmit delay timer (XDT)	230
2.	Initial polling urgency (Q) and polling rate (R) for active state	231
3.	Initial polling urgency (Q) and polling rate (R) for inactive state	232
4.	Initial polling urgency (Q) and polling rate (R) for unresponsive state	233
5.	No data message count (non-inact) and unresponsive timeout count (TO-UNRESP)	234
6.	Dead timeout count (TO-DEAD) and maximum message count (MMC)	235
7.	Selection interval timing counter	236
8.	Babbling tributary counter	237

See Table 4-2 for details

GSS PARAMETER		BSEL6
1.	Number of sync-characters to precede nonabutting messages	233
2.	Preset value for streaming tributary time counter	234
3.	Polling algorithm update interval (DELTA T)	235
4.	Polling rate for dead tributaries (DEAD T)	236
5.	Fixed polling delay (poll delay)	237

See Table 4-3 for details

NOTE

Some parameters are 8-bits in length. Thus, in those cases two parameters are indicated. All user accesses are on two byte boundaries.

Table 3-5 SEL6 Control Command Functions (Cont)

Bit	Name	Description
8	Enable Common Pool	A control command with this bit set allows a specified tributary (BSEL3) to use the common receive buffer pool. Usage of the common pool is based on a common pool quota. This quota is determined for the specified tributary by adding the octal value in BSEL4 to the current quota. If this results in a value equal to or greater than 377 octal, a procedural error results and the quota is reset to 376. However, a tributary may be set up for unlimited use of the common pool by setting BSEL4 to 377. Each time a tributary uses a common pool buffer, the quota is decremented by one. When the quota reaches zero, the tributary is prevented from using the common pool. See Section 3.3.4 for more details on common buffer pool. The common pool is checked first. If no buffers are available or the quota is zero, or the buffer is too small, the private receive buffers are checked.
9	Disable Common Pool	A control command with this bit set, disables the use of the common receive buffer pool for the tributary specified in BSEL3. The quota previously established for this tributary is cleared to zero.
10-11	Reserved	
12	Unlatch Polling State	A control command with this bit set, causes the polling state level of the tributary addressed by BSEL3 to go to the active polling state. Control of the polling activity for the specified tributary is then returned to the polling algorithm.
13	Latch Polling State	A control command with this bit set, establishes the polling state of the tributary addressed by BSEL3. The polling state is determined by bits 0 and 1 of BSEL4. These bits are encoded as follow: **Bits 1 & 0** **Polling State** 00 Active 01 Inactive 10 Unresponsible 11 Dead

Table 3-6   Request Key Field Definitions (Control Command)

Octal Code	Name	Description
00	No Request	This code allows the issuing of a null control command for the purpose of returning control of the CSRs to the DMV11. The no request code is used when RDI is set but there is no command to issue (see Section 4.2.3). This is effectively an NOP command. **NOTE** **The enable/disable common pool and/or latch/unlatch polling state bits in BSEL7 can be used in conjunction with this request key.**
01	Establish Tributary	This control function initiates the creation of the tributary status slot (TSS) data structure. This must be accomplished before any command is issued that uses a tributary address. The user program at the control station must issue one establish tributary control command for each tributary supported in the network. The tributary address is designated in BSEL3. **NOTE** **In a point-to-point network, this control command, with a tributary address of one in BSEL3, should be issued at each station to establish the required TSS.** The DMV11 has 12 available TSS blocks. Each block has 64 – 8-bit locations for storing status and other information necessary for maintaining communications over the data link. As a result of establishing one or more tributary addresses, the DMV11 creates a global status slot (GSS). This GSS is part of the overall status structure at each station. **NOTE** **This control command function can also be used during normal operation of a multipoint network to reestablish previously deleted tributaries. In such cases, the tributary address must be reestablished at both the control station and the pertinent tributary station.** **NOTE** **The enable/disable common pool and/or the latch/unlatch polling state bits in BSEL7 can be combined with this control function in a single control command.**

Table 3-6 Request Key Field Definitions (Control Command) (Cont)

Octal Code	Name	Description
02	Delete Tributary	This control function removes a specified tributary from operational status by eliminating its associated TSS. Prior to issuing this command, the user program must first halt the tributary being deleted. [See request key 05 (request halt state)]. The TSS can only be reestablished by using an establish tributary function. Only 12 addresses may be established at any one time.
03	Request Start-up State	This control function initializes the designated TSS and initiates the DDCMP start-up sequence for that tributary. BSEL3 specifies the tributary address. Request start-up state must only be issued to tributaries that are in the halt state.
		When the start-up sequence is completed, the DMV11 notifies the user program by issuing a control response. When this response (run state) is received by the user programs at the tributary and control station, message traffic can begin between these two stations (see Table 3-7).
		NOTE The enable/disable common pool and/or the latch/unlatch polling state bits in BSEL7 can be combined with this control function in a single control command.
04	Request Maint State	This control function places the tributary designated by BSEL3 into the DDCMP maintenance state.
		A tributary placed in the maintenance state can only transmit and receive maintenance messages. Both the control station and tributary must be in the maintenance state in order for maintenance message traffic to occur.
		The maintenance state must only be issued to tributaries that are in the halt state.
		NOTE The enable/disable common pool and/or the latch/unlatch polling state bits in BSEL7 can be combined with this control function in a single control command.

Table 3-6 Request Key Field Definitions (Control Command) (Cont)

Octal Code	Name	Description
05	Request Halt State	This control function places the tributary designated by BSEL3 into the DDCMP halt state. All outstanding buffers are returned.
		When a tributary is halted at the control station, the tributary is no longer polled. When a tributary is halted by its own user program, it no longer responds to polling.
		The TSS for the halted tributary remains unchanged at both the control and tributary stations. The halted tributary can be restarted by issuing a request start-up state control command.
		NOTE **The halt state may also be used on a global basis to return all common pool buffers. This is accomplished by using a tributary address of zero in BSEL3 when issuing the request halt state.**
		Tributaries must not be using the common pool when this function is issued. If the common pool is in use, a procedural error of 136 is generated (see Table 3-7).
20	Read Modem Control	This control function permits the user program to write the contents of BSEL4 into the DMV11 modem register. (See Appendix C).
21	Write Modem Control	This control function causes the DMV11 to read the modem register and pass this information to the user program through SEL4 by way of an information response. (See Appendix C.)

NOTE
Request key codes 6-17 and 22-37 are reserved.

3.3.4 Buffer Address/Character Count (BA/CC) Command

This command provides the user programs at both the control station and tributaries with the means to assign, transmit, and receive buffers.

The format for this command is shown in Figure 3-7. Note that the command has two forms to facilitate separate management of transmit and receive buffers. These two forms are distinguished by the type code in BSEL2. A type code of zero is used to allocate receive buffers and a type code of four is used to allocate transmit buffers.

The tributary address is specified by BSEL3 and the buffer address is contained in SEL4 and bits 14 and 15 of SEL6. The remaining 14 bits of SEL6 contain the character count in positive notation. A character count of zero is illegal.

In addition to allocating receive and transmit buffers, the buffer address/character count command is used to allocate common receive buffers by specifying a tributary address of zero in BSEL3. These buffers can only be used by tributaries authorized to do so by the enable common pool bit of a control command.

When the user program has a message to transmit, it informs the DMV11 of the size and address of the message buffer. This is done by the buffer address/character count command on a one buffer per command basis. A tributary address of zero when assigning transmit buffers results in a procedural error.

When the user program is receiving messages, it assigns receive buffers on a one buffer per command basis using the buffer address/character count command. These buffers may be in the common pool of buffers or be private buffers. Each BA/CC command used to assign a buffer to be the common pool must contain a zero in BSEL3. Although this command assigns buffers to a common pool, actual allocation is performed through the control command by enabling access to the common pool on a per tributary basis.

18 BIT ADDRESS MODE

	7	6	5	4	3	2	1	0	
	RQI			IEO				IEI	BSEL0
BSEL3 — TRIBUTARY ADDRESS (7–0)	RDO			RDI		CMD TYPE CODE*			BSEL2 / SEL2
BSEL5 — BUFFER ADDRESS HIGH BYTE (7–0)	BUFFER ADDRESS LOW BYTE								BSEL4 / SEL4
BSEL7 — B/A 17, B/A 16, CHARACTER COUNT HIGH SIX BITS	CHARACTER COUNT LOW BYTE								BSEL6 / SEL6
15 14 13 12 11 10 9 8	7	6	5	4	3	2	1	0	

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22 BIT ADDRESS MODE

	7	6	5	4	3	2	1	0	
	RQI			IEO				IEI	BSEL0
BSEL3 — TRIBUTARY ADDRESS (7–0)	RDO			RDI	22 BIT MODE 1	CMD TYPE CODE*			BSEL2 / SEL2
BSEL5 — BUFFER ADDRESS HIGH BYTE (7–0)	BUFFER ADDRESS LOW BYTE								BSEL4 / SEL4
BSEL7 — UNUSED	UNUSED		BUS ADDRESS BITS 16-21						BSEL6 / SEL6
BSEL11 — UNUSED, CHARACTER COUNT HIGH SIX BITS	CHARACTER COUNT LOW BYTE								BSEL10 / SEL10
15 14 13 12 11 10 9 8	7	6	5	4	3	2	1	0	

*TYPE CODES
BUFFER ADDRESS/CHARACTER COUNT COMMAND - RECEIVE = 000
BUFFER ADDRESS/CHARACTER COUNT COMMAND - TRANSMIT = 100

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Figure 3-7   Buffer Address/Character Count Command Format

In multipoint networks, user programs at both the control and tributary stations can handle allocation of receive buffers in two ways:

1. The first method involves the allocation of receive buffers from a common pool of buffers. With the common buffer pool enabled, receive buffers are assigned to the pool through the buffer address/character count command on the basis of one buffer for each command issued. Each buffer address/character count command used to assign a buffer to the common pool must contain a zero in BSEL3. Although this command assigns buffers to a common pool, actual allocation to a tributary is done through the control command by enabling access to the pool and assigning quotas (see Table 3-5).

2. In the second method, the user program can directly allocate private receive buffers based on anticipated message traffic using one buffer address/character count command for each private buffer allocated. In this context, a private buffer is defined as a receive buffer assigned to a specific tributary for its exclusive use, and in all cases the address of that tributary must be in BSEL3 of the assigning command.

Private buffers and buffers from a common pool can be used jointly at control and tributary stations in a multipoint network. Under these circumstances, the advantages provided by both methods are available to the user program.

Private buffers can be set for unanticipated messages and/or abnormally large messages.

The preceding information involved standard 18-bit addressing. However, the DMV11 may also operate in 22-bit addressing mode. The DMV11 allows the software to set the 22-bit address mode of operation. The bit indicating 22-bit address mode is set by the user program as part of a command when issuing transmit or receive buffers to the DMV11. The state of this bit is retained to indicate to the DMV11 the number of bits in the buffer address.

3.4 DMV11 OUTPUT RESPONSES
The DMV11 microcode has a set of three responses it can use to either reply to user-program commands or to inform the user program of error conditions. These responses are:

- Buffer disposition response;
- Control response;
- Information response.

As with input commands, each output response is identified by a typecode in bits zero, one, and two of BSEL2.

NOTE
In multipoint networks, each response issued contains (in BSEL3) the address of the tributary that relates to the response. However, in point-to-point networks, equivalent responses always contain a one in BSEL3.

3.4.1 Buffer Disposition Response

This response is used to return both used and unused buffers to the user program. Figure 3-8 shows the format of this response and identifies the five methods of message disposition in BSEL2. BSEL2 bits zero, one, and two are encoded as follows:

Bit2	Bit1	Bit0	Buffer Disposition
0	0	0	Receive buffer complete
0	1	1	Receive buffer unused
1	0	0	Transmit buffer complete
1	1	0	Transmit buffer sent but not acknowledged
1	1	1	Transmit buffer not sent

Receive Buffer Complete – When a message is received successfully and stored in the assigned main memory buffer, the DMV11 microcode notifies the user program by issuing a buffer disposition response with a type code of 000. Data in the receive buffer is not valid until such a response is issued. This response is issued for both common pool and private buffers.

Receive Buffer Unused – When the protocol for a specified tributary is halted, the DMV11 automatically returns all associated private receive buffers to the user program. To do this the DMV11 issues a buffer disposition response with a type code of 011 for each outstanding buffer held by the specified tributary. This pertains to private buffers only.
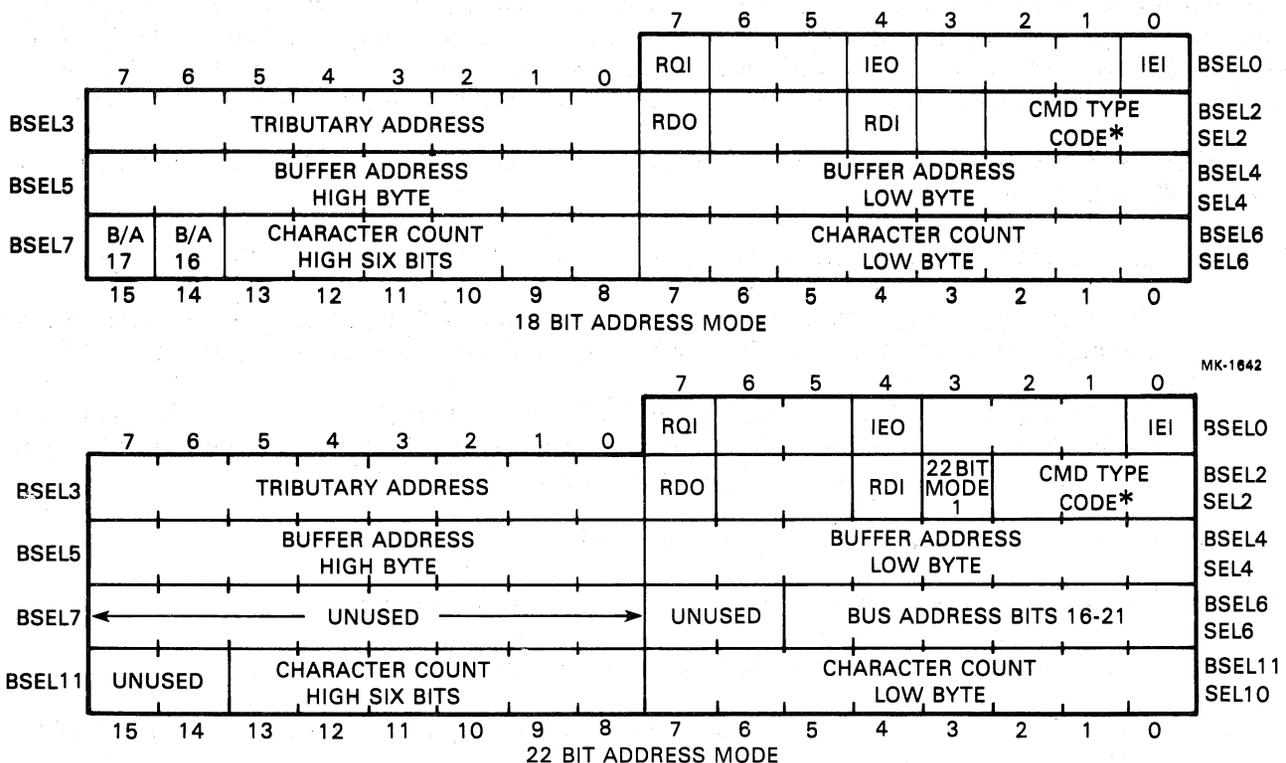

```
* BUFFER DISPOSITION RESPONSE TYPE CODES:
  1. RECEIVE BUFFER COMPLETE = 000
  2. RECEIVE BUFFER UNUSED = 011
  3. TRANSMIT BUFFER COMPLETE = 100
  4. TRANSMIT BUFFER SENT NOT ACK'd = 110
  5. TRANSMIT BUFFER NOT SENT = 111
```

Figure 3-8   Buffer Disposition Response Format

The DMV11 returns all common pool buffers if the user program issues a request halt state control command with a tributary address of zero. When all common pool buffers are returned, the DMV11 issues an information response indicating that the process is finished.

Transmit Buffer Complete – When a message is transmitted successfully, the DMV11 notifies the user program by issuing a buffer disposition response with a type code of 100. Successful transmission means that the receiving station has acknowledged receipt of the message.

Transmit Buffer Sent But Not Acknowledged – When the protocol for a specified tributary is halted, the DMV11 automatically returns all transmit buffers currently being processed by that tributary to the user program. To do this, the microcode issues a buffer disposition response with a type code of 110 for each buffer sent but not acknowledged.

> **NOTE**
> During protocol operation, after seven unacknow-
> ledged transmissions of a message occur, the trans-
> mit threshold error is exceeded and the DMV11 is-
> sues a control response indicating this error (see
> Section 3.4.2). The DMV11 continues to retransmit
> the message and responsibility for terminating the
> transmission belongs to the user program.

Transmit Buffer Not Sent – DMV11 maintains a queue of buffers to be transmitted for each tributary address established in the network. When the protocol for a given tributary is halted, the DMV11 returns all unused buffers in the associated queue to the user program. To do this, the DMV11 issues a buffer disposition response with a type code of 111 for each transmit buffer remaining in the queue.

The other CSRs used by the buffer disposition response are BSEL3, SEL4, and SEL6. The function of these CSRs is as follows:

- BSEL3 specifies the tributary address associated with the buffer disposition response.

- SEL4 and bits 14 and 15 of SEL6 contain the 18-bit buffer address for the buffer being completed or returned. For 22-bit address mode, bits 0-5 of BSEL6 are used with SEL4.

- SEL6 (or SEL10 in 22-bit address mode), bits zero through 13, compose a 14-bit character count allowing for a maximum buffer size of 16,383 bytes. A character count returned by a buffer disposition response is designated in positive binary notation.

Protocol is halted for a tributary in one of three ways when:

1. The user program issues a control command halting the tributary.

2. A DDCMP STRT message is received while the tributary is in the run state.

3. A DDCMP maintenance message is received, temporarily halting the protocol, while receive buffers are being returned.

3.4.2 Control Response
A control response is an unsolicited response issued by the DMV11 when an error is detected or when protocol information must be passed to the user program. The format for the control response is shown in Figure 3-9. BSEL3 contains the tributary address or character count, SEL4 and bits 8 through 13 of SEL6 contain the bus address for the affected buffer, and BSEL6 indicates the type of information being passed to the user program. In 22-bit address mode, SEL6 contains buffer address bits 16-21 and

BSEL10 indicates the type of information being passed to the user program. These types of information are indicated by an octal code and are listed in Table 3-7. Basically there are four categories of information.

1. System events
2. Protocol events
3. Network errors
4. Procedural errors

Table 3-7 Output Codes

Octal Code	Category	Information
002	Network Error	Receive threshold error – This error is reported to the user program when the number of consecutive receive errors equals seven. These receive error types are: 1. Message header blockcheck. 2. Message data blockcheck. 3. NAK in response to a DDCMP reply message. 4. Buffer temporarily unavailable. 5. Receive message overrun. 6. Message header format error. 7. When a message is too long for the available buffer. Each time the receive threshold error is reported, the counter is reset to zero.
004	Network Error	Transmit threshold error – This error is reported when the number of consecutive transmit errors equals seven. These transmit errors consist of four types and occur when: 1. A STRT message is transmitted but not acknowledged within the timeout period. 2. A STACK message is transmitted but not acknowledged within the timeout period. 3. A NAK is received in response to a transmission with a reason code other than REP response. 4. A data message is transmitted but a reply was not received within the timeout period. Each time a transmit threshold error is reported, the transmit error counter is reset to zero, except when remaining in the DDCMP ISTRT and ASTRT states.
006	Network Error	Select threshold error – This error is reported when the selection interval timeout counter for a given station has timed out seven times. The selection interval is the time allocated for a tributary to respond to a poll or for a point-to-point station to respond to a transmission. Each time the select threshold error is reported, the selection error counter is reset to zero.

Table 3-7 Output Codes (Cont)

Octal Code	Category	Information
		NOTE For more information on receive, transmit, or selection threshold errors, see Section 5.3.3.
010	Protocol Event	Start message received while running – This response indicates that a DDCMP STRT message was received from the station specified in BSEL3 while this station was in the DDCMP run state. In normal operation, this message is used by a control station to inform a tributary that the control station has started protocol operation for that tributary. The start message is also used to resynchronize the logical link between a control station and tributary. This might be necessary when message traffic is inhibited because of threshold errors or receive or transmit overruns. When the DDCMP STRT message is received: 1) the DMV11 responds with start message received while running, and 2) the protocol at the tributary halts and all buffers are returned. At this time the logical link may be restarted (request start-up state control command).
012	Protocol Event	Maintenance message received while running (or ISTRT or ASTRT) – This response indicates that a DDCMP maintenance message was received by a specific tributary while it was in the DDCMP run, ISTRT, or ASTRT state. This causes the tributary to notify the user program, return all unused buffers to the user program, and halt the protocol. The DMV11 then places the tributary in the maintenance state. The message that caused this event is lost.
014	Protocol Event	Maintenance message received while halted – This response indicates that a DDCMP maintenance message was received by a specific tributary while it was halted. This places the tributary in the maintenance state. The message that caused this event is lost.
016	Protocol Event	Start message received while in the maintenance state – This response indicates that a DDCMP STRT message was received by a specific tributary while it was in the maintenance state. No further action is taken by the microcode. The user program determines what action to take based on this response.
022	System Event	Tributary polling state dead – This response informs the user program at a control station that the specified tributary polling state has gone to the dead state. This response has no meaning in point-to-point networks.

Table 3-7 Output Codes (Cont)

Octal Code	Category	Information
024	Protocol Event	Run state – This response informs the user program at all stations that a specific tributary has entered the run state. The DMV11 microcode issues this response as a result of receiving a request start-up state control command and having completed the DDCMP start-up sequence.
026	Network Error	Babbling tributary – This response is issued to a user program to record the occurrence of a babbling tributary. It is only used by half-duplex point-to-point and multipoint control stations. A babbling tributary is one which continues to transmit valid control messages or message headers beyond the end of a programmable timeout (babbling tributary timeout counter). The babbling tributary response usually indicates a malfunction at the transmitting station or too short a period for the timeout counter. Recovery from this error condition generally requires human intervention at the remote station.
030	Network Error	Streaming tributary – This response is issued to a user program to indicate that the remote station failed to release the channel at the end of the selection interval. It is only used by half-duplex point-to-point and multipoint control stations. The streaming tributary timeout period is determined by the programmable streaming tributary timeout counter. The timeout period starts at the end of the selection interval. This error condition generally indicates a modem malfunction at the remote station or an inappropriate choice of the streaming tributary timeout counter. Recovery from this error condition generally requires human intervention at the remote station.
32-76	Reserved	
100-276	Procedural Error	Procedural errors – This response is issued by the DMV11 when the user program violates the procedures designated for interfacing the DMV11. In all cases, the event that caused the procedural error is ignored by the microcode. All procedural errors except octal codes 140, 300, and 302 are reported immediately to the user program. Those procedural errors are placed on the response queue. Specific procedural violations are identified by the octal code in BSEL6 as follows.

Table 3-7 Output Codes (Cont)

Octal Code	Category	Information
		Code **Description**
		100 A command other than a mode definition command is issued before the mode has been established.
		102 Invalid type code used in a command.
		104 Invalid mode change (for example, the mode of a tributary station is changed to point-to-point).
		106 A nonglobal command is issued to an unestablished tributary.
		110 A nonglobal command is issued having a tributary address of zero.
		112 Attempt to delete or place an unhalted tributary in the start or maintenance protocol state.
		114 Attempt to establish more than 12 tributaries.
		116 Attempt to establish an already established tributary.
		120 An invalid request key is used in a control command.
		122 Attempt to assign a buffer for an unestablished tributary.
		124 Attempt to assign a buffer for a halted tributary
		126 Attempt to assign a buffer having a byte count of zero.
		130 Attempt to assign a transmit buffer with a tributary address of zero.
		132 Attempt to write or read and clear a reserved area of a tributary or global status slot.
		134 Attempt to use the reserved bits in BSEL7 of control command.
		136 Attempt to return all common receive buffers while the common buffer pool is being used.
		140 Attempt to raise the common pool buffer quota to a value higher than 376 octal.
		142-276 Reserved
300	Procedural Error	Buffer too small – This response informs the user program that the assigned receive buffer is not large enough for the current incoming message. Recovery from this error condition is detailed in Section 4.6.2.2.

Table 3-7 Output Codes (Cont)

Octal Code	Category	Information
302	Procedural Error	Nonexistent memory – This response is issued to the user program when the DMV11 microcode attempts to access a CPU memory location that does not respond. The address that caused the error is returned in BSEL4, BSEL5, and BSEL7 for this response. This error is fatal to the station that initiated the memory access causing the error. That station must be halted and restarted (see Section 4.6.2.1). **NOTE** **With the exception of the buffer too small and nonexistent memory errors, the only control response fields used by the DMV11 when posting a procedural error are the type code field in BSEL2, and the output code field in BSEL6. All other fields remain as set by the user program in the command that originally generated the procedural error.**
304	System Event	Modem disconnected – This response informs the user program that an on-to-off transition of the EIA signal data set ready (DSR) was detected. Such a transition indicates that the modem is disconnecting from the communications line. Since this is a global response, the content of BSEL3 is zero.
306	System Event	Queue overflow – This response indicates that the free linked list is empty (see Section 4.6.2.3). This error typically indicates that for some reason output responses are being called for faster than the microcode can process them. **NOTE** **This is a global fatal error and the DMV11 initializes itself after attempting to return all information (response queue only).** Once this response is issued, the user program has three seconds to retrieve the next pending response from the CSRs. Three seconds are allowed for each pending response before the internal microdiagnostics clear the CSRs (see Section 4.3 for restarting).
310	System Event	Modem carrier loss – This control response code informs the user program that the EIA signal carrier detect has gone from on to off while the DMV11 was in the process of receiving a message. Since this is a global response, the content of BSEL3 is always zero.

Figure 3-9   Control-Out Command Format 18-Bit Mode

*ONLY APPLICABLE FOR NON-EXISTENT MEMORY
AND BUFFER TO SMALL ERRORS

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3.4.3   Information Response

An information response is issued by the DMV11 microcode in reply to a request for information by the user program. The format for this response is shown in Figure 3-10. The type code for this response is 010 binary as indicated in BSEL2. BSEL3 contains the tributary address and SEL4 contains the information requested by the user program. If the information requested is from a GSS, BSEL3 contains a zero.

An information response contains a return key code or a TSS or GSS address in BSEL6 bits 0-4. The return key codes are used in response to control request keys or protocol events and are encoded as shown in Table 3-8. The TSS address is used in response to a read or read and clear TSS/GSS command in conjunction with bits 5 and 6 of BSEL6.

Information responses to read or read and clear TSS/GSS control commands, use the TSS address field (bits 0-4 of BSEL6) to indicate the TSS or GSS location read. Bits 5 and 6 indicate whether the response is to a read or read and clear input command.

3.5   TSS/GSS ACCESS

When a user program accesses a TSS or a GSS through a control command, the DMV11 reads the designated location and passes the data to the user program by means of an information response. Reading a TSS or GSS location results in two bytes of data from that location being stored in BSEL4 and BSEL5 of the information response, with the low-order byte in BSEL4, and the high-order byte in BSEL5. If a TSS is being read, BSEL3 in the information response contains the associated tributary address. However, data read from a GSS is passed to the user program through an information response having a zero in BSEL3.

As described in Table 3-5, any TSS or GSS location can be read, and specific locations can be read and cleared. Along with the TSS/GSS address, BSEL6 in an information response also contains two single-bit fields that indicate a read or a read and clear TSS/GSS. These information response fields are described in detail below.

TSS/GSS address   This field (BSEL6, bits zero to four) contains the octal address of the TSS/GSS location from which the data in BSEL4 and BSEL5 is read.

Read TSS/GSS   When set, this bit (BSEL6, bit five) designates that BSEL4 and BSEL5 contain the data requested by the read TSS/GSS control command.

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Read and clear TSS/GSS   When set, this bit (BSEL6, bit six) designates that BSEL4 and BSEL5 contain the data requested by the read and clear TSS/GSS control command. In addition to reading the requested TSS/GSS location, the DMV11 also clears that location.

NOTE
The TSS/GSS locations accessible for writing, reading, and reading and clearing, are listed and described in Table 3-5.
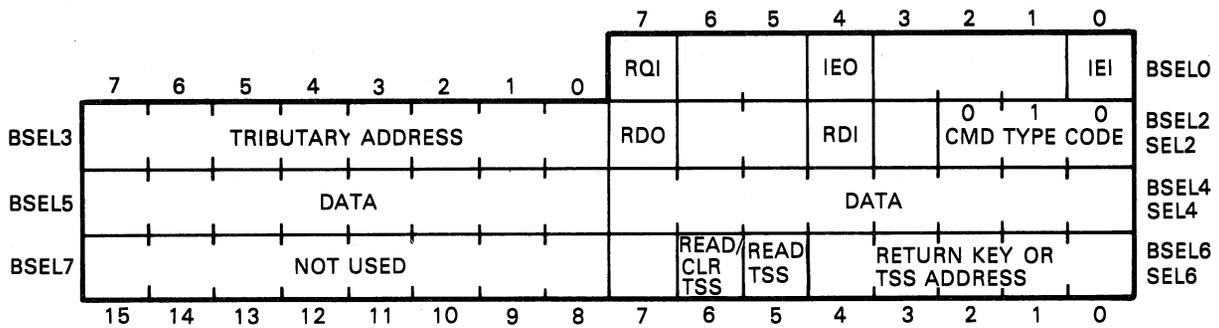
Figure 3-10   Information Response Format

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Table 3-8   Return Keys for Information Response

Octal Code	Name	Description
10	Return Modem Status	This code indicates that BSEL4 and BSEL5 contain the requested modem status (see Appendix C).
20	Buffer Return Complete	This code indicates that the process of returning all buffers is completed. Buffers are returned to the user program under the following circumstances: 1. The protocol event STRT message received while running occurred. This causes all private buffers assigned to the tributary designated by the address in BSEL3 to be returned. 2. The protocol event maintenance message received while running occurred. This causes all private buffers assigned to the tributary designated by the address in BSEL3 to be returned. 3. The user program issued a control command containing the request key request halt state causing all private buffers assigned to the tributary designated by the address in BSEL3 to be returned. 4. The user program issued a global control command (BSEL3 = zero) containing the request key request halt state. This causes all unused common pool buffers to be returned. Information responses containing the return key code for buffer return complete always have zeros in BSEL4 and BSEL5.

CHAPTER 4
PROGRAMMING TECHNIQUES

4.1 INTRODUCTION
Proper design of user programs for operation with DMV11-based multipoint and point-to-point networks requires that consideration be given to a number of programming topics. This chapter discusses the following programming topics.

- Command discipline and handshaking;
- DMV11 start-up;
- Criteria for determining user-defined parameters;
- Error counter access;
- Error recovery procedures;
- Booting a remote station.

These programming topics deal with interfacing the user program and DMV11 microcode by using the DMV11 command/response structure.

4.2 COMMAND/RESPONSE DISCIPLINE AND HANDSHAKING
The command/response interface between a DMV11 and the user program is accomplished through the DMV11 CSRs that are addressed through the CPU I/O page.

Since the DMV11 runs in a multiprocessing mode with the associated CPU, the passing of commands and responses through this interface must be highly disciplined to eliminate the possibility of a race condition (the user program setting bits in the CSRs after the microprocessor has read those bits). This interface discipline requires that the user program follow two separate procedures; one for issuing commands, and one for retrieving responses.

Figure 4-1 illustrates the control bits involved in CSR interface discipline. These bits are located in the DMV11 CSRs BSEL0 and BSEL2. Examination of Figure 4-1 shows that BSEL0 contains two control bits named interrupt enable in (IEI) and interrupt enable out (IEO), bits zero and four respectively. These bits when set, serve to enable the microprocessor to interrupt the main CPU under two circumstances:

1. When the CSRs become available for the issuing of a command after access is requested by the user program for that purpose (IEI and RDI).

2. When the microcode has a response to be retrieved from the CSRs by the user program (IEO and RDO).

NOTE
Interrupt mode must be used, otherwise, receive overruns and transmit underruns are very probable.

The procedures described below defining CSR interface discipline are based on operation in the interrupt mode. As a consequence, the IEI and IEO bits should be set by the user program prior to using the CSR interface.

7	6	5	4	3	2	1	0	
RQI			IEO				IEI	BSEL0
RDO			RDI					BSEL2

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Figure 4-1   CSR Interface Control Bits

4.2.1   Command Discipline

At start-up time, before the user program can execute any command, it must initialize the DMV11. This is accomplished by the program setting the master clear bit in BSEL1 and waiting for the DMV11 to set the run bit.

Once the DMV11 is initialized, commands may be issued. All commands are issued by the user program in two successive steps. The first step requests the use of the data port. The second step identifies the command type and the data port information for the appropriate command, and notifies the DMV11 that the command is in the CSRs. The specific content of each data port is further defined under each command description in Section 3.3. The handshaking procedure for input commands is as follows (see Figure 4-2).

- The user program requests the use of the data port to issue a command by setting request in (RQI) bit 7 of BSEL0. The user should also set bit 0 of BSEL0, interrupt enable in (IEI), at the same time (using the same instruction) to allow the DMV11 to interrupt the CPU when the data port is available. An interrupt is generated to XX0 when RDI is asserted by the DMV11.

- When the data port is available, the DMV11 informs the user by setting ready in (bit 4 of BSEL2) and generating an interrupt to vector XX0.

- On detecting RDI bit set, the user can: 1) load the appropriate information into SEL4 and SEL6, and 2) load the input command code into bit 0-2 of BSEL2.

- If a single command is to be issued, the user program clears RQI. If a series of commands are to be issued, RQI can remain set until just prior to the loading of the last command into the CSRs. By leaving RQI set while issuing a series of commands, the user program is assured of having access to the CSRs after the next response.

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PROGRAMMING TECHNIQUES

4.1 INTRODUCTION

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Figure 4-1 illustrates the control bits involved in CSR interface discipline. These bits are located in the DMV11 CSRs BSEL0 and BSEL2. Examination of Figure 4-1 shows that BSEL0 contains two control bits named interrupt enable in (IEI) and interrupt enable out (IEO), bits zero and four respectively. These bits when set, serve to enable the microprocessor to interrupt the main CPU under two circumstances:

1. When the CSRs become available for the issuing of a command after access is requested by the user program for that purpose (IEI and RDI).

2. When the microcode has a response to be retrieved from the CSRs by the user program (IEO and RDO).

NOTE
Interrupt mode must be used, otherwise, receive overruns and transmit underruns are very probable.

NOTE
It is recommended that the interrupt enable (IEI
and IEO) bits be set when interfacing with the
CSRs. It is imperative that they be set when
operating at 56K b/s because the microprocessor
is halted momentarily on every access to the
CSRs.

The procedures described below defining CSR interface discipline are based on operation in the interrupt mode. As a consequence, the IEI and IEO bits should be set by the user program prior to using the CSR interface.

7	6	5	4	3	2	1	0	
RQI			IEO				IEI	BSEL0
RDO			RDI					BSEL2

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Figure 4-1   CSR Interface Control Bits

4.2.1   Command Discipline
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- The user program requests the use of the data port to issue a command by setting request in (RQI) bit 7 of BSEL0. The user should also set bit 0 of BSEL0, interrupt enable in (IEI), at the same time (using the same instruction) to allow the DMV11 to interrupt the CPU when the data port is available. An interrupt is generated to XX0 when RDI is asserted by the DMV11.

NOTE
The 22-bit mode is used when the software supports
22-address bit buffers. A "one" in bit 3 of BSEL2
indicates to the DMV11 that the software supports
the change in the command format required to support 22-address bits.

- When the data port is available, the DMV11 informs the user by setting ready in (bit 4 of BSEL2) and generating an interrupt to vector XX0.

- On detecting RDI bit set, the user can: 1) load the appropriate information into SEL4 and SEL6, and 2) load the input command code into bit 0-2 of BSEL2.

- If a single command is to be issued, the user program clears RQI. If a series of commands are to be issued, RQI can remain set until just prior to the loading of the last command into the CSRs. By leaving RQI set while issuing a series of commands, the user program is assured of having access to the CSRs after the next response.

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4.2.2 Retrieving Responses

The DMV11 issues responses in two steps. If RDI is not set, the data pertinent to the responses being issued is loaded into BSEL3, SEL4, and SEL6. Once this is complete, the DMV11 sets the ready out (RDO) bit and the command code in BSEL2. An interrupt through vector XX4 is generated if the IEO bit is set. Generally, processing an output response involves the following steps:

- The user program checks for RDO set. This is done by waiting for an interrupt.

- To use the output interrupt capability, the user program must set the output interrupt enable bit in BSEL0 immediately after it detects that the run bit has been set following master clear.

- When an RDO set condition is detected, the user program should move the contents of SEL2, SEL4, and SEL6 into a working storage area and clear RDO in BSEL2 as soon as possible. When RDO is cleared, the data port (SEL4 and SEL6) is released to the DMV11 for more input or output processing.

4.2.3 CSR Interface Interactions

User-program access to the CSRs is under complete control of the DMV11 microcode. Access to the CSRs is granted upon request when the user program has a command to issue, or when the microcode has a response for the user program. Figure 4-2 illustrates the nature of the access window available to the user program under interrupt control, when issuing a command, or retrieving a response. As previously indicated, the user program requests use of the CSRs for the purpose of issuing a command by setting RQI. The DMV11 microcode makes the CSRs available for the issuing of a command, only when it is not using them, by setting RDI and interrupting the user program through the floating vector XX0. As a result, the time period between the setting of RQI by the user program and the granting of the CSRs through an interrupt is indeterminate.

When commands are being issued from a queue, and the last command has been issued with the user program still having ownership of the CSRs (RDI is set), there is a mechanism for returning the CSRs to the DMV11. In such cases, the user program can issue a control command with the code for no request in the request key field, thereby, signalling the microcode to ignore the contents of the CSRs. In this way, the possible reading of erroneous data by the DMV11 microcode is avoided.

