XVM UNICHANNEL SOFTWARE MANUAL

DEC-XV-XUSMA-A-D

XVM Systems

digital

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DEC-XV-XUSMA-A-D

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MASSBUS
OMNIBUS
OS/8
PHA
RSTS
RSX
TYPESET-8
TYPESET-10
TYPESET-11

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FIGURES

TABLE

LIST OF ALL XVM MANUALS

The following is a list of all XVM manuals and their DEC numbers, including the latest version available. Within this manual, other XVM manuals are referenced by title only. Refer to this list for the DEC numbers of these referenced manuals.

BOSS XVM USER'S MANUAL	DEC-XV-OBUAA-A-D
CHAIN XVM/EXECUTE XVM UTILITY MANUAL	DEC-XV-UCHNA-A-D
DDT XVM UTILITY MANUAL	DEC-XV-UDDTA-A-D
EDIT/EDITVP/EDITVT XVM UTILITY MANUAL	DEC-XV-UETUA-A-D
8TRAN XVM UTILITY MANUAL	DEC-XV-UTRNA-A-D
FOCAL XVM LANGUAGE MANUAL	DEC-XV-LFLGA-A-D
FORTRAN IV XVM LANGUAGE MANUAL	DEC-XV-LF4MA-A-D
FORTRAN IV XVM OPERATING ENVIRONMENT MANUAL	DEC-XV-LF4EA-A-D
LINKING LOADER XVM UTILITY MANUAL	DEC-XV-ULLUA-A-D
MAC11 XVM ASSEMBLER LANGUAGE MANUAL	DEC-XV-LMLAA-A-D
MACRO XVM ASSEMBLER LANGUAGE MANUAL	DEC-XV-LMALA-A-D
MTDUMP XVM UTILITY MANUAL	DEC-XV-UMTUA-A-D
PATCH XVM UTILITY MANUAL	DEC-XV-UPUMA-A-D
PIP XVM UTILITY MANUAL	DEC-XV-UPPUA-A-D
SGEN XVM UTILITY MANUAL	DEC-XV-USUTA-A-D
SRCCOM XVM UTILITY MANUAL	DEC-XV-USRCA-A-D
UPDATE XVM UTILITY MANUAL	DEC-XV-UUPDA-A-D
VP15A XVM GRAPHICS SOFTWARE MANUAL	DEC-XV-GVPAA-A-D
VT15 XVM GRAPHICS SOFTWARE MANUAL	DEC-XV-GVTAA-A-D
XVM/DOS KEYBOARD COMMAND GUIDE	DEC-XV-ODKBA-A-D
XVM/DOS READERS GUIDE AND MASTER INDEX	DEC-XV-ODGIA-A-D
XVM/DOS SYSTEM MANUAL	DEC-XV-ODSAA-A-D
XVM/DOS USERS MANUAL	DEC-XV-ODMAA-A-D
XVM/DOS V1A SYSTEM INSTALLATION GUIDE	DEC-XV-ODSIA-A-D
XVM/RSX SYSTEM MANUAL	DEC-XV-IRSMA-A-D
XVM UNICHANNEL SOFTWARE MANUAL	DEC-XV-XUSMA-A-D

PREFACE

This manual describes the XVM UNICHANNEL (UNICHANNEL) Software System and its primary component PIREX, the peripheral processor executive.

No attempt is made in this document to describe the various UNICHANNEL hardware instructions; those are explained in the UNICHANNEL-15 System Maintenance Manual. However, examples of instruction sequences will be used when necessary to clarify programming conventions or illustrate important aspects of the UNICHANNEL Software System.

It is recommended that the reader have a thorough understanding of the UNICHANNEL hardware components before attempting to proceed with this manual. The user who plans to use the UNICHANNEL Software System in conjunction with some operating system on the XVM, and not modify it, should gain a thorough understanding of Chapter 1 of this manual. Users who wish to modify the UNICHANNEL XVM Software System should read the UNICHANNEL XVM System Maintenance Manual. In addition, a knowledge of PDP-11 and its assembly language is necessary before attempting UNICHANNEL system modification.

A Glossary is included following the appendices, and should be used to clarify terms not familiar to the reader. Program flow charts are also included in this manual to aid the user in understanding the logic flow.

The following documents also pertain to the UNICHANNEL System:

MAC11 XVM Assembler Language Manual
XVM/DOS Users Manual
XVM/DOS System Manual
XVM UNICHANNEL Software Manual
Instruction List for the PDP-15
XVM Systems Reference Manual
XVM/DOS V1A System Installation Guide
RK11-E Controller Manual DEC-11-HRKA-B-D

CHAPTER 1

INTRODUCTION

1.1 XVM UNICHANNEL SOFTWARE COMPONENTS

The XVM UNICHANNEL Software System consists of the following four components:

1. XVM/PIREX
2. SPOL11
3. MAC11
4. ABSL11

1.1.1 XVM/PIREX

XVM/PIREX (peripheral executive), a component of the XVM UNICHANNEL (UC15) Software System, is described in Chapters 3 and 4 of this manual. XVM/PIREX (PIREX) is a multiprogramming peripheral processor executive executed by the PDP-11. It is designed to accept any number of requests from programs on the DIGITAL XVM (XVM) or PDP-11 and process them on a priority basis while processing other tasks concurrently (e.g., spooling other I/O requests). PIREX services all input/output requests from the XVM in parallel on a controlled priority basis. Requests to busy routines (tasks) are automatically entered (queued) onto a waiting list and processed whenever the task in reference is free. In a background environment, PIREX is also capable of supporting up to four priority-driven software tasks initiated by the XVM or the PDP-11.

1.1.2 SPOL11

Spooling is a method by which data to and from slow peripherals is buffered on an RK05 disk. Spooling allows the XVM to access and output data at high speed, freeing more of its time to do computation. Programs that do a great deal of I/O, especially printing and plotting, are not required to be core resident to complete the entire job. This frees the computer to quickly advance to more jobs, dramatically increasing the throughput of the entire system. The SPOL11 task permits simultaneous spooling of line printer and plotter output, and card reader input. The capacity of the spooler is user-defined with a possible maximum of over 1,800,000 characters allowed.

1.1.3 MAC11

MAC11 is a special version of the standard MACRO-11 assembler available on the traditional PDP-11 computer system. This program is executed as a task under the PIREX Executive. It is used to conditionally-assemble various components of the UNICHANNEL Software System. Since this assembler is a subset of MACRO-11, programs assembled under MACRO-11, will not necessarily assemble under MAC11. In addition, programs written and assembled under MAC11 will not necessarily operate correctly on other PDP-11 systems. MAC11 produces assembly listings and absolute binary paper tapes as outputs. Detailed information concerning MAC11 can be found in the MAC11 XVM Assembler Language Manual.

1.1.4 ABSL11

ABSL11 is a XVM Hardware Read In Mode (HRM) paper tape program used to bootstrap-load the UNICHANNEL peripheral processor with MAC11-generated absolute binary paper tapes. While primarily designed to load the PIREX executive into the PDP-11 memory, ABSL11 may be used to load any absolute program into the PDP-11 and optionally start it. Additional information on ABSL11 may be found in Chapter 2 of this manual.

1.1.5 UNICHANNEL Support Programs

1.1.5.1 Spooler Disk Area Generation (SPLGEN) - SPLGEN allows the user to dynamically create or alter the RK disk area used by the UNICHANNEL spooler on any RK disk unit (0 through 7).

1.1.5.2 Spooler Installation Program (SPLOAD) - SPLOAD allows the user to install, on the system disk, the SPOL11 paper tape produced by MAC11.

1.1.5.3 XVM Spooler Control Program (SPOOL) - SPOOL (SPOL15) is used to initiate or terminate UNICHANNEL spooling using any RK disk unit which has been previously prepared for spooling by SPLGEN.

1.1.5.4 XVM MAC11 Control Program (MAC11) - MAC11 (MACINT) is used to initiate, perform Input/Output for, and terminate the MAC11 assembler.

1.1.5.5 MCLOAD - MCLOAD allows the user to install on the system disk, the MAC11 paper tape produced as a part of the XVM/DOS build process.

1.1.6 System Software Modification

The complete UNICHANNEL Software System may be modified or expanded by the user when running under XVM/DOS or XVM/RSX programming systems. A common editor, called EDIT, allows source changes to the XVM or PDP-11 software. MACRO XVM, the MACRO XVM Assembler, and MAC11, a PDP-11 MACRO Assembler allow new object code to be generated. Both the MACRO XVM and MAC11 assemblers are powerful MACRO assemblers that facilitate easy code generation and source readability.

1.2 UNICHANNEL HARDWARE SYSTEM

The UNICHANNEL hardware (see Figure 1-1) consists of a PDP-11 minicomputer used as an intelligent peripheral controller for the larger XVM main computer. The XVM functions as the master processor by initiating and defining tasks while the PDP-11 peripheral processor functions as a slave in carrying out these tasks. In order to effectively operate, with a minimum of interference with the master processor, the peripheral processor uses its own local memory of between 8,192 and 12,288 16-bit words. Since peripheral control requires only a fraction of the peripheral processor resources, the remainder of the processor's resources can be used for parallel processing of background tasks.

1.2.1 Common Memory

Common memory is that memory directly accessible to both the master processor - the XVM, and the peripheral processor - the PDP-11. Thus common memory occupies the upper portion of the PDP-11 address space and at the same time the lower portion of the XVM address space. The UNICHANNEL System allows any Non-Processor Request device on the UNIBUS to access XVM memory so that data can be transferred between I/O devices and common memory.

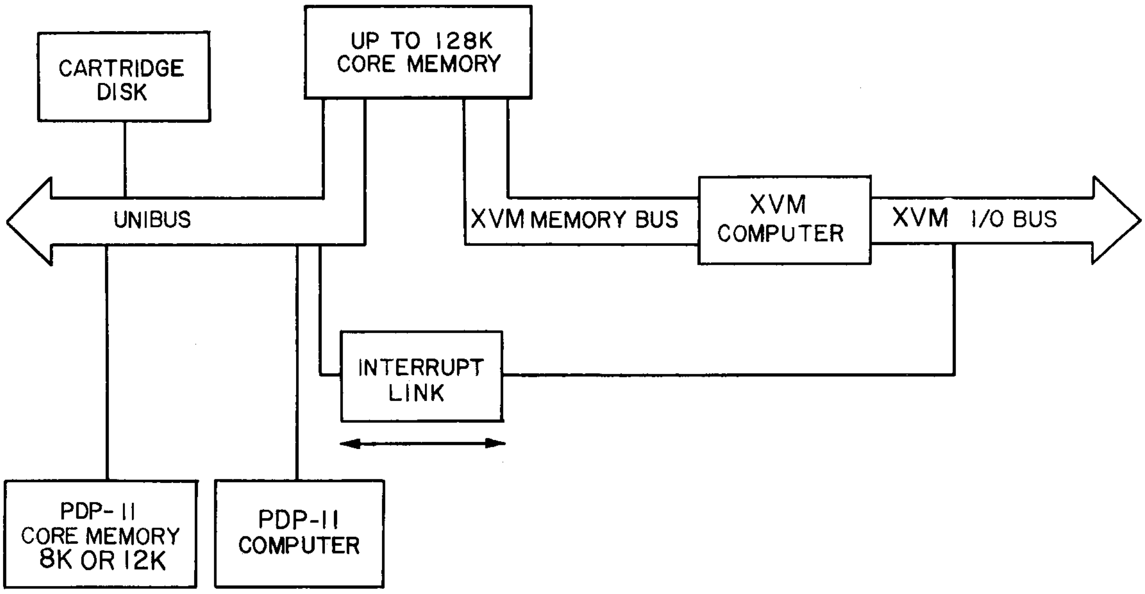


Figure 1-1
UNICHANNEL Hardware System

The use of common memory allows ease of data transfer between XVM memory and secondary storage (disk, magnetic tape, etc.). The PDP-11 peripheral processor can access a maximum of 28K of memory. Table 1-1 shows the amount of Common memory accessible to a PDP-11 processor with a given amount of Local memory.

Table 1-1
Common Memory Sizes

PDP-11 LOCAL MEMORY SIZE	COMMON MEMORY SIZE
8K	20K
12K	16K

The UNIBUS can address the combined XVM/PDP-11 memory, which can extend to a maximum of 124K. For instance, the RK05 and its disk controller can transfer information to or from a location outside of the common memory region. Figure 1-2 outlines a typical memory map of the XVM and PDP-11, illustrating the common shared memory address space and the PDP-11 local memory.

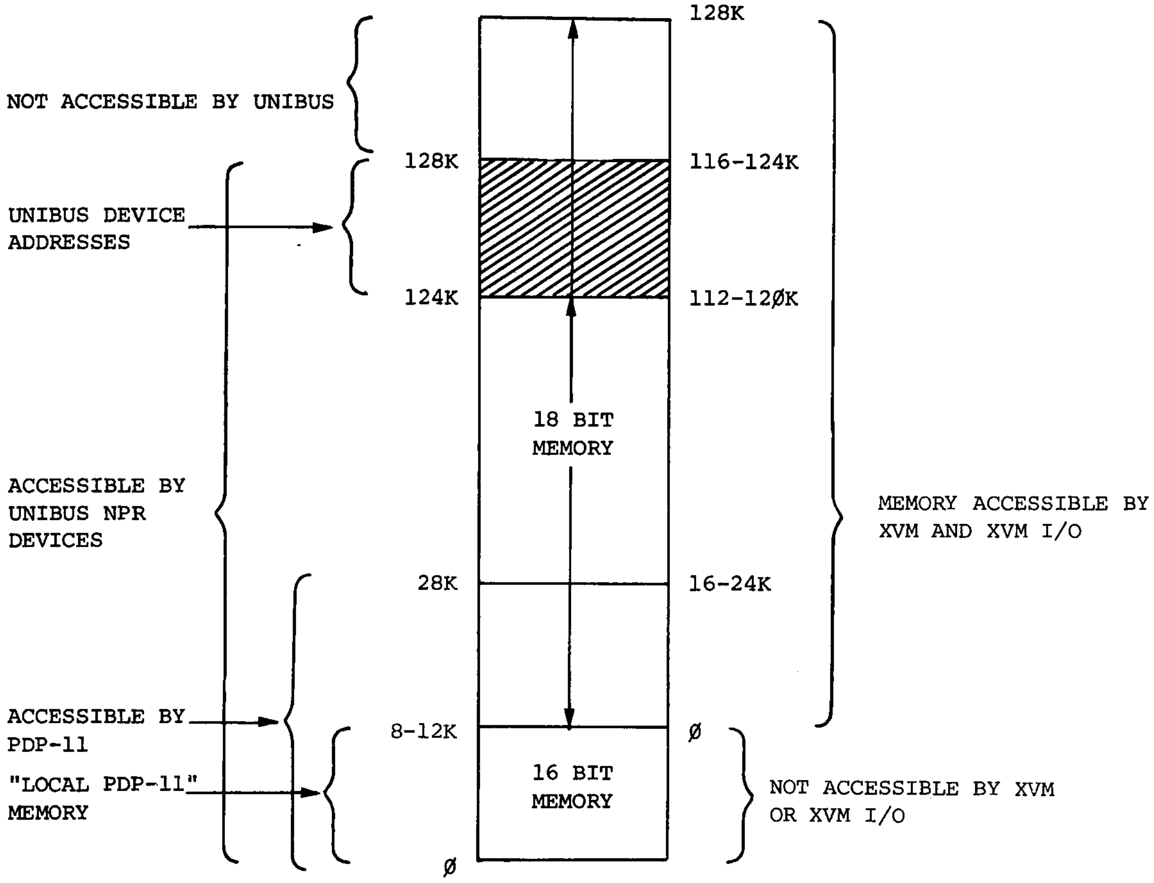


Figure 1-2
Memory Map of a UNICHANNEL System

1.2.2 Interrupt Link

The XVM central processor and the peripheral processor communicate with each other through device interfaces. When the XVM initiates a new task, it interrupts the peripheral processoı with a message. The message is designated as a Task Control Block Pointer (TCBP) and points to a table (Task Control Block) in common meinory where the task is defined. The peripheral processor performs the task and can signify its completion by sending an optional interrupt back to the XVM.

1.2.3 Peripheral Processor Hardware

The UNICHANNEL System in its standard configuration consists of the following equipment (Figure 1-3):

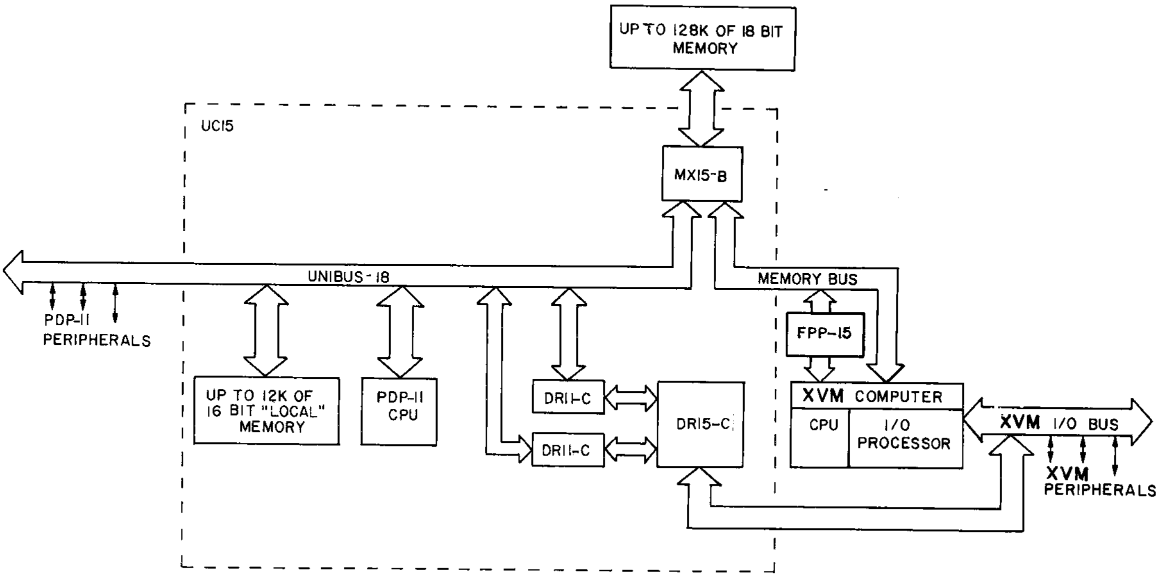


Figure 1-3
UNICHANNEL System

- PDP-11 Peripheral Processor
- DR15-C Device Interface
- Two DR11-C Device Interfaces
- XM15 Memory Bus Multiplexer
- 8192 or 12288 Words of 16-Bit Local Memory

The PDP-11, which functions as the peripheral processor, can itself only process 16-bit words but controls peripherals that can process 18-bit words to provide compatibility with the XVM. The DR15-C and the two DR11-C Device Interfaces provide the communication facility between the XVM and the PDP-11. The XVM can interrupt the PDP-11 and send a data word (TCBP) to the PDP-11; this interrupts the PDP-11 at priority level 7 (the highest priority level) and causes a trap thru location 310_8. The PDP-11, serving as a peripheral processor, can interrupt the XVM to indicate an error condition or job completion at any one of 128 API vector locations at any one of four API priorities.[1] The XM15 Memory Bus Multiplexer functions as a memory bus switch to allow either the XVM or the PDP-11 to communicate with the common memory. The XM15 also provides the PDP-11 with the capability of performing byte instructions which reference XVM memory.

[1] This applies to systems with the API option - systems without API can use four skip instructions, corresponding to the four hardware priority levels, to determine the nature of the interrupt.

CHAPTER 2
LOADING AND EXECUTION

2.1 INTRODUCTION

This chapter explains how to get the DEC-supplied XVM UNICHANNEL Software System up and running. In addition, a list of the UNICHANNEL software components used in the various XVM monitor systems is included. For information on how to tailor the system to a specific configuration, see the XVM/DOS System Installation Guide.

2.2 LOADING THE SYSTEM

The UNICHANNEL system is activated by using ABSL11 to load the PIREX executive into the PDP-11 UNICHANNEL local memory. XVM/DOS is then bootstrapped and the system is ready to:

1. Continue running under XVM/DOS
2. Begin execution of BOSS XVM
3. Begin execution of XVM/RSX

2.2.1 ABSL11

ABSL11 is an XVM absolute binary paper tape program which is read into the XVM at location 17700_8 via the Hardware Read In Mode (HRM) on the XVM. It is used to load PDP-11 absolute binary paper tape on to the PDP-11. This self starting program is written in MACRO XVM and octal. (The PDP-11 code is written in octal and assembled with MACRO XVM.)

Load ABSL11 from the XVM High Speed Reader. XVM will then halt. Start the PDP-11 from its console switches at 140000. Note that the previous (DOS V3A) start addresses for ABSL11 can also be used. Once the PDP-11 is running, load the PDP-11 tape into the XVM High Speed Reader. Depress the Continue Switch on the XVM, and the paper tape will read in. Each data frame from the paper tape is transferred into the PDP-11 as soon as it is read. At the end of the tape, XVM will halt with the AC register equal to zero. If the paper tape has a start address, the

PDP-11 will begin execution at that address. If the paper tape does not have a start address, the PDP-11 will halt. To load another tape, place it in the XVM High Speed Reader, and continue both machines.

Checksum errors are detected by the XVM and result in a halt with all l's in the AC register. The checksum error may be ignored by depressing the CONTINUE switch on the XVM.

2.2.2 Loading ABSL11, XVM/PIREX, and XVM/DOS

The following is a step-by-step description of how ABSL11, XVM/PIREX, and XVM/DOS are loaded.

1. Place the ABSL11 paper tape into the XVM paper tape reader. The paper tape reader ON/OFF switch must be in the ON position.
2. Verify that the RK05 Disk Cartridge is loaded into drive and:
   a. The LOAD/RUN switch is in the RUN position.
   b. The write ENABLE/PROTECT switch is in the ENABLE position.
3. Press the HALT switch on the PDP-11 UNICHANNEL console.
4. On the XVM console, set the address register switches to 17700 (octal), then press STOP and RESET simultaneously.
5. On the XVM console, press READ IN. The ABSL11 paper tape should read in.
6. When the paper tape reader stops, observe the XVM accumulator (AC) using the proper setting of the rotary register selector and register select switch on the XVM console.
   a. If the AC is 0, proceed to step 7.
   b. If the AC is not 0, retry starting at step 1. (If this fails consistently, there is either a bad ABSL11 paper tape or a hardware problem.)
7. On the PDP-11 UNICHANNEL console, load the starting address 140000 for the PDP-11 portion of ABSL11 into the switch registers:

   Then press the PDP-11 LOAD-ADR switch
8. On the PDP-11 UNICHANNEL console, raise the HALT/ENABLE switch to the ENABLE position and then press the START switch. The PDP-11 RUN light should now be on.
9. Remove the ABSL11 paper tape from the reader and place the PIREX paper tape into it.
10. On the XVM console, press the CONTINUE switch. PIREX paper tape should read in.

11. Remove the PIREX paper tape and verify that the bit 0 and RUN lights on the PDP-11 UNICHANNEL console are lit. This is an indication that PIREX is running.

12. Load the XVM/DOS Bootstrap tape (hardware read in mode tape) into the Paper Tape Reader.

13. Set Address Switches on the XVM Console to

    a. 77637_8 for a 32K or more XVM

    b. 57637_8 for a 24K XVM

14. On the XVM Console, press simultaneously STOP and RESET.

15. On the XVM Console, press the READ IN switch. The XVM/DOS Bootstrap tape should read in.

16. XVM/DOS should announce itself. If not, check that the console terminal is powered up, is ONLINE and not out of paper. Also check that the correct disk cartridge was loaded into RK unit 0.

2.3 PERIPHERAL OPERATION

2.3.1 Disk Cartridge

On the front of the disk cartridge unit there are two (optionally a third, ON/OFF) toggle switches, RUN/LOAD, and WRITE/PROT. To load the disk, press ON (if present) and LOAD. Pull the door open. Pick up the cartridge by the molded hand-grip, metal side down, horizontal, and slide gently into the path between the wire guides. Shut the door. Put the LOAD/RUN switch into the RUN position. In about 10 seconds, the two lights, RDY and ON CYL will come on, indicating that the cartridge is ready. To unload the disk, place the toggle switch on LOAD. Wait for about 30 seconds until the LOAD light is on. At this time, the drive will release the cartridge with a noticeable'click', only then open the door and pull the cartridge out.

WARNING

> Do not turn off the drive while unloading (if drive has an OFF-ON toggle).

2.3.2 Plotter

Unlike the XY311, the XY11 does not have an offline switch. In order to be able to indicate the XY11 plotter off-line condition, provision is made in the software through the PDP-11 console switches. By setting bit '2' of the console data/address switches in the up/on position ('l' state) the plotter can be put in the off-line mode. This is made possible by the plotter device driver task in PIREX, which monitors this bit before initiating each plotter I/O requests. Once the plotter problem condition (e.g., out of paper) has been corrected, plotting will continue automatically when bit '2' of the console switches is reset to zero (down position).

The user is provided with the capability of halting the output on the plotter at the end of current file in the spooled mode. This is done through bit '3' of the PDP-11 console switches. By setting bit '3' of the console data/address switches in the up/on position ('l' state) output on the plotter can be halted at the end of current file. The plotter driver task in PIREX provides this facility by monitoring this bit before initiating each plotter I/O requests. After performing the necessary operations on the plotter, output can be resumed by setting bit '3' of the console switch in the down/off position ('0' state).

2.3.3 Card Reader

For the purposes of spooling, a card with ALT MODE, ALT MODE in columns 1 and 2 is used as an end-of-deck card. The handler throws away such cards, continuing on to the next card, so that the XVM program using the handler never sees this card. This card is used to force data from a partially filled internal spooler buffer onto the disk where it can be despooled to the XVM.

2.3.4 Line Printer

Output to the Line Printer can be halted at the end of current file in the spooled mode. This is done through bit 'l' of the PDP-11 console switches. By setting bit 'l' of the console data/address switches in the up/on position ('l' state), outputs on the line printer can be halted at the end of current file. The Line Printer driver task in PIREX provides this facility by monitoring this bit before indicating completion of .CLOSE I/O request processing. After performing the necessary operations on the line printer, output can be resumed by setting bit 'l' of the console switch in the down/off position ('l' state).

2.4 ERROR HANDLING

Within the PIREX system, the device drivers on the PDP-11 side handle errors by placing error condition indicators in a table in PIREX. On the XVM side, a "poller" (part of the resident monitor of the operating system) periodically searches the table to see if any error messages are to be printed. In almost all cases the recovery is automatic when the error condition is rectified. See Appendix C for a list of UC15 related error messages.

2.4.1 Disk Cartridge Errors

Disk cartridges must be positioned properly during loading operations. Improper positioning of the cartridge can result in a drive not ready condition.

This condition can be eliminated in most instances by unloading the cartridge, repositioning it properly and reloading the cartridge.

The above operations should be repeated a few times before reporting the problem to your field service representative. Do not force the cartridge into or from position during the loading or unloading operation.

2.4.2 Card Reader Errors

The system divides card reader errors into two groups: hardware and software. A hardware error is a hardware read error (pick check, card jam, etc.) or an illegal punch combination. A software error is a supply error (hopper empty, stacker full) or an off-line condition.

For all hardware errors, the card causing the error will be on the top of the output stack. With most hardware errors, the card reader will stop, and a requisite light (i.e., pick check) will light on the reader. Remove the card, repair or replace it, and put it on the front of the input stack. Press the RESET button. The driver receives an interrupt when the device becomes ready again and will restart automatically.

For software errors, the card in the output hopper has already been read. It is merely necessary to fix the supply error and press the RESET button. Note that the card reader can be stopped by pressing the OFF-LINE button. To restart, press the RESET button.

Illegal punch combination (IOPSUC CDU 72) and card column lost (IOPSUC CDU 74) are exceptions to all other errors because in these cases alone, the card reader will stop, remain on line, and no diagnostic light will be lit. The card causing the error will be in the top of the output hopper. (Mangled cards may cause an illegal punch combination error.) Press the OFF-LINE button, repair or replace the faulty card, put it on the front of the input stack, and press the RESET button to restart.

2.4.3 Spooler Errors

During spooling operations, any unrecoverable disk error will result in the automatic termination of SPOOLing. Unrecoverable disk errors include:

> The attempt by the spooler to read/write a bad block on the disk cartridge.
>
> Setting the disk cartridge off line while SPOOLing is enabled. (This is detected even if no Input/Output to the disk cartridge is underway.)

The spooler is disconnected from PIREX upon the occurence of either of the above errors. The user may restart the spooler by issuing the XVM/DOS "SPOOL" command.

2.5 TASK CRASHES

During program development under PIREX on the PDP-11, the task under development may crash. Such crashes may not be apparent unless the PDP-11 halts, because PIREX keeps both the RUN light and bit 0 lit as if no problem existed.

2.6 UNICHANNEL RELATED SOFTWARE COMPONENTS

2.6.1 UC15 Components

NOMENCLATURE	SOURCE FILE NAME	BINARY FILE NAME
PIREX Executive	PIREX XXX	PIREX paper tape
SPOOLER	SPOL11 XXX	SPOOL ***
PDP-11 Absolute Loader	ABSL11 XXX *	ABSL11 paper tape
MAC11 Assembler	Special DOS-11 Tape**	MAC11 ***

2.6.2 XVM/DOS Components

NOMENCLATURE	SOURCE FILE NAME	BINARY FILE NAME
XVM SPOOLER Component	SPOL15 XXX	SPOOL ***
SPOOLER Disk Area Allocation	SPLGEN XXX	SPLGEN BIN
SPOOLER Image Loader	SPLIMG XXX	SPLOAD BIN
MAC11 XVM Component	MACINT XXX	MACINT ABS
MAC11 Image Loader	MACIMG XXX	MCLOAD BIN
DOS Resident Monitor	RESMON XXX	RESMON ****
DOS Non-Resident Monitor	DOSNRM XXX	DOS15 ****

NOMENCLATURE	SOURCE FILE NAME	BINARY FILE NAME
XVM LP11/LS11/LV11 Line Printer Handler	LPU. XXX	LPA. BIN
XVM XY11/XY311 Plotter Handler	XYU. XXX	XYA. BIN
XVM CR11 Card Reader Handler	CD.DOS XXX	CDB. BIN ****

[*] ABSL11 requires a special assembler, that is not available as a supported product. Assembly of ABSL11 with the standard MACRO XVM Assembler produces a paper tape with a load address of 17720.

[**] The MAC11 source is a PDP-11 DEC tape that must be assembled and linked under DOS/BATCH-11. This tape is not available as a part of the XVM/DOS kit.

[***] SPOL11 and MAC11 are combinations of XVM and PDP-11 code segments.

[****] These routines are versions of standard DOS-15 source files - created using special assembly parameters - see the XVM/DOS VIA System Installation Guide.

2.6.3 XVM/RSX Components

NOMENCLATURE	SOURCE FILE NAME	TASK NAME
RK05 Cartridge Disk File Handler	RFRES XXX	RK ....
Disk File Handler Overlay	RFOPEN XXX	RK ....
Disk File Handler Overlay	RFCLOS XXX	RK ....
Disk File Handler Overlay	RFREAD XXX	RK ....
Disk File Handler Overlay	RFDLET XXX	RK ....
Disk File Handler Overlay	RFCREA XXX	RK ....
Line Printer Handler	LP.XX SRC	LP ....
Card Reader Handler	CD.... XXX	CD ....
UNICHANNEL Poller	POLLER XXX	.POLLER
Plotter Handler	XY.XX SRC	XY ....
Executive	RSX.P1 XXX and RSX.P2 XXX	NA

CHAPTER 3
SYSTEM DESIGN AND THEORY OF OPERATION--PIREX

This chapter describes the design and theory of operation of the XVM UNICHANNEL Peripheral Processor Executive. Knowledge of this information is necessary to successfully modify the XVM UNICHANNEL Software System. Chapter 4 will discuss techniques for modification of the PIREX system.

3.1 PIREX--PERIPHERAL EXECUTIVE

PIREX is a multiprogramming peripheral processor executive designed to provide device driver support to operating systems on the DIGITAL XVM main-processor. PIREX is designed to be as independent of the particular XVM operating system as possible, executing in conjunction with XVM/DOS, BOSS XVM, or XVM/RSX. The PIREX Software System is designed to maximize flexibility and expandability and to minimize system overhead and complexity. To accomplish this, special software and hardware features are designed into the system.

3.1.1 PIREX-An Overview

PIREX is loaded from the XVM high-speed reader into the PDP-11 local memory and automatically started. Once running, PIREX is capable of accepting multiple requests and directives from the XVM or PDP-11 and processing them on a controlled-priority basis. Task requests are automatically queued (see Figure 3-1) and processed whenever the task in reference is free . When a particular device or routine completes the processing of a request, status information (e.g., parity or checksum errors, transfer OK, etc.) is passed back to the caller.

At the completion of a XVM request, an optional hardware interrupt is initiated in the XVM on any one of 128 possible API trap locations and at any one of 4 hardware API levels if requested. Since the software completely determines which interrupt vector and level to use when completing XVM requests, the routines initiating the interrupts could actually be software routines used to simulate hardware conditions or

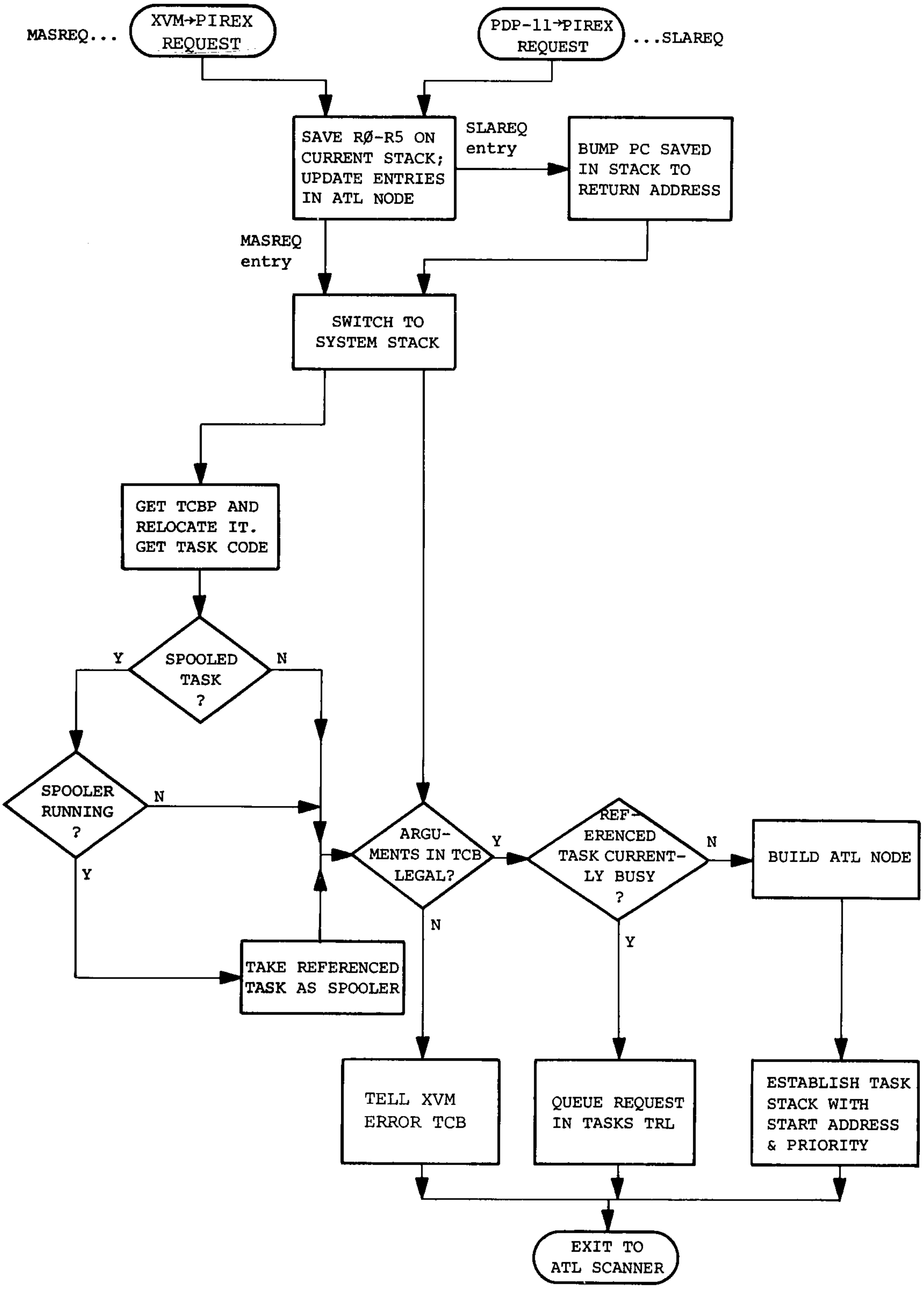

MASREQ...
XVM→PIREX REQUEST
PDP-11→PIREX REQUEST
...SLAREQ
SAVE RØ-R5 ON CURRENT STACK; UPDATE ENTRIES IN ATL NODE
SLAREQ entry
BUMP PC SAVED IN STACK TO RETURN ADDRESS
MASREQ entry
SWITCH TO SYSTEM STACK
GET TCBP AND RELOCATE IT. GET TASK CODE
SPOOLED TASK ?
Y
N
SPOOLER RUNNING ?
N
Y
TAKE REFERENCED TASK AS SPOOLER
ARGU-MENTS IN TCB LEGAL?
Y
N
REF-ERENCED TASK CURRENT-LY BUSY ?
N
Y
BUILD ATL NODE
TELL XVM ERROR TCB
QUEUE REQUEST IN TASKS TRL
ESTABLISH TASK STACK WITH START ADDRESS & PRIORITY
EXIT TO ATL SCANNER

Figure 3-1
Basic Flow Chart of XVM/PDP-11 Request Processing

just software tasks. If the request is issued from the PDP-11, the user may request an optional software interrupt after completion of the current request.

3.1.2 PIREX Services

The PIREX executive consists of modules that provide support for multiple I/O oriented tasks operating asynchronously with each other. In addition, support is provided for other background tasks such as MAC11. The services provided to tasks operating under PIREX include:

- Context switching - transferring control of the PDP-11 Central Processing Unit (CPU) from one task to another.
- Interprocessor communication - receiving requests for service from, and, sending results to the XVM main processor.
- Intraprocessor communication - receiving requests for service from, and, sending results to tasks operating on the PDP-11 peripheral processor.
- Scheduling - determining which task is to execute next.
- Request Queuing - stacking requests for a busy task until it is able to process them.
- Timing - providing a timed wake-up service for requesting tasks.
- Error Reporting - providing a list of current device and task errors to the XVM executive, on demand.
- Directive Processing - providing the XVM monitor with specific services such as: notification of available memory space, connecting, disconnecting or stopping tasks and returning the status of certain tasks.

These services are provided to both device driver tasks and background tasks.

3.1.3 Device Drivers

Device Drivers are tasks that typically perform rudimentary device functions such as read, write, search, process, interrupt, etc. They can, however, be complete handlers, performing complex operations such as character generation and directory searching. PIREX provides each driver with requests for I/O actions and returns the results of the actions to the caller. Associated drivers are provided for the RK05 Disk Cartridge, the LP11/LS11/LV11 Line Printer, the CR11 Card Reader, and the XY11 Plotter.

3.1.4 Software Routines in Background Mode

The following are run as background tasks--executing only when I/O drive tasks are idle:

1. SPOL11 -- an input/output spooling processor
2. MAC11 -- A MACRO assembler for the PDP-11

3.1.5 Unsupported Tasks

All tasks supplied with the PIREX software system are fully supported by Digital Equipment Corp. except the DECtape Driver task (DT). The DT task has not been completely tested, but is included in the system for illustrative purposes and for anyone who may desire to develop DECtape capability on the PDP-11.

3.1.6 Optional LV Support

For reasons of packaging optional LV support on a printer and a plotter is present in the standard PIREX ($LV=0). This support, however, is only at the device driver level. The PDP-15 side modules display-file-to-vector, vector-to-raster, and LV I/O handler may be purchased separately. Information is available through PDP-15 Marketing.

3.1.7 Optional DL Support

The DL-11 is supported as a communications protocal device between a DEC system-10 and a PDP-15. The code for this support is purchased separately and is available from the SDC. Information is available through PDP-15 Marketing.

3.1.8 Power Fail Routine

A power fail section is present in PIREX. It is, however, not supported by DEC and currently only saves the general registers and does not attempt to handle I/O in progress. This routine could be expanded by the user into a complete power fail handler.

3.2 PIREX - SIMPLIFIED THEORY OF OPERATION

3.2.1 NUL Task

When the PIREX Software System is running, it is normally executing the NUL Task (a PDP-11 WAIT instruction). The NUL Task is executed whenever there are no other runnable tasks or while all other tasks are in the WAIT state waiting for previously initiated I/O. The NUL Task entry is a permanent element in the Active Task List. The Active Task List is a priority ordered list of tasks that is used to schedule the next task to be executed. The NUL task occupies the last position in the Active Task List (ATL).

3.2.2 Clock Task

One other permanent entry in the ATL is the Clock Task. The Clock Task is entered once every 16.6 milliseconds for 60 Hz machines (20.0 milliseconds for 50 Hz). Its primary function is to provide other tasks with a wake up service. A typical use of the Clock Task would be to wake up the Line Printer Task every two seconds to check the Line Printer status for a change from OFF LINE to ON LINE. The Clock Task operates at the highest priority on the ATL.

3.2.3 Request Processing

When the XVM issues a request to the PDP-11 to be carried out by PIREX, it does so by interrupting the PDP-11 at level 7 (the highest PDP-11 priority level) and simultaneously passing it the address of a Task Control Block (TCB) through the interrupt link. This address is called the Task Control Block Pointer (TCBP). A PDP-11 task can issue requests to other tasks via the IREQ macro. The IREQ macro simulates the XVM request process and results in a TCBP being passed to PIREX. The contents of the Task Control Block completely describe the request (task addressed, function, optional interrupt return address and level, status words, etc.). The TCB will reside in the 'Common' Memory if the request is issued from the XVM or in the 'Common' or 'Local' Memory if the request is issued from the PDP-11.

The flow chart in Figure 3-1 illustrates the basic processing of requests to PIREX from the XVM or the PDP-11. Note that error conditions are passed back to either central processor in the TCB or via an error table to the XVM monitor poller along with status information necessary for control and monitoring of a request. Usually the request is to a device on the PDP-11 but other types are allowed.

3.2.4 Task Structure

A task is a PDP-11 software routine capable of being requested by the XVM or PDP-11 through the PIREX software system. The task may be a device driver, a directive processor, or just a software routine used to carry out a specified function. A task must have the format shown in Figure 3-2, TASK FORMAT.

```
                                  ****     LOWER CORE
                                  *  *
              task stack area     '  '
                                  '  '
                                  *  *
                                  ****
              control register    *  *
                                  ****
              busy/idle switch    *  *
                                  *  *
                                  ****
                                  *  *
              task program        *  *
              code                '  '
                                  *  *
                                  *  *
                                  ****     HIGHER CORE
```

Figure 3-2
Task Format

This structure consists of four sections; two are variable in size and two are fixed.

The "task program code" size is variable and contains the programming code necessary to carry out the task function.

The "busy/idle switch" consists of two words and is used by PIREX to determine if a task is busy or idle. The TCBP of the current request is stored in this section when the task is busy. This also enables a task to easily access the TCB.

The "control register" is either a dummy address (an address which points to an unused software variable) or the address of a device control register if the task is an I/O driver. This word is used only by the STOP TASKS (ST) task when shutting down I/O operations.

The "stack area" begins immediately below the control register and builds dynamically downwards. The purpose of the stack is to allow each task free use of a private space for temporary storage of data while it is executing and all its active registers during times when other higher priority tasks are being run. The stack area must be large enough to store the maximum number of temporary variables used at any one time plus one context register save. A context save requires 8 words of stack area plus an additional 3 words if the PDP-11 has an Extended Arithmetic Element (EAE). The stack size is fixed and determined at PIREX assembly time.

3.2.5 Task Control Block - TCB

Tasks, in PIREX, receive requests for action and return the results of their action in blocks of information called Task Control Blocks (TCB). The general format of a TCB consists of three words followed by task-specific optional words. The following information must be present in all TCBs since PIREX will honor requests in this format only.

	15 8	7 0	
TCB:	API TRAP ADDRESS	API LEVEL	WORD 0
	FUNCTION CODE	TASK CODE NUMBER	WORD 1
REV:	REQUEST EVENT VARIABLE		WORD 2
	OPTIONAL WORDS		WORD 3-N

3.2.5.1 API Trap Address and Level - The API trap address is a XVM API trap vector and has a value between 0 and 177_8 when a hardware interrupt on the XVM is required. Location 0 corresponds to location 0 in the XVM. The "API" level is the priority level at which the interrupt will occur in the XVM and has a value between 0 and 3 when a hardware interrupt on the XVM is required. A 0 signifies API level 0, a 1 for level 1, etc. The API trap address and level are used by tasks in the PDP-11 when informing the XVM that the requested operation is complete (e.g., a disk block transferred or line printed). If the XVM master computer doesn't have API or if API is not enabled, the PDP-11 issues an interrupt that when received is polled by the XVM using 4 UC15 skips (one per level) on the traditional skip chain.[1]

[1] API is optional on PDP-15's, standard on XVM's.

3.2.5.2 Function Code - The Function Code determines whether hardware interrupts on the PDP-15 or software interrupts on the PDP-11 are to be used at the completion of the request. If the code has a value of 0, a hardware interrupt is generated on the XVM at the completion of the request; if a 1, an interrupt is not made. If the Function Code is a 3, a software interrupt is issued by PIREX. The task routine or program using this facility sets up the trap address in the SEND11 table in PIREX prior to issuing the request to the task. The task or route should return to PIREX after interrupt processing through an "RTS PC" instruction. All registers are available for use by tasks.

3.2.5.3 Task Code Number - The Task Code Number (TCN) is a positive $(1\text{-}177_8)$[1] or a negative $(200\text{-}377_8)$ 7-bit number plus a sign bit that informs PIREX which task is being referenced. The mnemonic TCN as used in this manual refers to the 7-bit portion of the Task Code Number. Tasks are addressed by a numeric value rather than by name. Tasks with positive code numbers are spooled tasks and tasks with negative code numbers are unspooled tasks. When the SPOOLER (see Chapter 5) is enabled and running, requests to spooled tasks are routed to the SPOOLER. When the SPOOLER is disabled, requests to spooled tasks are routed directly to device drivers.

Task Code Numbers are currently assigned as follows:

CODE[2]	TCN	TASK	
-1[3]	-1	CL task (Clock)	Driver task[3]
200	0	ST task (Stop Task)	Software task
201	1	SD task (Software Directive)	Directive task
202	2	RF task (Cartridge Disk)	Driver task
203	3	DT task (DECTAPE)	Driver task
4	4	LP task (Line Printer)	Driver task
5	5	CD task (Card Reader)	Driver task
6	6	PL task (Plotter)	Driver task
207	7	SP task (Spooler)	Background task
210	10	LV task (Printer/Plotter)	Driver task
211	11	DL task (Hurley protocal communication task)	Driver task
212	12	Currently not used	-
213	13	Currently not used	-
214	14	Temporary Task Entry	Temporary task

[1] A task code of 0 indicates the STOP TASKS DIRECTIVE - See Section 3.5

[2] The code column corresponds to the typical task code in the TCB

[3] The minus 1 is represented internally as 377

PIREX is currently capable of handling these 14 tasks. Tasks 11-14 are spare task codes available for customer use.[1]

3.2.5.4 Request Event Variable - The REQUEST EVENT VARIABLE, commonly called REV, is initially cleared by PIREX (set to zero) when the TCB request is first received and later set to a value "n" (by the associated task) at the completion of the request. The values of "n" are:

0 = request pending or not yet completed

1 = request successfully completed

-200 = (mod $2^{16}-1$) nonexistent task referenced

-300 = (mod $2^{16}-1$) illegal API level given (illegal values are changed to level 3 and processed)

-400 = (mod $2^{16}-1$) illegal directive code given

-500 = (mod $2^{16}-1$) no free core in the PDP-11 local memory

-600 = (mod $2^{16}-1$) ATL node for this TCN missing

-777 = (mod $2^{16}-1$) request node was not available from the POOL (i.e., the node POOL was empty, and the referenced task was currently busy or the task did not have an ATL node in the Active Task List)

When an address is passed in a TCB as data, the receiver of the address must relocate it to correspond to the addressing structure in its memory space. For example, a PDP-15 address passed to the PDP-11 must first be multiplied by two to convert word to byte addressing and then the local memory size (LMS) of the PDP-11 must be added. For example,

PDP-11 address = (PDP-15 address *2) + LMS on PDP-11

The reverse is true for a PDP-11 address received by the XVM. For example,

XVM address = (PDP-11 address - LMS)/2

[1] See Section 4.4 for further information.

3.3 SYSTEM TABLES AND LISTS

The PIREX system uses various tables, lists, and deques to control events within the system.

3.3.1 Active Task List (ATL)

The selection of a task for execution by PIREX is accomplished by first scanning a priority-ordered linked list of all active tasks in the system called the Active Task List (ATL). An active task is one which satisfies one or more of the following conditions:

1. is currently executing
2. has a new request pending in its deque
3. is in a wait state, or
4. has been interrupted by a higher priority task

A task is inactive if there is no ATL node for it. A task can be in any one of the following states:

CODE	STATE	ACTIVITY
0	run	active
2	wait	active
4	exit	inactive

When a runnable task is found, the stack area and general purpose registers belonging to that task are restored and program control is transferred to it through an RTI instruction. Program execution normally begins at the first location of the task diagram code (see Figure 3-3) or at the point where the task was previously interrupted by a higher priority task, or in special cases at any desired location in the task using the 'PC' setting on the stack as in the RK task's error retry program logic. When a task is interrupted by other tasks, its general purpose registers are saved on its own stack. Control is returned to the interrupted task by restoring its stack pointer and then its active registers.

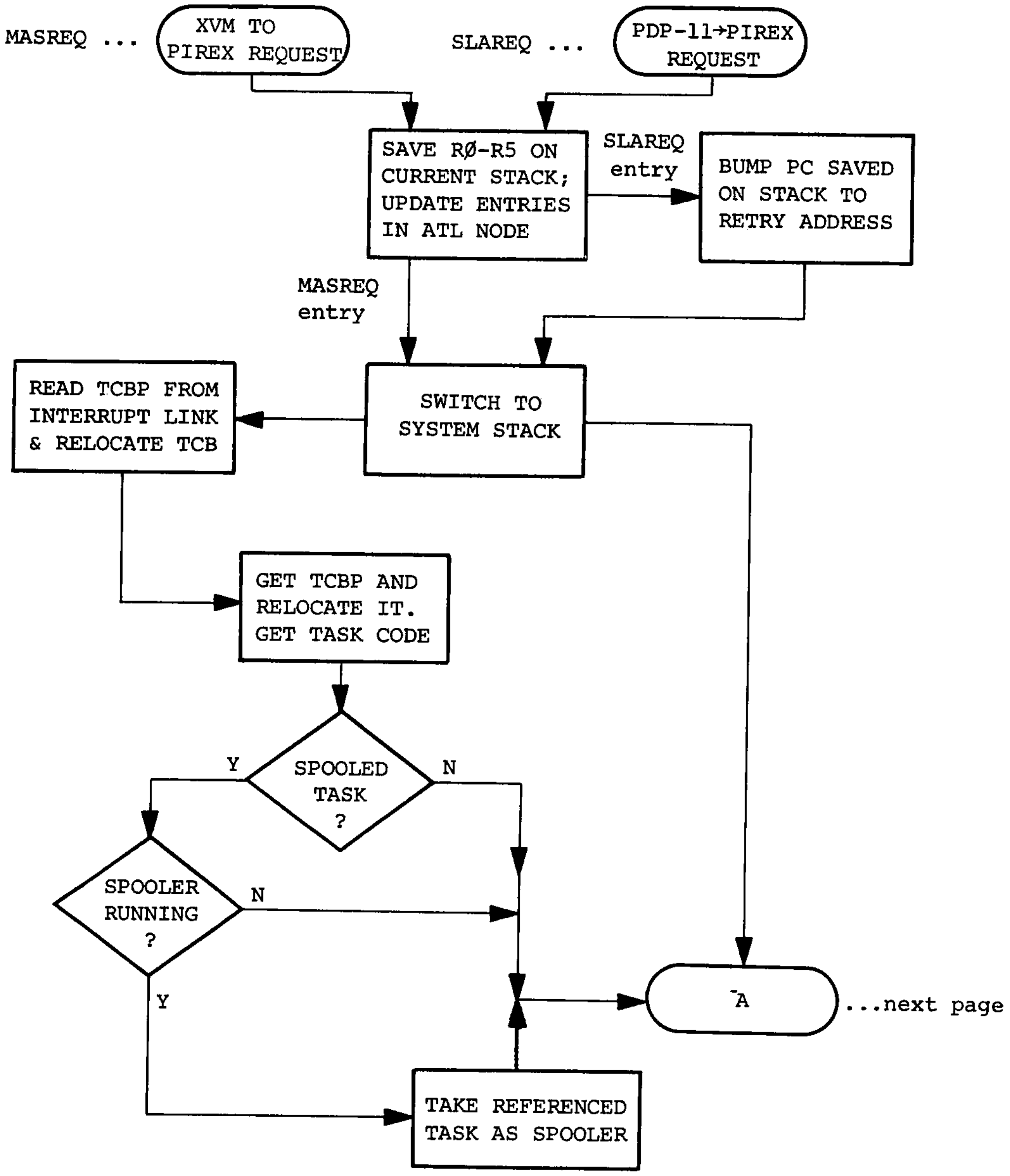

MASREQ ...
XVM TO PIREX REQUEST
SLAREQ ...
PDP-11→PIREX REQUEST
SAVE RØ-R5 ON CURRENT STACK; UPDATE ENTRIES IN ATL NODE
SLAREQ entry
BUMP PC SAVED ON STACK TO RETRY ADDRESS
MASREQ entry
READ TCBP FROM INTERRUPT LINK & RELOCATE TCB
SWITCH TO SYSTEM STACK
GET TCBP AND RELOCATE IT. GET TASK CODE
Y
SPOOLED TASK ?
N
SPOOLER RUNNING ?
N
Y
A
...next page
TAKE REFERENCED TASK AS SPOOLER

Figure 3-3
Detailed Flow Chart of XVM/PDP-11 Request Processing

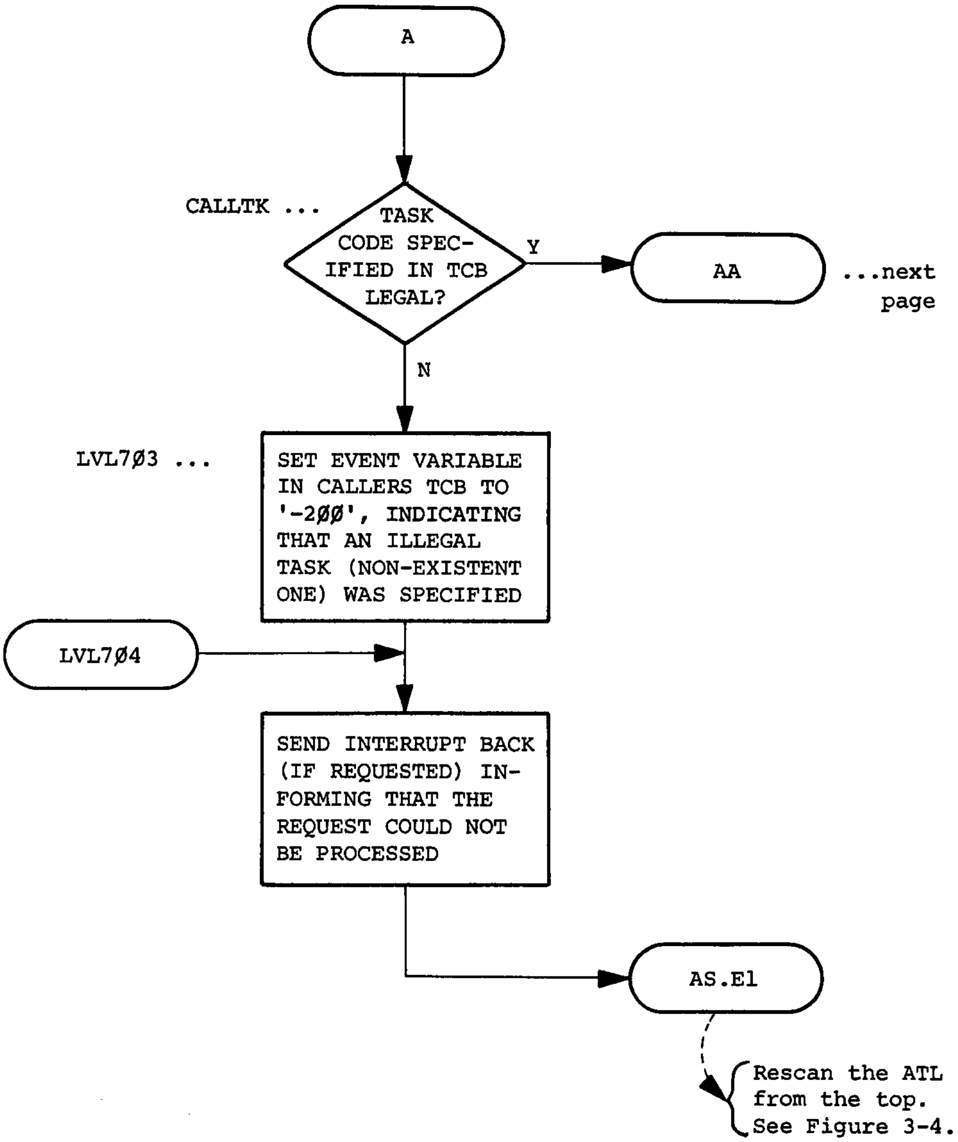

A
CALLTK ...
TASK CODE SPEC- IFIED IN TCB LEGAL?
Y
N
AA
...next page
LVL7Ø3 ...
SET EVENT VARIABLE IN CALLERS TCB TO '-2ØØ', INDICATING THAT AN ILLEGAL TASK (NON-EXISTENT ONE) WAS SPECIFIED
LVL7Ø4
SEND INTERRUPT BACK (IF REQUESTED) IN- FORMING THAT THE REQUEST COULD NOT BE PROCESSED
AS.E1
Rescan the ATL from the top. See Figure 3-4.

Figure 3-3 (Cont.)
Detailed Flow Chart of XVM/PDP-11 Request Processing

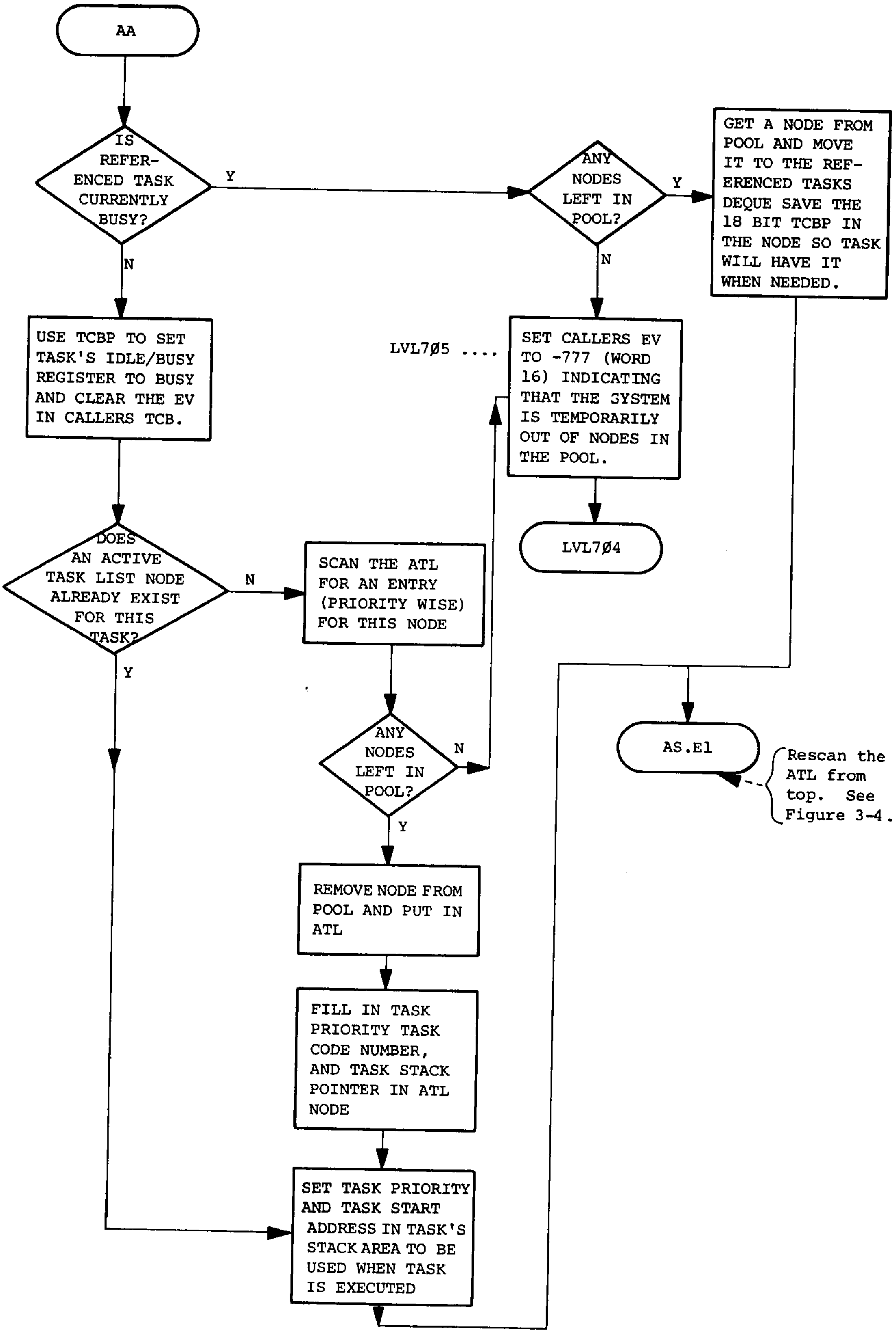

AA
IS REFERENCED TASK CURRENTLY BUSY?
Y
N
ANY NODES LEFT IN POOL?
Y
N
GET A NODE FROM POOL AND MOVE IT TO THE REFERENCED TASKS DEQUE SAVE THE 18 BIT TCBP IN THE NODE SO TASK WILL HAVE IT WHEN NEEDED.
USE TCBP TO SET TASK'S IDLE/BUSY REGISTER TO BUSY AND CLEAR THE EV IN CALLERS TCB.
LVL7Ø5 ....
SET CALLERS EV TO -777 (WORD 16) INDICATING THAT THE SYSTEM IS TEMPORARILY OUT OF NODES IN THE POOL.
LVL7Ø4
DOES AN ACTIVE TASK LIST NODE ALREADY EXIST FOR THIS TASK?
N
Y
SCAN THE ATL FOR AN ENTRY (PRIORITY WISE) FOR THIS NODE
ANY NODES LEFT IN POOL?
N
Y
AS.E1
Rescan the ATL from top. See Figure 3-4.
REMOVE NODE FROM POOL AND PUT IN ATL
FILL IN TASK PRIORITY TASK CODE NUMBER, AND TASK STACK POINTER IN ATL NODE
SET TASK PRIORITY AND TASK START ADDRESS IN TASK'S STACK AREA TO BE USED WHEN TASK IS EXECUTED

Figure 3-3 (Cont.)
Detailed Flow Chart of XVM/PDP-11 Request Processing

The ATL is rescanned when:

1. a new request is issued to a task
2. a previous request is completed
3. at the end of a clock interrupt
4. a task goes into a wait state

A task is said to be in a "wait" state when its ATL node exists and it is not runnable.

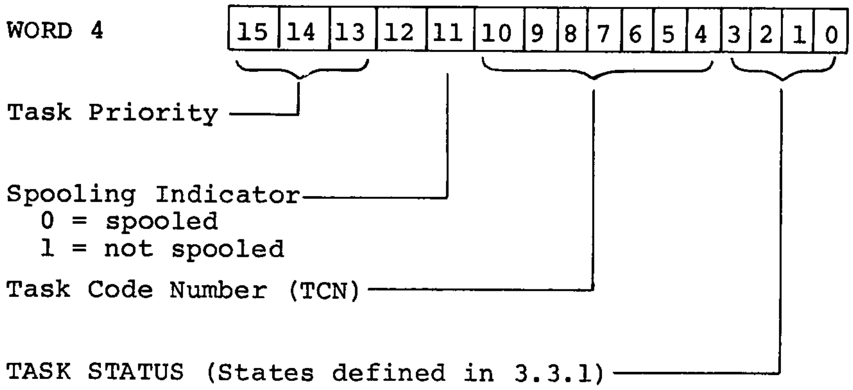
3.3.1.1 ATL Nodes - The Active Task List is a linked list containing 4 word entries called nodes.

An ATL node has the following structure:

WORD 1 - Forward pointer to next node

WORD 2 - Backward pointer to previous node

WORD 3 - Stack pointer of task



The ATL is referenced by a 2-word listhead. The listhead contains backward and forward links pointing to the first and last nodes in the list. The ATL is a priority-ordered list.

3.3.1.2 ATL Node Pointer (ATLNP) - Each task has a pointer to its Active Task List Node (see Section 3.3.1.1) stored in the ATLNP table. This table is in TCN order. An entry is 0 if the task is inactive.

The format of an ATLNP entry is:

```
    0   ;   NAME  task-code-number[1]
```

These entries are filled dynamically by PIREX with actual pointers.

3.3.2 Task Request List (TRL)

The Task Request Lists are doubly-linked, deque-structured lists of pending TCBs. If when a request arrives, the target task is busy, PIREX places the TCB pointer (TCBP) onto the busy task's deque for later processing. This deque is the Task Request List.

A TRL node has the following structure:

WORD 1 - Forward pointer to next node.
WORD 2 - Backward pointer to previous node.

WORD 3 -

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Request Identifier
0 = PDP-15 request
1 = PDP-11 request

Most significant bits of the TCBP (XVM bits 0 and 1)

WORD 4 - 16 least significant bits of TCBP (XVM bits 2-17)

Each TRL is referenced by a two-word listhead. The listhead contains backward and forward links pointing to the last and first nodes of a given task's TRL. The TRL is built on a first come first serve basis.

3.3.3 TRL Listheads (LISTHD)

Each task has its own Task Request List, (TRL). Each LISTHD entry is a double-linked listhead used to point to a task's TRL. The LISTHD is a TCN ordered list.

[1] The "NAME task-code-number" is a comment

The format for an entry is:

```
LISTHEAD  XX
```

where:

1. LISTHEAD is a system macro
2. XX is a two character task mnemonic (i.e., LP for Line Printer Task).

3.3.4 Clock Request Table (CLTABL)

The Clock Table (CLTABL) contains entries for one timing (wake up) request from each task. The format of a CLTABLE entry is:

```
XX[1].CL  =  .
.WORD 1   ;  Time Word
.WORD 1   ;  Address Word
```

Where the first word is remaining time before wakeup and the second word is the address for a JSR PC, XXX instruction. The JSR occurs at clock interrupt level (6). The user must do an RTS PC to return control to the clock routine. Time is measured in line frequency ticks: 16.6 milliseconds/tick for 60 Hz Systems. A task may cancel a timing request by clearing the time word. A request for a wakeup is made by:

1. Placing the address of the routine to be called into word 2 - then
2. Placing the time delay (measured in 1/60 sec. increments) into the time word.

The above sequence must be exactly followed. See Chapter 4 for further details on the use of wakeup calls. CLTABL is a TCN ordered list.

3.3.5 Device Error Status Table (DEVST)

The DEVST table is used to store error status codes for delayed transfer to the XVM monitor. The XVM monitor contains a routine called the

[1] XX represents the task mnemonic (e.g., RK.CL)

"Poller" which periodically requests error status codes from PIREX using a "get errors" software directive. This method of error transmission is useful for delayed error messages--such as those recognized on spooled devices. The specific XVM I/O handler may no longer be present in the PDP-15's memory--thus the Request Event Variable (REV) method of returning error status would be useless. The "Poller" requests the entire DEVST table and reports those events on the system console terminal. A "Get Errors" directive clears the DEVST table upon completion. The reporting task may, for instance, correct the error condition before the "Get Error" directive is issued. When this happens, the task could simply clear its message from the DEVST table and thus eliminate a spurious message. DEVST is a TCN ordered table. The format of a DEVST entry is as follows:

```
WORD 1  -  TASK (MNEMONIC IN SIXBIT/RAD50 RIGHT JUSTIFIED)

WORD 2  -  SPARE (used to report bad block numbers, and, to
           report disconnected spooler unit)

WORD 3  -  ERROR CODE:  SPOOLER ERROR CODE (HIGH BYTE)
                        TASK ERROR CODE (LOW BYTE)
```

3.3.6 LEVEL Table

The LEVEL table (task priority level) is used by the R.SAVE context switch routine to determine the priority level of the task about to begin execution. All interrupt vectors must specify a priority 7 entry into their respective interrupt routines. Upon entry, R.SAVE should be called to save the interrupt task state and return control to the interrupt processing routine at the proper priority--found in the LEVEL table. The LEVEL table is a TCN ordered task.

The LEVEL table entry format is:

```
.BYTE task priority *40
```

3.3.7 Task Starting Address (TEVADD)

The TEVADD Table contains the starting address of all defined tasks. The system currently has room for 13_8 tasks of which three are temporary entries used for tasks CONNECTED to and DISCONNECTED from PIREX. MAC11 is such a temporary task and uses the table entries of the currently unused highest task code. All PIREX systems must have at least one highest unused task entry to allow use of MAC11. The TEVADD table is TCN ordered.

The format of a TEVADD table entry is:

```
     .WORD START  ;  task name
```

where START is either:

1. The starting address of the task, or,
2. 0 indicating that this entry is currently unoccupied.

where "Task name" is a comment.

3.3.8 Transfer Vector Table (SEND11)

The SEND11 table is used to store transfer vectors for use when issuing IREQ macro calls. The entry is the address at which the requesting routine receives control back from PIREX. This table is TCN ordered.

The format of a SEND11 entry is:

```
     0  ;  task-name  task-code-number
```

where "task name task-code-number" is a comment.

3.3.9 System Interrupt Vectors

The device interrupt vector-pairs consist of interrupt routine address and priority level. The priority level of "all" devices should be Level-7 "only". This is to permit PIREX to do a context switch before processing the interrupt.

3.3.10 Internal Tables Accessible to All Tasks

All tasks in the PIREX system can easily access internal routines and tables through the use of the system registers. These registers begin at absolute location 1002_8 in the PDP-11 and contain either pointers to internal tables and listheads or entry points to commonly used subroutines. The following list summarizes these registers.

LOCATION		MNEMONIC	DESCRIPTION
01002		SEND11	INT. RETURN ADD. (ON 11) ON END OF I/O
01004	CURTSK:	000000	CURRENT TASK RUNNING
01006		POL.LH	ADDRESS OF POOL LISTHEAD
01010		LISTHD	ADDRESS OF TASK LISTHEADS
01012		R.SAVE	ENTRY POINT TO REGISTER SAVE
01014		R.REST	ENTRY POINT TO REGISTER RESTORE
01016		AS.E1	ENTRY POINT TO ATL RESCAN
01020		MOVEN	ENTRY POINT TO NODE MOVER
01022		DEQU	ENTRY POINT TO DEQUEUE
01024		SEND15	ENTRY POINT TO SEND INTERRUPT
01026		EMPTY	ENTRY POINT TO EMPTY A DEQUE
01030		ATLNP	ATL NODE POINTER TABLE
01032		RATLN	ENTRY POINT TO RETURN ATL NODE
01034		SPOLSW	SPOOLER SWITCHES ADDRESS
01036		RTURN	REUTURN INST. ADD. FOR PIC CODE
01040	NBRTEV:	NTEV	CURRENT NBR OF TASKS
01042	PWRDWN:	RTURN	ENTRY POINT TO PWR FAIL DOWN
01044	PWRUP:	RTURN	ENTRY POINT TO PWR FAIL UP
01046	SPOLSW:	000000	SPOOLER SWITCHES
01050		DEVST	DEVICE ERROR STATUS TABLE
01052		CLTABL	TABLE, A TIME-ADDR PAIR FOR EACH TASK
01054		DEQU1	ENTRY TO -SET TASK IN WAIT STATE-ROUTINE
01056		CEXIT	ENTRY TO -SET TASK IN RUN STATE-ROUTINE
01060		TEVADD	TABLE OF TASK START ADDRESSES
01062	DEVARE:	.WORD DEVTYP	PIREX DEVICES SWITCH
01064	DEVSPL:	.WORD 0	DEVICES SPOOLED SWITCH
01066	CTLCNT:	.WORD 0	XVM CTL C RUNNING COUNTER
01067	SPUNIT:	.WORD 0	UNIT CURRENTLY BEING SPOOLED TO

;
;

These registers are accessed as absolute memory locations by various permanent and temporary tasks. NO CHANGE in the location or order of this table is permitted. New system registers may be added to the end of this table.

3.4 DETAILED THEORY OF OPERATION-PIREX

3.4.1 Request Procedure

The UC15 system allows the XVM to initiate requests to the PDP-11 by interrupting at the highest PDP-11 hardware level and simultaneously passing to it an 18-bit Task Control Block address. Only the first 16 bits are used because PIREX does not support a memory management option[1] on the PDP-11. Requests from the XVM or PDP-11 could be for:

[1] Memory management hardware support is not a feature of PIREX.

1. a directive-handing routine
2. a data transfer to or from a device driver task on the PDP-11
3. a background software routine (task)

3.4.2 Directive Handling[1]

Directive handling consists of such functions as:

1. Connecting and disconnecting tasks from the PIREX system
2. Reporting core status on the PDP-11 local memory to the calling routine
3. Stopping I/O on a particular device or all devices
4. Reporting UNIBUS device status to the calling routine
5. Stopping any or all tasks currently running[2]
6. Reporting spooler status to the caller

3.4.3 Logic Flow

The flow charts in Figures 3-3, 3-4, and 3-5 illustrate in detail the program logic flow when a request from the XVM or PDP-11 is made to PIREX. Note that PIREX is capable of servicing requests in parallel on a priority basis.

3.4.4 Operating Sequence

PIREX is usually running the NUL task waiting for something to do. When a request is issued from the XVM or PDP-11, PIREX immediately:

1. saves the general-purpose registers onto the stack belonging to the current task running
2. saves the stack pointer in the ATL nodes
3. sets the task in a RUN state
4. switches to the system stack (refer to Figure 3-5)

All of the preceding is done at level 7 (protected). The system stack is used when switching between tasks or rescanning the ATL.

[1] See Section 3.6 for additional information.

[2] See Section 3.5 for additional information.

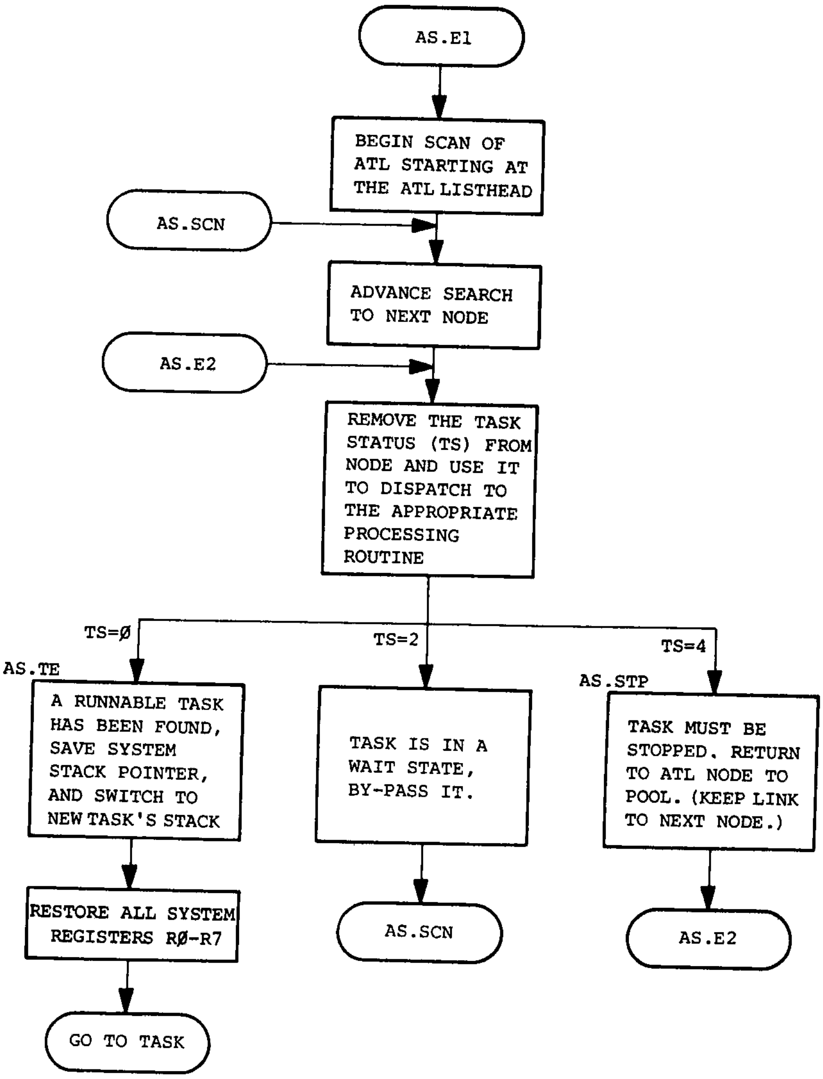

AS.E1
BEGIN SCAN OF ATL STARTING AT THE ATL LISTHEAD
AS.SCN
ADVANCE SEARCH TO NEXT NODE
AS.E2
REMOVE THE TASK STATUS (TS) FROM NODE AND USE IT TO DISPATCH TO THE APPROPRIATE PROCESSING ROUTINE
TS=Ø
TS=2
TS=4
AS.TE
A RUNNABLE TASK HAS BEEN FOUND, SAVE SYSTEM STACK POINTER, AND SWITCH TO NEW TASK'S STACK
TASK IS IN A WAIT STATE, BY-PASS IT.
AS.STP
TASK MUST BE STOPPED. RETURN TO ATL NODE TO POOL. (KEEP LINK TO NEXT NODE.)
RESTORE ALL SYSTEM REGISTERS RØ-R7
AS.SCN
AS.E2
GO TO TASK

Figure 3-4
Scan of Active Task List (ATL)

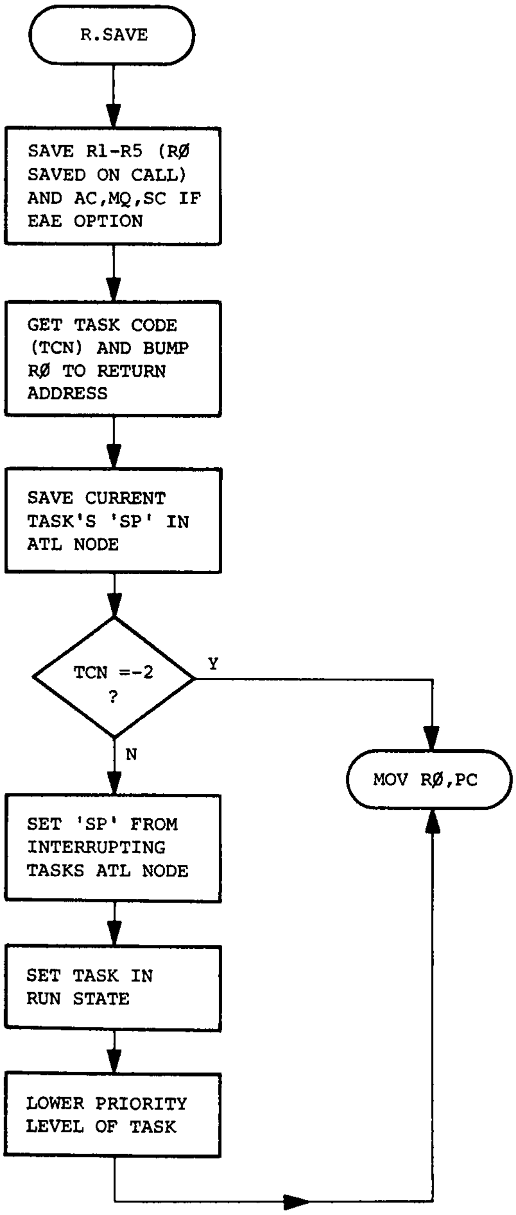

R.SAVE
SAVE R1-R5 (RØ SAVED ON CALL) AND AC,MQ,SC IF EAE OPTION
GET TASK CODE (TCN) AND BUMP RØ TO RETURN ADDRESS
SAVE CURRENT TASK'S 'SP' IN ATL NODE
TCN =-2 ?
Y
N
MOV RØ,PC
SET 'SP' FROM INTERRUPTING TASKS ATL NODE
SET TASK IN RUN STATE
LOWER PRIORITY LEVEL OF TASK

Figure 3-5
Context Switch or Save General Purpose Registers R0-R5

In the case of a XVM request, the TCBP (Task Control Block Pointer) register is now immediately read by the PDP-11 allowing additional requests to be made. PIREX corrects the TCBP by an amount equal to the PDP-11 local memory when a request comes from the XVM. The TCBP is present in R4 and R5 when the IREQ macro is issued by a PDP-11 routine and the PDP-11 is able to address the TCB directly and retrieve information from it. The task code number is then obtained from the caller TCB and used to determine which task or directive that is being referenced.

A check is made to determine if the called task is a spooled task or not. If bit 7 = 0, it is a spooled task and if bit 7 = 1, it is an unspooled task. If the called task is a spooled task and if the SPOOLER is enabled, the request is processed by the SPOOLER. If the SPOOLER is not enabled, a check is made to determine if the task in reference is currently active and busy with a previous request. If so, the request is queued to the task's deque (TRL) on a first come, first serve basis. If the task in reference is currently inactive, an ATL node is built containing the appropriate entries, the address of the ATL node is set in the ATLNP table and the task's priority in the LEVEL table. In either case, the ATL is rescanned and the highest priority task is selected for execution (see Figure 3-4).

UC15 peripherals, controlled by PIREX, use a minimal driver to carry out requested functions and report the results back to the calling task via the TCB. When a driver finishes a request (whether an error occurred or not), it informs the requestor by placing the results (status and error register) in the TCB associated with that request and sends an optional hardware or software interrupt back to the requestor.

The request event variable (REV) is set prior to sending an interrupt to the XVM/PDP-11 and may be used by the XVM or PDP-11 to determine if a request has been processed. This method is used during times when interrupts are not enabled or desired (as during the bootstrapping operation on the XVM). The hardware interrupt to the XVM (see Figure 3-6) is optional and can be made at any of the XVM API hardware levels and trap addresses. The API level and trap address are specified in the TCB associated with each request to allow complete flexibility in interrupt control.

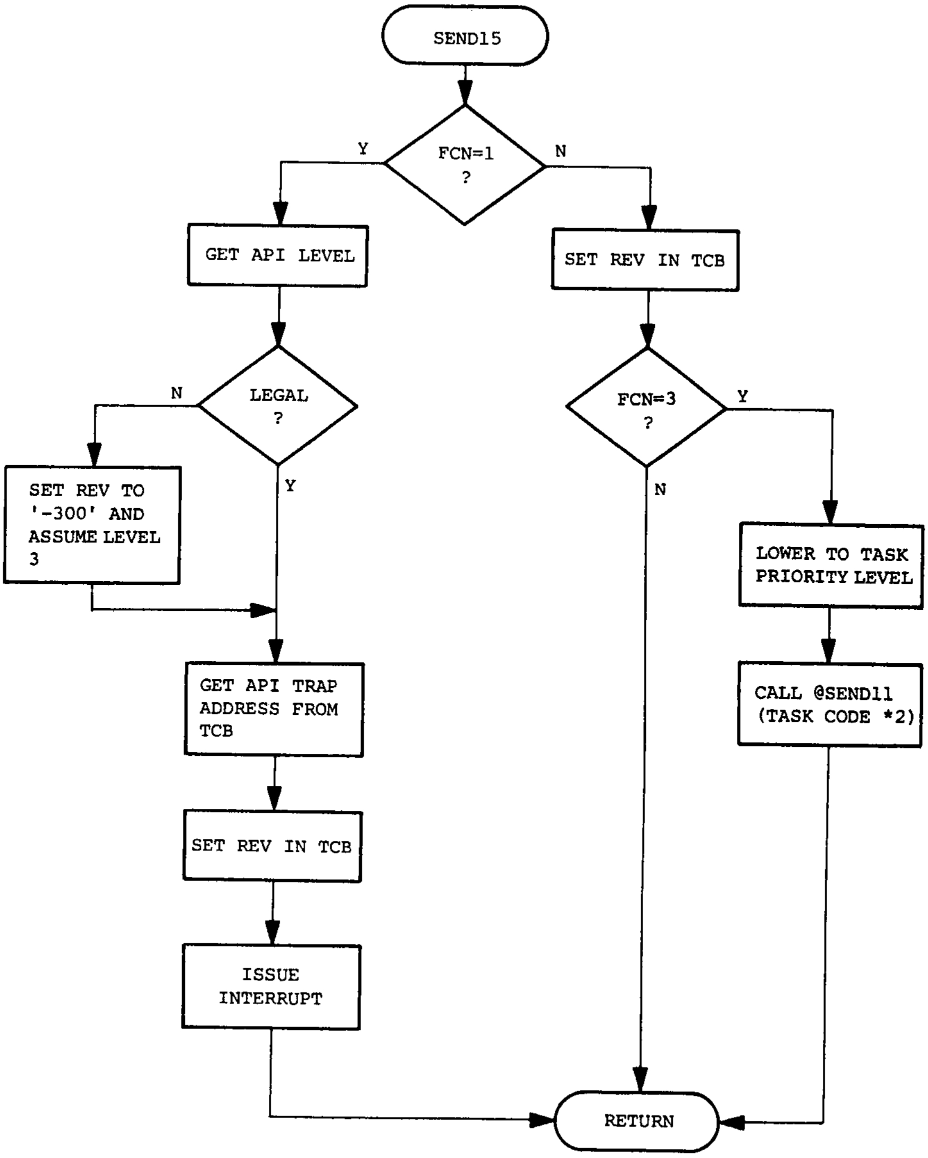

SEND15
FCN=1 ?
Y
N
GET API LEVEL
SET REV IN TCB
LEGAL ?
N
Y
SET REV TO '-300' AND ASSUME LEVEL 3
FCN=3 ?
Y
N
LOWER TO TASK PRIORITY LEVEL
CALL @SEND11 (TASK CODE *2)
GET API TRAP ADDRESS FROM TCB
SET REV IN TCB
ISSUE INTERRUPT
RETURN

Figure 3-6
Send Hardware Interrupt to XVM/Software Interrupt to PDP-11

3.4.5 Software Interrupt

A software interrupt return for the PDP-11 tasks is optional. This feature is available only if a hardware interrupt return to the XVM is not required. To generate a software interrupt, the task using the request has to set the trap address before issuing the request. Each task running under PIREX has an entry in the SEND11 Transfer Vector Table. PIREX traps to this location on completion of a request by executing a JSR PC, SEND11 (Task Code *2). The task issuing the request specifies its task code in the TCB. All registers are free to be used when the control is transferred. Control is returned to PIREX through an RTS PC instruction.

3.4.6 Task Completion

When the XVM has been notified (via interrupt) that its request has been completed, the task completing the request under PIREX becomes idle and calls DEQU (see Figure 3-7) to determine if any additional requests are pending. If no requests are pending, control is transferred to the ATL scanner (after saving the stack pointer and setting the current task in a wait state in its ATL node). If additional requests exist, the next request in the task's TRL is processed as if it were just received.

3.5 STOP TASKS

The STOP TASKS Task is used to stop tasks and/or I/O currently underway for either all tasks or for a particular task. STOP TASKS can cancel all requests or only XVM requests for the indicated task(s). There are four possibilities:

1. Stop all tasks unconditionally and cancel all pending XVM requests
2. Stop a given task unconditionally and cancel all pending XVM requests to that task
3. Cancel all XVM requests to all tasks - this has no effect on PDP-11 requests
4. Cancel all XVM requests to a given task - this has no effect on PDP-11 requests

The process of stopping a task includes (1 or 2 above):

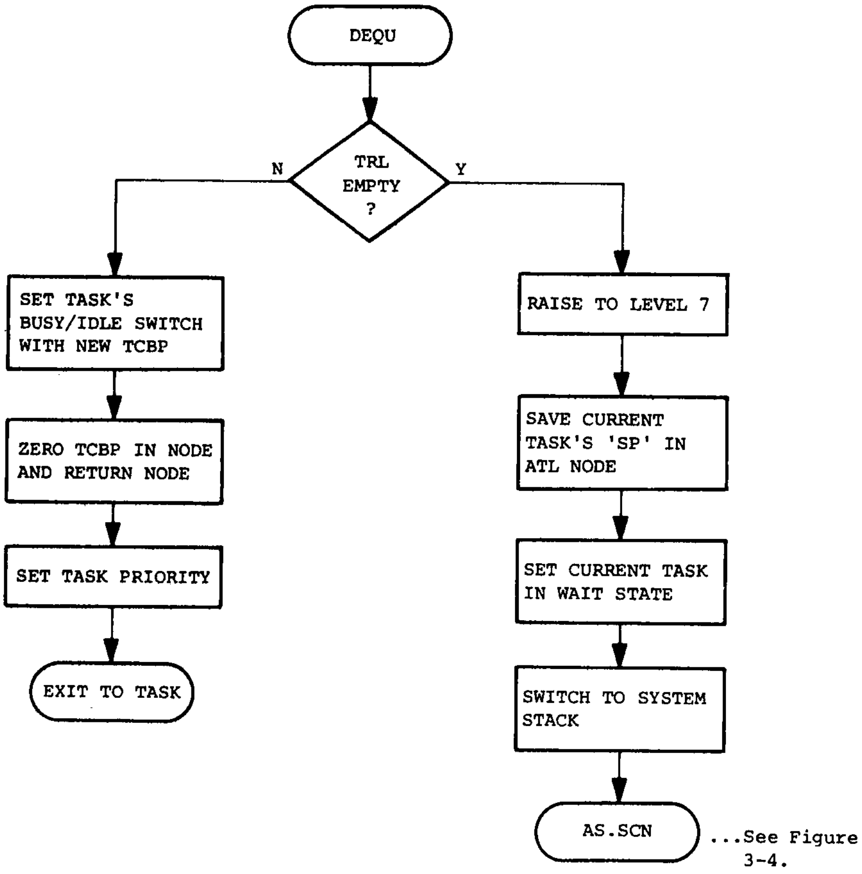

DEQU
TRL EMPTY ?
N
Y
SET TASK'S BUSY/IDLE SWITCH WITH NEW TCBP
ZERO TCBP IN NODE AND RETURN NODE
SET TASK PRIORITY
EXIT TO TASK
RAISE TO LEVEL 7
SAVE CURRENT TASK'S 'SP' IN ATL NODE
SET CURRENT TASK IN WAIT STATE
SWITCH TO SYSTEM STACK
AS.SCN
...See Figure 3-4.

Figure 3-7
Dequeue Node From Task's Deque

1. Removal of all appropriate XVM request nodes in the task(s) TRL(s)

2. Zero the Busy Idle Switch for the task(s)

3. Clear the I/O device register(s) for the task(s)

4. Set the tasks status in the ATL to EXIT (for a temporary task) or WAIT (for a permanent task).

5. Indicate completion by setting the REV of the STOP TASKS requestor. (An interrupt return is <u>not</u> allowed.)

The Stop Tasks TCB has the following format:

	15		0	
TCB:	0			Word 0
		TCN	200	Word 1
REV:	REV			Word 2

Word 1 bit 15 = 1 cancel XVM requests and the current pending request unconditionally.

bit 15 = 0 cancel XVM requests

TCN = 0 cancel all tasks

TCN ≠0 cancel Task TCN only

Word 2 REV = Return Event Variable

STOP TASKS is typically used by the XVM operating system to quiet all interaction between the XVM and the PDP-11.

3.6 SOFTWARE DIRECTIVE PROCESSING

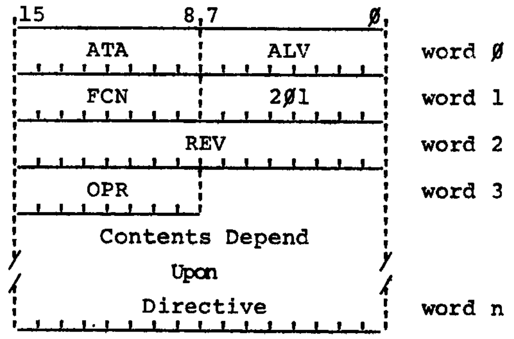
The software directive task provides two main capabilities. These are:

1. The capability to connect and disconnect temporary tasks to PIREX (such as MAC11

2. The capability to obtain various PIREX status information.

These capabilities are provided via five software directives, which are described later in this section.

The general format for software directive task control blocks is as follows:



ATA XVM API interrupt vector address

ALV XVM API interrupt priority level. Must be 0, 1, 2, or 3 (unless FCN = 3).

FCN Function to perform upon completion of this software directive request. Valid values are:

000 Interrupt the XVM at address ATA, priority ALV.

001 Do nothing (except set REV).

003 Cause a software interrupt to the PDP-11 task whose task code number is in ALV.

REV Request Event Variable. Initially zero, set to a non-zero value to indicate completion of the software directive request. The meaning of the various return values is described below.

OPR Indicates the exact operation (directive) to be performed. Must be one of the following values:

0 Disconnect Task

1 Connect Task

2 Core Status Report

3 Error Status Report

4 Spooler Status Report

5 MOVE

Returned REV values

1 Successful completion

-300 Invalid ALV value. The request may or may not have been performed - see individual directive descriptions. The XVM will be interrupted at level 3.

-400 Invalid OPR (directive/operation code) value.

Other See individual directive descriptions.

The following sections contain detailed descriptions of the individual software directives, their task control block (TCB) formats, and the REV values they may return.

3.6.1 Disconnect Task Directive

The disconnect task software directive instructs PIREX to delete a task from the active task list. Request should not be issued to a task after it has been disconnected. An attempt to issue a request to a disconnected task will result in a returned REV value of -200, implying that a non-existent task was referenced. The format of the task control block for the disconnect task software directive is as follows:

15 … 8	7 … Ø	
ATA	ALV	word Ø
FCN	2Ø1	word 1
REV		word 2
ØØØ	TCN	word 3
REL		word 4
First Address		word 5
unused		word 6
Length		word 7

TCN — The task code number of the task to be disconnected.

REL — 000000 if the task resides in XVM memory
100000 if the task resides in PDP-11 memory

First Address — PDP-11 byte address of the first location in memory occupied by this task (the lowest address of the task stack area). Only meaningful if the task resides in PDP-11 memory - if the task resides in XVM memory this word is ignored.

Length — Total size (in bytes) of this task, including stack area, control register, busy/idle switch, and program code. Only meaningful if the task resides in PDP-11 memory - if the task resides in XVM memory this word is ignored.

The disconnect task software directive verifies that the task to be disconnected is on the active task list. If present on the list, the task is disconnected - the active task list node is returned to the pool, the task's entry in the TEVADD table is cleared, and the task's task request list is cleared. If the task resides in PDP-11 memory, an attempt is made to free the memory space occupied by the task - if the first free local memory address is the address immediately following the storage area occupied by the task (as determined from the first address and length arguments), the task's first address becomes the new first free local memory address.

RESTRICTIONS:

1. If a task does not have an active task list node, it cannot be disconnected. Therefore, once a task has been connected, it cannot be disconnected until after a request has been issued to it.

2. All requests which are on the task request list of a task which is disconnected are forgotten. Such requests will never complete; their request event variables (REVs) will never be set to a non-zero value.

3. PDP-11 local memory resident tasks should only be disconnected if they are the last (highest address) task in local memory. If PDP-11 local memory resident tasks other than the last are disconnected first, the memory space occupied by these tasks will not be released. This will result in holes (of unusuable memory) in the PDP-11's local memory.

4. Tasks should be disconnected in a reverse sequential order by task code number. A task should not be disconnected if there are any connected tasks with higher task code numbers.

5. The high order bit of the task code number (TCN) must be clear.

Returned REV values:

1	Task successfully disconnected
2	Task successfully disconnected, but the (PDP-11 local) memory occupied by this task could not be released.
-300	Invalid ALV value, the task may or may not have been disconnected, its memory may or may not have been released.
-600	Task to be disconnected is not on the active task list (i.e., node not present)

3.6.2 Connect Task Directive

The connect task software directive instructs PIREX to add a new task to the system. Once a task has been connected to PIREX, the XVM and/or other tasks may issue requests (task control blocks) to it. The format of the task control block for the connect task software directive is as follows:

<table>
<tr><th>15 8</th><th>7 Ø</th><th></th></tr>
<tr><td>ATA</td><td>ALV</td><td>word Ø</td></tr>
<tr><td>FCN</td><td>2Ø1</td><td>word 1</td></tr>
<tr><td colspan="2">REV</td><td>word 2</td></tr>
<tr><td>ØØ1</td><td>TCN</td><td>word 3</td></tr>
<tr><td colspan="2">REL</td><td>word 4</td></tr>
<tr><td colspan="2">unused</td><td>word 5</td></tr>
<tr><td colspan="2">Entry Point</td><td>word 6</td></tr>
<tr><td colspan="2">Length</td><td>word 7</td></tr>
<tr><td>unused</td><td>Priority</td><td>word 1Ø</td></tr>
</table>

TCN The new task's task code number (TCN)

REL 000000 if the new task resides in XVM memory.
100000 if the new task resides in PDP-11 memory.

Entry Point Address of the new task's entry point - i.e., the first location of the task's program code. This address is a PDP-11 byte address if the new task resides in PDP-11 memory, a XVM word address if the new task resides in XVM memory.

Length Total size (in bytes) of the memory space occupied by this task, including stack area, control register, busy/idle switch, and program code. Only meaningful if the task resides in PDP-11 memory - if the task resides in XVM memory this is ignored.

Priority The task's priority *40_8.

The connect task directive enters the new task start address (appropriately relocated if the new task resides in XVM memory) into the TEVADD table. The directive does not actually create an active task list node for the new task; this occurs only when the first request is issued to the new task. The directive clears the new task's busy/idle switch (sets the task in idle state) and empties the new task's task request list. The new task priority is placed in the LEVEL table. If the new task resides in PDP-11 memory, PIREX updates its memory usage information by adding the size of the new task to the first free local memory address.

RESTRICTIONS:

1. The task code number must not be in use (correspond to any currently connected or permanently installed task) at the time this directive is issued.
2. The task code number must have been provided for when PIREX was assembled. As distributed by DEC, PIREX provides for task code numbers 0_8 through 13_8 inclusive.
3. The high order bit of the task code number must be clear.
4. If the task resides in PDP-11 memory, the first address it occupies must be the first free local memory address, as returned by the core status report software directive.
5. If the task resides in XVM memory, it must reside entirely within the area addressable by the PDP-11's 28K addressing range.
6. Tasks should be connected in sequential order by task code numbers. Temporary tasks (tasks which will subsequently be disconnected) should always be connected to a task code number one higher than that obtained via the core status report software directive.

Returned REV values:

1	Task successfully connected
-300	Invalid ALV value. Task has been connected.

3.6.3 Core Status Report Directive

The core status report software directive returns information regarding PDP-11 local memory and task code number usage in PIREX. The format of the task control block for the core status report software directive is as follows:

15 8	7 Ø	
ATA	ALV	word Ø
FCN	2Ø1	word 1
REV		word 2
ØØ2	TCN	word 3
Local Memory Size		word 4
First Free Address		word 5
unused		word 6
Number of Free Words		word 7

TCN	Set to the highest currently connected task code number in PIREX.
Local Memory Size	The amount of local memory in the PDP-11 UNICHANNEL.
First Free Address	Set to the PDP-11 byte address of the first free (unoccupied) address in local memory.
Number of Free Words	Set to the number of unused words in PDP-11 local memory. Equal to ((Local memory size in bytes) - (First free address))/2.

RESTRICTIONS:

1. The core status report software directive has no restrictions. However, the restrictions (especially those regarding order of use of memory and task code numbers) on the connect and disconnect software directives must be adhered to in order to have valid information returned by the core status report.

Returned REV values:

1	Successful completion
-300	Invalid ALV value. No information returned.
-500	No free PDP-11 memory. No information returned.

3.6.4 Error Status Report Directive

The error status report software directive returns information regarding device and/or spooler errors which have occurred since the last time this directive was issued. The format of the task control block for the error status software directive is as follows:

15 8	7 Ø	
ATA	ALV	word Ø
FCN	2Ø1	word 1
REV		word 2
ØØ3	unused	word 3
Returned Error Information		word 4 word n

The error status report software directive copies error status information from the DEVST table onto the requestor's task control block, then clears the DEVST table to store new error information. The error information returned consists of a series of three word blocks, one per PIREX task. As distributed by DEC, eleven such blocks will be returned - one for each permanent task (excluding the clock task) plus two more for spare or temporary tasks. The number of these blocks returned may change, however, if users alter the number of tasks (especially permanent tasks) in PIREX. The format of each of these three word information blocks is as follows:

15 8	7 ∅	
Task Name		word ∅
unused--zero		word 1
SPLERR	DEVERR	word 2

Task Name A three character (.SIXBT) mnemonic for the task to which the error information applies.

DEVERR Device error code for device associated with this task.

SPLERR Spooler error code for this task.

The mnemonics for the tasks and the order in which the blocks for the various tasks appear are as follows:

MNEMONIC	TASKS
EST	"Stop Task" task
ESD	Software directive task
DKU	RK (Cartridge) disk driver
DTU	DECTAPE driver
LPU	Line Printer driver
CDU	Card reader driver
GRU	XY (Plotter) driver
ESP	Spooler
LVU	LV11 printer/plotter driver
---	spare--no mnemonic
---	spare--no mnemonic

RESTRICTIONS: none

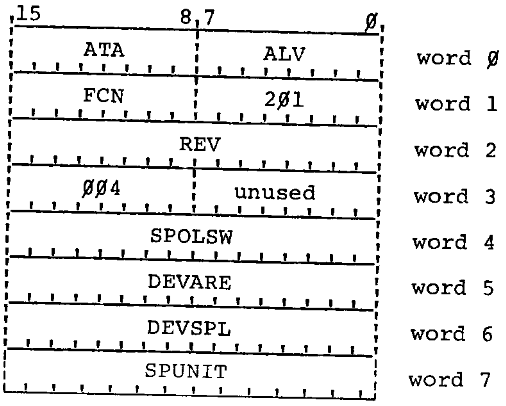
Returned REV values:

1 Successful completion.

-300 Invalid ALV value. Information has been returned.

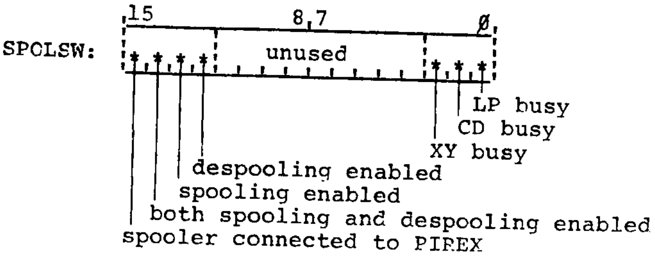
3.6.5 Spooler Status Report Directive

The spooler status report software directive returns information regarding spooler status and devices present in PIREX. The format of the task control block for the spooler status report software directive is as follows:

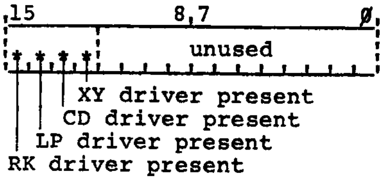


15 — 8	7 — ∅	
ATA	ALV	word ∅
FCN	2∅1	word 1
REV		word 2
∅∅4	unused	word 3
SPOLSW		word 4
DEVARE		word 5
DEVSPL		word 6
SPUNIT		word 7

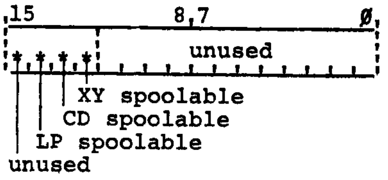
SPOLSW, SPUNIT, DEVARE, and DEVSPL are four locations (within PIREX) in which information is kept concerning spooler status and which devices have been assembled into PIREX. The spooler stātus report software directive merely copies the contents of SPOLSW, SPUNIT, DEVARE, and DEVSPL into the task control block. Three of these words consist of a number of one-bit flags. If the bit is set (1) the corresponding condition is asserted: the device driver is present, spoolable, or busy; the activity is enabled. If the bit is clear (0) the opposite condition applies: the device driver is absent, non-spoolable, or idle, the activity is disabled. The exact format of these three words is as follows:



DEVARE:



DEVSPL:



SPUNIT is the RK unit onto which the spooler is currently (or was previously) spooling data.

RESTRICTIONS:

1. DEVSPL and SPOLSW contain zero until after the first request has been issued to the spooler.

Returned REV value:

1	Successful completion.
-300	Invalid ALV value. Information has been returned.

3.6.6 PIREX MOVE Directive

NOTE

> This directive commonly is used to transfer information between common and local memory

The PIREX MOVE directive moves information from one place in the PDP-11's address space to another place in its address space. (The address space is composed of both Local-11 and Common Memory.) The format of the task control block for the PIREX MOVE directive is as follows:

15 8	7 ∅	
ATA	ALV	word ∅
FLN	2∅1	word 1
REV		word 2
∅∅5		word 3
FROM LOCATION		word 4
TO LOCATION		word 5
WORDS TO MOVE		word 6

From Location — PDP-11 byte address of beginning of information to be moved.

To Location — PDP-11 byte address of a new starting location for information.

Words to Move — The number of words to move.

CHAPTER 4
TASK DEVELOPMENT

4.1 INTRODUCTION

This chapter discusses in detail the procedure for developing a task and for installing it into the PIREX software system. The development of tasks in the UC15 system normally begins by the determination of the function to be performed by the task. Once the basic function of the task has been determined and designed, the user can integrate it into the UC15 system. The following summary describes the steps necessary to accomplish this:

1. Determine the priority level at which the task will execute.
2. Design one or more appropriate TCB formats.
3. Assign a Task Code Number to the task.
4. Enter appropriate information into the various PIREX lists and tables.
5. Design and code the requesting program. This is the program which issues requests to the task.
6. Design and code the task.
7. Assemble all programs and test.

The remaining sections describe these steps in detail.

4.2 PRIORITY LEVEL DETERMINATION

The selection of a priority level for a newly developed task must be based upon its function. If the task is a device driver, a device priority should be selected. If the task is a data manipulation routine, a background priority should be chosen.

4.2.1 Device Priorities

The device priorities are 7 (highest) through 4 (lowest).

- Priority 7 must be reserved for certain PIREX routines and should not be used as a task priority. (Certain short instructions sequences require priority level 7 protection but a general use of priority 7 must be avoided.)

- Priority 6 should be used only if interaction with the CR11 Card Reader can be avoided. If the CR11 is in use, excessive IOPSUC CDU 74 errors (card column lost) will occur if this level is used by another task executing in parallel.
- Priorities 4 and 5 can be used in an unrestricted manner.

There are three types of priorities to consider when selecting the priority of a device driver.

1. The actual device hardware priority N.
2. The priority stored in the trap vector for the device (its new PS) must be priority 7 to allow an uninterrupted context switch.
3. The priority at which the task will execute after the context switch (R.SAVE). This should be N (the above constraints must be considered before deciding that it will be N). This priority is set in the LEVEL table (see Section 3.3.6).

4.2.2 Background Task Priorities

The standard UC15 PDP-11 computer does not differentiate between the software priorities 0 through 3. All software priorities are interruptable by any device operating at any device priority. These software priorities, while treated by the hardware as the same, are not treated by PIREX as identical. The background task's position in the Active Task List (the list to schedule the next task to run) is based upon its priority (as indicated in the LEVEL Table). Thus a priority 2 task is always selected for execution before a priority 1 task.

It should always be remembered that the ATL is built dynamically and is composed of only active tasks. Thus a task's actual ability to execute depends both on its priority and on what other tasks of equal or greater priority are actually available to execute (active). Tasks of the same priority are run on a first come-first serve basis.

4.3 TCB FORMAT AND LOCATION

The design of new Task Control Blocks (TCBs) must be governed by several constraints:

1. Certain "fixed" items of information must be present.
2. There may be a size constraint depending upon source of the TCB.
3. TCBs issued by the XVM have a location constraint.

The first three TCB words have a fixed format (see Section 3.2.5). The remainder of the TCB should be as follows:

1. Control words should be allocated to fixed pre-defined locations.
2. Data words should be blocked into the location following the control words.
3. The TCB size should be kept constant for ease of core allocation.

Location and size constraints are interrelated:

1. If the TCB is for a task executing under PIREX in PDP-11 Local Memory, there is no location constraint. The TCB size must be kept small enough so that the TCB does not overflow into common memory.
2. If the TCB is for a PDP-11 task executing in Common Memory, it must be positioned so that it is:

   a. present entirely in Common memory (not XVM Local Memory, and

   b. not overlaying any of the XVM monitor resident code.

   These constraints actually apply to any PDP-11 Code or data located beyond PDP-11 Local Memory.
3. If the TCB is for an XVM/RSX routine, it must be located in a task partition or common area that is within the Common Memory.
4. Since the specification of absolute core location is difficult in XVM/DOS, the TCB placement problem is somewhat more complex. The standard XVM/DOS system has seven TCBs assembled into the resident monitor. These include TCBs for RK Disk, XY11 Plotter, CR11 Card Reader and LP11/LV11/LS11 Printer. In addition there are three spare TCBs of various sizes. The user developing his own UNICHANNEL handler should take advantage of these spare TCBs. .SCOM+100 (location 200_8 in XVM memory) points to a table of pointers to each of these TCBs. The user should select the one closest to his size requirement. (See the XVM/DOS Systems Manual.)

4.4 TASK CODE NUMBER DETERMINATION

Task code numbers are composed of two fields. Bits 6 through 0 are used to contain the actual task code number. This is the number used when searching tables and lists ordered by TCN. In the DEC-supplied system, these numbers range from 0 through 13_8. Bit 7 is used in TCBs to determine if the task is spooled. If bit 7 = 1, the task is not spooled. If bit 7 = 0, the TCBs for the task are routed to the spooler if the spooler is enabled. (There must then be a spooler module prepared to handle TCBs for that particular task (see Chapter 5).)

Task codes 11, 12, and 13 are spare task codes in the DEC-supplied system. They are used in increasing order. The highest task code position must not be used for a permanent task because MAC11 requires this slot for its use as a temporary task (a task that is connected and disconnected at run time).