If the user program is to issue a single command, RQI should be cleared prior to issuing the command to the CSRs, as indicated in Figure 4-2. However, if a series of commands are to be issued, the user program can leave RQI set. In this circumstance, when a command is issued and RDI is cleared, the microcode relinquishes the CSRs to the user program as soon as they become available. The time period between clearing RDO upon completing one command, and an interrupt initiating the next command, is also indeterminate.

When the DMV11 has a response to be passed to the user program, it sets RDO then interrupts the main CPU through the floating vector XX4. At this point, the user program has ownership of the CSRs and can proceed by reading the response. Once the response is read from the CSRs, the user program should immediately clear the RDO bit. User-program routines responsible for issuing commands and retrieving responses should limit the CSR access time required to load a command or retrieve a response.

4.3 DMV11 START-UP

Starting a DMV11 requires that the user program perform a series of steps to; 1) configure the DMV11 to operate within the context of the associated network, 2) establish user-defined parameters, and 3) initiate protocol operations at the DMV11.
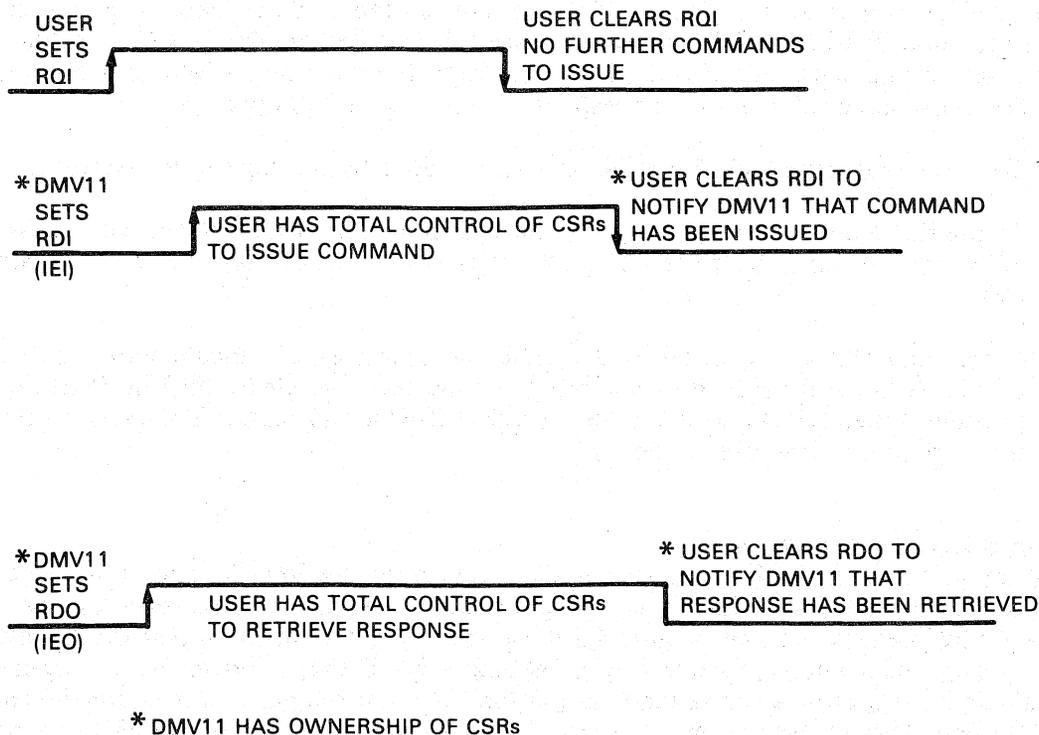
```
USER                              USER CLEARS RQI
SETS  ┌──────────────────────┐    NO FURTHER COMMANDS
RQI  ─┘                       └─  TO ISSUE


*DMV11                              *USER CLEARS RDI TO
 SETS  ┌───────────────────────┐    NOTIFY DMV11 THAT COMMAND
 RDI  ─┘ USER HAS TOTAL CONTROL OF CSRs └─ HAS BEEN ISSUED
 (IEI)     TO ISSUE COMMAND


*DMV11                              * USER CLEARS RDO TO
 SETS  ┌───────────────────────┐      NOTIFY DMV11 THAT
 RDO  ─┘ USER HAS TOTAL CONTROL OF CSRs └─ RESPONSE HAS BEEN RETRIEVED
 (IEO)     TO RETRIEVE RESPONSE


        * DMV11 HAS OWNERSHIP OF CSRs

                                              MK-2514
```

Figure 4-2   CSR Access Window

4.3.1   Configuration Procedure

The sequence to configure a DMV11 control and tributary station for network operation is formed by the following steps:

1. Set the master clear bit and wait for the run bit to set. (See Section 3.3.1).

2. When the run bit is set, read BSEL4 and BSEL6.

3. If the contents of BSEL4 equals octal 33, and the contents of BSEL6 equals octal 305, the start-up diagnostics have successfully executed and the DMV11 is running. Any other value in BSEL6 indicates that an error condition was detected by the start-up diagnostics. The values and meanings of these diagnostic error codes are listed in Table 4-1.

4. If the DMV11 operational mode is software selectable, set the mode for that device by issuing the appropriate mode definition command (see Section 3.3.2). If the mode for the DMV11 is selected by internal switches, this step can be ignored.

4.3.2   Specifying User-Defined Parameters

After a DMV11 is configured, the user parameters are specified. User-defined parameters include parameters used by the polling algorithm, and parameters specific to protocol operation. In addition, those user parameters that are specific to the operation of tributaries, are stored in the tributary status slot (TSS) associated with each tributary. Parameters that are pertinent to overall system operation are stored in the global status slot (GSS) for the control or tributary station.

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Table 4-1 Diagnostic Error Codes

BSEL6	BSEL4	Description
101	N/A	Branch test has failed and the microcode is spinning in a loop.
102	N/A	6502 internal resister test has failed and the microcode is spinning in a loop.
103	N/A	Load and store instructions test has failed and the microcode is spinning in a loop.
104	N/A	Compare instructions test has failed and the microcode is spinning in a loop.
105	N/A	Increment and decrement instructions test has failed and the microcode is spinning in a loop.
106	N/A	Shift and rotate instructions test has failed and the microcode is spinning in a loop.
107	N/A	Logic instructions test has failed and the microcode is spinning in a loop.
110	N/A	Add with carry, subtract with carry, set and clear decimal mode instructions test has failed and the microcode is spinning in a loop.
111	N/A	Stack push and pull instructions test has failed and the microcode is spinning in a loop.
112	N/A	Subroutine instructions test has failed and the microcode is spinning in a loop.
113	N/A	Ram scratchpad, CSR, and NPR address resisters addressing test has failed and the microcode is spinning in a loop.
114	N/A	Ram scratchpad, CSR, and NPR address resisters data test has failed and the microcode is spinning in a loop.
115	N/A	True interrupt test has failed and the microcode is spinning in a loop.
116	N/A	Ram data and addressing test has failed and the microcode is spinning in a loop.
117	N/A	Ram alternating data test has failed and the microcode is spinning in a loop.
120	N/A	Indexed indirect addressing mode instruction test has failed and the microcode is spinning in a loop.
121	N/A	Line unit message test has failed and the microcode is spinning in a loop.
305	33	The microdiagnostics have completed without errors.

As described in Section 3.3.3, user parameters are specified through control commands configured to address a TSS or a GSS. These control commands write the data contained in BSEL4 and BSEL5 into the locations specified by bits 0-4 of BSEL6 (TSS or GSS address). In establishing polling and protocol parameters, the user program has the option of accepting the default for a parameter or setting the parameter to some predetermined value. Chapter 5 details the criteria to be used in determining optimum values for the various polling parameters. Criteria for determining the remaining parameters, which generally concern the operation of the communications link, are presented in Section 4.6.

<div align="center">

NOTE
Although the majority of user-defined parameters are 16-bits in length, some are single byte parameters. If the user program wishes to change one of the single-byte parameters and accept the default for the other, both parameters must be written. This is necessary because both TSS and GSS user-defined parameters are written on 2-byte boundaries.

</div>

The process of establishing user-defined parameters is presented as two separate steps:

1. Specifying user-defined parameters for control and tributary station TSS structures.

2. Specifying user-defined parameters for control and tributary station GSS structures.

4.3.2.1 Specifying TSS Parameters – TSS parameters that can be specified by the user program are listed in Table 4-2 by name, BSEL3 address, size, and default value. A functional summary of each parameter is also given. The actual order of setting TSS parameters through appropriately configured control commands is arbitrary. The complete command series to specify these parameters for TSS structures at a multipoint control station is listed below:

1. Issue a series of control commands to set the value for the transmit delay timer. This is referred to as the preset value.

2. Issue a series of control commands to establish the polling parameters Q and R for the three polling levels.

3. Issue a series of control commands to specify values for the active, inactive, unresponsive, and dead polling state-change parameters.

4. Issue a series of control commands to specify values for the maximum transmitted message count.

5. Issue a series of control commands to set the selection timers for tributaries (or issue a single command to set the point-to-point station reply timer).

6. Issue a series of control commands to set the babbling tributary timers.

Table 4-2   User-Defined TSS Parameters

Name	TSS Addr (Octal) BSEL6	Size (Bits)	Default (Octal)	Description
XDT PRESET	230	16	0	Preset value for the transmit delay timer. This parameter provides a fixed delay between transmission of data and maintenance messages. The default value of 0 = no delay.
Q (Active)	231	8	377	
Q (Inactive)	232	8	0	
Q (Unresp)	233	8	0	The initial value of polling urgency (U) for the tributary: The TSS for a tributary must be assigned a Q value for each of the three activity levels; active, inactive, and unresponsive. This parameter is applicable only to TSS structures at the control station.
R (Active)	231	8	0	The rate (R) by which the urgency (U) is increased for the tributary.
R (Inactive)	232	8	100	
R (Unresp)	233	8	20	The TSS for the tributary must be assigned an R value for each of the three activity levels; active, inactive, and unresponsive. Both the Q and R for a given tributary are established through a single control command. Therefore, if

Table 4-2   User-Defined TSS Parameters (Cont)

Name	TSS Addr (Octal) BSEL6	Size (Bits)	Default (Octal)	Description
				one parameter is to be set to a unique value, and the default is to be accepted for the other, both the default value and the unique value must be written. This parameter is applicable only to the TSS structures at the multipoint control station.
NDM-INACT	234	8	10	Number of no data messages required to go inactive: This is the number of consecutive polls to be made (without receiving a data message) before changing the activity level of that tributary from active to inactive. This parameter is applicable only to the TSS structures at the control station.
TO-UNRSP	234	8	2	Number of timeouts to go unresponsive: The number of consecutive polls of a tributary (without response) before changing the activity level of that tributary from active or inactive to unresponsive. Both the NDM-INACT and TO-UNRSP counts are established through a single control

Table 4-2   User-Defined TSS Parameters (Cont)

Name	TSS Addr (Octal) BSEL6	Size (Bits)	Default (Octal)	Description
				command. Therefore, if one parameter is to be set to a unique value, and the default is to be accepted for the other, both the default value and the unique value must be written. This parameter is applicable only to the TSS structures at the multipoint control station.
TO-DEAD	235	8	20	Number of timeouts to go dead: The number of consecutive polls of an unresponsive tributary (consecutive selection timeouts) before the activity level of that tributary is changed from unresponsive to dead. This parameter is applicable only to the TSS structures at the multipoint control station.
MXMC	235	8	4	Maximum transmitted message count: This parameter is a count of the maximum number of abutting data messages to be transmitted by a station before it deselects itself. This count applies to the TSS structures at both control and tributary

Table 4-2   User-Defined TSS Parameters (Cont)

Name	TSS Addr (Octal) BSEL6	Size (Bits)	Default (Octal)	Description
				stations in multi-point networks as well as point-to-point stations. Both TO-DEAD and MXMC for a given tributary are established through a single control command. Therefore, if one parameter is to be set to a unique value, and the default is to be accepted for the other, both the default value and the unique value must be written. At tributary and point-to-point stations, the polling parameter TO-DEAD is ignored.
SEL TIMER	236	16	3 (seconds) (5670 Octal)	Selection interval timer: This timer is started when a message is transmitted with the select flag set, and halted when a valid reply is received or the line is resynchronized. The selection timer is used as a reply timer for full-duplex point-to-point networks (see Section 4.4.1). It is used as the select timer at multipoint control stations, and in half-duplex point-to-point networks. This

Table 4-2 User-Defined TSS Parameters (Cont)

Name	TSS Addr (Octal) BSEL6	Size (Bits)	Default (Octal)	Description
				counter counts in milliseconds (ms) from 1 to 65,535 ms.
BAB TIMER	237	16	6 (seconds) (13560 Octal)	Babbling tributary timer: This timer is used to detect a babbling tributary (see Section 4.4.2). In a multipoint network this parameter is applicable only to the control station. However, this parameter is applicable to both stations in point-to-point networks operating half-duplex.

4.3.2.2 Specifying GSS Parameters – As previously indicated, when one or more tributary addresses are established at a DMV11, the DMV11's microcode automatically creates a GSS for that control or tributary station. The GSS parameters that can be specified by a user program are listed in Table 4-3 by name, BSEL3 address, size, and default value. A functional summary of each parameter is also given. If a value is not specified for a parameter the microcode uses the default value. Specifying a user-defined GSS parameter requires that BSEL3 in the pertinent control command contain zero. The control commands necessary to specify GSS parameters for a multidrop station are listed below:

1. A control command to specify the number of sync-characters (NUM SYNC) that are to precede nonabutting transmit messages.

2. A control command to set the streaming tributary timer.

3. Three control commands to establish values for the global polling parameters delta time (DELTA T), dead tributary (DEAD T), and poll delay, respectively.

Specific user-defined TSS and GSS parameters are common to both control and tributary stations. Note that control commands specifying TSS parameters must have the address of the tributary associated with the TSS being accessed in BSEL3. Similarly, each control command specifying a GSS parameter must have BSEL3 set to zero. Since the prior steps have covered user-defined TSS and GSS

parameters (see Table 4-2 and 4-3) at the control station, the two steps listed below complete the parameter-specifying process at the tributary stations:

1. Issue a series of control commands at each tributary station to set the maximum transmitted message count (MXMC) for each active TSS in a tributary station TSS structure. Note that the 8-bit value for MXMC must be placed in BSEL5 of each command (the tributary station microcode ignores BSEL4 in these commands). The procedure for determining an optimum value of this parameter for tributary stations is the same one used for control stations.

2. Issue a single control command at each tributary station to set a value for the number of sync-characters (NUM SYNC) that are to precede nonabutted transmit messages. The procedure for determining an optimum value of this parameter for tributary stations is the same one used for control stations.

Table 4-3   User-Defined GSS Parameters

Name	GSS Addr (Octal) BSEL6	Size (Bits)	Default (Octal)	Description
NUM SYNC	233	16	10 (low speed) 15 (high speed)	Number of sync-characters: This global value specifies the number of sync-characters that are to precede nonabutting transmitted messages. This parameter applies to all stations. Low speed is defined as less than 56K b/s, and high speed is 56K b/s.
STREAM TRIB	234	16	6 (sec.) (13560 Octal)	Streaming tributary timer preset: This timer is used to detect a streaming tributary (see Section 4.4.3) and Table 3-7). In a multipoint network, this parameter is applicable only to the control station. However, in point-to-point networks, this parameter is applicable to both stations.
DELTA T	235	16	200 (ms) (310 Octal)	Delta time: This is the polling algorithm update increment. This global parameter, which is applicable only to multipoint control stations, is used by the polling

Table 4-3   User-Defined GSS Parameters (Cont)

Name	GSS Addr (Octal) BSEL6	Size (Bits)	Default (Octal)	Description
				algorithm to calculate polling urgency (see Section 5.2.1). The default value of 200 ms is the minimum value for this parameter. DELTA T is also used as the interval for updating the transmit delay timer.
DEAD T	236	16	10 (sec.) (17500 Octal)	Dead timer: This is the interval between polls for dead tributaries. This global parameter applies only to multipoint control stations.
POLL DELAY	237	16	0 (no delay)	This parameter provides for a fixed delay between polls for all tributaries in a network. If the default is accepted, the next poll for any tributary occurs immediately following the current poll.

4.3.3   Protocol Operation
At this point the DMV11 has been configured for operation in the associated network and is ready for protocol operation. The steps required to initiate protocol operation are:

1.   Place established tributaries in the ISTRT state by issuing one control command containing the request key. Request ISTRT state for each tributary address.

2.   If the DMV11 is a station in a point-to-point network, one control command must be issued containing the request ISTRT state request key with a tributary address of one in BSEL3.

3.   The DMV11 confirms that the protocol is operational at each tributary by issuing a control response (one for each control command issued) containing the protocol event code for DDCMP run state entered.

4.4   CRITERIA FOR DETERMINING COMMUNICATIONS LINK PARAMETERS
User-defined TSS and GSS parameters fall into two categories: polling parameters that provide for user-program control over the dynamic activity of the polling algorithm, and communications link pa-

rameters that provide the user program with the ability to regulate data traffic over the physical communications line. Referring to Tables 4-2 and 4-3, the communications link parameters include:

- Selection interval timer,
- Number of sync-characters,
- Babbling tributary timer,
- Maximum transmitted message count,
- Streaming tributary timer,
- Transmit delay timer.

Values for the selection interval timer and the number of sync-characters are interrelated, as are values for the babbling tributary timer and the maximum transmitted message count. These interrelated parameters are described in Sections 4.4.1 and 4.4.2.

4.4.1 Setting the Selection Interval Timer

The function performed by the selection interval timer at a DMV11 depends on the mode selected for that DMV11. In full-duplex point-to-point networks, this timer is used as a reply timer for the purpose of message accountability. This timer serves as a selection interval timer when the mode for the associated DMV11 is one of the following:

- A full-duplex control station;
- A half-duplex control station;
- A half-duplex point-to-point station.

In this capacity, it performs the link management function and provides for message accountability.

Link management is the process of controlling the transmission and reception of data over networks where there are two or more transmitter/receiver devices actively connected to the same physical communications link. This applies to half- and full-duplex multipoint networks as well as half-duplex point-to-point links. On half-duplex links, only one transmitter can be active at any time, and on full-duplex links, only one slave transmitter can be active at a time.

A station on such links can transmit when it is selected or granted ownership of the link. Link ownership is passed through use of the select flag in the DDCMP message header. Detecting a select flag in a received message allows the receiving station to transmit after message reception is completed. Sending a select flag means that the transmitting station ceases transmitting after the current message is sent.

A selection timer detects the loss of a select flag by timing the interval required to receive the longest message from a station. A timer is started when a station is selected and reset when valid messages are received from that station. When the timer interval is exceeded at the sending station (a message was not received during the period of the timer) it is assumed that messages with the select flag were either transmitted or received in error.

At this point, the station that originally sent the messages with the select flag set assumes ownership of the link. This station resumes transmitting as if it had received a valid select return.

The values assigned to select interval timers at stations in half-duplex point-to-point networks should be different at both stations to avoid possible deadlock race conditions. For both multipoint control stations and half-duplex point-to-point stations, the criteria for determining the value for a select timer includes such factors as:

- Maximum message length;
- Number of sync-characters;
- Line speed;
- Line turnaround time;
- Message processing delays.

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As indicated in Table 4-3, the GSS parameter number of sync-characters has two defaults; one for low-speed operation (10), and one for high-speed operation (15). The operational speed range of a DMV11 is specified by the line unit low-speed/high-speed switch which is placed in the appropriate position when the DMV11 is hardware configured (see Section 2.5). In the low-speed position the DMV11 can operate at line speeds up to 19.2K b/s, and in the high-speed position the device line speed is 56K b/s. It is recommended that the default for the appropriate line speed range be taken for this parameter.

Some recommended values for a selection interval timer are given in Table 4-4. The calculations shown in Table 4-4 include the following overhead factors:

        256 bytes of data
         28 bytes of header, sync, and pad characters
        ____

Total   284 bytes

The formula used to derive the values listed in Table 4-4 is:

$$\frac{8 \text{ bits per byte}}{\text{baud rate (bits per second)}} \times 284 \text{ bytes per message} + \text{RTS/CTS delay} = \text{Timer value (in seconds)}$$

NOTE
Most modems include an RTS/CTS delay that must be included in the calculation of the value for the selection interval timer. When operating with an external (EIA) modem, the typical delay used is 150 ms. The delay used when operating with the integral modem is 100 μs.

Table 4-4   Recommended Selection Interval Timer Values

Bits Per Second	Calculated Timer Value for a 256 Byte Message
4.8K	473 ms + 150 ms = 623 ms (700 ms)
9.6K	236 ms + 150 ms = 386 ms (400 ms)
56K	40.5 ms + 0.1 ms = 40.6 ms (50 ms)

The values listed in Table 4-4 represent absolute minimums. In most cases, specific applications require additional delay time over these values to prevent a timeout during reception of a valid message. Requirement for additional delay time can be caused by processing delays that occur when receiving from a non-DMV11 device, or by line delays encountered when dealing with satellite networks. When determining this value, keep in mind that it represents the time the system can reasonably expend waiting for a response from another station.

When used as a reply timer, the selection interval timer sets the maximum waiting period between sending a message and receiving an acknowledgement before taking error recovery actions. This timeout is necessary to recover from outages and the distortion of messages by the link. This timeout also prevents the protocol from being deadlocked.

The same criteria used to determine a value for a selection interval timer in multipoint networks, are also used to determine a value when this timer is used as a reply timer. As shown in Table 4-2, the default value for both cases is three seconds.

4.4.2 Setting the Babbling Tributary Timer

This user parameter is applicable to half-duplex and full-duplex multidrop network control stations. A babbling tributary is a tributary that continues to transmit valid DDCMP messages after a programmable timeout has expired, thereby, denying equal access to other nodes. This situation is controlled by the babbling tributary timer which monitors the total time period a tributary continuously transmits without relinquishing the communications line. When this period exceeds the timeout period of the babbling tributary timer, the user program is notified through a control response. The control response contains the code for a babbling tributary along with the identity of the offending tributary. When a babbling tributary is detected, the control station takes no action beyond this notification.

A major consideration in determining a value for the tributary timer is the total time interval that a given tributary requires to end a selection interval. Determining the value for this timer is similar to that for the selection interval timer because the same range of factors are used as criteria for calculating the value. The main difference in the two determinations is that the total number of message bytes should be used in babbling tributary timer parameter calculations rather than the number of bytes in the longest message.

A value for the maximum transmitted message count parameter must also be considered in conjunction with the parameter for the babbling tributary timer. The user-defined parameter to set this counter places a limit on the number of messages that a tributary can transmit during the selection period. This is done by forcing the select flag when the count of messages received from a tributary equals the value of the maximum transmitted message count. This count relieves the user program from having to limit the number of messages queued for transmission in order to avoid a babbling tributary condition.

In any case, the period established for the timeout of a babbling tributary timer should be long enough to ensure that timer expiration definitely indicates an error condition. In addition, the parameter assigned to the maximum transmitted message count should also be considered when establishing the period of the babbling tributary counter.

4.4.3 Setting the Streaming Tributary Timer

A streaming tributary is a tributary station on a multipoint line (or an associated point-to-point station) that continues to assert the carrier signal on the link after it has relinquished ownership of the link. In normal operation, ownership of the link is returned to the control station when it receives a select flag or the period of the selection interval timer is exceeded. A timeout of the streaming tributary timer indicates a potential jamming of the link by a defective tributary station, a defective point-to-point station, or a malfunctioning modem.

The streaming tributary is started when ownership of the link is granted to the control station by the remote station, and stopped when the carrier is dropped by that station. When a streaming tributary is detected, through expiration of the streaming tributary timer, the user program is notified in the same manner as with a babbling tributary. The control station does not transmit until the carrier is dropped.

Determination of a value for the streaming tributary timer requires consideration of such factors as settling time of the communications line and modem delays. As with determining periods for the selection interval timer and the babbling tributary timer, the period specified for this timer should be long enough to preclude premature expiration of the timer. For most network applications the default of one second is sufficient.

4.5 ERROR COUNTER ACCESS

The DMV11 is equipped with a large compliment of error counters designed to isolate a wide range of error conditions. The TSS for each established tributary contains seven error counters along with three statistical counters that provide background information for error analysis. In addition, the GSS at each station contains four error counters that tabulate errors that are global to the station. The three TSS statistical counters are 16 bits in length, and the threshold error counters are three bits in length. The remaining TSS/GSS error counters are eight bits long.

4.5.1 Reading the Counters

Both TSS and GSS counters are accessed through an appropriate control command with the content of the requested counter or counters being returned through an information response (see Sections 3.3 and 3.4). Through the control command, the user program has the option of reading, or reading and clearing the counters. When doing error analysis it is recommended that a user program read and clear these counters to assure a zero-base for subsequent sampling of the counters. If copies of the counters are being maintained in main CPU memory, it is also recommended that counters be read and cleared.

NOTE
The three-bit threshold error counters are automatically reset when the maximum count is reached so that access to these counters is restricted to reading only.

The DMV11 error and statistical counter structure is designed to be complimentary. As an example of this complimentary structure, consider the data errors inbound counter and the data messages received counter. The data errors inbound counter tabulates the errors related to the validity of message reception such as block-check errors, whereas, the data messages received counter records the total number of messages received. A ratio of message reception errors to total number of messages received can be derived from these two counters.

4.5.2 Counter Skew

When performing error analysis, there is a potential of skew between counts due to read time lags and the requirement that counters be read one at a time. The probability of skew between counts is a function of line speed; the higher the line speed, the greater the probability of a skew condition. An example of this potential skewing is the possible discrepancy between the number of selection intervals and the number of selection timeouts. A skew could result from additional selection timeouts occurring while the counters are being read.

If circumstances require that error/statistical counters be read without the potential for skew, this can be done by halting the protocol at the tributary. With the protocol halted, the contents of the error/statistical counters in a TSS and in the GSS are frozen at the counts recorded when the protocol was halted. The counters can then be read without the problem of skew due to read time lags.

4.6 ERROR RECOVERY PROCEDURES

Within a DMV11-based network, there are three basic levels of error recovery involving the user program:

1. Procedural violations where only the user program is notified.

2. Recovery from errors requiring protocol shutdown initiated by the user program.

3. Fatal errors resulting in system shutdown with minimal notice to the user program.

Referring to Table 3-7, procedural error codes from 100 to 140 are reported to the user program with no recovery required. The remaining two procedural errors (codes 300 and 302) involve error recovery levels two and three respectively. All network errors require recovery through protocol shutdown, and the control response (queue overflow) could result in network shutdown.

4.6.1 Recovery from Network Errors
In all cases, recovery from network errors requires that the protocol be halted at the tributary or station recording the error. Two similar but separate procedures are recommended for recovery from threshold errors, and babbling and streaming tributary errors. These recovery procedures are described below.

4.6.1.1 Recovery from Threshold Errors – DMV11 threshold errors are detailed in Section 5.3.3. The recommended recovery procedure to be initiated by the user program at the station recording the errors is presented below:

1. Halt the protocol (see Table 3-6).

2. Read the error counters to determine the nature and cause of the threshold error condition. If the error results from a shortage of receive buffers, correct the condition. If the transmit or selection threshold is being exceeded, check the operational condition of the remote station.

3. When the conditions causing the errors have been eliminated, restart the protocol (see Section 4.3.3).

4.6.1.2 Recovery from Babbling and Streaming Tributary Errors – Babbling or streaming tributary errors are created when their respective timers are exceeded. Therefore, a timeout can result from an actual error condition, or because the period of the timer is too short for the type of message activity on the line (see Sections 4.4.2 and 4.4.3). A suggested recovery procedure to be used when encountering these conditions is:

1. Halt the protocol.

2. Check the value of timer parameters and increase if the value is not appropriate.

3. Restart the protocol (see Section 4.3.3).

4. If this error condition persists, reconfigure the station as specified by Section 4.3.1.

5. When the cause of the timeout originates at the remote station, action must be taken at the remote station to ascertain and correct the fault. The local station is at fault only if the values of the timer parameters are inappropriate.

4.6.2 Recovery from Procedural Errors
The three procedural errors that require a recovery procedure are:
1. Nonexistent memory error.
2. Buffer too small error.
3. Queue overflow error.

The recovery procedure for each of these errors is detailed in Sections 4.6.2.1 through 4.6.2.3.

4.6.2.1 Recovery from a Nonexistent Memory Error – Nonexistent memory errors occur when the DMV11 tries to access an allocated receive or transmit buffer having an invalid bus address. When this error is detected, the DMV11 posts a control response to the user program containing the invalid address (see Section 3.4.2). It is up to the user program to determine whether the nonexistent address concerns a transmit or receive buffer.

NOTE
Depending on microcode processing circumstances, the nonexistent memory address returned to the user program could have been incremented to the next sequential location.

The suggested recovery procedure for this error is as follows:

1. Halt the protocol for the tributary or station recording this error to initiate return of all outstanding buffers.

2. If the error concerns a buffer from the common pool, the user program should issue the global halt command to initiate return of all outstanding receive buffers from the common pool.

3. Restart the protocol and reallocate buffers as necessary.

Persistent recurrence of this error indicates a possible main CPU or DMV11 malfunction.

NOTE
If the network line speed is 56K b/s, the requests for retransmission generated by a nonexistent memory address can result in the overflow of the DMV11 response queue causing a fatal system error (see Section 4.6.2.3).

4.6.2.2 Recovery from a Receive Buffer Too Small Error – When the DMV11 receives a message, it first checks for the availability of a buffer from the common buffer pool linked list, and if one is available, it uses that buffer. If the common buffer pool is empty or not enabled, the private buffer linked list is checked. If a private buffer is not available, the receiving station NAKs the incoming message. The steps taken by the DMV11 microcode in this process are listed below.

1. Is the message number in sequence? Yes, continue; No, ignore message.

2. Is the common buffer pool enabled? Yes, continue; No, go to Step 6.

3. Is the common buffer pool quota = 0? Yes, go to Step 6; No, continue.

4. Is a common pool buffer available? Yes, continue; No, go to Step 6.

5. Is the common pool buffer too small? Yes, go to Step 8; No, use this buffer.

6. Is a private buffer available? Yes, continue; No, send NAK – buffer temporarily unavailable.

7. Is private buffer too small? Yes, send NAK – buffer too small; No, use this buffer.

8. Is private buffer available? Yes go to Step 7; No, send NAK – buffer too small.

NOTE
The DMV11 does not scan the common pool or private linked list structures looking for a buffer of sufficient size. Rather, it uses the next available buffer from the list.

Buffer too small errors apply only to receive buffers. The procedure for recovery from this error is dependent on whether the allocated buffer is from the common pool or is a private buffer. The applicable recovery procedures are explained below.

A. Common pool buffer too small

1. Assign a private buffer of sufficient size to the receiving tributary through a buffer address/character count command (see Section 3.3.4).

B. Both private and common pool buffers too small

1. Halt the protocol for the offending tributary to initiate return of all outstanding private buffers.

2. Restart the protocol.

3. Assign a private buffer of sufficient size to the receiving tributary through a buffer address/character count command (see Section 3.3.4).

C. Private buffer too small, and common pool not enabled

1. If buffers from the common pool are available to other tributaries, and are of sufficient size, enable common pool buffers for this tributary (see Section 3.3.4).

2. If the common buffer pool is not in use for other tributaries, follow recovery procedure B above.

4.6.2.3 Recovery from a Queue Overflow Error – This error is always fatal to the DMV11 recording the error since it forces automatic shutdown of the device. The basic cause of this error is the inavailability of link blocks from the free linked list (see Section 5.4.1.1). Typically, this error results when the internal response queue overflows because the DMV11 generated responses faster than the user program could retrieve responses from the queue. This error can also occur if an inordinate number of receive buffers have been allocated. One cause of response queue overflow is the occurrence of repetitive nonexistent memory errors in high-speed networks (see Section 4.6.2.1).

When this error occurs, the DMV11 posts the most current entry in the response queue to the user program. The user program then has three seconds after being interrupted to retrieve the response. If it is retrieved during this three second window, the next response is posted. As long as the user program retrieves each response within this window, the process continues until the internal response queue is empty. These responses can then be analyzed to determine the cause of the queue overflow.

After the last response has been posted, or the three second response period has expired, the DMV11 shuts itself down. At this point, returning the DMV11 to operational status requires that the start-up procedure be initiated from the beginning (see Section 4.3).

4.7 BOOTING A REMOTE STATION
DMV11-based networks provide the user program, at the multipoint control station or point-to-point station, with the ability to boot the main CPU at a remote station that has been shut down due to power outage or software malfunction. There are three ways this boot function can be performed:

1. Remote load detect: The control station starts the primary MOP boot procedure for a remote station.

2. Power-on boot: The first poll received after power-up at the remote station causes the DMV11 at that station to request that the control station start the MOP boot procedure.

3. Invoke primary MOP: The user program at the remote station causes the DMV11 to request that the control station start the primary MOP boot procedure.

NOTE
Control station is either a multipoint control or point-to-point station that is transmitting (over the link) the boot or requested program to the remote station. Remote station is either a multipoint tributary or point-to-point station that is receiving (over the link) the boot or requested program.

NOTE
Power-on boot, remote load detect, and invoke primary MOP are not mutually exclusive. All three features could be used in a particular application.

Primary MOP boot procedures require that the DMV11 be switch-configured in the manner specified in this section. The steps taking place at the remote station and over the communications line leading to each of the three primary MOP boot functions are presented in the following sections.

4.7.1 Steps Leading to a Remote Load Detect Boot
The steps taking place at the DMV11 remote station and its host CPU in response to an enter MOP mode message from the control station are:

1. The DMV11 NPRs a tight-loop routine into main memory.

2. The DMV11 transfers control to the routine through the power fail/restart vector. This routine inactivates the CPU to prevent any intervention during the NPR process.

3. The DMV11 then sends a primary MOP request program message to the control station. The control station responds in turn with a primary MOP memory load with transfer address message containing the boot or related program to be loaded into main memory at the remote station.

4. The DMV11 NPRs that program into main memory, then starts executing the program.

5. At this point the remote station is operating in the manner intended by the down-line loaded program.

The steps occurring over the communications line during a remote load detect boot are:

1. The control station sends an enter MOP mode message to a remote station.

2. The remote station recognizes the address and password in the message, then inactivates its host CPU.

3. The remote station then responds with a primary MOP request program message.

4. The control station responds to this message with a primary MOP memory load with transfer address message containing the boot or related program to be loaded into the host CPU at the remote station.

4.7.2 Steps Leading to a Power-On Boot
When power is restored after a shutdown at a remote station, the DMV11 performs the same steps used during a remote load detect boot. However, the first two steps performed over the communications line are omitted, and the tributary station responds to the first poll from the control station with an MOP request program message. The same sequence used in the remote load detect boot procedure is then followed.

4.7.3 Steps Leading to an Invoke Primary MOP Boot

This boot operation is initiated when a user at a remote station sets the boot and master clear bits in the DMV11 initialization register (see Section 3.3.1). The steps taken by the DMV11 are the same as with a power-on boot.

4.7.4 DMV11 Switch Settings for the Boot Functions

At remote stations, in networks supporting the primary MOP boot functions, the switches must be configured in a specific way in order to properly perform the boot functions (see Section 2.5 and Table 2-6).

NOTE
The switch setting procedures described below apply only to tributary stations in a multipoint network and one node in a point-to-point network.

The unit number (zero or one) of each DMV11 must be appropriately set. This number allows the boot program, once it is loaded into the host CPU, to identify the specific DMV11 (within the host's floating address space) performing the boot.

NOTE
When primary MOP booting is supported in a network, the operating mode of each tributary station eligible for booting must be set in the switches rather than through the mode definition command.

The operating mode of a DMV11 is specified by setting the mode enable switch to one (OFF) (switch number 1 of the boot enable switch pack), and setting switches numbered 6, 7, and 8 to the required operating mode. The settings for these switches are listed in Table 4-5.

4.7.4.1 Switch Settings for the Power-On Boot Function

To enable the power-on boot function at a remote station, switch number 4 of the boot enable switch pack (power-on boot) must be set to one (OFF). In addition, the tributary address of this station must be set in the DDCMP address switch pack.

4.7.4.2 Switch Settings for the Invoke Primary MOP Boot Function

The DMV11 switch settings for the invoke primary MOP boot function are the same as those for the power-on boot function. However, the setting of the power-on boot switch has no affect on the invoke primary MOP boot.

An additional feature of the invoke primary MOP boot is that it may allow the tributary address of the remote station to be software assigned instead of switch assigned. This feature is only valid for remote stations that are multipoint tributaries. To use this feature, the following conditions must exist.

● The tributary address/password in the DDCMP address switch pack must be zero.

● The user program at the remote station must have established the tributary using the control command (establish tributary). If the remote station is using the multiple address tributary option, the tributary address used for booting must be the first one established.

NOTE
Invoke primary MOP boot with the software-assigned tributary address does not work if the power-on boot switch is enabled.

Table 4-5 Mode Switch Settings

Mode Switches			Line Characteristics	Network Configuration	DMC11 Line Compatibility
6	7	8			
ON	ON	ON	Half-duplex	Point-to-point	Yes
OFF	ON	ON	Full-duplex	Point-to-point	Yes
ON	OFF	ON	Half-duplex	Point-to-point	No
OFF	OFF	ON	Full-duplex	Point-to-point	No
ON	ON	OFF	Half-duplex	Multipoint control station	N/A
OFF	ON	OFF	Full-duplex	Multipoint control station	N/A
ON	OFF	OFF	Half-duplex	Multipoint tributary station	N/A
OFF	OFF	OFF	Full-duplex	Multipoint tributary station	N/A

4.7.4.3 Switch Settings for the Remote Load Detect Boot Function – To enable the remote load detect boot function at a remote tributary station, switch number 5 of the boot enable switch pack (enable remote load detect) must be set to one (OFF). For the remote load detect boot function, the switch-specified tributary address also serves as the password which is contained in the enter MOP mode message.

When using boot functions in point-to-point networks, the tributary address/password switches can, for security purposes, be set to a unique value since the address of a point-to-point node is always known to be one.