4.5 UPDATING LISTS AND TABLES

The installation of a new task requires placing entries into the various tables and lists. There are two cases:

1. the installation of a new task into a current spare task entry.
2. the installation of a new task into a new entry (by expanding the tables).

For each of these two cases there are two types of task entries:

1. permanent tasks
2. temporary tasks

A permanent task is one that is assembled into the PIREX binary. Its actual starting address and priority level are known.

A temporary task is one that is dynamically connected to and disconnected from PIREX. Its starting address is dependent upon its placement in memory. (Temporary tasks must be written in Position Independent Code - see MAC11 Assembler Language Manual.)

Chapter 3 describes the format of each table entry.

4.5.1 Temporary Task Installation - Existing Spare Entry

To install a Temporary Task into an Existing unused Task Entry, TCN 11_8, 12_8, or 13_8, simply use the CONNECT and DISCONNECT directives. No new table space and no new table entries are required.

4.5.2 Permanent Task Installation - Existing Spare Entry

To install a Permanent Task into an Existing unused Task Entry, TCN 11 or 12 perform the following:

1. Update the LEVEL table entry for that TCN with the task's priority (see Section 3.3.6).
2. Update the TEVADD Table entry for that TCN with the task's starting address (see Section 3.3.7).
3. Optionally update the interrupt vector table if the task is a device driver task (see Section 3.3.9).

4.5.3 Temporary Task - New Entry

To install a Temporary Task into a new Temporary Task Entry (i.e., to expand the table to accommodate a new Temporary Task) perform the following:

1. Add an entry to the ATLNP Table (see Section 3.3.1.2).
2. Add an entry to the LISTHD Table (see Section 3.3.3).
3. Add an entry to the LEVEL Table (use ".BYTE 0" as the priority value since this is a Temporary Task Entry and the actual task priority will be filled in by the connect directive).
4. Add an entry to the DEVST Table (see Section 3.3.5).[1]
5. Add an entry to the CLTABL (see Section 3.3.4).
6. Add an entry to the TEVADD Table (use ".WORD 0" as the entry, since this is a Temporary Task entry that will be filled in by the CONNECT directive).
7. Add an entry in the SEND11 Table (see Section 3.3.8).

[1] PIREX transfers, upon request, the entire DEVST Table to the XVM/DOS monitor. The XVM/DOS resident monitor can accommodate a maximum of 5 additional DEVST entries beyond the current 13$_8$. Expansion beyond 20$_8$ entries would require reassembly of the XVM/DOS resident monitor.

4.5.4 Permanent Task Installation - New Entry

For a new Permanent Task, repeat the procedure in paragraph 4.5.3, for a new Temporary Task, with the following changes:

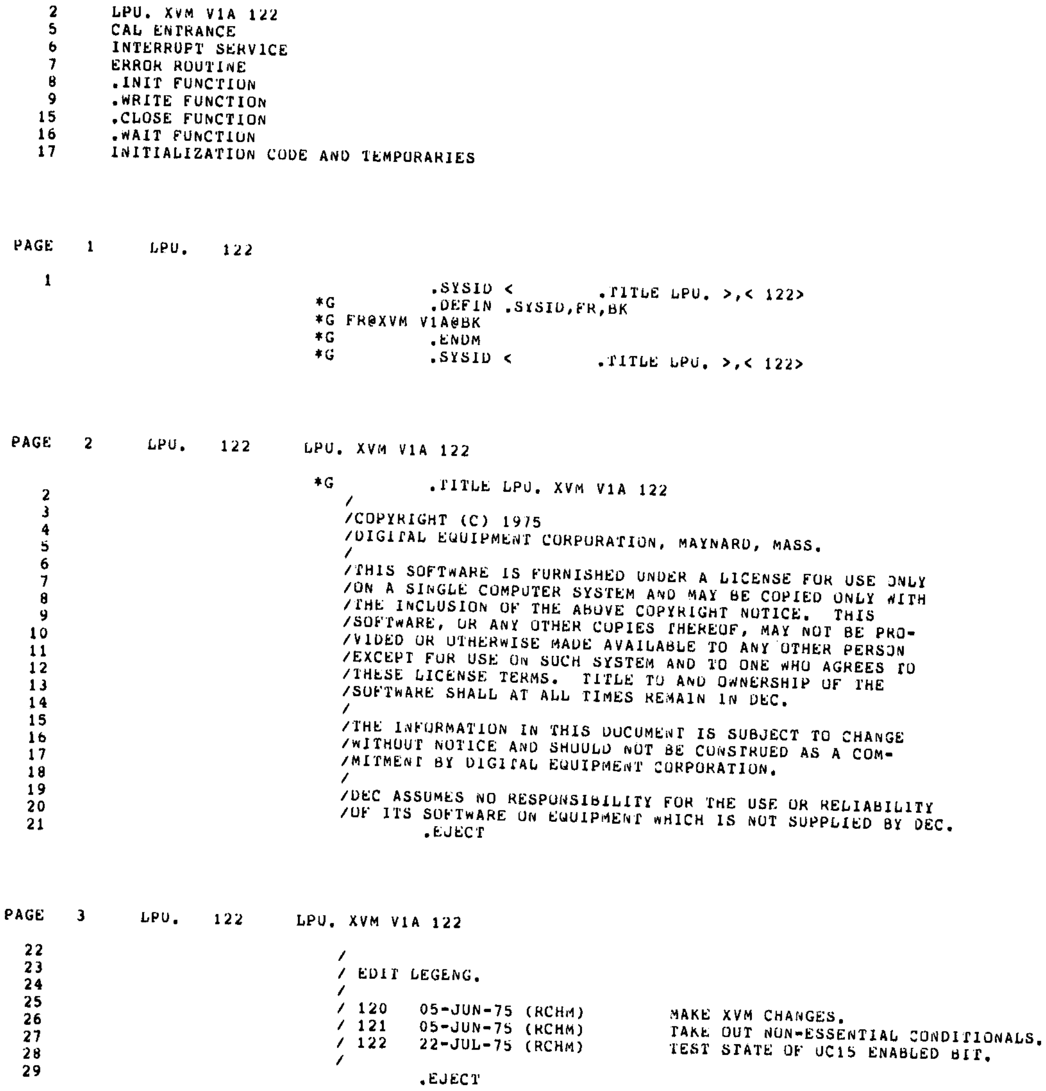
1. Step 3 is changed to: Place the task's priority in the new LEVEL Table entry (see Section 3.3.6).
2. Step 6 is changed to: Place the task's starting address in the new TEVADD entry (see Section 3.3.7).
3. Optionally update the interrupt vector table if the task is a device driver task (see Section 3.3.9).

4.6 CONSTRUCTING DEVICE HANDLERS

This section describes how to construct device handlers for XVM/DOS and XVM/RSX. Additional information on construction of a PDP-11 requesting task is provided.

4.6.1 Constructing a XVM/DOS UNICHANNEL Device Handler

The following description of how to construct a handler for the XVM/DOS monitor does not discuss those topics related to all XVM/DOS handlers both traditional and UNICHANNEL. General issues pertaining to all XVM/DOS device handlers can be found in the XVM/DOS Systems Manual. The UNICHANNEL Line Printer handler is used as a descriptive example (see Figure 4-1). Several constants should be defined in a UNICHANNEL handler source file before the executable code (see Figure 4-1, lines 48-55, 71-73). These constants include:



```
     2     LPU. XVM V1A 122
     5     CAL ENTRANCE
     6     INTERRUPT SERVICE
     7     ERROR ROUTINE
     8     .INIT FUNCTION
     9     .WRITE FUNCTION
    15     .CLOSE FUNCTION
    16     .WAIT FUNCTION
    17     INITIALIZATION CODE AND TEMPORARIES



PAGE    1      LPU.    122

                                   .SYSID <         .TITLE LPU. >,< 122>
                        *G         .DEFIN .SYSID,FR,BK
                        *G FR@XVM V1A@BK
                        *G         .ENDM
                        *G         .SYSID <         .TITLE LPU. >,< 122>


PAGE    2      LPU.    122    LPU. XVM V1A 122

                        *G         .TITLE LPU. XVM V1A 122
                           /
                           /COPYRIGHT (C) 1975
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                           /
                           /THIS SOFTWARE IS FURNISHED UNDER A LICENSE FOR USE ONLY
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                           /EXCEPT FOR USE ON SUCH SYSTEM AND TO ONE WHO AGREES TO
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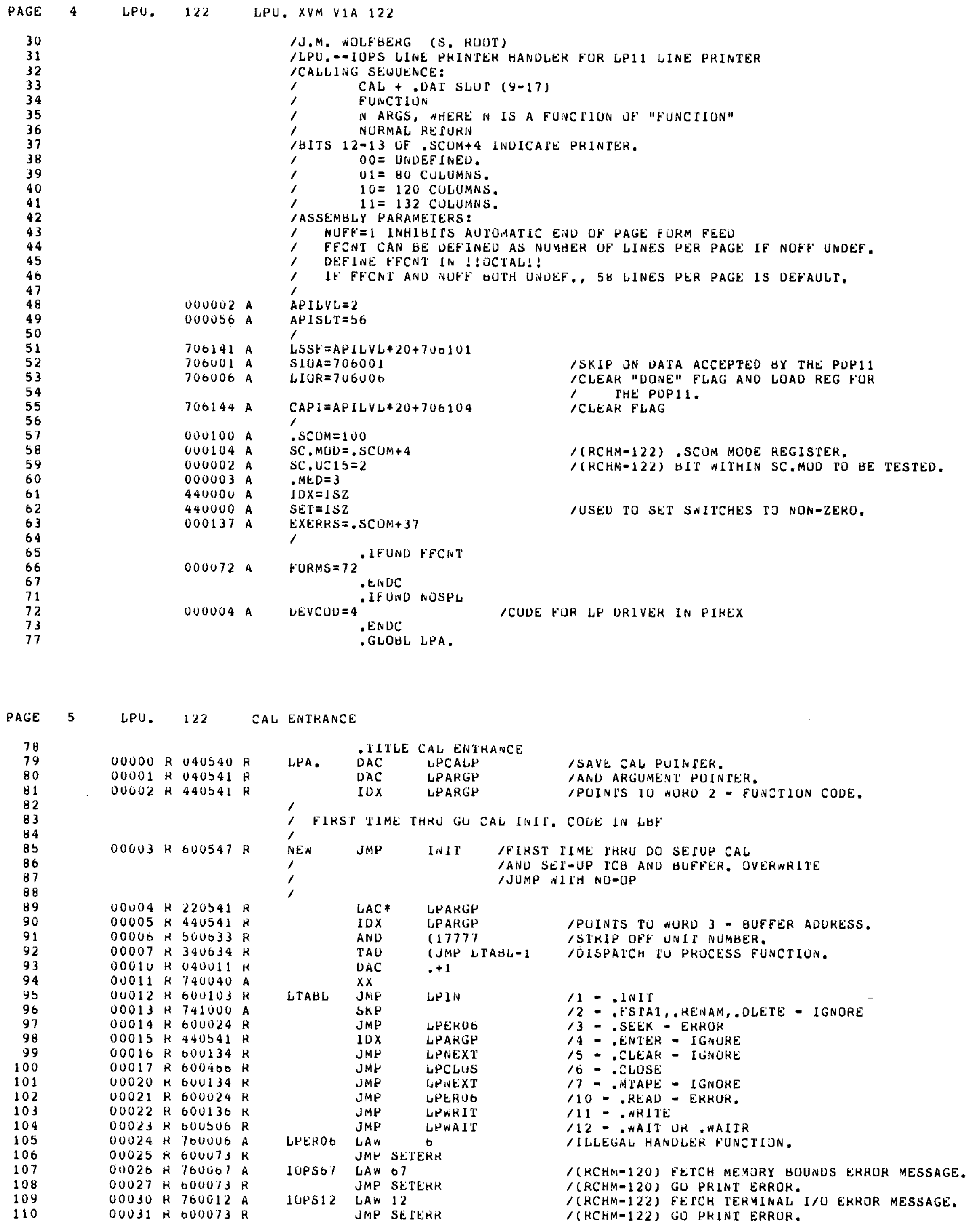
                           /MITMENT BY DIGITAL EQUIPMENT CORPORATION.
                           /
                           /DEC ASSUMES NO RESPONSIBILITY FOR THE USE OR RELIABILITY
                           /OF ITS SOFTWARE ON EQUIPMENT WHICH IS NOT SUPPLIED BY DEC.
                                   .EJECT


PAGE    3      LPU.    122    LPU. XVM V1A 122

                           /
                           / EDIT LEGEND.
                           /
                           / 120    05-JUN-75 (RCHM)         MAKE XVM CHANGES.
                           / 121    05-JUN-75 (RCHM)         TAKE OUT NON-ESSENTIAL CONDITIONALS.
                           / 122    22-JUL-75 (RCHM)         TEST STATE OF UC15 ENABLED BIT.
                           /
                                   .EJECT
```

Figure 4-1
XVM LP11 DOS Handler



```
PAGE    4      LPU.    122      LPU. XVM V1A 122

           /J.M. WOLFBERG  (S. ROOT)
           /LPU.--IOPS LINE PRINTER HANDLER FOR LP11 LINE PRINTER
           /CALLING SEQUENCE:
           /       CAL + .DAT SLOT (9-17)
           /       FUNCTION
           /       N ARGS, WHERE N IS A FUNCTION OF "FUNCTION"
           /       NORMAL RETURN
           /BITS 12-13 OF .SCOM+4 INDICATE PRINTER.
           /       00= UNDEFINED.
           /       01= 80 COLUMNS.
           /       10= 120 COLUMNS.
           /       11= 132 COLUMNS.
           /ASSEMBLY PARAMETERS:
           /   NOFF=1 INHIBITS AUTOMATIC END OF PAGE FORM FEED
           /   FFCNT CAN BE DEFINED AS NUMBER OF LINES PER PAGE IF NOFF UNDEF.
           /   DEFINE FFCNT IN !!OCTAL!!
           /   IF FFCNT AND NOFF BOTH UNDEF., 58 LINES PER PAGE IS DEFAULT.
           /
000002 A   APILVL=2
000056 A   APISLT=56
           /
706141 A   LSSF=APILVL*20+706101
706001 A   SIOA=706001                     /SKIP ON DATA ACCEPTED BY THE PDP11
706006 A   LIOR=706006                     /CLEAR "DONE" FLAG AND LOAD REG FOR
                                           /    THE PDP11.
706144 A   CAPI=APILVL*20+706104           /CLEAR FLAG
           /
000100 A   .SCOM=100
000104 A   SC.MOD=.SCOM+4                  /(RCHM-122) .SCOM MODE REGISTER.
000002 A   SC.UC15=2                       /(RCHM-122) BIT WITHIN SC.MOD TO BE TESTED.
000003 A   .MED=3
440000 A   IDX=ISZ
440000 A   SET=ISZ                         /USED TO SET SWITCHES TO NON-ZERO.
000137 A   EXERRS=.SCOM+37
           /
                  .IFUND FFCNT
000072 A   FORMS=72
                  .ENDC
                  .IFUND NOSPL
000004 A   DEVCOD=4              /CODE FOR LP DRIVER IN PIREX
                  .ENDC
                  .GLOBL LPA.


PAGE    5      LPU.    122      CAL ENTRANCE

                          .TITLE CAL ENTRANCE
00000 R 040540 R   LPA.   DAC     LPCALP         /SAVE CAL POINTER.
00001 R 040541 R          DAC     LPARGP         /AND ARGUMENT POINTER.
00002 R 440541 R          IDX     LPARGP         /POINTS TO WORD 2 - FUNCTION CODE.
                   /
                   /  FIRST TIME THRU GO CAL INIT. CODE IN LBF
                   /
00003 R 600547 R   NEW    JMP     INIT    /FIRST TIME THRU DO SETUP CAL
                   /                      /AND SET-UP TCB AND BUFFER. OVERWRITE
                   /                      /JUMP WITH NO-OP
                   /
00004 R 220541 R          LAC*    LPARGP
00005 R 440541 R          IDX     LPARGP         /POINTS TO WORD 3 - BUFFER ADDRESS.
00006 R 500633 R          AND     (17777         /STRIP OFF UNIT NUMBER.
00007 R 340634 R          TAD     (JMP LTABL-1   /DISPATCH TO PROCESS FUNCTION.
00010 R 040011 R          DAC     .+1
00011 R 740040 A          XX
00012 R 600103 R   LTABL  JMP     LPIN           /1 - .INIT
00013 R 741000 A          SKP                    /2 - .FSTAT,.RENAM,.DLETE - IGNORE
00014 R 600024 R          JMP     LPER06         /3 - .SEEK - ERROR
00015 R 440541 R          IDX     LPARGP         /4 - .ENTER - IGNORE
00016 R 600134 R          JMP     LPNEXT         /5 - .CLEAR - IGNORE
00017 R 600466 R          JMP     LPCLOS         /6 - .CLOSE
00020 R 600134 R          JMP     LPNEXT         /7 - .MTAPE - IGNORE
00021 R 600024 R          JMP     LPER06         /10 - .READ - ERROR.
00022 R 600136 R          JMP     LPWRIT         /11 - .WRITE
00023 R 600506 R          JMP     LPWAIT         /12 - .WAIT OR .WAITR
00024 R 760006 A   LPER06 LAW     6              /ILLEGAL HANDLER FUNCTION.
00025 R 600073 R          JMP SETERR
00026 R 760067 A   IOPS67 LAW 67                 /(RCHM-120) FETCH MEMORY BOUNDS ERROR MESSAGE.
00027 R 600073 R          JMP SETERR             /(RCHM-120) GO PRINT ERROR.
00030 R 760012 A   IOPS12 LAW 12                 /(RCHM-122) FETCH TERMINAL I/O ERROR MESSAGE.
00031 R 600073 R          JMP SETERR             /(RCHM-122) GO PRINT ERROR.
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE   6      LPU.    122      INTERRUPT SERVICE

                                           .TITLE INTERRUPT SERVICE
                                    /
                                    /LPU. INTERRUPT SERVICE
         00032 R 600042 R     LPINT    JMP      LPPIC    /PIC ENTRY, JUMP TO CODE
         00033 R 040566 R              DAC      LPAC     /SAVE INTERRUPTED AC
         00034 R 200032 R              LAC      LPINT    /GET INTERRUPTED PC
         00035 R 040567 R              DAC      LPOUT    /SAVE FOR COMMON EXIT
         00036 R 200635 R              LAC      (JMP LPPIC /RESTORE PIC ENTRY
         00037 R 040032 R              DAC      LPINT
         00040 R 200636 R              LAC      (NOP     /WE DON'T NEED ION IN COMMON EXIT
         00041 R 600046 R              JMP      LPICM    /JOIN COMMON CODE
                                    /
         00042 R 040566 R     LPPIC    DAC      LPAC     /PIC CODE, SAV AC
         00043 R 220637 R              LAC*     (0       /GET INTERRUPTED PC
         00044 R 040567 R              DAC      LPOUT    /SAVE
         00045 R 200640 R              LAC      (ION     /NEED INTERRUPT ON INST. IN COMMON CODE
         00046 R 040056 R     LPICM    DAC      LPISW
         00047 R 706144 A              CAPI              /CLEAR FLAG, NOW IN COMMON CODE
         00050 R 220553 R              LAC*     LPEV     /EVENT VARIABLE FROM PIREX
         00051 R 742010 A              RTL               /PDP-11 (MINUS) BIT TO OUR AC0
         00052 R 743120 A              SPA!RTR           /+ IS OK
         00053 R 600061 R              JMP      LPIERR   /ERROR, GO LOOK
         00054 R 140544 R     LPIRT    DZM      LPUND    /CLEAR UNDERWAY FLAG
         00055 R 200566 R     LPIRT1   LAC      LPAC     /RESTORE AC
         00056 R 740040 A     LPISW    HLT               /ION OR NOP
         00057 R 703344 A              DBR
         00060 R 620567 R              JMP*     LPOUT
                                    /
                                    /
         00061 R 500641 R     LPIERR   AND      (177777 /KEEP REAL 16 BITS FROM PDP-11
         00062 R 540642 R              SAD      (177001 /CODE FROM OUT OF NODES IN PIREX
         00063 R 600066 R              JMP      RETRY   /JUST TRY AGAIN, LEAVING LPUND SET
         00064 R 340643 R              TAD      (600000 /MAKE - NUMBER FOR IOPS
         00065 R 600073 R              JMP      SETERR  /TREAT AS REGULAR IOPS ERROR
                                    /                   /NOTE THAT THIS SHOULDN'T HAPPER.
                                    /
                                    /
         00066 R 200550 R     RETRY    LAC      LPTCB    /TCB ADDRESS
         00067 R 706001 A              SIOA
         00070 R 600067 R              JMP      .-1      /
         00071 R 706006 A              LIOR              /THIS MAGIC SHIPS TCB ADDR. TO PDP-11
         00072 R 600055 R              JMP      LPIRT1   /EXIT FROM INTERRUPT
                                    /
                                    /


PAGE   7      LPU.    122      ERROR ROUTINE

                                           .TITLE  ERROR ROUTINE
                                    /
         00073 R 040102 R     SETERR   DAC ERRNUM
         00074 R 740000 A     ERLOOP   NOP                            /'JMP LPTRY' IF IOPS 4 ERROR.
         00075 R 200102 R              LAC ERRNUM
         00076 R 120644 R     EROUT    JMS* (EXERRS
         00077 R 600074 R              JMP ERLOOP
         00100 R 777777 A              LAW -1
         00101 R 142025 A              .SIXBT 'LPU'
         00102 R 000000 A     ERRNUM   0                              /HOLDS ERROR NUMBER FOR REPEAT.
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE   8      LPU.    122      .INIT FUNCTION

                                        .TITLE .INIT FUNCTION
                               /
                               /.INIT
                               /
     00103 R 220645 R          LPIN     LAC* (SC.MOD)             /(RCHM-122) CHECK MODE REGISTER FROM SCOM,
     00104 R 500646 R                   AND (SC.UC15)             /(RCHM-122)  FOR UC15 ENABLED.
     00105 R 741200 A                   SNA                       /(RCHM-122) IS IT?
     00106 R 600030 R                   JMP IOPS12                /(RCHM-122) NO, GO PRINT ERROR.
     00107 R 440541 R                   IDX LPARGP                /(RCHM-122)
     00110 R 200555 R                   LAC BUFSIZ                /36(10) FOR 80 COLS; 56(10) FOR 132 COLS.
     00111 R 060541 R                   DAC* LPARGP               /RETURN TO USER.
     00112 R 440541 R                   IDX LPARGP                /NOW POINTS TO RETURN.
     00113 R 200542 R                   LAC      PAGSIZ  /LF COUNTER
     00114 R 040543 R                   DAC      PAGCNT
     00115 R 220540 R                   LAC*     LPCALP  /DOES INIT INHIBIT AUTO FORMS FEED
     00116 R 500647 R                   AND      (4000   /THIS IS INHIBIT BIT
     00117 R 340546 R                   TAD      FFFF    /FFFF ASSEMBLED AS NOP FOR NOFF, ISZ IF NOT
     00120 R 540546 R                   SAD      FFFF    /SKIP IF INIT INHIBITS FF
     00121 R 741000 A                   SKP              /INIT DOESN'T INHIBIT, USE ASSEMBLED VALUE
     00122 R 200636 R                   LAC      (NOP    /INIT INHIBITS IT, USE NOP
     00123 R 040545 R                   DAC      FFSW    /THIS SWITCH XCT'ED BY FORMS CONTROL
                               /                         /SECTION IN PUTCH SUBROUTINE
     00124 R 100455 R                   JMS      RESETL  /RESET TAB AND LINE WIDTH COUNTERS
     00125 R 100524 R                   JMS      LPIOCK  /CHECK LP BUSY
     00126 R 140562 R                   DZM      COP     /SAY A FF OCCURRED
     00127 R 750030 A                   CLA!IAC          /COUNT OF ONE BYTE FOR HEADER
     00130 R 060551 R                   DAC*     LPBUF   /HEADER
     00131 R 723013 A                   AAC      13      /FORM FEED
     00132 R 060552 R                   DAC*     LPBUFD  /FOR BUFFER
                                        .IFUND   NOFF    /DO ONLY IF NOFF NOT DEFINED
     00133 R 100531 R                   JMS      LPSET   /THIS SENDS REQ. TO PDP-11
                                        .ENDC
                               /
                               /NORMAL CAL EXIT
                               /
     00134 R 703344 A          LPNEXT   DBR
     00135 R 620541 R                   JMP*     LPARGP
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE    9      LPU.    122      .WRITE FUNCTION

                                     .TITLE .WRITE FUNCTION
                            /
                            /.WRITE
                            /
00136 R 100524 R            LPWRIT   JMS LPIOCK               /PRINTER BUSY?
00137 R 220540 R                     LAC* LPCALP              /GET THE DATA MODE FROM THE USER CAL.
00140 R 500650 R                     AND     (1000    /MAKE SKP-NOP IN MIX
00141 R 240651 R                     XOR     (SKP
00142 R 040565 R                     DAC     MIX
00143 R 220541 R                     LAC*    LPARGP           /USER BUFFER ADDRESS.
00144 R 440541 R                     IDX LPARGP       /NOW POINTS TO WORD COUNT
00145 R 040561 R                     DAC     TCHAR    /SAVE POINTER TO BUFFER HEADER
00146 R 723002 A                     AAC     2        /MAKE X12 POINT TO DATA NOT HEADER
00147 R 040570 R                     DAC     X12      /GETTER POINTER
00150 R 500652 R                     AND (700000)             /(RCHM-120) EXTRANC EXTEND ADDRESSING BITS FROM BUFFER ADDR3ESS.
00151 R 740200 A                     SZA                      /(RCHM-120) ARE ANY SET?
00152 R 600026 R                     JMP IOPS67               /(RCHM-120) YES, ISSUE IOPS67 ERROR MESSAGE.
                            /
                            /  SET UP LIMIT OF INPUT BUFFER SIZE TO PREVENT DATA OVERRUN
                            /  FOR BOTH IOPS ASCII AND IMAGE ASCII
                            /
00153 R 777000 A                     LAW     17000    /GET PAIR COUNT FROM LEFT HALF
00154 R 520561 R                     AND*    TCHAR
00155 R 742030 A                     SWHA             /BRING TO RIGHT. PAIR COUNT INCLUDES HEADER
                            /                         /PAIR COUNT. WE ISZ BEFORE LOOP SO THAT'S
                            /                         /OK. IOPS NOW SET XCPT CMA!IAC
00156 R 400565 R                     XCT     MIX      /SKIP IF ASCII, NOT IF IMAGE
00157 R 751001 A                     SKP!CLA!CMA      /IMAGE -1 IN AC, SKIP. -1 BECAUSE WE ISZ FIRST
00160 R 741031 A                     SKP!CMA!IAC      /IOPS COMPLEMENTED TO CORRECT VALUE
00161 R 360541 R                     TAD*    LPARGP   /IMAGE ADD IN TOTAL WORD COUNT, INCL
                            /                         /TWO WORDS FOR HEADER. WE ISZ BEFORE LOOP.
00162 R 040554 R                     DAC     TEMP1    /INTO CONTROLLER, BOTH MODES
00163 R 440541 R                     ISZ     LPARGP   /MOVE ARG POINTER TO EXIT
00164 R 200552 R                     LAC     LPBUFD   /POINTER TO DATA PORTION OF BUFFER
00165 R 040571 R                     DAC     PUTP     /LOAD TO CHARACTER PUTTER POINTER
00166 R 200347 R                     LAC     GETIN    /INIT. CHAR GETTER
00167 R 040344 R                     DAC     GETSW
00170 R 200443 R                     LAC     PUTIN    /INIT CHAR PUTTER
00171 R 040441 R                     DAC     PUTSW
00172 R 750000 A                     CLA              /INIT OUTPUT BUFFER HEADER
00173 R 400565 R                     XCT     MIX      /TO 0 IF IOPS, 400 FOR IMAGE
00174 R 200653 R                     LAC     (400
00175 R 060551 R                     DAC*    LPBUF
00176 R 750001 A                     CLA!CMA          /COUNT OF 1 BLANK AS DEFUALT
                            /                         /FOR ZERO LENGTH IOPS LINE
00177 R 060552 R                     DAC*    LPBUFD   /IN FIRST DATA CHAR
                            /
                            /  MAIN LOOP TO TRANSFER CHAR'S TO HANDLER BUFFER
                            /
00200 R 100332 R            MAIN     JMS     GETCH    /CHARACTER GETTER, LEAVES IT IN AC
00201 R 741200 A                     SNA              /SKIP UNLESS NULL CHAR
00202 R 600200 R                     JMP     MAIN     /NULL, IGNORE
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE  10      LPU.    122      .WRITE FUNCTION

         00203 R 540654 R                SAD      (177      /IGNORE RUB-OUT
         00204 R 600200 R                JMP      MAIN      /MAIN
         00205 R 040561 R                DAC      TCHAR     /SAVE CHAR THROUGH TESTING
         00206 R 723740 A                AAC      -40       /SEPARATE 'TEXT' CHAR'S FROM CONTROL CHAR'S
         00207 R 741300 A                SNA!SPA            /SKIP ON REGULAR CHARS
         00210 R 600247 R                JMP      MSPEC     /GO DO SPECIALS
         00211 R 540655 R                SAD      (135      /ALT MODE
         00212 R 600314 R                JMP      UCLP03    /END OF LINE ON ALT MODE
                                  /
                                  /  SORRY ABOUT NE XT FIVE L NES.
                                  /  THE LOGIC AT PUTCH TO DO FORMS CONTROL DOESN'T DO IMPLIED
                                  /  LINE FEEDS, I.E. THOSE LINES HAVING NO LEADING CONTROL CHAR.
                                  /  WE HAVE TO FAKE IT OUT BY   LACING A LINE FEED ON SUCH LINES!?!
                                  /
         00213 R 200560 R                LAC      FIRST     /DO ONLY IF FIRST CHAR OF LINE IS REGULAR
         00214 R 740100 A                SMA                /SKIP IF FIRST CHAR
         00215 R 600220 R                JMP      .+3       /NOT FIRST CHAR, JUST CONTINUE
         00216 R 200656 R                LAC      (12       /HERE IS LINE FEED
         00217 R 100400 R                JMS      PUTCH     /AND CALL TO DO FORMS CONTROL
                                  /
         00220 R 750030 A                CLA!IAC            /SET FLAG SAYING A REAL CHAR SINCE A FF
         00221 R 040562 R                DAC      COP
                                  /
         00222 R 200563 R                LAC      BLANKC    /DO WE HAVE PENDING BLANKS/TABS TO SEND
                                  /
                                  /  NOTE BLANKC HAS MINUS COUNT OF CONSECTIVE BLANKS/TABS
                                  /  SINCE PDP-11 CONTROLLER PRINTS ONLY BLANKS
                                  /
         00223 R 744100 A                SMA!CLL            /SKIP IF ANY COLLECTED, TO PUT OUT BEFORE
                                  /                         /REAL CHAR'S
         00224 R 600235 R                JMP      MAINC     /NONE, PENDING, GO PUT OUT THE CHAR
         00225 R 340657 R                TAD      (200      /TOUGH, IF MORE THAN 127 COLLECTED, MUST
                                  /                         /PUT OUT TWO COUNTS
         00226 R 750100 A                SMA!CLA            /SKIP IF NEED TWO COUNTS
         00227 R 600233 R                JMP      MAIND     /NO, JUST PUT OUT COLLECTED COUNT
         00230 R 340657 R                TAD      (200      /TWO COUNTS, HERE IS FIRST
         00231 R 100400 R                JMS·     PUTCH
         00232 R 200657 R                LAC      (200      /SET UP TO DO SECOND
         00233 R 340563 R         MAIND  TAD      BLANKC    /COMMON CODE, LAST COUNT FOR EITHER CASE
         00234 R 100400 R                JMS      PUTCH
         00235 R 140563 R         MAINC  DZM      BLANKC    /CLEAR OUT BLANK COUNTER
         00236 R 200561 R                LAC      TCHAR     /GET BACK ORIGINAL CHAR
         00237 R 100400 R                JMS      PUTCH     /TO OUTPUT BUFFER
         00240 R 440564 R         MAINK  ISZ      TABC      /INCREMENT TAB COUNTER
         00241 R 600244 R                JMP      MAINE     /NOT OVERFLOW, GO CHECK LINE COUNTER
         00242 R 777770 A                LAW      -10       /RESET TAB COUNTER
         00243 R 040564 R                DAC      TABC
         00244 R 440557 R         MAINE  ISZ      MAXC      /HAVE WE RUN OUT OF LINE
         00245 R 600200 R                JMP      MAIN      /NO
         00246 R 600314 R                JMP      UCLP03    /YES, GO FINISH UP, WITH END OF LINE
                                  /
                                  /  SPECIAL CHARACTERS
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE  11      LPU.    122      .WRITE FUNCTION

                                 /
           00247 R 750201 A    MSPEC   SZA!CLA!CMA      /SKIP IF IT IS A BLANK
           00250 R 600254 R            JMP      MSPEC2  /NOPE, CHECK FOR OTHER THINGS
           00251 R 340563 R            TAD      BLANKC  /ADD ONE TO BLANK COUNTER (IS MINUS COUNTER)
           00252 R 040563 R            DAC      BLANKC
           00253 R 600240 R            JMP      MAINK   /JOIN LINE AND TAB CONTROL SECTION
           00254 R 200561 R    MSPEC2  LAC      TCHAR   /GET BACK ORIGINAL CHAR
           00255 R 540660 R            SAD      (11     /IS IT A TAB
           00256 R 600300 R            JMP      MTAB    /YUP, GO DO IT
           00257 R 540661 R            SAD      (15     /CARRIAGE RETURN
           00260 R 600314 R            JMP      UCLP03  /END OF LINE ON CARRIAGE RETURN
           00261 R 540662 R            SAD      (20     /FORTRAN OTS OVERPRINT, DO AS CR
           00262 R 600275 R            JMP      MCR
           00263 R 540663 R            SAD      (14     /FORM FEED
           00264 R 600270 R            JMP      MSPEC3  /JUST PUT IT OUT, FOR NOW
           00265 R 540664 R            SAD      (21     /FORTRAN DOUBLE SPACE
           00266 R 600272 R            JMP      MSPEC4  /DO AS TWO 12'S
           00267 R 200656 R    MSPEC5  LAC      (12     /DEFAULT ON UNRECOGNIZED CONTROL CHAR. IS LINE FEED
           00270 R 100400 R    MSPEC3  JMS      PUTCH   /PLACE IN BUFFER
           00271 R 600200 R            JMP      MAIN    /GO DO NEXT
           00272 R 200656 R    MSPEC4  LAC      (12     /FIRST OF TWO 12'S FOR THE 21
           00273 R 100400 R            JMS      PUTCH
           00274 R 600267 R            JMP      MSPEC5  /GO DO THE SECOND 112
           00275 R 100455 R    MCR     JMS      RESETL  /NEW LINE, RESET VARIOUS GUYS
           00276 R 200661 R            LAC      (15     /CARRIAGE RETURN
           00277 R 600270 R            JMP      MSPEC3  /PUT CHAR AND LOOP
           00300 R 200564 R    MTAB    LAC      TABC    /GET REMAINING COUNT FOR TAB
           00301 R 340563 R            TAD      BLANKC  /AND ADD TO CUMULATIVE BLANK COUNT
           00302 R 040563 R            DAC      BLANKC
           00303 R 200564 R            LAC      TABC    /AND TO LINE CHECKER
           00304 R 740031 A            CMA!IAC
           00305 R 340557 R            TAD      MAXC
           00306 R 040557 R            DAC      MAXC
           00307 R 740100 A            SMA              /SKIP IF SOME LINE LEFT
           00310 R 600314 R            JMP      UCLP03  /NONE LEFT, FINISH UP LINE
           00311 R 777770 A            LAW      -10
           00312 R 040564 R            DAC      TABC    /RESET TAB COUNTER
           00313 R 600200 R            JMP      MAIN    /NEXT CHAR
                               /
           00314 R 200661 R    UCLP03  LAC      (15     /CARRIAGE RETURN
           00315 R 400565 R            XCT      MIX     /PLACE IN BUFFER ONLY ON IMAGE!!!
           00316 R 100400 R            JMS      PUTCH
           00317 R 100455 R            JMS      RESETL
           00320 R 440562 R    UCLP04  ISZ      COP     /A BLANK LINE IS STILL A REAL CHAR SINCE FF
           00321 R 220551 R            LAC*     LPBUF   /ZERO CHAR COUNT??
           00322 R 500665 R            AND      (377    /COUNT ONLY IN LOW 8 BITS
           00323 R 740200 A            SZA              /SKIP IF ZERO COUNT
           00324 R 600330 R            JMP      UCLP05  /NON-ZERO, JUST GO DO REGULAR
           00325 R 400565 R            XCT      MIX     /IMAGE OR IOPS
           00326 R 600134 R            JMP      LPNEXT  /IMAGE DO NOTHING
           00327 R 460551 R            ISZ*     LPBUF   /IOPS MAKE FAKE 1 COUNT
                               /                        /WE ARE DOING A BLANK LINE, AND 0
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE  12      LPU.    122      .WRITE FUNCTION

                                /                          /COUNT MAKES SPOOLER VERY ILL
         00330 R 100531 R       UCLP05  JMS      LPSET    /SEND BUFFER TO PDP-11
         00331 R 600134 R               JMP      LPNEXT   /CAL EXIT
                                /
                                /       CHARACTER UNPACKING ROUTINE
                                /
                                /
                                /  THIS ROUTINE 'OWNS' THE MQ
                                /
                                /
                                /  CHARACTERS ARE OBTAINED FROM X12 POINTER. EACH CHAR
                                /  IS RETURNED RIGHT JUSTIFIED IN THE AC
                                /  TEMP1 HAS A MINUS COUNT OF THE WORDS TO BE OBTAINED
                                /  FROM THE INPUT POINTER X12
                                /
         00332 R 000000 A       GETCH   0
         00333 R 400565 R               XCT      MIX      /SKIP IF IT IS ASCII
         00334 R 741000 A               SKP
         00335 R 620344 R               JMP*     GETSW    /GETSW IS POINTER TO CORRECT ACTION ON ONTHE
                                /                          /CORRECT ONE OF THE FIVE POSSIBLE CHAR'S
                                /
                                /  NOW DO IMAGE MODE
                                /
         00336 R 440554 R               ISZ      TEMP1
         00337 R 741000 A               SKP               /SKP ON NOT THRU YET
         00340 R 600320 R               JMP      UCLP04   /DONE
         00341 R 220570 R               LAC*     X12
         00342 R 440570 R               ISZ      X12
         00343 R 600345 R               JMP      GETCM    /FINISH UP IN COMMON
                                /
         00344 R 000000 A       GETSW   0                 /POINTER TO CORRECT ACTION. INIT'ED FROM GETIN
                                /                          /FILLED BY JMS GETSW AFTER EACH CHAR
         00345 R 500654 R       GETCM   AND      (177     /COMMON FINISH UP, STRIP XTRA BITS
         00346 R 620332 R               JMP*     GETCH    /OUT
                                /
         00347 R 000351 R       GETIN   GET1              /INIT GETSW TO POINT TO FIRST CHAR ACTION
                                /
                                /  INDIVIDULA CHARACTER ACTION
                                /
         00350 R 100344 R       GETQ    JMS      GETSW    /AFTER 5TH CHAR, POINT BACK TO FIRST
                                /
         00351 R 440554 R       GET1    ISZ      TEMP1    /OUT OF PAIRS?
         00352 R 600355 R               JMP      .+3      /CONTINUE IF OK
         00353 R 100455 R               JMS      RESETL   /END OF LINE RESET SONE STUFF
         00354 R 600320 R               JMP      UCLP04
         00355 R 220570 R               LAC*     X12      /FIRST WORD OF PAIR
         00356 R 440570 R               ISZ      X12
         00357 R 652000 A               LMQ               /INTO MQ FOR SHIFTING
         00360 R 640607 A               LLS      7
         00361 R 100344 R               JMS      GETSW    /DONE, LEAVE POINTER FOR SECOND CHAR
         00362 R 640607 A       GET2    LLS      7        /SECOND CHAR
         00363 R 100344 R               JMS      GETSW    /LEAVING POINTER FOR THIRD
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE  13    LPU.   122    .WRITE FUNCTION

   00364 R 640604 A   GET3   LLS     4       /THE HALF-AND-HALF CHAR
   00365 R 040344 R          DAC     GETSW   /VERY TEMPORARY
   00366 R 220570 R          LAC*    X12     /CAN'T END IN MIDDLE OF PAIR
   00367 R 440570 R          ISZ     X12
   00370 R 652000 A          LMQ             /SECOND WORD TO SHIFTER
   00371 R 200344 R          LAC     GETSW   /BRING BACK FIRST
   00372 R 640603 A          LLS     3       /COMPLETE CHAR
   00373 R 100344 R          JMS     GETSW   /LEAVING POINTER TO FOURTH ACTION
   00374 R 640607 A   GET4   LLS     7
   00375 R 100344 R          JMS     GETSW   /LEAVING FOR 5
   00376 R 640607 A   GET5   LLS     7
   00377 R 600350 R          JMP     GETQ    /BACK TO TOP FOR POINTER TO 1
                      /
                      /
                      /
                      /  CHARACTER PUTTER FOR PDP-11
                      /
                      /  TWO CHAR'S PER WORD FORMAT. FIRST CHAR IS RIGHT JUSTIFIED, SECOND
                      /  IS PLACED IMMEDIATELY ABOVE FIRST, LEAVING TOP TWO BITS OF WORD
                      /  UNUSED. CHAR IS DELEVERD TO US IN AC. INIT PUTSW BY DAC'ING CONTENTS
                      /  OF PUTIN INTO IT. ROUTINE COUNTS THE OUTPUT CHARS IN LBF
                      /
                      /  THIS ROUTINE ALSO HANDLES FORM FEED PAGE CONTROL
                      /  THE PDP-11 ASSUMES LINES HAVE A LF IN BEGINNING AND CR AT END
                      /  SO THIS ROUTINE REMOVES ANY LEADING LF.
                      /
                      /
   00400 R 000000 A   PUTCH   0
   00401 R 500665 R          AND     (377    /STRIP TO EIGHT BITS
   00402 R 540656 R          SAD     (12     /SPECIAL CASE #1, LINE FEED
   00403 R 600412 R          JMP     PUTLF   /GO DO IT
   00404 R 540663 R          SAD     (14     /SPECIAL CASE #2, FORM FEED
   00405 R 600427 R          JMP     PUTFF   /GO DO IT
   00406 R 440560 R   PUTY   ISZ     FIRST   /BUMP FIRST TIME THRU SWTICH
   00407 R 740000 A          NOP             /IN CASE SKIPS, WE DON'T NEED IT HERE
   00410 R 460551 R   PUTZ   ISZ*    LPBUF   /COUNT AN OUTPUT CHAR
   00411 R 620441 R          JMP*    PUTSW   /DISPATCH TO FIRST OR SECOND CHAR ACTION
                      /
   00412 R 200562 R   PUTLF  LAC     COP     /HAS A REAL CHAR OCCURRED SINCE FF?
   00413 R 740200 A          SZA             /SKIP IF NO REAL CHAR
   00414 R 600424 R          JMP     PUTW    /GO DO REGULAR
   00415 R 220552 R          LAC*    LPBUFD  /IF WE ALREADY HAVE A FF
   00416 R 540663 R          SAD     (14     /IN BUFFER OUT, DON'T NEED A CR
   00417 R 620400 R          JMP*    PUTCH
   00420 R 200661 R          LAC     (15     /LEAD WITH CR, SO PDP-11 DOESN'T PUT ON AUTOMATIC LF
   00421 R 400565 R          XCT     MIX     /BUT DO NOTHING FOR IMAGE MODE
   00422 R 620400 R          JMP*    PUTCH
   00423 R 600406 R          JMP     PUTY    /GO REAJOIN
   00424 R 200656 R   PUTW   LAC     (12     /GET BACK LINE FEED
   00425 R 400545 R          XCT     FFSW    /ISZ OR NOP FOR COUNT OF FF PER PAGE
   00426 R 600434 R          JMP     PUTLFR  /NO FORM FEED NOW
   00427 R 200542 R   PUTFF  LAC     PAGSIZ  /FORM FEED, RESET PAGE COUNTER
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE  14     LPU.   122     .WRITE FUNCTION

       00430 R 040543 R               DAC      PAGCNT
       00431 R 140562 R               DZM      COP      /FLAG SAYING FF OCCURRED.
       00432 R 200663 R               LAC      (14      /FORM FEED CODE
       00433 R 600410 R               JMP      PUTZ     /GO COUNT CHAR, AND PLACE IT
       00434 R 400565 R     PUTLFR    XCT      MIX      /SKIP ON IOPS ASCII
       00435 R 600406 R               JMP      PUTY     /IMAGE, ACTUALLY PLACE LF
       00436 R 440560 R               ISZ      FIRST    /ASCII, IS IT FIRST THRU?
       00437 R 600410 R               JMP      PUTZ     /NOT FIRST, DO LF
       00440 R 620400 R               JMP*     PUTCH    /FIRST TIME, JUST RETURN
       00441 R 000000 A     PUTSW     0                 /INIT'ED AS PUT1. FILLED LATER BY JMS PUTSW
       00442 R 620400 R               JMP*     PUTCH    /DONE, RETURN
                            /
       00443 R 000445 R     PUTIN     PUT1              /START AT FIRST CHAR
                            /
       00444 R 100441 R     PUTQ      JMS      PUTSW    /LEAVE POINTER FOR FIRST AFTER SECOND
       00445 R 060571 R     PUT1      DAC*     PUTP     /FIRST CHARACTER ACTION, PLACE RIGHT JUSTIFIED
       00446 R 100441 R               JMS      PUTSW    /LEAVING POINTER FOR SECOND
                            /
       00447 R 746030 A     PUT2      CLL!SWHA          /PUT CHAR IN RIGHT PLACE
       00450 R 740020 A               RAR
       00451 R 260571 R               XOR*     PUTP     /PUT HALVES TOGETHER
       00452 R 060571 R               DAC*     PUTP     /BOTH IN BUFFER
       00453 R 440571 R               ISZ      PUTP     /MOVE POINTER
       00454 R 600444 R               JMP      PUTQ     /GO TELL PUTSW  THAT PUT1 IS NEXT
                            /
                            /  OUTINE TO RESET LINE AND TAB COUNTRS
                            /
       00455 R 000000 A     RESETL    0
       00456 R 777777 A               LAW      -1       /SET FIRST CHAR OF LINE REMEMBERER
       00457 R 040560 R               DAC      FIRST
       00460 R 777770 A               LAW      -10      /SET TAB COUNTR
       00461 R 040564 R               DAC      TABC
       00462 R 200556 R               LAC      LINLIM   /SET UP MAX PER LINE COUNTER
       00463 R 040557 R               DAC      MAXC
       00464 R 140563 R               DZM      BLANKC   /RESET SPACE AND TAB COUNTER
       00465 R 620455 R               JMP*     RESETL
                            /


PAGE  15     LPU.   122     .CLOSE FUNCTION

                                      .TITLE .CLOSE FUNCTION
                            /
                            /
                            /.CLOSE
                            /
       00466 R 100524 R     LPCLOS    JMS      LPIOCK            /CHECK I/O UNDERWAY.
       00467 R 140562 R               DZM      COP      /SAY A FF OCCURRED
       00470 R 440502 R               ISZ      LPCLSW            /777777 IN AC IF HAVEN'T BEEN THRU CLOSE CODE.
       00471 R 600503 R               JMP      LPCLDN            /DONE.
       00472 R 750030 A               CLA!IAC           /SPOOLER REQUIRES FF,CR AS CLOSE
       00473 R 060551 R               DAC*     LPBUF    /JUST GIVE FF TO DRIVER, HOWEVER
       00474 R 200660 R               LAC      (6414    /THIS IS FF,CR IN PDP-11
       00475 R 060552 R               DAC*     LPBUFD   /FIRST DATA WORD POINTER
                            /                           /THIS MEANS ALWAYS A FF ON CLOSE!!!
       00476 R 100531 R               JMS      LPSET    /SEND BUFFER TO PDP-11
       00477 R 100455 R               JMS      RESETL   /RESET THE WORLD
       00500 R 703344 A     LPCALX    DBR
       00501 R 620540 R               JMP*     LPCALP            /HANG ON CAL.
       00502 R 777777 A     LPCLSW    777777                     /-1 = .CLOSE NOT DONE.
       00503 R 777777 A     LPCLDN    LAW -1
       00504 R 040502 R               DAC      LPCLSW            /INITIALIZE .CLOSE INDICATOR
       00505 R 600134 R               JMP      LPNEXT            /EXIT.
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE  16      LPU.    122      .WAIT FUNCTION

                                          .TITLE .WAIT FUNCTION
                               /
                               /.WAIT OR .WAITR
                               /
        00506 R 220540 R       LPWAIT   LAC*     LPCALP
        00507 R 500650 R                AND      (1000
        00510 R 741200 A                SNA                         /BIT 8 = 1 FOR .WAITR
        00511 R 600522 R                JMP      LPWAT1             /.WAIT - GO HANG ON CAL.
        00512 R 200652 R                LAC      (700000            /LINK, ETC.
        00513 R 500540 R                AND      LPCALP
        00514 R 040540 R                DAC      LPCALP
        00515 R 220541 R                LAC*     LPARGP             /15-BIT BUSY ADDRESS.
        00516 R 500667 R                AND      (77777
        00517 R 240540 R                XOR      LPCALP
        00520 R 040540 R                DAC      LPCALP
        00521 R 440541 R                IDX      LPARGP
        00522 R 100524 R       LPWAT1   JMS      LPIOCK             /CHECK I/O UNDERWAY.
        00523 R 600134 R                JMP      LPNEXT             /OK - RETURN.
                               /
                               /CHECK FOR I/O UNDERWAY
                               /
                               /LPUND 0 WHEN FREE, NONO WHEN BUSY
                               /
        00524 R 000000 A       LPIOCK   0
        00525 R 200544 R                LAC      LPUND              /0 = NO ACTIVITY.
        00526 R 741200 A                SNA
        00527 R 620524 R                JMP*     LPIOCK             /NO I/O UNDERWAY.
        00530 R 600500 R                JMP      LPCALX             /HANG ON CAL TIL NOT BUSY.
                               /
                               / SETUP AND OUTPUT TO PRINTER.
                               /
        00531 R 000000 A       LPSET    0
        00532 R 200550 R                LAC      LPTCB   /SEND TCB POINTER TO PDP-11
        00533 R 706001 A                SIOA                        /MAKE SURE ITS ABLE TO GET IT
        00534 R 600533 R                JMP      .-1                /NOTE THAT THIS IS PROTECTED SINCE
                                                                    /    THE LIOR WILL BE ISSUED DIRECTLY
                                                                    /    AFTER THE SIOA (FREE INSTRUCTION).
        00535 R 706006 A                LIOR
        00536 R 040544 R                DAC LPUND                   /SET I/O BUSY FLAG.
        00537 R 620531 R                JMP* LPSET
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE  17     LPU.   122     INITIALIZATION CODE AND TEMPORARIES

                                   .TITLE INITIALIZATION CODE AND TEMPORARIES
                           /
00540 R 000000 A           LPCALP  0                 /POINTER TO CAL ADDR
00541 R 000000 A           LPARGP  0                 /POINTER ARGUMENTS OF CAL
00542 R 777706 A           PAGSIZ  -FORMS            /ASSEMBLED LINES PER PAGE
00543 R 777706 A           PAGCNT  -FORMS            /COUNT THE LINES HERE
00544 R 777772 A           LPUND   -6                /0=FREE,+=BUSY,-=ERROR
                           /                         /COUNTS UP TO INITAL 0 BELOW
                           /
                                   .IFUND NOFF
00545 R 440543 R           FFSW    ISZ     PAGCNT    /ACTION FOR FORMS CONTROL, NEMORY
00546 R 440543 R           FFFF    ISZ     PAGCNT    /FFSW LOADED INTO HERE
                                   .ENDC
00547 R 200636 R           INIT    LAC     (NOP      /WRITE OVER JUMP TO HERE
00550 R 040003 R           LPTCB   DAC     NEW       /PREVENT RE-ENTRY
00551 R 220645 R           LPBUF   LAC*    (.SCOM+4  /GT PRINTER LINE WIDTH
00552 R 742020 A           LPBUFD  RTR
00553 R 740020 A           LPEV    RAR               /MOVE TO '6' POSITION
00554 R 500670 R           TEMP1   AND     (6        /STRIP GARBAGE, LITERAL 6
00555 R 741200 A           BUFSIZ  SNA
00556 R 340670 R           LINLIM  TAD     (6        /TREAT 0 (UNDEFINED) AS 132 COLUMN!??!
00557 R 340624 R           MAXC    TAD     LBFTP     /POINTER TO CONSTANTS
00560 R 040624 R           FIRST   DAC     LBFTP
00561 R 220624 R           ICHAR   LAC*    LBFTP     /LINE WIDTH
00562 R 040556 R           COP     DAC     LINLIM
00563 R 440624 R           BLANKC  ISZ     LBFTP
00564 R 220624 R           TABC    LAC*    LBFTP     /BUFFER SIZE
00565 R 040555 R           MIX     DAC     BUFSIZ
                           /
                           /  NOW SET UP POINTERS TO BUFFER AND TCB LOC'S
                           /
00566 R 220657 R           LPAC    LAC*    (.SCUM+100  /POINTER TO TABLE OF POINTERS
00567 R 740030 A           LPOUT   IAC               /OUR POINTER IN TABLE +1
00570 R 040554 R           X12     DAC     TEMP1
00571 R 220554 R           PUTP    LAC*    TEMP1     /POINTER TO TCB
00572 R 040550 R                   DAC     LPTCB
00573 R 040554 R                   DAC     TEMP1     /POINTER TO FILL LOCATIONS
00574 R 723002 A                   AAC     2         /MAKE POINTER TO EVENT VARIABLE
00575 R 040553 R                   DAC     LPEV
00576 R 723002 A                   AAC     2         /MAKE POINTER TO TCB POINTER
00577 R 040564 R                   DAC     TABC      /TO BUFFER ADDR
00600 R 723005 A                   AAC     5         /MAKE POINTER TO FIRST DATA WORD
00601 R 040552 R                   DAC     LPBUFD
                           /
                           /  MAKE TCB
                           /
00602 R 200671 R                   LAC     (APISLT*400+APILVL
00603 R 060554 R                   DAC*    TEMP1
00604 R 440554 R                   ISZ     TEMP1
00605 R 200672 R                   LAC     (DEVCOD /PIREX CODE FOR LP DRIEVER
00606 R 060554 R                   DAC*    TEMP1
00607 R 440554 R                   ISZ     TEMP1     /ZERO THRU FIRST BUFFER LOC
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE  18     LPU.   122     INITIALIZATION CODE AND TEMPORARIES

        00610 R 160554 R              DZM*    TEMP1
        00611 R 440544 R              ISZ     LPUND
        00612 R 600607 R              JMP     .-3
        00613 R 200554 R              LAC     TEMP1    /THIS POINTS TO BUFFER
        00614 R 060564 R              DAC*    TABC     /TO LOCATION IN TCB THAT NEEDS
        00615 R 040551 R              DAC     LPBUF    /AND A POINTER FOR US
        00616 R 100455 R              JMS     RESETL   /RESET LINE AND TAB COUNTRS
        00617 R 000056 A              CAL     APISLT   /ISSUE SETUP CAL TO ESTABLISH INTERRUPTS
        00620 R 000016 A              16
        00621 R 706141 A              LSSF
        00622 R 000032 R              LPINT
        00623 R 600003 R              JMP     NEW      /wHEw, DONE
                               /
                                      .DEC
        00624 R 000623 R       LBFTP  .-1              /POINTER TO SIZE TABLE
        00625 R 777660 A              -80
        00626 R 000044 A              36
        00627 R 777610 A              -120
        00630 R 000064 A              52
        00631 R 777574 A              -132
        00632 R 000070 A              56
                000000 A              .END
        00633 R 017777 A *L
        00634 R 600011 R *L
        00635 R 600042 R *L
        00636 R 740000 A *L
        00637 R 000000 A *L
        00640 R 700042 A *L
        00641 R 177777 A *L
        00642 R 177001 A *L
        00643 R 600000 A *L
        00644 R 000137 A *L
        00645 R 000104 A *L
        00646 R 000002 A *L
        00647 R 004000 A *L
        00650 R 001000 A *L
        00651 R 741000 A *L
        00652 R 700000 A *L
        00653 R 000400 A *L
        00654 R 000177 A *L
        00655 R 000135 A *L
        00656 R 000012 A *L
        00657 R 000200 A *L
        00660 R 000011 A *L
        00661 R 000015 A *L
        00662 R 000020 A *L
        00663 R 000014 A *L
        00664 R 000021 A *L
        00665 R 000377 A *L
        00666 R 006414 A *L
        00667 R 077777 A *L
        00670 R 000006 A *L


PAGE  19     LPU.   122     INITIALIZATION CODE AND TEMPORARIES

        00671 R 027002 A *L
        00672 R 000004 A *L
            SIZE=00673      NO ERROR LINES
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE    20   LPU.   CROSS REFERENCE

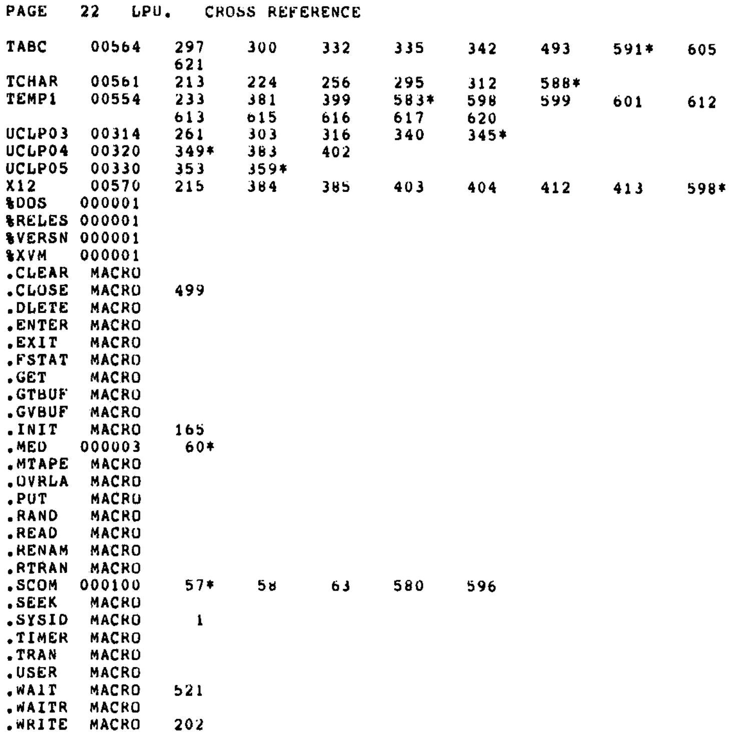
APILVL 000002    48*    51     55     611
APISLT 000056    49*   611    624
BLANKC  00563   277    292    294    309    310    333    334    496
                590*
BUFSIZ  00555   174    584*   592
CAPI   706144    55*   128
COP     00562   189    275    349    448    463    505    589*
DEVCOD 000004    72*    75*   614
ERLOOP  00074   158*   161
EROUT   00076   160*
ERRNUM  00102   157    159    164*
EXERRS 000137    63*   160
FFFF    00546   181    182    572*   576*
FFSW    00545   185    459    571*   575*
FIRST   00560   268    443    468    491    587*
FORMS  000072    66*    69*   565    566
GETCH   00332   251    373*   391
GETCM   00345   386    390*
GETIN   00347   237    393*
GETQ    00350   397*   421
GETSW   00344   238    376    388*   397    407    409    411    415
                417    419
GET1    00351   393    399*
GET2    00362   408*
GET3    00364   410*
GET4    00374   418*
GET5    00376   420*
IDX    440000    61*    81     90     98    173    176    212    536
INIT    00547    85    578*
IOPS12  00030   109*   172
IOPS67  00026   107*   218
LBFTP   00624   586    587    588    590    591    631*
LINLIM  00556   494    585*   589
LIOR   706006    53*   151    558
LPAC    00566   115    123    134    596*
LPARGP  00541    80     81     89     90     98    173    175    176
                201    211    212    231    234    532    536    564*
LPA.    00000    77     79*
LPBUF   00551   191    244    350    356    445    509    580*   622
LPBUFD  00552   193    235    247    451    511    581*   607
LPCALP  00540    79    179    207    516    525    530    531    534
                535    563*
LPCALX  00500   515*   548
LPCLDN  00503   507    518*
LPCLOS  00466   100    504*
LPCLSW  00502   506    517*   519
LPER06  00024    97    102    105*
LPEV    00553   129    582*   603
LPICM   00046   121    127*
LPIERR  00061   132    140*
LPIN    00103    95    169*
LPINT   00032   114*   116    119    627
LPIOCK  00524   188    206    504    537    544*   547
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