4.8 MAINTENANCE REGISTER EMULATION
The DMV11 is placed into maintenance mode when the user program sets bits 0 and 6 at the same time in BSEL1. When this happens, the microcode enters a maintenance loop and sets MNT RDY (bit 7 of BSEL2) to indicate that the microcode is ready to receive a command as defined by bits zero through three of BSEL2 (see Figure 4-3). The functions of these commands are described in Table 4-6.

NOTE
The microdiagnostics must complete tests 1-12 as a minimum before allowing entry into the maintenance loop.

In the maintenance mode, the functions of the CSRs are redefined as follows:

- BSEL0, bits zero and four, enable the respective microprocessor LSI bus interrupts as defined by bits one and two. See Figure 4-3.

- BSEL2, bits zero through three, define the maintenance loop command function. Bits four and five are used for interrupting the CPU if an internal microprocessor interrupt occurs. These interrupts are enabled by BSEL0. Bit seven is set by the microprocessor when the maintenance loop is ready to receive another command function in bits zero through three (Table 4-6).

- SEL4 contains a DMV11 memory location for function codes one through five (Table 4-6).

- SEL6 contains data written or read for functions one, two, and six. It also contains a 16-bit address for functions three and four.

- SEL10 contains the upper address bits for functions three and four. Only the low byte of this CSR is used.

NOTE
BSEL10 and 11 are only used in 22-bit mode.
BSEL12 through 17 are not shown because they are
never used by the user/DMV11-command structure.
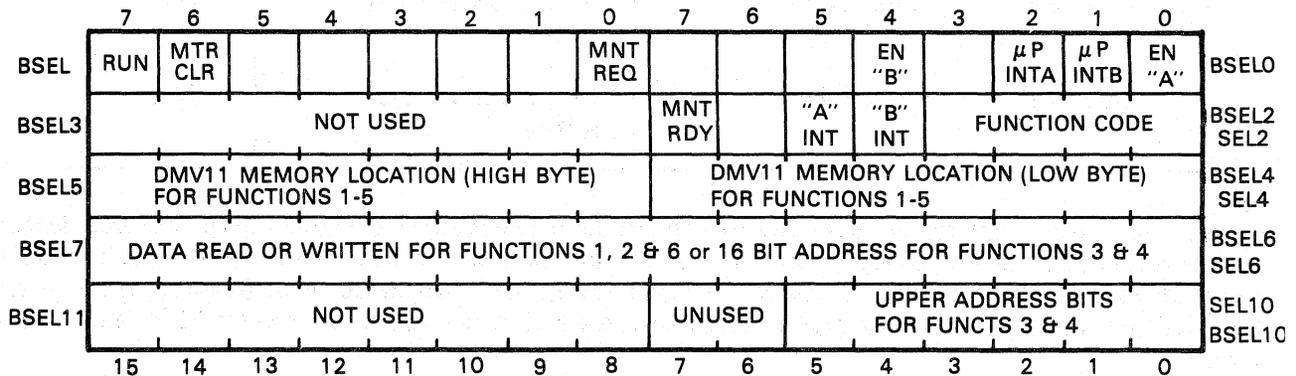
Figure 4-3   DMV11 Maintenance Loop Command Format

Table 4-6   Maintenance Command Functions BSEL2 Bits 0-3

Octal Code Bits 0-3	Function
0	Reserved to avoid unpredictable results.
1	Read DMV11 memory location specified by SEL4 (16-bit address specifying a byte). SEL6 contains the data read from this location.
2	Write DMV11 memory location specified by SEL4. SEL6 contains the data written to this location.
3	Read 256 bytes of DMV11 memory. SEL4 points to the starting DMV11 memory address from which the information is read. The lower eight bits of this address are ignored. SEL6 and BSEL8 point to the starting LSI-11 bus address where the information is stored.
4	Write 256 bytes of DMV11 memory. SEL4 points to the starting DMV11 memory address to which the information is written. The lower eight bits of this address are ignored. SEL6 and BSEL8 point to the starting LSI-11 bus address from which the information is read.
5	Set the 6502 microprocessor's program counter to the value contained in SEL4. This is used to start the microprocessor executing code at the DMV11 memory location specified by SEL4.
6	Set internal loop and null clock for functional diagnostics. Null clock is initialized for 56K b/s.
7	Set maintenance interrupt flags and clear interrupt disable in processor status.

CHAPTER 5
ASPECTS OF DMV11
MICROCODE OPERATION

5.1 INTRODUCTION
The functionality of the DMV11 results from the microprocessor and its associated microprogram or microcode. This chapter discusses the microcode as it relates to:

- The polling algorithm,
- Error recording, and
- The internal data base.

5.2 DMV11 POLLING ALGORITHM
In a polling operation the tributaries are in effect asked one by one whether they have anything to transmit. To accomplish this, the control station sends a polling message with a unique tributary address down the line. The station which recognizes the address responds with data messages or a positive response.

With DMV11s, polling is based on a priority scheme which is derived automatically and applied dynamically by the microcode. To control polling and data message transmission, the DMV11 uses the following information:

- The tributary's recent poll history,
- The tributary's user-defined parameters,
- The tributary's protocol state.

In regard to protocol state, the multipoint network control station polls all established tributaries that are not in the DDCMP halt state. The protocol state of every established tributary is maintained in the associated TSS by the control station. When a tributary is eligible for polling, all outstanding transmit messages for that tributary are sent as the poll, up to the limit imposed by the maximum transmitted message count. If no transmit messages are available for a tributary eligible for polling, the DMV11 automatically transmits the appropriate DDCMP control message.

The DMV11 polling algorithm determines which tributary is to be polled next, based on each tributary's polling urgency level. The DMV11 polling algorithm employs the user-defined TSS and GSS polling parameters as the basis for categorizing tributaries into polling levels. The polling algorithm also determines the rate at which polling urgency is increased within each polling level. A tributary's polling level is based on its recent response history. This classification mechanism, combined with periodic incrementing of polling urgency, results in the most active tributaries being polled most often.

5.2.1 Calculating Polling Urgency

The polling urgency (priority) of each tributary is periodically calculated when a global timer expires. This periodic calculation enables the algorithm to enforce minimum poll intervals for each tributary, and to account for competition between tributaries. The minimum poll interval prevents unneeded polls from:

- Delaying other tributaries,
- Interfering with output traffic, and
- Causing unnecessary processor overhead.

The polling urgency of a tributary is calculated as a linear function of time elapsed since the last poll. The calculation is truncated when the maximum value of 255 is reached. The three parameters in this calculation are:

1. Q – the initial value of the polling urgency (U);
2. R – the rate at which Q is to be increased;
3. DELTA T – the polling algorithm global update interval.

Figure 5-1 shows the relationship between these three parameters. The appropriate choice of Q and R can give a variety of behaviors. For this reason, the choice of these values must be based on the desired performance. One method of choosing Q and R is to define the minimum poll time and the time to reach maximum poll urgency, and to use these values in the following equations.

$$\text{Minimum poll time} = \frac{128\text{-}Q\,(\text{DELTA T})}{R}$$

$$\text{Time to reach maximum poll urgency} = \frac{255\text{-}Q\,(\text{DELTA T})}{R}$$

DELTA T is the user-defined period of the global timer and its value depends on the line speed. It must be smaller than the smallest nonzero minimum poll interval, but no smaller than 200 ms. The poll priority is calculated for each tributary and stored in a single byte of the TSS. With every DELTA T, the polling urgency byte is updated. The following interpretation is placed on its value. These values are represented as base lines on the graph of Figure 5-1. Figure 5-2 shows the relationship of the polling urgency to different values of Q and R.

0 – 127	Do not poll the tributary. The minimum poll interval has not expired.
128	Minimum poll interval has expired. The tributary is eligible for polling.
129 – 254	Minimum poll interval is exceeded. The tributary is eligible for polling. The higher values indicate increasing priority in the event of competition between tributaries.
255	Maximum poll urgency is reached. Competition between tributaries at this priority is round-robin.

This method of determining values for Q and R is applicable when static behavior is desired. For many applications, however, dynamic behavior can improve performance by polling active tributaries at a faster rate and with a higher priority than inactive tributaries.

During each DELTA T time period, the control station polling algorithm updates the urgency of each operational tributary by adding the value of R for the appropriate polling state (excluding dead) to the urgency value of each tributary. This updating sequence is performed on the TSS data base in the order

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in which tributaries were originally established at the control station. When the polling algorithm determines that the next poll is to be sent, it selects the tributary to be polled by scanning the TSS data base (in the original order of tributary establishment), starting at the TSS following the last tributary polled. In this process, the tributary having the highest value of U from active, inactive, and unresponsive tributaries is selected as the next tributary to be polled.
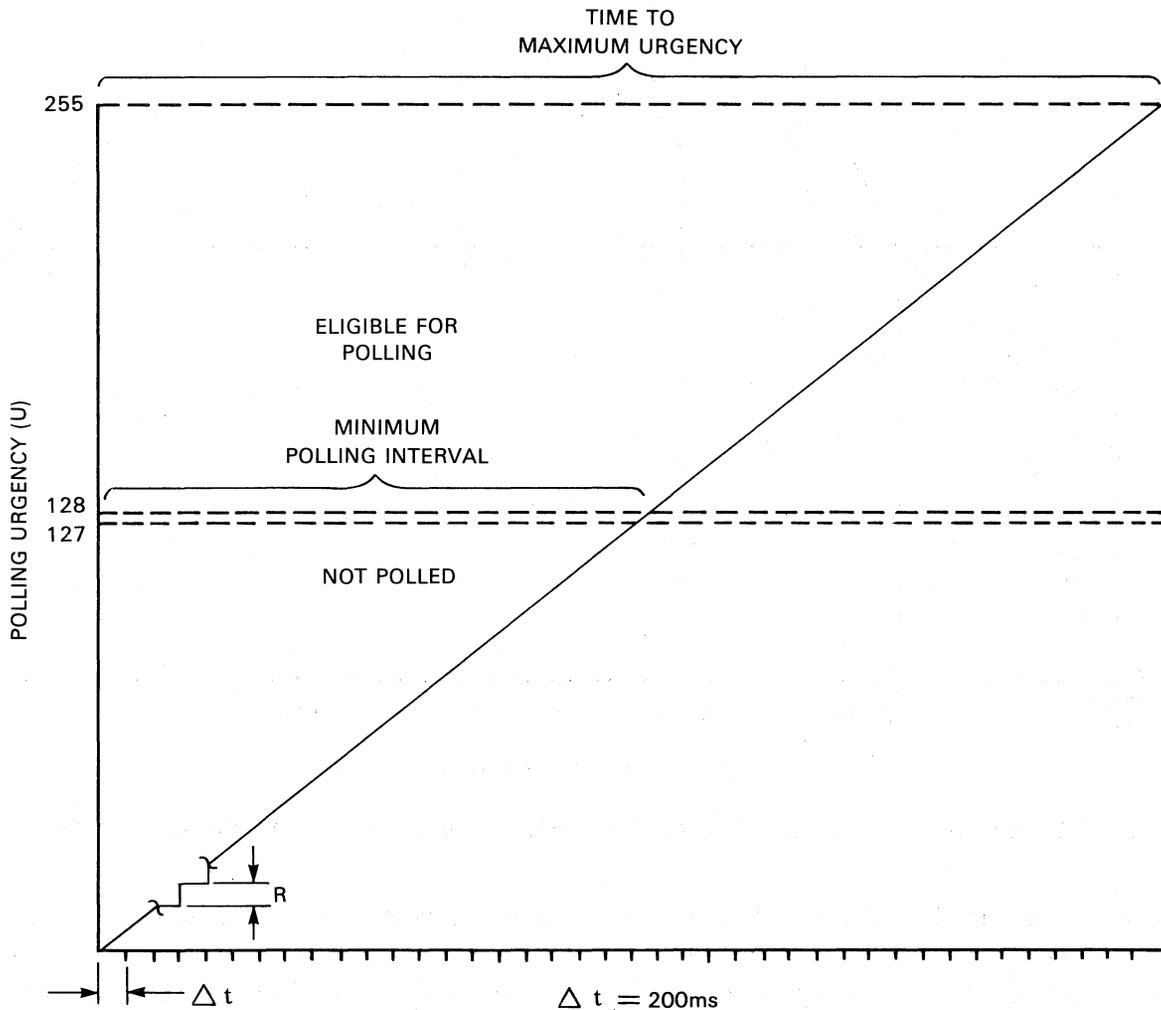
Figure 5-1 Interrelationship Between Polling Parameters Q, R, and DELTA T

If an urgency of 255 is detected during the process of scanning the TSS data base for the tributary having the highest value of U, the scan process is halted and that tributary is immediately selected for polling. Once the selected tributary is polled, its urgency reverts to the assigned value of Q for its polling level.

Dead tributaries are polled at a rate determined by the user-defined parameter DEAD T. One dead tributary is polled at each expiration of the DEAD T timer, and the scan of dead tributaries is resumed from the last dead tributary polled.
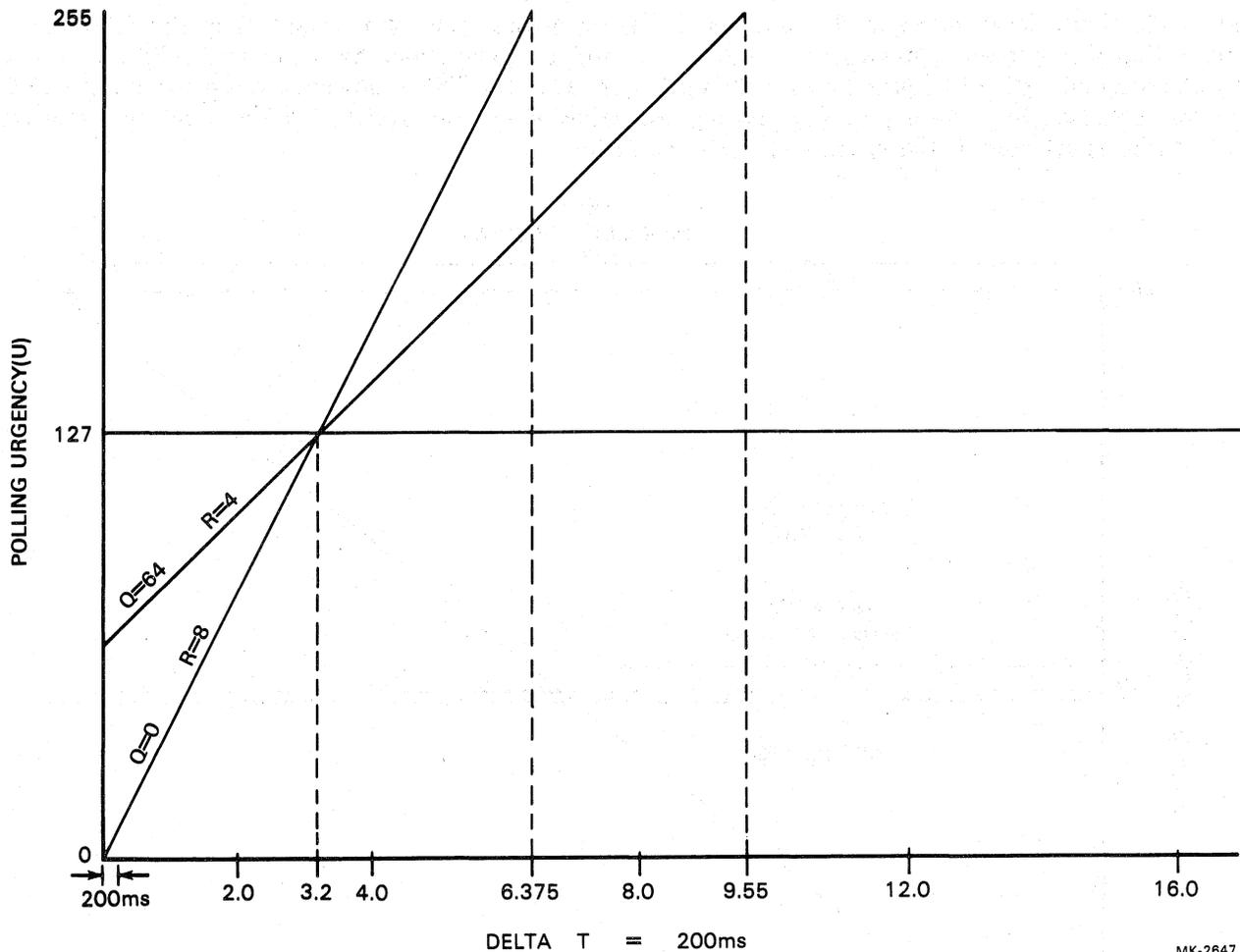
Figure 5-2   Relationship Between Polling Parameters Q, R, and the Minimum Polling Interval

The dynamic polling algorithm uses Q and R values based on dynamically modified states. There are four of these states:

1. Active – The polling algorithm maintains a tributary as active when it responds to polls with data messages.

2. Inactive – The polling state of an active tributary is changed to inactive when it responds to a consecutive number of polls with nondata DDCMP messages. The count of consecutive non-data messages received from a tributary in the active state is designated by the user-defined parameter NDM-INACT (number of no-data messages required to go inactive).

3. Unresponsive – A tributary currently active or inactive is changed to the unresponsive state when it fails to respond in any way to a consecutive number of polls (each poll results in a selection timeout). The count of consecutive polls without responses is designated by the user-defined parameter TO-UNRESP (number of timeouts to go unresponsive).

4. Dead – A currently unresponsive tributary which continues to be unresponsive to consecutive polls is changed to dead. This occurs when the number of selection interval timeouts designated by the user-defined parameter TO-DEAD (number of timeouts to go dead) is exceeded. Unlike tributaries in the other polling states, dead tributaries are always polled on a round-robin basis with the period between polls being determined by the user-defined global parameter DEAD T (dead timer).

When specifying the parameters controlling polling levels, the user has the option of accepting the defaults (see Table 4-2 and 4-3), or selecting specific values in place of these defaults. The user program can set the polling state of a tributary to any state at any time by issuing a latch polling state control command. The polling state imposed by a control command remains in effect, irrespective of tributary performance, until polling control is handed back to the polling algorithm by the user program. This is done by issuing an unlatch polling state control command.

Figure 5-3 shows the relationship of the the default values of Q and R for the active, inactive, and unresponsive polling states.
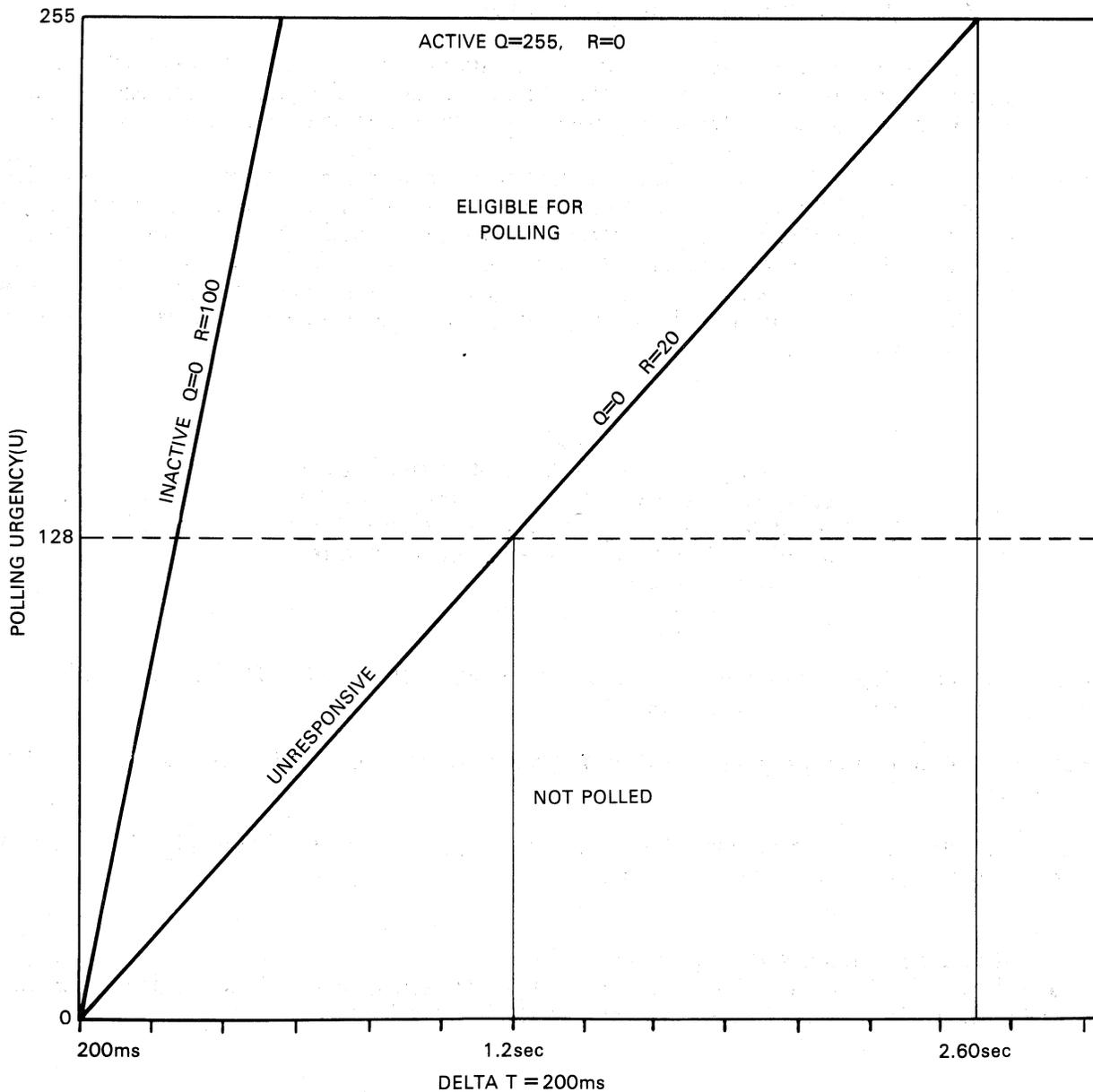
Figure 5-3   Relationship Between the Default Values for Q and R for the Three
Polling Activity Levels

Each tributary has Q and R values defined by the user for the active, inactive, and unresponsive polling states. This allows dynamic modification of the behavior of the polling algorithm. The basic mechanics of the polling algorithm are:

- If a tributary always responds to a poll with data, it remains in the active state. The polling urgency in this case is calculated using the Q and R values specified for the active state.

- If a tributary responds to a user-defined number of consecutive polls with no data messages (ACKs only), polling is changed to inactive. The polling urgency is then calculated based on the Q and R values defined for the inactive state.

- If a tributary in either the active or inactive states fails to respond (times out) to a predetermined number of consecutive polls, the polling state is changed to unresponsive. The Q and R values defined for the unresponsive state are used to calculate the polling urgency.

- If a tributary in the unresponsive state fails to respond to a predetermined number of consecutive polls, the polling state is changed to dead. The user is notified of this transition by a control response. Polling dead tributaries is very time-consuming because it usually requires a timeout. Therefore, dead tributaries are not polled on a priority basis. Instead, a global poll interval is defined for dead tributaries. Each time this timer expires, a single dead tributary is polled. If at any time a dead tributary responds to a poll with a data message or ACK, its state is changed to active.

NOTE
A tributary (not in the active polling state) is automatically returned to the active state when it responds to a poll with a valid data message. It also becomes active when the user program allocates a transmit buffer to it.

Figure 5-4 is a state diagram describing the transitions between polling states. The actual transitions are dependent on the particular polling parameters.

The user may control sending of all polls by defining a poll delay interval that must expire before a poll can be sent.

The program-selectable parameters which pertain to polling are included in Table 4-2. These parameters are set by the user with a write TSS command.

5.2.2 Criteria for Determining Polling Parameters
Although there are no absolute rules for determining polling parameters, there are general guidelines for deriving them. These guidelines are presented in sections 5.2.2.1 through 5.2.2.4.

5.2.2.1 Determining a Value for DELTA T – For most multipoint network applications, the default value of 200 ms for DELTA T is adequate. The default value of 200 ms is the smallest permissible value for DELTA T and represents the actual time required for the microcode to update the urgencies of 12 tributaries. However, in specific cases a higher value of DELTA T might be recommended. An example of this is a network formed by low traffic devices.

NOTE

The minimum polling interval defines the time required for a tributary to reach the urgency threshold value of 128. This is the minimum time required to be eligible for polling. The maximum polling interval cannot be determined. This is because it is a function of line speed, message traffic, the number of tributaries in a network, and the polling states of those tributaries. These variables make it impossible to predict the time at which any tributary in a network is polled.
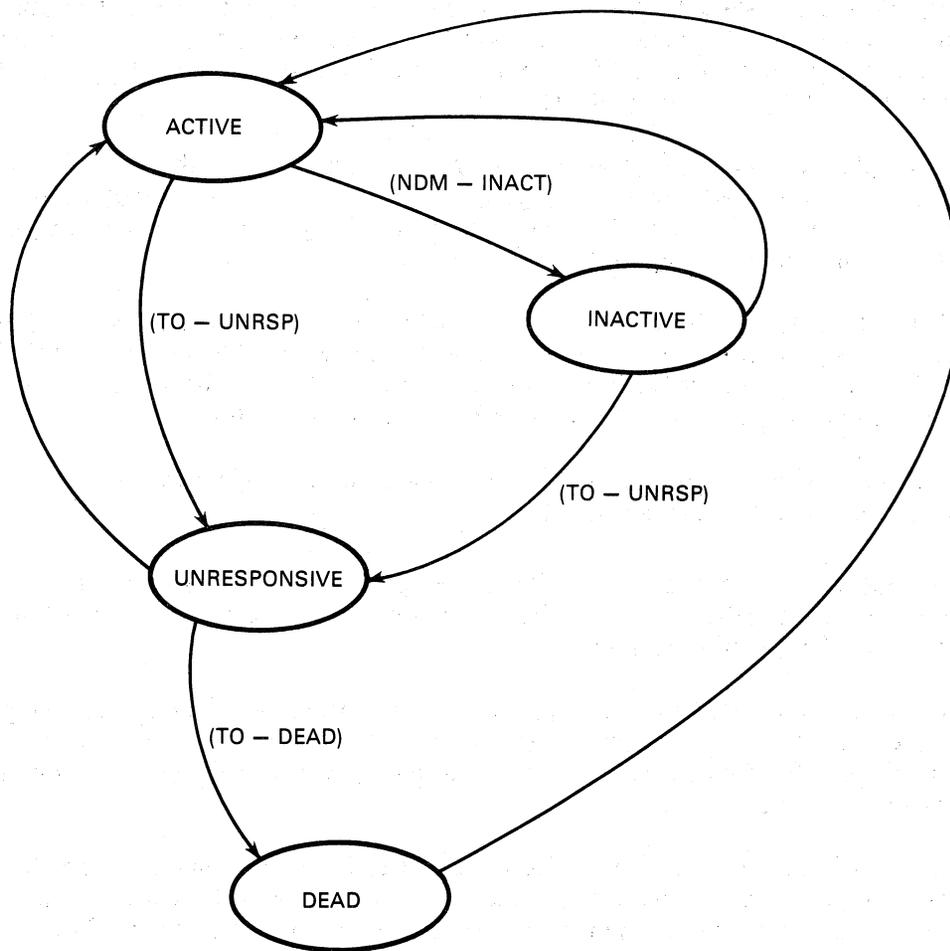
MK-1956

Figure 5-4   State Diagram of Polling State Transitions

5.2.2.2   Determining Values for Q and R – For a given value of DELTA T, the minimum polling interval is a function of the user-defined parameters Q and R. For example, if a minimum polling interval of 3.2 seconds is desired for a tributary (assuming DELTA T = 200 ms), the parameters Q = 0, and R = 8 satisfy this requirement. With these values of Q and R, the time to reach maximum polling urgency is

6.375 seconds (see Figure 5-2). Notice that if Q = 64 and R = 4, the minimum polling interval remains at 3.2 seconds but the maximum polling urgency increases to 9.55 seconds.

NOTE
Reaching maximum polling urgency represents maximum eligibility for polling, but does not guarantee that a tributary will be polled.

Figure 5-3 graphs the relationship between the default values of Q and R for each of the three polling states. When all tributaries in a network have the default value for Q and R, and all tributaries are in the active polling state, the manner of polling is round-robin.

5.2.2.3 Determining a Value for Poll Delay – The user-defined global parameter poll delay imposes a fixed delay between control station polls. This provides a mechanism for regulating message traffic without changing the values of Q and R for individual tributaries. During this delay, transmission from the control station to tributaries is halted for the interval defined by the poll delay timer. This interval begins when the tributary just polled deselects itself.

The ability to regulate message traffic through a single parameter is valuable in multipoint networks. This is especially true where DMV11s are configured together with slower character interrupt communication devices such as DUP11s. The value selected for poll delay in these circumstances is a function of the character handling rates of the non-DMV11 devices.

In remote multipoint networks where the distance between the control station and tributaries varies significantly, there is a greater chance of transmit and receive errors. This is due to the difference in communication line settling time in such a network. In such instances, the settling time for the most distant tributary station should be used for determining a value for poll delay.

For DMV11-implemented high-speed local networks, this parameter is unnecessary. The default value (zero) for poll delay is used in these networks.

5.2.2.4 Determining a Value for DEAD T – This global parameter establishes the rate at which dead tributaries are polled. Dead tributaries are polled on a round-robin basis, with one tributary polled at each expiration of the dead tributary timer.

Polling dead tributaries can significantly impact network line utilization. The shorter the period of this timer – the greater the impact. For a given value of DEAD T, the impact decreases as system line speed increases. When determining a value for this parameter, the primary goal is to minimize the impact on network line utilization.

The value for DEAD T should be based on the period of the selection interval timer for the specific application. For example, if the period of the dead tributary timer and the selection interval timer are equal, only dead tributaries are polled. For most system applications, the period of the dead tributary should be from three to ten times greater than that of the selection interval timer. This of course depends on line speed. The default value for DEAD T is ten seconds. This is about three times the default value for the selection interval timer.

5.3 ERROR COUNTERS
In multipoint networks many tributaries tie to the same transmission line. Because of this, it is more difficult to determine which link, if any, is causing errors. To aid in troubleshooting, the DMV11 maintains extensive error counters. Every DMV11 in the network (the control station and each tributary) uses error counters to record errors. This allows user programs at any DMV11 in the network to determine overall error rates and to detect a malfunctioning link.

Data link errors are indicated to the DMV11 by DDCMP negative acknowledge messages (NAKs). Each NAK contains an address field and a reason code that identifies the source and reason for the NAK. In general, when an error is detected in an incoming message, the station that receives the message sends a NAK to the station that sent the message. By recording NAKs sent and NAKs received, each point or tributary in the network is able to compile statistics on the condition of the link established between the two stations. DDCMP error recording has been designed so that even if one of the stations on the link cannot record errors, the other station may be used to record errors for all communications in both directions on the link.

There are three main categories of error counters used by the DMV11; data link counters, station counters, and threshold counters. Data link counters and threshold counters are maintained for each tributary/control station pair on a physical link. These counters are located in the tributary status slots of the data memory (Figure 5-5). Station counters are maintained for the physical link as a whole, and are located in the global status slots of the data memory (Figure 5-6). Unless otherwise stated, all counters increment to a maximum value and hold that value until cleared.

5.3.1 Data Link Error Counters

Data link counters are of two types; cumulative and background. The cumulative counters are 8-bit registers which latch at 255. The background counters are 16-bit registers which latch at 65535. The cumulative data link counters record and total all occurrences of an error and group them into the following categories.

- Data errors outbound,
- Data errors inbound,
- Local reply timeouts,
- Remote reply timeouts,
- Local buffer errors,
- Remote buffer errors,
- Selection timeouts.

Background data link counters are used to provide a statistical base for the cumulative error counters and therefore record:

- The number of data messages transmitted,
- The number of data messages received, and
- The number of selection intervals.

A point-to-point station maintains a single set of data link counters. Multipoint stations (control and tributary) maintain a separate set of data link counters for each established tributary. Data link counters are cleared by:

- A master clear of the DMV11,
- A control command to establish the tributary, or
- A user-issued control command to read and clear the TSS error counters.

5.3.1.1 Data Errors Outbound – This 8-bit group counter records NAKs received for data errors occurring on the communications channel outbound from this station. There are three types of outbound errors for which this counter records NAKs received; header blockcheck (OHBCC), data field blockcheck (ODBCC), and reply response (OREP). Three separate flag bits indicate which type of outbound error is being counted.

- OHBCC (outbound header blockcheck) is set when a NAK with a reason code of one is received for a header block-check error for either data or control messages.

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- ODBCC (outbound data field blockcheck) is set when a NAK with a reason code of two is received for a data field block-check error.

- OREP (outbound reply response) is set when a NAK with a reason code of three is received for a reply message response.

TRIBUTARY STATUS SLOT (TSS)
ADDRESS (OCTAL)

Address				
5	RESERVED			
	RECEIVE THRESHOLD ERRORS			
6	TRANSMIT THRESHOLD ERRORS			
	SELECTION THRESHOLD ERRORS			
7	DATA MESSAGES TRANSMITTED			
10	DATA MESSAGES RECEIVED			
11	SELECTION INTERVALS			
12	DATA ERRORS OUTBOUND			
	RESERVED	OREP	ODBCC	OHBCC
13	DATA ERRORS INBOUND			
	RESERVED	IREP	IDBCC	IHBCC
14	LOCAL BUFFER ERRORS			
	RESERVED		LBTS	LBTU
15	REMOTE BUFFER ERRORS			
	RESERVED		RBTS	RBTU
16	SELECTION TIMEOUTS			
	RESERVED		IRTS	NRTS
17	LOCAL REPLY TIMEOUTS			
	REMOTE REPLY TIMEOUTS			

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Figure 5-5 Data Link and Threshold Error Counters

15	REMOTE STATION ERRORS				
		RSTR	RSEL	RMHFE	ROVRN
16	LOCAL STATION ERRORS				
		LOVR	LUNDR	LMHFE	LOVRN
17	GLOBAL HEADER BLOCK CHECK ERRORS				
	MAINT. DATA BLOCK CHECK ERRORS				

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Figure 5-6   Station Error Counters

5.3.1.2   Data Errors Inbound – This 8-bit group counter records occurrences which normally result from data errors on the communications channel inbound to this station. Three separate bits indicate specific error types associated with this counter.

- IHBCC (inbound header blockcheck) is set when messages having header-block check errors are received. When this error occurs, point-to-point stations and multipoint control stations send a NAK with a reason code of one. A multipoint control station records this error for the selected tributary regardless of the address field in the received message. A multipoint tributary records this error only if the address field matches its station address.

- IDBCC (inbound data field blockcheck) is set when NAKs with a reason code of two are to be sent for data field block-check errors.

- IREP (inbound reply response) is set when NAKs with a reason code of three are to be sent for a reply response.

5.3.1.3   Local Reply Timeouts – This 8-bit counter records occurrences which result from:

- The loss of communications between two stations while the one recording this error has data to transmit, or

- The choice of an inappropriate value for the reply timer.

Specifically, this error counter records the sending of a REP message.

5.3.1.4   Remote Reply Timeouts – This 8-bit counter records occurrences which result from:

- The loss of communications between two stations while the remote station has data to transmit, or

- The choice of an inappropriate value for the remote station reply timer.

Specifically, this counter records ACKs sent in response to a REP. The remote station sent a REP because it received no acknowledgement for messages it previously sent. The local station received those messages, but the remote station never received the acknowledgement.

5.3.1.5 Local Buffer Errors – This 8-bit counter records the fact that the user program at the station recording the error failed to properly allocate receive buffers to data messages from the remote station. Two separate bits indicate the specific errors associated with this counter.

- LBTU (local buffer temporarily unavailable) is set when a buffer is temporarily unavailable. This condition indicates that a NAK with a reason code of eight is to be sent.

- LBTS (local buffer too small) is set when a local buffer is too small for the incoming message. This condition indicates that a NAK with a reason code of 16 is to be sent.

5.3.1.6 Remote Buffer Errors – This 8-bit counter records the fact that the user program at the remote station failed to properly allocate receive buffers to data messages from the station recording the error. Two separate bits indicate the specific errors associated with this counter.

- RBTU (remote receive buffer temporarily unavailable) is set when a NAK with a reason code of eight is received.

- RBTS (remote receive buffer too small) is set when a NAK with a reason code of 16 is received.

5.3.1.7 Selection Timeouts – This 8-bit counter records the occurrences which result from:

- Loss of communications with a remote station,
- Data errors on the communications channel to or from the remote station, and
- The choice of an inappropriate value for this station's select timer.

This counter is used only by half-duplex point-to-point or multipoint control stations. Two separate bits indicate the specific errors associated with this counter.

- NRTS (no reply to select) is used to record selection intervals in which no transmission is received from the tributary, and no attempt to transmit is detected. Specifically, it records the expiration of the select timer without the receipt of a valid control message or header, or the detection of an attempted transmission.

- IRTS (incomplete reply to select) is used to record selection intervals which were not properly terminated. Specifically, it records the expiration of the select timer preceded by receipt of a valid control message, receipt of a valid header, or detection of an attempted transmission. An attempted transmission is indicated by:

    - The presence of a carrier signal,
    - The receipt of a DDCMP synchronization sequence, and
    - The receipt of an SOH, ENQ, or DLE.

5.3.1.8 Data Messages Transmitted – This 16-bit counter records messages transmitted by this station, and latches at a count of 65535. It can be used as a statistical base when evaluating data errors outbound, local reply timeouts, and remote buffer errors. Messages sent as a result of retransmission are *not* included in this count.

5.3.1.9 Data Messages Received – This 16-bit counter records messages received by this station, and latches at a count of 65535. It can be used as a statistical base when evaluating data errors inbound, remote reply timeouts, and local buffer errors. Messages received out of sequence or in error are *not* included in this count.

5.3.1.10 Selection Intervals – This 16-bit counter records the number of times this station selects the other station. It also latches at a count of 65535. Specifically, it records the number of messages transmitted with the select flag on. It is only used by half-duplex point-to-point and multipoint control stations. It can be used as a statistical base when evaluating the number of selection timeouts.

5.3.2 Station Error Counters

Station counters are 8-bit counters which latch at 255 and record unusual occurrences. These occurrences may be the result of:

- A hardware or software fault at this station,

- A hardware or software fault at a remote station, or

- A data error on the communications channels undetected by the header block-check field.

A single set of these counters is used for all tributaries on a multipoint link.

There are four types of station counters:

1. Remote station errors,
2. Local station errors,
3. Global header block-check errors, and
4. Maintenance data field block-check errors.

Station counters are cleared by:

- A master clear of the DMV11, or
- A user-issued control command to read and clear the GSS error counters.

5.3.2.1 Remote Station Errors – This 8-bit counter records occurrences caused by a fault in a remote station or by an undetected data error on the channel inbound to this station. Four separate bits indicate the specific errors associated with this error counter.

- ROVRN (remote receive overrun) is set when a NAK with a reason code of nine is received for a receive overrun.

- RMHFE (remote message header format errors) is set when a message is received which has a header format error. This condition indicates that a NAK with a reason code of 17 is to be sent.

- RSEL (remote selection address error) is set when a multipoint control station receives a message containing an address field which does not match the address of the currently selected tributary. RSEL is a flag used only by multipoint control stations.

- RSTR (remote streaming tributaries) is set by either one of two events: 1) an implementation-dependent maximum transmission interval is exceeded without releasing the channel (babbling tributary), or 2) the channel is not released following the end of a selection interval (streaming tributary).

5.3.2.2 Local Station Errors – This 8-bit counter records occurrences caused by a fault in a local station or by an undetected data error on the channel outbound from this station. Four separate bits indicate the specific errors associated with this error counter.

- LOVRN (local receive overrun, NAK sent) is set for local station receive overruns. This condition indicates a NAK with a reason code of nine is to be sent.

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- LOVR (local receive overrun, NAK not sent) is set by a receive overrun when a NAK is not sent. For a multipoint tributary, this happens if an overrun occurs while receiving a header. For other stations, this occurs when the station is not in the DDCMP run state.

- LUNDR (local transmit underruns) is set when a transmit underrun occurs.

- LMHFE (local message header format error) is set when a NAK with a reason code of 17 is received to indicate a message with a header format error was sent by this station.

5.3.2.3 Global Header Block-Check Errors – This 8-bit counter records the occurrence of header block-check errors that are not recorded on a per tributary basis. Specifically, it counts header block-check errors for maintenance messages and for messages to tributaries where the address field does not match the station address.

5.3.2.4 Maintenance Data Field Block-Check Errors – This 8-bit counter records the occurrence of data field block-check errors for maintenance messages.

5.3.3 Threshold Error Counters
Threshold error counters are used to determine if a persistent fault exists. A persistent fault is one which occurs seven consecutive times. Whenever a threshold counter reaches its maximum value (7), the user program is notified by a control response.

In the DDCMP run state, threshold counters are cleared when the user is notified. In this way the user is continually informed of a persistent fault. In the DDCMP ISTRT and ASTRT states, threshold counters are not cleared when the user is notified. In this way the user is not continually informed of an inoperative remote station.

A point-to-point station maintains a single set of threshold counters. A multipoint control station maintains a separate set for each tributary. A multipoint tributary maintains a single set unless it supports multiple tributary addresses in which case it maintains a single set for each established tributary address.

There are three types of threshold error counters: transmit, receive, and selection.

5.3.3.1 Transmit Threshold Errors – This 3-bit counter is incremented (if less than seven) in the following instances.

1. The DMV11 is in the ISTRT state when a STRT message is sent,

2. The DMV11 is in the ASTRT state when a STACK message is sent, or

3. The DMV11 is in the run state and a NAK with a reason code other than three (REP response) is received, or when sending a REP message.

The transmit threshold error counter is cleared:

- Upon entering the ISTRT, ASTRT, or run states.

- While in the run state one of the following occurs:

    - A transmit threshold error is reported,

    - A NAK, ACK, or data message is received acknowledging a new message, or

    - A NAK, ACK, or data message is received when no messages are outstanding.

HEXADECIMAL

Address	Section	Size
0000	SCRATCH PADS	16 BYTES
10	Q-BUS CSRs	8 BYTES
1B	SCRATCH PADS	32 BYTES
3B	OUT NPR ADDRESS	3 BYTES
3B	SCRATCH PAD	1 BYTE
3C	IN NPR ADDRESS	3 BYTES
3F	SCRATCH PAD	BYTE
80	GLOBAL STATUS SLOT	64 BYTES
C0	SLOT MAPPING TABLE (SMT)	256 BYTES
1FF	MICROPROCESSOR STACK	64 BYTES
500	BUFFER AND OUTPUT QUEUE 98 ENTRIES	8 BYTES/ENTRY
800	TRIBUTARY STATUS SLOTS 12 ENTRIES	64 BYTES/ENTRY

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Figure 5-7 Data Memory Map

A DMV11 linked list is made up of five kinds of linked lists.

1. The free linked list – A list of empty link blocks used by the microcode to form the remaining kinds of linked lists.

2. The response linked list – A queue of responses for posting to the user program.

3. The common buffer pool linked list – A list of the accessing information for each receive buffer assigned to the common pool. There is one link block for each assigned buffer.

4. Receive buffer linked list – A list of receive buffer accessing information. One of these is maintained by the microcode for each established tributary having private receive buffers assigned. There is one link block for each buffer.

5. Transmit buffer linked list – A list of transmit buffer accessing information. One of these is maintained by the microcode for each established tributary having transmit buffers assigned. There is one linked list for each buffer.

5.4.1.1 The Free Linked List – The free linked list from which all other linked lists draw link blocks, is maintained in the lower section of data memory called the buffer and output queue (BOQ) (Figure 5-7). These 832 bytes translate into a total of 104 link blocks available for use by the operational linked lists. In this way, the free linked list functions as a finite resource for the operational linked lists.

5.3.3.2 Receive Threshold Errors – This 3-bit counter is incremented (if less than seven) when a NAK with one of the following reason codes is sent.

Reason Code	Description
1	Header block-check error.
2	Data field block-check error.
3	REP response.
8	Buffer temporarily unavailable.
9	Receive overrun.
16	Message header format error.

This counter is cleared when:

- Entering the ISTRT, ASTRT, or run states,

- A control message with a correct header blockcheck is received without a header format error,

- A data message with correct header and data field blockchecks is received without a header format error, or

- In the run state, a receive threshold error is reported.

5.3.3.3 Selection Threshold Errors – This 3-bit counter is only used by multipoint control stations and half-duplex point-to-point stations. It is incremented (if less than seven) when a selection timeout occurs.

It is cleared upon receipt of a message with the select bit set, or while in the run state and a selection threshold error is reported.

5.4 DMV11 MICROCODE INTERNAL DATA BASE OVERVIEW

Functionally, the DMV11 internal data base provides the mechanism for managing:

- The assignment and completion of transmit and receive buffers,

- The queuing of DMV11 responses,

- The assignment of TSS structures to established tributaries for the storage and maintenance of tributary and global status information.

A map of this data base is shown in Figure 5-7. The data base is implemented by three basic structures:

- Linked lists,
- Slot mapping table,
- TSS and GSS structures.

Each of these are described below in terms of organization and function.

5.4.1 Linked Lists

A linked list is an open-ended data list made up of fixed-length blocks linked by pointers. Each of these blocks (link blocks), contain seven bytes of data and a one byte pointer to the next link block in the list. The pointer in the last block in the list is a terminator value. Figures 5-8 and 5-9 illustrate the standard format for DMV11 linked-list structures.
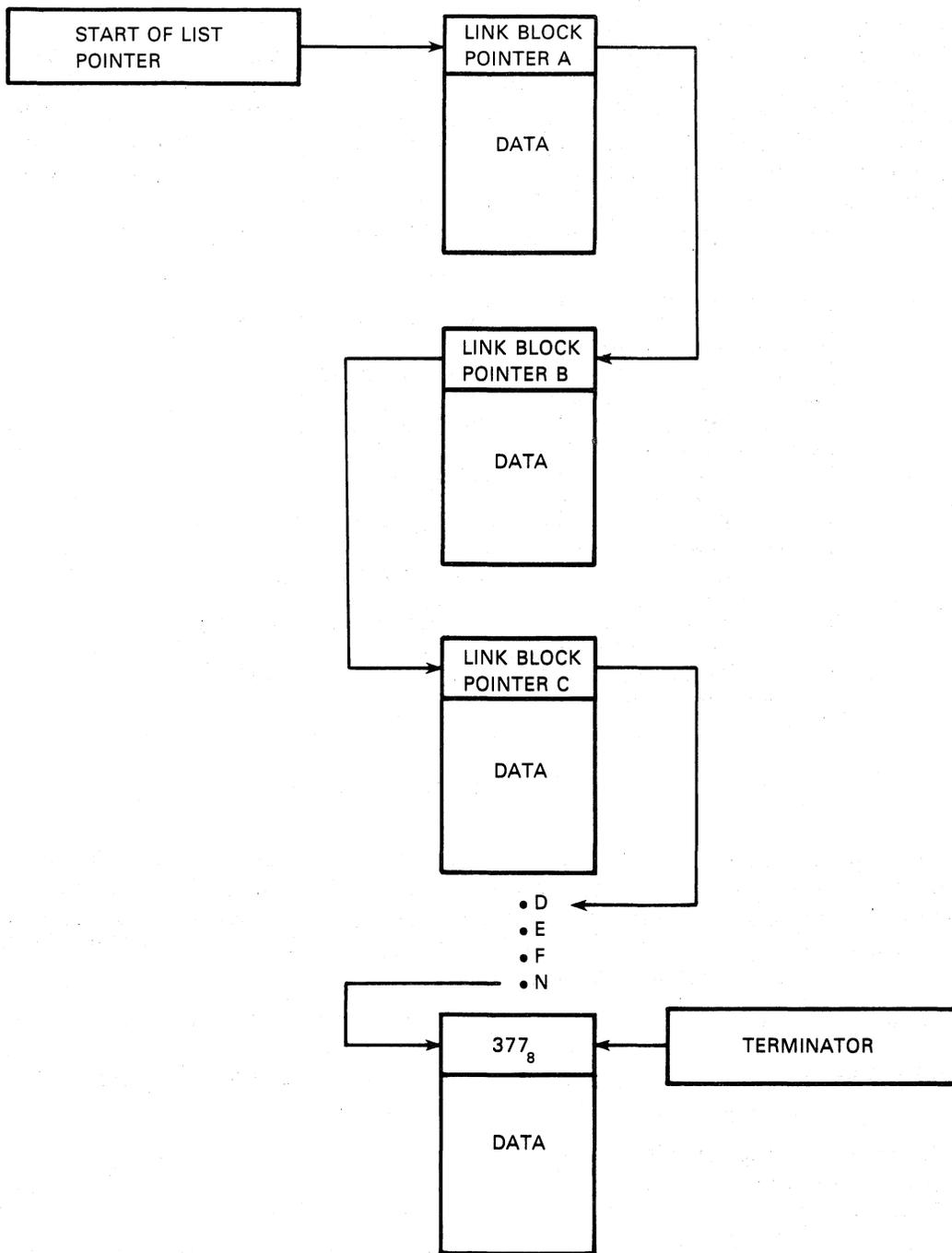
Figure 5-8   DMV11 Linked List Structure Format

As previously stated, a linked list is equipped with two list pointers; one that points to the start of the list and one that points to the end of the list. When a link block is removed from the free linked list, the start of the list pointer is changed to point to the next available link block in the free linked list. When a link block is completed by one of the operational linked lists, it is added to the end of the free linked list and its internal pointer is set to the terminator value of 377 octal. In addition, the internal pointer in the next to last link block is changed from 377 octal to the address of the link block just added. The start- and end-of-list pointers for the free linked list are maintained in the station GSS.

Link blocks are removed from the free linked list and added to the receive, transmit, or common pool buffer linked lists when the user program issues control or buffer address/character count commands for that purpose. Similarly, link blocks are removed from the free linked list and added to the response linked list when the DMV11 microcode posts a response to the user program. If the last link block is removed from the free linked list, the start of the list pointer is set to the terminator value of 377 octal to indicate there are no more link blocks available. In this event, the next request for a link block generates the fatal error QUEUE OVERFLOW. For this reason, the buffer allocation strategy for a user program must be designed to assure an adequate number of link blocks.

LINK POINTER	POINTER TO THE NEXT LINK BLOCK
MESSAGE NUMBER	DDCMP MESSAGE NUMBER
BSEL 3	TRIBUTARY ADDRESS
BSEL 4	BUS ADDRESS
BSEL 5	BUS ADDRESS
BSEL 6	CHARACTER COUNT LOW
BSEL 7	CHARACTER CNT HIGH, BA 16, BA 17
BSEL 2	TYPE CODE AND BA 18-21

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Figure 5-9   Standard Link Block

5.4.1.2   The Response Linked List – This linked list functions as a queue of buffer disposition, control, and information responses to be posted to the user program. The format of the link block for each of these three responses is shown in Figure 5-8. When preparing a link to convey a control or information response, the microcode clears all unused bit positions in the link block to zero. However, link blocks restored to the free linked list remain unchanged.

The start-of-list and end-of-list pointers for the response linked list are maintained in the station GSS.

5.4.1.3   Buffer Linked Lists – A buffer linked list is provided for each type of message buffer allocated by a user program. These are:

- Common pool receive buffers,
- Private receive buffers, and
- Transmit buffers.

Each link block in a buffer linked list provides the location and size of a buffer in main memory.

The Common Buffer Pool Linked List – This linked list provides a queue of receive buffers available to all established tributaries according to the quota assigned to each tributary.

Common pool buffers are assigned through the buffer address/character count command, and enabled with tributary quota assignments through the control command (see Section 3.3.3). The start-of-list and end-of-list pointers for this linked list are maintained in the station GSS.

Receive Buffer Linked List – This linked list serves as a queue of private receive buffers. One list is maintained for each tributary established at a multipoint station. For point-to-point stations, one list is maintained at each station. The start- and end-of-list pointers for each receive buffer linked list are maintained in the associated tributary's (or station's) TSS.

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Transmit Buffer Linked List – This list functions as a queue of transmit buffers. One list is maintained for each tributary established at a multipoint station. For point-to-point stations, one list is maintained at each station. The start- and end-of-list pointers for each transmit buffer linked list are maintained in the associated tributary's (or station's) TSS.

A unique feature of this link block is the message number field. When a message is transmitted from a buffer, the header of that message contains the DDCMP message number (in the message number field). The microcode uses this field to locate the buffer for a message that has been NAKed after transmission and, therefore, must be retransmitted.

5.4.2 Slot Mapping Table

Under DDCMP, the 8-bit message header address field permits a maximum of 255 unique tributary addresses in a multipoint network. However, the DMV11 microcode limits the number of established tributaries to 12. In order to implement DDCMP, a tributary in a DMV11-based multipoint network can have a TSS address in the range of 1 to 255. However, only 12 of these tributaries may be established at any one time.

TSS addresses are assigned at both control and tributary stations through the slot mapping table (SMT). As shown in Figure 5-7, this table occupies 256 locations in DMV11 data memory; one location for each of the 255 possible tributary addresses, and one location to address the GSS.

The function of the SMT is to map an 8-bit tributary address into one of the 12 available TSS structures. When a tributary is deleted, its TSS and SMT entry is released for reassignment. When 12 tributaries are established and an attempt is made to establish a 13th, a procedural error is posted to the user program.

5.4.3 TSS and GSS Structures

The TSS and GSS structures occupy separate sections of data memory. The GSS is a single 64-byte section while the TSS structure consists of twelve 64-byte sections.

5.4.3.1 The Global Status Slot (GSS) – Functionally, the GSS is used to:

- Maintain control and status information specific to the operation of the microcode,
- Record event counts and error conditions that are global in nature, and
- Store global parameters.

The majority of the GSS is devoted to microcode control and status information. A detailed map of the GSS is shown in Figure 5-10.

Access to the GSS is accomplished on word boundaries. A user program can read any GSS location through the control command. The content of the addressed location is transferred to the user program through an information response. A user program can read and clear only GSS station error counters. The four global parameters (locations 34 through 37) are written by the user program through the control command.

5.4.3.2 Tributary Status Slots (TSS) – A TSS contains four general categories of tributary information (Figure 5-11):

1. Protocol and tributary status,
2. Error and statistical counters,
3. Message exchange variables, and
4. Polling parameters.

Protocol and Tributary Status – This category includes information on the tributary's protocol state, its status with relation to the logical communications line, its protocol status, and its polling status. Tributary polling status is maintained only at a multipoint network control station. Although this information is only pertinent to, and used by the DMV11 microcode, it can be read by a user program.

Error and Statistical Counters – These counters provide the user program with a wide range of error counts, and a set of statistical counts that permit analysis of the meaning of specific error counts. These counters can be read and cleared by the user program. The function of each of these counters is described in detail in Section 5.3.

Message Exchange Variables – This category includes a range of variables used by the microcode to control the transmission and reception of message data. This includes the common buffer pool quota assigned by the user program.

A group of timers is also included in the message exchange variables. These timers can be preset to a specific timeout value by the user program, and directly concern message traffic transferred on the logical link by the associated tributary. These timers are referred to as:

- Transmit delay timer,
- Selection interval timer,*
- Maximum transmitted message count,
- Babbling tributary timer.

The link management functions performed by these timers is detailed in Chapter 4.

Polling Parameters – These parameters are user-defined values that are used by the polling algorithm to conduct dynamic polling activity in multipoint networks. The functions performed by the DMV11 polling algorithm, and the criteria for determining the values for each parameter, are discussed in detail in Section 5.2.

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*A timeout value for the selection interval timer is maintained in each tributary's TSS, but the actual timer is maintained in the GSS.

GSS ADDRESS					
0	POLPTR				
	RCVPTR				
1	XMTPTR				
	TSP				
2	NASP				
	BUFPTR				
3	S/OF				
	E/OF				
4	S/OQ				
	E/OQ				
5	S/OC				
	E/OC				
6	TIMER STATUS				
	S/R TIMER (LOW)				
7	(HIGH)				
	B/CW TIMER (LOW)				

GSS ADDRESS					
10	(HIGH)				
	RPM CNTR				
11	ACKTIM (LOW)				
	ACKTIM (HIGH)				
12	MODEM				
	MODE				
13	UNUSED				
	FLAG REGISTER "D"				
14	CLEAR TO SEND TIMER (LOW)				
	(HIGH)				
15	REMOTE STATION ERRORS				
		RSTR	RSEL	RMHFE	ROVRN
16	LOCAL STATION ERRORS				
		LOVR	LUNDR	LMHFE	LOVRN
17	GLOBAL HDR BCC ERRORS				
	MAINT DATA BCC ERRORS				

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Figure 5-10 Global Status Slot (Sheet 1 of 2)

GSS ADDRESS	Field			GSS ADDRESS	Field	
20	XHDR	(1)		30	POLL DELAY TIMER	(LOW)
		(2)				(HIGH)
21		(3)		31	POLL UPDATE POINTER	
		(4)			DEAD SCAN	
22		(5)		32	CARRIER LOSS TIMER	
		(6)			USYRT HANG TIMER	
23	RCVHDR	(1)		33	NUMBER OF SYNCS	
		(2)			RESERVED	
24		(3)		34	CARRIER WAIT	
		(4)			TIMER COUNTER	
25		(5)		35	DELTA T	(LOW)
		(6)				(HIGH)
26	R TIMER	(LOW)		36	DEAD T	(LOW)
		(HIGH)				(HIGH)
27	D TIMER	(LOW)		37	POLL DELAY	(LOW)
		(HIGH)				(HIGH)

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Figure 5-10   Global Status Slot (Sheet 2 of 2)

TSS Address	Contents		TSS Address	Contents
0	TRIB STATUS FLAGS		10	DATA MESSAGES
	TRIB STATUS FLAGS			RECEIVED
	NAK REASON		11	SELECTION
	TRIBUTARY ADDRESS			INTERVALS
2	POLL STATUS FLAGS		12	DATA ERRORS OUTBOUND
	POLL STATUS FLAGS			RESERVED | OREP | ODBCC | OHBCC
3	POLL RATE (R_i)		13	DATA ERRORS INBOUND
	POLL PRIORITY (V_i)			RESERVED | IREP | IDBCC | IHBCC
4	RESERVED		14	LOCAL BUFFER ERRORS
	MAX MSG COUNTER			RESERVED | LBTS | LBTU
5	COMMON POOL QUOTA		15	REMOTE BUFFER ERRORS
	RECEIVE THRESHOLD ERRORS			RESERVED | RBTS | RBTU
6	TRANSMIT THRESHOLD ERRORS		16	SELECTION TIMEOUTS
	SELECTION THRESHOLD ERRORS			RESERVED | IRTS | NRTS
7	DATA MESSAGES		17	LOCAL REPLY TIMEOUTS
	TRANSMITTED			REMOTE REPLY TIMEOUTS

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Figure 5-11   Tributary Status Slot (Sheet 1 of 2)

20	N HIGHEST MSG NUMBER XMIT'D
	A HIGHEST MSG NUMBER ACK'D
21	T NEXT MSG NUMBER TO XMIT
	TPTR ADDR OF LNKBK FOR MSG T
22	X LAST MSG NUMBER XMIT'T
	XPTR ADDR OF LNKBK FOR MSG X
23	CX (CONTROL X REPLY T/O)
	S/DX START OF XMIT BUF QUEUE
24	E/OX END OF XMIT BUFFER QUEUE
	R HIGHEST MSG NUMBER RCV'D
25	S/OR START OF RCV BUFFER QUEUE
	E/OR END OF RCV BUFFER QUEUE
26	TRANSMIT DELAY
	TIMER
27	NO DATA MESSAGE COUNTER
	T/O COUNTER

30	PRESET VALUE FOR TRANSMIT
	DELAY TIMER
31	Q VALUE FOR ACTIVE STATE
	R VALUE FOR ACTIVE STATE
32	Q VALUE FOR INACTIVE STATE
	R VALUE FOR INACTIVE STATE
33	Q VALUE FOR PDEAD STATE
	R VALUE FOR PDEAD STATE
34	#NDM --> INACTIVE STATE
	#T/O ---> PDEAD STATE
35	#T/O ---> DEAD STATE
	MAXIMUM MESSAGE COUNTER
36	SELECTION INTERVAL
	TIMING COUNTER
37	BABBLING TRIBUTARY
	TIMING COUNTER

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Figure 5-11   Tributary Status Slot (Sheet 2 of 2)

CHAPTER 6
TECHNICAL DESCRIPTION

6.1 INTRODUCTION
This chapter provides a block diagram functional description of the DMV11.

The DMV11 is basically a 6502 microprocessor with interfaces to the LSI-11 bus and the outside world. The 6502 is supported with 16K bytes of ROM and 2K bytes of RAM. All I/O is memory mapped to the 6502 data bus. The LSI-11 interface is made up of three areas:

1. NPR circuitry – Full 16-bit direct memory access is allowed on data transferred in and out. Independant address registers are provided for the in and out NPR addresses.

2. CSRs – Eight 16-bit CSRs are mapped into the on-board RAM. Any time the LSI-11 bus accesses these registers, the 6502 is halted, the on-board 8-bit RAM is demultiplexed to 16 bits, and 16-bit data is read from or written to the RAM.

3. Interrupt circuitry – The 6502 can cause interrupts to the LSI-11 bus if enabled by the CPU. Two separate bits allow two levels of interrupt to be initiated.

The outside world interface is handled by a USYRT using a serial transmit and a serial receive line. The USYRT interfaces directly to the 6502 data bus; activated and monitored by data and status transfers using a predefined address space.

The remaining circuitry which makes up the DMV11 is used to support the USYRT, the LSI-11 interface, the DDCMP protocol, and the modem interfaces.

6.2 LOGIC DESCRIPTION
For discussion purposes, the DMV11 logic is divided into the blocks shown in Figure 6-1. The circuitry and functions represented by each of these blocks is described in Sections 6.2.1 through 6.2.7.

6.2.1 Control and Address Decoder
This block contains the 6502 microprocessor, timing circuits, 6502 data and address interfaces, and address decoders.

6.2.1.1 The 6502 Microprocessor – The 6502 microprocessor is a 40-pin microprocessor with a full 16-bit address bus, an 8-bit bidirectional data bus, and two interrupts.

The 6502 is organized around two primary buses: the address bus and the data bus. The address bus is used to transfer the address generated by the microprocessor to the address inputs of memory. The data bus consists of an 8-bit bidirectional data path. All data and instructions are transmitted on this bus.

The 6502 provides a sync-signal to indicate when it is fetching operation code from program memory.

The timing of all data transfers is controlled by a two-phase clock (two nonoverlapping square waves) referred to as Phase 1 and Phase 2. The address lines and read/write line stabilize during Phase 1 and data is transferred during Phase 2.
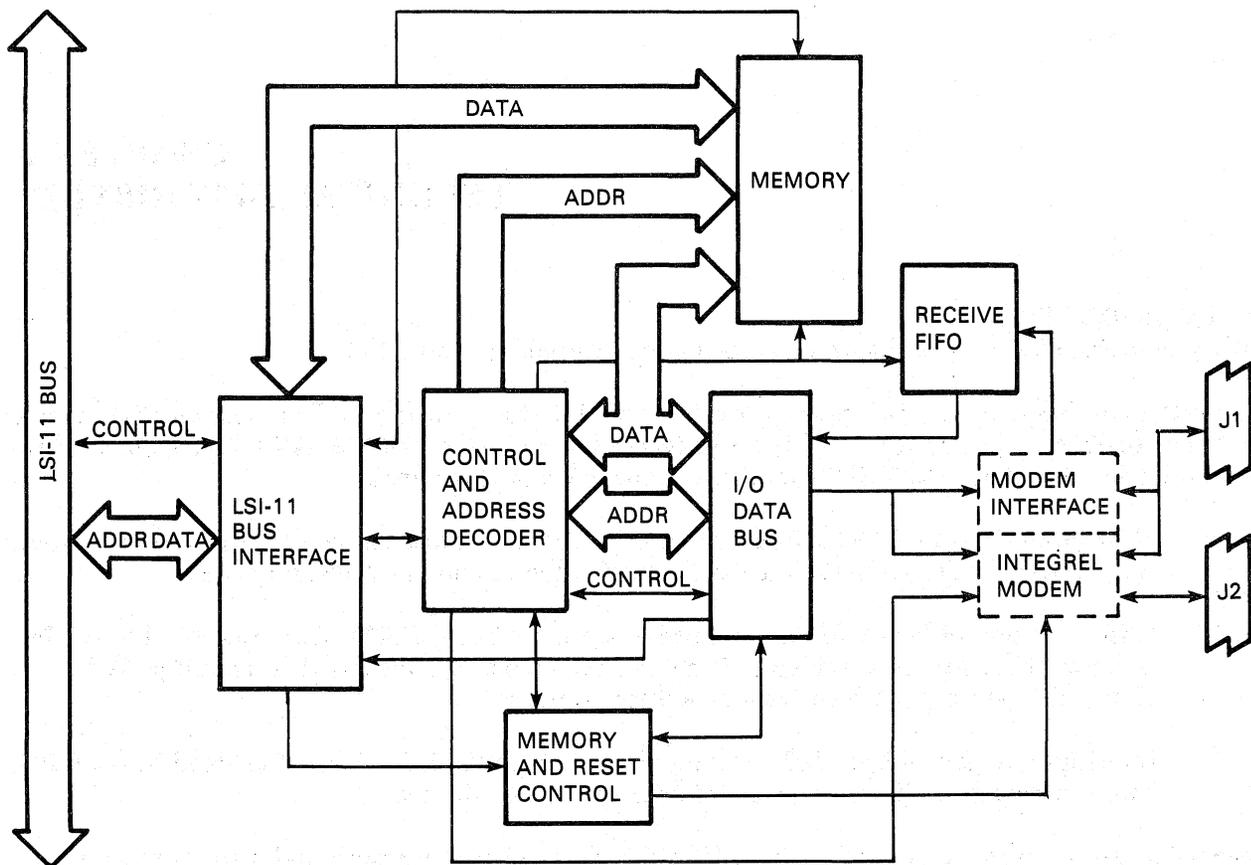
Figure 6-1   DMV11 Block Diagram

6.2.1.2   Timing Circuits – The source for all the timing signals necessary for the DMV11 is a 20 MHz crystal. The timing signals produced from this source are:

- The 6502 microprocessor clock – This clock rate is 1.67 MHz and is generated by dividing the 20 MHz clock by 6 and then by 2. The 1.67 clock has a duty cycle of 50% ±2 ns.

- The integral modem receiver 20 times clock – This is a 1.11 MHz clock (20 times 56 KHz receive clock rate) which is generated by dividing the 20 MHz clock by 9 and then by 2.

- The integral modem 2 times clock – This is a 111 KHz clock which is generated by dividing the 1.11 MHz clock by 10.

ROM timing is provided for strobing the 8K by eight ROMS. This signal is produced by delaying the Phase 2 signal from the 6502 by approximately 160 ns. This allows enough time for the address to stablize at the ROMs before strobe time.

6.2.1.3   6502 Data and Address Interface – This circuit consists of buffers for the address and data outputs of the 6502. The buffers have .5 mV low-level inputs so that they are compatible with the 6502 driving requirements.

6.2.1.4 Address Decoders – Addresses for the address bus come from two sources: 1) the 6502 for normal microcode execution, and 2) the LSI-11 bus for accessing the CSRs. Accessing the CSRs has priority over the 6502 addressing requirements. CSRs are in RAM and are accessed by the CPU through the LSI bus interface.

Decoding of the address bus is accomplished by three separate circuits:

1. Block address decoder – A programmable array logic (PAL) is used to decode the ROM, I/O, and RAM blocks; and to demultiplex the RAM to 16-bit words when CSRs are accessed by the LSI-11 bus.

2. I/O decoder – This decoder breaks a part of the I/O page up into eight 256-byte sections when the block address decoder selects I/O. No attempt is made to decode to a specific address within a section. Thus, multiple addresses within a given section decode the same device.

3. NPR current address decoder – This circuit decodes to a specific address in the RAM address space. Thus, the NPR address registers are mapped directly from RAM. They reflect the contents of the NPR address locations assigned in RAM (Figure 6-2).
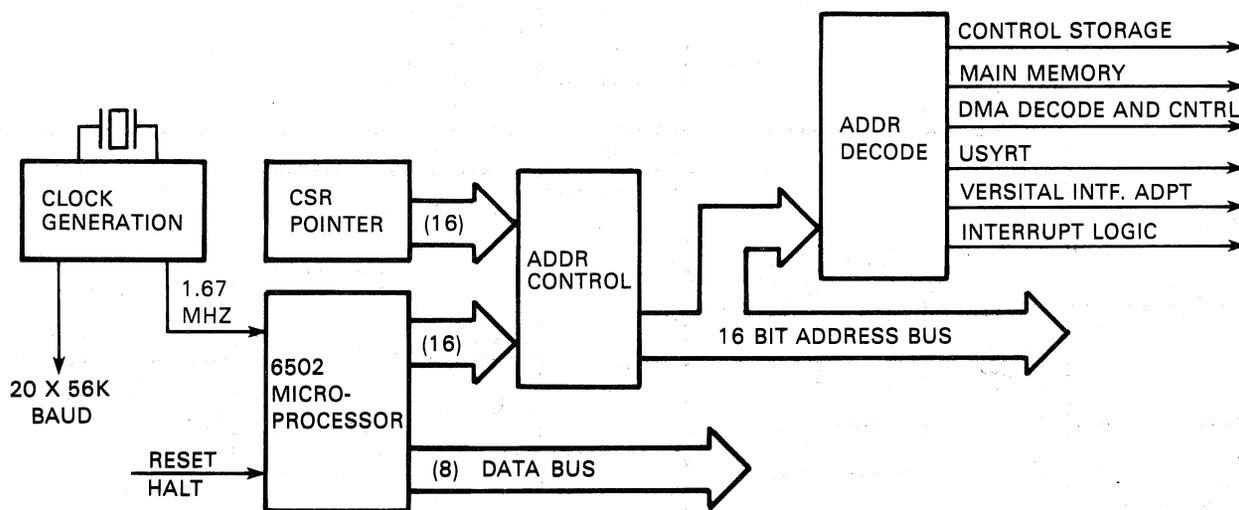
Figure 6-2   Control and Address Decoder

6.2.2 I/O Data Bus

This block contains the USYRT, USYRT control, and line interface control. See Figure 6-3.

6.2.2.1   USYRT – The USYRT is an LSI subsystem for synchronous communications. It provides the necessary logic support by way of parameter registers for DDCMP. Within this discipline a wide range of support such as programmable error detection, character recognition, complete serialization, deserialization, and buffering of data is provided.

6.2.2.2   USYRT Control – This circuit consists of a 74LS245 data transceiver, a 74LS373 tristate input data latch, a 74LS244 tristate output data buffer, a 74LS373 tristate address latch, and three

74LS74 controlling flip-flops and associated gates. For discussion, the operation of the USYRT control logic is divided into write and read operations. See Figure 6-4.

Write – The 6502 asserts the address, selects the USYRT, and generates the write signal approximately 140 ns after Phase 1 high is asserted. The data is available from the 6502 approximately 115 ns after Phase 2 high is asserted. The USYRT on the other hand, requires data 50 ns prior to the assertion of data port enable (DPENA). To achieve the necessary timing relationship, the address and data are latched into buffers and strobed into the USYRT by the controlling flip-flops which are clocked by signals generated from Phase 1 and Phase 2 timing. Phase 2 is used to gate DPENA to guarantee the USYRT minimum requirement of 250 ns for DPENA.

Read – Again the 6502 asserts the address and selects the USYRT as in a write cycle. The USYRT is strobed by the controlling flip-flops and data is made available from the USYRT. In a read operation, the address select lines must be held for 30 ns after DPENA (the 6502 does not guarantee this). Therefore, the address is latched when Phase 2 high is asserted.
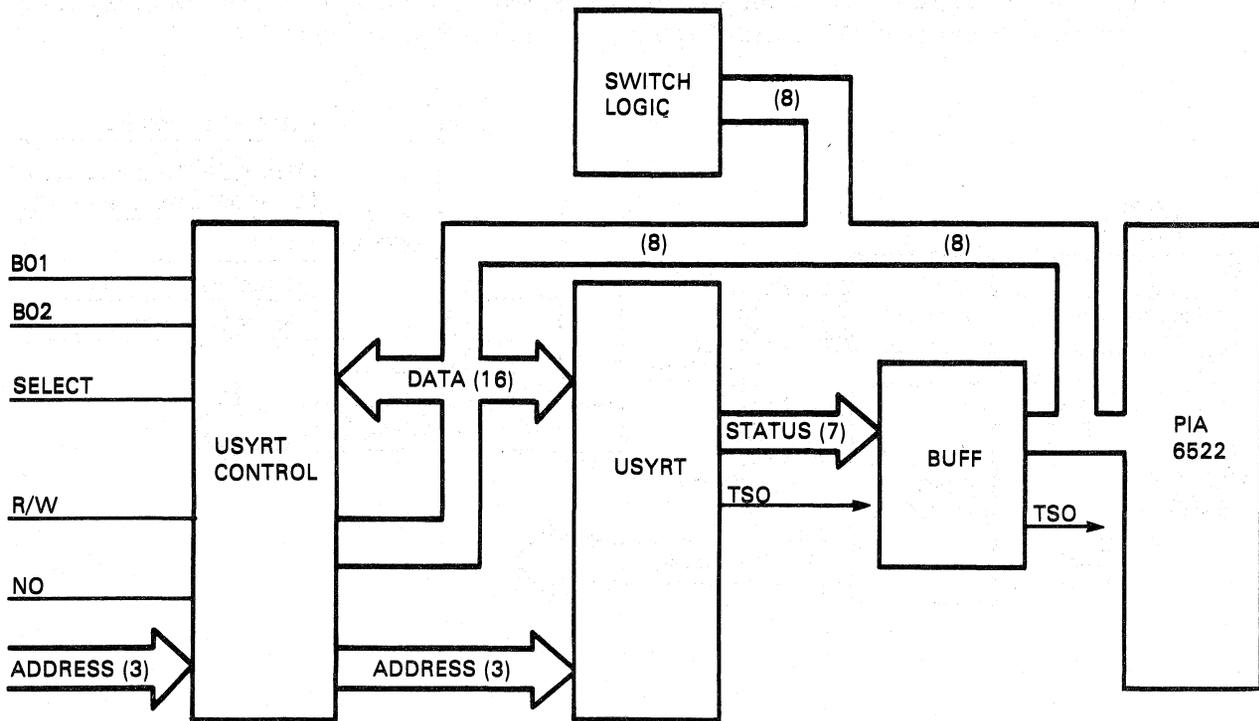
MK-2499

Figure 6-3   I/O Data Bus
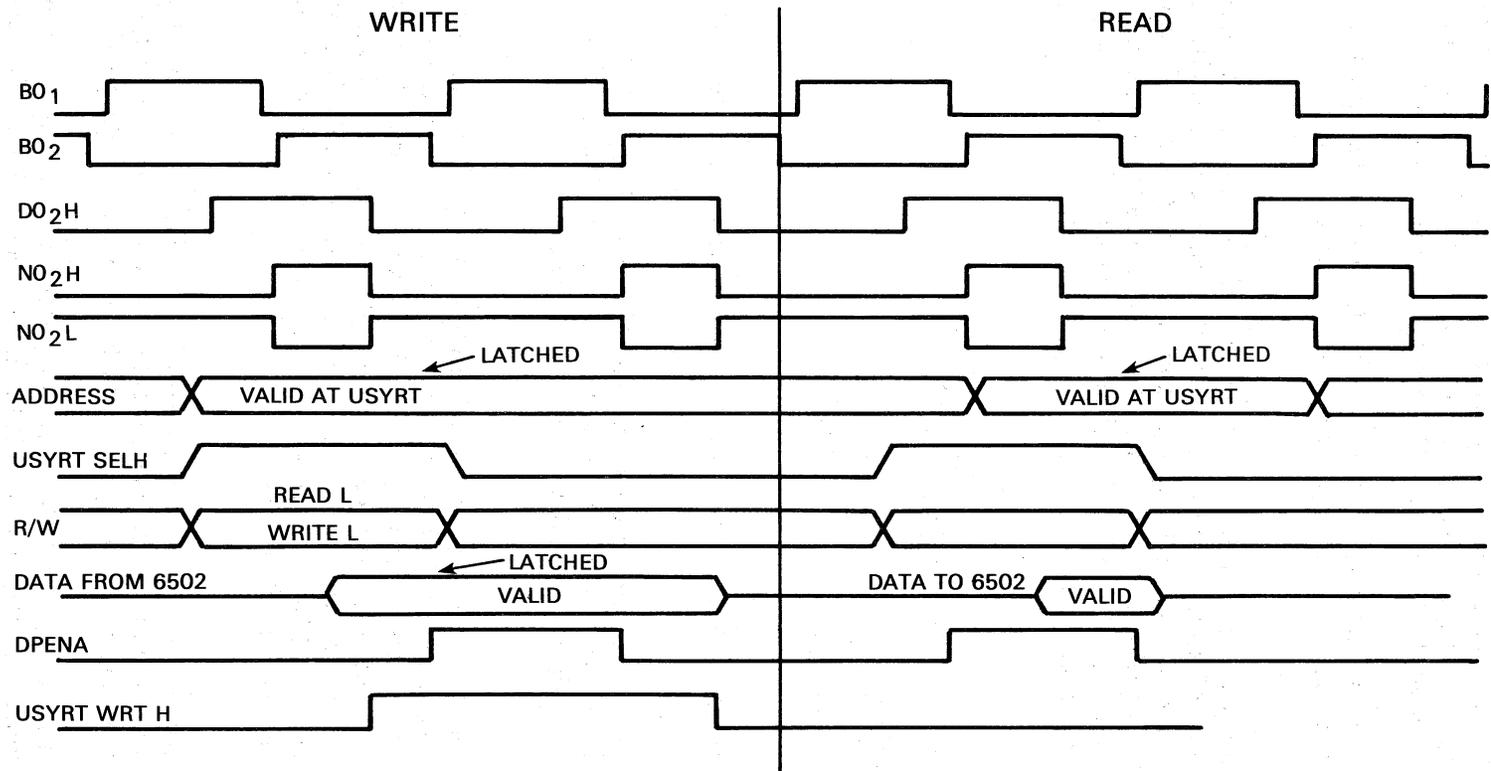
Figure 6-4   USYRT Timing Diagram

6-5

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6.2.2.3 Line Interface Control – The line interface control section of logic can be broken into two sub-sections: 1) switch logic, and 2) programmable interface adapter.