```
PAGE   21   LPU.   CROSS REFERENCE

LPIRT   00054   133*
LPIRT1  00055   134*   152
LPISW   00056   127    135*
LPNEXT  00134    99    101    200*   355    360    520    538
LPOUT   00567   117    125    137    597*
LPPIC   00042   114    118    123*
LPSET   00531   195    359    513    552*   560
LPTCB   00550   148    553    579*   600
LPUND   00544   133    545    559    567*   618
LPWAIT  00506   104    525*
LPWAT1  00522   528    537*
LPWRIT  00136   103    206*
LSSF   706141    51*   626
LTABL   00012    92     95*
MAIN    00200   251*   253    255    302    325    343
MAINC   00235   284    294*
MAIND   00233   288    292*
MAINE   00244   298    301*
MAINK   00240   297*   311
MAXC    00557   301    337    338    495    586*
MCR     00275   318    329*
MIX     00565   210    228    242    346    354    374    455    466
                592*
MSPEC   00247   259    307*
MSPEC2  00254   308    312*
MSPEC3  00270   320    324*   331
MSPEC4  00272   322    326*
MSPEC5  00267   323*   328
MTAB    00300   314    332*
NEW     00003    85*   579    628
PAGCNT  00543   178    462    566*   571    572
PAGSIZ  00542   177    461    565*
PUTCH   00400   272    290    293    296    324    327    347    437*
                453    456    470    472
PUTFF   00427   442    461*
PUTIN   00443   239    474*
PUTLF   00412   440    448*
PUTLFR  00434   460    466*
PUTP    00571   236    477    482    483    484    599*
PUTQ    00444   476*   485
PUTSW   00441   240    446    471*   476    478
PUTW    00424   450    458*
PUTY    00406   443*   457    467
PUTZ    00410   445*   465    469
PUT1    00445   474    477*
PUT2    00447   480*
RESETL  00455   187    329    348    401    489*   497    514    623
RETRY   00066   142    148*
SC.MOD 000104    58*   169
SC.UC1 000002    59*   170
SET    440000    62*
SETERR  00073   106    108    110    144    157*
SIOA   706001    52*   149    554
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler



```
PAGE    22   LPU.   CROSS REFERENCE

TABC     00564   297     300     332     335     342     493     591*    605
                 621
TCHAR    00561   213     224     256     295     312     588*
TEMP1    00554   233     381     399     583*    598     599     601     612
                 613     615     616     617     620
UCLP03   00314   261     303     316     340     345*
UCLP04   00320   349*    383     402
UCLP05   00330   353     359*
X12      00570   215     384     385     403     404     412     413     598*
%DOS    000001
%RELES  000001
%VERSN  000001
%XVM    000001
.CLEAR   MACRO
.CLOSE   MACRO   499
.DLETE   MACRO
.ENTER   MACRO
.EXIT    MACRO
.FSTAT   MACRO
.GET     MACRO
.GTBUF   MACRO
.GVBUF   MACRO
.INIT    MACRO   165
.MED    000003    60*
.MTAPE   MACRO
.OVRLA   MACRO
.PUT     MACRO
.RAND    MACRO
.READ    MACRO
.RENAM   MACRO
.RTRAN   MACRO
.SCOM   000100    57*     58      63     580     596
.SEEK    MACRO
.SYSID   MACRO     1
.TIMER   MACRO
.TRAN    MACRO
.USER    MACRO
.WAIT    MACRO   521
.WAITR   MACRO
.WRITE   MACRO   202
```

Figure 4-1 (Cont.)
XVM LP11 DOS Handler

APILVL	The API level at which PIREX should interrupt the XVM; this is used in TCBs and in the definition of CAPI. APILVL should indicate API level 0, 1, 2, or 3.[1]
APISLT	The API slot to which PIREX should issue interrupts; used in TCBs and in the CONNECT/DISCONNECT software directives.
DEVICE SKIP	In this case LSSF, one of the four possible UC15 skips. This skip is determined by which API level is chosen. SKIP = APILVL*20 + 706101 The skip is used in the standard setup interrupts CAL (Figure 4-1, lines 624-628).
SIOA	Skip if PDP-11 can accept a TCBP mnemonic; (706001).
LIOR	Issue TCBP mnemonic; (706006).
CAPI	Clear interrupt flag mnemonic; set to APILVL*20 + 706104, used in interrupt service routine.
DEVCOD	The device code as defined in PIREX: used in TCBs.

NOTE

The conditional use of the spooled bit (PDP-11 bit 7) (Figure 4-1, lines 71-76).

4.6.1.1 Initialization - The CAL entry of an XVM/DOS handler must have a once only section of code that:

1. Sets up a pointer to one of the reserved TCB areas in the XVM/DOS monitor. This is done by locating a pointer to the TCB area in the table pointed to by .SCOM+100 (Figure 4-1, lines 596-600).
2. Computes pointers to the various locations within this TCB area, such as the event variable (Figure 4-1, lines 601-607).
3. Constructs the constant fields within the TCB such as the API RETURN and device code (Figure 4-1, lines 611-619).
4. Sets up a pointer to the data area in the TCB, which will be used as a buffer (Figure 4-1, lines 620-622).

4.6.1.2 .INIT Function - The .INIT function of any XVM UNICHANNEL handler should check to see if the UNICHANNEL is enabled by testing bit 16 of .SCOM+4. If bit 16 is set, the UNICHANNEL is enabled, or else if bit 16 is not set, IOPS 12 (device error) should be issued. (Figure 4-1, lines 169-172.)

[1] Level 0 may be used, but is not recommended because it could hang the XVM system if the interrupt occurred at the wrong time.

4.6.1.3 Request Transmission - When issuing requests to a task from a XVM program, the requesting program (e.g., a XVM I/O handler) issues the following sequence of instructions.

```
DZM EV          /CLEAR EV IN TCB

LAC (TCB)       /ADDRESS OF TCB IN AC

SIOA            /MAKE SURE PDP-11 CAN ACCEPT REQUEST

JMP .-1         /WAIT FOR IT IF NOT

LIOR            /ISSUE REQUEST TO THE PDP-11.  THIS CAUSES A
                  LEVEL/7 INTERRUPT TO THE PDP-11 AND CONTROL
                  TRANSFERRED/TO THE LEVEL 7 HANDLER IN PIREX.
```

The instruction sequence which issues requests to tasks from the XVM should have an identical format as shown above. These five instructions are ordered in a way which:

1. Clears the event variable (EV) before issuing the request.
2. Allows an interruptible sequence while waiting for the PDP-11.
3. Allows a non-interruptible sequence once the SIOA instruction skips and the LIOR is issued.

This occurs because the XVM always allows a non-interruptible instruction following an IOT (in this case the SIOA). The SIOA and JMP .-1 sequence is interruptible immediately following the execution of JMP .-1.

The LPSET routine is used by the line printer handler to perform the request transmission and thus send data to the line printer (or line printer spooler) task (see Figure 4-1, lines 551-560).

4.6.1.4 Interrupt Section - Result Reception - After receipt of a request to PIREX, the PDP-11 will use the contents of the TCB to schedule the referenced task.

Meanwhile, the requesting program can either:

1. Give up control and wait for an interrupt from the PDP-11 as in the XVM/DOS line printer handler case or

2. Test the EV until it goes non-zero. i.e.,

   ```
   LAC EV

   SNA

   JMP .-2
   ```

   to determine completion of the request. The EV is automatically set to a non-zero value by the referenced task when the request has been completed.[1]

Interrupts generated by the PDP-11 for the XVM are serviced by the XVM in a fashion identical to regular XVM interrupts. As in a non-API environment, a SAPI N (N = 0, 1, 2, or 3 depending on what API level would have been used if the XVM had API) instruction tests for the flag associated with the request. In an API environment, the appropriate API trap address must be set up before the interrupt occurs. When program control is transferred to the interrupt service routine, a CAPI N instruction must be issued to clear the hardware flag associated with the request.

After clearing this flag, the event variable should be tested to detect an error condition (negative event variable). See Figure 4-1, lines 129-132.

If an error has occurred, the event variable should be tested for a possible PIREX out-of-node condition (PIREX ran out of space to store the request). If the error was an out-of-node error (EV = 177001) a retry of the request should be attempted (see Figure 4-1, lines 148-152).

If the error was not an out-of-node error, an error message should be sent to the user. The error code should be composed of the event variable and a handler mnemonic such as LPU (Figure 4-1, lines 155-164).

[1] When interrupt returns are used, the EV is set to non-zero just prior to the issuing of the interrupt.

4.6.1.5 .READ and .WRITE Requests - Actual input and output is accomplished by using typical XVM/DOS handler code with the following exceptions:

1. The TCB is used as the data buffer[1]
2. The actual I/O is done by calls to the TCB transmission routine. In the example this is a call to LPSET (Figure 4-1, line 359)

4.6.1.6 .CLOSE Function - If PIREX provides spooling services for the device, there is a need to inform the device's spooler module that the current job has completed so that the spooler is forced to process any existing partially-filled buffers. The writer must insure that both the XVM/DOS handler and the PIREX spooler module agree upon a convention to indicate this end-of-file. In the example, a form feed carriage return (6414) acts as an end-of-file (Figure 4-1, lines 499-513).

4.6.2 PDP-11 Requesting Task

Tasks such as MAC11 may execute under control of the PIREX executive in a background mode. Considerations such as TCB structure and event variable checking are similar to those of the XVM/DOS handler.

When the requesting program is a PDP-11 task, it must issue the initiate request macro (IREQ) in lieu of the 5 instruction sequence shown for the XVM. (See section 4.6.2.) If the task being requested has a higher priority than the current one issuing the request, it will execute immediately; otherwise, control will return to the first instruction following the IREQ macro. IREQ is defined as follows:

```
.MACRO IREQ TCBP

MOV TCBP,R5

MOV #100000,R4

IOT

.BYTE 2,0

.ENDM
```

The #100000 in R4 is used by PIREX to identify a PDP-11 request.

[1] Depending on Driver task design the TCB need not be used as a data buffer for NPR devices.

A TCBP is a TCB pointer. If the requesting task desires a software interrupt it should place the interrupt return address in the proper entry of the "SEND 11" Table (see Section 3.3.8).

4.6.3 UNICHANNEL Device Handlers for XVM/RSX

The following description of how to write a UNICHANNEL device handler for XVM/RSX does not discuss those topics pertaining to all XVM/RSX I/O handlers, see the chapter on Advanced Task Construction in the XVM/ RSX System Manual.

4.6.3.1 Definition of Constants - Several constants are defined in a UNICHANNEL handler's source file before any executable code (see Figure 4-2, lines 67-80). These constants include:

APISLT — The API slot to which PIREX issues interrupts; this is used in TCBs and the CONNECT/DISCONNECT software directives.

APILVL — The API level at which PIREX interrupts the XVM; this is used in the TCB and in definition of CAPI. APILVL should indicate API level 1, 2, or 3.

DEVICE SKIP — UNICHANNEL device skip equated to APILVL*20+706101.

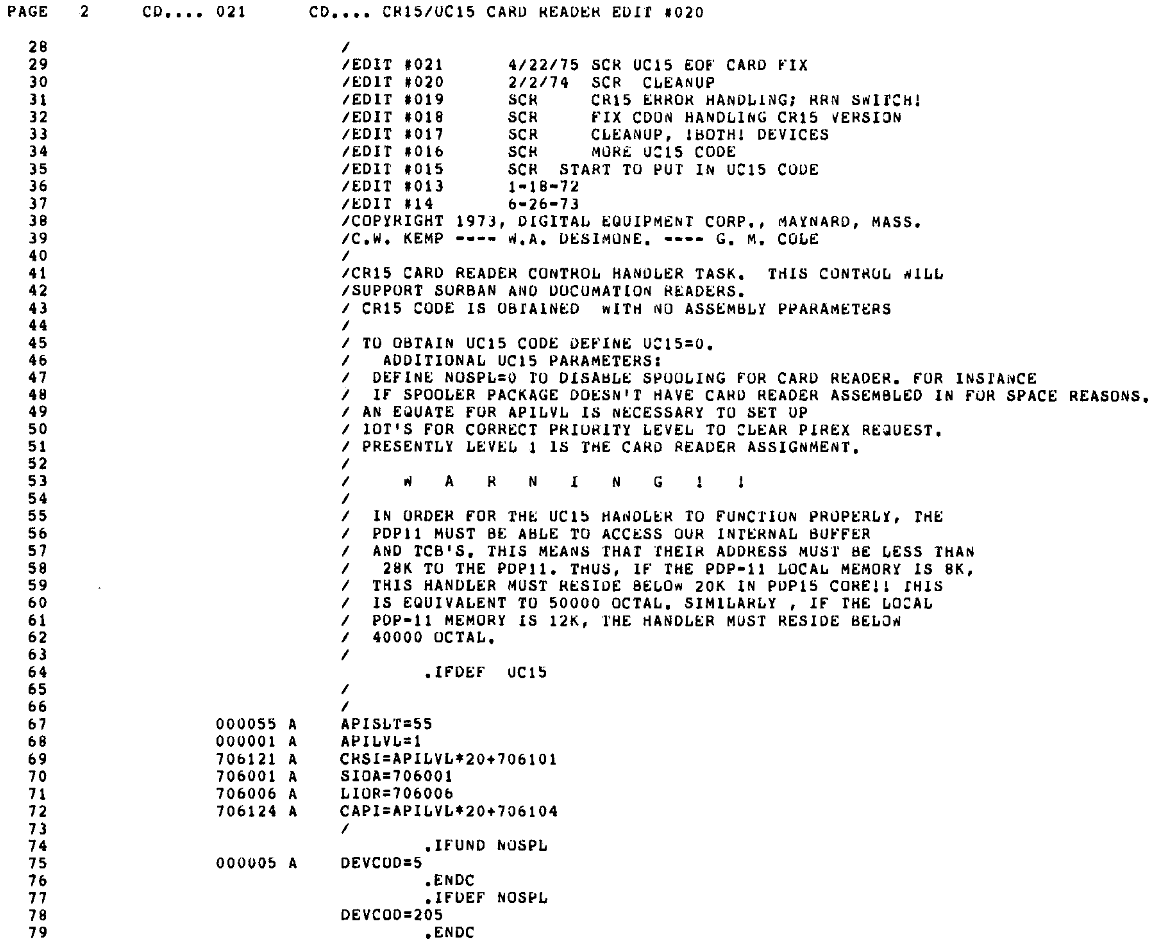
SIOA — Mnemonic for "skip of PDP-11 can accept a TCBP"; 706001.

LIOR — Mnemonic for "Issue TCBP"; 706006.

CAPI — Clear interrupt flag mnemonic; set this to APILVL *20+706104. It is used in the interrupt service routine.

DEVCOD — The device code as defined in PIREX; this is used in TCBs.

4.6.3.2 Initialization - The handler initialization is located immediately following these definitions (see Figure 4-2, lines 263-321). During handler initialization, the PIREX device driver status must be cleared and the event variable checked to see if the driver is functioning (see Figure 4-2, lines 288-305). Since it is not obvious to XVM/ RSX whether or not the driver is operational, a message should be printed before the handler exits if the driver is not running under PIREX.



```
PAGE   2     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

                              /
                              /EDIT #021       4/22/75 SCR UC15 EOF CARD FIX
                              /EDIT #020       2/2/74  SCR  CLEANUP
                              /EDIT #019       SCR     CR15 ERROR HANDLING; RRN SWITCH!
                              /EDIT #018       SCR     FIX CDON HANDLING CR15 VERSION
                              /EDIT #017       SCR     CLEANUP, !BOTH! DEVICES
                              /EDIT #016       SCR     MORE UC15 CODE
                              /EDIT #015       SCR  START TO PUT IN UC15 CODE
                              /EDIT #013       1-18-72
                              /EDIT #14        6-26-73
                              /COPYRIGHT 1973, DIGITAL EQUIPMENT CORP., MAYNARD, MASS.
                              /C.W. KEMP ---- W.A. DESIMONE. ---- G. M. COLE
                              /
                              /CR15 CARD READER CONTROL HANDLER TASK.  THIS CONTROL WILL
                              /SUPPORT SORBAN AND DOCUMATION READERS.
                              / CR15 CODE IS OBTAINED  WITH NO ASSEMBLY PPARAMETERS
                              /
                              / TO OBTAIN UC15 CODE DEFINE UC15=0.
                              /   ADDITIONAL UC15 PARAMETERS:
                              /  DEFINE NOSPL=0 TO DISABLE SPOOLING FOR CARD READER. FOR INSTANCE
                              /  IF SPOOLER PACKAGE DOESN'T HAVE CARD READER ASSEMBLED IN FOR SPACE REASONS.
                              / AN EQUATE FOR APILVL IS NECESSARY TO SET UP
                              / IOT'S FOR CORRECT PRIORITY LEVEL TO CLEAR PIREX REQUEST.
                              / PRESENTLY LEVEL 1 IS THE CARD READER ASSIGNMENT.
                              /
                              /    W   A   R   N   I   N   G   !   !
                              /
                              /  IN ORDER FOR THE UC15 HANDLER TO FUNCTION PROPERLY, THE
                              /  PDP11 MUST BE ABLE TO ACCESS OUR INTERNAL BUFFER
                              /  AND TCB'S. THIS MEANS THAT THEIR ADDRESS MUST BE LESS THAN
                              /   28K TO THE PDP11. THUS, IF THE PDP-11 LOCAL MEMORY IS 8K,
                              /  THIS HANDLER MUST RESIDE BELOW 20K IN PDP15 CORE!! THIS
                              /  IS EQUIVALENT TO 50000 OCTAL. SIMILARLY , IF THE LOCAL
                              /  PDP-11 MEMORY IS 12K, THE HANDLER MUST RESIDE BELOW
                              /  40000 OCTAL.
                              /
                                      .IFDEF  UC15
                              /
                              /
                  000055 A    APISLT=55
                  000001 A    APILVL=1
                  706121 A    CRSI=APILVL*20+706101
                  706001 A    SIOA=706001
                  706006 A    LIOR=706006
                  706124 A    CAPI=APILVL*20+706104
                              /
                                      .IFUND NOSPL
                  000005 A    DEVCOD=5
                                      .ENDC
                                      .IFDEF NOSPL
                              DEVCOD=205
                                      .ENDC
```

Figure 4-2
XVM CR11 XVM/RSX Handler

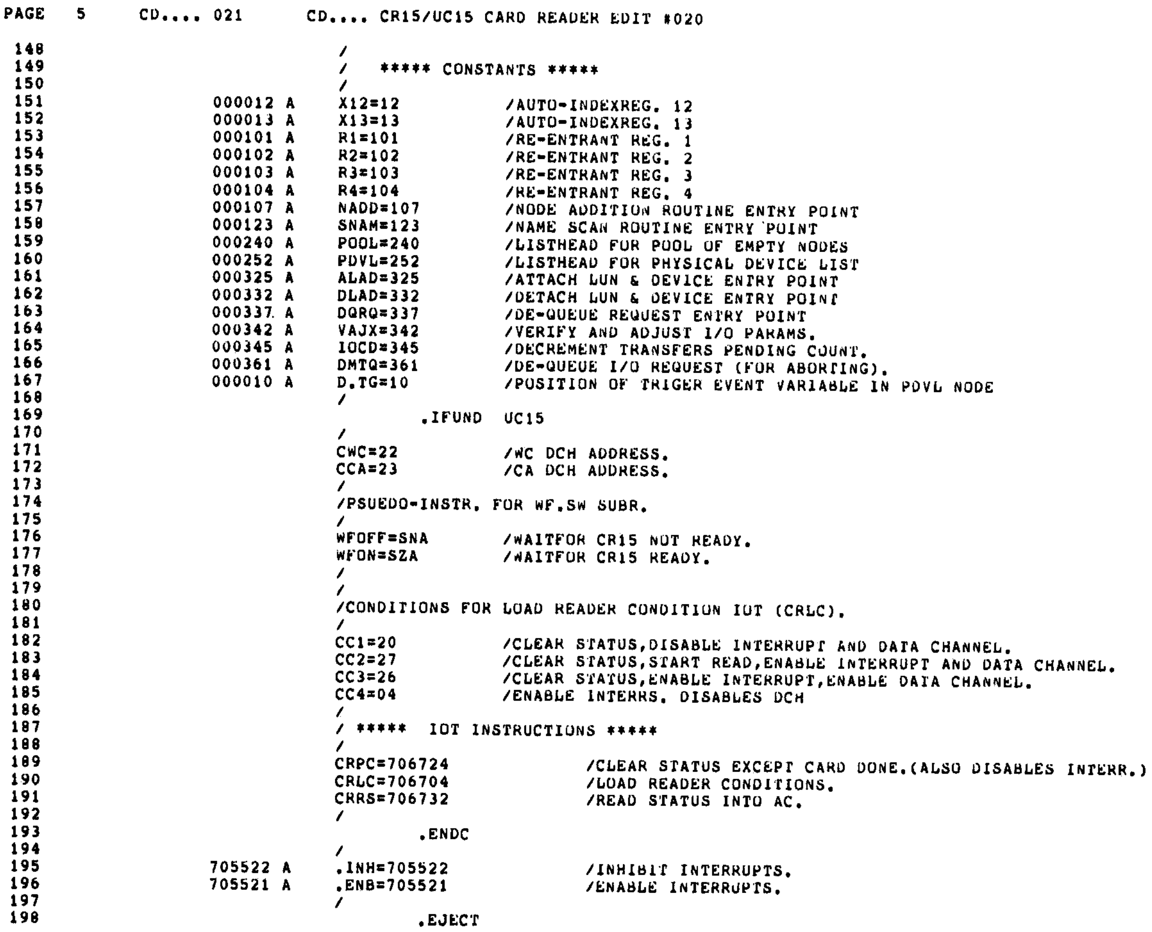
```
PAGE    3     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

                 .ENDC
        /
        /EDIT 14 ADDS ASSEMBLY PARAMETER ERRLUN TO SPECIFY LOGICAL UNIT
        /        FOR ALL ERROR MESSAGES. THE IS SET TO 3 IF USED INTERACTIVELY
        /        MOST OF THE TIME OR TO 100 WHEN USED WITH PHASE
        /        III BATCH. LUN 100 IS DEFINED TO BE THE BATCH OPERATOR DEVICE.
        /
                 .IFUND  ERRLUN
        ERRLUN=100
                 .ENDC
        /THIS IS AN IOPS ASCII ONLY HANDLER TASK.
        /IT CAN BE ASSEMBLED TO READ 029 OR 026 IBM KEYPUNCHED CARDS.
        /DEFINE DEC026 TO READ 026 PUNCHED CARDS.
        /DEC026 UNDEFINED TO READ 029 PUNCHED CARDS.
        /
        /
        /
        / THE FOLLOWING QUEUE I/O DIRECTIVES ARE IMPLEMENTED
        /
        /        CPB      3600     HANDLER INFORMATION (HINF)
        /                 EVA
        /                 LUN
        /
        / FOR HINF THE FOLLOWING INFORMATION IS RETURNED IN THE EV
        /
        /        BIT   0           UNUSED
        /        BIT   1 = 1       INPUT DEVICE
        /        BIT   2 = 0       NOT OUTPUT DEVICE
        /        BIT   3 = 0       NOT FILE-ORIENTED
        /        BITS  4-11        UNIT NUMBER 'ZERO'
        /        BITS  12-17       DEVICE CODE = 7  CARD READER
        /
        /
        /        CPB      2400     ATTACH CARD READER
        /                 EVA
        /                 LUN
        /
        /        CPB      2500     DETACH CARD READER
        /                 EVA
        /                 LUN
        /
        /        CPB      2600     READ CARD
        /  (1)            EVA
        /  (2)   LUN
        /  (3)            MODE
        /  (4)            BUFF
        /  (5)            SIZE
        /
        /IF A REQUEST CANNOT BE QUEUED, THE FOLLOWING EVENT VARIABLE
        /VALUES ARE RETURNED:
        /
        /        -101 -- INDICATED LUN DOES NOT EXITS.


PAGE    4     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

        /        -102 -- INDICATED LUN IS NOT ASSIGNED TO PHYSICAL DEVICE.
        /        -103 -- HANDLER TASK IS NOT CORE RESIDENT.
        /        -777 -- NODE FOR REQUEST QUEUE NOT AVAILABLE.
        /
        /
        /IF THE QUEUED I/O REQUEST CANNOT BE SUCCESSFULLY DEQUEUED,
        /THE FOLLOWING EVENT VARIABLE VALUES ARE RETURNED:
        /
        /        -7   -- ILLEGAL DATA MODE.
        /        -6   -- UNIMPLEMENTED FUNCTION.
        /        -24  -- LUN REASSIGNED WHILE ATTACH/DETACH REQUEST IN QUEUE.
        /        -30  -- OUT OF PARTITION TRANSFER (NORMAL MODE).
        /        -203 -- CAL NOT TASK ISSUED.
        /
        /
                 .EJECT
```

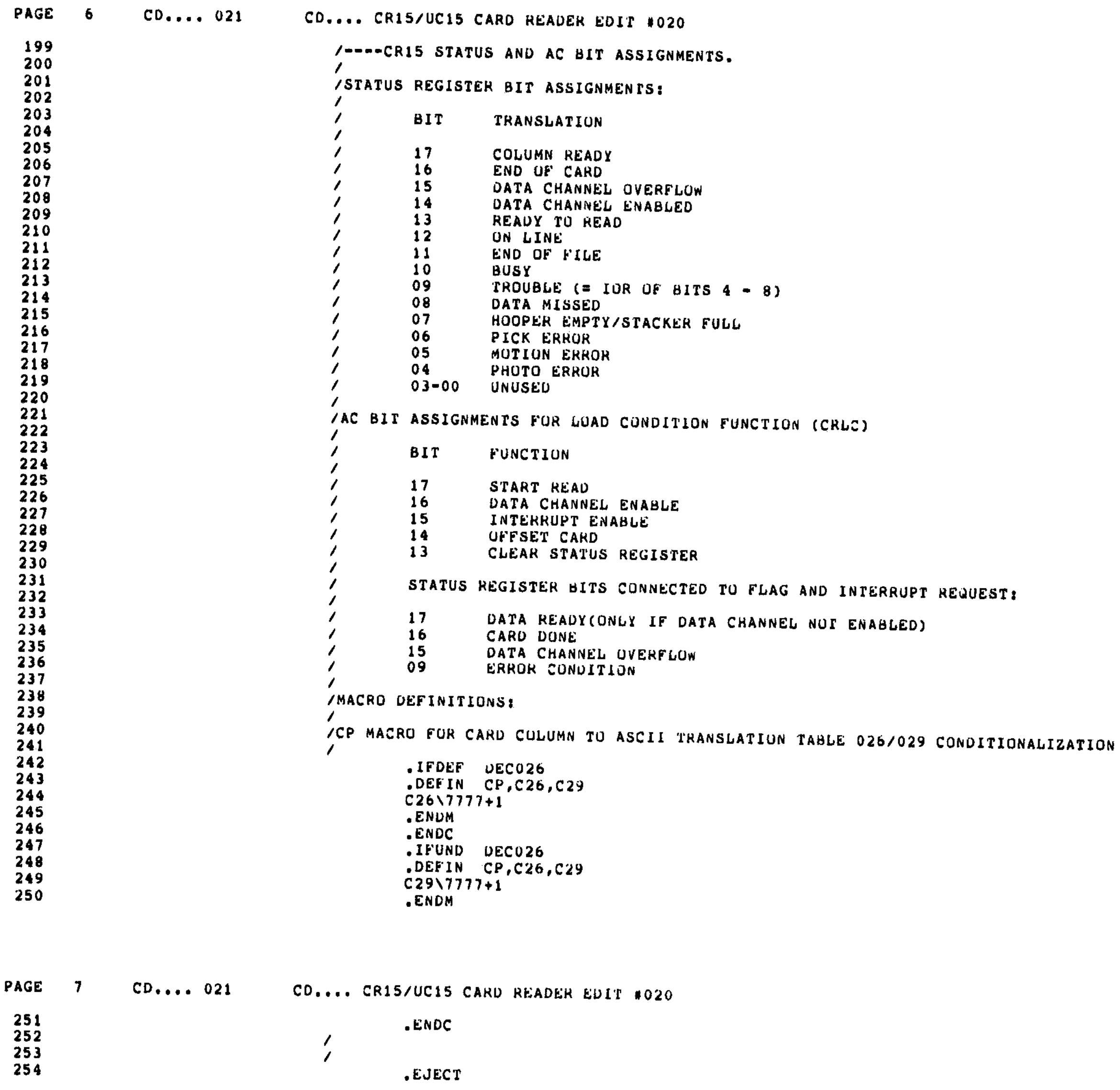
Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler



```
PAGE   5     CD.... 021      CD.... CR15/UC15 CARD READER EDIT #020

                           /
                           /   ***** CONSTANTS *****
                           /
              000012 A     X12=12           /AUTO-INDEXREG. 12
              000013 A     X13=13           /AUTO-INDEXREG. 13
              000101 A     R1=101           /RE-ENTRANT REG. 1
              000102 A     R2=102           /RE-ENTRANT REG. 2
              000103 A     R3=103           /RE-ENTRANT REG. 3
              000104 A     R4=104           /RE-ENTRANT REG. 4
              000107 A     NADD=107         /NODE ADDITION ROUTINE ENTRY POINT
              000123 A     SNAM=123         /NAME SCAN ROUTINE ENTRY POINT
              000240 A     POOL=240         /LISTHEAD FOR POOL OF EMPTY NODES
              000252 A     PDVL=252         /LISTHEAD FOR PHYSICAL DEVICE LIST
              000325 A     ALAD=325         /ATTACH LUN & DEVICE ENTRY POINT
              000332 A     DLAD=332         /DETACH LUN & DEVICE ENTRY POINT
              000337 A     DQRQ=337         /DE-QUEUE REQUEST ENTRY POINT
              000342 A     VAJX=342         /VERIFY AND ADJUST I/O PARAMS.
              000345 A     IOCD=345         /DECREMENT TRANSFERS PENDING COUNT.
              000361 A     DMTQ=361         /DE-QUEUE I/O REQUEST (FOR ABORTING).
              000010 A     D.TG=10          /POSITION OF TRIGER EVENT VARIABLE IN PDVL NODE
                           /
                                   .IFUND  UC15
                           /
                           CWC=22           /WC DCH ADDRESS.
                           CCA=23           /CA DCH ADDRESS.
                           /
                           /PSUEDO-INSTR. FOR WF.SW SUBR.
                           /
                           WFOFF=SNA        /WAITFOR CR15 NOT READY.
                           WFON=SZA         /WAITFOR CR15 READY.
                           /
                           /
                           /CONDITIONS FOR LOAD READER CONDITION IOT (CRLC).
                           /
                           CC1=20           /CLEAR STATUS,DISABLE INTERRUPT AND DATA CHANNEL.
                           CC2=27           /CLEAR STATUS,START READ,ENABLE INTERRUPT AND DATA CHANNEL.
                           CC3=26           /CLEAR STATUS,ENABLE INTERRUPT,ENABLE DATA CHANNEL.
                           CC4=04           /ENABLE INTERRS. DISABLES DCH
                           /
                           / *****  IOT INSTRUCTIONS *****
                           /
                           CRPC=706724              /CLEAR STATUS EXCEPT CARD DONE.(ALSO DISABLES INTERR.)
                           CRLC=706704              /LOAD READER CONDITIONS.
                           CRRS=706732              /READ STATUS INTO AC.
                           /
                                   .ENDC
                           /
              705522 A     .INH=705522              /INHIBIT INTERRUPTS.
              705521 A     .ENB=705521              /ENABLE INTERRUPTS.
                           /
                                   .EJECT
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler



```
PAGE    6      CD.... 021        CD.... CR15/UC15 CARD READER EDIT #020

                                   /----CR15 STATUS AND AC BIT ASSIGNMENTS.
                                   /
                                   /STATUS REGISTER BIT ASSIGNMENTS:
                                   /
                                   /       BIT      TRANSLATION
                                   /
                                   /       17       COLUMN READY
                                   /       16       END OF CARD
                                   /       15       DATA CHANNEL OVERFLOW
                                   /       14       DATA CHANNEL ENABLED
                                   /       13       READY TO READ
                                   /       12       ON LINE
                                   /       11       END OF FILE
                                   /       10       BUSY
                                   /       09       TROUBLE (= IOR OF BITS 4 - 8)
                                   /       08       DATA MISSED
                                   /       07       HOOPER EMPTY/STACKER FULL
                                   /       06       PICK ERROR
                                   /       05       MOTION ERROR
                                   /       04       PHOTO ERROR
                                   /       03-00    UNUSED
                                   /
                                   /AC BIT ASSIGNMENTS FOR LOAD CONDITION FUNCTION (CRLC)
                                   /
                                   /       BIT      FUNCTION
                                   /
                                   /       17       START READ
                                   /       16       DATA CHANNEL ENABLE
                                   /       15       INTERRUPT ENABLE
                                   /       14       OFFSET CARD
                                   /       13       CLEAR STATUS REGISTER
                                   /
                                   /       STATUS REGISTER BITS CONNECTED TO FLAG AND INTERRUPT REQUEST:
                                   /
                                   /       17       DATA READY(ONLY IF DATA CHANNEL NOT ENABLED)
                                   /       16       CARD DONE
                                   /       15       DATA CHANNEL OVERFLOW
                                   /       09       ERROR CONDITION
                                   /
                                   /MACRO DEFINITIONS:
                                   /
                                   /CP MACRO FOR CARD COLUMN TO ASCII TRANSLATION TABLE 026/029 CONDITIONALIZATION
                                   /
                                           .IFDEF   DEC026
                                           .DEFIN   CP,C26,C29
                                           C26\7777+1
                                           .ENDM
                                           .ENDC
                                           .IFUND   DEC026
                                           .DEFIN   CP,C26,C29
                                           C29\7777+1
                                           .ENDM


PAGE    7      CD.... 021        CD.... CR15/UC15 CARD READER EDIT #020

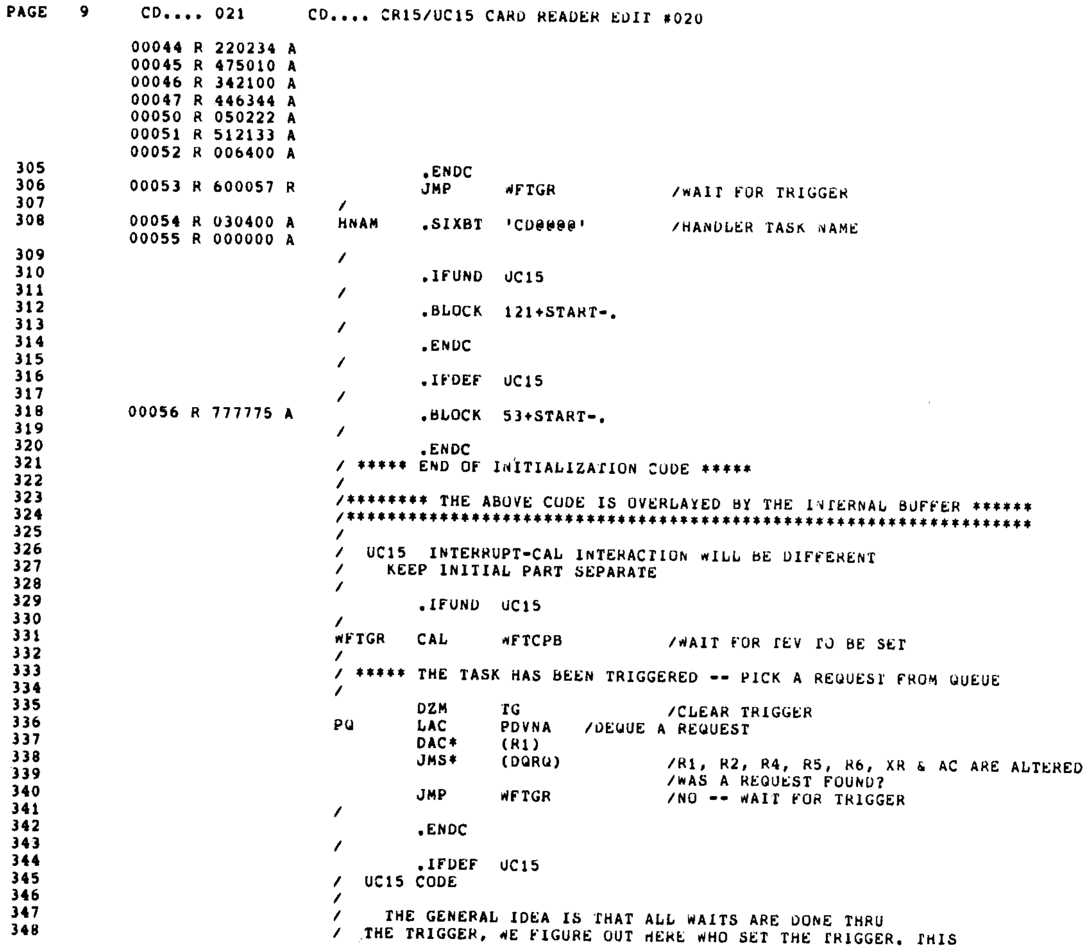
                                           .ENDC
                                   /
                                   /
                                           .EJECT
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE    8     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

                    /
                    /
                    / ***** HANDLER INITIALIZATION ***** (ONCE ONLY CODE)
                    /
                    /START                              /STORAGE FOR AC IN INTERR. SERVICE.
                    /IBUF                               /TOP OF INTERNAL BUFFER.
                    /
                    /
00000 R 200646 R    START   LAC     (PDVL)              /SCAN PDVL FOR THIS DEVICE'S NODE
00001 R 060647 R    IBUF    DAC*    (R1)
00002 R 200650 R            LAC     (HNAM)
00003 R 060651 R            DAC*    (R2)
00004 R 120652 R            JMS*    (SNAM)              /R, R2, R6, XR, & AC ARE ALTERED
                                                        /NODE FOUND?
00005 R 000653 R            CAL     (10)                /NO -- EXIT
00006 R 040567 R            DAC     PDVNA               /YES -- PDVL NODE ADDRESS IN AC.
00007 R 723010 A            AAC     D.TG                /SAVE NODE ADDRESS AND
00010 R 040570 R            DAC     PDVTA               /TRIGGER EVENT VARIABLE ADDRESS
00011 R 000577 R            CAL     CCPB                /CONNECT INTERRUPT LINE
00012 R 200561 R            LAC     EV                  /CONNECT OK?
00013 R 741100 A            SPA
00014 R 000653 R            CAL     (10)                /NO -- EXIT
00015 R 200654 R            LAC     (TG)                /YES -- SET TEV ADDRESS
00016 R 060570 R            DAC*    PDVTA
00017 R 500655 R            AND     (70000)             /DETERMINE 'XR-ADJ'
00020 R 740031 A            TCA
00021 R 040563 R            DAC     XADJ
                    /
                            .IFUND  UC15
                            LAC     (CC1)               /CLEAR STATUS, DISABLE INTER, AND DCH.
                            CRLC                        /LOAD FUNCTION.
                            .ENDC
                            .IFDEF  UC15
00022 R 100625 R            JMS     CLEAR     /CLEAR OUT PIREX DEVICE, WAIT FOR COMPLETE
00023 R 200613 R            LAC     EV11K     /FIND OUT IF OK
00024 R 742010 A            RTL               /PDP11 SIGN BIT TO OURS
00025 R 740100 A            SMA               /SKIP IF TROUBLE
00026 R 600057 R            JMP     WFTGR     /NOT, GO WAIT FOR WORK
00027 R 000034 R            CAL     MSINIT    /PRINT PIREX HAS NO CD MESSAGE
00030 R 000032 R            CAL     WFMS      /WAIT FOR MESSAGE COMPLETION
00031 R 000653 R            CAL     (10       /EXIT
                    /
00032 R 000020 A    WFMS    20
00033 R 000561 R            EV
00034 R 002700 A    MSINIT  2700
00035 R 000561 R            EV
00036 R 000100 A            ERRLUN
00037 R 000002 A            2
00040 R 000041 R            INITMS
00041 R 004002 A    INITMS  004002; 000000; .ASCII "*** NO CD IN PIREX"<15>
00042 R 000000 A
00043 R 251245 A
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler



```
PAGE   9     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

            00044 R 220234 A
            00045 R 475010 A
            00046 R 342100 A
            00047 R 446344 A
            00050 R 050222 A
            00051 R 512133 A
            00052 R 006400 A
                                         .ENDC
            00053 R 600057 R             JMP     WFTGR           /WAIT FOR TRIGGER
                                 /
            00054 R 030400 A     HNAM    .SIXBT  'CD@@@'         /HANDLER TASK NAME
            00055 R 000000 A
                                 /
                                         .IFUND  UC15
                                 /
                                         .BLOCK  121+START-.
                                 /
                                         .ENDC
                                 /
                                         .IFDEF  UC15
                                 /
            00056 R 777775 A             .BLOCK  53+START-.
                                 /
                                         .ENDC
                                 / ***** END OF INITIALIZATION CODE *****
                                 /
                                 /******** THE ABOVE CODE IS OVERLAYED BY THE INTERNAL BUFFER ******
                                 /*****************************************************************
                                 /
                                 /  UC15  INTERRUPT-CAL INTERACTION WILL BE DIFFERENT
                                 /    KEEP INITIAL PART SEPARATE
                                 /
                                         .IFUND  UC15
                                 /
                                 WFTGR   CAL     WFTCPB          /WAIT FOR TEV TO BE SET
                                 /
                                 / ***** THE TASK HAS BEEN TRIGGERED -- PICK A REQUEST FROM QUEUE
                                 /
                                         DZM     TG              /CLEAR TRIGGER
                                 PQ      LAC     PDVNA   /DEQUE A REQUEST
                                         DAC*    (R1)
                                         JMS*    (DQRQ)          /R1, R2, R4, R5, R6, XR & AC ARE ALTERED
                                                                 /WAS A REQUEST FOUND?
                                         JMP     WFTGR           /NO -- WAIT FOR TRIGGER
                                 /
                                         .ENDC
                                 /
                                         .IFDEF  UC15
                                 /  UC15 CODE
                                 /
                                 /    THE GENERAL IDEA IS THAT ALL WAITS ARE DONE THRU
                                 /  THE TRIGGER, WE FIGURE OUT HERE WHO SET THE TRIGGER. THIS
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  10     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

                                / ALLOWS US TO GET OUT OF HUNG DEVICE, SINCE WE WAIT HERE,
                                / AND CAN SEE AN ABORT COMING THRU.
                                /
        00057 R 000575 R      WFTGR   CAL     WFTCPB  /WAIT FOR EVENT VARIABLE TG
        00060 R 200562 R      PQ      LAC     TG      /FIND OUT WHO IS CALLING
        00061 R 140562 R              DZM     TG      /RESET
        00062 R 742010 A              RTL             /ABORT BIT TO SIGN BIT
        00063 R 751130 A              SPA!CLA!IAC     /SKIP IF NOT ABORT, 1 IN AC.
        00064 R 600071 R              JMP     PQ1     /GO DO ABORT IN REGULAR WAY. THE HANGING
                              /                       /READ IS REMEMBERED IN RRN!
        00065 R 540554 R              SAD     CDON    /HAS A CARD BEEN DECLARED DONE BY INTERRUPT
        00066 R 600177 R              JMP     GOTCRD  /YEAH, GO TRANSLATE IT
        00067 R 540407 R              SAD     POST    /ARE WE WAITING FOR INTERRUPT
        00070 R 600057 R              JMP     WFTGR   /YES, AND IT HASN'T HAPPENED YET, SINCE
                              /                       /CDON NOT SET. WAIT ON THIS CAL REQ, TO BE
                              /                       /DONE AFTER THE INTERRUPT HAPPENS. IF ABORT
                              /                       /COMES IN THE MEANTIME, HE IS PUT AT HEAD
                              /                       /OF DEQUE OF WAITING REQ.'S SO WE DO HIM.
                              /
        00071 R 200567 R      PQ1     LAC     PDVNA   /TRY TO DEQUE AFTER OPERATION BEFORE WAITING
        00072 R 060647 R              DAC*    (R1     /IN CASE WAITING FOR INTERRUPT HAS HELD OFF
        00073 R 120656 R              JMS*    (DQRQ   /A REQUEST.
        00074 R 600057 R              JMP     WFTGR   /DIDN'T FIND ONE, GO WAIT
                              /
                                      .ENDC
                              /
        00075 R 040564 R              DAC     RN              /YES -- SAVE ADDRESS OF REQUEST NODE
        00076 R 340563 R              TAD     XADJ            /SETUP XR TO ACCESS NODE
        00077 R 721000 A              PAX
                              /
                              / ***** I/O REQUEST NODE FORMAT *****
                              /
                              /    (0) FORWARD LINK
                              /    (1) BACKWARD LINK
                              /    (2) STL PTR.
                              /    (3) PART. BLK PTR. (0 IF EXM TSK).
                              /    (4) TASK PRIORITY
                              /    (5) I/O FCN CODE IN BITS 9-17 AND LUN IN BITS 0-8
                              /    (6)  -- EVENT VARIABLE ADDRESS
                              /    (7) CTB PTR.
                              /    (10) EXTRA
                              /    (11) EXTRA
                              /
        00100 R 210005 A              LAC     5,X             /FETCH I/O FCN CODE
        00101 R 500657 R              AND     (777)
        00102 R 540660 R              SAD     (024)           /ATTACH REQUEST?
        00103 R 600120 R              JMP     ATTACH          /YES -- ATTACH TO TASK
        00104 R 540661 R              SAD     (025)           /NO -- DETACH REQUEST?
        00105 R 600127 R              JMP     DETACH          /YES -- DETACH FROM TASK
        00106 R 540662 R              SAD     (026)           /NO -- READ REQUST?
        00107 R 600140 R              JMP     READ            /YES -- READ CARD
        00110 R 540663 R              SAD     (036)           /NO -- HANDLER INFO.?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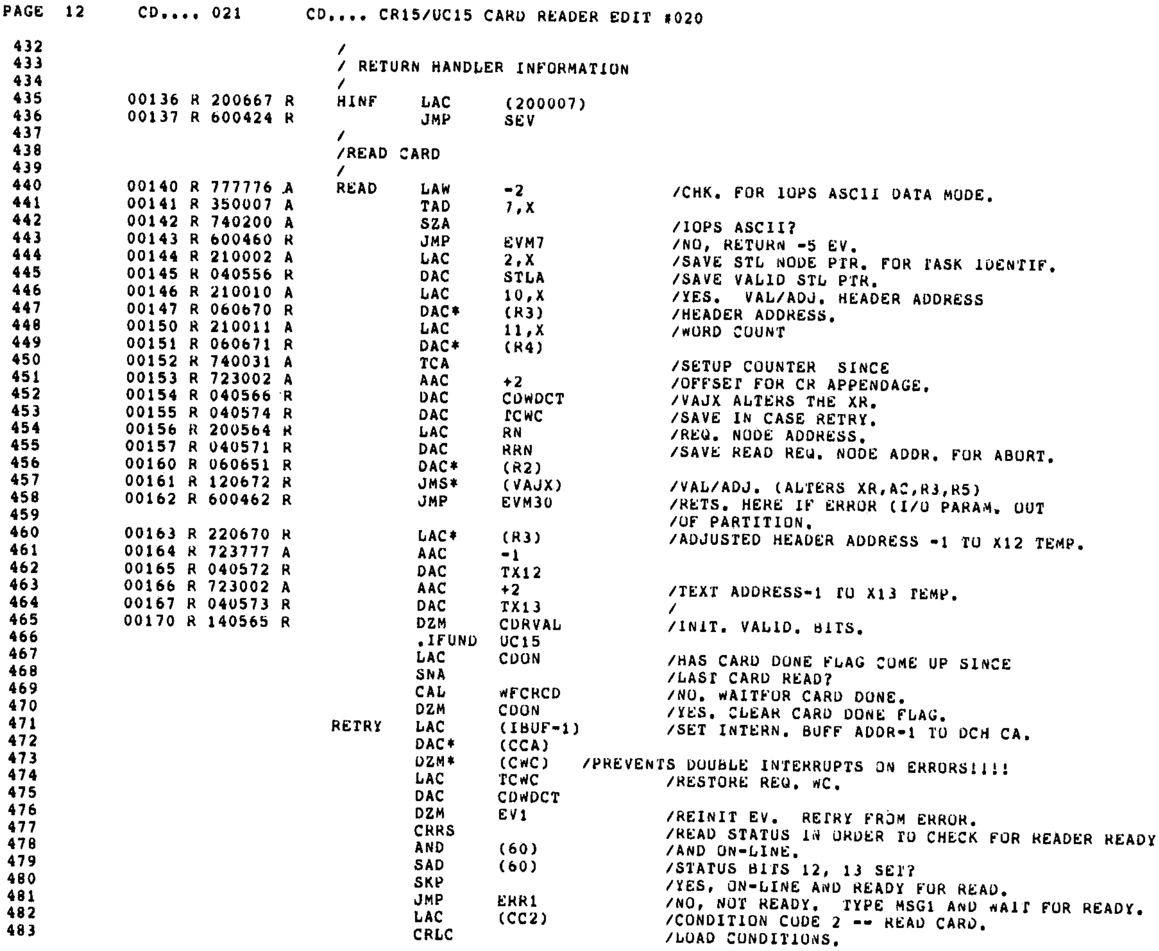
        00111 R 600136 R              JMP     HINF            /YES -- RETURN INFO IN EV
        00112 R 540657 R              SAD     (777)           /NO -- EXIT (DEASSIGNED) REQUEST?
        00113 R 600464 R              JMP     DAEX            /YES -- DEATTACH & EXIT
        00114 R 540664 R              SAD     (017)           /ABORT REQUEST?
        00115 R 600502 R              JMP     CDABRT          /YES.
        00116 R 777772 A      EVM6    LAW     -6              /NO -- UNIMPLEMENTED FUNCTION -- SET
        00117 R 600424 R              JMP     SEV             /EVENT VARIABLE TO -6
                              /
                              / ATTACH TO A TASK
                              /
        00120 R 200567 R      ATTACH  LAC     PDVNA           /ATTACH LUN & DEVICE
        00121 R 060647 R              DAC*    (R1)
        00122 R 200564 R              LAC     RN
        00123 R 060651 R              DAC*    (R2)
        00124 R 120665 R              JMS*    (ALAD)          /R3, R4, R5, R6, X10, X11, XR & AC ARE ALTERED
                                                              /WAS LUN ATTACHED?
        00125 R 600424 R              JMP     SEV             /NO -- SET REQUESTOR'S EV TO -24
        00126 R 600423 R              JMP     REQCMP          /YES REQUEST COMPLETED
                              /
                              / DETACH FROM TASK
                              /
        00127 R 200567 R      DETACH  LAC     PDVNA           /DETACH LUN & DEVICE
        00130 R 060647 R              DAC*    (R1)
        00131 R 200564 R              LAC     RN
        00132 R 060651 R              DAC*    (R2)
        00133 R 120666 R              JMS*    (DLAD)          /R3, R4, R5, R6, X10, X11, XR & AC ARE ALTERED
                                                              /WAS LUN ATTACHED
        00134 R 600424 R              JMP     SEV             /NO -- SET REQUESTOR'S EV TO -24
        00135 R 600423 R              JMP     REQCMP          /YES -- REQUEST COMPLETED
                              /
                                      .EJECT
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler



```
PAGE  12      CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

                                 /
                                 / RETURN HANDLER INFORMATION
                                 /
           00136 R 200667 R      HINF    LAC     (200007)
           00137 R 600424 R              JMP     SEV
                                 /
                                 /READ CARD
                                 /
           00140 R 777776 A      READ    LAW     -2                   /CHK. FOR IOPS ASCII DATA MODE.
           00141 R 350007 A              TAD     7,X
           00142 R 740200 A              SZA                          /IOPS ASCII?
           00143 R 600460 R              JMP     EVM7                 /NO, RETURN -5 EV.
           00144 R 210002 A              LAC     2,X                  /SAVE STL NODE PTR. FOR TASK IDENTIF.
           00145 R 040556 R              DAC     STLA                 /SAVE VALID STL PTR.
           00146 R 210010 A              LAC     10,X                 /YES.  VAL/ADJ. HEADER ADDRESS
           00147 R 060670 R              DAC*    (R3)                 /HEADER ADDRESS.
           00150 R 210011 A              LAC     11,X                 /WORD COUNT
           00151 R 060671 R              DAC*    (R4)
           00152 R 740031 A              TCA                          /SETUP COUNTER  SINCE
           00153 R 723002 A              AAC     +2                   /OFFSET FOR CR APPENDAGE.
           00154 R 040566 R              DAC     CDWDCT               /VAJX ALTERS THE XR.
           00155 R 040574 R              DAC     TCWC                 /SAVE IN CASE RETRY.
           00156 R 200564 R              LAC     RN                   /REQ. NODE ADDRESS.
           00157 R 040571 R              DAC     RRN                  /SAVE READ REQ. NODE ADDR. FOR ABORT.
           00160 R 060651 R              DAC*    (R2)
           00161 R 120672 R              JMS*    (VAJX)               /VAL/ADJ. (ALTERS XR,AC,R3,R5)
           00162 R 600462 R              JMP     EVM30                /RETS. HERE IF ERROR (I/O PARAM. OUT
                                                                      /OF PARTITION.
           00163 R 220670 R              LAC*    (R3)                 /ADJUSTED HEADER ADDRESS -1 TO X12 TEMP.
           00164 R 723777 A              AAC     -1
           00165 R 040572 R              DAC     TX12
           00166 R 723002 A              AAC     +2                   /TEXT ADDRESS-1 TO X13 TEMP.
           00167 R 040573 R              DAC     TX13                 /
           00170 R 140565 R              DZM     CDRVAL               /INIT. VALID. BITS.
                                         .IFUND  UC15
                                         LAC     CDON                 /HAS CARD DONE FLAG COME UP SINCE
                                         SNA                          /LAST CARD READ?
                                         CAL     WFCRCD               /NO. WAITFOR CARD DONE.
                                         DZM     CDON                 /YES. CLEAR CARD DONE FLAG.
                                 RETRY   LAC     (IBUF-1)             /SET INTERN. BUFF ADDR-1 TO DCH CA.
                                         DAC*    (CCA)
                                         DZM*    (CWC)    /PREVENTS DOUBLE INTERRUPTS ON ERRORS!!!!
                                         LAC     TCWC                 /RESTORE REQ. WC.
                                         DAC     CDWDCT
                                         DZM     EV1                  /REINIT EV.  RETRY FROM ERROR.
                                         CRRS                         /READ STATUS IN ORDER TO CHECK FOR READER READY
                                         AND     (60)                 /AND ON-LINE.
                                         SAD     (60)                 /STATUS BITS 12, 13 SET?
                                         SKP                          /YES, ON-LINE AND READY FOR READ.
                                         JMP     ERR1                 /NO, NOT READY.  TYPE MSG1 AND WAIT FOR READY.
                                         LAC     (CC2)                /CONDITION CODE 2 -- READ CARD.
                                         CRLC                         /LOAD CONDITIONS.
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  13     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

                CAL      WFCRCB          /WAIT FOR INTERRUPT.
        /
        /
        /
        /UPON RESUMPTION FOLLOWING WAITFOR, EXAMINE EV AND TAKE THE FOLLOWING
        /ACTION:
        /
        /IF EV BIT 9 = 0 (TROUBLE BIT), NO ERRORS.  TRANSLATE CARD PUNCHES
        /TO ASCII AND PASS TO USER AS 5/7 PACKED ASCII.
        /IF BIT 9 = 1 (TROUBLE BIT), ERROR BITS 08 TO 04 ARE CHECKED IN
        /DESCENDING NUMERICAL ORDER.  THE FOLLOWING ERROR MESSAGES FOR THE
        /GIVEN ERROR CONDITIONS ARE OUTPUT:
        /
        /DATA MISSED OR PHOTO ERROR - '*** CD DATA MISSED/PHOTO ERROR'
        /PICK OR MOTION ERROR - '*** CD PICK ERROR'
        /HOPPER EMPTY OR STACKER FULL - IGNORED.  CAUGHT ON SUBSEQ.
        /READ AS A READER NOT READY CONDITION.
        /IN ALL CASES WHERE A MESSAGE IS TYPED,  THIS HANDLER TASK MARKS TIME
        /UNTIL THE ERROR IS REMEDIED.  AT THIS POINT, THE CARD IS REREAD.
        /
                LAC      EV1             /EV SET AT INTERR. LEVEL TO CONTENTS OF
                DAC      TST             /STATUS.  SAVE TEMP.
                SWHA                     /SWAP HALVES FOR TROUBLE BIT CHECK.
                SMA!RAR                  /IF NEG.,TROUBLE.
                JMP      TRANS           /NO TROUBLE.  GO TRANSLATE.
                SZL!RAR                  /DATA MISSED?
                JMP      ERR4            /YES.
                SZL!RAR                  /NO.  HOPPER EMPTY/STACK. FULL?
                JMP      TRANS           /YES. IGNORE.  WHEN NEXT CRD. READ CAUGHT AS NOT READY.
                SZL!RAR                  /PICK ERROR?
                JMP      ERR3            /YES.
                SZL!RAR                  /MOTION ERROR?
                JMP      ERR3            /YES.
                JMP      ERR4            /NO.  MUST BE PHOTO ERROR.
        /
        /
        ERR4    ISZ      ERRPT
        ERR3    ISZ      ERRPT
        ERR2    ISZ      ERRPT
        ERR1    LAC*     ERRPT           /ERRMSG. BUFFER ADDR. TO AC.
                JMS      TTYOUT          /TYPE MESSAAE.
                JMS      WF.SW           /WAITFOR READER READY.
                         WFON
                LAC      (ERRPT+1)       /REINIT. ERRPT.
                DAC      ERRPT
                JMP      RETRY           /READ ANOTHER CARD.
        /
                .EJECT
        TRANS   LAC      TX12            /SET AUTO INDEX REG.
                DAC*     (X12)
                LAC      TX13
                DAC*     (X13)
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  14     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

/
/  NOW BRING BACK RN FROM RRN, IN CASE RN DESTROYED IN MEANTIME
/
        LAC     RRN
        DAC     RN
        LAC     (IBUF)                  /TOP OF INTERNAL BUFFER
        DAC     ICA                     /PTR TO BUFFER
        LAW     -20
        DAC     CDCOLC                  /CARD COL COUNT
CDRM5   LAW     -5
        DAC     CDR5CT
CDML2   LAC*    ICA                     /GET
        SAD     CDRALT                  /ALT MODE (12,1,8 PUNCH)?
        JMP     CDGALT                  /YES -- TERMINATE BUFFER
        SAD     (7777                   /NO -- IS IT AN EOF?
        JMP     EOF                     /YES.
        LAC     CDTABL                  /NO -- TRANSLATE TO ASCII
        DAC     CDTPTR                  /GET TOP OF TABLE AND SET PTR
        LAC     CDTLN1                  /SET TABLE LENGTH
CDML4   DAC     CDTLEN                  /CURRENT LENGTH/2
        ADD     CDTPTR                  /CURRENT TABLE TOP + LENGTH/2
        DAC     CDCPTR
        LAC*    CDCPTR                  /GET CURRENT ITEM
        AND     (7777
        SZA!CLL
        ADD     CD7700                  /ADD IN REST OF 2'S COMPLEMENT WORD
        TAD*    ICA                     /CURRENT COLUMN
        SNA!CLA                         /MATCH FOUND?
        JMP     CDCFND                  /YES
        SAD     CDTLEN                  /CURRENT TABLE LENGTH =0?
                                        /THIS MEANS AN UNKNOWN CARD PUNCH
        JMP     ILLCP                   /GO OUTPUT 'ILLEGAL CARD PUNCH'.
        SNL                             /L=0 JUMP UP, L=1 JUMP DOWN TABLE
        JMP     CDDPTR
        LAC     CDCPTR                  /SET TABLE TOP TO LOWER HALF
        DAC     CDTPTR
CDDPTR  LAC     CDTLEN                  /UPDATE TABLE LENGTH
        CLL!RAR
        JMP     CDML4
CDGALT  LAW     4000                    /ALT MODE
        JMP     CDCPUT
/
EOF     LAC     (1005
        JMP     REQCMA                  /SET HDR WDI TO EOF
                                        /REQUEST COMPLETE
/
/COME HERE ON MATCH FOUND
/
CDCFND  LAC*    CDCPTR                  /GET CURRENT ENTRY
        CMA!CLL                         /GEN. LEFTMOST BIT
        TAD     CDTABL+1                /ADD 4000000
        CMA
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  15     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

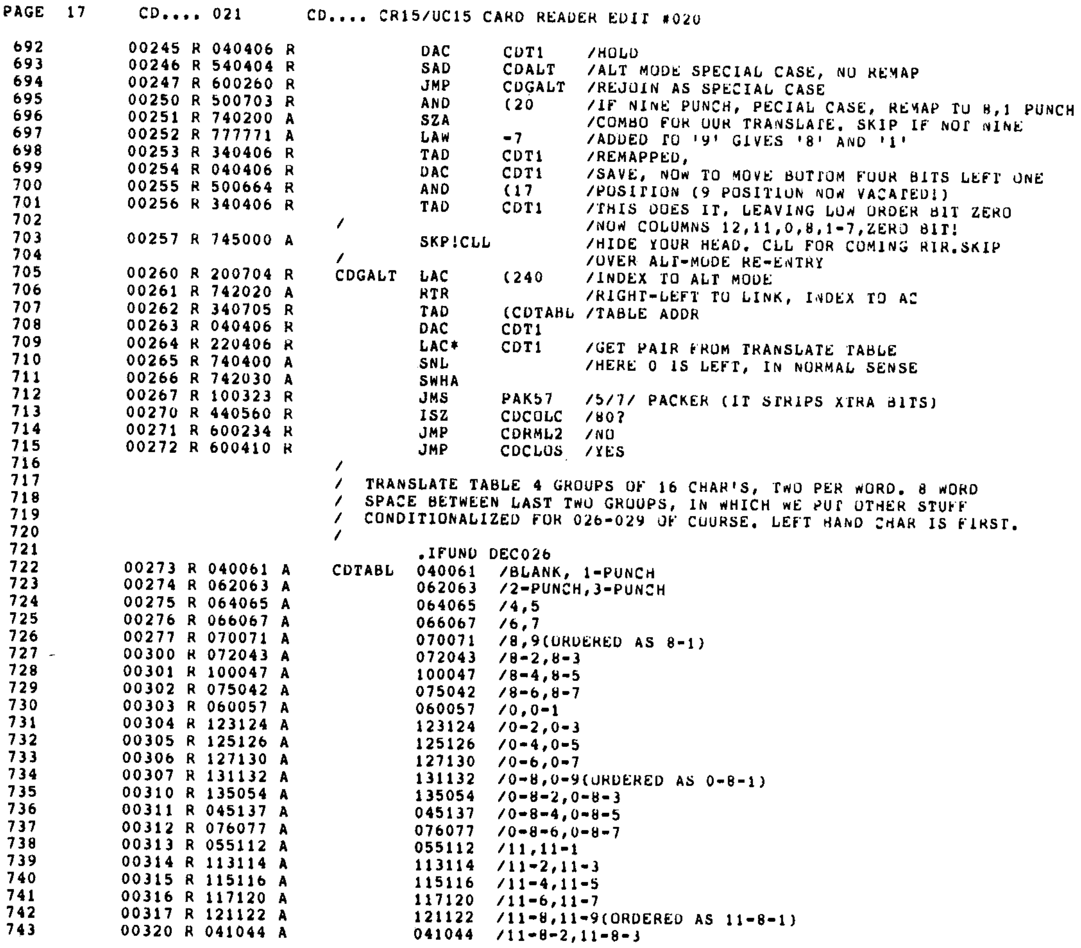
                       XOR    CDTABL+1        /RESTORE SIXTH BIT
                       RAR
                CDCPUT DAC    CDRWD3          /PUT IN TOP OF 3 WORD SHIFT BLOCK
                CDCLAW LAW    -7
                       DAC    CDR7CT
                CDCPL1 LAC    CDRWD3          /CDEWD3,CDRWD2 & CDRWD1 SHIFT AS A UNIT USING
                                              /THE LINK TO PASS BITS FROM WORD TO WORD
                       RAL
                       DAC    CDRWD3
                       LAC    CDRWD2
                       RAL
                       DAC    CDRWD2
                       LAC    CDRWD1
                       RAL
                       DAC    CDRWD1
                       ISZ    CDR7CT
                       JMP    CDCPL1
                       ISZ    ICA             /POINT TO NEXT CARD COL
                       ISZ    CDR5CT          /HAVE WE PROCESSED 5 WORDS?
                       JMP    CDML2           /NO GET ANOTHER ONE
                       LAC    CDWDCT          /YES -- UPDATE WORD COUNT AND
                       TAD    (2              /CHECK TO SEE IF WE HAVE OVERFLOWED THE
                       DAC    CDWDCT          /USER'S BUFFER
                       SMA
                       JMP    CDVER2          /YES -- WE HAVE OVERFLOWED
                       LAC    CDRWD2          /NO -- INSERT 5/7 WORDS IN USER'S BUFFER
                       CLL!RAL
                       DAC    CDRWD2
                       LAC    CDRWD1
                       RAL
                       DAC*   X13             /STORE FIRST WORD
                       LAC    CDRWD2
                       DAC*   X13             /STORE SECOND WORD
                       ISZ    CDCOLC
                       JMP    CDRM5
               /
                       .ENDC
               /
                       .IFDEF UC15
               /
               /   IN THE CASE OF THE UNICHANNEL, WE RECIEVE A 42(10) WORD
               /  BUFFER. THE FIRST WORD IS A BYTE COUNT (NOW ALWAYS 80(10)).
               /  NOTE THAT AN EOF CARD HAS A BYTE COUNT OF 1!!
               /  SPOOLER DOES CHECKSUM CALCULATION, NOT US.
               /  THE SECOND IS A CHECKSUM SO ENTIRE BUFFER ADDS TO 0
               /  !!!###MODULO 2^16 THAT IS###!!!. THEN ARE 40(10) WORDS
               /  OF 'COMPRESSED COLUMN'. (SEE CR-11 DRIVER MANUAL). EACH
               /  WORD HAS TWO EXTRANEOUS BITS AT LEFT, THE !SECOND CHAR!
               /  OF THE PAIR, AND FINALLY THE FIRST CHAR OF PAIR AT RIGHTMOST
               /  OF WORD. THE PDP-11 HAS ALREADY CHECKED FOR VALID PUNCH
               /  COMBINATIONS (64 VALID CARD ASCII, PLUS 12-1-8 FOR ALTMODE).
               /
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  16     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

00171 R 750030 A    RETRY   CLA!IAC         /SET VARIABLE SAYBING WE'RE WAITING FOR
00172 R 040407 R            DAC     POST    /INTERRUPT
00173 R 140554 R            DZM     CDON    /AND SAY WE HAVEN'T GOTTEN IT YET
00174 R 200614 R            LAC     TCBP    /ADDR OF TABLE TELLING PDP-11 TO READ CARD
00175 R 100616 R            JMS     CDIU    /ROUTINE TO SEND REQUEST TO PDP-11
00176 R 600057 R            JMP     WFTGR   /WAIT FOR COMPLETION INTERRUPT
                    /
                    /  COME BACK HERE WHEN CARD IS READ
                    /
00177 R 200571 R    GOTCRD  LAC     RRN     /RESTORE RN NODE
00200 R 040564 R            DAC     RN
00201 R 140407 R            DZM     POST    /CLEAR INTERRUPT FLAGS
00202 R 140554 R            DZM     CDON    /BEST TO CLEAR POST FIRST!
00203 R 200605 R            LAC     EV11    /EVENT VARIABLE FROM PDP-11
00204 R 742010 A            RTL             /PDP-11 SIGN BIT TO OUR SIGN BIT
00205 R 745120 A            SPA!CLL!RAR     /SKIP IF OK, START CLEARING HIGH BITS
00206 R 600636 R            JMP     CDUCEC  /GO CHECK WHICH KIND OF PIREX ERROR
00207 R 200572 R            LAC     TX12    /SETUP X12,X13 FOR USER BUFFER
00210 R 060673 R            DAC*    (X12    /MANIPULATIONS. X12 HEADER POINTER
00211 R 200573 R            LAC     TX13    /X13 DATA POINTER
00212 R 060674 R            DAC*    (X13
00213 R 220675 R            LAC*    (IBUF+2 /GET FIRST CHARACTER PAIR (2 WORD HDR)
00214 R 540676 R            SAD     (104611 /SPOOLER USES AN ALT-ALT CARD AS AN END
                    /                       /OF DECK CARD, WE SHOULD IGNORE IT!!
00215 R 600171 R            JMP     RETRY   /IT WAS ONE, JUST READ THE NEXT CARD
00216 R 500677 R            AND     (340    /12,11,0 PUNCHES IN FIRST COLM.=EOF
00217 R 340700 R            TAD     (445    /IF IT IS ONE, MAKE A 1005
00220 R 540701 R            SAD     (1005   /WELL, IF SO GO LACE 1005 AS HEADER
00221 R 600420 R            JMP     REQCMA  /EOF CARD, JUST SET HEADER.
                    /
00222 R 200675 R            LAC     (IBUF+2 /DATA STARTS AT BUFF+2
00223 R 744010 A            CLL!RAL         /TOP 17 BITS ADDRESS, LAST IS RIGHT-LEFT FLOP
00224 R 040405 R            DAC     CDIPTR  /TO GET INCOMING CHAR'S
00225 R 777660 A            LAW     -120    /80 CHAR'S
00226 R 040560 R            DAC     CDCOLC  /NOTE WE USE COUNTERS DIFERENT ALSO
00227 R 200331 R    PKINT   LAC     PAKI    /INIT 5/7 PACKER TO EXPECT
00230 R 040327 R            DAC     PAKSW   /1ST CHAR OF A BUNCH OF FIVE
00231 R 200566 R            LAC     CDWDCT  /WE USE AS COUNT OF PAIRS, NOT WORDS
00232 R 744020 A            CLL!RAR         /SO DIVIDE BY TWO
00233 R 040566 R            DAC     CDWDCT
00234 R 200405 R    CDRML2  LAC     CDIPTR  /WATCH IT! TOP 17 BITS ADDR, LOW BIT LEFT
00235 R 440405 R            ISZ     CDIPTR  /RIGHT FLIP-FLOP. AND!! POINTER POINTS TO
                    /                       /NEXT CHAR, NOT LAST ONE RETREIVED.
00236 R 744020 A            CLL!RAR         /FLIP-FLOP TO LINK, ADDR AC
00237 R 040406 R            DAC     CDT1    /HOLD POINTER IN TEMPORARY
00240 R 220406 R            LAC*    CDT1    /GET CHARACTER PAIR
00241 R 741410 A            SZL!RAL         /THESE THREE GET CORRECT CHAR
00242 R 743030 A            SWHA!SKP        /TO LOW ORDER 8 BITS OF WORD
00243 R 740020 A            RAR
00244 R 500702 R            AND     (377    /STRIP OTHER CHARACTER
                    /                       /AT THIS POINT HAVE CLOMNS 12,11,0,9,8,1-7
                    /                       /WHERE 1-7 CODED IN THREE BITS
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler



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00245 R 040406 R              DAC     CDT1     /HOLD
00246 R 540404 R              SAD     CDALT    /ALT MODE SPECIAL CASE, NO REMAP
00247 R 600260 R              JMP     CDGALT   /REJOIN AS SPECIAL CASE
00250 R 500703 R              AND     (20      /IF NINE PUNCH, PECIAL CASE, REMAP TO 8,1 PUNCH
00251 R 740200 A              SZA              /COMBO FOR OUR TRANSLATE. SKIP IF NOT NINE
00252 R 777771 A              LAW     -7       /ADDED TO '9' GIVES '8' AND '1'
00253 R 340406 R              TAD     CDT1     /REMAPPED,
00254 R 040406 R              DAC     CDT1     /SAVE, NOW TO MOVE BOTTOM FOUR BITS LEFT ONE
00255 R 500664 R              AND     (17      /POSITION (9 POSITION NOW VACATED!)
00256 R 340406 R              TAD     CDT1     /THIS DOES IT, LEAVING LOW ORDER BIT ZERO
                      /                        /NOW COLUMNS 12,11,0,8,1-7,ZERO BIT!
00257 R 745000 A              SKP!CLL          /HIDE YOUR HEAD. CLL FOR COMING RIR.SKIP
                      /                        /OVER ALT-MODE RE-ENTRY
00260 R 200704 R      CDGALT  LAC     (240     /INDEX TO ALT MODE
00261 R 742020 A              RTR              /RIGHT-LEFT TO LINK, INDEX TO AC
00262 R 340705 R              TAD     (CDTABL  /TABLE ADDR
00263 R 040406 R              DAC     CDT1
00264 R 220406 R              LAC*    CDT1     /GET PAIR FROM TRANSLATE TABLE
00265 R 740400 A              SNL              /HERE 0 IS LEFT, IN NORMAL SENSE
00266 R 742030 A              SWHA
00267 R 100323 R              JMS     PAK57    /5/7/ PACKER (IT STRIPS XTRA BITS)
00270 R 440560 R              ISZ     CDCOLC   /80?
00271 R 600234 R              JMP     CDRML2   /NO
00272 R 600410 R              JMP     CDCLOS   /YES
                      /
                      /  TRANSLATE TABLE 4 GROUPS OF 16 CHAR'S, TWO PER WORD. 8 WORD
                      /  SPACE BETWEEN LAST TWO GROUPS, IN WHICH WE PUT OTHER STUFF
                      /  CONDITIONALIZED FOR 026-029 OF COURSE. LEFT HAND CHAR IS FIRST.
                      /
                              .IFUND DEC026
00273 R 040061 A      CDTABL  040061  /BLANK, 1-PUNCH
00274 R 062063 A              062063  /2-PUNCH,3-PUNCH
00275 R 064065 A              064065  /4,5
00276 R 066067 A              066067  /6,7
00277 R 070071 A              070071  /8,9(ORDERED AS 8-1)
00300 R 072043 A              072043  /8-2,8-3
00301 R 100047 A              100047  /8-4,8-5
00302 R 075042 A              075042  /8-6,8-7
00303 R 060057 A              060057  /0,0-1
00304 R 123124 A              123124  /0-2,0-3
00305 R 125126 A              125126  /0-4,0-5
00306 R 127130 A              127130  /0-6,0-7
00307 R 131132 A              131132  /0-8,0-9(ORDERED AS 0-8-1)
00310 R 135054 A              135054  /0-8-2,0-8-3
00311 R 045137 A              045137  /0-8-4,0-8-5
00312 R 076077 A              076077  /0-8-6,0-8-7
00313 R 055112 A              055112  /11,11-1
00314 R 113114 A              113114  /11-2,11-3
00315 R 115116 A              115116  /11-4,11-5
00316 R 117120 A              117120  /11-6,11-7
00317 R 121122 A              121122  /11-8,11-9(ORDERED AS 11-8-1)
00320 R 041044 A              041044  /11-8-2,11-8-3
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  18     CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

       00321 R 052051 A                052051  /11-8-4,11-8-5
       00322 R 073134 A                073134  /11-8-6,11-8-7
                                       .ENDC
                                       .IFDEF DEC026
                               CDTABL  040061
                                       062063
                                       064065
                                       066067
                                       070071
                                       137075
                                       100136
                                       047134
                                       060057
                                       123124
                                       125126
                                       127130
                                       131132
                                       073054
                                       050042
                                       043045
                                       055112
                                       113114
                                       115116
                                       117120
                                       121122
                                       072044
                                       052133
                                       076046
                                       .ENDC
                      /
                      /  NOW THE 8 LOC. BREAK IN THE TABLE
                      /
                      /  THE 5/7 PACKER, A LITTLE TRICKY PAKSW KEEPS A PC WHICH
                      /  'REMEMBERS' WHICH CHARQCTER OF 5 WE ARE AT. TO INIT PACKER,
                      /  SEE TWO LINES OF CODE AT PAKINT. NORMAL 'FLUSH' OUT WOULD
                      /  BE TO SEND NUL CHAR'S UNTIL PAKSW=PAKI. IN THIS
                      /  HANDLER, PAST HISTORY SAYS WE TRUNCATE ALWAYS AT A WORD
                      /  PAIR BOUNDARY, EVEN FOR SHORT BUFFERS. I AM AFRAID TO
                      /  CHANGE THIS, EVEN THOUGH I DON'T LIKE IT.
                      /
       00323 R 000000 A   PAK57   0                /CALL WITH CHAR IN AC, (DESTROYED)
                          /                        /PUSHES CHAR'S THRU X13. EARLY END CHECK
                          /                        /IN CDWDCT.
       00324 R 500706 R           AND     (177     /STIP XTRA
       00325 R 744000 A           CLL              /FOR ALL ROTATES AND SWAPS!
       00326 R 620327 R           JMP*    PAKSW    /TO WHATEVER ACTION THIS CHAR. NEEDS.
       00327 R 740040 A   PAKSW   HLT              /POINTER TO ACTINS FOR CHARACTER
       00330 R 620323 R           JMP*    PAK57    /THAT'S ALL, OUT
       00331 R 000345 R   PAKI    PAKST            /INIT PAKSW FOR FIRST CHAR.
       00332 R 000000 A   PAKT    0                /TEMPORARY FOR PARTIAL WORDS
                          /
                          /  REST OF TRANSLATE TABLE
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
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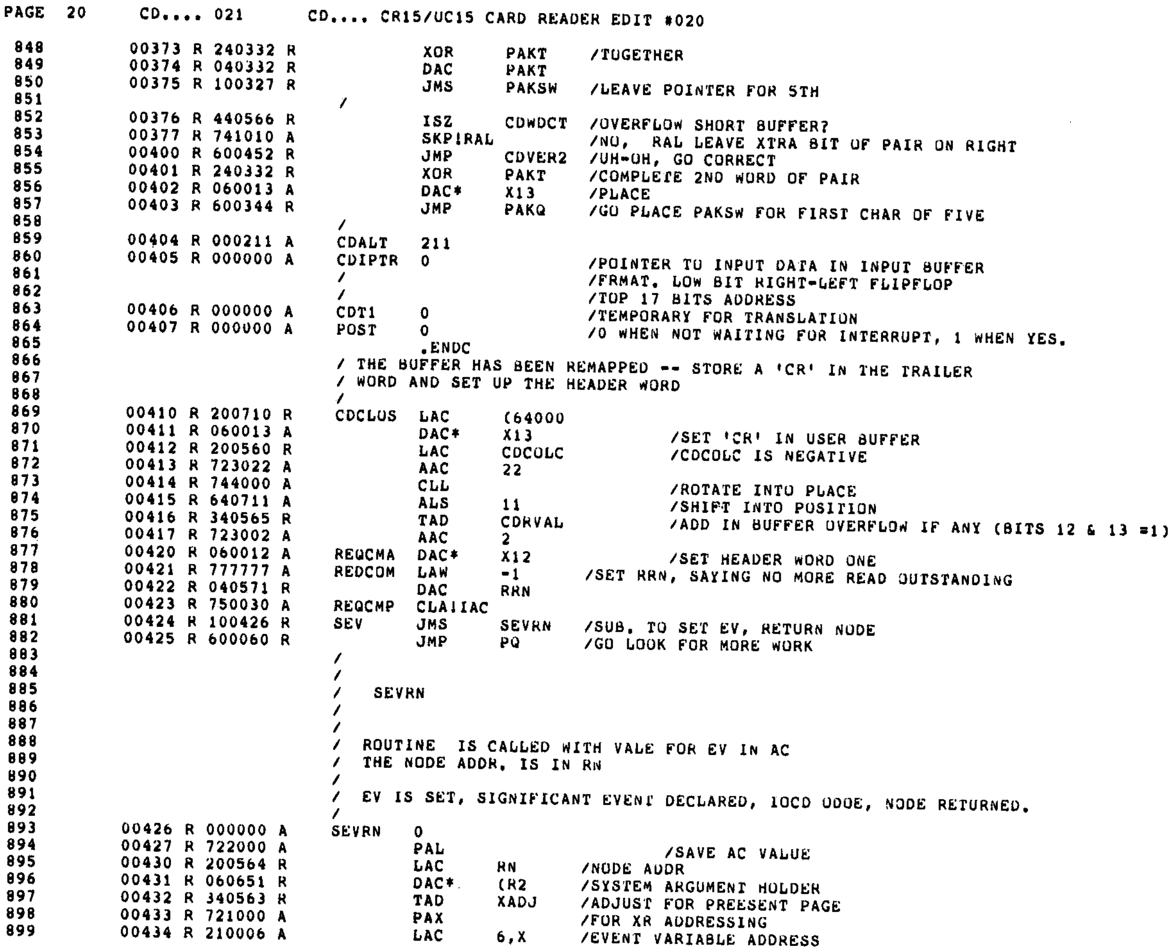
                    /
                            .IFUND DEC026
00333 R 046101 A            046101  /12,12-1
00334 R 102103 A            102103  /12-2,12-3
00335 R 104105 A            104105  /12-4,12-5
00336 R 106107 A            106107  /12-6,12-7
00337 R 110111 A            110111  /12-8,12-9(ORDERED AS 12-8-1)
00340 R 133056 A            133056  /12-8-2,12-8-3
00341 R 074050 A            074050  /12-8-4,12-8-5
00342 R 053136 A            053136  /12-8-6,12-8-7
                            .ENDC
                            .IFDEF DEC026
                            053101
                            102103
                            104105
                            106107
                            110111
                            077056
                            051135
                            074041
                            .ENDC
00343 R 175000 A            175000          /ALT MODE, FOR BOTH PUNCH SETS.
                    /
                    /  NOW REST OF 5/7 PACKER
                    /
00344 R 100327 R    PAKQ    JMS     PAKSW   /5TH CHAR WRAP BACK TO 1ST. JMS TO PAKSW
                    /                       /LEAVES ADDR OF ACTION FOR 1ST.!.
00345 R 742010 A    PAKST   RTL             /1ST CHARACTER ACTION, MOVE TO LEFT OF WORD
00346 R 742030 A            SWHA
00347 R 040332 R            DAC     PAKT    /HOLD AS PARTIALLY ASSEMBLED WORD
00350 R 100327 R            JMS     PAKSW   /LEAVE POINTER TO 2ND CHAR
                    /
00351 R 742010 A            RTL             /2ND CHAR ACTION
00352 R 742010 A            RTL
00353 R 240332 R            XOR     PAKT    /MARGE WITH FIRST
00354 R 040332 R            DAC     PAKT    /WAIT FOR PART OF 3RD TO FILL WORD
00355 R 100327 R            JMS     PAKSW   /LEAVE POINTER TO THIRD
                    /
00356 R 742020 A            RTR             /3RD, TWO PARTS, FIRST IS TOP 4 BITS
00357 R 740020 A            RAR             /RIGHT JUSTIFIED 1ST WORD OF PAIR
00360 R 040327 R            DAC     PAKSW   /VERY-TEMPORARY IN HERE
00361 R 500664 R            AND     (17     /ZAP OTHER BITS
00362 R 240332 R            XOR     PAKT    /COMPLETE 1ST WORD OF PAIR
00363 R 060013 A            DAC*    X13     /PLACE IN USER BUFFER
00364 R 200327 R            LAC     PAKSW   /GET BACK THIRD CHAR (LINK STILL OK!!!)
00365 R 740020 A            RAR             /2ND JOB, LOW THREE BITS OF CHAR TOP OF
00366 R 500707 R            AND     (700000 /2ND WORD OF PAIR
00367 R 040332 R            DAC     PAKT    /WHEW!, HOLD THAT IN PARTIAL WORD
00370 R 100327 R            JMS     PAKSW   /LEAVE POINTER FOR FOURTH
                    /
00371 R 742030 A            SWHA            /4TH, SNUG UP TO 3 BITS ON TOP
00372 R 740020 A            RAR
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler



```
PAGE  20     CD.... 021      CD.... CR15/UC15 CARD READER EDIT #020

       00373 R 240332 R           XOR      PAKT      /TOGETHER
       00374 R 040332 R           DAC      PAKT
       00375 R 100327 R           JMS      PAKSW     /LEAVE POINTER FOR 5TH
                          /
       00376 R 440566 R           ISZ      CDWDCT    /OVERFLOW SHORT BUFFER?
       00377 R 741010 A           SKP!RAL            /NO,  RAL LEAVE XTRA BIT OF PAIR ON RIGHT
       00400 R 600452 R           JMP      CDVER2    /UH-OH, GO CORRECT
       00401 R 240332 R           XOR      PAKT      /COMPLETE 2ND WORD OF PAIR
       00402 R 060013 A           DAC*     X13       /PLACE
       00403 R 600344 R           JMP      PAKQ      /GO PLACE PAKSW FOR FIRST CHAR OF FIVE
                          /
       00404 R 000211 A   CDALT   211
       00405 R 000000 A   CDIPTR  0                  /POINTER TO INPUT DATA IN INPUT BUFFER
                          /                          /FRMAT. LOW BIT RIGHT-LEFT FLIPFLOP
                          /                          /TOP 17 BITS ADDRESS
       00406 R 000000 A   CDT1    0                  /TEMPORARY FOR TRANSLATION
       00407 R 000000 A   POST    0                  /0 WHEN NOT WAITING FOR INTERRUPT, 1 WHEN YES.
                                  .ENDC
                          / THE BUFFER HAS BEEN REMAPPED -- STORE A 'CR' IN THE TRAILER
                          / WORD AND SET UP THE HEADER WORD
                          /
       00410 R 200710 R   CDCLOS  LAC      (64000
       00411 R 060013 A           DAC*     X13                 /SET 'CR' IN USER BUFFER
       00412 R 200560 R           LAC      CDCOLC              /CDCOLC IS NEGATIVE
       00413 R 723022 A           AAC      22
       00414 R 744000 A           CLL                          /ROTATE INTO PLACE
       00415 R 640711 A           ALS      11                  /SHIFT INTO POSITION
       00416 R 340565 R           TAD      CDRVAL              /ADD IN BUFFER OVERFLOW IF ANY (BITS 12 & 13 =1)
       00417 R 723002 A           AAC      2
       00420 R 060012 A   REQCMA  DAC*     X12                 /SET HEADER WORD ONE
       00421 R 777777 A   REDCOM  LAW      -1        /SET RRN, SAYING NO MORE READ OUTSTANDING
       00422 R 040571 R           DAC      RRN
       00423 R 750030 A   REQCMP  CLA!IAC
       00424 R 100426 R   SEV     JMS      SEVRN     /SUB. TO SET EV, RETURN NODE
       00425 R 600060 R           JMP      PQ        /GO LOOK FOR MORE WORK
                          /
                          /
                          /   SEVRN
                          /
                          /
                          /  ROUTINE  IS CALLED WITH VALE FOR EV IN AC
                          /  THE NODE ADDR. IS IN RN
                          /
                          /  EV IS SET, SIGNIFICANT EVENT DECLARED, IOCD DODE, NODE RETURNED.
                          /
       00426 R 000000 A   SEVRN   0
       00427 R 722000 A           PAL                          /SAVE AC VALUE
       00430 R 200564 R           LAC      RN        /NODE ADDR
       00431 R 060651 R           DAC*     (R2       /SYSTEM ARGUMENT HOLDER
       00432 R 340563 R           TAD      XADJ      /ADJUST FOR PREESENT PAGE
       00433 R 721000 A           PAX                /FOR XR ADDRESSING
       00434 R 210006 A           LAC      6,X       /EVENT VARIABLE ADDRESS
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  21     CD.... 021      CD.... CR15/UC15 CARD READER EDIT #020

00435 R 741200 A                SNA               /SKIP IF REALLY ONE
00436 R 600443 R                JMP      NOSET    /NOPE, SO DON'T SET
00437 R 340563 R                TAD      XADJ     /MODIFY IT FOR ADDRESSING
00440 R 721000 A                PAX
00441 R 730000 A                PLA               /BRING BACK SETTING VALUE
00442 R 050000 A                DAC      0,X      /THERE IT GOES!
00443 R 200711 R       NOSET    LAC      (401000  /DECLARE A SIGNIFICANT EVENT
00444 R 705504 A                ISA
00445 R 200704 R                LAC      (POOL    /GIVE NODE TO POOL
00446 R 060647 R                DAC*     (R1      /SYSTEM ARGUMENT REG
00447 R 120712 R                JMS*     (IOCD    /DECREMENT IO COUNT
00450 R 120713 R                JMS*     (NADD    /GIVE BACK NODE
00451 R 620426 R                JMP*     SEVRN    /THAT/S IT
                       /
                       /
                       /
                       / ***** BUFFER OVERFLOW
                       /
00452 R 777776 A       CDVER2   LAW      -2                 /BACKUP USER BUFFER PTR
00453 R 360674 R                TAD*     (X13)
00454 R 060674 R                DAC*     (X13)
00455 R 200714 R                LAC      (60)               /SET OVERFLOW BITS FOR USE BY CDCLOS
00456 R 040565 R                DAC      CDRVAL
00457 R 600410 R                JMP      CDCLOS
                       /
00460 R 777771 A       EVM7     LAW      -7                 /ILLEGAL DATA MODE.
00461 R 600424 R                JMP      SEV
00462 R 777750 A       EVM30    LAW      -30                /I/O PARAM. OUT OF PARTITION.
00463 R 600424 R                JMP      SEV
                       /
                                .IFUND   UC15
                       /
                       AEVM6    LAW      -6                 /ILLEGAL FUNCTION.
                                JMP      SAEV               /SET ABORT EV.
                       /
                       /ON ILLEGAL CARD PUNCH, WAIT FOR READER NOT READY FOLLOWED BY
                       /READER READY SEQUENCE BEFORE READING ANOTHER CARD.
                       /
                       ILLCP    LAC      (ERRMG2)           /TYPE 'ILLEGAL CARD PUNCH'.
                                JMS      TTYOUT
                                JMS      WF.SW              /WAIT FOR READER NOT READY.
                                         WFOFF              /PSUEDO INSTR. FOR WF.SW.
                                JMS      WF.SW              /WAIT FOR READER READY.
                                         WFON               /PSUEDO INSTR. FOR WF.SW.
                                JMP      RETRY              /READ ANOTHER CARD.
                       /
                       /        SUBR. TO WAIT FOR READER NOT READY OR READY FOR READ
                       /        PER PSUEDO INSTR. IN CALLING SEQUENCE. AFTER MARK TIME REQS.,
                       /        THE TRIG. EV. IS CHECKED FOR AN ABORT REQ. IN THE QUEUE.
                       /        IF TASK REQ. READ IS TO BE ABORTED, THE SUBR. DOESN'T
                       /        RETURN NORMALLY,BUT EVENTUALLY JUMPS TO CDABRT.
                       /        CALLING SEQUENCE:
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
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                              /
                              /       JMS      WF.SW
                              /                PSUED. INSTR.  (WFOFF OR WFON)
                              /       SUBR. RETURN ,IF NO INTERVENING ABORT FOR THIS TASK.
                              /
                              WF.SW   0
                                      LAC*     WF.SW                /GET PSUEDO INSTR.
                                      DAC      PV1
                                      ISZ      WF.SW                /BUMP EXIT.
                              WF.SWA  CRRS                          /READ CARD READER STATUS.
                                      AND      (20)                 /CHECK FOR READER READY FOR READ.
                              PV1     XX                            /SNA OR SZA.  (READER READY IF NON-ZERO AC).
                                      JMP*     WF.SW                /EXIT.
                                      CAL      MTCPB                /MARK TIME FOR WAIT.
                                      CAL      WFECB                /WAIT FOR MARK TIME INTERVAL.
                                      DZM      EV
                                      LAC      TG                   /CHECK FOR ABORT REQ. IN QUEUE.
                                      RTL
                                      SMA                           /ABORT REQ.?
                                      JMP      WF.SWA               /CHECK AGAIN.
                                      DZM      TG                   /YES.  DEQUEUE ABORT REQ.
                                      LAC      PDVNA    /PDVL NODE ADDR.
                                      DAC*     (R1)
                                      JMS*     (DQRQ)               /DEQUEUE ABRT. REQ. R1,R2,R4,R5,R6,XR,AC
                                      NOP                           /ALTERED.  ASSUME ABRT. REQ. IN QUEUE.
                                      DAC      RN                   /SAVE ABORT REQ. NODE ADDR.
                                      TAD      XADJ                 /SET XR.
                                      PAX
                                      LAC      6,X                  /GET ABRT. REQ. EV.
                                      DAC      ARE
                                      LAC      5,X                  /CHECK FOR ZERO LUN.
                                      AND      (777000)             /BITS 0-8
                                      SZA
                                      JMP      AEVM6                /ERROR.  NON-ZERO LUN.
                                      LAC      2,X                  /GET STL. NODE PTR. AND CHECK AGAINST
                                      SAD      STLA                 /READ REQ. STL NODE PTR. SAME?
                                      JMP      CDARD                /YES.  ABORT READ REQ. AND CLEAN UP.
                                      LAC      PDVNA    /NO.  CLEAN UP QUEUE OF TASK TO BE ABRTED.
                                      DAC*     (R1)                 /ALSO RETR. ABRT. REQ. NODE TO POOL AND
                                      LAC      RN                   /DECR. TRANSF. PEND. CNT.  ABRT. REQ. NODE
                                      DAC*     (R2)                 /ADDR. TO R2.
                                      JMS*     (DMTQ)               /EMPTY REQ. QUEUE OF ALL I/O
                                                                    /REQ.'S MADE BY TASK BEING ABORTED.
                                                                    /R1,R2,R3,R5,R6,X10,X11,X12,XR,AC ALTERED.
                                      LAC      (1)                  /SET ABRT. REQ. EV TO +1.
                              SAEV    PAL
                                      LAC      ARE                  /ABORT REQ. EV.
                                      TAD      XADJ
                                      PAX
                                      PLA
                                      DAC      0,X
                                      LAC      (401000)


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                                      ISA                           /DECLARE SIGNIF. EVENT.
                                      LAC      RN                   /RETRN. ABRT. REQ. NODE TO POOL.
                                      DAC*     (R2)
                                      LAC      (POOL)
                                      DAC*     (R1)
                                      JMS*     (IOCD)               /DECR. TRANSF. PEND. CNT.
                                      JMS*     (NADD)               /RETRN. NODE TO POOL.
                                      JMP      WF.SWA               /CHECK AGAIN.
                              CDARD   CLA!IAC                       /SET CARD DONE FLAG.
                                      DAC      CDON
                                      JMP      CDABRT               /PROCEED WITH ABORT.
                              /
                                      .ENDC
                                      .EJECT
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
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                            /
                            / EXIT REQUEST (FROM TASK "....REA")
                            /
00464 R 200704 R            DAEX    LAC     (POOL)          /RETURN REQUEST NODE TO POOL
00465 R 060647 R                    DAC*    (R1)
00466 R 200564 R                    LAC     RN
00467 R 060651 R                    DAC*    (R2)
00470 R 120712 R                    JMS*    (IOCD)          /DECREMENT TRANSF. PENDING COUNT
00471 R 120713 R                    JMS*    (NADD)
                                    .IFUND  UC15
                                    LAC     (CC1)           /CONDITION CODE 1 -- CLEAR CONTROL.
                                    CRLC
                                    CAL     DCPB            /DISCONNECT
                                    .ENDC
                                    .IFDEF  UC15
00472 R 100625 R                    JMS     CLEAR   /CLEAR DEVICE , WAIT FOR COMPLETION
00473 R 440577 R                    ISZ     CCPB            /MAKE CONNECT A DISCONNECT (BURP)
00474 R 000577 R                    CAL     CCPB            /DISCONNECT
                                    .ENDC
00475 R 440570 R                    ISZ     PDVTA           /POINT TO ASSIGN INHIBIT FLAG
00476 R 705522 A                    .INH                    /INHIBIT INTERRUPTS.
00477 R 160570 R                    DZM*    PDVTA           ///ZERO IT
00500 R 705521 A                    .ENB                    ///ENABLE INTERRUPTS.
00501 R 000653 R                    CAL     (10)            ///EXIT
                            /
                            /
                            /ABORT REQUEST.
                            /
00502 R 777000 A            CDABRT  LAW     17000   /MASK TO KEEP HALF WORD TO CHECK ABORT VALIDITY
00503 R 510005 A                    AND     5,X     /HAS TO BE ZERO TO BE OK
00504 R 740200 A                    SZA             /SO SKIP IF OK
00505 R 600116 R                    JMP     EVM6    /ERROR RETURNED IF NOT
00506 R 200567 R                    LAC     PDVNA   /MT THE DEQUE FOR THE ABORTED TASK
00507 R 060647 R                    DAC*    (R1
00510 R 200564 R                    LAC     RN      /ABORT NODE
00511 R 060651 R                    DAC*    (R2
00512 R 120715 R                    JMS*    (DMTQ   /THIS ROUTINE DOES ALL WORK
                            /
                            /  NOW WAS THIS ABORT FOR AN OUTSTANDING READ?
                            /
00513 R 200564 R                    LAC     RN      /2+RN IS STL NODE ADDR
00514 R 340563 R                    TAD     XADJ    /USE AS IDENTIFIER
00515 R 721000 A                    PAX
00516 R 210002 A                    LAC     2,X
00517 R 540556 R                    SAD     STLA    /SAME ADDR FOR LAST READ DONE
00520 R 751001 A                    SKP!CLA!CMA     /SKIP IF SAME, SET UP -1
00521 R 600423 R                    JMP     REQCMP  /NOPE, WE'RE DONE, GO GIVE BACK NODE ETC.
00522 R 240571 R                    XOR     RRN     /NASTY, MAKES 0 IF NO READ NOW! IN PROGRESS
00523 R 741201 A                    SNA!CMA         /SKIP IF READ IN PROGRESS, RECREATE ITS NODE ADDR!
00524 R 600423 R                    JMP     REQCMP  /NOPE, JUST COMPLETE
00525 R 060651 R                    DAC*    (R2     /GIVE BACK NODE AND IOCD FOR SUSPENDED READ
00526 R 200704 R                    LAC     (POOL


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00527 R 060647 R                    DAC*    (R1
00530 R 120712 R                    JMS*    (IOCD
00531 R 120713 R                    JMS*    (NADD
00532 R 750001 A                    CLA!CMA         /SET READ NOT HERE SWITCH
00533 R 040571 R                    DAC     RRN
                                    .IFUND  UC15
                                    LAC     (CC1    /CLEAR DEVICE
                                    CRLC
                                    .ENDC
                                    .IFDEF  UC15
00534 R 100625 R                    JMS     CLEAR   /AND CLEAR FOR UNICHANNEL
                                    .ENDC
00535 R 600423 R                    JMP     REQCMP          /DONE
                            /
                            /
                            /
                            /
                                    .EJECT
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
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                                  /
                                  / INTERRUPT SERVICE ROUTINE
                                  /
          00536 R 000000 A        INT       0
          00537 R 707762 A                  DBA
          00540 R 040000 R                  DAC      START             /SAVE AC
                                            .IFUND   UC15
                                            CRRS                       /READ STATUS INTO AC.
                                            DAC      EV1               /SAVE FOR TASK LEVEL PROCESSING.
                                            AND      (2)               /CARD DONE?  BIT 16.
                                            SNA
                                            JMP      INT1              /NO.  DON'T CLEAR CARD DONE.
                                            DAC      CDON     /PLACE 2 INTO CDON TO SAY DONE
                                            LAC      (CC3)             /YES.  CLEAR CARD DONE.  LEAVE
                                            CRLC                       /INTERR. AND DCH ENABLED.
                                  INT1      CRPC                       /CLEAR ALL BUT CARD DONE.
                                            LAC      (CC4)             /ENABLE INTERRS.  DISABLE DCH
                                            CRLC                       /NEEDED SINCE CRPC DISABLES INTERRS.
                                            .ENDC
                                  /
                                            .IFDEF   UC15
          00541 R 706124 A                  CAPI                       /CLEAR FLAG FROM PDP-11
          00542 R 200407 R                  LAC      POST     /ARE WE WANTING AN INTERRUPT
          00543 R 741200 A                  SNA               /SKIP IF YES/USE VALUE TO SET
          00544 R 600551 R                  JMP      INTAC    /NO DO NOTHING
          00545 R 040554 R                  DAC      CDON     /AS FLAG TO DISTINGUISH CARD DONE FROM CAL
          00546 R 040562 R                  DAC      TG       /AND SET TG TO WAKE UP CAL LEVEL
                                            .ENDC
          00547 R 200711 R                  LAC      (401000)          /DECLARE SIGNIF. EVENT.
          00550 R 705504 A                  ISA
          00551 R 200000 R        INTAC     LAC      START             /RESTORE AC.
          00552 R 703344 A                  DBR
          00553 R 620536 R                  JMP*     INT
                                            .EJECT


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                                  /
                                            .IFUND  UC15
                                  /SUBR. TO OUTPUT ERROR MESSAGES VIA ERRLUN.' AC SHOULD CONTAIN
                                  /ADDRESS OF ERROR MESSAGE BUFFER.
                                  /
                                  TTYOUT    0
                                            DAC      TECPB4            /SET CPB BUFFER ADDRESS.
                                            CAL      TE                /TYPE ERROR MESSAGE.
                                            CAL      WFECB             /WAITFOR EV.
                                            JMP*     TTYOUT
                                  /
                                  /ERROR MESSAGE BUFFERS AND TABLE OF PTRS.:
                                  /
                                  ERRPT     .+1
                                            ERRMG1
                                            ERRMG2
                                            ERRMG3
                                            ERRMG4
                                            ERRMG5
                                  /
                                  /
                                  /
                                  ERRMG1    ERRMG2-ERRMG1*1000/2+2
                                            0
                                            .ASCII '*** CD READER NOT READY'<15>
                                  ERRMG2    ERRMG3-ERRMG2*1000/2+2
                                            0
                                            .ASCII '*** CD ILLEGAL PUNCH'<15>
                                  ERRMG3    ERRMG4-ERRMG3*1000/2+2
                                            0
                                            .ASCII '*** CD PICK ERROR'<15>
                                  ERRMG4    ERRMG5-ERRMG4*1000/2+2
                                            0
                                            .ASCII '*** CD DATA MISSED/PHOTO ERROR'<15>
                                  ERRMG5=.
                                            .EJECT
                                  / ***** CARD COL TO ASCII TRANSLATION TABLE *****
                                  /
                                  /EACH TABLE ENTRY REPRESENTS VALID ASCII CARD PUNCHES WITH
                                  /THE FOLLOWING FORMAT:
                                  /
                                  /BITS 0 - 5      SIXBIT ASCII CHARACTER.
                                  /BITS 6 - 17     CARD PUNCHES WITH THE FOLLOWING MAPPING:
                                  /
                                  /BIT 6 = ZONE 12
                                  /BIT 7 = ZONE 11
                                  /BITS 8 - 17  = ZONES 0 - 9.
                                  /THE ASSEMBLER BUILDS THE TWOS COMPLEMENT OF BITS 6-17 VIA THE
                                  /7777\+1 OPERATION.  THE TABLE IS ORDERED ACCORDING TO INCREASING
                                  /MAGNITUDE OF CARD PUNCHES(CONSIDERED AS 12 BIT RIGHT JUSTIFIED
                                  /INTEGER VALUES).
                                  /EXAMPLE:  ASCII '9' HAS FOLLOWING TABLE REPRESENTATION:
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  28      CD.... 021      CD.... CR15/UC15 CARD READER EDIT #020

                /
                /         710001\7777+1
                /
                /WHERE 0001 INDICATES ZONE 9 PUNCHED AND 71 IS SIXBIT ASCII '9'.
                /
                /GRAPHIC CHARACTERS FOR 026 PUNCHES ARE IN PARENTHESES BELOW:
                /
                CDTABL  CDTABL+1
                        400000                  /BLANK
                        710001\7777+1           /9
                        700002\7777+1           /8
                        670004\7777+1           /7
                        CP 340006,420006        /" (\)
                        660010\7777+1           /6
                        CP 470012,750012        /= (')
                        650020\7777+1           /5
                        CP 360022,470022        /, (^)
                        640040\7777+1           /4
                        000042\7777+1           /@
                        630100\7777+1           /3
                        CP 750102,430102        /# (=)
                        620200\7777+1           /2
                        CP 370202,720202        /: (_)
                        610400\7777+1           /1
                        601000\7777+1           /0
                        321001\7777+1           /Z
                        311002\7777+1           /Y
                        301004\7777+1           /X
                        CP 451006,771006        /? (%)
                        271010\7777+1           /W
                        CP 431012,761012        /> (#)
                        261020\7777+1           /V
                        CP 421022,371022        /RIGHT ARROW (")
                        251040\7777+1           /U
                        CP 501042,451042        /% (()
                        241100\7777+1           /T
                        541102\7777+1           /'
                        231200\7777+1           /S
                        CP 731202,351202        /](;)
                        571400\7777+1           //
                        552000\7777+1           /-
                        222001\7777+1           /R
                        212002\7777+1           /Q
                        202004\7777+1           /P
                        CP 462006,342006        /\ (&)
                        172010\7777+1           /O
                        CP 762012,732012        /; (>)
                        162020\7777+1           /N
                        CP 332022,512022        /) ([)
                        152040\7777+1           /M
                        522042\7777+1           /*
                        142100\7777+1           /L


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                        442102\7777+1           /$
                        132200\7777+1           /K
                        CP 722202,412202        /! (:)
                        122400\7777+1           /J
                        CP 534000,464000        /& (+)
                        114001\7777+1           /I
                        104002\7777+1           /H
                        074004\7777+1           /G
                        CP 414006,364006        /^ (!)
                        064010\7777+1           /F
                        CP 744012,534012        /+ (<)
                        054020\7777+1           /E
                        CP 354022,504022        /( (])
                        044040\7777+1           /D
                        CP 514042,744042        /< ())
                        034100\7777+1           /C
                        564102\7777+1           /.
                        024200\7777+1           /B
                        CP 774202,334202        /[ (?)
                        014400\7777+1           /2
                CDTLN1  .-1-CDTABL/2
                CDRALT  4402
                        .ENDC
                        .EJECT
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  30     CD.... 021      CD.... CR15/UC15 CARD READER EDIT #020

                             /
                             / ***** INTERNAL VARIABLES *****
                             /
        00554 R 000001 A     CDON     1                 /CARD DONE FLAG.
        00555 R 000000 A     TST      0                 /TEMP STORAGE FOR STATUS.
        00556 R 000000 A     STLA     0                 /STL NODE. ADDR.
        00557 R 000000 A     ARE      0                 /ABORT REQ. EV.
        00560 R 000000 A     CDCOLC   0                 /CARD COL COUNT USED IN TRANSLATING CARDS
        00561 R 000000 A     EV       0                 /INTERNAL EVENT VARIABLE
        00562 R 000000 A     TG       0                 /TRIGGER EVENT VARIABLE
        00563 R 000000 A     XADJ      0                /XR ADJUST CONSTANT TO SUBTRACT PAGE BITS
        00564 R 000000 A     RN       0                 /ADDRESS OF THE REQUEST NODE PICKED FROM AUEUE
        00565 R 000000 A     CDRVAL   0                 /BUFFER OVERFLOW FLAG WORD
        00566 R 000000 A     CDWDCT   0                 /WORD COUNT CHECK WORD SET FROM I/O REQUEST
                             /
                                      .IFUND  UC15
                             /
                             /  SAVE SOME ROOM FOR UC15, THESE ARE NOT NEEDED
                             /
                             ICA      0                 /INTERNAL BUFFER CURRENT ADDRESS POINTER
                             CDR7CT   0                 /SEVEN COUNTER USED BY THE 5/7 ASCII PACKING ROUTINE
                             CDR5CT   0                 /COUNTER FOR 5/7 ASCII PACKING
                             CDTPTR   0                 /POINTER TO TRANSLATION TABLE
                             CDTLEN   0                 /TRANSLATION TABLE LENGTH
                             CD7700   770000            /USED IN CARD TRANSLATION
                             CDCPTR   0                 /POINTER TO CURRENT INTEM IN TRANSLATION TABLE
                             CDRWD3   0                 //
                             CDRWD2   0                 // THREE WORD SHIFT REG. FOR 5/7 ASCII PACKING
                             CDRWD1   0                 //
                             EV1      0                 /CARD READER EV.
                             /
                                      .ENDC
                             /
        00567 R 000000 A     PDVNA    0                 /PHYSICAL DEVICE NODE ADDRESS
        00570 R 000000 A     PDVTA    0                 /ADDRESS OF ADDRESS OF TEV IN PHY DEV NODE
        00571 R 777777 A     RRN      777777            /READ BEING PROC. FLAG.  -1 IF NOT BEING
                                                        /PROCESSED.  READ REQ. NODE ADDRESS IF BEING
                                                        /PROCESSED.
        00572 R 000000 A     TX12     0                 /TEMP. FOR X12 STOR.
        00573 R 000000 A     TX13     0                 /TEMP. FOR X13 STOR.
        00574 R 000000 A     TCWC     0                 /TEMP. FOR REQ. WC.
                             /
                                      .EJECT
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  31    CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

                                /
                                / ***** CAL PARAMETER BLOCKS *****
                                /
                                /
            00575 R 000020 A    WFTCPB  20                      /WAIT FOR TRIGGER CPB
            00576 R 000562 R            TG
                                /
            00577 R 000011 A    CCPB    11                      /CONNECT CPB
            00600 R 000561 R            EV
            00601 R 000015 A            15                      /LINENUMBER
            00602 R 000536 R            INT                     /ENTRY ADDRESS OF INTERRUPT SERVICE ROUTINE
                                /
                                        .IFUND  UC15
                                /
                                /  UC15 SAVE SPACE BY LEAVING OUT SOME CAL'S
                                /
                                /
                                /
                                WFECB   20                       /WAIT FOR EV CPB
                                        EV
                                /
                                DCPB    12                      /DISCONNECT CPB
                                        0                       /EV ADDRESS
                                        15                      /INTERRUPT LINE NUMBER
                                        INT                     /CURRENT INTERRUPT TRANSFER ADDRESS
                                /
                                TE      2700                    /WRITE TO ERRLUN.
                                        EV
                                        ERRLUN          /WRITE OUT THE ERROR MESSAG TO THE DESIRED
                                                        /TELETYPE
                                        2
                                TECPB4  XX
                                /
                                MTCPB   13                      /MARK TIME REQ.
                                        EV
                                        12                      /12 UNITS.
                                        1                       /UNIT (TICK).
                                /
                                WFCRCB  20              /WAIRFOR CR INTERRS.
                                        EV1
                                /
                                WFCRCD  20              /WAIT FOR CARD DONE FLAG TO BE SET.
                                        CDON
                                /
                                        .ENDC
                                /
                                /
                                        .IFDEF  UC15
                                /
                                /  I/O INFORMATION , ROUTINES , ETC. FOR UC15
                                /
                                /  TCB (TASK CONTROL BLOCK) TELLING PDP-11 TO SEND US A CARD
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE   32      CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

                                 /
        00603 R 026401 A    TCB      APISLT*400+APILVL        /TELL PDP-11 WHERE TO COME BACK
        00604 R 000005 A             DEVCOD                   /PIREX CODE FOR CD;THE 200 BIT SAYS
                            /                                 /WE ARE NOT TO BE SPOOLED.
        00605 R 000000 A    EV11     0                        /EVENT VARIABLE FROM PDP11 TO US
        00606 R 000000 A             0                        /DUMMY, HIGH PORTION OF 18 BIT
                            /                                 /ADRESS. NOT PRESENTLY USED
        00607 R 000001 R             IBUF                     /POINTER TO BUFFER TO PUT CARD IN
        00610 R 000000 A             0                        /UNIT #; FOR FUTURE GENERATIONS.
                            /
                            /  TCB TO TELL PDP11 TO CLEAR OUT CARD READER DEVICE
                            /
        00611 R 000000 A    TCBK     0                  /THIS WORKS, SEE PIREX FOR INFO.
        00612 R 002600 A             DEVCOD&177*400+200
        00613 R 000000 A    EV11K    0                  /EVENT VARIABLE FOR CLEAR OPERTAION
                            /
                            /  POINTERS TO TCB, TDBK
                            /
        00614 R 000603 R    TCBP     TCB
        00615 R 000611 R    TCBKP    TCBK
                            /
                            /
                            /  CDIU IS THE SUBROUTINE TO SEND A TCB TO THE PDP-11
                            /
                            /  CAL WITH THE ADRESS OF THE TCB IN THE AC
                            /
        00616 R 000000 A    CDIU     0
        00617 R 140605 R             DZM      EV11      /CLEAR ONE COMING FROM PDP-11
        00620 R 140613 R             DZM      EV11K     /AND THE OTHER ONE, IN CASE IT  USED
        00621 R 706001 A             SIOA               /SKIP IF PDP-11 CAN TAKE REQUEST
        00622 R 600621 R             JMP      .-1
        00623 R 706006 A             LIOR               /TELL IT TO DO TCB WHOSE ADDRESS IN AC
        00624 R 620616 R             JMP*     CDIU      /THAT'S ALL THERE IS TO IT.
                            /
                            /
                            /  CLEAR  CLEARS SWITCHES, AND CD IN PIREX, WAITS FOR COMPLETE
                            /
        00625 R 000000 A    CLEAR    0
        00626 R 140407 R             DZM      POST
        00627 R 140554 R             DZM      CDON
        00630 R 200615 R             LAC      TCBKP     /TCB FOR CLEAR
        00631 R 100616 R             JMS      CDIU
        00632 R 000634 R             CAL      WFCLER    /WAIT FOR CLEAROUT
        00633 R 620625 R             JMP*     CLEAR
                            /
        00634 R 000020 A    WFCLER   20
        00635 R 000613 R             EV11K
                            /  CDUCEC EXAMINES NEGATIVE EVENT VARIABLES FROM PIREX
                            /
        00636 R 744020 A    CDUCEC   CLL!RAR            /CLEAR OTHER TOP BIT
        00637 R 340716 R             TAD      (600000 /SIGN EXTEND TO PDP-15 WORD
        00640 R 540717 R             SAD      (777001 /THIS ONLY 'LEGAL' VALUE AT PRESENT
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