1. Switch logic – This section consists of two sets of switches and their associated buffers. One set of switches has its configuration latched into its buffer at boot time. The configuration of the other set of switches is latched at DDCMP interface selection time.

2. Programmable interface adapter (also referred to as VIA) – This circuit consists of a 6522 chip and is used to control and monitor the various interface signals to the modem interface logic.

Referring to the 6522, the PB section and bit 0 of the PA section are used as an output register only. Bits one through seven of the PA section are used as an input register. CA1 and CA2 are used to monitor, by way of the 6502 interrupt, modem ready high and clear to send high. PB7 is used to generate modem clocks when self-testing with loopback connectors. CB1 is used to produce eight clock pulses at a time when instructed to do so by the 6502 microcode. These clock pulses are used to flush the US-YRT receiver of data after carrier drops.

6.2.3 DMV11 Memory
This block may be divided into three sections as follows.

1. ROM control storage,
2. RAM,
3. NPR in/out registers.

6.2.3.1 ROM Control Storage – ROMS are used for storing operation codes for the 6502 micro-processor.

In order to provide the most immediate access to data for the 6502, 200 ns ROMs are used and the ROM clock is continuously applied to the chip enable (CE) pin of the ROM. 74S241 buffers are used on the output so that no more than 9 ns additional delay is introduced.

6.2.3.2 RAM – This is the data memory for the DMV11. It is organized functionally as shown in Figure 6-5. The hardware organizes the RAM into even and odd sections for the sole purpose of having 16-bit CSRs. When CSRs are accessed from the LSI-11 bus, even, odd, or both sections of the RAM are enabled. Two 74LS245 transceivers are used to enable and direct data to and from the LSI-11 bus. The other two 74LS245 transceivers are used for drive buffering and to disable the RAM from the 8-bit microprocessor data bus when the CSRs are accessed by the LSI-11 bus. The microprocessor is halted when the CSRs are accessed by the LSI-11 bus.

6.2.3.3 NPR In/Out Registers – This circuitry consists of two 16-bit registers (one for address in, and one for address out), and two 16-bit registers (one for data in, and one for data out). Extended address capabilities are included in two scratchpad registers which are four words deep by four bits wide.

The microprocessor loads the appropriate NPR address register (in or out) to set up the address for an NPR data transfer. This address is then enabled onto the LSI-11 bus during the address enable cycle.

During a read cycle, the data-in register is loaded from the LSI-11 bus and read by the 6502. During a write cycle, the data-out register is loaded by the 6502 and read by the LSI-11 bus.

HEXADECIMAL

0000	SCRATCH PADS	16 BYTES
10	Q-BUS CSRs	8 BYTES
1B	SCRATCH PADS	32 BYTES
3B	OUT NPR ADDRESS	3 BYTES
3B	SCRATCH PAD	1 BYTE
3C	IN NPR ADDRESS	3 BYTES
3F	SCRATCH PAD	BYTE
80	GLOBAL STATUS SLOT	64 BYTES
C0	SLOT MAPPING TABLE (SMT)	256 BYTES
	MICROPROCESSOR STACK	64 BYTES
1FF	BUFFER AND OUTPUT QUEUE 98 ENTRIES	8 BYTES/ENTRY
500	TRIBUTARY STATUS SLOTS 12 ENTRIES	64 BYTES/ENTRY
800		

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Figure 6-5   Data Memory Organization

6.2.4   LSI-11 Bus Interface
The circuitry in this block interfaces the LSI-11 bus to the 6502 microprocessor (see Figure 6-6). It consists primarily of the:

- LSI-11 bus DAL interface,
- CSR controller,
- Interrupt controller, and
- NPR controller.

6.2.4.1   LSI-11 Bus DAL Interface – This circuit consists of four DC005 chips which interface the LSI-11 data and address lines to the DMV11. The device address of the DMV11, which may be anywhere in the I/O page, and its associated vector address, is selected by switches on the input to the DC005 chips.

The DC005s are initially in the receive mode (receiving from the LSI-11 bus) in anticipation of an address match from the LSI-11 bus. When a match occurs, the collector-ored match lines go high and enable the CSR control circuit. In addition to detecting an address match, the DC005s in the receive mode pass address or data to the DAL lines. In the transmit mode, the DC005s pass data from the DAL lines to the LSI-11 bus.

6-7

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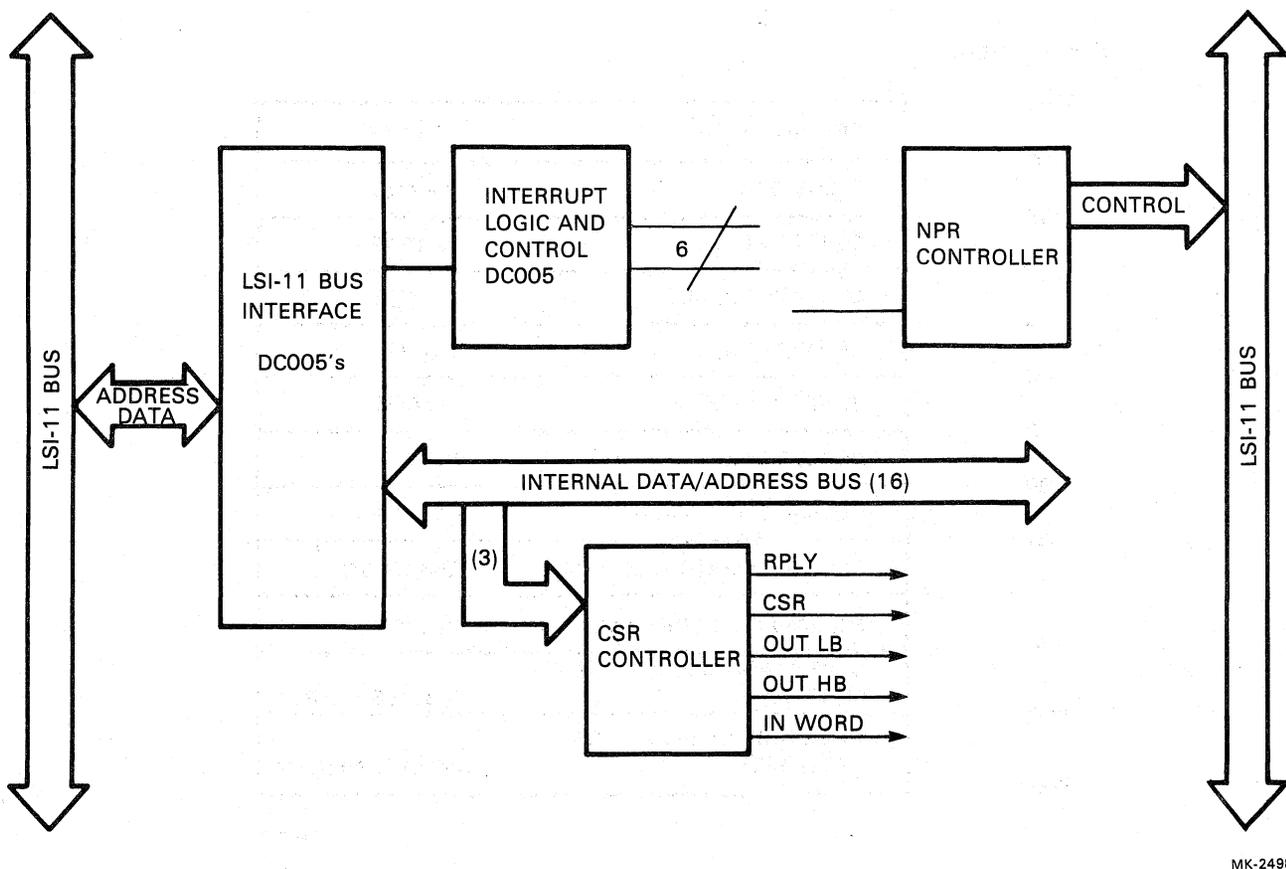
Figure 6-6   LSI-11 Bus Interface

6.2.4.2   CSR Controller – This circuit consists of a DC004 which:

● Supplies outputs which indicate when CSRs are selected. CSRs are decoded when the enable pin is asserted high and BYSNC strobes on its negative edge.

● Supplies outputs indicating when a word of data is to be placed on the LSI-11 bus, or when a byte or word of data is to be read from the bus. Byte operations are controlled by the OUT HB and OUT LB signals.

● Asserts BRPLY approximately 30 ns after information is placed on the LSI-11 bus. BRPLY is then applied to a sequencer which halts the 6502 and accesses the particular CSR mapped in the RAM.

● Applies the BRPLY from the sequencer to the LSI-11 bus by the LSI-11 control-line interface.

6.2.4.3   Interrupt Controller – This circuit consists of a DC003 interrupt controller chip and two 74LS74 flip-flops. The DC003 is used in a typical manner for interrupt servicing of the LSI-11 bus. The two flip-flops hold the interrupt request (one for A and one for B) until it is serviced. When either request is serviced, both flip-flops are cleared by the vector signal.

6-8

6.2.4.4 NPR Controller – The DC010 is used in this application for doing direct memory accesses to the LSI-11 memory. Only single NPRs are allowed; HOG mode is not implemented. A description of the NPR operation follows.

The microcode sets up the NPR current address and data-out registers, and then sets the A flip-flop by writing to the NPR register with bit 6 equal to zero. Once the NPR is initiated, the DC010 handles the sequence of enabling appropriate registers to transmit or receive data from the LSI-11 bus. This operation is sequenced by the 5 MHz clock input to the DC010.

When the NPR is honored, the leading edge of RPLY releases the NPR so that a second request does not occur. The trailing edge of RPLY sets NPR busy H to zero to indicate that the NPR transfer is complete. However, when doing data-out transfers, the NPR data-out register must not be updated for 100 ns after the trailing edge of RPLY in order to comply with LSI-11 bus specifications. The microcode can immediately service the data-in register when NPR busy H is cleared during a data-in transfer.

The NPR abort timer is used to ensure that an NPR transfer does not take more than 16 μs. If 16 μs are exceeded, the transfer is aborted. The timer is set each time an NPR is initiated.

6.2.5 Memory and Reset Control
CSR access control allows the LSI-11 bus to access the CSRs. The operation is as follows.

1. The CSR controller (Section 6.2.4.2) asserts the CSR L signal when a CSR is selected. This signal is used by the processor halt circuit to halt the microprocessor on the next Phase 2 cycle if a write is not in progress. When the processor has halted, the 74LS164 shift register is enabled.

2. When the first output of the shift register is true, the appropriate CSR address is selected and the direction of transfer is determined by the state of the WRT RAM L signal from the PAL. WRT RAM L sets the direction of the RAM transceivers (Section 6.2.3.2).

3. During the next Phase 2 cycle, the CSR is either read and its contents placed onto the LSI-11 bus, or the data on the LSI-11 bus is written into the CSR.

4. The next Phase 2 cycle terminates the write cycle if in the write mode, and asserts BRPLY to the LSI-11 bus.

5. After RPLY from the DC004 drops, the microprocessor address and data bus are again controlled by the 6502. When CSR select is dropped, the microprocessor resumes operation.

Memory and reset control also generates signals for master resetting the DMV11 and halting the microprocessor.

6.2.6 Modem Interface
The modem interface consists of line receivers and drivers for all modem data and control signals. The interface supports RS-232-C, RS-423-A, V.35, and the integral modem. Circuitry to accommodate internal loopback for test purposes is also provided. Because the DMV11 supports RS-423-A for category 1 signals (except test mode and ring), dummy generators are used for the following signals.

- Select frequency,
- Terminal in service,
- New signal,
- SRTS,
- Remote loop,
- Local loop, and
- Select standby.

Only one interface can be enabled at a time. The modem interface select circuit enables an interface as selected by the interface select switch. On power-up and during any reset operation, the selected interface is disabled and loopback is selected until deselected by the microcode (Section 6.2.2.3).

Interface to the outside world is implemented with two 40-pin Berg connectors. J2 is used for RS-232-C and RS-423-A with a BC55H-type cable. J1 is used for V.35 with the BC05Z cable or for the integral modem with the BC55F cable.

The modem interfaces all have a null clock that is switch selectable for speeds of 56K b/s or 19.2K b/s and controlled by the PIA.

6.2.7 Integral Modem
The integral modem is used for local communications and is transformer-coupled to twinax or triax cables for common mode rejection and common mode voltages up to 500 V. For discussion purposes, the integral modem is described in two sections: receive (Figure 6-7) and transmit (Figure 6-8).

6.2.7.1 Receive – The received data enters the modem through an isolation transformer whose output is directed to a differential amplifier to eliminate common mode noise. The amplifier's second stage uses an active Buterworth filter with an added passive filter for high and low cutoff. The filter's complimentary outputs are input to a comparator which detects zero crossover. Positive and negative transitions from the comparator clock the UP and DOWN flip-flops. All clocking is done at a clock rate 20 times the b/s rate and the UP and DOWN flip-flops latch until cleared by the transitions (TRANS) flip-flop.

When either the UP or DOWN flip-flop is set, the next clock pulse loads the transitions (TRANS) flip-flop which then clears the UP or DOWN flip-flop and holds it clear for one clock time. The clock input to the TRANS flip-flop and receive counter (REC CNTR) is 20 times the data-rate clock time.

The REC CNTR is clocked at half clock time (or inverted 20X clock), and counts 16 clock times and sets the 3/4 time flip-flop. The counter is loaded if the TRANS flip-flop is set and 16 clocks have occurred since the last load. The counter enable is true except in an overflow condition or when operating in half-duplex mode with the transmitter active.

When 3/4 T is set, and the time between transitions is greater than 16 clock times, the IDATA flip-flop is clocked to one. If the transition time is less than 16 clock times when 3/4 T is set, the IDATA flip-flop is clocked to a zero. The minimum time between transitions is .05 to .10 bit times as determined by the TRANS flip-flop clearing the UP and DOWN flip-flops. The next 3/4 T clock loads IDATA into the RI DATA flip-flop. The next 3/4 T clock ANDs RI DATA with IDATA, and if IDATA is zero, sets the I CARRIER flip-flop. IDATA is input to the receive FIFO and I CARRIER is gated with LINE UNIT STEP to become GRX CLK.

The overflow flip-flop is set when no transition occurs within one and one-half bit times. Overflow then sets IDATA which allows the next clock pulse to clear the RI DATA and I CARRIER flip-flops until the next sequence of one followed by two zeros occurs.

6.2.7.2 Transmit – The transmit circuit encodes the data into diphase space; in a square wave sequence. The output is 6 V peak-to-peak into a 50 ohms load and does not exceed 15 V peak-to-peak into an open circuit.

RTS allows TI CLK to set the ICS flip-flop. When the ICS flip-flop is set, the encoder flip-flop (ENC) is allowed to toggle with each data or TI CLK. The encoded output feeds a bipolar line driver that generates an ac signal with zero crossover points. The line driver output is connected to the protection transformer.

The +5 V low circuit turns off the transistors on low logic power to keep the transmitter from generating noise or from loading the line. During power-up, this circuit keeps the modem in the disabled state for several milliseconds to prevent the transmission of nonsense characters that would interfere with transmission in progress on a multipoint line.

The transmitter is disabled when line units are not transferring data. The transmitter does not load the line when power is off.
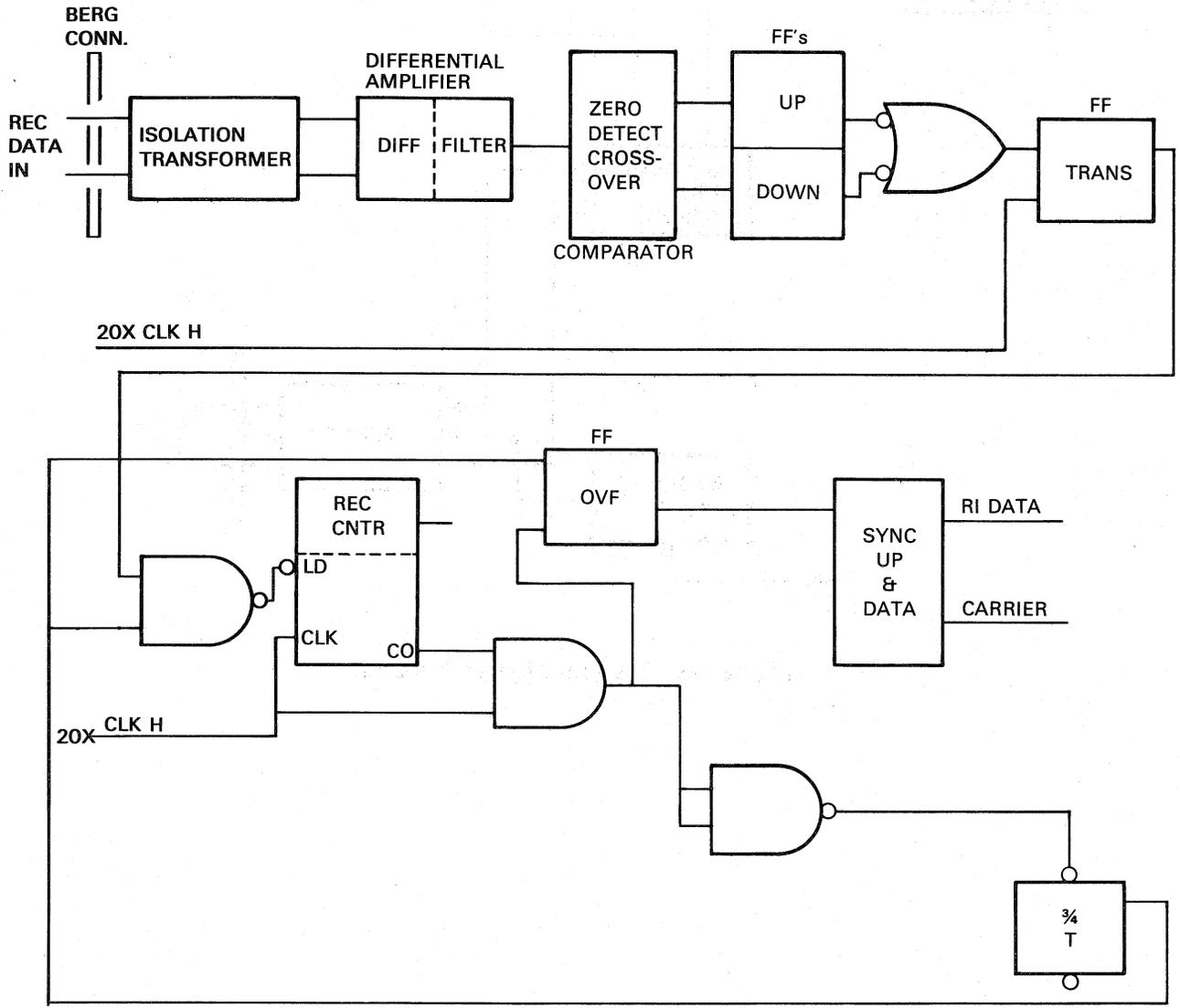
Figure 6-7   Integral Modem Receive
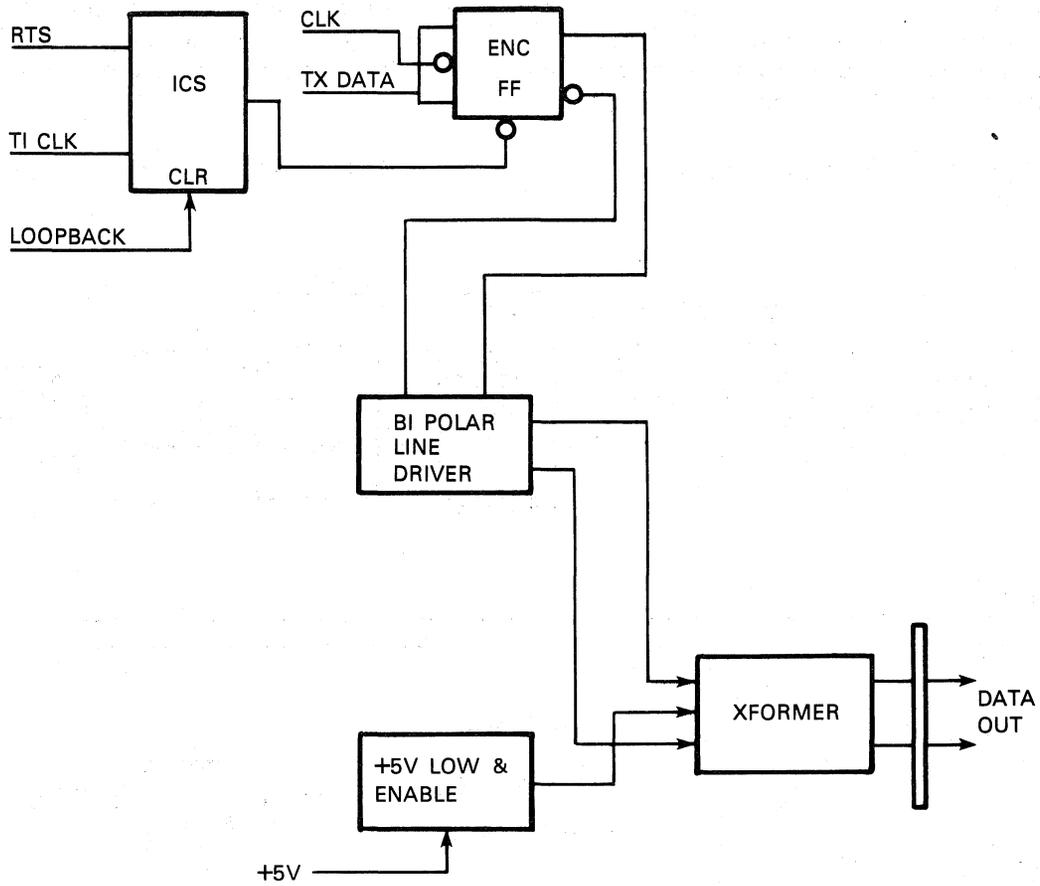
Figure 6-8   Integral Modem Transmit

CHAPTER 7
SERVICE

7.1 SCOPE
This chapter provides information for servicing the DMV11. It includes the maintenance philosophy, troubleshooting techniques in a multipoint environment, maintenance functions, preventive maintenance, and corrective maintenance. The section on troubleshooting techniques in a multipoint environment includes:

- The general overall approach to multipoint troubleshooting.

- Some common problems associated with different multipoint network configurations.

- The use of error counters and other information for isolating problems to a specific portion of the physical link.

The corrective maintenance section contains brief descriptions of the diagnostics associated with the DMV11.

7.2 MAINTENANCE PHILOSOPHY
The field replaceable unit (FRU) for the DMV11 is either a module (M8053 or M8064 microcontroller/line unit) or cable. Training of field service personnel is directed to functional and application troubleshooting, using diagnostics, for fault isolation to the FRU. Spare parts for module repair are not stocked in the field. Typical applications of the DMV11 do not permit lengthy troubleshooting sessions, and component troubleshooting/repair requires at least a 16-channel logic analyzer.

7.3 TROUBLESHOOTING TECHNIQUES FOR MULTIPOINT
Because of the complexity of some multipoint network configurations, there is a potential for using valuable time in trying to isolate a problem. For this reason, troubleshooting techniques for multipoint networks differ from those for point-to-point networks.

The following sections discuss these troubleshooting techniques in terms of approach and error counters.

7.3.1 Approach
Before attempting any corrective measures, it is important to get some basic information about the network configuration and the nature of the problem. This information can be obtained by querying the user and by referring to the topology diagram for the network. The topology diagram is generated at installation time and is maintained by the field service representative. The flow chart (Figure 7-1) illustrates a typical approach to troubleshooting from the time a service call is placed, until corrective maintenance is begun. This procedure should be followed to help isolate a failing tributary before anyone is dispatched to a site.
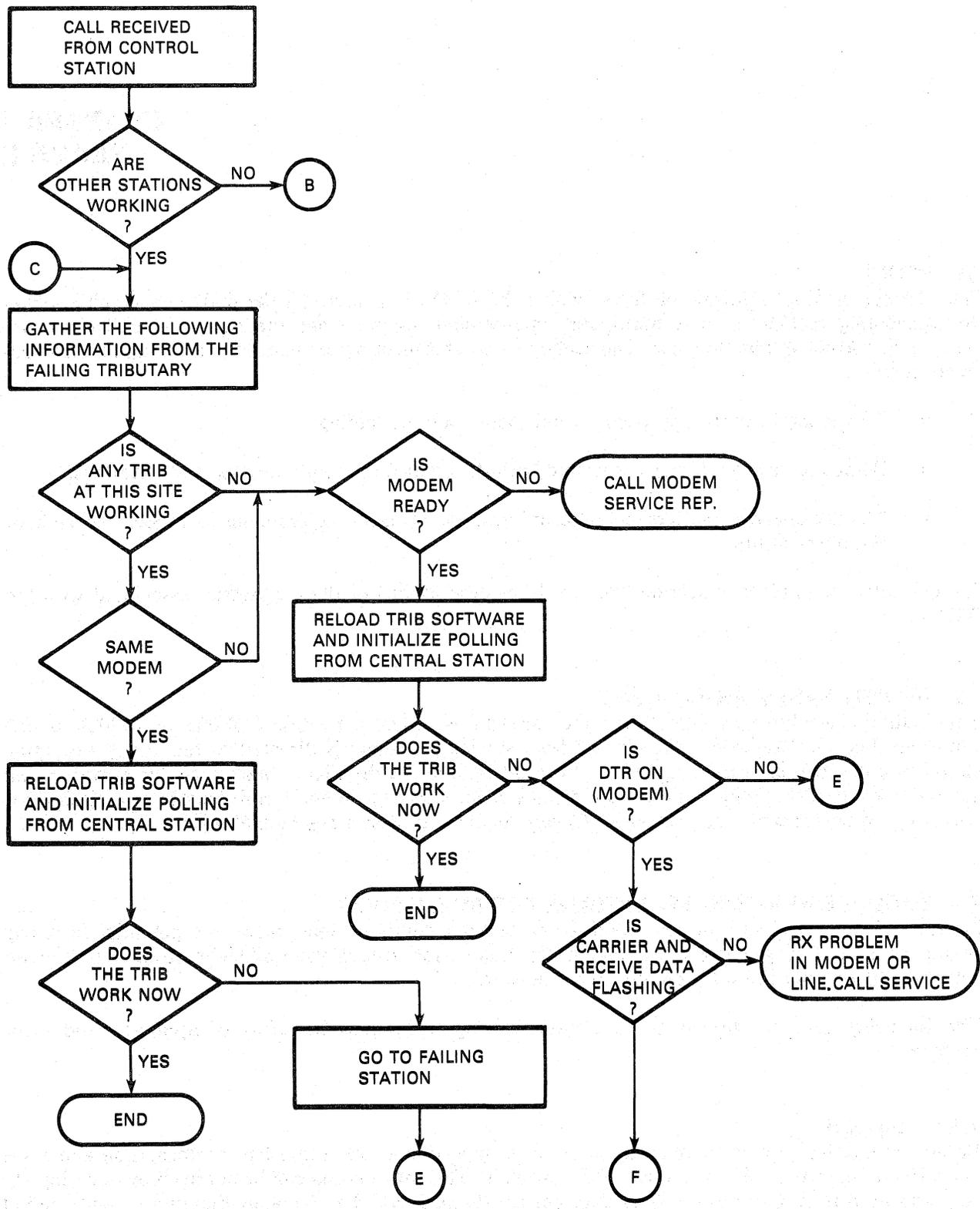
Figure 7-1 Example of a Typical Isolation Flow Diagram (Sheet 1 of 5)

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The +5 V low circuit turns off the transistors on low logic power to keep the transmitter from generating noise or from loading the line. During power-up, this circuit keeps the modem in the disabled state for several milliseconds to prevent the transmission of nonsense characters that would interfere with transmission in progress on a multipoint line.

The transmitter is disabled when line units are not transferring data. The transmitter does not load the line when power is off.

Figure 6-7   Integral Modem Receive

Figure 6-8   Integral Modem Transmit

MK-2503

B

RELOAD SOFTWARE AND
RESTART AT CONTROL
AND TRIB STATIONS

ARE
ALL TRIBS
WORKING
?

NO → ARE
ANY TRIBS
WORKING
?

NO → IS
MODEM READY
AT CONTROL
SITE
?

NO → CALL MODEM
SERVICE REP.

YES ↓ END

YES ↓ C

YES ↓

G

ARE
DTR AND RTS
ON AT
MODEM
?

NO → GO TO CONTROL
STATION

YES ↓

E

IS
CTS COMING
ON AT
MODEM
?

NO → CALL MODEM
SERVICE REP.

YES ↓

TX
DATA LAMP ON
AT MODEM
?

NO → G

YES ↓

ARE
ANY TRIBS
RECEIVING
POLLING
?

NO → TX PROBLEM IN
MODEM OR LINE.
CALL SERVICE

↓

I
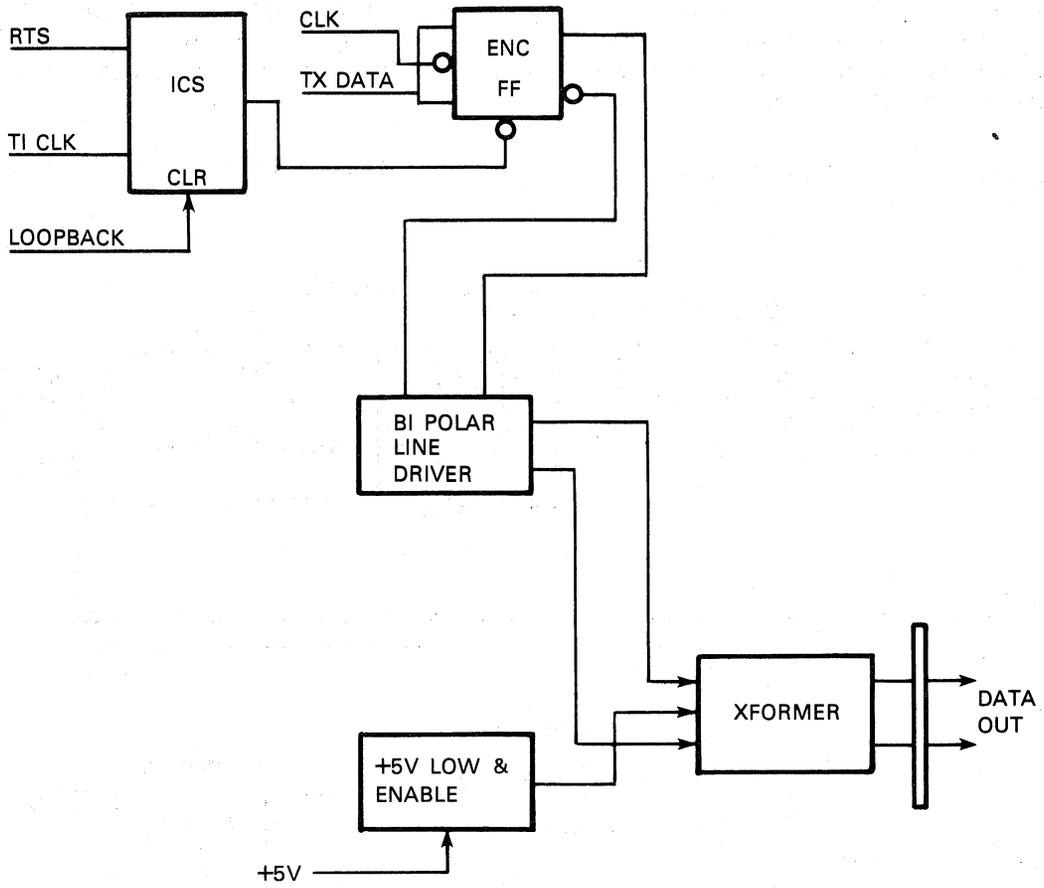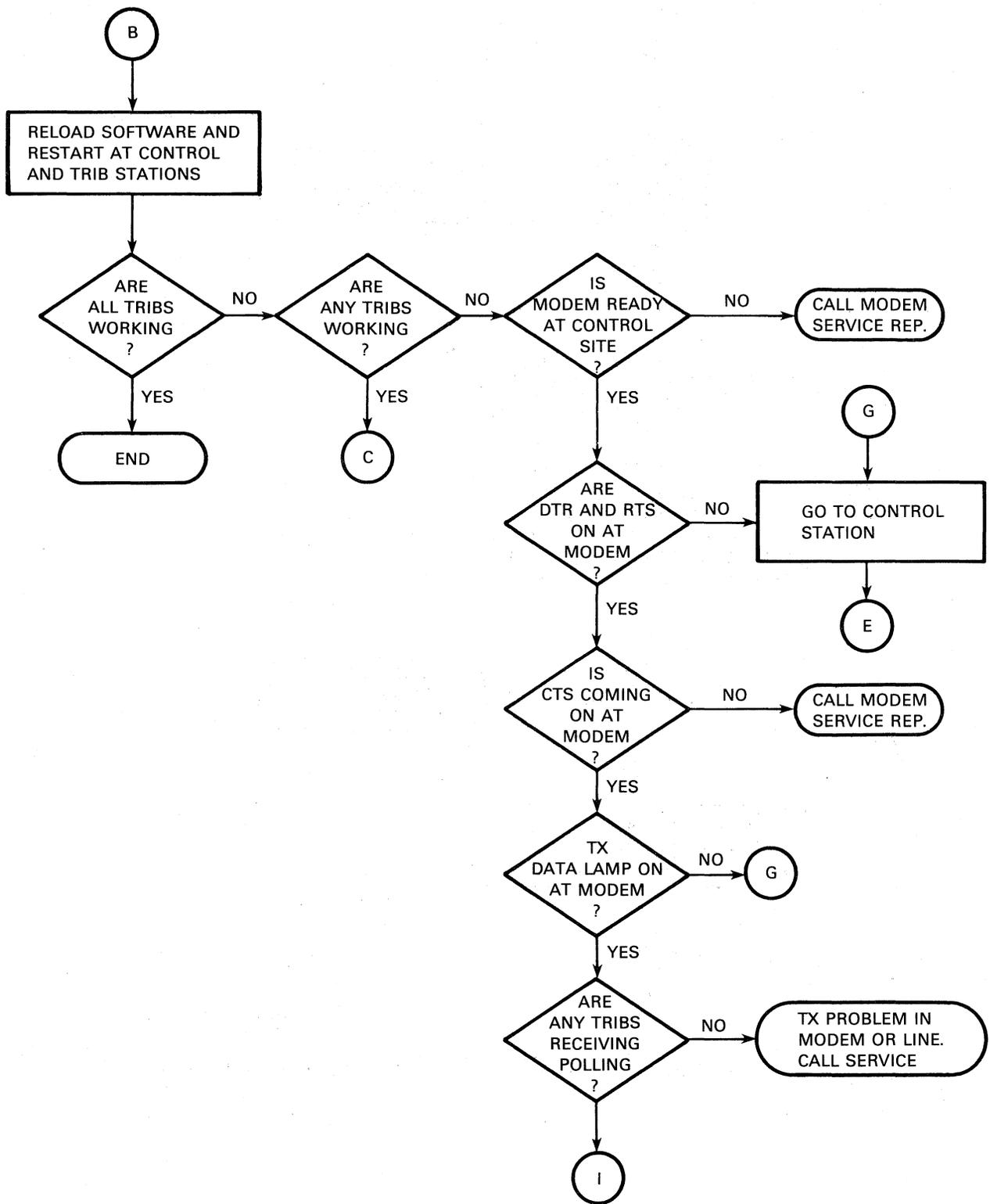
MK-2399