```
PAGE  33      CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

1397          00641 R 600171 R              JMP      RETRY    /THAT SAYS PIREX IS OUT OF NODES,
1398                                /                           /WE SHOULD TRY AGAIN TO GET ONE
1399          00642 R 100426 R              JMS      SEVRN    /OTHERS, RETURN NEG VARIABLE AS EV.
1400                                /                           /THIS IS SLIGHTLY FLAKEY, BUT WE
1401                                /                           /REALLY SHOULD NEVER GET HERE!?!?
1402          00643 R 777777 A              LAW      -1       /SAY NO MORE READ OUTSTANDING
1403          00644 R 040571 R              DAC      RRN
1404          00645 R 600060 R              JMP      PQ       /BACK TO LOOK FOR MORE WORK
1405                                /
1406                                /
1407                                        .ENDC
1408                  000000 R              .END START
              00646 R 000252 A *L
              00647 R 000101 A *L
              00650 R 000054 R *L
              00651 R 000102 A *L
              00652 R 000123 A *L
              00653 R 000010 A *L
              00654 R 000562 R *L
              00655 R 070000 A *L
              00656 R 000337 A *L
              00657 R 000777 A *L
              00660 R 000024 A *L
              00661 R 000025 A *L
              00662 R 000026 A *L
              00663 R 000036 A *L
              00664 R 000017 A *L
              00665 R 000325 A *L
              00666 R 000332 A *L
              00667 R 200007 A *L
              00670 R 000103 A *L
              00671 R 000104 A *L
              00672 R 000342 A *L
              00673 R 000012 A *L
              00674 R 000013 A *L
              00675 R 000003 R *L
              00676 R 104611 A *L
              00677 R 000340 A *L
              00700 R 000445 A *L
              00701 R 001005 A *L
              00702 R 000377 A *L
              00703 R 000020 A *L
              00704 R 000240 A *L
              00705 R 000273 R *L
              00706 R 000177 A *L
              00707 R 700000 A *L
              00710 R 064000 A *L
              00711 R 401000 A *L
              00712 R 000345 A *L
              00713 R 000107 A *L
              00714 R 000060 A *L
              00715 R 000361 A *L


PAGE  34      CD.... 021       CD.... CR15/UC15 CARD READER EDIT #020

              00716 R 600000 A *L
              00717 R 777001 A *L
                 SIZE=00720      NO ERROR LINES
```

Figure 4-2 (Cont.)
XVM CR11 XVM/RSX Handler

4.6.3.3 Requests - Following handler initialization, requests can be processed. Note that the request dequeuing algorithm (see Figure 4-2 lines 352-407) is executed whenever Q-I/O places a request node in the list associated with the handler's PDVL node or whenever an interrupt for the device has occurred on the XVM. The latter condition implies that the handler's interrupt service routine (Figure 4-2, lines 1091-1120) will set the trigger event variable on each interrupt.

4.6.3.4 ABORT Requests - Because of the nature of the UNICHANNEL configuration, ABORT requests should be handled on a high priority basis. Hence, whenever the trigger event variable is set, the handler should first check to see if an ABORT request has been issued. (Figure 4-2, lines 353-357). This condition can be tested using the following algorithm:

```
LAC   TG       /GET THE TRIGGER EVENT VARIABLE INTO THE AC
RTL            /MOVE THE ABORT BIT INTO BIT ZERO OF THE AC
SPA            /SKIP IF ABORT BIT IS NOT SET
JMP   PICK     /ABORT REQUEST-DEQUEUE AND PROCESS IT
 .
 .             /NOT AN ABORT REQUEST-CHECK OTHER
 .             /REASONS FOR HAVING TRIGGER EVENT VARIABLE SET.
```

4.6.3.5 Interrupts - If the trigger event variable was not set due to an ABORT request, either PIREX has issued an interrupt or a new request for I/O is pending. Before checking for new requests, the handler should see if an interrupt occurred (see Figure 4-2, lines 359-362). If it did, the handler should check to see if an interrupt was requested. Unrequested interrupts should be ignored but the handler should finish processing the outstanding I/O request if the interrupt indicates that I/O is now complete.

If the trigger event variable was not set due to an interrupt and no I/O is being processed by PIREX, the handler can pick off the new I/O request and begin processing it (see Figure 4-2, lines 368-407).

On ABORT requests, the handler should determine if I/O is in progress on the PDP-11 for the task being aborted (see Figure 4-2, lines 1058-1067). If so, the handler should issue a "clear device directive" to PIREX to stop the I/O in progress (see Figure 4-2, lines 1073-1080).

The "clear device directive" must also be issued whenever a DISCONNECT and EXIT request from the MCR function REASSIGN is processed (see Figure 4-2, line 1033).

4.6.3.6 READ and WRITE Requests - READ and WRITE request processing usually involves the following procedures:

1. Checking the range of the issuing task's TCB and buffer.
2. Making data conform to PDP-11 standards for WRITE requests and XVM standards for READ requests.
3. Sending a TCB directive to PIREX.
4. Waiting for PIREX to complete the operation initiated by sending the TCB directive.
5. Checking the event variable sent back to the handler by PIREX.
6. Setting data into the issuing task's request buffer for READ.
7. Sending an event variable to the task which initiated the request for I/O.

The following is a brief outline of the procedure used by the UNICHANNEL Card Reader handler when it processes a read request. (Refer to Figure 4-2).

1. Dequeue the I/O request node (lines 352-407)
2. Check the range of the task TCB and buffer (lines 440-465).
3. Clear the TCB event variable (line 1372).
4. Clear the "I/O Done" flage (line 642).
5. Set the "Interrupt Expected" flage (lines 640-641).
6. Issue the READ TCB to the Card Reader Driver in PIREX (lines 1374-1376).
7. Wait for the Trigger Event Variable (line 352).
8. When the Card Reader Driver has completed the request, the Card Reader handler interrupt service routine sets the Trigger Event Variable and the "I/O Done" flage (lines 113-114).
9. The handler then checks the Event Variable sent back by PIREX (lines 653-656).
10. Convert the data to XVM card format and transfer it to the task's buffer (lines 670-879).

11. Set the task's Event Variable (lines 880-881).

12. Wait for the next request (line 352).

Note that in order for a UNICHANNEL handler to function properly, the PDP-11 must be able to access the handler's internal buffers and TCBs. Hence, all locations within these TCBs and buffers must be within the common memory accessible to the PDP-11.[1] Also, note that the XVM/RSX POLLER task should be modified to interrogate PIREX concerning the status of the new device.

4.7 BUILDING A XVM/PIREX DEVICE DRIVER

A device driver is a software routine that performs rudimentary I/O functions. PIREX device drivers typically operate in conjunction with more complex XVM handlers. While a rudimentary device driver is typical, a PIREX task can be as complex as a full handler. The PIREX XY driver is a good example of a very complex driver. The PIREX line printer driver, a typical rudimentary driver, will be used to examine the construction of a device driver.

4.7.1 General Layout

The general layout of a driver task (see Figure 4-3 and Section 4.5) consists of:

1. Entries on PIREX internal lists.

2. A stack area which will be used when the task is executing.

3. The address of a device control register. This is used to stop the device during STOP I/O requests. Dummy addresses are used for tasks which are not device drivers.

4. A 2-word busy/idle switch used to store the caller's 18-bit TCBP. When the busy/idle switch is zero, the routine is not busy.

5. The task request setup/processing section.

6. The task interrupt processing section, if the task is a device driver.

[1] Depending on Driver task design the buffers for an NPR device may not have to be in common memory.

Task Development

The task request setup/processing section obtains the parameters from the TCB and uses them to set up the referenced device or process the request. Entry into this section is made from the ATL scanner or DEQU with the current task stack area active at the priority level associated with that task. All general purpose registers are available for use by the current task at this time. The TCBP is stored in the busy/idle switch preceding the request section and signifying that the task is busy. Once some operation is underway or completed, the task returns to the ATL scanner by issuing the "SEXIT" macro instruction (refer to Section 4.7.2.4).

If the task is a device driver, the interrupt section is called at the completion of an I/O request. All device interrupt priority vectors specify priority 7. This is done to allow the interrupt routine to save the general-purpose registers on the current task stack pointer and lower the system to the priority level of this task. (The interrupt section accomplishes this by calling R.SAVE.)

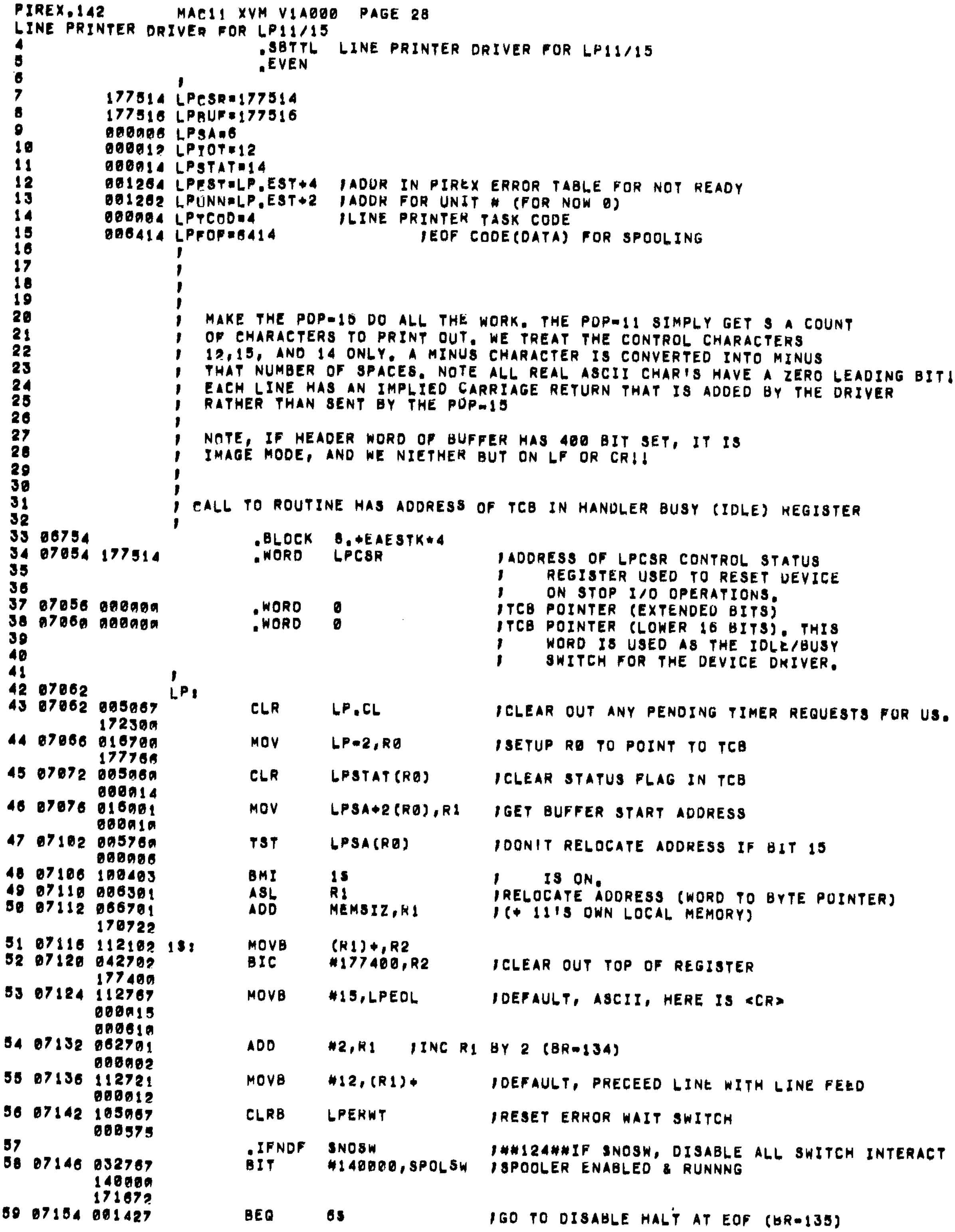
Control is transferred to the driver, which then checks for errors, stores status information into the TCB, clears the device busy switch (the driver becomes idle when the busy switch is cleared) and sends an optional interrupt (via SEND15, see Figure 3-6) to the system informing it that the request has been processed. The driver then transfers control to the routine DEQU (see Figure 3-7) to determine if more requests are in its TRL. If not, control is transferred to the ATL scanner, after saving the task stack pointer and setting the task status to the wait state in the ATL node.

4.7.2 Task Program Code

The task program code is necessary to carry out the task's function.

4.7.2.1 Code Sections - The program code section of a device driver is composed of three or four of the following subsections (refer to Figure 4-3).[1]

[1] Page number refers to the page number at the top of the PIREX listing.

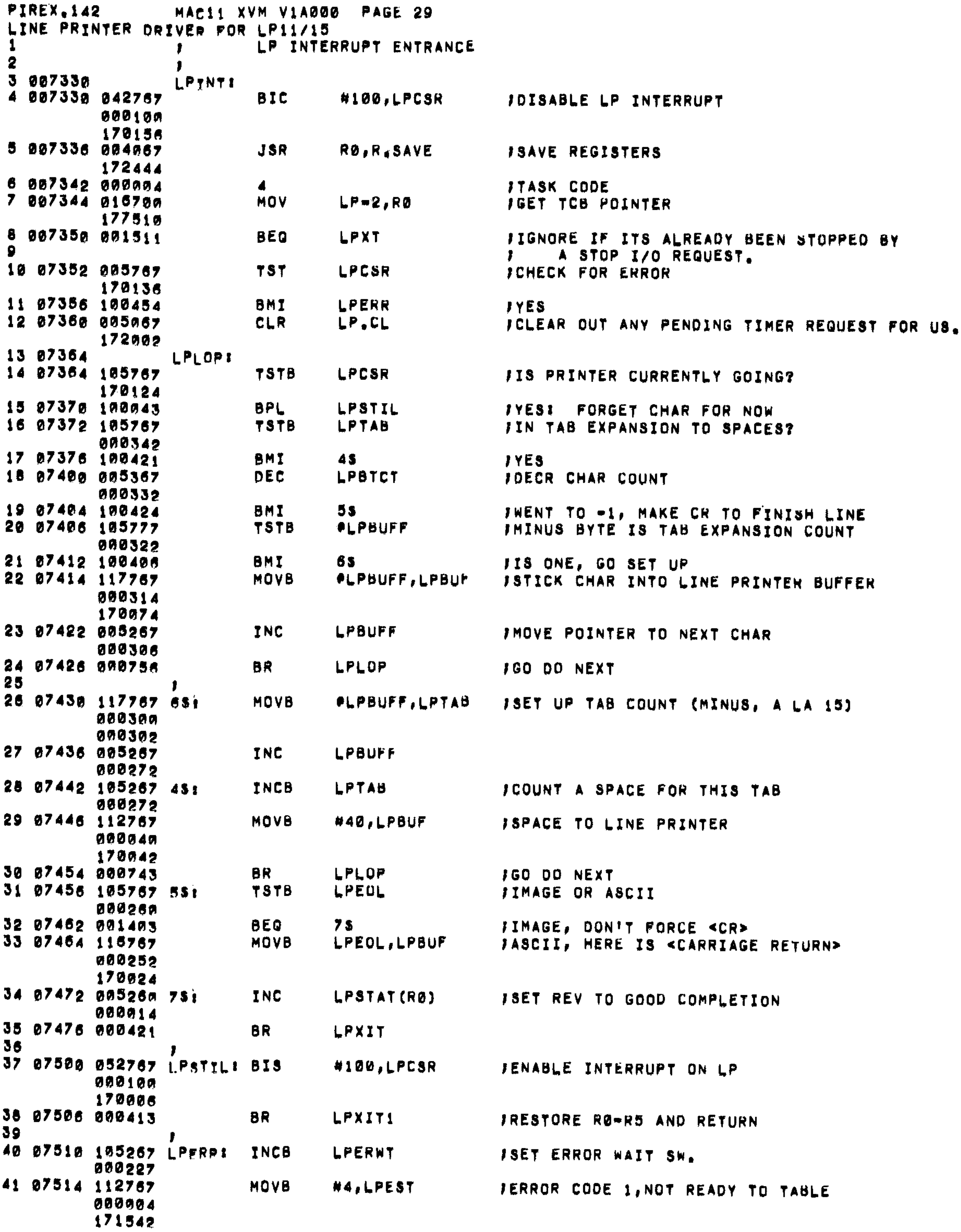


```
PIREX.142          MAC11 XVM V1A000   PAGE 28
LINE PRINTER DRIVER FOR LP11/15
                            .SBTTL  LINE PRINTER DRIVER FOR LP11/15
                            .EVEN
                   ;
       177514 LPCSR=177514
       177516 LPBUF=177516
       000006 LPSA=6
       000012 LPTOT=12
       000014 LPSTAT=14
       001264 LPEST=LP.EST+4  ;ADDR IN PIREX ERROR TABLE FOR NOT READY
       001262 LPUNN=LP.EST+2  ;ADDR FOR UNIT # (FOR NOW 0)
       000004 LPTCOD=4        ;LINE PRINTER TASK CODE
       006414 LPFOF=6414               ;EOF CODE(DATA) FOR SPOOLING
                   ;
                   ;
                   ;
                   ;
                   ;  MAKE THE PDP-15 DO ALL THE WORK. THE PDP-11 SIMPLY GET S A COUNT
                   ;  OF CHARACTERS TO PRINT OUT. WE TREAT THE CONTROL CHARACTERS
                   ;  12,15, AND 14 ONLY. A MINUS CHARACTER IS CONVERTED INTO MINUS
                   ;  THAT NUMBER OF SPACES. NOTE ALL REAL ASCII CHAR'S HAVE A ZERO LEADING BIT!
                   ;  EACH LINE HAS AN IMPLIED CARRIAGE RETURN THAT IS ADDED BY THE DRIVER
                   ;  RATHER THAN SENT BY THE PDP-15
                   ;
                   ;  NOTE, IF HEADER WORD OF BUFFER HAS 400 BIT SET, IT IS
                   ;  IMAGE MODE, AND WE NIETHER BUT ON LF OR CR!!
                   ;
                   ;
                   ; CALL TO ROUTINE HAS ADDRESS OF TCB IN HANDLER BUSY (IDLE) REGISTER
                   ;
06754                       .BLOCK  8.+EAESTK*4
07054 177514                .WORD   LPCSR            ;ADDRESS OF LPCSR CONTROL STATUS
                                                     ;    REGISTER USED TO RESET DEVICE
                                                     ;    ON STOP I/O OPERATIONS.
07056 000000                .WORD   0                ;TCB POINTER (EXTENDED BITS)
07060 000000                .WORD   0                ;TCB POINTER (LOWER 16 BITS). THIS
                                                     ;    WORD IS USED AS THE IDLE/BUSY
                                                     ;    SWITCH FOR THE DEVICE DRIVER.
                   ;
07062              LP:
07062 005067                CLR     LP.CL            ;CLEAR OUT ANY PENDING TIMER REQUESTS FOR US.
      172300
07066 016700                MOV     LP-2,R0          ;SETUP R0 TO POINT TO TCB
      177766
07072 005060                CLR     LPSTAT(R0)       ;CLEAR STATUS FLAG IN TCB
      000014
07076 016001                MOV     LPSA+2(R0),R1    ;GET BUFFER START ADDRESS
      000010
07102 005760                TST     LPSA(R0)         ;DON'T RELOCATE ADDRESS IF BIT 15
      000006
07106 100403                BMI     1$               ;    IS ON.
07110 006301                ASL     R1               ;RELOCATE ADDRESS (WORD TO BYTE POINTER)
07112 066701                ADD     MEMSIZ,R1        ;(+ 11'S OWN LOCAL MEMORY)
      170722
07116 112102       1$:      MOVB    (R1)+,R2
07120 042702                BIC     #177400,R2       ;CLEAR OUT TOP OF REGISTER
      177400
07124 112767                MOVB    #15,LPEOL        ;DEFAULT, ASCII, HERE IS <CR>
      000015
      000610
07132 062701                ADD     #2,R1    ;INC R1 BY 2 (BR-134)
      000002
07136 112721                MOVB    #12,(R1)+        ;DEFAULT, PRECEED LINE WITH LINE FEED
      000012
07142 105067                CLRB    LPERWT           ;RESET ERROR WAIT SWITCH
      000575
                            .IFNDF  $NOSW            ;##124##IF $NOSW, DISABLE ALL SWITCH INTERACT
07146 032767                BIT     #140000,SPOLSW   ;SPOOLER ENABLED & RUNNNG
      140000
      171672
07154 001427                BEQ     6$               ;GO TO DISABLE HALT AT EOF (BR-135)
```

Figure 4-3
UNICHANNEL LP Driver

```
PIREX.142       MAC11 XVM V1A000  PAGE 28+
LINE PRINTER DRIVER FOR LP11/15
60 07156 022711         CMP     #LPEOF,(R1)     ;EOF RECORD?
         006414
61 07162 001421         BEQ     5$              ;CURRENT TCB CONTAINS EOF (BR-135)
62 07164 105767         TSTB    LPEFWT          ;WAS LAST RECORD AN EOF ? (BR-135)
         000554
63 07170 001423         BEQ     2$              ;NO - BRANCH TO NORMAL CODE (BR-135)
64 07172 105067         CLRB    LPEFWT          ;YES - CLEAR SWITCH FOR NEXT USE (BR-135)
         000546
65 07176 032767         BIT     #2,SW           ;IS SWITCH 2 UP ON 11 CONSOLE ? (BR-135)
         000002
         170364
66 07204 001415         BEQ     2$              ;NO - RESUME NORMAL CODE (BR-135)
67 07206 012767         MOV     #LPECHK,LP.CL+2 ;YES - SET UP CLOCK (BR-135)
         007626
         172154
68 07214 012767         MOV     #170,LP.CL      ;TWO SECOND RETRY (BR-135)
         000170
         172144
69 07222                $EXIT   WAITST          ;EXIT TO SYSTEM
   07222 000004         IOT
   07224    000         .BYTE   0,WAITST
   07225    002
70 07226 105267 5$:     INCB    LPEFWT          ;SET EOF FLAG FOR NEXT TCB (BR-135)
         000512
71 07232 000402         BR      2$              ;RESUME NORMAL CODE (BR-135)
72 07234 105067 6$:     CLRB    LPEFWT          ;CLEAR FLAG - IN CASE SPOOLER JUST TURNED OFF (BR-135)
         000504
73                      .ENDC
74 07240 132761 2$:     BITB    #1,-3(R1)       ;400  BIT SET IN HEADER IF IMAGE
         000001
         177775
75 07246 001403         BEQ     3$              ;NOT IMAGE, CHECK FORMS CONTROL
76 07250 105067         CLRB    LPEOL           ;IMAGE, DON'T FORCE CR AFTER MESSAGE
         000466
77 07254 000410         BR      4$              ;ALLOW ALL FORMS CONTROL
78 07256 122711 3$:     CMPB    #14,(R1)        ;FIRST CHAR FORM FEED?
         000014
79 07262 001405         BEQ     4$              ;YES, DON'T ADD LINE FEED TO LINE
80 07264 122711         CMPB    #15,(R1)        ;FIRST CHAR CARRIAGE RETURN
         000015
81 07270 001402         BEQ     4$              ;YES, DON'T ADD LINE FEED TO LINE
82 07272 005301         DEC     R1              ;MOVE POINTER BACK TO LINE FEED
83 07274 005202         INC     R2              ;COUNT ADDITION OF LF TO BUFFER
84 07276 010267 4$:     MOV     R2,LPBTCT       ;SAVE COUNT
         000434
85 07302 010167         MOV     R1,LPBUFF       ;SAVE POINTER
         000426
86 07306 105067         CLRB    LPTAB
         000426
87 07312 105767         TSTB    LPBUF           ;HISTORY SAYS THIS HERE
         170200
88 07316 052767         BIS     #100,LPCSR      ;ENABLE INTERRUPTS TO LP GOING
         000100
         170170
89 07324                $EXIT   WAITST          ;EXIT IN A WAIT STATE AND RESCAN
   07324 000004         IOT
   07326    000         .BYTE   0,WAITST
   07327    002
90                                              ;    THE ATL NOW.
91              ;
92              ;
```

Figure 4-3 (cont)
UNICHANNEL LP Driver



```
PIREX.142         MAC11 XVM V1A000  PAGE 29
LINE PRINTER DRIVER FOR LP11/15
                  ;       LP INTERRUPT ENTRANCE
                  ;
  007330          LPINT:
  007330 042767           BIC     #100,LPCSR       ;DISABLE LP INTERRUPT
         000100
         170156
  007336 004067           JSR     R0,R.SAVE        ;SAVE REGISTERS
         172444
  007342 000004           4                        ;TASK CODE
  007344 016700           MOV     LP-2,R0          ;GET TCB POINTER
         177510
  007350 001511           BEQ     LPXT             ;IGNORE IF ITS ALREADY BEEN STOPPED BY
                                                   ;    A STOP I/O REQUEST.
   07352 005767           TST     LPCSR            ;CHECK FOR ERROR
         170136
   07356 100454           BMI     LPERR            ;YES
   07360 005067           CLR     LP.CL            ;CLEAR OUT ANY PENDING TIMER REQUEST FOR US.
         172002
   07364          LPLOP:
   07364 105767           TSTB    LPCSR            ;IS PRINTER CURRENTLY GOING?
         170124
   07370 100043           BPL     LPSTIL           ;YES:  FORGET CHAR FOR NOW
   07372 105767           TSTB    LPTAB            ;IN TAB EXPANSION TO SPACES?
         000342
   07376 100421           BMI     4$               ;YES
   07400 005367           DEC     LPBTCT           ;DECR CHAR COUNT
         000332
   07404 100424           BMI     5$               ;WENT TO -1, MAKE CR TO FINISH LINE
   07406 105777           TSTB    @LPBUFF          ;MINUS BYTE IS TAB EXPANSION COUNT
         000322
   07412 100406           BMI     6$               ;IS ONE, GO SET UP
   07414 117767           MOVB    @LPBUFF,LPBUF    ;STICK CHAR INTO LINE PRINTER BUFFER
         000314
         170074
   07422 005267           INC     LPBUFF           ;MOVE POINTER TO NEXT CHAR
         000306
   07426 000756           BR      LPLOP            ;GO DO NEXT
                  ;
   07430 117767 6$:       MOVB    @LPBUFF,LPTAB    ;SET UP TAB COUNT (MINUS, A LA 15)
         000300
         000302
   07436 005267           INC     LPBUFF
         000272
   07442 105267 4$:       INCB    LPTAB            ;COUNT A SPACE FOR THIS TAB
         000272
   07446 112767           MOVB    #40,LPBUF        ;SPACE TO LINE PRINTER
         000040
         170042
   07454 000743           BR      LPLOP            ;GO DO NEXT
   07456 105767 5$:       TSTB    LPEOL            ;IMAGE OR ASCII
         000260
   07462 001403           BEQ     7$               ;IMAGE, DON'T FORCE <CR>
   07464 116767           MOVB    LPEOL,LPBUF      ;ASCII, HERE IS <CARRIAGE RETURN>
         000252
         170024
   07472 005260 7$:       INC     LPSTAT(R0)       ;SET REV TO GOOD COMPLETION
         000014
   07476 000421           BR      LPXIT
                  ;
   07500 052767 LPSTIL: BIS     #100,LPCSR       ;ENABLE INTERRUPT ON LP
         000100
         170006
   07506 000413           BR      LPXIT1           ;RESTORE R0-R5 AND RETURN
                  ;
   07510 105267 LPERR:  INCB    LPERWT           ;SET ERROR WAIT SW.
         000227
   07514 112767           MOVB    #4,LPEST         ;ERROR CODE 1,NOT READY TO TABLE
         000004
         171542
```

Figure 4-3 (cont)
UNICHANNEL LP Driver

```
PIREX.142         MAC11 XVM V1A000  PAGE 29+
LINE PRINTER DRIVER FOR LP11/15
42 07522 012767 LPFRR1: MOV     #LPCHK,LP.CL+2  ;ADDR. FOR TIMER REQ.
         007646
         171640
43 07530 012767         MOV     #170,LP.CL      ;2 SECS. IN TICKS(OCTAL)
         000170
         171630
44 07536 000167 LPXIT1: JMP     DEQU1           ;SCHEDULE NEXT TASK
         173616
45                ;
46 07542 105067 LPXIT:  CLRB    LPEST           ;INDICATE SUCCESSFULL OPERATION
         171516
47 07546 052767         BIS     #340,PS         ;INHIBIT INTERRUPTS
         000340
         170222
48 07554 005067         CLR     LPCSR           ;SHUT DOWN DEVICE
         167734
49 07560 012701         MOV     #1,R1           ;TELL CALLER DONE
         000001
50 07564 016700         MOV     LP-2,R0         ;GET TCBP
         177270
51 07570                CALL    SEND15          ;TELL CALLER DONE
   07570 004767         JSR     PC,SEND15
         173626
52 07574          LPXT:
53 07574 052767         BIS     #340,PS         ;INHIBIT INTERRUPTS
         000340
         170174
54 07602 005067         CLR     LP-2            ;CLEAR BUSY(IDLE) FLAG
         177252
55 07606 005067         CLR     LP-4
         177244
56 07612 012703         MOV     #LP,R3          ;DEQUEUE ANOTHER REQUEST IF ANY
         007062
57 07616 012701         MOV     #LP.LH,R1       ;    IN THIS DRIVERS DEQUE.
         001452
58 07622 000167         JMP     DEQU
         173450
59                ;
60                ;
61                ;
62                ;             SUBROUTINE TO FIELD CLOCK COUNT-DOWN
63                ;
64                ;
65 07626 005767 LPFCHK: TST     LP-2            ;HAVE WE BEEN DISABLED  ? (BR-135)
         177226
66 07632 001437         BEQ     LPCX            ;YES - RETURN TO CLOCK - NO RETRY (BR-135)
67 07634 032767         BIT     #2,SW           ;NO - IS SWITCH 2 STILL UP ? (BR-135)
         000002
         167726
```

Figure 4-3 (cont)
UNICHANNEL LP Driver

```
PIREX.142         MAC11 XVM V1A000  PAGE 29+
LINE PRINTER DRIVER FOR LP11/15
68 07642 001031              BNE     LPCXIT             ;YES - SET UP CLOCK RETRY (BR-135)
69 07644 000406              BR      LPCLK              ;NO - SET UP RETRY OF TCB (BR-135)
70 07646 005767 LPCHK:       TST     LP-2               ;HAVE WE BEEN DISABLED
         177206
71 07652 001427              BEQ     LPCX               ;IF YES, EXIT, LEAVING CLOCK DISABLED (BR-135)
72 07654 005767              TST     LPCSR              ;DOES ERROR STILL EXIST ? (BR-135)
         167634
73 07660 100422              BMI     LPCXIT             ;YES - SET UP CLOCK RETRY (BR-135)
74 07662 012702 LPCLK:       MOV     #LPTCOD*2,R2       ;SCAN ATL FOR OUR NODE (BR-135)
         000010
75 07666 016201              MOV     ATLNP(R2),R1
         001144
76 07672 012767              MOV     #LP,LP-12          ;RESTART AT BEGINNING OF REQ.
         007062
         177150
77 07700 042761              BIC     #17,A.TS(R1)       ;R1 POINTS TO OUR NODE, MAKE RUNNABLE
         000017
         000006
78 07706 012761              MOV     #LP-26,A.SP(R1) ;SET UP STACK POINTER
         007034
         000004
79 07714 006202              ASR     R2                 ;MAKE BYTE ADDRESSING
80 07716 116267              MOVB    LEVEL(R2),LP-10 ;SET UP PS
         001125
         177126
81 07724 000207              RTS     PC                 ;RETURN TO CLOCK (BR-135)
82 07726 012710 LPCXIT: MOV     #170,(R0)          ;R0 POINTS TO TIMER ENTRY
         000170
83 07732 000207 LPCX:   RTS     PC                 ;RETURNS TO CLOCK
84                      ;
85 07734 000000 LPBUFF: .WORD   0                  ;BUFFER POINTER
86 07736 000000 LPBTCT: .WORD   0                  ;BYTE COUNT
87 07740 000000 LPTAB:  .WORD   0                  ;TAB LOCATION
88 07742    000 LPEOL:  .BYTE   0                  ;0 IF IMAGE, 15 IF ASCII
89 07743    000 LPERWT: .BYTE   0                  ;MAKE EVEN
90 07744    000 LPEFWT: .BYTE   0                  ;EOF WAS LAST RECORD FLAG (BR-135)
91                      .EVEN                      ;MAKE EVEN (BR-135)
92                      ;
```

Figure 4-3 (cont)
UNICHANNEL LP Driver

Task Development

1. Equates, device locations, etc. (Page 28, lines 7-15).
2. Initialization and I/O request section (Page 28, lines 1-90); used to set up and initiate a device operation.
3. Interrupt section, used to respond to the completion of a device operation and to check for errors (Page 30, lines 1-59).
4. An optional clock wake-up section; used to check the correction on an error condition on the clearing of a wait-at-end of file condition and either retry the offending operation or set another wake-up call (Page 29, lines 61-91).

4.7.2.2 Task Entry - Initialization - When the task is initially called, the user stack area is reset. Execution normally begins at the first location of the program code. At this point, all general purpose registers are available for use by the task. If the task is interrupted by a higher priority task before completing the request, execution will resume at the point of interruption when program control is returned. Various steps in device driver (Figure 4-3) initialization include:[1]

1. Clearing out any pending timer requests (if the task uses wakeup services). (Page 28, line 43).
2. Setting up a pointer to the data buffer and relocating the pointer value if it comes from the XVM (Page 28, lines 44-50, 74-87).
3. Various device dependent operations (Page 28, lines 51-56).
4. Detect and initiate halt at end of file procedure (Page 28, line 57-73).
5. Start up the device (Page 28, line 88).
6. Exit in a WAIT state (Page 28, line 89) until reawakened by an interrupt (see Section 4.7.2.4).

4.7.2.3 Interrupt Processing - An interrupt transfers control to the device driver interrupt section at priority 7. Interrupt processing (Figure 4-3) is composed of the following steps:

1. Disable the device interrupt (Page 29, line 4).
2. Save the interrupted task registers switch stacks and drop down to the task's actual priority as specified in the LEVEL table. This is all accomplished by a JSR R0, R.SAVE (Page 29, lines 5 and 6). R.SAVE is called the task's "TCN" as a parameter and passed.

[1] Page number refers to the page number at the top of the PIREX listing.

3. Test the task busy idle switch to see if the request has been cancelled (Page 27, lines 7 and 8). If it was cancelled, use the normal DEQU exit without sending a completion message to the caller (see Section 4.7.2.4).

4. Perform task interrupt processing and error checking (Page 29, lines 10-36).

5. If a correctable error is detected, set the error code in the DEVST table. This error code should indicate a correctable error. The DEQU1 return should be used in conjunction with a clock wake-up call to allow automatic retry of the operation (Page 29, lines 40-44). See Section 4.7.2.4 for information on DEQU1 and Section 4.7.3 for information on the timed wake-up.

6. If a fatal error occurs, the event variable should be set to indicate this error.

7. If the operation was successfully completed, use the normal exit procedure described in Section 4.7.2.4 (Page 29, lines 46-58).

4.7.2.4 Exit Techniques - When a task has finished execution, it can exit by issuing the SEXIT macro (exit and change state of task to "s").

```
.MACRO SEXIT s

IOT

.BYTE 0,s

.ENDM
```

The SEXIT macro allows a task to change status to state "s" after exiting. A task state of "0" indicates the task is runnable, a state of "2" indicates a wait state, and a state of "4" indicates a stop state with removal of the ATL node. Task states must always be an even number since they are used to compute a word index in the PDP-11. A SEXIT in state "0" causes the system to rescan the ATL list for the highest priority task.

There are actually three modes in which a task may exit. In the first mode, is used on completion of a request. Before a task exits, it must:

1. Zero the busy/idle switch.

2. Set the caller's Event Variable to indicate the nature of task completion and send an optional interrupt to the XVM or the PDP-11.

3. Dequeue a request from its deque and process it if found; otherwise exit.

Before a task can begin the three previously mentioned steps, it must be executing at level 7 (the highest priority level in the PDP-11). As an example, assuming a task name is "XR" (the first executable instruction of every task has the task name as its label), then the following program code would accomplish the three necessary steps:

```
BIS #340, @#PS;INHIBIT INTERRUPTS

MOV #?,R1   ;SET CALLER'S EV TO ? (APPROPRIATE VALUE)

CALL SEND15  ;  AND SEND CALLER

             ;  AN OPTIONAL INTERRUPT

             ;  TELLING THE REQUESTOR THAT THE

             ;  REQUEST HAS BEEN PROCESSED

             ;  (A COMPLETE LIST OF EVENT)

             ;  VARIABLE SETTINGS MAY BE

             ;  FOUND IN SECTION 3.2.5.4

BIS #340, @#PS;INHIBIT INTERRUPTS,

CLR XR-2     ;CLEAR THE BUSY/IDLE SWITCH ("XR" is the tag
               associated with the first executable
               instruction in the task program code)

CLR XR-4

MOV #XR,R3   ;DEQUEUE ANOTHER REQUEST IF ANY

MOV #XR,LH,R1

JMP DEQU     ;  EXISTS IN THIS TASK'S DEQUE

             ;  IF A REQUEST EXISTS, NO RETURN

             ;  IS MADE FROM ROUTINE DEQUE
             ;  AND THE REQUEST IS AUTOMATICALLY

             ;  REMOVED AND PROCESSED AS IF IT

             ;  WERE JUST RECEIVED WHEN THE

             ;  TASK WAS IDLE
```

This first method is used in the task interrupt section upon successful completion of a request.

The second method is one where the task exits from the initialization section (Figure 4-3, Page 29, lines 46-58) in a wait state using the SEXIT macro, and an interrupt routine or other task will complete the previously mentioned three steps at a later time. A device driver is typically exited in this way (Figure 4-3, Page 29, line 57). The initial section of the device driver is used to set up the device controller and begin the I/O operation. The task will then exit in a wait state until the I/O is complete, the interrupt section is called, the device is shut down, and the previously mentioned three steps are done informing the requestor that the I/O operation has been completed.

The third method of exiting is one used either when a recoverable error is detected in the interrupt section of a driver and the intention is to exit and wait for an error recovery or when another I/O request is issued in the interrupt section and another interrupt is expected. This exit through DEQU1 does not cause the dequeuing of pending requests but simply places the task in a WAIT state. This method assumes that an R.SAVE has been performed upon entry to the interrupt process routine. The required code to use this exit is:

```
     JMP DEQU1
```

No registers are preserved by this exit. Control is returned to the interrupt section upon occurrence of an interrupt or via the clock routine wake-up, to a location chosen by the clock set up section. (Figure 4-3, Page 29, line 44).

4.7.3 Timed Wakeup

In the design of a device driver it is useful to include features that eliminate operator intervention whenever possible.

For instance, in the example of the PIREX Line Printer Task, an OFF Line condition is handled by retrying the printing every two seconds until successful. This is accomplished by using the wakeup feature of the Clock Task. This is done by simply placing the return address and the time dealy into the Clock Table "CLTABL" (See Section 3.3.4) Figure 4-3, Page 29, lines 42-43) and the exits using the DEQU1 type exit.

When the wakeup call occurs, the clock wakeup subsection specified by the return address will be invoked. In this subsection:

1. Test the task IDLE/BUSY switch to see if the task has been shut down. If shut down, a RTS PC return to the Clock Task is in order. (Page 29, lines 65, 70-71, 83.)
2. Determine if the error has been corrected. If not, reset the timer and RTS PC to the Clock Task. (Page 29, lines 72, 73, 82, 83.)
3. If the error has been corrected, reprocess the original TCB request and return to the Clock Task. (Page 29, lines 74-81.) This will cause PIREX to retry the TCB.

4.7.4 Assembly and Testing

4.7.4.1 Assembly and Loading - New PIREX device driver should be assembled as a part of the PIREX monitor. Background tasks may be assembled separately.

In the background task case, the user should construct an XVM program to load the background task binary into XVM memory. (See SPOL15 for an example of the required technique.) The XVM program must then issue a CONNECT Directive. To start the task, if the task is to execute in PDP-11 local memory, two additional steps are required:

1. Issue a local memory size directive to determine if there is enough local memory to accommodate the new task.
2. Issue a CONNECT directive (assuming there was enough room in local memory for the task).
3. After issuing the CONNECT directive, use the initial portion of the PDP-11 code to move the remainder of the task into the local memory starting at the first free location.

4.7.4.2 Testing - Since the typical UNICHANNEL system does not have a terminal device attached to the PDP-11 processor, the only debugging facility present is the console indicators on the PDP-11. An additional aid is the UDMP11 paper tape provided with all UC15 XVM/DOS systems. This program provides a destructive dumping facility that recovers the entire state of the PDP-11 LOCAL memory and dumps it into the LP11/LS11/LV11 Printer.

NOTE

The UDMP11 program is an unsupported package that can only be used on systems with a printer device on the PDP-11 UNICHANNEL Processor. For tasks executing in the common memory, the traditional ↑ Q-DUMP feature of the XVM/DOS monitor should be used.

CHAPTER 5
SPOOLER DESIGN AND THEORY OF OPERATION

5.1 INTRODUCTION

This chapter discusses the design concepts of the XVM UNICHANNEL SPOOLER software and its theory of operation. This information is provided to enable the user to understand the SPOOLER software in order to add new SPOOLED tasks or to modify existing software. The actual modification process is described in Chapter 6. Flowcharts are provided whenever it is necessary.

5.2 OVERVIEW

5.2.1 SPOOLER

The word 'spool' and 'spooling' originated in the textile industry. During thread manufacture, the threads are wound on small spools by first storing them on large spindles and then transferring them onto small spools. This entire process is called spooling. In the computing industry, the term spooling is used to describe the process of collecting and storing data on a large high-speed medium and controlling the flow of this data to slow speed devices. The "SPOOLER" is a distinct piece of software that controls the entire spooling operations. Spooling permits data flow between a data source and a data sink to proceed at independent rates. This feature gives the user greater computing power and faster turn-around time because of better system resource utilization under an integrated operating system.

5.2.2 XVM UNICHANNEL Spooler

In the XVM UNICHANNEL system, spooling is achieved by using the dual processing capability of the system. The two processors, XVM and PDP-11, operate in the Master and Slave mode respectively. The Slave processor (PDP-11) controls the entire spooling operation. Data to be spooled is supplied by either the master processor (XVM), or by tasks running under PIREX. Spooled data is stored on a disk cartridge.

The Line Printer, Card Reader, and the Incremental Plotter, all being UNIBUS devices, are supported by the XVM UNICHANNEL spooler.

5.3 SPOOLER DESIGN

The XVM UNICHANNEL SPOOLER is based on a simple design. Spooling of data is done through the RK05 disk. A contiguous portion of disk is allocated via SPLGEN for this purpose by the operating system on the XVM. The starting block number and the size in terms of number of blocks is conveyed to the SPOOLER when it is issued the 'BEGIN' directive. The SPOOLER allocates and deallocates this space on the disk through a BITMAP it maintains. The spooling and despooling operations of every task are performed through a central "TABLE", in which every spooled task has a slot. Against each slot there are several entries used to keep track of the data during spooling and despooling. Provisions are made in the SPOOLER to permit spooling of data regardless of the number of blocks occupied in the spool space and the number of buffers in the SPOOLER provided despooling operations are going on. This prevents system lockout. All the data blocks on the disk belonging to a spooled task are linked together by forward pointers stored in the last word (377_8) of each data block. The end of data in a block is indicated by a zero word. Records are assumed to be less than 374_8 words in size. The last block in a spooled file has a pointer to the previous file's last block in word '1_8' or a -1 if there is no active previous file, if the last spooled file has not yet been despooled. Also the last block in a spooled file contains an end of file indicator in word '376_8' of the data block. Sections 5.3 and 5.4 describe the static layout of the spooler. The dynamic layout is described in Section 5.5.

5.4 SPOOLER COMPONENTS

The following are the major components of the SPOOLER software:

1. request dispatcher
2. directive processing routine
3. task call service routine
4. device interrupt dispatcher
5. device interrupt service routine

6. utility routines

7. buffers, TABLE, BITMAP, TCBs

A brief description of each of the above components follows.

5.4.1 Request Dispatcher

This routine dispatches (routes) all requests made by the SPOOLER and requests to the spooled tasks. This is done by using the TCN in word '1' of the TCB. The dispatcher transfers control to the appropriate directive processing routines, in the case of spooler requests and to the task call service routine, in the case of requests to spooled tasks.

5.4.2 Directive Processing Routines

These routines process directives issued to the SPOOLER to control spooling operations. The basic operations are "BEGIN" spooling and "END" spooling. These routines may initialize switches, TABLE, BIT-MAP, pointers, buffers, set up TCB, start tasks, stop tasks, ... etc.

5.4.3 Task Call Service Routines

A task call service routine processes requests addressed to tasks running under PIREX. It spools data onto disk in case of output tasks, and for input tasks it despools the data from disk. Output tasks buffer data from several requests into blocks and transfer the blocks to disk when full. Input tasks read into core, data blocks stored on disk, and unpack the data into the requestor's buffer. Task Call Service Routines update the TABLE, pointers, and switches, and use the utility routines present in the SPOOLER to write or read a block onto or from the disk, get or give a buffer, get or give a TCB, etc. (Refer to Figure 5-2.)

5.4.4 Device Interrupt Dispatcher

All interrupts from devices interacting with the SPOOLER are dispatched by this routine to the appropriate service routines. This is done by using the TCN of the requestor for that task request present in word '13_8' of the TCB.

5.4.5 Device Interrupt Service Routines

These routines handle completion of I/O requests from devices. They supplement the driver routines present in PIREX as in the device handlers. Besides the disk interrupt service routine, each spooled task has its own interrupt service routine. The disk interrupt service routine is made up of the "read interrupt processor" and the "write interrupt processor". These are in turn made up of routines handling read/write operation for each specific spooled task. The interrupt service routine of a spooled task controls the despooling operation for output tasks and the spooling operation for input tasks. These operations are driven by the table entries which determine the end of the operation. Device interrupt service routines update the TABLE, pointers, switches and use the utility routines to write or read a block onto or from the disk, get or give a buffer, get or give a TCB, etc.

5.4.6 Utility Routines

Each SPOL11 utility routine performs a specific function. They are:

FINDBK	Find a free block on disk and set its bit in the BITMAP Table (protected).[1]
FREEBK	Free the block indicated and reset its bit in the BITMAP Table.
GETBUF	Get an unused buffer from the buffer pool (protected).[1]
GIVBUF	Give the used buffer back to the buffer pool.
GETRKT	Get a disk TCB from the Disk TCB pool.
GIVRKT	Give back the TCB to the Disk TCB pool.
GETBLK	Read a block from disk.
PUTBLK	Put a block on disk.
GETPUT	Get or put a block on disk.
RESTRQ	Reissue a delayed request.
DEQREQ	Tell requestor that a request is done and dequeue the next request, if any.

[1] Protected routines are those run at priority level 7.

5.4.7 Buffers, TABLE, BITMAP, TCBs

Buffers

The SPOOLER maintains a pool of buffers in a doubly linked list for general use. Buffers are used to pack data into blocks to be written onto disk (by output task call service routines) and to unpack data from data blocks read from disk into requestor buffers (by input task call service routines).

TABLE

The entire spooling and despooling operation of all tasks is controlled by entries in this table. Every spooled task has the following entries:

WORD 0: DEV device mnemonic (set by the BEGIN routine)

WORD 1: CBN current despooling block number (set by the despooler).

WORD 2: CRP current record pointer (set by the despooler).

WORD 3: NBN next despooling block number (set by the despooler).

WORD 4: LSB last spooled block number (set by the spooler).

WORD 5: LFB last spooled file block number (set by the spooler).

BITMAP

A record of availability of disk spooling space is maintained in the BITMAP. Corresponding to each disk block reserved for spooling is a bit which is 'ON' if the block is in use and 'OFF' if free.

TCBs

Buffered blocks of data are read from disk and written onto disk using TCBs. Output spooled tasks despool data to devices using TCBs and input spooled task spool data from devices using TCBs.

5.5 THEORY OF OPERATION

This section will describe in detail the flow of control in the SPOOLER among the above components. To illustrate this process, the spooling and despooling operations of the Line Printer will be discussed. The routines in the SPOOLER listing (Figure 5-1) are broken up into logic boxes and referenced by line numbers.

5.5.1 SPOOLER Startup

Spooling under an operating system on the XVM is accomplished as follows. The SPOOLER task should be added to PIREX, by reading it into local memory and connecting it at run time via SPOOL (SPOL15). As supplied by DEC, the SPOOLER is a separate binary program from PIREX. A special XVM program referred to as the system/SPOOLER interface (SPOL15) is responsible for loading the SPOOLER into PDP-11 local memory and then issuing requests to PIREX to connect the SPOOLER and then begin its operation.

SPOL15 (SPOOL) determines if the spooler is running. If so, SPOL15 asks "END?". If the reply is yes, a terminate spooling directive is sent to PIREX and the SPOOLER is disabled. If the SPOOLER is not running, SPOL15 asks on which RK drive the user wishes to begin spooling. Spooling may be done on any RK unit that has a cartridge that has been initialized with a SPOOLER area by the SPLGEN program. If the cartridge has a SPOOLER area and if there is room in the PDP-11 local memory, the SPOOLER is read from the system disk (DP0, DK, or RK0) and transferred to local PDP-11 memory and started. Note that the questions "RK UNIT#" and "BEGIN?" must be answered in this process.

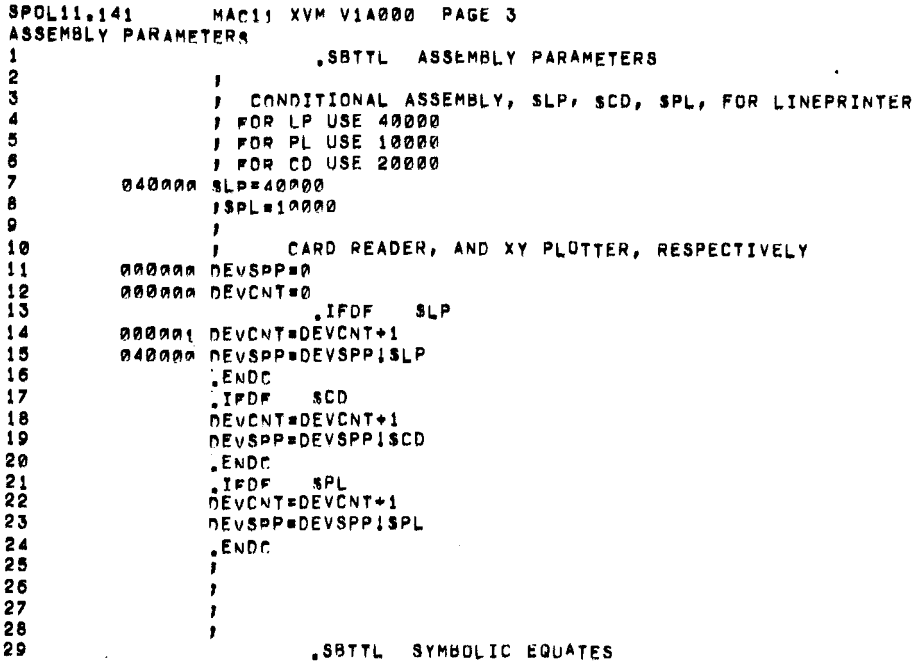
All questions have default replies displayed. These replies may be selected by entering a carriage return. The options on YES/NO questions are "Y" or "N". The default valve for the RK unit is the unit upon which spooling was done previously (or unit 0 if PIREX was just loaded).

```
Example:     XVM/DOS Vnxnnn
             $SPOOL
           SPOOL XVM Vnxnnn
               RK UNIT # [1] 1
               BEGIN? (Y) Y
               SPOOLING ENABLED
             XVM/DOS Vnxnnn
             $SPOOL
           SPOOL XVM Vnxnnn
               END?  (Y)  Y
               SPOOLING DISABLED
             XVM/DOS Vnxnnn
             $
```

Subsequently when PIREX schedules the SPOOLER task to run, the "BEGIN" request is processed. On gaining control, the 'request dispatcher' transfers control to the 'BEGIN' routine. The first time the SPOOLER processes a directive it also executes a once only section of code, which builds a central address table. This table contains addresses of frequently addressed locations in the SPOOLER and is necessary since the SPOOLER is coded in Position Independent Code (PIC) and thus can be loaded anywhere in the PDP-11 memory. SPOOLER is coded in PIC to permit additional tasks to be added to PIREX without necessitating SPOOLER changes. The BEGIN routine performs the following; general startup operations and the specific line printer startup operations (refer to Figure 5-1):

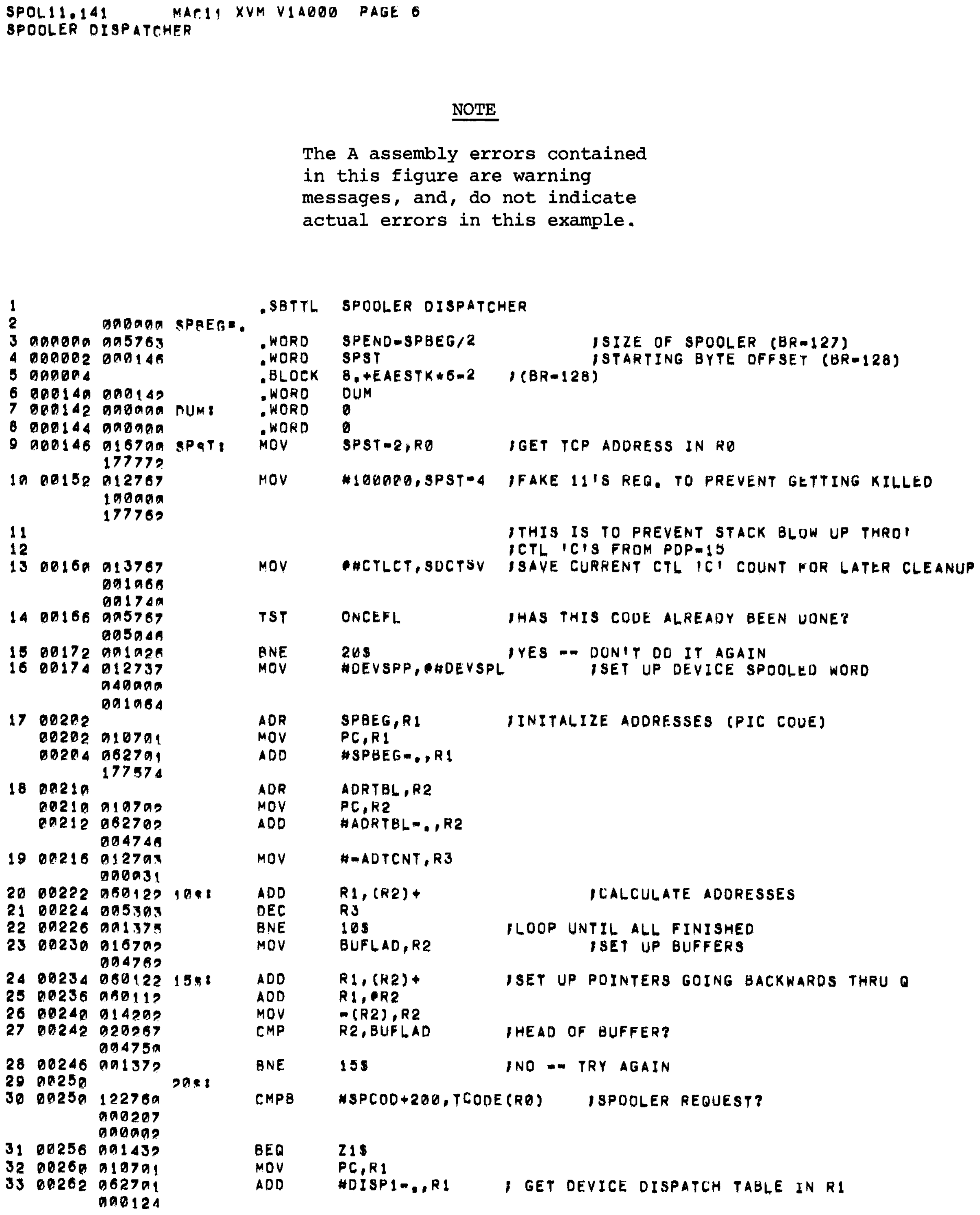
GENERAL OPERATIONS - BEGIN DIRECTIVE:

Set up the SOFTWARE INTERRUPT trap address in the PIREX SEND11 table	page 7, lines 9-12
Save the SPOOLER start address in the "disconnect SPOOLER" TCB	line 13
Initialize the FINDBK routine switches and pointers.	lines 15-18, 40



```
SPOL11.141       MAC11 XVM V1A000  PAGE 3
ASSEMBLY PARAMETERS
1                             .SBTTL  ASSEMBLY PARAMETERS
2                    ;
3                    ;  CONDITIONAL ASSEMBLY, SLP, SCD, SPL, FOR LINEPRINTER
4                    ; FOR LP USE 40000
5                    ; FOR PL USE 10000
6                    ; FOR CD USE 20000
7             040000 $LP=40000
8                    ;$PL=10000
9                    ;
10                   ;     CARD READER, AND XY PLOTTER, RESPECTIVELY
11            000000 DEVSPP=0
12            000000 DEVCNT=0
13                            .IFDF   $LP
14            000001 DEVCNT=DEVCNT+1
15            040000 DEVSPP=DEVSPP!$LP
16                   .ENDC
17                   .IFDF   $CD
18                   DEVCNT=DEVCNT+1
19                   DEVSPP=DEVSPP!$CD
20                   .ENDC
21                   .IFDF   $PL
22                   DEVCNT=DEVCNT+1
23                   DEVSPP=DEVSPP!$PL
24                   .ENDC
25                   ;
26                   ;
27                   ;
28                   ;
29                            .SBTTL  SYMBOLIC EQUATES
```

Figure 5-1
UNICHANNEL Spooler Components



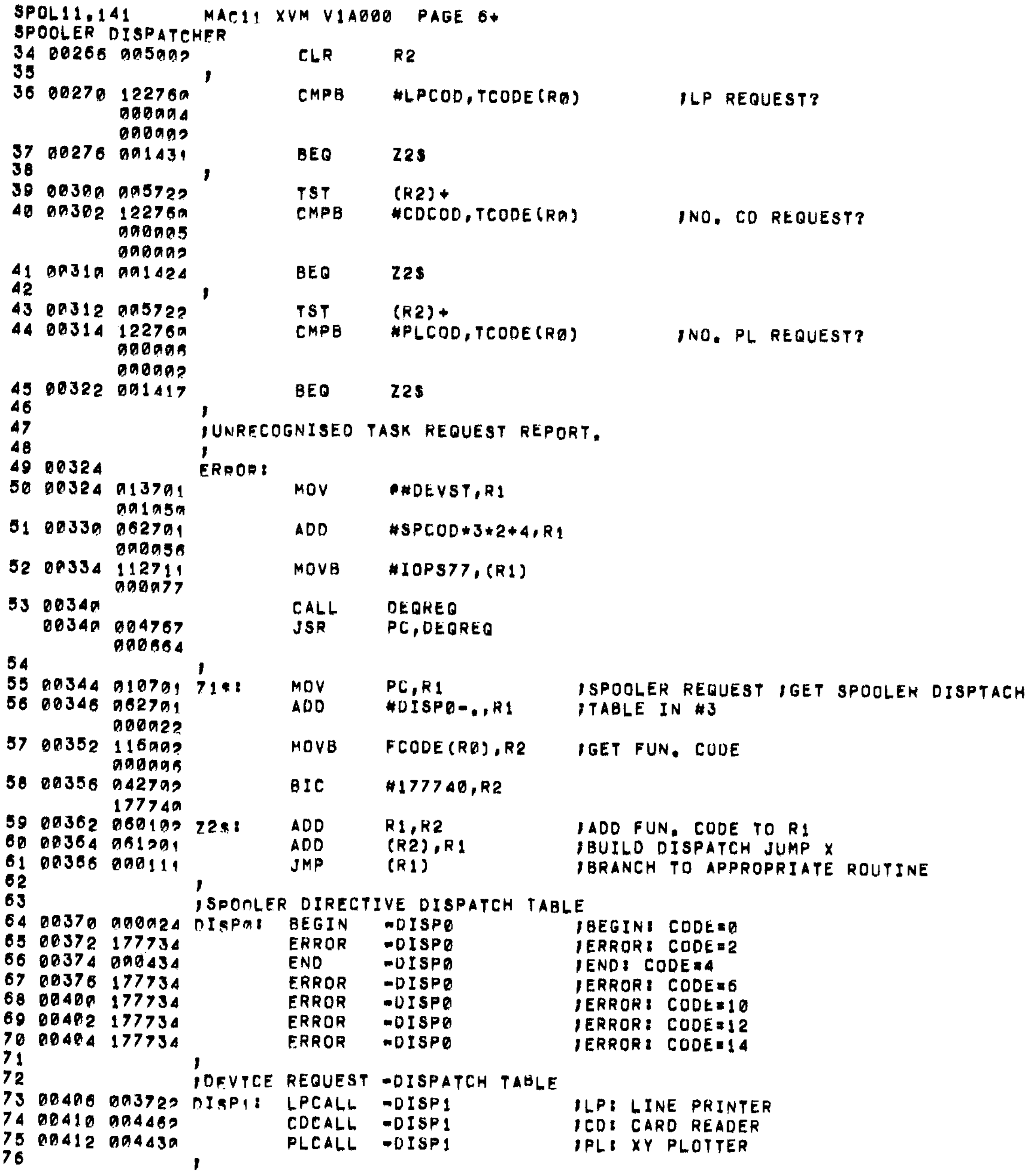
```
SPOL11.141      MAC11  XVM V1A000  PAGE 6
SPOOLER DISPATCHER
```

NOTE

The A assembly errors contained in this figure are warning messages, and, do not indicate actual errors in this example.

```
1                                .SBTTL  SPOOLER DISPATCHER
2          000000 SPBEG=.
3 000000 005763                  .WORD   SPEND-SPBEG/2             ;SIZE OF SPOOLER (BR-127)
4 000002 000146                  .WORD   SPST                      ;STARTING BYTE OFFSET (BR-128)
5 000004                         .BLOCK  8.+EAESTK*6-2    ;(BR-128)
6 000140 000142                  .WORD   DUM
7 000142 000000 DUM:             .WORD   0
8 000144 000000                  .WORD   0
9 000146 016700 SPST:            MOV     SPST-2,R0        ;GET TCP ADDRESS IN R0
           177772
10 00152 012767                  MOV     #100000,SPST-4   ;FAKE 11'S REQ. TO PREVENT GETTING KILLED
           100000
           177762
11                                                        ;THIS IS TO PREVENT STACK BLOW UP THRU'
12                                                        ;CTL 'C'S FROM PDP-15
13 00160 013767                  MOV     @#CTLCT,SDCTSV   ;SAVE CURRENT CTL 'C' COUNT FOR LATER CLEANUP
           001066
           001740
14 00166 005767                  TST     ONCEFL           ;HAS THIS CODE ALREADY BEEN DONE?
           005046
15 00172 001026                  BNE     20$              ;YES -- DON'T DO IT AGAIN
16 00174 012737                  MOV     #DEVSPP,@#DEVSPL          ;SET UP DEVICE SPOOLED WORD
           040000
           001064
17 00202                         ADR     SPBEG,R1         ;INITALIZE ADDRESSES (PIC CODE)
   00202 010701                  MOV     PC,R1
   00204 062701                  ADD     #SPBEG-.,R1
           177574
18 00210                         ADR     ADRTBL,R2
   00210 010702                  MOV     PC,R2
   00212 062702                  ADD     #ADRTBL-.,R2
           004746
19 00216 012703                  MOV     #-ADTCNT,R3
           000031
20 00222 060122 10$:             ADD     R1,(R2)+                  ;CALCULATE ADDRESSES
21 00224 005303                  DEC     R3
22 00226 001375                  BNE     10$              ;LOOP UNTIL ALL FINISHED
23 00230 016702                  MOV     BUFLAD,R2                 ;SET UP BUFFERS
           004762
24 00234 060122 15$:             ADD     R1,(R2)+         ;SET UP POINTERS GOING BACKWARDS THRU Q
25 00236 060112                  ADD     R1,@R2
26 00240 014202                  MOV     -(R2),R2
27 00242 020267                  CMP     R2,BUFLAD        ;HEAD OF BUFFER?
           004750
28 00246 001372                  BNE     15$              ;NO -- TRY AGAIN
29 00250               20$:
30 00250 122760                  CMPB    #SPCOD+200,TCODE(R0)     ;SPOOLER REQUEST?
           000207
           000002
31 00256 001432                  BEQ     Z1$
32 00260 010701                  MOV     PC,R1
33 00262 062701                  ADD     #DISP1-.,R1      ; GET DEVICE DISPATCH TABLE IN R1
           000124
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components



```
SPOL11.141        MAC11 XVM V1A000  PAGE 6+
SPOOLER DISPATCHER
00266 005002             CLR     R2
                  ;
00270 122760             CMPB    #LPCOD,TCODE(R0)        ;LP REQUEST?
      000004
      000002
00276 001431             BEQ     Z2$
                  ;
00300 005722             TST     (R2)+
00302 122760             CMPB    #CDCOD,TCODE(R0)        ;NO. CD REQUEST?
      000005
      000002
00310 001424             BEQ     Z2$
                  ;
00312 005722             TST     (R2)+
00314 122760             CMPB    #PLCOD,TCODE(R0)        ;NO. PL REQUEST?
      000006
      000002
00322 001417             BEQ     Z2$
                  ;
                  ;UNRECOGNISED TASK REQUEST REPORT.
                  ;
00324             ERROR:
00324 013701             MOV     @#DEVST,R1
      001050
00330 062701             ADD     #SPCOD*3*2+4,R1
      000056
00334 112711             MOVB    #IOPS77,(R1)
      000077
00340                    CALL    DEQREQ
00340 004767             JSR     PC,DEQREQ
      000664
                  ;
00344 010701      71$:   MOV     PC,R1           ;SPOOLER REQUEST ;GET SPOOLER DISPTACH
00346 062701             ADD     #DISP0-.,R1     ;TABLE IN #3
      000022
00352 116002             MOVB    FCODE(R0),R2    ;GET FUN. CODE
      000006
00356 042702             BIC     #177740,R2
      177740
00362 060102      Z2$:   ADD     R1,R2           ;ADD FUN. CODE TO R1
00364 061201             ADD     (R2),R1         ;BUILD DISPATCH JUMP X
00366 000111             JMP     (R1)            ;BRANCH TO APPROPRIATE ROUTINE
                  ;
                  ;SPOOLER DIRECTIVE DISPATCH TABLE
00370 000024      DISP0: BEGIN   -DISP0          ;BEGIN: CODE=0
00372 177734             ERROR   -DISP0          ;ERROR: CODE=2
00374 000434             END     -DISP0          ;END: CODE=4
00376 177734             ERROR   -DISP0          ;ERROR: CODE=6
00400 177734             ERROR   -DISP0          ;ERROR: CODE=10
00402 177734             ERROR   -DISP0          ;ERROR: CODE=12
00404 177734             ERROR   -DISP0          ;ERROR: CODE=14
                  ;
                  ;DEVICE REQUEST -DISPATCH TABLE
00406 003722      DISP1: LPCALL  -DISP1          ;LP: LINE PRINTER
00410 004462             CDCALL  -DISP1          ;CD: CARD READER
00412 004430             PLCALL  -DISP1          ;PL: XY PLOTTER
                  ;
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

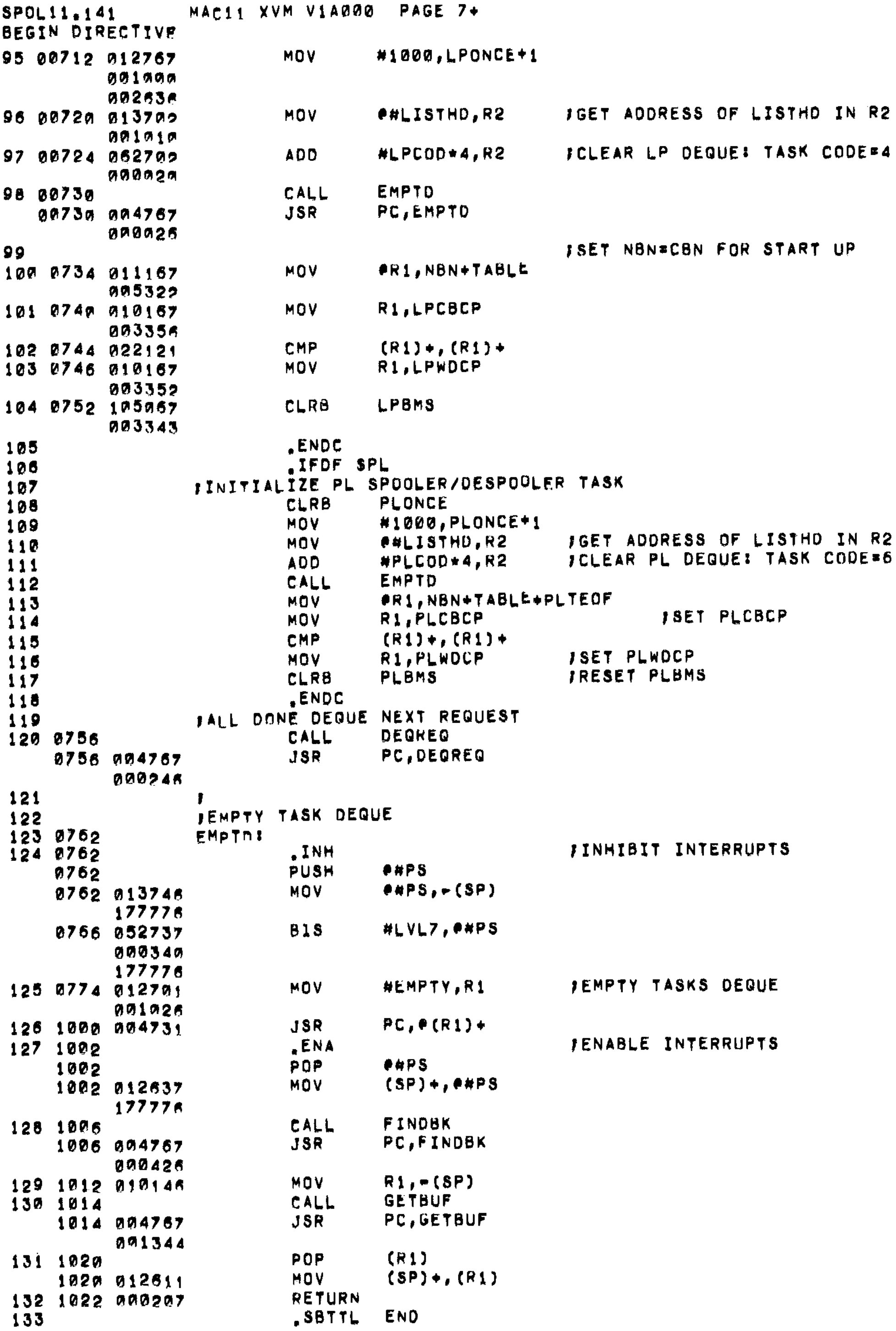
```
SPOL11.141      MAC11 XVM V1A000  PAGE 7
BEGIN DIRECTIVE
                        .SBTTL  BEGIN DIRECTIVE
                ;
                ;THIS ROUTINE STARTS ALL SPOOLING OPERATIONS, SWITCHES, CONTROL REGISTERS
                ;ETC. ARE SET . THE BUFFER POOL, TCB POINTERS, BITMAP, TABLE ETC. ARE
                ;SET UP;BITMAP & TABLE ARE SAVED ON DISK(FOR BACKUP OPERATIONS), EACH
                ;INDIVIDUAL SPOOLED TASK IS THEN INITIALIZED & STARTED UP IF NECESSARY
                ;
                ;
  000414 010701 BEGIN:  MOV     PC,R1           ;GET ADDRESS OF DEVINT IN R1
  00416 062701          ADD     #DEVINT-.,R1
        002346
  00422 013702          MOV     @#SEND11,R2
        001002
  00426 010162          MOV     R1,SPCOD+2(R2)          ;SET SEND11 ADDRESS IN PIREX
        000016
  00432 016067          MOV     14(R0),TCBDSA+TCBDIS
        000014
        006274
                ; INITIALIZE ALL SWITCHES
  00440 012767          MOV     #1,CBTPTR       ;START BIT MAP SEARCH
        000001
        001440
  00446 016701          MOV     ASPLFU,R1       ;##139##SETUP TASK CODE STACK FOR FINDBK
        004542
  00452 010167          MOV     R1,TCDINI       ;##139##WHEN MORE THAN ONE GUY FINDS OUT
        001432
  00456 010167          MOV     R1,TCDPNT       ;##139##THERE ARE NO BLOCKS
        001430
                ;SET  CONTROL REGS.
  00462 010701          MOV     PC,R1           ;GET ADD. OF DUM IN R1
  00464 062701          ADD     #DUM-.,R1
        177456
  00470                 PUSH    R1              ;SAVE ON STACK
  00470 010146          MOV     R1,-(SP)
  00472                 POP     -(R1)           ; SET SPOOLER CONTROL REG.11
  00472 012641          MOV     (SP)+,-(R1)
                ;SETUP BUFFER POOL
                ;INITIALIZE RK TCB POINTERS
  00474 016701          MOV     RKCAD,R1                ;GET RKTCBP ADD. IN R1
        004460
  00500 010702          MOV     PC,R2           ;GET TCBR01 ADD. IN R2
  00502 062702          ADD     #TCBST-.,R2
        006012
  00506 012703          MOV     #TCBCT,R3       ;SETUP TCBCT TCB'S
        000005
  00512 010221 2$:      MOV     R2,(R1)+        ;SET TCBRK1 POINTER
  00514 062702          ADD     #30,R2          ;BUMP R2 TO TCBRK2
        000030
  00520 005303          DEC     R3
  00522 001373          BNE     2$
                ;INITIALIZE BITMAP
  00524                 PUSH    NBK(R0)         ;GET SIZE OF SPOOLER AREA NUMBER
  00524 016046          MOV     NBK(R0),-(SP)


SPOL11.141      MAC11 XVM V1A000  PAGE 7+
BEGIN DIRECTIVE
        000012
  00530 006216          ASR     (SP)            ;COMPUTE SIZE OF BIT MAP
  00532 006216          ASR     (SP)            ;SIZE=NUMBK/8+2
  00534 006216          ASR     (SP)
  00536 042716          BIC     #1,(SP)         ;GET EVEN NUMBER
        000001
  00542 016767          MOV     BTMPAD,CWDPTR   ;RESET CWDPTR
        004420
        001334
  00550 016701          MOV     BTMPAD,R1       ;(BR0112, TEMP FIX)
        004412
  00554 062601          ADD     (SP)+,R1        ;ADD OFFSET TO END
  00556 010167          MOV     R1,BTMPED       ;SET UP BTMPED
        005460
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

```
SPOL11.141          MAC11  XVM  V1A000   PAGE 7+
BEGIN DIRECTIVE
44 00562 016701            MOV     STBKNA,R1                 ;GET ADDRESS OF STBKNM-4 IS R1
         004402
45 00566 016021            MOV     SBN(R0),(R1)+    ;SET STARTING LOCK #
         000010
46 00572 016021            MOV     NBK(R0),(R1)+    ;SET NUMBER OF BLOCKS
         000012
47 00576 016037            MOV     UNIT(R0),@#SPUNIT         ;TELL PIREX SPOOLING UNIT (BR-126)
         000016
         001070
48 00604 016067            MOV     UNIT(R0),UNITSP           ;COPY INTO LOCAL MEM, (BR-126)
         000016
         001550
49 00612 000367            SWAB    UNITSP                    ;SET UP FOR TCB USE (BR-126)
         001544
50 00616 012702            MOV     #BTMPSZ,R2       ;GET BIT MAP SIZE IN R2
         000362
51 00622 010103            MOV     R1,R3
52 00624 005023 4$:        CLR     (R3)+
53 00626 005302            DEC     R2
54 00630 001375            BNE     4$
55                 ;INITIALIZE TABLE
56 00632 016701            MOV     TABLAD,R1                 ;GET ADDRESS OF TABLE IN R1,R3,R1
         004334
57 00636 010103            MOV     R1,R3
58 00640 012702            MOV     #TABLSZ,R2       ;GET TABLE SIZE IN R2
         000044
59 00644 012723 3$:        MOV     #-1,(R3)+
         177777
60 00650 005302            DEC     R2
61 00652 001374            BNE     3$
62 00654 012711            MOV     #LP1,(R1)        ;SET LP1(DED) IN TABLE
         142061
63 00660 012761            MOV     #CD1,CDTEOF(R1)  ;SET CD1 (DED) IN TABLE
         030461
         000014
64 00666 012761            MOV     #LT1,PLTEOF(R1)  ;SET PL1 (DED) IN TABLE
         142461
         000030
65                 ;SFT SPOOLER SWITCHES
66 00674 005037 1$:        CLR     @#SPOLSW         ;RESET SPOOLER SWITCHES
         001046
67 00700 052737            BIS     #BEGSW,@#SPOLSW  ;SET SPOOLER ENABLED AND RUNNING
         170000
         001046
68                 ;
69                 ;ALL SPOOLED TASKS HAVE TO BE INITIALISED. OPERATIONS LIKE SETTING
70                 ;& RFSETTING SWITCHES, SETTING UP POINTERS, BUFFERS, STARTING UP
71                 ;TASK FTC. HAVE TO BE DONE AS INDICATED FOR EACH TASK
72                 ;
73                         .IFDF $CD
74                         BIS     #2,@#SPOLSW      ;SET CD ON ONLY IF PRESENT
75                 ;INITIALIZE CD SPOOLER/DESPOOLER TASK
76                         CLRB    CDONCE
77                         MOV     #1000,CDONCE+1
78                         MOV     @#LISTHD,R2      ;GET ADDRESS OF LISTHD IN R2
79                         ADD     #CDCOD*4,R2               ;CLEAR CD DEQUE TASK CODE=5
80                         CALL    EMPTD
81                         MOV     @R1,NBN+TABLE+CDTEOF
82                         MOVB    #1,CDCNTI        ;INITIALIZE CDCNTI
83                         CLRB    CDBMS            ;RESET CDBMS
84                         CLRB    CDBFS
85                         MOV     R1,CDCBIP
86                         CMP     (R1)+,(R1)+
87                         MOV     R1,CDWDIP
88                         ADD     #CDSIZE,CDWDIP   ;BUMP TO NEXT CARD
89                         MOV     R1,R5            ;SAVE BUFFER ADDRESS ON DTA H
90                         CALL    STUPCT           ;SET UP TCB TO READ A CARD
91                         .ENDC
92                         .IFDF $LP
93                 ;INITIALIZE LP SPOOLER/DESPOOLER TASK
94 00706 105067            CLRB    LPONCE
         002643
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components



```
SPOL11.141         MAC11 XVM V1A000  PAGE 7+
BEGIN DIRECTIVE
95 00712 012767            MOV     #1000,LPONCE+1
         001000
         002630
96 00720 013702            MOV     @#LISTHD,R2      ;GET ADDRESS OF LISTHD IN R2
         001010
97 00724 062702            ADD     #LPCOD*4,R2      ;CLEAR LP DEQUE: TASK CODE=4
         000020
98 00730                   CALL    EMPTD
   00730 004767            JSR     PC,EMPTD
         000026
99                                                  ;SET NBN=CBN FOR START UP
100 0734 011167            MOV     @R1,NBN+TABLE
         005322
101 0740 010167            MOV     R1,LPCBCP
         003356
102 0744 022121            CMP     (R1)+,(R1)+
103 0746 010167            MOV     R1,LPWDCP
         003352
104 0752 105067            CLRB    LPBMS
         003343
105                        .ENDC
106                        .IFDF SPL
107                ;INITIALIZE PL SPOOLER/DESPOOLER TASK
108                        CLRB    PLONCE
109                        MOV     #1000,PLONCE+1
110                        MOV     @#LISTHD,R2      ;GET ADDRESS OF LISTHD IN R2
111                        ADD     #PLCOD*4,R2      ;CLEAR PL DEQUE: TASK CODE=6
112                        CALL    EMPTD
113                        MOV     @R1,NBN+TABLE+PLTEOF
114                        MOV     R1,PLCBCP                  ;SET PLCBCP
115                        CMP     (R1)+,(R1)+
116                        MOV     R1,PLWDCP        ;SET PLWDCP
117                        CLRB    PLBMS            ;RESET PLBMS
118                        .ENDC
119                ;ALL DONE DEQUE NEXT REQUEST
120 0756                   CALL    DEQREQ
    0756 004767            JSR     PC,DEQREQ
         000246
121                ;
122                ;EMPTY TASK DEQUE
123 0762           EMPTD:
124 0762                   .INH                     ;INHIBIT INTERRUPTS
    0762                   PUSH    @#PS
    0762 013746            MOV     @#PS,-(SP)
         177776
    0766 052737            BIS     #LVL7,@#PS
         000340
         177776
125 0774 012701            MOV     #EMPTY,R1        ;EMPTY TASKS DEQUE
         001026
126 1000 004731            JSR     PC,@(R1)+
127 1002                   .ENA                     ;ENABLE INTERRUPTS
    1002                   POP     @#PS
    1002 012637            MOV     (SP)+,@#PS
         177776
128 1006                   CALL    FINDBK
    1006 004767            JSR     PC,FINDBK
         000426
129 1012 010146            MOV     R1,-(SP)
130 1014                   CALL    GETBUF
    1014 004767            JSR     PC,GETBUF
         001344
131 1020                   POP     (R1)
    1020 012611            MOV     (SP)+,(R1)
132 1022 000207            RETURN
133                        .SBTTL  END
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

```
SPOL11.141       MAC11 XVM V1A000  PAGE 9
END
1                ;
2                ;THIS ROUTINE SHUTS DOWN ALL SPOOLING OPERATIONS. THE TIMER REQUEST
3                ;IS CANCELLED, SOFTWARE INTERRUPTS ARE IGNORED AND THE SPOL11 TASK
4                ;IS DISCONNECTED FROM PIREX
5                ;
6                ;
7 001024 052737 END:    BIS     #LVL7,@#PS      ;PROTECT ROUTINE (BR-138)
         000340
         177776
8 001032 013701         MOV     @#CLTABL,R1     ;NULL SPOOLER TIMER REQUEST
         001052
9 001036 005067         CLR     SPST-4          ;ENABLE STOP ALL I/O
         177100
10 01042 005037         CLR     @#DEVSPL                ;CLEAR DEVICED SPOOLED SWITCH
         001064
11 01046 005061         CLR     SPCOD*4(R1)
         000034
12 01052 005037         CLR     @#SPOLSW        ;RESET SPOOLER SWITCH
         001046
13 01056 042737         BIC     #LVL7,@#PS      ;UNPROTECT TO ALLOW INTS. TO RUN DOWN (BR-138)
         000340
         177776
14 01064 012705         MOV     #20,R5          ;ALLOW 20 INTERRUPTS (CLOCK OR DEVICE) (BR-138)
         000020
15 01070 000001 1$:     WAIT                    ;WAIT FOR THEM (BR-138)
16 01072 005305         DEC     R5              ;COUNT 20 INTS. (BR-138)
17 01074 001375         BNE     1$              ;BRANCH IF NOT 20 (BR-138)
18 01076 052737         BIS     #LVL7,@#PS      ;INHIBIT INT.
         000340
         177776
19 01104 013701         MOV     @#TEVADD,R1     ;FIND THE ENTRY ADDRESS
         001060
20                      .IFDF   $LP
21 01110 016102         MOV     LPCOD*2(R1),R2  ;FIND TASK ADDRESS
         000010
22 01114                CALL    STPTSK          ;STOP THE TASK
   01114 004767         JSR     PC,STPTSK
         000054
23                      .ENDC
24                      .IFDF   $CD
25                      MOV     CDCOD*2(R1),R2  ;STOP THE CARD READER TASK
26                      CALL    STPTSK          ;STOP  THE TASK
27                      .ENDC
28                      .IFDF   $PL
29                      MOV     PLCOD*2(R1),R2  ;STOP THE PLOTTER TASK
30                      CALL    STPTSK
31                      .ENDC
32 01120 012701         MOV     #RTURN,R1       ;GET RETURN INST. ADD IN R1
         001036
33 01124 013702         MOV     @#SEND11,R2
         001002
34 01130 011162         MOV     (R1),SPCOD*2(R2) ;SHUT OFF SEND11
         000016
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

```
SPOL11.141         MAC11 XVM V1A000   PAGE 9+
END
35 01134 026027              CMP      FCODE(R0),#4      ;SEE IF THIS WAS  "END" OR IOPSUC 20 (BR-138)
         000006
         000004
36 01142 001005              BNE      2$                ;BRANCH IF IOPSUC 20 (BR-138)
37 01144 012701              MOV      #1,R1             ;TELL SPOL15 DONE
         000001
38 01150 012702              MOV      #SEND15,R2
         001024
39 01154 004732              JSR      PC,@(R2)+
40 01156          2$:        ADR      TCBDIS,R5         ;SET FA
   01156 010705              MOV      PC,R5
   01160 062705              ADD      #TCBDIS-.,R5
         005542
41 01164                     IREQ                       ;SEND REQUEST
   01164 012704              MOV      #100000,R4
         100000
   01170 000004              IOT
   01172    001              .BYTE    1,0
   01173    000
42                ;
43 01174 005702   STPTSK:    TST      R2                ;(GAR-141) IS TASK IN EXISTENCE?
44 01176 001413              BEQ      1$                ;(GAR-141) BRANCH IF NOT.
45 01200 005762              TST      -4(R2)   ;PDP-11 REQUEST?
         177774
46 01204 100010              BPL      1$                ;NO -- IGNORE
47 01206 014203              MOV      -(R2),R3          ;YES -- TEST FOR SPOLLER REQUEST?
48 01210 122713              CMPB     #SPCOD,@R3
         000007
49 01214 001004              BNE      1$
50 01216 005012              CLR      @R2
51 01220 005042              CLR      -(R2)    ;STOP TASK (CLEAR TCB ADR
52 01222 005072              CLR      @-2(R2)           ;STOP DEVICE FROM INTERRUPTING
         177776
53 01226 000207   1$:        RETURN
54                ;
55                ;
```

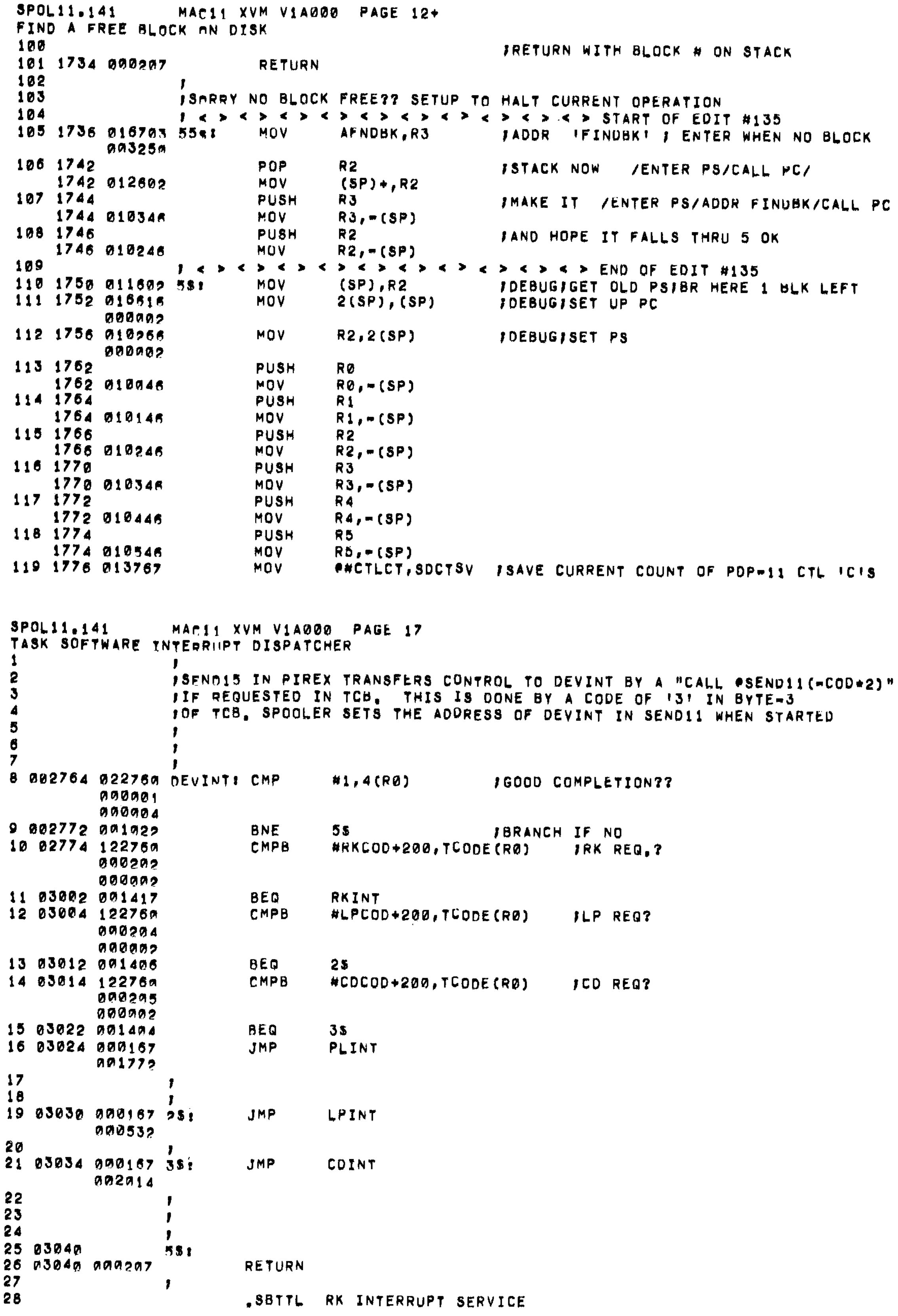
Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

```
SPOL11.141        MAC11 XVM V1A000  PAGE 11
UTILITY ROUTINES
                                   .SBTTL  UTILITY ROUTINES
                                   .IFDF $CD
                         ;
                         ;SET UP TCB TO READ A CARD FROM CD
                         ;CALLING SEQUENCE:        MOV      BUFAD,R5
                         ;                         CALL     STUPCT
                         ;                                  ;
                         STUPCT: MOV      PC,R1             ;GET ADDRESS OF TCBCD IN R1
                                 ADD      #TCBCD-.,R1
                                 BR       STUCOM            ;ENTER COMMON ROUTNINE
                                 .ENDC
                                 .IFDF $LP
                         ;
                         ;SET UP TCB TO WRITE A LINE ON LP
                         ;CALLING SEQUENCE:        MOV      BUFAD,R5
                         ;                         CALL     STUPLT
                         ;
  01320 010701           STUPLT: MOV      PC,R1             ;GET ADDRESS OF TCBLP IN R1 & R5
  01322 062701                   ADD      #TCBLP-.,R1
        005362
  01326 000400                   BR       STUCOM
                                 .ENDC
                                 .IFDF $PL
                         ;
                         ;SET UP TCB TO WRITE A LINE ON PL
                         ;CALLING SEQUENCE:        MOV      BUFAD,R5
                         ;                         CALL     STUPPT
                         ;
                         STUPPT: MOV      PC,R1             ;GET ADDRESS OF TCBPL IN R1 & R5
                                 ADD      #TCBPL-.,R1
                                 .ENDC
  01330 010561           STUCOM: MOV      R5,10(R1)
        000010
  01334 010105                   MOV      R1,R5
  01336 005061                   CLR      4(R1)             ;RESET REV
        000004
  01342                          IREQ                       ;SEND
  01342 012704                   MOV      #100000,R4
        100000
  01346 000004                   IOT
  01350    001                   .BYTE    1,0
  01351    000
  01352 000207                   RETURN
                         ;
                         ;SET UP DISK TCB TO READ A BLOCK WITH NO INTERRUPTS & RETURN ADDRESS
                         ;        CALLING SEQUENCE:        ADR      BUFF,R4
                         ;                                 ADR      -.CBN,R3
                         ;                                 ADR      TCBDK-,R2
                         ;                                 CALL     STUPDT
                         ;
  01354 010205           STUPDT: MOV      R2,R5             ;SAVE TCBP IN R5
  01356 022222                   CMP      (R2)+,(R2)+       ;BUMP TO REV
  01360 005022                   CLR      (R2)+             ;RESET REV
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

```
SPOL11.141      MAC11 XVM V1A000  PAGE 12+
FIND A FREE BLOCK ON DISK
01556 020103          CMP     R1,R3           ;DID WE GET TO BEGINNING WORD
01560 101066          BHI     55$             ;YES, NO BITS, SET UP FOR 'ERROR'
                ;
01562 014102 7$:      MOV     -(R1),R2        ;BACK UP TO GET COPY OF MAP WORD
                ; < > < > < > < > < > < > < > < > < > < > END OF EDIT #135
01564 010167          MOV     R1,CWDPTR       ;SAVE FIND POSITION FOR NEXT TIME CALLED
      000314
01570 005202          INC     R2              ;SETS FIRST ZERO BIT IN WORD!!
01572 041102 6$:      BIC     (R1),R2         ;CLEAR ALL REST,LEAVING BIT FOR OUR BLOK
01574 050211          BIS     R2,(R1)         ;SET BIT IN MAP
01576 010267          MOV     R2,CBTPTR       ;REMEMBER BIT FOR NEXT TIME
      000304
01602 166701          SUB     BTMPAD,R1       ;BYTE INDEX FOR FOUND BLOCK #
      003360
01606 105702          TSTB    R2              ;IS BIT IN LOW HALF OF WORD
01610 001001          BNE     8$              ;YUP, NO CHANGE
01612 005201          INC     R1              ;IN HIGH HALF, INC BYTE COUNT
01614 006301 8$:      ASL     R1              ;NIBBLE (4 BIT) INDEX FOR FIND
01616 032702          BIT     #170360,R2      ;IS BIT IN HIGH NIBBLE OF BYTE
      170360
01622 001401          BEQ     9$              ;NO, NOCHANGE
01624 005201          INC     R1              ;YES, SO INCR NIBBLE COUNT
01626 006301 9$:      ASL     R1              ;CRUMB (2 BIT) INDEX FOR FOUND BLOCK
01630 032702          BIT     #146314,R2      ; IS BIT IN HIGH CRUMB OF NIBBLE
      146314
01634 001401          BEQ     10$             ;NO, NO CHANGE
01636 005201          INC     R1              ;YES, SO INCR CRUMB COUNT
01640 006301 10$:     ASL     R1              ;NOW HAVE BIT COUNT FOR BLOCK
01642 032702          BIT     #125252,R2      ;IS BIT IN HIGH BIT OF CRUMP
      125252
01646 001401          BEQ     11$             ;NO, NO CHANGE
01650 005201          INC     R1              ;YES, SO ADD ONE
01652 066701 11$:     ADD     STBKNM,R1       ;AND FINALLY ADD #OF FIRST MAPPED BLOCK
      003414
                ;
                ; < > < > < > < > < > < > < > < > < > < > END OF EDIT #133
                ;
                ;THE FOLLOWING PIECE OF CODE CHECKS TO SEE IF THE CURRENT BLOCK TO BE
                ;ALLOCATED TO THE CURRENT SPOOLING TASK EQUALS THE CBN OF THIS
                ;DESPOOLING TASK;IF THIS IS TRUE, THEN THE 'SPOOLER IS DECLARED FLOODED'
                ;THIS HAPPENS ONLY ON A WRAP AROUND(ENTIRE SPOOLER AREA IS TREATED AS A
                ;RING BUFFER)WHEN SPOOLING OPERATIONS ARE WAY AHEAD OF DESPOOLING OPERATIONS
                ;
                ;
                ;*****NOTE: AS NEW TASKS ARE ADDED NEW CODE HAS TO BE ADDED*****
                ;********** SIMILAR TO THE CODE FOR EXISTING TASKS**************
                ;
01656 116002          MOVB    2(R0),R2        ;GET CURRENT TASK CODE
      000002
01662 122702          CMPB    #LPCOD,R2       ;LP?
      000004
01666 001411          BEQ     21$
01670 122702          CMPB    #CDCOD+200,R2   ;NO, CD?
      000205
01674 001411          BEQ     22$
01676 122702          CMPB    #PLCOD,R2       ;NO, PL?
      000006
01702 001012          BNE     26$
01704 016702          MOV     TABPLC,R2       ;YES
      003266
01710 000405          BR      30$
01712 016702 21$:     MOV     TABPCB,R2
      003256
01716 000402          BR      30$
                ;
01720 016702 22$:     MOV     TABCDC,R2
      003254
01724        30$:
01724 020112          CMP     R1,(R2)
01726 001410          BEQ     55$
01730        26$:
01730                 POP     @#PS            ;DEBUG;UNPROTECT
01730 012637          MOV     (SP)+,@#PS
      177776
```

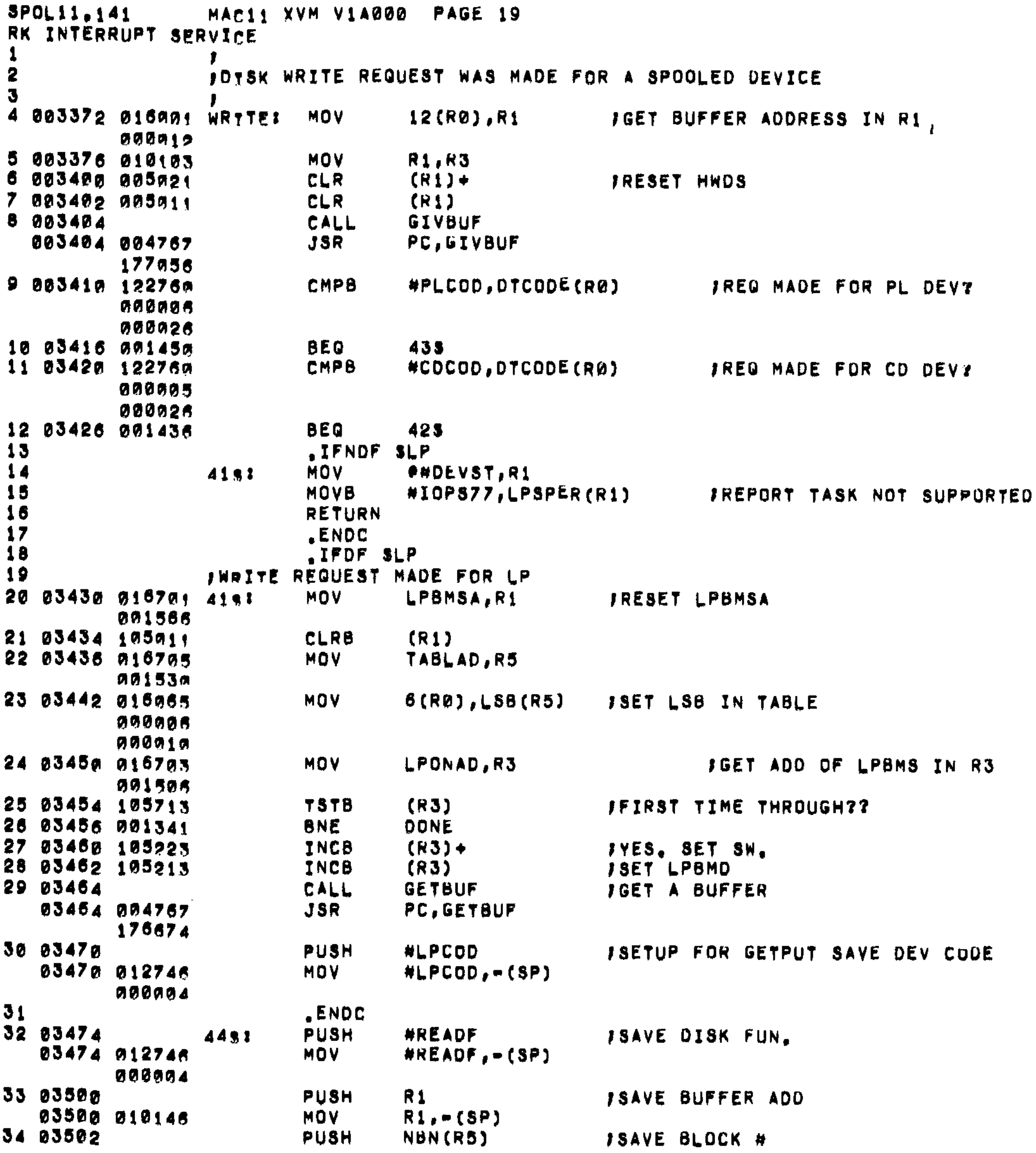
Figure 5-1 (Cont.)
UNICHANNEL Spooler Components



```
SPOL11.141      MAC11 XVM V1A000  PAGE 12+
FIND A FREE BLOCK ON DISK
100                                                     ;RETURN WITH BLOCK # ON STACK
101 1734 000207          RETURN
102                 ;
103                 ;SORRY NO BLOCK FREE?? SETUP TO HALT CURRENT OPERATION
104                 ; < > < > < > < > < > < > < > < > < > < > START OF EDIT #135
105 1736 016703 55$:     MOV     AFNDBK,R3          ;ADDR  'FINDBK' ; ENTER WHEN NO BLOCK
         003250
106 1742                 POP     R2                 ;STACK NOW   /ENTER PS/CALL PC/
    1742 012602          MOV     (SP)+,R2
107 1744                 PUSH    R3                 ;MAKE IT  /ENTER PS/ADDR FINDBK/CALL PC
    1744 010346          MOV     R3,-(SP)
108 1746                 PUSH    R2                 ;AND HOPE IT FALLS THRU 5 OK
    1746 010246          MOV     R2,-(SP)
109                 ; < > < > < > < > < > < > < > < > < > < > END OF EDIT #135
110 1750 011602 5$:      MOV     (SP),R2            ;DEBUG;GET OLD PS;BR HERE 1 BLK LEFT
111 1752 016616          MOV     2(SP),(SP)         ;DEBUG;SET UP PC
         000002
112 1756 010266          MOV     R2,2(SP)           ;DEBUG;SET PS
         000002
113 1762                 PUSH    R0
    1762 010046          MOV     R0,-(SP)
114 1764                 PUSH    R1
    1764 010146          MOV     R1,-(SP)
115 1766                 PUSH    R2
    1766 010246          MOV     R2,-(SP)
116 1770                 PUSH    R3
    1770 010346          MOV     R3,-(SP)
117 1772                 PUSH    R4
    1772 010446          MOV     R4,-(SP)
118 1774                 PUSH    R5
    1774 010546          MOV     R5,-(SP)
119 1776 013767          MOV     @#CTLCT,SDCTSV    ;SAVE CURRENT COUNT OF PDP-11 CTL 'C'S
```