Figure 7-1   Example of a Typical Isolation Flow Diagram (Sheet 2 of 5)
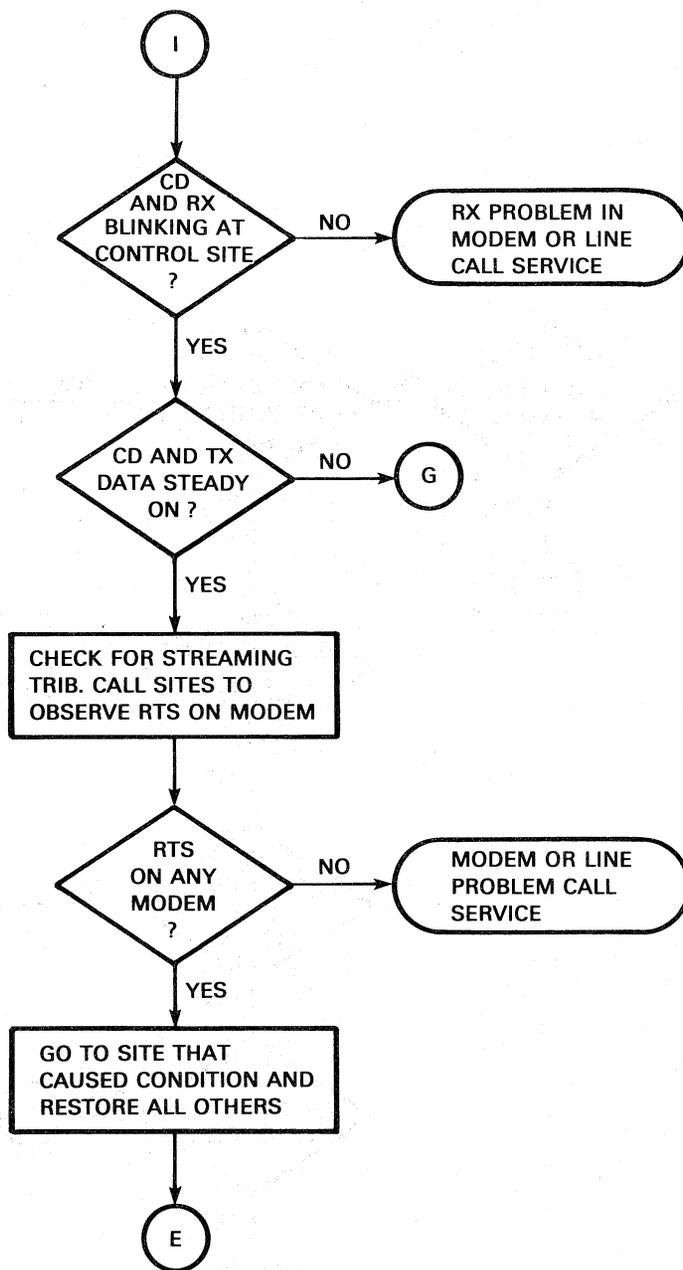
Figure 7-1   Example of a Typical Isolation Flow Diagram (Sheet 3 of 5)
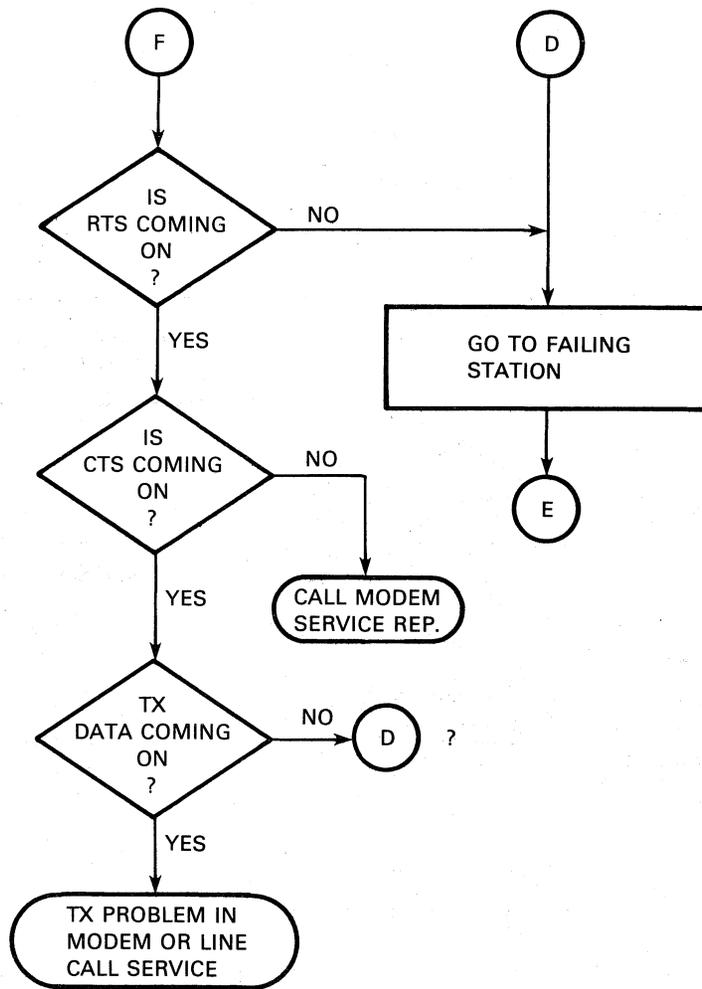
MK-2401

Figure 7-1   Example of a Typical Isolation Flow Diagram (Sheet 4 of 5)
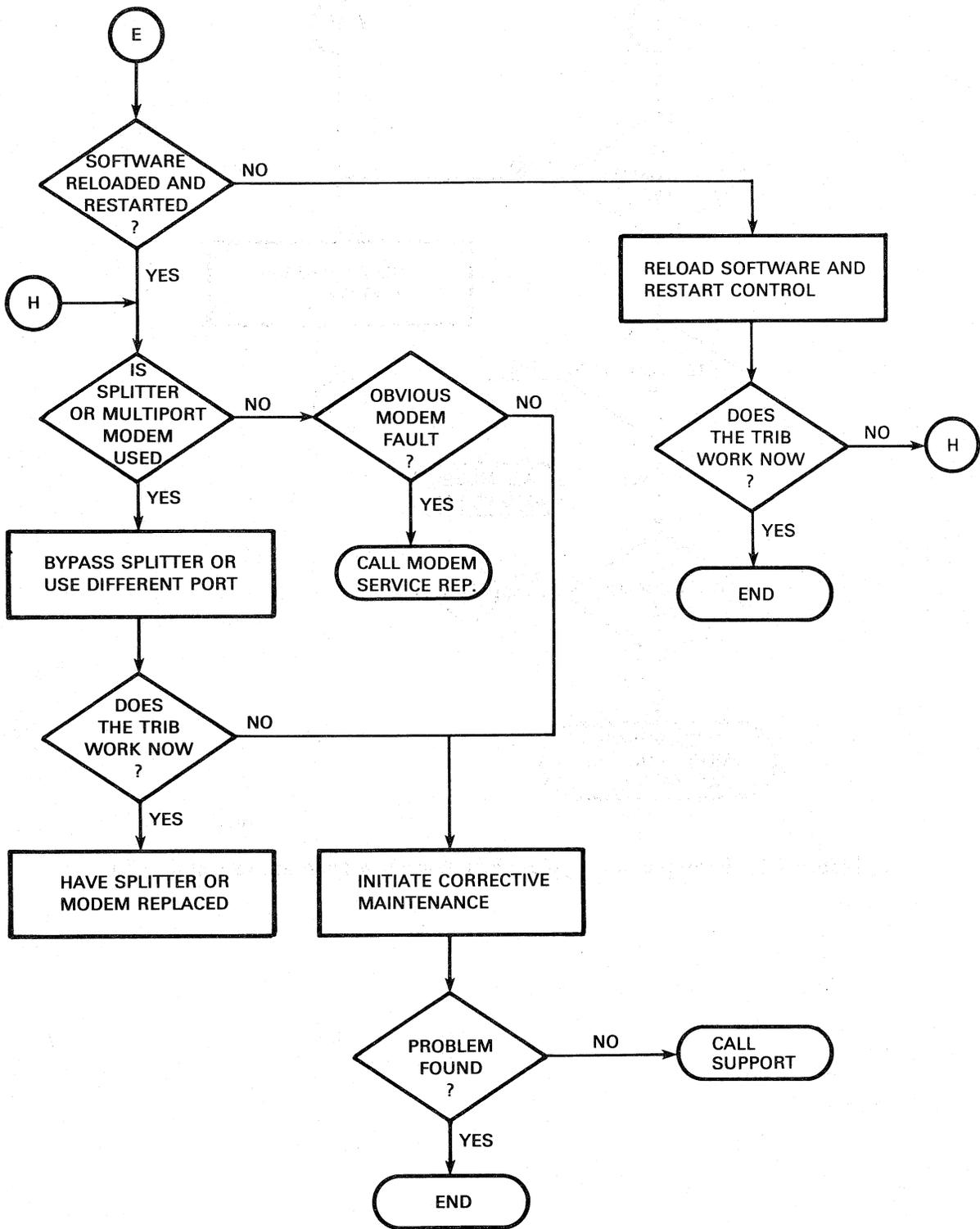
Figure 7-1   Example of a Typical Isolation Flow Diagram (Sheet 5 of 5)

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7.3.2 Error Counters

In multipoint networks many tributaries tie to the same transmission line. Because of this, it is more difficult to determine which link, if any, is causing errors. To aid in troubleshooting, the DMV11 uses error counters. Every DMV11 in the network (the control station and each tributary) uses error counters to record errors. This allows user programs at any DMV11 in the network to determine overall error rates and to detect a malfunctioning link.

The main way in which errors are indicated to the DMV11 is by DDCMP negative acknowledge messages (NAKs). Each NAK contains an address field and a reason code that identifies the source and reason for the NAK. In general, when an error is detected in an incoming message, the station that receives the message sends a NAK to the station that sent the message. By recording NAKs sent and NAKs received, each point or tributary in the network is able to compile statistics on the condition of the link established between the two stations. DDCMP has been designed so that even if one of the stations on the link cannot record errors, the other station may be used to record errors for all communications in both directions on the link.

There are three main categories of error counters used by the DMV11; data link counters, station counters, and threshold counters. Data link counters and threshold counters are maintained for each tributary/control station pair on a physical link. These counters are located in the tributary status slots (TSS) of the data memory (Figure 7-2). Station counters are maintained for the physical link as a whole, and are located in the global status slots (GSS) of the data memory (Figure 7-3). The information gained by checking error counters may be helpful in pinpointing a problem area.

7.3.2.1 Data Link Error Counters

7.3.2.1 Data Link Error Counters – Data link counters are of two types; cumulative and background. The cumulative counters are 8-bit counters which latch at 255. The background counters are 16-bit counters which latch at 65535. The cumulative data link counters record and total all occurrences of an error and group them into the following categories.

- Data errors outbound,
- Data errors inbound,
- Local reply timeouts,
- Remote reply timeouts,
- Local buffer errors,
- Remote buffer errors,
- Selection timeouts.

Background data link counters are used to provide a statistical base for the cumulative error counters and therefore record:

- The number of data messages transmitted,
- The number of data messages received, and
- The number of selection intervals.

A point-to-point station maintains a single set of data link counters. Multipoint stations (control and tributary) maintain a separate set of data link counters for each established tributary. Data link counters are cleared by:

- A master clear of the DMV11,
- A control command to establish the tributary, or
- A user-issued control command to read and clear the TSS error counters.

Data Errors Outbound – This 8-bit group counter records NAKs received for data errors occurring on the communications channel outbound from this station. There are three types of outbound errors for which this counter records NAKs received; header blockcheck (OHBCC), data field blockcheck (ODBCC), and reply response (OREP). Three separate flag bits indicate which type of outbound error is being counted.

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- OHBCC (outbound header blockcheck) is set when a NAK with a reason code of one is received for a header block-check error for either data or control messages.
- ODBCC (outbound data field blockcheck) is set when a NAK with a reason code of two is received for a data field block-check error.
- OREP (outbound reply response) is set when a NAK with a reason code of three is received for a reply message response.

TRIBUTARY STATUS SLOT (TSS)
ADDRESS (OCTAL)

Addr	Field			
5	RESERVED			
	RECEIVE THRESHOLD ERRORS			
6	TRANSMIT THRESHOLD ERRORS			
	SELECTION THRESHOLD ERRORS			
7	DATA MESSAGES TRANSMITTED			
10	DATA MESSAGES RECEIVED			
11	SELECTION INTERVALS			
12	DATA ERRORS OUTBOUND			
	RESERVED	OREP	ODBCC	OHBCC
13	DATA ERRORS INBOUND			
	RESERVED	IREP	IDBCC	IHBCC
14	LOCAL BUFFER ERRORS			
	RESERVED		LBTS	LBTU
15	REMOTE BUFFER ERRORS			
	RESERVED		RBTS	RBTU
16	SELECTION TIMEOUTS			
	RESERVED		IRTS	NRTS
17	LOCAL REPLY TIMEOUTS			
	REMOTE REPLY TIMEOUTS			

MK-1960

Figure 7-2   Data Link and Threshold Error Counters

7-8

15	REMOTE STATION ERRORS				
		RSTR	RSEL	RMHFE	ROVRN
16	LOCAL STATION ERRORS				
		LOVR	LUNDR	LMHFE	LOVRN
17	GLOBAL HEADER BLOCK CHECK ERRORS				
	MAINT. DATA BLOCK CHECK ERRORS				

MK-1959

Figure 7-3   Station Error Counters

Data Errors Inbound – This 8-bit group counter records occurrences which normally result from data errors on the communications channel inbound to this station. Three separate bits indicate specific error types associated with this counter.

- IHBCC (inbound header blockcheck) is set when messages having header block-check errors are received. When this error occurs, point-to-point stations and multipoint control stations send a NAK with a reason code of one. A multipoint control station records this error for the selected tributary regardless of the address field in the received message. A multipoint tributary records this error only if the address field matches its station address.

- IDBCC (inbound data field blockcheck) is set when NAKs with a reason code of two are to be sent for data field block-check errors.

- IREP (inbound reply response) is set when NAKs with a reason code of three are to be sent for a reply response.

Local Reply Timeouts – This 8-bit counter records occurrences which result from:
- The loss of communications between two stations while the one recording this error has data to transmit, or

- The choice of an inappropriate value for the reply timer.

Specifically, this error counter records the sending of a REP message.

Remote Reply Timeouts – This 8-bit counter records occurrences which result from:
- The loss of communications between two stations while the remote station has data to transmit, or

- The choice of an inappropriate value for the remote station reply timer.

Specifically, this counter records ACKs sent in response to a REP. The remote station sent a REP because it received no acknowledgement for messages it previously sent. The local station received those messages, but the remote station never received the acknowledgement.

Local Buffer Errors – This 8-bit counter records the fact that the user program at the station recording the error failed to properly allocate receive buffers to data messages from the remote station. Two separate bits indicate the specific errors associated with this counter.

- LBTU (local buffer temporarily unavailable) is set when a buffer is temporarily unavailable. This condition indicates that a NAK with a reason code of eight is to be sent.

- LBTS (local buffer too small) is set when a local buffer is too small for the incoming message. This condition indicates that a NAK with a reason code of 16 is to be sent.

Remote Buffer Errors – This 8-bit counter records the fact that the user program at the remote station failed to properly allocate receive buffers to data messages from the station recording the error. Two separate bits indicate the specific errors associated with this counter.

- RBTU (remote receive buffer temporarily unavailable) is set when a NAK with a reason code of eight is received.

- RBTS (remote receive buffer too small) is set when a NAK with a reason code of 16 is received.

Selection Timeouts – This 8-bit counter records the occurrences which result from:

- Loss of communications with a remote station,
- Data errors on the communications channel to or from the remote station, and
- The choice of an inappropriate value for this station's select timer.

This counter is used only by half-duplex point-to-point or multipoint control stations. Two separate bits indicate the specific errors associated with this counter.

- NRTS (no reply to select) is used to record selection intervals in which no transmission is received from the tributary, and no attempt to transmit is detected. Specifically, it records the expiration of the select timer without the receipt of a valid control message or header, or the detection of an attempted transmission.

- IRTS (incomplete reply to select) is used to record selection intervals which were not properly terminated. Specifically, it records the expiration of the select timer preceded by receipt of a valid control message, receipt of a valid header, or detection of an attempted transmission. An attempted transmission is indicated by:

  - The presence of a carrier signal,
  - The receipt of a DDCMP synchronization sequence, and
  - The receipt of an SOH, ENQ, or DLE.

Data Messages Transmitted – This 16-bit counter records messages transmitted by this station, and latches at a count of 65535. It can be used as a statistical base when evaluating data errors outbound, local reply timeouts, and remote buffer errors. Messages sent as a result of retransmission are *not* included in this count.

Data Messages Received – This 16-bit counter records messages received by this station, and latches at a count of 65535. It can be used as a statistical base when evaluating data errors inbound, remote reply timeouts, and local buffer errors. Messages received out of sequence or in error are *not* included in this count.

Selection Intervals – This 16-bit counter records the number of times this station selects the other station. It also latches at a count of 65535. Specifically, it records the number of messages transmitted with the select flag on. It is only used by half-duplex point-to-point and multipoint control stations. It can be used as a statistical base when evaluating the number of selection timeouts.

7.3.2.2 Station Error Counters – Station counters are 8-bit counters which latch at 255 and record unusual occurrences. These occurrences may be the result of:

- A hardware or software fault at this station,
- A hardware or software fault at a remote station, or
- A data error on the communications channel undetected by the header block-check field.

A single set of these counters is used for all tributaries on a multipoint link.

There are four types of station counters:

1. Remote station errors,
2. Local station errors,
3. Global header block-check errors, and
4. Maintenance data field block-check errors.

Station counters are cleared by:

- A master clear of the DMV11, or
- A user-issued control command to read and clear the GSS error counters.

Remote Station Errors – This 8-bit counter records occurrences caused by a fault in a remote station or by an undetected data error on the channel inbound to this station. Four separate bits indicate the specific errors associated with this error counter.

- ROVRN (remote receive overrun) is set when a NAK with a reason code of nine is received for a receive overrun.

- RMHFE (remote message header format errors) is set when a message is received which has a header format error. This condition indicates that a NAK with a reason code of 17 is to be sent.

- RSEL (remote selection address error) is set when a multipoint control station receives a message containing an address field which does not match the address of the currently selected tributary. This error is recorded only by multipoint control stations.

- RSTR (remote streaming tributary) is set by either one of two events: 1) an implementation-dependent maximum transmission interval is exceeded without releasing the channel (babbling tributary), or 2) the channel is not released following the end of a selection interval (streaming tributary).

Local Station Errors – This 8-bit counter records occurrences caused by a fault in a local station or by an undetected data error on the channel outbound from this station. Four separate bits indicate the specific errors associated with this error counter.

- LOVRN (local receive overrun, NAK sent) is set for local station receive overruns. This condition indicates a NAK with a reason code of nine is to be sent.

- LOVR (local receive overrun, NAK not sent) is set by a receive overrun when a NAK is not sent. For a multipoint tributary, this happens if an overrun occurs while receiving a header. For other stations, this occurs when the station is not in the DDCMP run state.

- LUNDR (local transmit underruns) is set when a transmit underrun occurs.

- LMHFE (local message header format error) is set when a NAK with a reason code of 17 is received to indicate a message with a header format error was sent by this station.

Global Header Block-Check Errors – This 8-bit counter records the occurrence of header block-check errors that are not recorded on a per tributary basis. Specifically, it counts header block-check errors for maintenance messages and for messages to tributaries where the address field does not match the station address.

Maintenance Data Field Block-Check Errors – This 8-bit counter records the occurrence of data field block-check errors for maintenance messages.

7.3.2.3 Threshold Error Counters – Threshold error counters are used to determine if a persistent fault exists. A persistent fault is one which occurs seven consecutive times. Whenever a threshold counter reaches its maximum value (7), the user program is notified by a control response.

In the DDCMP run state, threshold counters are cleared when the user is notified. In this way the user is continually informed of a persistent fault. In the DDCMP ISTRT and ASTRT states, threshold counters are not cleared when the user is notified. In this way the user is not continually informed of an inoperative remote station.

A point-to-point station maintains a single set of threshold counters. A multipoint control station maintains a separate set for each tributary. A multipoint tributary maintains a single set unless it supports multiple tributary addresses in which case it maintains a single set for each established tributary address.

There are three types of threshold error counters: transmit, receive, and selection.

Transmit Threshold Errors – This 3-bit counter is incremented (if less than 7) in the following instances.

1. The DMV11 is in the ISTRT state when a STRT message is sent,

2. The DMV11 is in the ASTRT state when a STACK message is sent, or

3. The DMV11 is in the run state and a NAK with a reason code other than three (REP response) is received, or when this station sends a REP message.

The transmit threshold error counter is cleared:

- Upon entering the ISTRT, ASTRT, or run states.

- While in the run state one of the following occurs.

    - A transmit threshold error is reported,

    - A NAK, ACK, or data message is received acknowledging a new message, or

    - A NAK, ACK, or data message is received when no messages are outstanding.

Receive Threshold Errors – This 3-bit counter is incremented (if less than seven) when a NAK with one of the following reason codes is sent.

Reason Code	Description
1	Header block-check error.
2	Data field block-check error.
3	REP response.
8	Buffer temporarily unavailable.
9	Receive overrun.
16	Message header format error.

This counter is cleared when:

- Entering the ISTRT, ASTRT, or run states,

- A control message with a correct header blockcheck is received without a header format error,

- A data message with correct header and data field blockchecks is received without a header format error, or

- In the run state, a receive threshold error is reported.

Selection Threshold Errors – This 3-bit counter is only used by multipoint control stations and half-duplex point-to-point stations. It is incremented (if less than seven) when a selection timeout occurs.

It is cleared upon receipt of a message with the select bit set, or while in the run state and a selection threshold error is reported.

7.3.3 Error Counter Analysis
In most applications the software operating system records all the error counters, but does not attempt to analyze or take any particular action of its own as a result of any specific errors.

The system manager or another operator instructs the software to retrieve the counters. The counters are analyzed by the operator or system manager and then the software is instructed to perform a specific function relative to the counter indications.

For information on retrieving the counters, refer to the system-specific *DECnet System Manager's Guide* or consult the network manager.

The following example serves to illustrate how the counters can be used in diagnosing a system failure (refer to Figure 7-4). A user should keep in mind that DCLT also allows access to error counters. See Section 7.6.5.

Assume that a full-duplex multipoint network is made up of seven tributaries and a control station as shown in Figure 7-4. The type of electrical interface (EIA RS-232/RS-449, V.35, integral modem) is not important in this example. The system manager at the control station notices that data transfers over the network appear to be "sluggish." Some standard file transfers are taking a longer time than usual to complete. (Note that in some cases this could be caused by a sudden increase in traffic on the network.) The problem appears to be intermittent in nature since no threshold errors have occurred and data is still being transferred between all tributaries. The system manager examines the error counters at the control station for tributary seven. They are as follows.

CONTROL

TSS 1	TSS 4
TSS 2	TSS 5
TSS 3	TSS 6
TSS 7	
RCV	XMT

INTERNAL DMV11
NETWORK DATA
BASE

LOCATION OF
CABLE FAULT
(FOR EXAMPLE
A HIGH RESISTANCE
CONNECTION)

| XMT | RCV |
| TRIB 1 | |

| XMT | RCV |
| TRIB 2 | |

| XMT | RCV |
| TRIB 3 | |

| XMT | RCV |
| TRIB 4 | |

| XMT | RCV |
| TRIB 5 | |

| XMT | RCV |
| TRIB 6 | |

| XMT | RCV |
| TRIB 7 | |
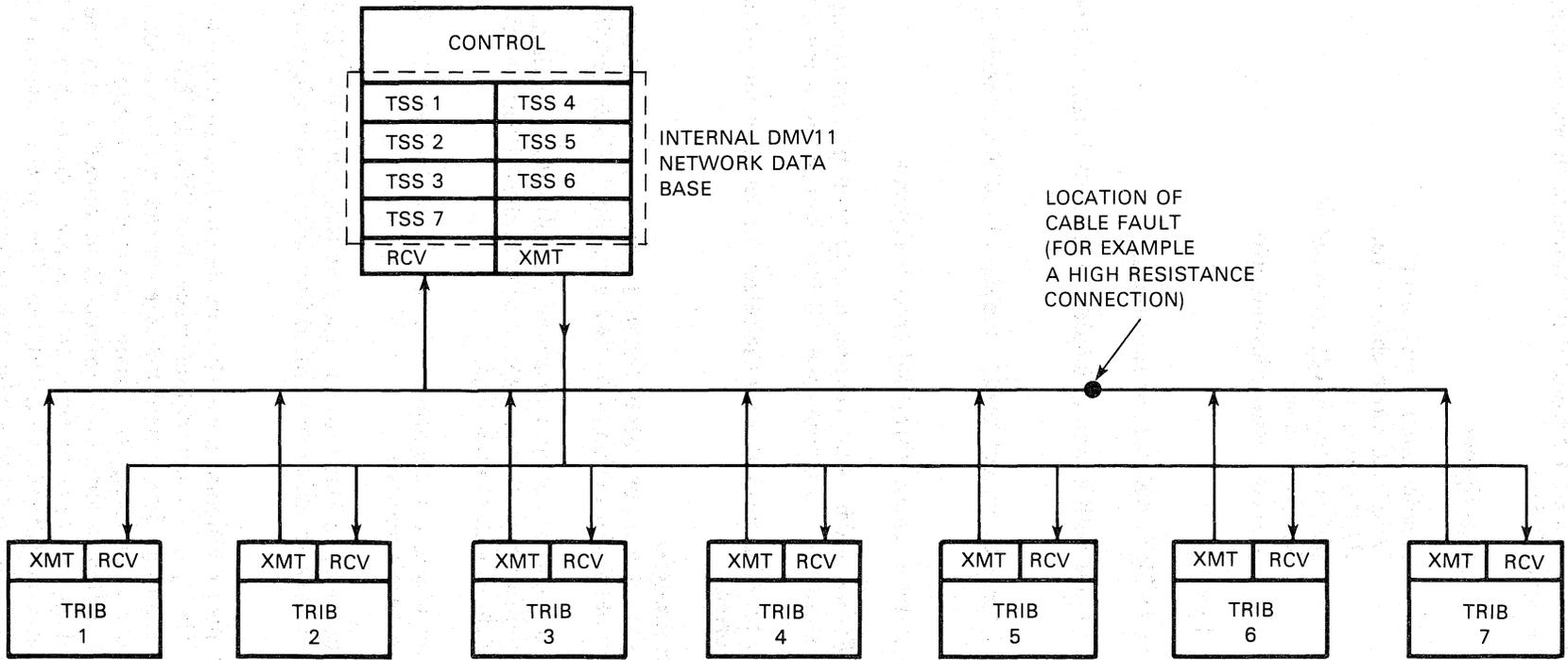
MK-2649

Figure 7-4   Full-Duplex Seven Tributary Multipoint Network

ERROR COUNTERS FOR TRIBUTARY SEVEN (AT THE CONTROL STATION)

        DATA ERRORS OUTBOUND = 0
        DATA ERRORS INBOUND = 255 (IREP, IDBCC, IHBCC)
        LOCAL REPLY TIMEOUTS = 40
        REMOTE REPLY TIMEOUTS = 0
        LOCAL BUFFER ERRORS = 0
        REMOTE BUFFER ERRORS = 0
        SELECTION TIMEOUTS = 50 (IRTS)
        DATA MESSAGES TRANSMITTED = 420
        DATA MESSAGES RECEIVED = 310
        SELECTION INTERVALS = 212

The data errors inbound counter (which is latched) indicates that NAKS have been sent:

- For header BCC errors (IHBCC),
- For data BCC errors (IDBCC), and
- In response to receiving a REP (IREP).

Local reply timeouts show that REP messages have been sent to the tributary because acknowledgements for outstanding messages have not been received. Selection timeouts have also occurred where the tributary received a poll and transmitted (raised carrier) but did not deselect itself (incomplete reply to select – IRTS). From the information gathered so far, there appears to be a problem on the link between the tributary's transmitter and the control station's receiver. This is reenforced by the fact that there are no data errors outbound indicating that NAKS have not been received from the tributary. The problem could be in the control station's receiver hardware (DMV11, modem, and so forth), the cable to the tributary, or the tributary's transmitter hardware (DMV11, modem, and so forth). The next logical step is to examine the error counters at the control station for the other tributaries. Upon doing this the system manager notices that tributary six has the same type and relative number of errors as tributary seven. This indicates that the problem is in the control station's receiver or the cable from tributaries six and seven. (It could be that both tributaries six and seven have transmitter problems, but this is unlikely.) Examination of the error counters for the remaining tributaries reveals very few errors. This rules out the control station hardware.

NOTE
If failures occur at the control station, they are indicated by the fact that in most cases all stations are affected.

The problem appears to be an intermittent cable fault on the control station's receive line (tributaries transmit line) between tributaries five and six. (Note that this could also be a modem-related problem if tributaries six and seven share the same modem by using a modem splitter.) More information about the problem can be gained by examining the error counters at the tributary end of the link.

ERROR COUNTERS FOR TRIBUTARY SEVEN (AT THE TRIBUTARY STATION)

        DATA ERRORS OUTBOUND = 255 (IREP, IDBCC, IHBCC)
        DATA ERRORS INBOUND = 0
        LOCAL REPLY TIMEOUTS = 23
        REMOTE REPLY TIMEOUTS = 40
        LOCAL BUFFER ERRORS = 0
        REMOTE BUFFER ERRORS = 0
        SELECTION TIMEOUTS = N/A
        DATA MESSAGES TRANSMITTED = 310
        DATA MESSAGES RECEIVED = 420
        SELECTION TIMEOUTS = N/A

Notice that these error counters provide the same type of information as the control station error counters. The errors all seem to be in one direction, namely outbound. Notice also that the number of data messages transmitted and received match those at the control station. Since data transfer is occurring, the likelihood of a hard error in the hardware is low.

<div align="center">

NOTE
Hard errors at the control or tributary stations gen-
erally are revealed during the start-up sequence.

</div>

Examination of the remainder of the tributary's error counters reveals that tributary six has errors similar to tributary seven, and the other tributaries have very few errors. The "sluggishness" of the network is due to the:

- Timeouts that intermittently occur when polling tributaries six and seven, and

- Numerous retransmissions that occur in order to get the data transferred.

These timeouts and retransmissions of data are the result of a cable fault between tributary five and six as indicated in Figure 7-4.

7.4 MAINTENANCE
For maintenance purposes the DMV11 may be operated in two basic modes:

1. Maintenance mode, or
2. Standard operating mode.

7.4.1 Maintenance Mode
Maintenance mode is used to test the DMV11 by causing the microcode to respond to certain command functions issued by a diagnostic program. Section 4.8 discusses the maintenance mode in detail.

7.4.2 Standard Operating Mode
The DMV11 is tested in the standard operating mode by terminating the cable at the BC55F or BC55H panel or at the modem end of the external cable, and running diagnostics.

The DMV11 options are configured as follows:

1. DMV11-AA (for RS-232-C; RS-423-A)

    - The modem must be disconnected and the test connector must be attached to the cable. This may be done at the BC55H panel or at the modem end of the external cable.

EIA	Test Connector	Interface Cable	Modem Cable
RS-232-C	H325	BC55H	BC05D-25
RS-423-A	H3251	BC55H	BC55D-33

    - The clock signal is looped back in the test connector to simulate modem transmit and receive clocks. The data rate for this application must not exceed 19.2K b/s.

    - Modem control signals are tested for proper level conversion and cable paths. These signals are looped back in the test connector as shown in the signal flow of Figure 2-8 View E.

2. DMV11-AB (CCITT V.35/DDS)

- The modem must be disconnected and the H3250 test connector must be attached to the BC05Z-25 cable.

- The clock signal is looped back in H3250 to simulate modem transmit and receive clocks.

- Modem control signals are tested for proper level conversion and cable paths. These signals are looped in the H3250 as shown in the signal flow of Figure 2-8 View B.

3. DMV11-AC (for integral modem local use)

- The local link connections of the BC55F connector panel are disconnected at the local panel, and the FDX switch on the BC55F connector panel is switched to half-duplex to accomplish the external loopback.

CAUTION
If DMV11 is connected to another running DMV11, disconnect the cable at the BC55F connector panel during diagnostic execution.

- The data is looped back through the BC55F connector panel to test, transmit, and receive data. The data rate for this application must be 56K b/s.

7.5 PREVENTIVE MAINTENANCE (PM)
There is no specific DMV11 PM schedule. A general check of voltages and connections should be done when system PM is performed. After handling DMV11 modules or cables, a complete checkout of the device, by running all diagnostics and, if possible, the interprocessor test, is required.

7.6 CORRECTIVE MAINTENANCE
Since the FRU is either a module or cable, all corrective diagnosis should be directed towards isolating the failing FRU. DMV11 diagnostics are designed to aid in the isolation process and should be run starting with the DMV11 static logic test and continuing to the DEC/XII program. The proper sequence of diagnostics is shown in Table 7-1.

7.6.1 DMV11 Static Logic Tests Parts 1 and 2
These diagnostics test the DMV11 microcontroller circuits except for the USYRT. Through dialogue with the operator and by using the diagnostic supervisor (DS), the program allows modification of device parameters, such as the LSI-11 bus address, vector address, and processor type.

These programs are compatible with the stand-alone diagnostic supervisor and do not exceed 16K of memory. The total time required to run DMV11 static tests is approximately from 30 seconds to 2 minutes per pass, depending on the CPU type.

DMV11 static logic tests part 1 and part 2 are compatible with XXDP+, ACT/SLIDE, and APT. XXDP+ and ACT/SLIDE may be run in dump or chain modes. APT can be run in program or script modes. A summary of the tests performed are listed in Tables 7-2 and 7-3.

Table 7-1 DMV11 Diagnostics

Diagnostic	Description
(C)VDMA**	DMV11 static logic test part 1
(C)VDMB**	DMV11 static logic test part 2
(C)VDMC**	DMV11 static logic test part 3
(C)VDMD**	DMV11 static logic test part 4
(C)VDME**	DMV11 static logic test part 5
(C)ZDMT**	DMV11 functional diagnostic
(C)ZCLM**	DMV11 DCLT program
(C)XDMD**	DMV11 DEC/XII master module
(C)XDME**	DMV11 DEC/XII slave module

** Indicates the revision level

Table 7-2 DMV11 Static Logic Test Part 1 Diagnostic Summary

Test Number	Description
1	DMV11 availability
2	Master clear, run microdiagnostics
3	CSR addressing
4	CSR registers data read/write
5	Basic master clear
6	Bus reset
7	CSR, maintenance microcode interaction
8	Run flip-flop
9	Low RAM (00-0F) scratchpad
10	Data RAM moving inversions (LOC's 0018-01FF hex)
11	VIA register addressing
12	VIA's DDRB data read/write
13	VIA's DDRA data read/write
14	VIA's ORB data read/write
15	VIA's timer #1 data read/write
16	VIA's shift register data read/write
17	VIA's ACR data read/write
18	VIA's PCR data read/write
19	VIA's IER data read/write
20	VIA's ORB/DDRB master clear test
21	VIA's DDRB master clear test
22	VIA's DDRA master clear test
23	VIA's shift register master clear test
24	VIA's ACR master clear test
25	VIA's PCR master clear test
26	VIA's IER master clear test

Table 7-3 DMV11 Static Logic Test Part 2 Diagnostic Summary

Test Number	Description
1	VIA timer 2 one shot mode
2	VIA's SR input (MODE 2) – system clock mode
3	NPR control register – master clear
4	NPR data-out
5	NPR data-in
6	NPR XFFR abort
7	NPR extended address bit test
8	Special MFG extended bit test
9	Q-Bus interrupt "A" & "B" selection
10	Bus reset with disable init set
11	Master clear with disable init spt
12	DCOK H LO bit
13	Halt mode verification

7.6.2 DMV11 Static Logic Tests Parts 3, 4, and 5

These diagnostics perform static tests of USYRT read/write logic; basic transmitter functions; receiver sequencing and data buffering; and static operations in character and bit-stuffing modes. In addition, data messages are sent at TTL level or through an external test connector with a specific modem interface selected.

Static logic tests provide troubleshooting capabilities such as tight-scope loops, switch options, and the ability to lock on intermittent errors. Additional tests provide fault isolation to facilitate replacement of the smallest field replaceable unit.

These programs conform to the stand-alone version of the diagnostic supervisor and are compatible with ACT, APT, XXDP+, and SLIDE. Through dialogue with the operator, the programs permit modifications of device parameters such as the LSI-11 bus address, vector addresses, and device priority. The operator can specify particular tests to be run and a variety of looping, running, and reporting modes.

Device errors are reported as they occur. The report includes the test number and error description, good and bad test data, and applicable device register contents.

A summary of the tests performed are listed in Tables 7-4, 7-5, and 7-6. For greater detail, refer to the diagnostics listings.

Table 7-4 DMV11 Static Logic Test Part 3 Diagnostic Summary

Test Number	Description
1	TBMT microcode interrupt test
2	Switch setting test
3	USYRT master clear test
4	USYRT program reset test
5	USYRT register addressing test
6	R/W bit test of PCSAR high point

Table 7-4 DMV11 Static Logic Test Part 3 Diagnostic Summary (Cont)

Test Number	Description
7	R/W bit test of S/AR register
8	R/W bit test of PCR register
9	R/W bit test of TDSR register's high byte
10	R/W bit test of TXDB register
11	Pseudo R/W bit test of RXDB
12	Pseudo R/W bit test of RDSR's high byte
13	Null clock test
14	BCP TX reset w/IDLE = 0
15	BCP TX reset w/IDLE = 1
16	BCP TX underrun w/TSOM termination
17	BCP TX underrun w/RESET termination
18	BCP TX disable test
19	FIFO stacking characters test
20	BCP character length test
21	BOP TX TABORT/(IDLE = 0) test
22	BOP TX TABORT/(IDLE = 1) test
23	BOP TX TXGA (transmit go-ahead) test
24	BOP TX message without CRC
25	BOP RX character length test
26	TX "spacing sequence"
27	FIFO overrun integrity test
28	BCP PX overrun set and clear test
29	BCP RX sync-character recognition
30	BCP RX strip-sync test
31	BCP RX lost RXE test

Table 7-5 DMV11 Static Logic Test Part 4 Diagnostic Summary

Test Number	Description
1	VRC parity generation test
2	VRC error detection test
3	BCP CRC generation/detection test
4	BOP RX basic receive/flag recognition test
5	BOP RX secondary station addressing
6	BOP RX all parties address test
7	BOP RX bit stuffing test
8	BOP RX underrun idle aborts/flags
9	BOP RX lost RXE test
10	BOP RX GA (go-ahead) recognition
11	BOP RX "ABC" test

Table 7-6 DMV11 Static Logic Test Part 5 Diagnostic Summary

Test Number	Description
1	RX data flushing test
2	Integral modem interface test
3	Data test – BCP external loopback (XLB) CRC-16
4	Data test – BCP XLB odd VRC
5	Data test – BCP XLB even VRC
6	Data test – BOP XLB CRC-CCITT-1
7	Data test – BOP XLB CRC-CCITT-0
8	Modem control signal loopback test
9	DDCMP message test

7.6.3 DMV11 Functional Diagnostic

This diagnostic performs testing on the DMV11 option in a functional manner to verify its proper operation under microcode controlled use of the DDCMP. This includes a ROM CRC/CCITT check, microdiagnostic, command utilization, and error generation.

This functional test provides troubleshooting capabilities such as tight-scope loops, switch options, and the ability to lock on intermittent errors. Additionally, this program conforms to the stand-alone version of the diagnostic supervisor and is compatible with APT, ACT, XXDP+, and SLIDE.

Through dialogue with the operator, the program permits modification of device parameters such as the LSI-11 bus address, vector addresses, and device priority. The operator can specify particular tests to be run and a variety of looping, running, and reporting modes.

A summary of the tests performed are listed in Table 7-7. For greater detail, refer to the diagnostics listings.

7.6.4 DMV11 Microdiagnostic Error Reporting

Internal diagnostics test registers and data paths that are internal to the microprocessor. These diagnostic routines run automatically on a master clear and must complete successfully before normal interaction with the CPU can take place.

The user program is notified of the results by way of the CSRs. Table 7-8 is a summary of the possible results.

7.6.5 Data Communications Link Test Program (DCLT)

DCLT is a communications equipment maintenance tool designed to verify DMV11 to DMV11 communication links. The DCLT program provides the coverage necessary to isolate the following faults:

- Communications interface program functionality,
- Communication modem,
- Communication cabling and installation, and
- Physical link/network.

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DCLT programs allow testing between modes with different hardware interfaces implementing the same or compatible protocol. The DCLT program can be exercised under normal maintenance loop-back tests:

- Internal TTL loopback,

- Hardware loopbacks:

    - Module test connectors, or
    - Cable test connectors,

- Manual-controlled local modem analog and digital loopback functions (full-duplex mode),

- Programmable-controlled local modem analog loopback (full-duplex mode),

- Programmable-controlled remote modem digital loopback (full-duplex mode).

DCLT's main goal is to test the communications link. DCLT assumes that the CPUs and DMV11s at each end of the link have previously been tested and found to be in proper working order.

Prior to analyzing any data, the user must have a thorough understanding of the protocol formats applicable to the system under test.

DCLT may be used to access DMV11 error counters or other information by using the print command. The print command invokes a DCLT level called REPORT within which the following commands are available.

Command	Description
HELP OR ?	Prints help information for RPT.
TSS NNN/SW	Shows tributary status slot information where NNN is the decimal tributary address and SW is one of the following switches.
ERROR	Indicates that only error slots are to be printed.
FULL	Indicates that all tributary status slots are to be printed.
OFFSET = NN	Indicates that the tributary status slot whose offset is NN is to be printed.
GSS/SW	Print the global status information. Switches are the same as for TSS.
LOG	Dumps the event log.
EXIT	Exits back to the command level that the user entered from. [DCLT> or DP>].

DCLT is XXDP+ or APT compatible and runs under control of the diagnostic supervisor (DS). It requires 24K of memory. For more information on DCLT refer to the (C)ZCLM** document.

Table 7-7 DMV11 Functional Diagnostic Summary

Test Number	Description
1	Address test
2-7	DMP ROM verification tests
8-9	DMV ROM verification tests
10	Initialization test
11	DMP interface diagnostics
12	RDI remains set test
13	Test for RDO setting
14	Check for procedure error 100
15	Check for procedure error 104
16	Test mode change of duplex portion of mode
17	Test for max tribs to be established
18	Read/write tributary status slots test
19-20	Tests for procedure error 132
21	Test for read/clear command
22	Tests for global status slots
23	Halt trib command tests
24	Kill trib command tests
25	Check for procedure error of 102
26	Check for procedure error of 110
27	Check for procedure error of 120
28	Check for procedure error of 134
29	Latch/unlatch poll check
30	Short message sending test
31	Check for procedure error 122
32	Check for procedure error 124
33	Check for procedure error 126
34	Check for procedure error 130
35	Transmit/receive 256 bytes, MTP, DDCMP
36	DMV Q22 mode TX/RX 256 bytes, MTP, DDCMP
37	Transmit/receive 255 bytes, MTP, DDCMP
38	DMP read/write modem register tests
39-41	Test of mem extension bits
42	Test for TX/RX 257 byte
43	Test for TX/RX 1 byte
44	Polling state tests

Table 7-8 Microdiagnostic Error Codes

BSEL6	BSEL4	Description
101	N/A	Branch test has failed and the microcode is spinning in a loop.
102	N/A	6502 internal register test has failed and the microcode is spinning in a loop.
103	N/A	Load and store instructions test has failed and the microcode is spinning in a loop.
104	N/A	Compare instructions test has failed and the microcode is spinning in a loop.
105	N/A	Increment and decrement instructions test has failed and the microcode is spinning in a loop.
106	N/A	Shift and rotate instructions test has failed and the microcode is spinning in a loop.
107	N/A	Logic instructions test has failed and the microcode is spinning in a loop.
110	N/A	Add with carry, subtract with carry, set and clear decimal mode instructions test has failed and the microcode is spinning in a loop.
111	N/A	Stack push and pull instructions test has failed and the microcode is spinning in a loop.
112	N/A	Subroutine instructions test has failed and the microcode is spinning in a loop.
113	N/A	Ram scratchpad, CSR, and NPR address resisters addressing test has failed and the microcode is spinning in a loop.
114	N/A	Ram scratchpad, CSR, and NPR address resisters data test has failed and the microcode is spinning in a loop.
115	N/A	True interrupt test has failed and the microcode is spinning in a loop.
116	N/A	Ram data and addressing test has failed and the microcode is spinning in a loop.
117	N/A	Ram alternating data test has failed and the microcode is spinning in a loop.
120	N/A	Indexed indirect addressing mode instruction test has failed and the microcode is spinning in a loop.
121	N/A	Line unit message test has failed and the microcode is spinning in a loop.
305	33	The microdiagnostics have completed without errors.

7.6.6 DEC/X11 DMV11 Modules

There are two DEC/X11 modules for the DMV11; DMD* and DME*. Together these two modules can operate:

- Up to 16 DMV11 devices in point-to-point links.

- A single DMV11 configured as a multipoint control station communicating with up to 12 tributaries.

- Up to 16 devices configured as multipoint tributaries on the same LSI-11 bus.

These modules transmit, receive, and check 32 data messages of 1024 bytes each on a given physical link. By default, this involves a single LSI-11 system with one or more devices operating in internal or external loopback mode. However, by operator selection of nondefault modes, actual point-to-point or multipoint operation is possible.

7.6.6.1 DMD* – DMD* is the master module. It can operate up to 16 DMV11 devices in looped-back and point-to-point modes, or a single device in multipoint control mode. DMD* can be self-sufficient or it can communicate with slave modules on the same or another processor.

A separate DMD* module is required for each group of looped-back DMV11 devices, each control station, or each group of point-to-point devices.

The actual operating mode for each DMD* module is selected by software switch registers for that module. The DMD* module uses switch registers SR1-SR4 as follows:

SR4 has three allowable values: 0, 1, or 2.

       SR4=0 :IF TESTING DMP11
       SR4=1 :IF TESTING DMV11
       SR4=2 :IF TESTING DMV11 (AND Q22 SOFTWARE MODE IS DESIRED).

SR1 has three allowable values; 0, 1, or 2.

When SR1=0:

- All selected DMV11s run in point-to-point full-duplex mode with internal or external loop-back on all devices.

- SR2 has the following meaning:

   If SR2=0, internal loopback is provided by the program. This is accomplished using TTL-level loopback on the line unit. SR2=0 is the default mode of operation.

   If SR2=1, external loopback is provided by H3254 or H3255 test connnectors on each device.

   If SR2=2, cable loopback is provided by H3250 or H3251 test connectors.

When SR1=1:

- All selected DMV11s run in point-to-point full- or half-duplex mode without loopback.

- The DMD* module communicates with DME* (slave) modules on the same or other LSI-11 systems.

- SR2 and SR3 software switch registers are not used.

When SR1 = 2:

- Only one DMV11 is selected.

- The selected DMV11 runs in multipoint control full- or half-duplex mode without loopback.

- The DMD* module communicates with DME* (slave) modules on the same or other LSI-11 systems.

- SR2 = The total number of tributaries on this multipoint link. The allowable range is from 1 to 14_8.

- SR3 = The starting tributary address. The program uses this starting address to compute the other addresses. The allowable address range is from 1 to 377_8 and they may wraparound (377 to 1) if necessary.

7.6.6.2 DME* – DME* is the slave module. It can operate up to 16 DMV11 devices in point-to-point slave or multipoint tributary modes.

A separate DME* module is required for each group of point-to-point slaves or multipoint tributaries on a system.

As with the DMD* module, the actual operating mode for each DME* module is selected by software switch registers for that module. The DME* module uses software switch registers SR1-SR4 as follows:

SR4 has three allowable values: 0, 1, or 2.

        SR4=0 :IF TESTING DMP11
        SR4=1 :IF TESTING DMV11
        SR4=2 :IF TESTING DMV11 (AND Q22 SOFTWARE MODE IS DESIRED).

SR1 has two allowable values; 0 and 1.

    When SR1=0:

- All selected DMV11 devices run in point-to-point slave, full- or half-duplex mode without loopback.

- The DME* module communicates with the DMD* (master) modules on the same or other LSI-11 systems.

- SR2 and SR3 are unused.

When SR1 = 1:

- All selected DMV11 devices run in multipoint tributary full- or half-duplex mode without loopback.

- The DME* module communicates with a DMD* (master) module on the same or other LSI-11 systems.

- SR2 = The total number of tributaries on the multipoint link on this CPU. The allowable range is from 1 to 14_8.

- SR3 = The starting tributary address. The program uses this starting address to compute the other addresses. The allowable address range is from 1 to 377_8 and they may wraparound (377 to 1) if necessary.

NOTE
If the DMV11 DEC/X11 modules are configured to run in linkmode, it is recommended that the exerciser be started in run lock mode. If this is not done, the exerciser may hang.

7.6.7 Soft Error Reports Under DEC/X11

Soft errors indicate errors which occurred causing a message retransmission. The DMD* module requests data errors inbound and outbound for each pass. If any errors are present, they are reported as soft errors. The soft error report may be used in the isolation of certain DMV11 failures from UNIBUS loading or data late problems.

The DMV11 has no data late bit or capabilities for detecting the fact that it did not obtain bus mastership in time to service the synchronous line. The DMV11 interprets such a condition as an error in the synchronous data stream (a BCC error, transmitter underrun, or receiver overrun) and DDCMP causes the message to be retransmitted. This occurrence causes incrementation of the cumulative error counters in DMV11 RAM memory.

A process of elimination must be used to determine whether soft errors (BCC) are caused by bus latency or failing DMV11 hardware.

Typically, the DMV11 should show no errors when running in a local loopback mode. This is normally a noise-free circuit. Therefore, any soft error reports should be examined and the cause isolated.

If soft errors are reported while running a DMV11 on a fully loaded system (other devices being exercised simultaneously), they may be due to bus latency. This may be verified by running only the DMD*DEC/X11 module with only one DMV11 enabled. If the soft errors cease, a latency condition is indicated.

If soft errors persist while running only the DMD*DEC/X11 module, the DMV11 device diagnostics should be run. The problem could be a faulty DMV11 or cable.

SR1 and SR2 (bit 0) may be used in the isolation process. If SR1=0 and SR2=1, DEC/X11 does not set line unit loopback but it uses an external turnaround. By running with SR1=0 and SR2=0, a TTL loopback is performed, eliminating the possibility of the cable/turnaround connector being faulty.

TTL loopback eliminates the level converters and the integral modem. The bit rate selected is 56K b/s using the internal clock.

A.1 DDCMP

The Digital Data Communications Message Protocol (DDCMP) provides a data link control procedure that ensures a reliable data communication path between communication devices connected by data links. DDCMP has been designed to operate over full- and half-duplex synchronous and asynchronous channels in both point-to-point and multipoint modes. It can be used in a variety of applications such as distributed computer networks, host front-end processors, remote terminal concentrators, and remote job entry-exit systems.

A.1.1 Controlling Data Transfers

The DDCMP message format is shown in Figure A-1. Three control characters are provided in DDCMP to differentiate between the three possible types of messages:

- SOH – Data message follows,
- ENQ – Control message follows,
- DLE – Maintenance message follows.

Note that the use of a fixed-length header and message size declaration obviates the requirement for extensive message and header delimiter codes.

SYN	SYN	SOH	COUNT 14 BITS	FLAG 2 BITS	RESPONSE 8 BITS	SEQUENCE 8 BITS	ADDRESS 8 BITS	CRC-1 16 BITS	DATA (ANY NUMBER OF 8-BIT CHARACTERS UP TO 2^{14})	CRC-2 16 BITS
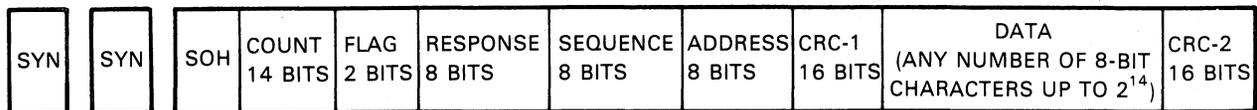
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Figure A-1   DDCMP Data Message Format

A.1.2 Error Checking and Recovery

DDCMP uses a 16-bit cycle redundancy check (CRC-16) for detecting transmission errors. When an error occurs, DDCMP sends a separate negative acknowledge (NAK) message. DDCMP does not require an acknowledgement message for all data messages. The number in the response field of a normal header or in either the special NAK or acknowledge (ACK) control message specifies the sequence number of the last good message received. For example, if messages 4, 5, and 6 have been received since the last time an acknowledgement was sent and message 6 is bad, the NAK message specifies number 5 which says "messages 4 and 5 are good and 6 is bad." When DDCMP operates in full-duplex mode, the line does not have to be turned around; the NAK is simply added to the sequence of messages for the transmitter.

When a sequence error occurs in DDCMP, the receiving station does not respond to the message. The transmitting station detects, from the response field of the messages it receives (or via timeout), that

the receiving station is still looking for a certain message and sends it again. For example, if the next message the receiver expects to receive is 5, but receives 6 instead, the receiver does not change the response field (which contains a 4) of its data messages. The receiver will say, "I accept all messages up through message 4 and I'm still looking for message 5."

A.1.3 Character Coding
DDCMP uses ASCII control characters for SYN, SOH, ENQ and DLE. The remainder of the message, including the header, is transparent.

A.1.4 Data Transparency
DDCMP defines transparency by use of a count field in the header. The header is of a fixed length. The count in the header determines the length of the transparent information field, which can be from 1 to 16,383 bytes long. To validate the header and count field, it is followed by a CRC-16 field; all header characters are included in the CRC calculation. Once validated, the count is used to receive the data and to locate the second CRC-16, which is calculated on the data field. Thus, character stuffing is avoided.

A.1.5 Data Channel Utilization
DDCMP uses either full-duplex or half-duplex circuits at optimum efficiency. In the full-duplex mode, DDCMP operates as two independent one-way channels, each containing its own data stream. The only dependency is the acknowledgements which must be sent in the data stream in the opposite direction.

Separate ACK messages are unnecessary, therefore, reducing the control overhead. Acknowledgements are simply placed in the response field of the next data message for the opposite direction. If several data messages are received correctly before the terminal is able to send a message, all of them can be acknowledged by one response. Only when a transmission error occurs, or when traffic in the opposite direction is light (no data message to send), is it necessary to send a special NAK or ACK message, respectively.

In summary, DDCMP data channel utilization features include:

1. The ability to run on full-duplex or half-duplex data channel facilities,

2. Low control character overhead,

3. No character stuffing,

4. No separate ACKs when traffic is heavy; this saves on extra sync-characters and inter-message gaps,

5. Multiple acknowledgements (up to 255) with one ACK, and

6. The ability to support point-to-point and multipoint lines.

A.2 PROTOCOL DESCRIPTION
DDCMP is a very general protocol; it can be used on synchronous or asynchronous, half-duplex or full-duplex, serial or parallel, and point-to-point or multipoint systems. Most applications involving protocols are half-duplex or full-duplex transmissions in a serial synchronous mode; that operating environment is emphasized in the following description.

The header is the most important part of the message because it contains the message sequence numbering information and the character count, the two most important features of DDCMP. Because of the importance of the header information, it merits its own CRC blockcheck, indicated in Figure A-2 as CRC-1. Messages that contain data, rather than just control information, have a second section which contains any number of 8-bit characters (up to a maximum of 16,383) and a second CRC (indicated in Figure A-2 as CRC-2).

Figure A-2 DDCMP Message Format in Detail

NOTE 1

SYN	SYN	CLASS	COUNT 14 BITS	FLAG 2 BITS	RESPONSE 8 BITS	SEQUENCE 8 BITS	ADDRESS 8 BITS	CRC 1 16 BITS	INFORMATION ANY NUMBER OF 8-BIT CHARACTERS	CRC 2 16 BITS

NOTE 6 · NOTE 2 · NOTES 3,4 · NOTE 5

	CLASS	COUNT	FLAG	RESPONSE	SEQUENCE	ADDRESS
	XXXXXXXX	XXXXXXXXXXXXXX	XX	XXXXXXXX	XXXXXXXX	XXXXXXXX
SOH – DATA MESSAGES	10000001	CHARACTER COUNT	QS	RESP #	MESSAGE#	ADDRESS
ENQ { ACKNOWLEDGEMENT	00000101	00000001000000	QS	RESP #	00000000	ADDRESS
NEGATIVE ACKNOWLEDGE	00000101	00000010--------	QS	RESP #	00000000	ADDRESS

REASONS:

BCC HEADER ERROR	000001
BCC DATA ERROR	000010
REP RESPONSE	000011
BUFFER UNAVAILABLE	001000
RECEIVER OVERRUN	001001
MESSAGE TOO LONG	010000
HEADER FORMAT ERROR	010001

ENQ { REPLY MESSAGE	00000101	00000011000000	QS	00000000	LSTMESS#	ADDRESS
START MESSAGE	00000101	00000110000000	11	00000000	00000000	ADDRESS
START ACKNOWLEDGEMENT	00000101	00000111000000	11	00000000	00000000	ADDRESS
DLE MAINTENANCE MESSAGE	10010000	CHARACTER COUNT	11	00000000	00000000	ADDRESS

NOTES:

1. ONLY THE DATA MESSAGE AND THE MAINTENANCE MESSAGE HAVE CHARACTER COUNTS, SO ONLY THESE MESSAGES HAVE THE INFORMATION AND CRC2 FIELDS SHOWN IN THE MESSAGE FORMAT DIAGRAM ABOVE.

2. "RESP #" REFERS TO RESPONSE NUMBER. THIS IS THE NUMBER OF THE LAST MESSAGE RECEIVED CORRECTLY. WHEN USED IN A NEGATIVE ACKNOWLEDGE MESSAGE, IT IS ASSUMED THAT THE NEXT HIGHER NUMBERED MESSAGE WAS NOT RECEIVED, WAS RECEIVED WITH ERRORS, OR WAS UNACCEPTED FOR SOME OTHER REASON. SEE "REASONS."

3. "MESSAGE#" IS THE SEQUENTIALLY ASSIGNED NUMBER OF THIS MESSAGE. NUMBERS ARE ASSIGNED BY THE TRANSMITTING STATION MODULO 256; I.E., MESSAGE 000 FOLLOWS 255.

4. "LSTMESS#" IS THE NUMBER OF THE LAST MESSAGE TRANSMITTED BY THE STATION. SEE THE TEXT DISCUSSION OF REP MESSAGES.

5. " ADDRESS" IS THE ADDRESS OF THE TRIBUTARY STATION IN MULTIPOINT SYSTEMS AND IS USED IN MESSAGES BOTH TO AND FROM THE TRIBUTARY. IN POINT TO POINT OPERATION, A STATION SENDS THE ADDRESS "1" BUT IGNORES THE ADDRESS FIELD ON RECEPTION.

6. "Q" AND "S" REFER TO THE QUICK SYNC FLAG BIT AND THE SELECT BIT. SEE TEXT.

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Figure A-2 DDCMP Message Format in Detail

A-3

Before the message format is discussed in greater detail, the message sequencing system should be explained because most of the header information is directly or indirectly related to the sequencing operation.

In DDCMP, any pair of stations that exchange messages with each other number those messages sequentially starting with message number one. Each successive data message is numbered using the next number in sequence, modulo 256. Thus, a long sequence of messages would be numbered 1, 2, 3,...254, 255, 0, 1,...255. The first message sequence always starts with a number 1, and every sequence thereafter begins with a 0. The numbering applies to each direction separately. For example, station A might be sending its messages 6, 7, and 8 to station B, while station B is sending its messages 5, 6, and 7 to station A. Thus, in a multipoint configuration where a control station is engaged in two-way communication with ten tributary stations, there are 20 different message number sequences involved – one sequence for messages from each of the ten tributaries to the control station, and one sequence for messages from the control station to each of the ten tributaries.

Whenever a station transmits a message to another station, it assigns its next sequential message number to that message and places that number in the sequence field of the message header. In addition to maintaining a counter for the sequentially numbered messages which it sends, the station also maintains a counter of the message numbers received from the other station. It updates that counter whenever a message is received with a message number exactly one higher than the previously received message number. The contents of the received message counter are included in the response field of the message being sent, to indicate to the other station the highest sequenced message that has been received.

When a station receives a message containing an error, that station sends a negative acknowledge (NAK) message back to the transmitting station. DDCMP does not require an acknowledgement for each message, as the number in the response field of a normal header (or in either the special NAK or positive acknowledgement message ACK) specifies the sequence number of the last good message received.

When a station receives a message that is out of sequence, it does not respond to that message. The transmitting station detects this from the response field of the messages which it receives; if the reply interval expires before the transmitting station receives an acknowledgement, the transmitting station sends a REP (reply) message. The REP message contains the sequence number of the most recent unacknowledged message sent to the remote station. If the receiving station has correctly received the message referred to in the REP message (as well as the messages preceding it), it replies to the REP by sending an ACK. If it has not received the message referred to in sequence, it sends a NAK containing the number of the last message that it did receive correctly. The transmitting station then retransmits all data messages after the message specified in the NAK.

The numbering system for DDCMP messages permits up to 255 unacknowledged messages outstanding; a useful feature when working on high-delay circuits such as those using satellites. However, the DMV11 limits the maximum number of unacknowledged messages outstanding to be 127.

A.3 MESSAGE FORMAT

With the above background, it is now time to explore the various DDCMP message formats in full detail, as shown in Figure A-2. The first character of the message is the class of message indicator, represented in ASCII with even parity. There are three classes of messages; data, control, and maintenance. These are indicated by class of message indicators SOH, ENQ, and DLE, respectively. The next two characters of the message are broken into a 14-bit field and a 2-bit field. The 14-bit field is used in data and maintenance messages to indicate the number of characters that follow the header CRC field and form the information part of the message. In control messages, the first eight bits of the 14-bit field are used to designate what type of control message it is; the last six bits are generally filled with zeros. The exception is in NAK messages where the last six bits are used to specify the reason for the NAK. The 2-bit field contains the quick-sync and select flags.

The quick-sync flag is used to inform the receiving station that the message will be followed by sync-characters; the receiver may wish to set its associated synchronous receiver hardware into sync-search mode and sync-strip mode. This reestablishes synchronization and syncs are discarded until the first character of the next message arrives. The purpose of this is to permit the receiving station to engage any hardware sync-stripping logic it might have and prevent it from filling its buffers with sync-characters. The select flag is used to control link management in half-duplex or multipoint configurations where transmitters need to get turned on and off.

Link management is the process of controlling the transmission and reception of data on links where there may be two or more transmitters and/or receivers actively connected to the same signal channels. This is true of half-duplex point-to-point links, as well as full- and half-duplex multipoint links. On half-duplex links, only one transmitter may be active at a time; on full-duplex links, only one slave transmitter may be active on the link at a time.

A station on such a link may transmit when it has been selected or granted ownership of the link. This ownership is passed by use of the select flag existing in all messages. A select flag set in a received message allows the addressed station to transmit after completing reception of the message. The select flag also means that the transmitter ceases transmitting after the message is sent.

The response field contains the number of the last message correctly received. This field is used in data messages and in the positive and negative acknowledge types of control messages. Its function should be evident from the preceding discussion of sequence control.

The sequence field is used in data messages and in the REP type of control message. In a data message, it contains the sequence number of the message as assigned by the transmitting station. In a REP message, it is used as part of the question, "Have you received all messages up through message number (specify) correctly?"

The address field is used to identify the tributary station in multipoint networks and is used in messages both to and from the tributary. In point-to-point operation, each station uses an address of 1.

In addition to the positive and negative acknowledgement and REP types of control messages, there are also start and start acknowledge control messages. These are used to place the station which receives them in a known state. In particular, they initialize the message counters, timers, and other counters. The start acknowledge message indicates that this has been accomplished.

Figure A-2 also shows the maintenance message. This is typically a bootstrap message containing load programs in the information field. A complete treatment of maintenance messages and start-up procedures is beyond the scope of this book.

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NOTE
Refer to the DDCMP specification order (AA-D599A-TC) for a complete detailed description of DDCMP.

</div>

APPENDIX B
FLOATING DEVICE
AND VECTOR ADDRESSES

B.1 FLOATING DEVICE ADDRESSES

UNIBUS and LSI-11 addresses, starting at 760010 and continuing through 763776, are designated as floating device addresses (see Figure B-1). These are used as register addresses for communications (and other) devices interfacing with the PDP-11 (refer to Table B-1).

NOTE

Some devices are not supported by LSI-11; however, the same scheme applies. That is, gaps are provided as appropriate. The convention for assigning these addresses is as follows:

A gap of 10_8 must be left between the last address of one device type and the first address of the next device type. The first address of the next device type must start on a modulo 10_8 boundary. The gap of 10_8 must also be left for devices that are not installed but are skipped over in the priority ranking list. Multiple devices of the same type must be assigned contiguous addresses. Reassignment of device types already in the system may be required to make room for additional ones.

B.2 FLOATING VECTOR ADDRESSES

Vector addresses, starting at 300 and proceeding upward to 777, are designated as floating vectors. These are used for communications (and other) devices that interface with the PDP-11 and VAX-11. Multiple devices of the same type would be assigned vectors sequentially (refer to Table B-2).

NOTE

Some devices are not supported by LSI-11; however, the same scheme applies. Vector size is determined by the device type.

There are no gaps in floating vectors unless required by physical hardware restrictions (in data communications devices, the receive vector must be on a zero boundary and the transmit vector must be on a 4_8 boundary).

```
                                              777 777

         2K        DIGITAL EQUIPMENT
        WORDS      CORPORATION

                   (FIXED ADDRESSES)


                                              770 000
         1K              DR11-C               767 777
        WORDS              ↓
                           ↑
                   USER ADDRESSES             764 000
                                              763 777

         1K                ↑
        WORDS      FLOATING ADDRESSES
                                              760 010
                                              760 006
       DIGITAL EQUIP CORP (DIAGNOSTICS)       760 000
                                              757 777



                                              001 000
                                              000 777
         80
       VECTORS           ↑
                   FLOATING VECTORS
                                              000 300
                                              000 277
         48        TRAP & INTERRUPT
       VECTORS         VECTORS

                                              000 000
```

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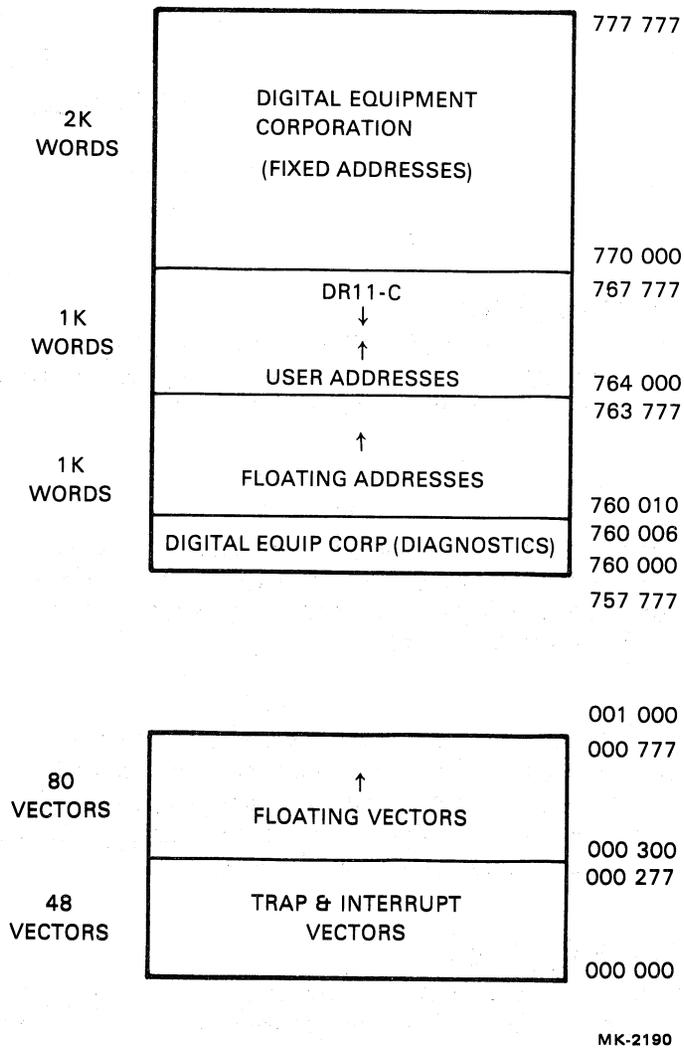
Figure B-1   UNIBUS and LSI-11 Address Map

B-2

Table B-1 Floating CSR Address Devices

Rank	Option	Decimal Size	Octal Modulus
1	DJ11	4	10
2	DH11	8	20†
3	DQ11	4	10
4	DU11	4	10
5	DUP11	4	10
6	LK11A	4	10
7	DMC11/DMR11	4	10
8	DZ11* and DZV11/DZ32	4	10
9	KMC11	4	10
10	LPP11	4	10
11	VMV21	4	10
12	VMV31	8	20†
13	DWR70	4	10
14	RL11 and RLV11	4	10 (extra only)
15	LPA11-K	8	20 (extra only)
16	KW11-C	4	10
17	Reserved	4	10
18	RX11	4	10 (extra only)
19	DR11-W	4	10
20	DR11-B	4	10 (after second)
21	DMP11-AD	4	10
22	DPV11	4	10
23	ISB11	4	10
24	DMV11-AD	8	20

*DZ11E and DZ11F are dual DZ11s and are treated by the algorithm as two DZ11s.
†Starting CSR address must be an even multiple of 20 (octal).

Table B-2 Floating Interrupt Vector Devices

Rank	Option	Decimal Size	Octal Modulus
1	DC11	4	10
2	KL11 (extra)	4	10*
2	DL11-A (extra)	4	10*
2	DL11-B (extra)	4	10
3	DP11	4	10
4	DM11-A	4	10
5	DN11	2	4
6	DM11-BB	2	4
7	DH11 modem control	2	4
8	DR11-A	4	10*
9	DR11-C	4	10*

*The vector for the device of this type must always be on a 10_8 boundary.

Table B-2 Floating Interrupt Vector Devices (Cont)

Rank	Option	Decimal Size	Octal Modulus
10	PA611 (reader & punch)	8	10*
11	LPD11	4	10
12	DT11	4	10*
13	DX11	4	10*
14	DL11-C	4	10*
14	DL11-D	4	10*
14	DL11-E	4	10*
15	DJ11	4	10*
16	DH11	4	10†
17	GT40/VSV11	8	10
18	LPS11	12	10*
19	DQ11	4	10†
20	KW11-W	4	10
21	DU11	4	10*
22	DUP11	4	10*
23	DV and modem control	6	10
24	LK11-A	4	10
25	DWUN	4	10
26	DMC11/DMR11	4	10*
27	DZ11/DZ32/DZV11	4	10*
28	KMC11	4	10
29	LPP11	4	10
30	VMV21	4	10
31	VMV31	4	10
32	VTV01	4	10
33	DWR70	4	10*
34	RL11/RLV11	2	4
35	TS11	2	4 (after the first)
36	LPA11-K	4	10
37	IP11/IP300	2	4
38	KW11-C	4	10
39	RX11/RX211	2	4 (after the first)
40	DR11-W	2	4
41	DR11-B	2	4 (after the first)
42	DMP11-AD	4	10
43	DPV11	4	10
44	ML11	2	4 (MASSBUS device)
45	ISB11	4	10
46	DMV11-AD	4	10

*The vector for the device of this type must always be on a 10_8 boundary.

†These devices can have either a M7820 or M7821 interrupt control module. However, it should always be on a 10_8 boundary.

B.3 EXAMPLES OF DEVICE AND VECTOR ADDRESS ASSIGNMENT

This example has three devices that require device and vector address assignment in the floating address space. The devices are:

- 1 RLV11
- 2 DPV11s
- 1 DMV11

Device (Option)	Device Address	Vector Address	Comment
	760010		Gap left for DJ11
	760020		Gap left for DH11
	760030		Gap left for DQ11
	760040		Gap left for DU11
	760050		Gap left for DUP11
	760060		Gap left for LK11A
	760070		Gap left for DMC11/DMR11
	760100		Gap left for DZ11/DZV11
	760110		Gap left for KMC11
	760120		Gap left for LPP11
	760130		Gap left for VMV21
	760140		Gap left for VMV31
	760150		Gap left for DWR70
RLV11	760160	300	First and only RLV11
	760170		Gap left between RLV11 and next device
	760200		Gap left for LPA11-K
	760210		Gap left for KW11-C
	760220		Reserved
	760230		Gap left for RX11
	760240		Gap left for DR11-W
	760250		Gap left for DR11-B
	760260		Gap left for DMP11
DPV11	760270	310	First DPV11
DPV11	760300	320	Second DPV11
	760310		Gap left between DPV11 and next device
	760320		Gap left for ISB11
DMV11	760340	330	First and only DMV11
	760360		Gap left after last device, in this case the DMV11, to indicate that no other devices follow

C.1 MODEM CONTROL REGISTER FORMATS

The modem signals made available by the DMV11 can be examined or modified by the user program if needed. This supplies the flexibility needed to meet the various modem interface requirements of different countries.

READ MODEM STATUS

BSEL4:

Bit	Name	Description
0	CARRIER	Received line signal detector, commonly referred to as carrier detect, indicates that there is an appropriate audio tone being received from the remote modem. Typically, in full- and half-duplex applications, carrier detect is on whenever the communications line is intact and the remote modem has the signal request to send asserted (the modem is transmitting). This signal is also applicable to the DMV11 integral modem.
1	NOT USED	ALWAYS READ AS ZERO.
2	CLEAR TO SEND	This signal is generated by the local modem to indicate whether or not it is ready to transmit data. Clear to send is the local modem's response to the asserting of request to send. This signal has a slightly different meaning with different modems. With some modems it indicates that the carrier is being received from the remote modem, and, therefore, is an indication that a suitable communications channel exists.
3	MODEM READY	This signal indicates that the modem is ready to operate. The ON condition indicates that the local modem is connected to the communications line and is ready to exchange further control signals with the DMV11. The OFF condition indicates that the local modem is not ready to operate. This signal, when implemented by the modem, is used by the DMV11 to detect either a power-off condition or a cable-related modem malfunction.
4	HALF-DUPLEX	This signal, when asserted, indicates that the DMV11 is in the half-duplex mode. This means that the DMV11 is connected to a communications line designed for transmission in either direction, but not in both directions simultaneously. When cleared, it implies full-duplex operation which is two-way independent transmission in both directions.

Bit	Name	Description
5	REQUEST TO SEND	This signal serves to control the data channel transmit function of the local modem, and on a half-duplex channel, to control the direction of data transmission of the local modem. On a full-duplex channel, the ON condition maintains the modem in the transmit mode, and the OFF condition maintains the modem in the non-transmit mode. On a half-duplex channel, the ON condition maintains the modem in the transmit mode and inhibits the receive mode. The OFF condition maintains the modem in the receive mode. A transition from OFF to ON instructs the modem to enter the transmit mode. The modem responds by taking such action as may be necessary and indicates completion of such actions by asserting clear to send, thereby, indicating to the DMV11 that data may be transferred across the communications channel. A transition from ON to OFF instructs the modem to complete the transmission of all data that was previously transferred to the modem and then assume a nontransmit or receive mode, whichever is appropriate. The modem responds to this instruction by turning OFF the signal clear to send when it is again prepared to respond to a subsequent ON condition of request to send.
6	DATA TERMINAL READY	This signal controls the switching of the local modem to and from the communications line. When asserted, this signal serves to inform the local modem that the DMV11 is ready to operate. This signal also prepares the modem for connection to the communications line and maintains this connection as long as it is ON. When turned OFF, this signal causes the local modem to disconnect after all data previously transferred to the modem has been transmitted. This signal can be used by the local modem to detect a power-off condition in the DMV11 or a cable-related modem malfunction.
7	RING	This signal indicates whether an incoming call signal is being received by the local modem. When ON, this signal indicates that an incoming call (ringing) signal is being received by the local modem. The ON state of ring must appear approximately at the same time as the ON segment of the ringing cycle (during rings) on the communications line. The OFF condition must be maintained during the OFF segment of the ringing cycle (between rings) and at all other times that ringing is not being received. This signal is not affected by the state of data terminal ready.

READ MODEM STATUS

BSEL5

Bit	Name	Description
0	MODE	This bit indicates the operational mode of the line unit. A one indicates character-oriented protocol operation, and a zero indicates bit-oriented protocol operation. The DMV11 initializes this bit to one.

Bit	Name	Description
1	NOT USED	ALWAYS READ AS ZERO.
2	TEST MODE	This signal indicates whether or not the local modem is in a test condition. (This signal applies only to modems that support this feature.) When in the ON condition, this signal indicates to the DMV11 that the local modem has been placed in a test condition. The ON condition can also be in response to either local or remote activation by means of any other modem test condition. Activation of a telecommunications network test condition (for example, facility loopback) that is known to the modem can also cause this signal to be ON. In the OFF condition, this signal indicates that the modem is not in the test mode and is available for normal operation.
3	NOT USED	ALWAYS READ AS ZERO
4	NOT USED	ALWAYS READ AS ZERO
5	NOT USED	ALWAYS READ AS ZERO
6	NOT USED	ALWAYS READ AS ZERO
7	NOT USED	ALWAYS READ AS ZERO

WRITE MODEM CONTROL

BSEL4

Bit	Name	Description
0	NOT USED	
1	SELECT STANDBY	Defaulted to 0 by DMV11 hardware.
2	MAINTENANCE MODE 2	Defaulted to 0 by DMV11 hardware.
3	MAINTENANCE MODE 1	Defaulted to 0 by DMV11 hardware.
4	HALF-DUPLEX	The DMV11 uses this bit to place the line unit into the half-duplex mode. The user program cannot set or clear this bit. The DMV11 can change line characteristics only through the mode definition command. The DMV11 is equipped with a software interlock that prevents simultaneous transmission and reception when in the half-duplex mode. While the transmitter is transmitting, the receiver is disabled from receiving data via a hardware interlock.
5	SELECT FREQUENCY	This signal is used to select the transmit and receive frequency bands of a modem. In the ON condition, the higher frequency

Bit	Name	Description
		band is selected for transmission to the communications channel, and the lower frequency band is selected for reception from the communications channel. When OFF, the lower frequency band is selected for transmission to the communications channel, and the higher frequency band is selected for reception from the communications channel.

NOTE
The modem, if it supports select frequency, must be
set up to ignore this signal from DMV11.

Bit	Name	Description
6	DATA TERMINAL READY	This signal controls switching of the local modem to and from the communications line. When asserted, this signal serves to inform the local modem that the DMV11 is ready to operate. This signal also prepares the modem for connection to the communications line and maintains this connection as long as it is ON. When turned OFF, this signal causes the local modem to disconnect after all data previously transferred to the modem has been transmitted. This signal can be used by the local modem to detect a power-off condition at the DMV11 or a cable-related modem malfunction.
7	NEW SIGNAL	This signal determines whether or not the local modem will rapidly respond to new data on the communications line. This signal is used at control stations in multipoint networks where the remote modems operate in switched-carrier mode. This incoming signal to the control station appears as a series of short message bursts transmitted by each tributary as it responds to the poll from the control station. In order to permit rapid accommodation to signals from several tributaries appearing in quick succession, the control station informs the local modem when a new signal is about to begin by asserting polling for a brief interval. For synchronous systems, clock timing on the incoming message varies from message to message because the remote modems are in no way synchronized to each other. If the time interval between messages is too short, the clock holdover after the end of one message may preclude rapid synchronization on the following message. The use of this signal allows the control station to reset the modem receiver timing recovery circuit, enabling it to respond more quickly to the line signal present after polling has been turned OFF. This signal applies only to modems that support polling.

C.2 RS-449 VERSUS RS-232-C

The most common interface standard in use during recent years is RS-232-C. However, when used in modern communications systems it has critical limitations; the most serious being speed and distance.

For this reason, the interface standard RS-449 was developed to replace RS-232-C. This standard maintains a degree of compatibility with RS-232-C to accommodate an upward transition to RS-449.

The most significant difference between RS-449 and RS-232-C is the electrical characteristics of signals used between the data communications equipment (DCE) and the data terminal equipment

(DTE). The RS-232-C standard specifies only unbalanced circuits, whereas, RS-449 specifies both balanced and unbalanced circuits. The specifications for these two circuit types supported by RS-449 are contained in EIA standards RS-422-A for balanced circuits and RS-423-A for unbalanced circuits. These new standards permit greater transmission speeds and allow greater distance between the DTE and DCE. The maximum transmission speeds supported by RS-422-A and RS-423-A specified circuits vary with circuit length. The normal transmission speed limits are 20K b/s for RS-423-A at 61 m (200 feet) and 2M b/s for RS-422-A also at 61 m (200 feet). These normal transmission speeds can be varied by tradeoffs between speed and distance.

Another major difference between RS-449 and RS-232-C is the specification of two new connectors to accommodate the leads required to support additional circuit functions and the balanced interface circuits. One connector is a 37-pin cinch used to accommodate the majority of data communications applications. The other is a 9-pin cinch for applications requiring secondary channel functions. Some of the new circuits implemented by RS-449 support local and remote loopback testing and standby channel selection.

The transition from RS-232-C to RS-449 will not happen immediately. Therefore, applications that require connection between RS-232-C and RS-449 interfaces must adhere to the limitations of RS-232-C, which specifies a normal transmission speed of 20K b/s at a maximum distance of 15.2 m (50 feet).

DMV11 does not support RS-422-A balanced circuits.

D.1 MODEM CONTROL
There are two levels of modem control available to the DMV11. The first level is provided by the hardware, and the second by the DMV11 microcode.

D.1.1 Hardware Modem Control
The DMV11 provides the following modem control function:

- Prevention of simultaneous transmission and reception in half-duplex mode.

Half-Duplex Mode – When set, HALF-DUPLEX specifies that the DMV11 is in the half-duplex mode. In half-duplex mode, a hardware interlock prevents the DMV11 from transmitting and receiving simultaneously.

NOTE
This hardware lockout prevents the DMV11 from being used in the half-duplex mode on a full-duplex modem with the continuous carrier option installed.

D.1.2 Modem Control Implemented by the DMV11 Microcode
The modem control signals implemented by the DMV11 are:

- Modem ready (data set ready),
- Request to send/clear to send,
- Carrier,
- Data terminal ready, and
- Auto answer.

Each of these signals are outlined in Table D-1.

Once modem ready goes ON, the DMV11 reports any transition from ON to OFF to the user program by issuing a control response containing the code for the system-event modem disconnect. The microcode tests that modem ready is OFF for 10 ms. Transmission is initially inhibited by the microcode by interlocking the signals modem ready and request to send.

Whenever the signal carrier detect is dropped by the modem for greater than 1.28 seconds, the user program is notified by a control response containing the code for the system event modem carrier loss.
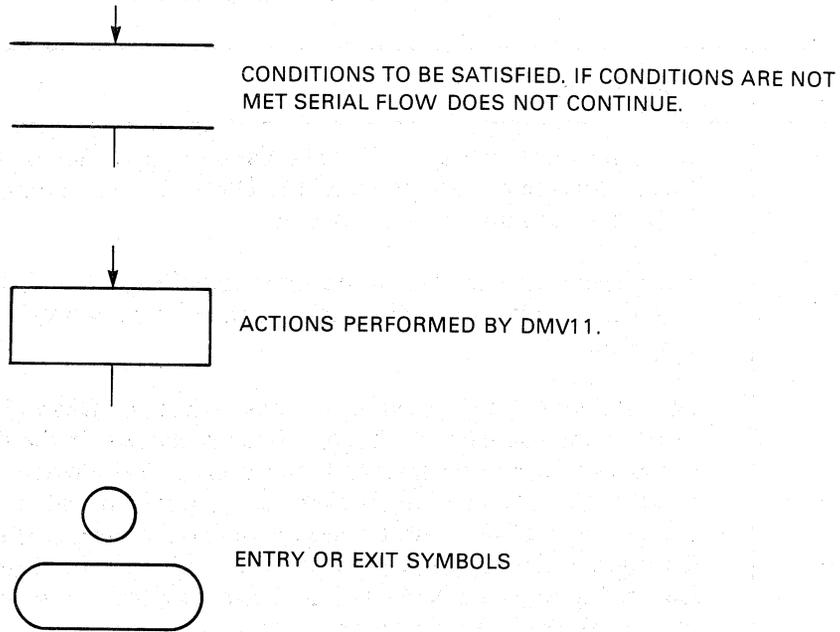
Diagrams are used in the discussion of modem control functions. Refer to Figure D-1 as an aid in interpreting these diagrams. The flow depicted by the diagrams (Figures D-2 through D-8) describes the processing of EIA modem control signals by the DMV11. Each diagram represents a serial flow for a specific modem control function. However, the functions performed, as represented by each diagram, are performed in parallel. The readable and writeable modem signals listed on the diagram for modem status can be read and written through the control command using the request keys read modem status and write mode control.

Table D-1 DMV11 Modem Control Functions

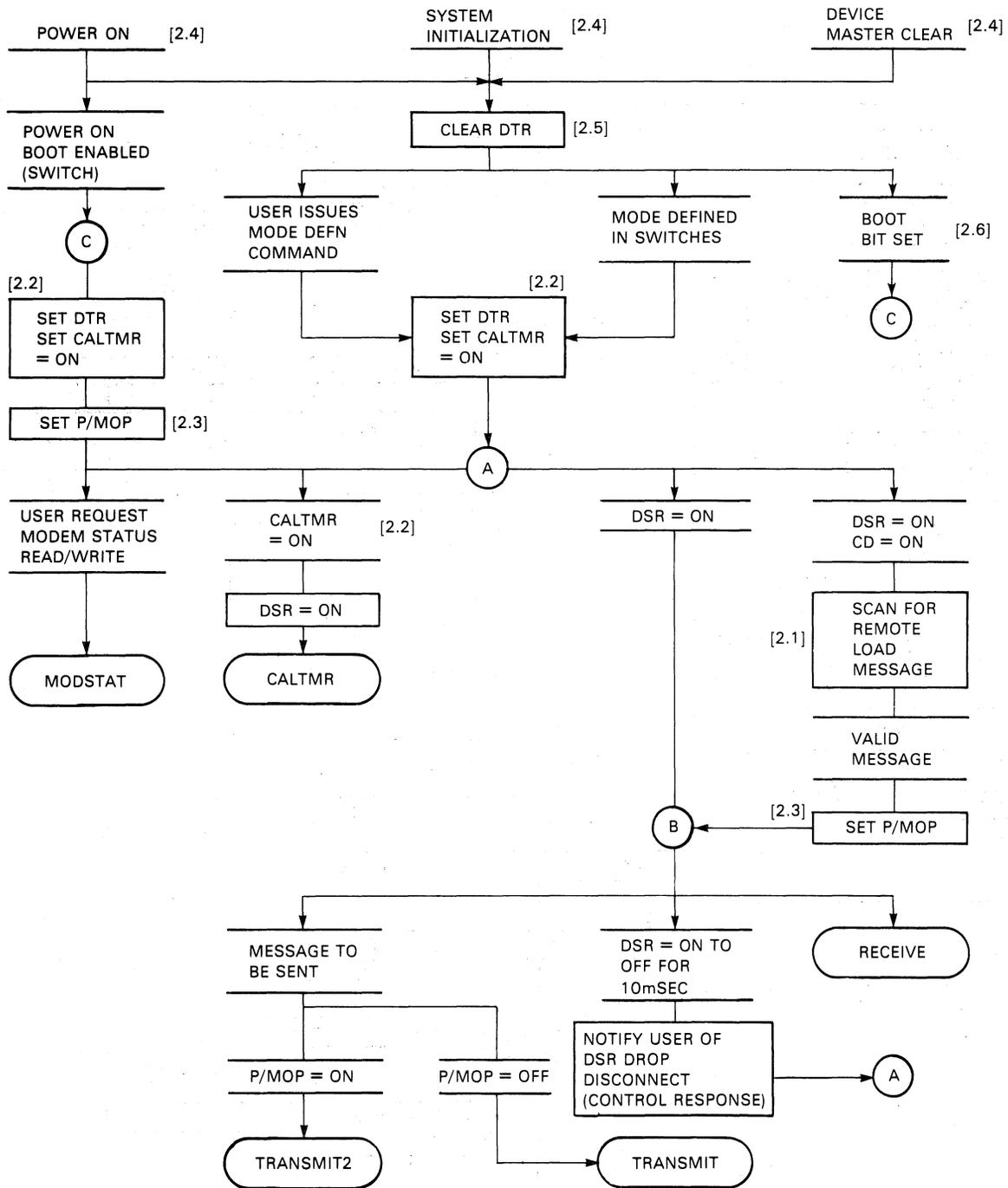| Signal	Description
Data Set Ready–Modem Ready:	Software interlock prevents the DMV11 from transmitting if DSR is not returned. If DSR drops (meaning that it once was asserted) for a period of 10 ms, the transmitter and receiver are resynchronized, the transmitter and receiver sections of the microcode are reset to the idle state to allow the user to return buffers, DTR is then dropped to clear the line (see DTR for reasserting conditions), and the user is then notified of the DSR drop via a control-out for disconnect. Software interlock preventing the DMV11 from transmitting if DSR is not returned: If the DMV11 has been instructed by the user to start up the communications line, and DSR is not asserted, the DMV11 does not transmit. There is no timer started for the first assertion of DSR. It is the responsibility of the user to ensure that the modem is plugged in. Also, if the modem is a dial-up modem, the user should make sure that the number is dialed. In most cases the start command is issued with the intent of waiting for an incoming call. In this case, the timer value is arbitrary so that it has been left up to the user software to determine this timeout. If data terminal ready (DTR) is not asserted because of a past error condition that caused the dropping of DTR (that is, disconnect), the user program may assert DTR via the write modem command to enable transmission.
Request to Send/Clear to Send:	For all applications: Before RTS is asserted (if already asserted this is bypassed) CTS is checked for the "ON" condition. If CTS is "ON", a 10-20 ms timer is started while waiting for CTS to drop. If CTS does not drop within the timer period, constant CTS is assumed and RTS is set. For all applications: Software interlock prevents transmission if CTS is not returned. IF CTS is not returned within 30 seconds (plus or minus 10 ms), a disconnect control-out is queued with a CTS failure code in BSEL7. The transmitter and receiver are resynchronized, the transmitter and receiver sections of the microcode are reset to the idle state to allow the user to return buffers, and DTR is then dropped to clear the line. (See DTR for reasserting conditions). For all applications: During the time that RTS is set, every 10 ms CTS is checked for the "ON" condition. If CTS stays in the "OFF" condition for 30 seconds (plus or minus 10 ms), a disconnect control out is queued with a CTS failure code in BSEL7. The transmitter and receiver are resynchronized, the transmitter and receiver sections of the microcode are reset to the idle state to allow the user to return buffers, and DTR is then dropped to clear the line. (See DTR for reasserting conditions). For all half-duplex applications: The setting of request to send is "ANDED" with the half-duplex bit in the hardware to "blind" the receiver when transmitting.

Signal	Description
Carrier:	Software interlocks prevent transmission in half-duplex if carrier is in the "ON" condition. This prevents the DMV11 from running half-duplex on four-wire constant carrier modems.
	For all applications: Hardware interlock of carrier and the receiver clock stop the USYRT from receiving if carrier were to drop in the middle of a message.
	For all applications: If carrier "drops" while the DMV11 is in the process of receiving the carrier, the loss timer is started. If the carrier loss timer expires (1.28 second interval), the user is notified via a control-out for carrier loss. The receiver is then resynchronized and the receiver micro-code is reset to the waiting state for the next message. If the carrier loss is less than 1.28 seconds (carrier is reasserted before the timeout), the message being received is allowed to finish. If CRC errors are detected (normal case), the protocol recovers from the failure.
Data terminal ready:	DMV11 clears DTR on a power-up bus initialization, and a master clear. This is a hardware function. DTR is not gated from the interface drivers when the DMV11 is placed in loopback mode. DTR is monitored by diagnostics running in internal loopback to ensure that the microcode does not set it.
	When DTR is dropped because of errors, it is only reasserted if any of the following conditions exist: auto answer is enabled or remote load detect is enabled. The code is in the process of power-on boot or request boot.
Auto Answer:	This option is switch selectable. If enabled, the DMV11 asserts DTR and waits for modem ready (DSR). Because of the difference between modems in the U.S. and other countries, ring is not used as an indication that an incoming call has been established. As it stands, DSR is the indication that the call has been established. If a valid DDCMP message is not received within 30 seconds (plus or minus 10 ms) after a connection is established, DTR is dropped (hang up the phone). The connection is considered to be established on assertion of carrier or clear to send. The transmitter and receiver are resynchronized, the transmitter and receiver sections of the microcode are reset to the idle state, and DTR is then reasserted after DSR drops (or in 10 seconds whichever comes first). In this case the user is not notified of the cancelled call. An internal counter is incremented to log the incoming calls (latches at 256) and is available for reading by the user program.

CONDITIONS TO BE SATISFIED. IF CONDITIONS ARE NOT
MET SERIAL FLOW DOES NOT CONTINUE.

ACTIONS PERFORMED BY DMV11.

ENTRY OR EXIT SYMBOLS

MK-2657

Figure D-1   Flow Diagram Symbology

POWER ON [2.4]
SYSTEM INITIALIZATION [2.4]
DEVICE MASTER CLEAR [2.4]

CLEAR DTR [2.5]

POWER ON BOOT ENABLED (SWITCH)

USER ISSUES MODE DEFN COMMAND

MODE DEFINED IN SWITCHES

BOOT BIT SET [2.6]

C

[2.2]

SET DTR SET CALTMR = ON

[2.2]

SET DTR SET CALTMR = ON

C

SET P/MOP [2.3]

A

USER REQUEST MODEM STATUS READ/WRITE

CALTMR = ON [2.2]

DSR = ON

DSR = ON CD = ON

DSR = ON

[2.1]

SCAN FOR REMOTE LOAD MESSAGE

MODSTAT

CALTMR

VALID MESSAGE

B

[2.3]

SET P/MOP

MESSAGE TO BE SENT

DSR = ON TO OFF FOR 10mSEC

RECEIVE

P/MOP = ON

P/MOP = OFF

NOTIFY USER OF DSR DROP DISCONNECT (CONTROL RESPONSE)

A

TRANSMIT2

TRANSMIT

NOTES:
[2.1] REMOTE LOAD DETECT IS A MAINT. DDCMP MESSAGE INITIATING A DOWN LINE LOAD.
[2.2] CALTMR - (CALL TIMER): USED TO DETERMINE IF VALID MESSAGE IS RECEIVED. "ON" INDICATES TIMER RUNNING.
[2.3] P/MOP - PRIMARY MAINTENANCE OPERATION PROTOCOL, REQUESTING REMOTE LOAD.
[2.4] RUN COMPLETE MICRODIAGNOSTICS (MICROPROCESSOR AND LINE UNIT)
[2.5] HARDWARE FUNCTION
[2.6] INVOKE PRIMARY MOP BOOT (BIT FIVE, BSEL 1)
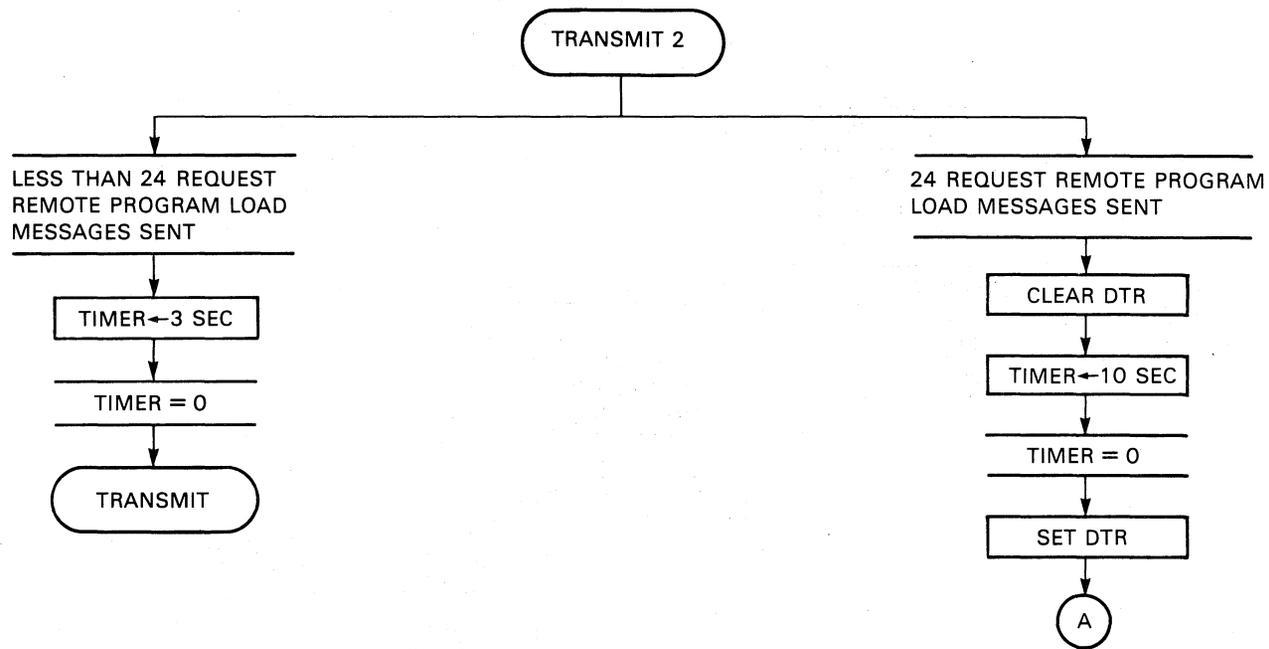
MK-2705

Figure D-2   Modem Control (Start)

D-5
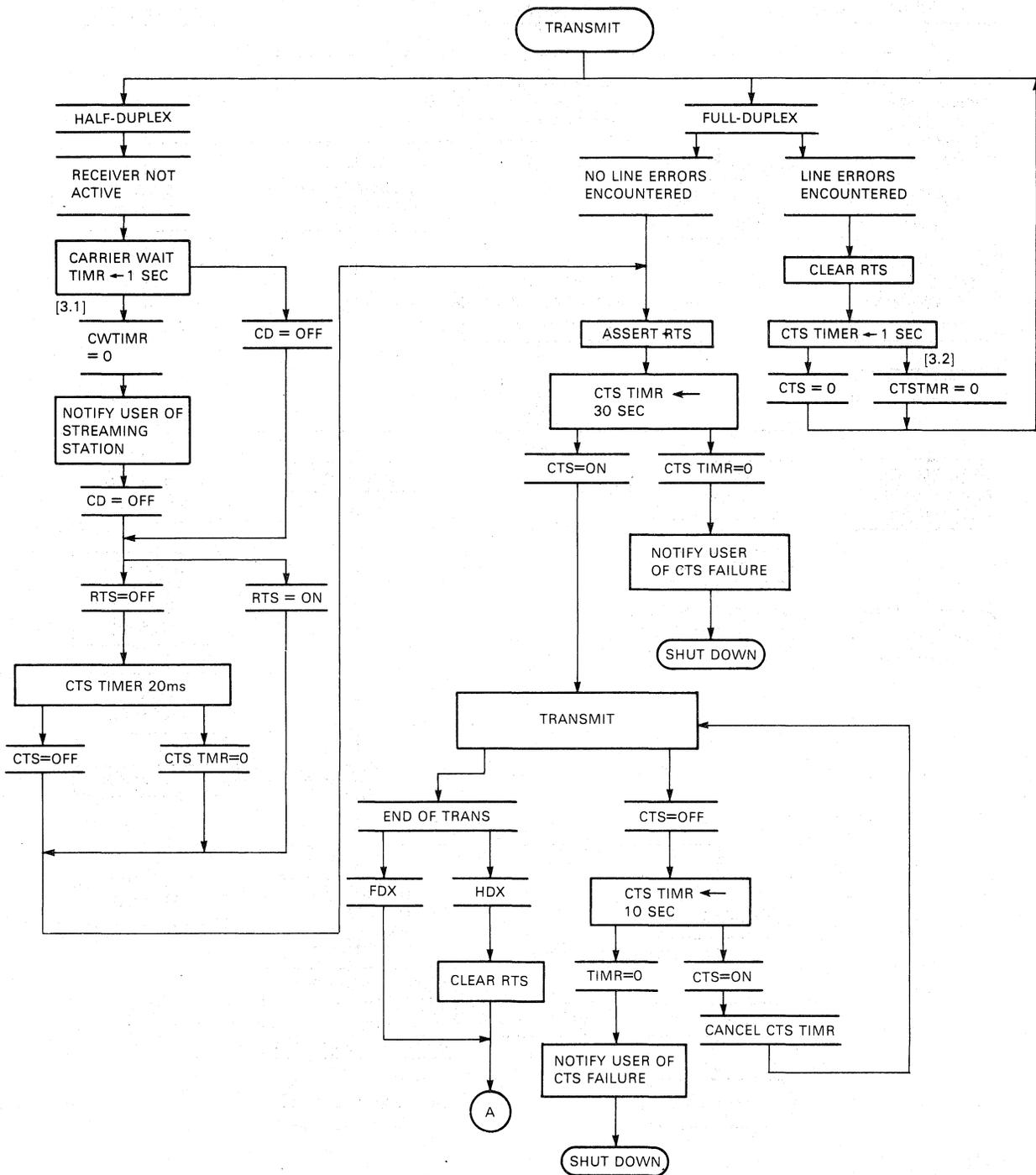
NOTES:
[3.1] CWTIMR -- CARRIER WAIT TIMER. IT DETECTS THE CONDITION WHERE THE LINK WAS NOT RELINQUISHED IN TIME BY THE REMOTE END.
[3.2] CTSTMR -- CLEAR TO SEND TIMER. TIME CLEAR TO SEND GOING AWAY WHEN DROPPING RTS BECAUSE OF LINE ERRORS. FALL-OUT COVERS CONDITION OF CONSTANT CTS MODEMS.
[3.3] IN FULL DUPLEX MODE -- DMP11 ASSERTS RTS CONSTANTLY. RTS IS DROPPED ONLY WHEN THERE ARE LINE ERRORS.
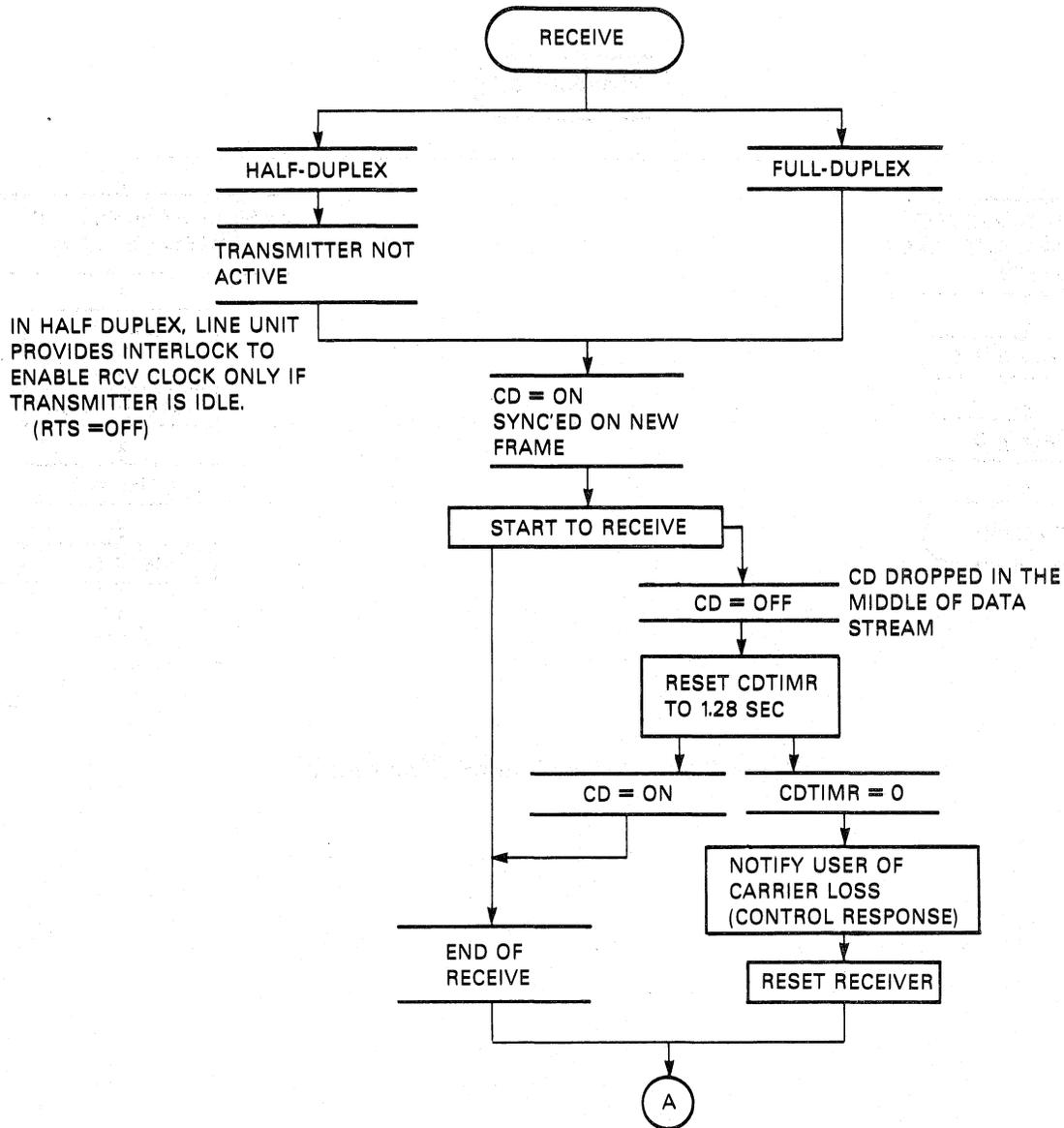[3.4] SOFTWARE INTERLOCK - CONDITION IS SWITCH SELECTABLE FOR CONSTANT CTS MODEMS.
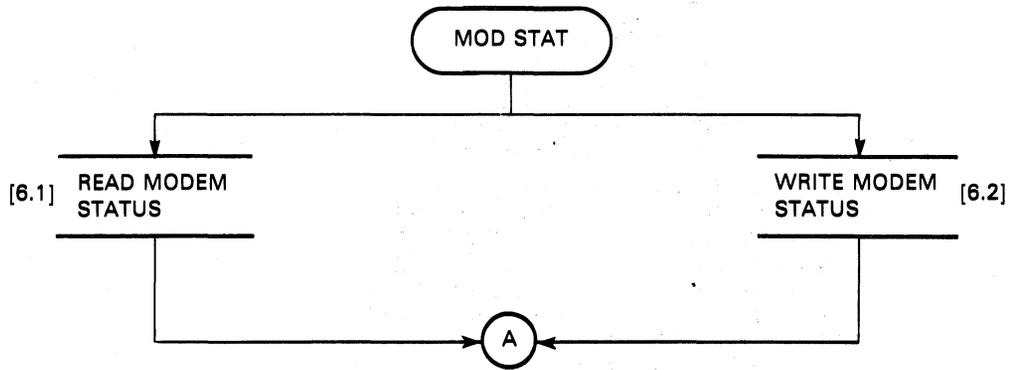
MK-2706

Figure D-3   Modem Control (Transmit)

D-6

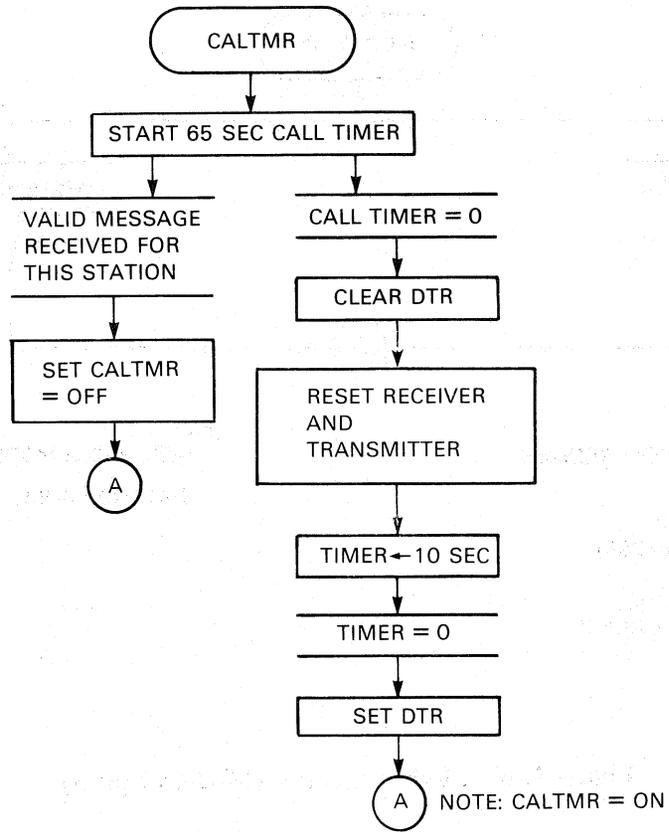Figure D-4   Modem Control (Transmit 2)

Figure D-5   Modem Control (Receive)

MK-2704

```
                    ┌─────────────┐
                    │  MOD STAT   │
                    └──────┬──────┘
              ┌────────────┴────────────┐
              ▼                         ▼
     ─────────────────          ─────────────────
[6.1]  READ MODEM                 WRITE MODEM    [6.2]
       STATUS                     STATUS
     ─────────────────          ─────────────────
              │                         │
              └──────────►( A )◄────────┘
```

[6.1]
  READABLE MODEM SIGNALS:

  CARRIER
  CLEAR TO SEND
  MODEM READY (DSR)
  HALF DUPLEX
  REQUEST TO SEND
  DATA TERMINAL READY
  RING
  TEST MODE
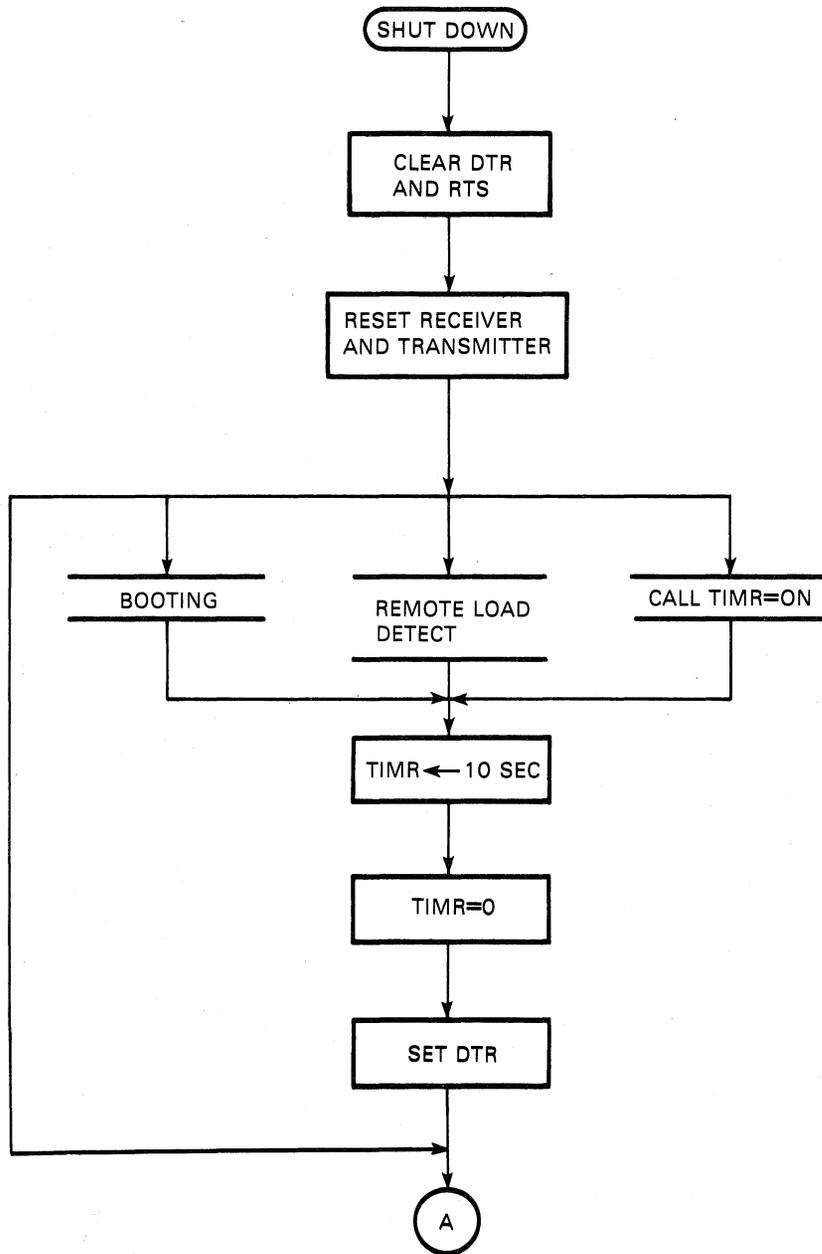
[6.2]
  WRITEABLE MODEM SIGNALS:

  DATA TERMINAL READY

MK-2702

Figure D-6   Modem Control (Modem Status)

Figure D-7   Modem Control (Call Timer)

SHUT DOWN

CLEAR DTR
AND RTS

RESET RECEIVER
AND TRANSMITTER

BOOTING

REMOTE LOAD
DETECT

CALL TIMR=ON

TIMR ← 10 SEC

TIMR=0

SET DTR

A

MK-2655

Figure D-8   Modem Control (Shutdown)

D-11

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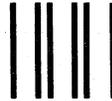**Digital Equipment Corporation
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