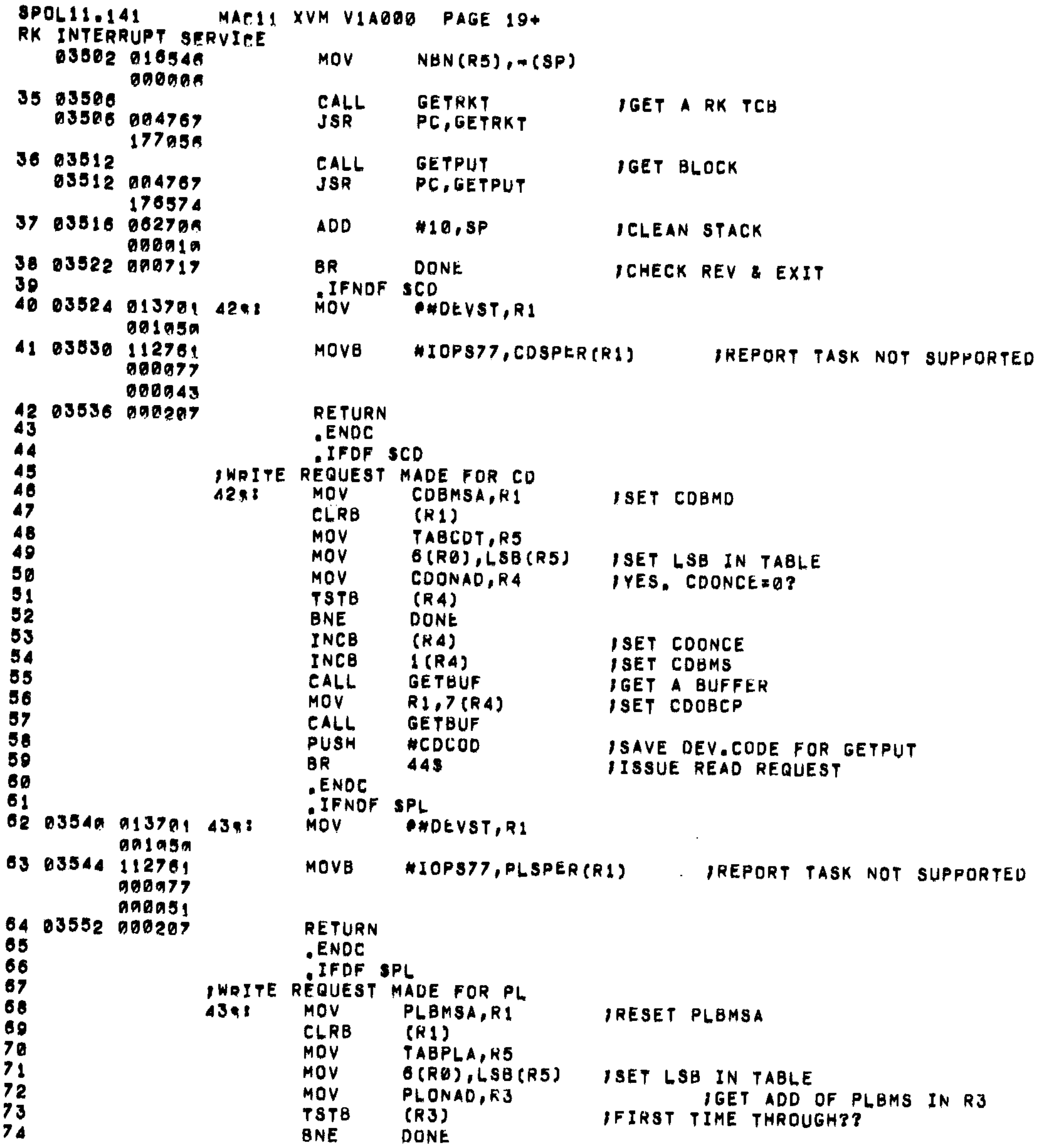
```
SPOL11.141      MAC11 XVM V1A000  PAGE 17
TASK SOFTWARE INTERRUPT DISPATCHER
1                   ;
2                   ;SEND15 IN PIREX TRANSFERS CONTROL TO DEVINT BY A "CALL @SEND11(-COD*2)"
3                   ;IF REQUESTED IN TCB.  THIS IS DONE BY A CODE OF '3' IN BYTE-3
4                   ;OF TCB. SPOOLER SETS THE ADDRESS OF DEVINT IN SEND11 WHEN STARTED
5                   ;
6                   ;
7                   ;
8 002764 022760 DEVINT: CMP      #1,4(R0)          ;GOOD COMPLETION??
         000001
         000004
9 002772 001022          BNE      5$                ;BRANCH IF NO
10 02774 122760          CMPB     #RKCOD+200,TCODE(R0)    ;RK REQ.?
         000202
         000002
11 03002 001417          BEQ      RKINT
12 03004 122760          CMPB     #LPCOD+200,TCODE(R0)    ;LP REQ?
         000204
         000002
13 03012 001406          BEQ      2$
14 03014 122760          CMPB     #CDCOD+200,TCODE(R0)    ;CD REQ?
         000205
         000002
15 03022 001404          BEQ      3$
16 03024 000167          JMP      PLINT
         001772
17                 ;
18                 ;
19 03030 000167 2$:      JMP      LPINT
         000532
20                 ;
21 03034 000167 3$:      JMP      CDINT
         002014
22                 ;
23                 ;
24                 ;
25 03040           5$:
26 03040 000207          RETURN
27                 ;
28                       .SBTTL  RK INTERRUPT SERVICE
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components



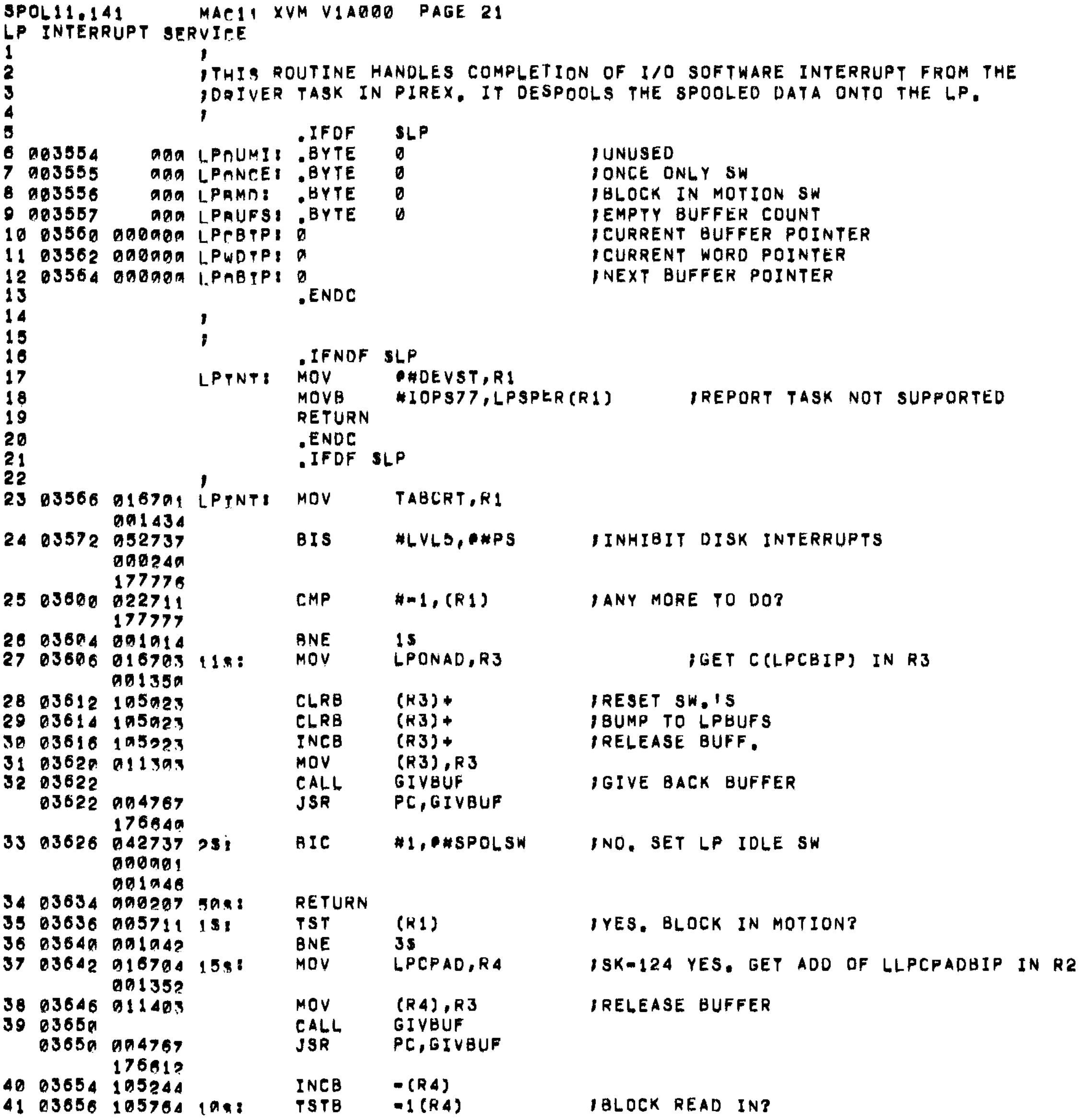
```
SPOL11.141        MAC11 XVM V1A000  PAGE 19
RK INTERRUPT SERVICE
                  ;
                  ;DISK WRITE REQUEST WAS MADE FOR A SPOOLED DEVICE
                  ;
  003372 016001 WRITE:  MOV     12(R0),R1       ;GET BUFFER ADDRESS IN R1
         000012
  003376 010103         MOV     R1,R3
  003400 005021         CLR     (R1)+           ;RESET HWDS
  003402 005011         CLR     (R1)
  003404                CALL    GIVBUF
  003404 004767         JSR     PC,GIVBUF
         177056
  003410 122760         CMPB    #PLCOD,DTCODE(R0)       ;REQ MADE FOR PL DEV?
         000006
         000026
   03416 001450         BEQ     43$
   03420 122760         CMPB    #CDCOD,DTCODE(R0)       ;REQ MADE FOR CD DEV?
         000005
         000026
   03426 001436         BEQ     42$
                        .IFNDF $LP
                41$:    MOV     @#DEVST,R1
                        MOVB    #IOPS77,LPSPER(R1)      ;REPORT TASK NOT SUPPORTED
                        RETURN
                        .ENDC
                        .IFDF $LP
                ;WRITE REQUEST MADE FOR LP
   03430 016701 41$:    MOV     LPBMSA,R1       ;RESET LPBMSA
         001566
   03434 105011         CLRB    (R1)
   03436 016705         MOV     TABLAD,R5
         001530
   03442 016065         MOV     6(R0),LSB(R5)   ;SET LSB IN TABLE
         000006
         000010
   03450 016703         MOV     LPONAD,R3               ;GET ADD OF LPBMS IN R3
         001506
   03454 105713         TSTB    (R3)            ;FIRST TIME THROUGH??
   03456 001341         BNE     DONE
   03460 105223         INCB    (R3)+           ;YES. SET SW.
   03462 105213         INCB    (R3)            ;SET LPBMD
   03464                CALL    GETBUF          ;GET A BUFFER
   03464 004767         JSR     PC,GETBUF
         176674
   03470                PUSH    #LPCOD          ;SETUP FOR GETPUT SAVE DEV CODE
   03470 012746         MOV     #LPCOD,-(SP)
         000004
                        .ENDC
   03474        44$:    PUSH    #READF          ;SAVE DISK FUN.
   03474 012746         MOV     #READF,-(SP)
         000004
   03500                PUSH    R1              ;SAVE BUFFER ADD
   03500 010146         MOV     R1,-(SP)
   03502                PUSH    NBN(R5)         ;SAVE BLOCK #
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components



```
SPOL11.141       MAC11 XVM V1A000  PAGE 19+
RK INTERRUPT SERVICE
03502 016546             MOV     NBN(R5),-(SP)
      000006
03506                    CALL    GETRKT            ;GET A RK TCB
03506 004767             JSR     PC,GETRKT
      177056
03512                    CALL    GETPUT            ;GET BLOCK
03512 004767             JSR     PC,GETPUT
      176574
03516 062706             ADD     #10,SP            ;CLEAN STACK
      000010
03522 000717             BR      DONE              ;CHECK REV & EXIT
                         .IFNDF  $CD
03524 013701  42$:       MOV     @#DEVST,R1
      001050
03530 112761             MOVB    #IOPS77,CDSPER(R1)      ;REPORT TASK NOT SUPPORTED
      000077
      000043
03536 000207             RETURN
                         .ENDC
                         .IFDF   $CD
              ;WRITE REQUEST MADE FOR CD
              42$:       MOV     CDBMSA,R1         ;SET CDBMD
                         CLRB    (R1)
                         MOV     TABCDT,R5
                         MOV     6(R0),LSB(R5)     ;SET LSB IN TABLE
                         MOV     CDONAD,R4         ;YES, CDONCE=0?
                         TSTB    (R4)
                         BNE     DONE
                         INCB    (R4)              ;SET CDONCE
                         INCB    1(R4)             ;SET CDBMS
                         CALL    GETBUF            ;GET A BUFFER
                         MOV     R1,7(R4)          ;SET CDOBCP
                         CALL    GETBUF
                         PUSH    #CDCOD            ;SAVE DEV.CODE FOR GETPUT
                         BR      44$               ;ISSUE READ REQUEST
                         .ENDC
                         .IFNDF  $PL
03540 013701  43$:       MOV     @#DEVST,R1
      001050
03544 112761             MOVB    #IOPS77,PLSPER(R1)      ;REPORT TASK NOT SUPPORTED
      000077
      000051
03552 000207             RETURN
                         .ENDC
                         .IFDF   $PL
              ;WRITE REQUEST MADE FOR PL
              43$:       MOV     PLBMSA,R1         ;RESET PLBMSA
                         CLRB    (R1)
                         MOV     TABPLA,R5
                         MOV     6(R0),LSB(R5)     ;SET LSB IN TABLE
                         MOV     PLONAD,R3                 ;GET ADD OF PLBMS IN R3
                         TSTB    (R3)              ;FIRST TIME THROUGH??
                         BNE     DONE
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

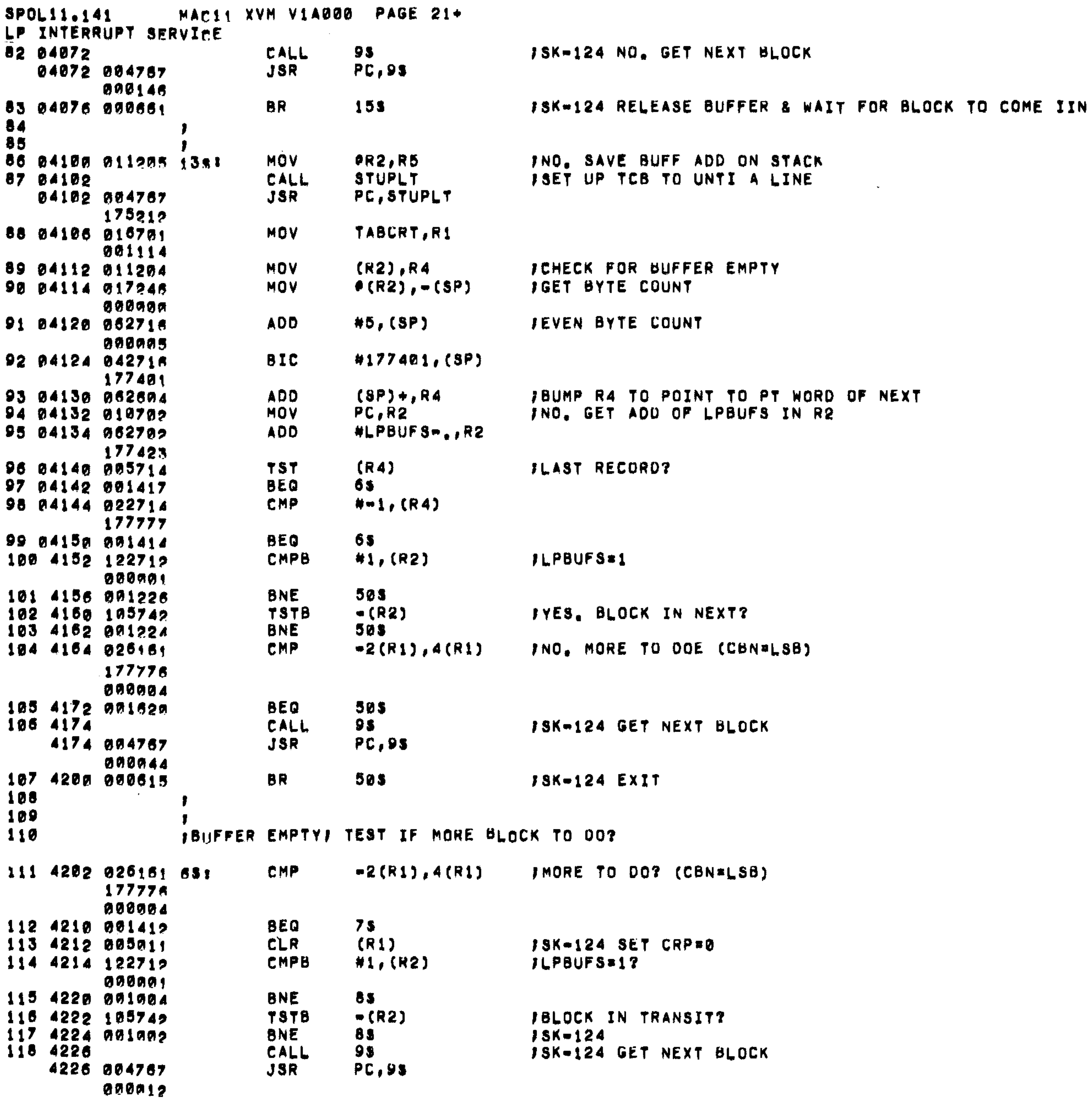


```
SPOL11.141      MAC11 XVM V1AØØØ  PAGE 21
LP INTERRUPT SERVICE
1                       ;
2                       ;THIS ROUTINE HANDLES COMPLETION OF I/O SOFTWARE INTERRUPT FROM THE
3                       ;DRIVER TASK IN PIREX. IT DESPOOLS THE SPOOLED DATA ONTO THE LP.
4                       ;
5                               .IFDF   $LP
6 ØØ3554        ØØØ LPDUMI: .BYTE   Ø                       ;UNUSED
7 ØØ3555        ØØØ LPONCE: .BYTE   Ø                       ;ONCE ONLY SW
8 ØØ3556        ØØØ LPBMD:  .BYTE   Ø                       ;BLOCK IN MOTION SW
9 ØØ3557        ØØØ LPBUFS: .BYTE   Ø                       ;EMPTY BUFFER COUNT
10 Ø356Ø ØØØØØØ LPCBIP: Ø                                   ;CURRENT BUFFER POINTER
11 Ø3562 ØØØØØØ LPWDIP: Ø                                   ;CURRENT WORD POINTER
12 Ø3564 ØØØØØØ LPNBIP: Ø                                   ;NEXT BUFFER POINTER
13                              .ENDC
14                      ;
15                      ;
16                              .IFNDF $LP
17                      LPINT:  MOV     @#DEVST,R1
18                              MOVB    #IOPS77,LPSPER(R1)      ;REPORT TASK NOT SUPPORTED
19                              RETURN
2Ø                              .ENDC
21                              .IFDF $LP
22                      ;
23 Ø3566 Ø167Ø1 LPINT:  MOV     TABCRT,R1
         ØØ1434
24 Ø3572 Ø52737         BIS     #LVL5,@#PS              ;INHIBIT DISK INTERRUPTS
         ØØØ24Ø
         177776
25 Ø36ØØ Ø22711         CMP     #-1,(R1)                ;ANY MORE TO DO?
         177777
26 Ø36Ø4 ØØ1Ø14         BNE     1$
27 Ø36Ø6 Ø167Ø3 11$:    MOV     LPONAD,R3                       ;GET C(LPCBIP) IN R3
         ØØ135Ø
28 Ø3612 1Ø5Ø23         CLRB    (R3)+                   ;RESET SW.'S
29 Ø3614 1Ø5Ø23         CLRB    (R3)+                   ;BUMP TO LPBUFS
3Ø Ø3616 1Ø5223         INCB    (R3)+                   ;RELEASE BUFF.
31 Ø362Ø Ø113Ø3         MOV     (R3),R3
32 Ø3622                CALL    GIVBUF                  ;GIVE BACK BUFFER
   Ø3622 ØØ4767         JSR     PC,GIVBUF
         17664Ø
33 Ø3626 Ø42737 2$:     BIC     #1,@#SPOLSW             ;NO. SET LP IDLE SW
         ØØØØØ1
         ØØ1Ø46
34 Ø3634 ØØØ2Ø7 5Ø$:    RETURN
35 Ø3636 ØØ5711 1$:     TST     (R1)                    ;YES. BLOCK IN MOTION?
36 Ø364Ø ØØ1Ø42         BNE     3$
37 Ø3642 Ø167Ø4 15$:    MOV     LPCPAD,R4               ;SK-124 YES. GET ADD OF LLPCPADBIP IN R2
         ØØ1352
38 Ø3646 Ø114Ø3         MOV     (R4),R3                 ;RELEASE BUFFER
39 Ø365Ø                CALL    GIVBUF
   Ø365Ø ØØ4767         JSR     PC,GIVBUF
         176612
4Ø Ø3654 1Ø5244         INCB    -(R4)
41 Ø3656 1Ø5764 1Ø$:    TSTB    -1(R4)                  ;BLOCK READ IN?
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

```
SPOL11.141        MAC11  XVM  V1A000   PAGE 21+
LP INTERRUPT SERVICE
           177777
42 03662 001403           BEQ     4$
43 03664                  CALL    WAITBK
   03664 004767           JSR     PC,WAITBK
         175530
44 03670 000772           BR      10$
45 03672           4$:
46 03672 016701           MOV     TABCRT,R1         ;DEBUG
         001330
47 03676 016767           MOV     TABLE+NBN,TABLE+CBN      ;SET CBN=NBN
         002360
         002352
48 03704 012767           MOV     #4,TABLE+CRP             ;SET CRP
         000004
         002346
49 03712 010703           MOV     PC,R3             ;GET LPOBIP ADD. IN R3
50 03714 062703           ADD     #LPOBIP-.,R3
         177650
51 03720 011304           MOV     (R3),R4           ;GET C(LPOBIP) IN R3 & BUMP TO TWD1
52 03722 016467           MOV     TWD1(R4),TABLE+NBN       ;SET LP.NBN
         000776
         002332
53 03730 016702           MOV     LPCPAD,R2                ;GET ADD. OF LLPCPADBIP IN R2
         001264
54 03734 011322           MOV     (R3),(R2)+        ;SET LPCBIP
55 03736 011312           MOV     (R3),(R2)         ;SET LPWDIP
56 03740 062712           ADD     #4,(R2)
         000004
57 03744 000412           BR      5$                ;SEND WRITE REQ IF NOT SHUT DOWN
58 03746 016702 3$:       MOV     LPCWAD,R2                ;GET ADD OF LPWDIP IN R2
         001234
59 03752 017246           MOV     @(R2),-(SP)
         000000
60 03756 062716           ADD     #5,(SP)           ;EVEN BYTE COUNT
         000005
61 03762 042716           BIC     #177401,(SP)
         177401
62 03766 061611           ADD     (SP),(R1)         ;BUMP CRP
63 03770 062612           ADD     (SP)+,(R2)        ;BUMP LPWDIP
64 03772 032737 5$:       BIT     #40000,@#SPOLSW ;SHUT DOWN?
         040000
         001046
65 04000 001712           BEQ     2$
66 04002 032737           BIT     #1,@#SPOLSW       ;SHUT LP?
         000001
         001046
67 04010 001706           BEQ     2$
68 04012 032737           BIT     #10000,@#SPOLSW ;SHUT DESPOOLER
         010000
         001046
69 04020 001702           BEQ     2$
70 04022 005772           TST     @(R2)             ;FIRST RECORD A .CLOSE?
         000000
71 04026 001024           BNE     13$
72 04030 026161           CMP     -2(R1),4(R1)      ;ANY MORE DATA?
         177776
         000004
73 04036 001003           BNE     14$
74 04040                  CALL    12$               ;NO. SET TABLE ENTRIES
   04040 004767           JSR     PC,12$
         000240
75 04044 000660           BR      11$               ;RESET SWITCHES & EXIT
76 04046 016702 14$:      MOV     LPONAD,R2         ;DEBUG;SK-124 GET LPBUFS ADRRESS
         001110
77 04052 062702           ADD     #2,R2             ;DEBUG;SK-124
         000002
78 04056 122712           CMPB    #1,(R2)           ;DEBUG;SK-124 ONE FREE BUFFER?
         000001
79 04062 001267           BNE     15$               ;SK-124
80 04064 105762           TSTB    -1(R2)            ;DEBUG;SK-124 YES, BLOCK IN MOTION?
         177777
81 04070 001264           BNE     15$               ;SK-124
```

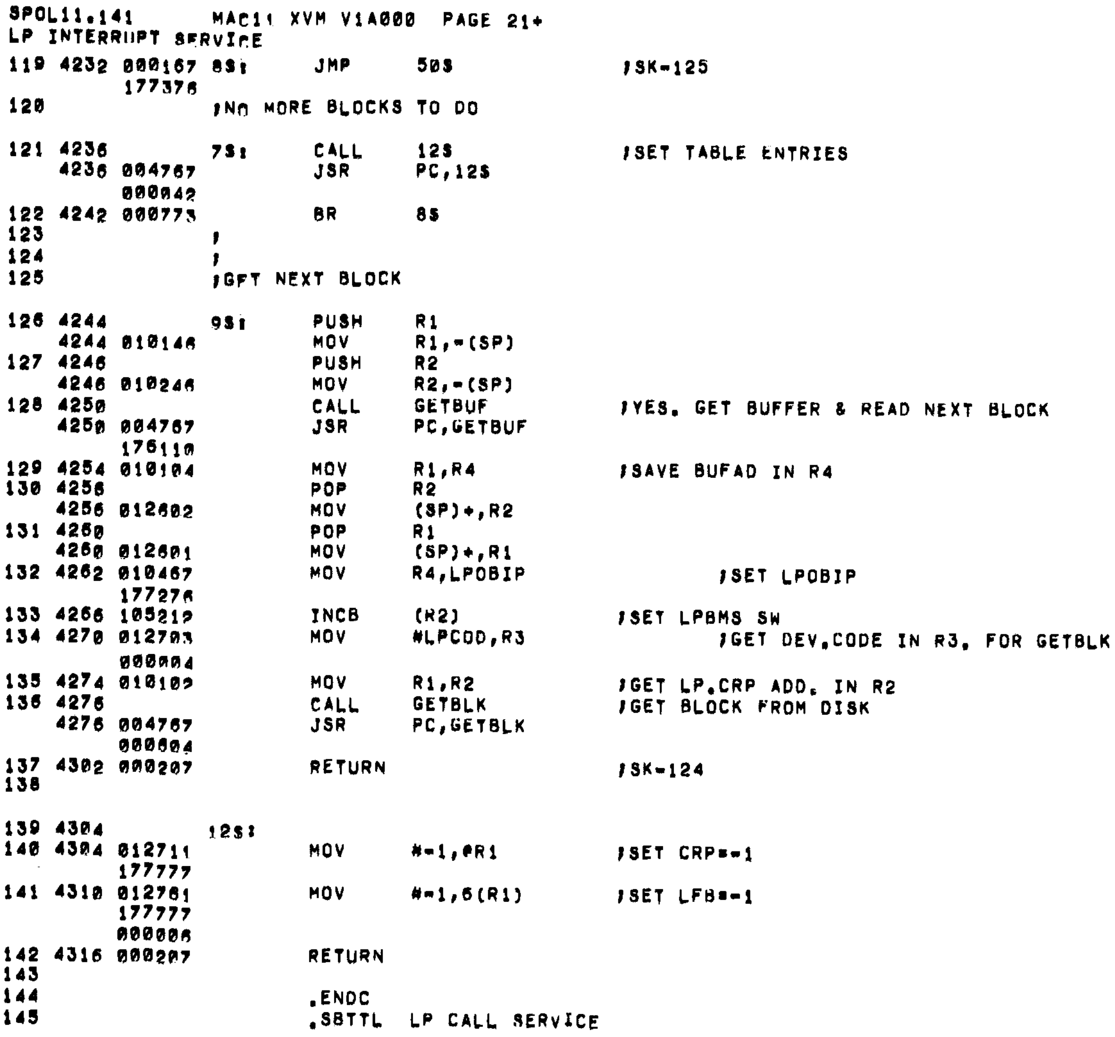
Figure 5-1 (Cont.)
UNICHANNEL Spooler Components



```
SPOL11.141      MAC11 XVM V1A000  PAGE 21+
LP INTERRUPT SERVICE
82 04072                     CALL    9$                  ;SK-124 NO. GET NEXT BLOCK
   04072 004767              JSR     PC,9$
         000146
83 04076 000661              BR      15$                 ;SK-124 RELEASE BUFFER & WAIT FOR BLOCK TO COME IIN
84                   ;
85                   ;
86 04100 011205 13$:         MOV     @R2,R5              ;NO. SAVE BUFF ADD ON STACK
87 04102                     CALL    STUPLT              ;SET UP TCB TO UNTI A LINE
   04102 004767              JSR     PC,STUPLT
         175212
88 04106 016701              MOV     TABCRT,R1
         001114
89 04112 011204              MOV     (R2),R4             ;CHECK FOR BUFFER EMPTY
90 04114 017246              MOV     @(R2),-(SP)         ;GET BYTE COUNT
         000000
91 04120 062716              ADD     #5,(SP)             ;EVEN BYTE COUNT
         000005
92 04124 042716              BIC     #177401,(SP)
         177401
93 04130 062604              ADD     (SP)+,R4            ;BUMP R4 TO POINT TO PT WORD OF NEXT
94 04132 010702              MOV     PC,R2               ;NO. GET ADD OF LPBUFS IN R2
95 04134 062702              ADD     #LPBUFS-.,R2
         177423
96 04140 005714              TST     (R4)                ;LAST RECORD?
97 04142 001417              BEQ     6$
98 04144 022714              CMP     #-1,(R4)
         177777
99 04150 001414              BEQ     6$
100 4152 122712              CMPB    #1,(R2)             ;LPBUFS=1
         000001
101 4156 001226              BNE     50$
102 4160 105742              TSTB    -(R2)               ;YES. BLOCK IN NEXT?
103 4162 001224              BNE     50$
104 4164 026161              CMP     -2(R1),4(R1)        ;NO. MORE TO DOE (CBN=LSB)
         177776
         000004
105 4172 001620              BEQ     50$
106 4174                     CALL    9$                  ;SK-124 GET NEXT BLOCK
    4174 004767              JSR     PC,9$
         000044
107 4200 000615              BR      50$                 ;SK-124 EXIT
108                  ;
109                  ;
110                  ;BUFFER EMPTY; TEST IF MORE BLOCK TO DO?

111 4202 026161 6$:          CMP     -2(R1),4(R1)        ;MORE TO DO? (CBN=LSB)
         177776
         000004
112 4210 001412              BEQ     7$
113 4212 005011              CLR     (R1)                ;SK-124 SET CRP=0
114 4214 122712              CMPB    #1,(R2)             ;LPBUFS=1?
         000001
115 4220 001004              BNE     8$
116 4222 105742              TSTB    -(R2)               ;BLOCK IN TRANSIT?
117 4224 001002              BNE     8$                  ;SK-124
118 4226                     CALL    9$                  ;SK-124 GET NEXT BLOCK
    4226 004767              JSR     PC,9$
         000012
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components



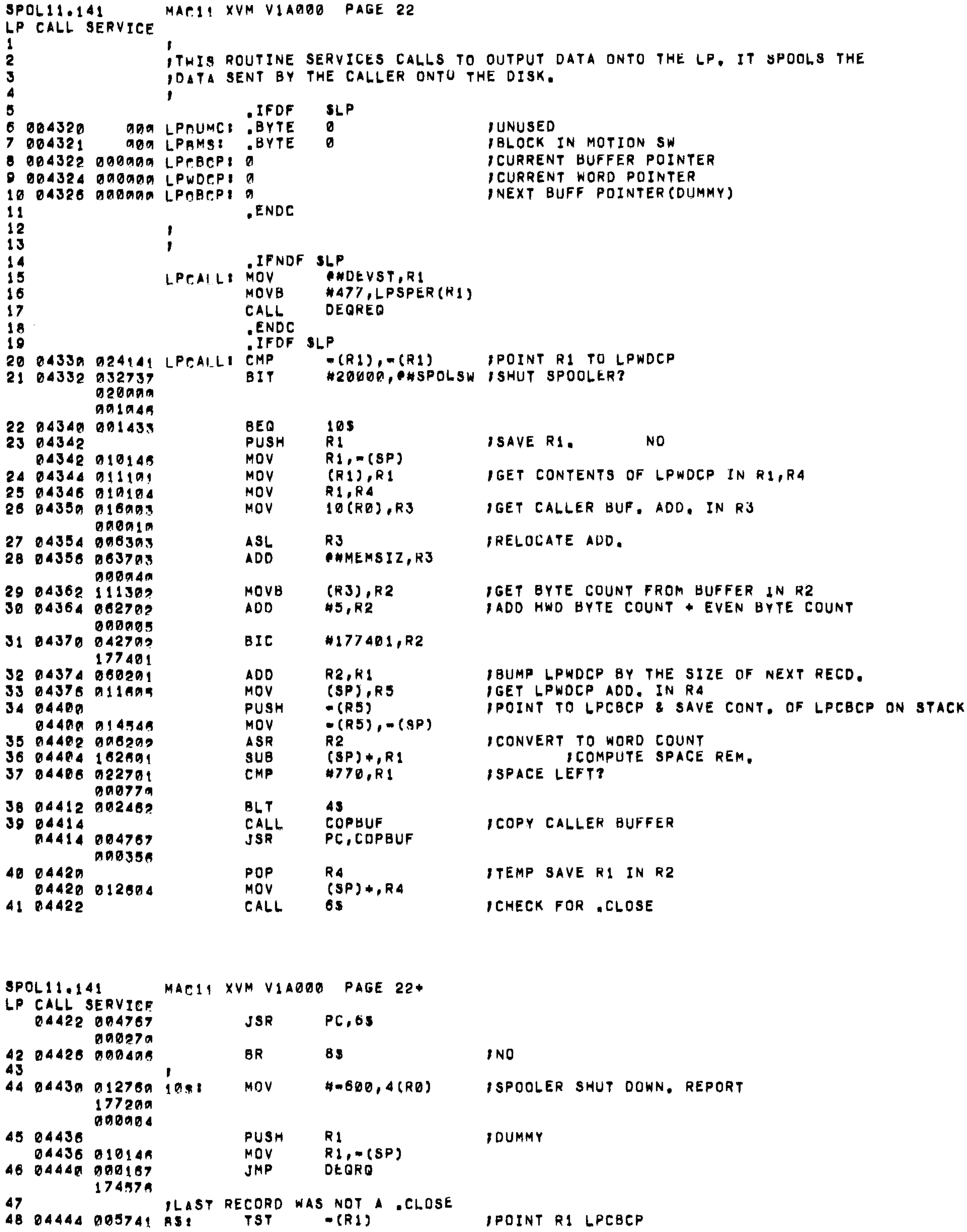
```
SPOL11.141      MAC11 XVM V1A000  PAGE 21+
LP INTERRUPT SERVICE
119 4232 000167 8$:     JMP     50$             ;SK-125
         177376
120                ;NO MORE BLOCKS TO DO

121 4236        7$:     CALL    12$             ;SET TABLE ENTRIES
    4236 004767         JSR     PC,12$
         000042
122 4242 000773         BR      8$
123                ;
124                ;
125                ;GET NEXT BLOCK

126 4244        9$:     PUSH    R1
    4244 010146         MOV     R1,-(SP)
127 4246                PUSH    R2
    4246 010246         MOV     R2,-(SP)
128 4250                CALL    GETBUF          ;YES. GET BUFFER & READ NEXT BLOCK
    4250 004767         JSR     PC,GETBUF
         176110
129 4254 010104         MOV     R1,R4           ;SAVE BUFAD IN R4
130 4256                POP     R2
    4256 012602         MOV     (SP)+,R2
131 4260                POP     R1
    4260 012601         MOV     (SP)+,R1
132 4262 010467         MOV     R4,LPOBIP               ;SET LPOBIP
         177276
133 4266 105212         INCB    (R2)            ;SET LPBMS SW
134 4270 012703         MOV     #LPCOD,R3               ;GET DEV.CODE IN R3, FOR GETBLK
         000004
135 4274 010102         MOV     R1,R2           ;GET LP.CRP ADD. IN R2
136 4276                CALL    GETBLK          ;GET BLOCK FROM DISK
    4276 004767         JSR     PC,GETBLK
         000604
137 4302 000207         RETURN                  ;SK-124
138

139 4304        12$:
140 4304 012711         MOV     #-1,@R1         ;SET CRP=-1
         177777
141 4310 012761         MOV     #-1,6(R1)       ;SET LFB=-1
         177777
         000006
142 4316 000207         RETURN
143
144                     .ENDC
145                     .SBTTL  LP CALL SERVICE
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components



```
SPOL11.141        MAC11 XVM V1A000  PAGE 22
LP CALL SERVICE
1                 ;
2                 ;THIS ROUTINE SERVICES CALLS TO OUTPUT DATA ONTO THE LP. IT SPOOLS THE
3                 ;DATA SENT BY THE CALLER ONTO THE DISK.
4                 ;
5                          .IFDF   $LP
6 004320     000 LPDUMC: .BYTE    0                   ;UNUSED
7 004321     000 LPBMS:  .BYTE    0                   ;BLOCK IN MOTION SW
8 004322 000000 LPCBCP: 0                             ;CURRENT BUFFER POINTER
9 004324 000000 LPWDCP: 0                             ;CURRENT WORD POINTER
10 04326 000000 LPNBCP: 0                             ;NEXT BUFF POINTER(DUMMY)
11                         .ENDC
12                ;
13                ;
14                         .IFNDF $LP
15                LPCALL: MOV      @#DEVST,R1
16                         MOVB     #477,LPSPER(R1)
17                         CALL     DEQREQ
18                         .ENDC
19                         .IFDF $LP
20 04330 024141 LPCALL: CMP      -(R1),-(R1)         ;POINT R1 TO LPWDCP
21 04332 032737            BIT      #20000,@#SPOLSW ;SHUT SPOOLER?
         020000
         001046
22 04340 001433            BEQ      10$
23 04342                   PUSH     R1                  ;SAVE R1.        NO
   04342 010146            MOV      R1,-(SP)
24 04344 011101            MOV      (R1),R1             ;GET CONTENTS OF LPWDCP IN R1,R4
25 04346 010104            MOV      R1,R4
26 04350 016003            MOV      10(R0),R3           ;GET CALLER BUF. ADD. IN R3
         000010
27 04354 006303            ASL      R3                  ;RELOCATE ADD.
28 04356 063703            ADD      @#MEMSIZ,R3
         000040
29 04362 111302            MOVB     (R3),R2             ;GET BYTE COUNT FROM BUFFER IN R2
30 04364 062702            ADD      #5,R2               ;ADD HWD BYTE COUNT + EVEN BYTE COUNT
         000005
31 04370 042702            BIC      #177401,R2
         177401
32 04374 060201            ADD      R2,R1               ;BUMP LPWDCP BY THE SIZE OF NEXT RECD.
33 04376 011605            MOV      (SP),R5             ;GET LPWDCP ADD. IN R4
34 04400                   PUSH     -(R5)               ;POINT TO LPCBCP & SAVE CONT. OF LPCBCP ON STACK
   04400 014546            MOV      -(R5),-(SP)
35 04402 006202            ASR      R2                  ;CONVERT TO WORD COUNT
36 04404 162601            SUB      (SP)+,R1                ;COMPUTE SPACE REM.
37 04406 022701            CMP      #770,R1             ;SPACE LEFT?
         000770
38 04412 002462            BLT      4$
39 04414                   CALL     COPBUF              ;COPY CALLER BUFFER
   04414 004767            JSR      PC,COPBUF
         000356
40 04420                   POP      R4                  ;TEMP SAVE R1 IN R2
   04420 012604            MOV      (SP)+,R4
41 04422                   CALL     6$                  ;CHECK FOR .CLOSE


SPOL11.141        MAC11 XVM V1A000  PAGE 22+
LP CALL SERVICE
   04422 004767            JSR      PC,6$
         000270
42 04426 000406            BR       8$                  ;NO
43                ;
44 04430 012760 10$:       MOV      #-600,4(R0)         ;SPOOLER SHUT DOWN. REPORT
         177200
         000004
45 04436                   PUSH     R1                  ;DUMMY
   04436 010146            MOV      R1,-(SP)
46 04440 000167            JMP      DEQRQ
         174570
47                ;LAST RECORD WAS NOT A .CLOSE
48 04444 005741 8$:        TST      -(R1)               ;POINT R1 LPCBCP
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

```
SPOL11.141      MAC11  XVM V1A000  PAGE 22+
LP CALL SERVICE
49 04446 010102          MOV     R1,R2           ;SAVE IN R2
50 04450 005721          TST     (R1)+           ;BUMP R1 LPWDCP
51 04452 011101          MOV     (R1),R1         ;GET CURRENT WORD ADD. IN R1
52 04454 161201          SUB     (R2),R1         ;GET REMAINNING # OF WORDS
53 04456 022701          CMP     #770,R1         ;SPACE LEFT?
         000770
54 04462 003034          BGT     2$
55 04464 010701  9$:     MOV     PC,R1           ;GET ADD. OF LPWDCP IN R1
56 04466 062701          ADD     #LPWDCP-.,R1
         177636
57 04472 005071          CLR     @(R1)           ;NO. PUT BUFFER ON DISK
         000000
58 04476                 CALL    FINDBK          ;GET DISK BLOCK #
   04476 004767          JSR     PC,FINDBK
         174736
59 04502                 PUSH    R1              ;SAVE BLOCK # ON STACK
   04502 010146          MOV     R1,-(SP)
60 04504 016702          MOV     LPCBCP,R2               ;GET C(LPCBIP) IN R2
         177612
61 04510 011662          MOV     (SP),TWD1(R2)   ;SAVE BLOCK # IN TWD1
         000776
62 04514 012703          MOV     #LPCOD,R3               ;GET LP.DEV CODE IN R3
         000004
63 04520 016701          MOV     LPBMSA,R1       ;SET LPBMSA
         000476
64 04524 105211          INCB    (R1)
65 04526                 CALL    PUTBLK          ;PUT BUFF. ON DISK
   04526 004767          JSR     PC,PUTBLK
         000376
66 04532 016704          MOV     LPCBAD,R4               ;GET ADD. OF LLPCBADBCP IN R3&R4
         000446
67 04536         3$:     CALL    GETBUF          ;GET A NEW BUF
   04536 004767          JSR     PC,GETBUF
         175622
68 04542 010124          MOV     R1,(R4)+        ;SET LPCBCP=BUFAD
69 04544                 POP     (R1)            ;SET BLOCK # IN HWD0 OF NEW BUFF.
   04544 012611          MOV     (SP)+,(R1)
70 04546 062701          ADD     #4,R1           ;BUMP R2 TO WORD 2 OF BUF
         000004
71 04552 010114          MOV     R1,(R4)         ;SET LPWDCP
72 04554         2$:     CALL    DEQREQ          ;DEQUE REQUEST & EXIT IN WAIT STATE
   04554 004767          JSR     PC,DEQREQ
         174450
73 04560         4$:     POP     R1              ;RESTORE ADD. OF CURRENT WORD IN R1
   04560 012601          MOV     (SP)+,R1
74 04562                 PUSH    R3              ;SAVE R3,R2
   04562 010346          MOV     R3,-(SP)
75 04564                 PUSH    R2
   04564 010246          MOV     R2,-(SP)
76 04566 005071          CLR     @(R1)           ;SET BUFF. END SW
         000000
77 04572                 CALL    FINDBK          ;GET DISK BLOCK #
   04572 004767          JSR     PC,FINDBK
         174642
78 04576                 PUSH    R1              ;SAVE BLOCK #
   04576 010146          MOV     R1,-(SP)
79 04600                 CALL    GETBUF          ;GET A BUFF.
   04600 004767          JSR     PC,GETBUF
         175560
80 04604 011611          MOV     (SP),(R1)       ;SET BLOCK # IN HWD0 OF NEW BUFF.
81 04606 016704          MOV     LPCBAD,R4               ;GET ADD. OF LLPCBADBCP IN R4
         000372
82 04612                 PUSH    (R4)
   04612 011446          MOV     (R4),-(SP)
83 04614                 PUSH    (R4)            ;SAVE CONT. OF LPCBCP
   04614 011446          MOV     (R4),-(SP)
84 04616 062716          ADD     #TWD1,(SP)      ;BUMP TO TWD1
         000776
85 04622 016636          MOV     4(SP),@(SP)+    ;SET LINK IN OLD BUFF.
         000004
86 04626 010124          MOV     R1,(R4)+        ;SET LPCBCP & BUMP TO LPWDCP
87 04630 062701          ADD     #4,R1           ;POINT TO WORD 2 IN BUFF.
         000004
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

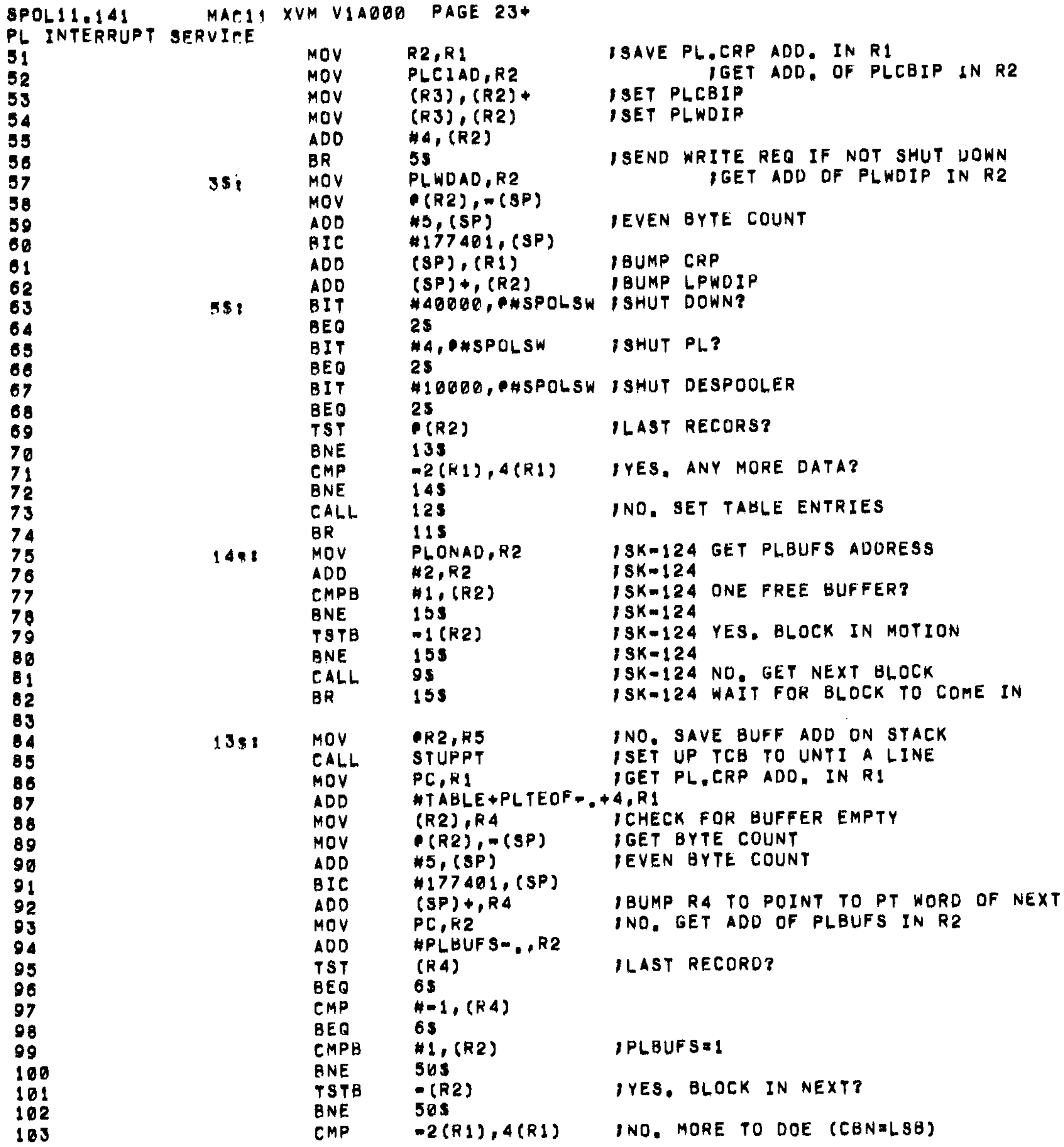
```
SPOL11.141        MAC11 XVM V1A000  PAGE 22+
LP CALL SERVICE
88 04634                   PUSH    R4                ;SAVE LPWDCP ADD. ON STACK
   04634 010446            MOV     R4,-(SP)
89 04636 010114            MOV     R1,(R4)           ;SET LPWDCP
90 04640 010104            MOV     R1,R4             ;GET CONT. OF LPWDCP
91 04642 016602            MOV     6(SP),R2          ;RESTORE R3,R2
         000006
92 04646 016603            MOV     10(SP),R3
         000010
93 04652                   CALL    COPBUF            ;COPY CALLER BUFFER
   04652 004767            JSR     PC,COPBUF
         000120
94 04656                   POP     R4                ;SAVE LPWDCP ADD. IN R4
   04656 012604            MOV     (SP)+,R4
95 04660                   POP     R2                ;CONT. OF LPCBCP ON STACK TOP???
   04660 012602            MOV     (SP)+,R2
96 04662 012703            MOV     #LPCOD,R3         ;GET DEV.CODE IN R3. FOR PUTBLK
         000004
97 04666 062706            ADD     #6,SP             ;CLEAN STACK
         000006
98 04672                   PUSH    R4                ;SAVE R5
   04672 010446            MOV     R4,-(SP)
99 04674 016701            MOV     LPBMSA,R1         ;SET LPBMSA
         000322
100 4700 105211            INCB    (R1)
101 4702                   CALL    PUTBLK            ;PUT BUFF. ON DISK
    4702 004767            JSR     PC,PUTBLK
         000222
102 4706                   POP     R4                ;TEMP SAVE R1
    4706 012604            MOV     (SP)+,R4
103 4710                   CALL    6$                ;CHECK FOR .CLOSE
    4710 004767            JSR     PC,6$
         000002
104 4714 000717            BR      2$
105 4716 010401 6$:        MOV     R4,R1             ;SAVE R4
106 4720 011104            MOV     (R1),R4           ;GET C(LPWDCP) IN R4
107 4722 022764            CMP     #LPCLOS,-2(R4)    ;FF+CR??
         006414
         177776
108 4730 001021            BNE     7$
109 4732 010104            MOV     R1,R4             ;RESTORE R4
110 4734                   ADR     TABLE+LFB,R2      ;GET LP.LFB ADD. IN R2
    4734 010702            MOV     PC,R2
    4736 062702            ADD     #TABLE+LFB-.,R2
         001330
111 4742 016701            MOV     LPCBAD,R1
         000236
112 4746                   PUSH    (R2)              ;SAVE OLD LFB
    4746 011246            MOV     (R2),-(SP)
113 4750 017112            MOV     @(R1),(R2)        ;SET LFB IN TABLE
         000000
114 4754 011101            MOV     (R1),R1
115 4756                   POP     2(R1)             ;SET OLD LFB IN BUFFER
    4756 012661            MOV     (SP)+,2(R1)
         000002
116 4762 012761            MOV     #-1,TWD0(R1)      ;SET EOF CODE IN BUFFER
         177777
         000774
117 4770 005726            TST     (SP)+    ;RETURN TO 9 (NOT SUB RETURN)
118 4772 000634            BR      9$

119 4774 000207 7$:        RETURN
120             ;
121                        .ENDC
122 4776        COPBUF:
123 4776 026737            CMP     SDCTSV,@#CTLCT    ;DEBUG
         175124
         001066
124 5004 001005            BNE     1$
125 5006 012324            MOV     (R3)+,(R4)+       ;COPY CALLER BUFFER
126 5010 005302            DEC     R2
127 5012 001371            BNE     COPBUF
128 5014 010476            MOV     R4,@2(SP)
         000002
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

```
SPOL11.141       MAC11 XVM V1A000  PAGE 23
PL INTERRUPT SERVICE
                 ;
                 ;THIS ROUTINE HANDLES COMPLETION OF I/O SOFTWARE INTERRUPT FROM THE
                 ;DRIVER TASK IN PIREX. IT DESPOOLS THE SPOOLED DATA ONTO THE XY PLOTTER.
                 ;
                         .IFDF   SPL
                 PLDUMI: .BYTE   0                      ;UNUSED
                 PLONCE: .BYTE   0                      ;ONCE ONLY SW
                 PLBMD:  .BYTE   0                      ;BLOCK IN MOTION SW
                 PLBUFS: .BYTE   0                      ;EMPTY BUFFER COUNT
                 PLCBIP: 0                              ;CURRENT BUFFER POINTER
                 PLWDIP: 0                              ;CURRENT WORD POINTER
                 PLNBIP: 0                              ;NEXT BUFFER POINTER
                         .ENDC
                 ;
                 ;
                         .IFNDF SPL
   05022 013701  PLINT:  MOV     @#DEVST,R1
         001050
   05026 112761          MOVB    #IOPS77,PLSPER(R1)       ;REPORT TASK NOT SUPPORTED
         000077
         000051
   05034 000207          RETURN
                         .ENDC
                         .IFDF SPL
                 ;
                 PLINT:  MOV     TABPDT,R1
                         BIS     #LVL5,@#PS            ;INHIBIT DISK INT.
                         CMP     #-1,(R1)              ;ANY MORE TO DO?
                         BNE     1$
                 11$:    MOV     PLONAD,R3                 ;GET C(PLCBIP) IN R3
                         CLRB    (R3)+                 ;RESET SW.'S
                         CLRB    (R3)+                 ;BUMP TO PLBUFS
                         INCB    (R3)+                 ;RELEASE BUFF.
                         MOV     (R3),R3
                         CALL    GIVBUF                ;GIVE BACK BUFFER
                 2$:     BIC     #4,@#SPOLSW           ;NO. SET PL IDLE SW
                 50$:    RETURN
                 1$:     TST     (R1)                  ;YES. BLOCK IN MOTION?
                         BNE     3$
                 15$:    MOV     PLCIAD,R4             ;SK-124 YES. GET ADD OF PLCBIP IN R2
                         MOV     (R4),R3               ;RELEASE BUFFER
                         CALL    GIVBUF
                         INCB    -(R4)
                 10$:    TSTB    -1(R4)                ;BLOCK READ IN?
                         BEQ     4$
                         CALL    WAITBK                ;NO
                         BR      10$
                 4$:     MOV     TABPDT,R2
                         MOV     2(R2),-2(R2)          ;SET CBN=NBN
                         MOV     #4,(R2)               ;SET CRP
                         MOV     PLOIAD,R3                 ;GET PLOBIP ADD. IN R3
                         MOV     (R3),R4               ;GET C(PLOBIP) IN R3 & BUMP TO TWD1
                         MOV     TWD1(R4),2(R2)        ;SET PL.NBN
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components



```
SPOL11.141      MAC11  XVM V1A000  PAGE 23+
PL INTERRUPT SERVICE
                        MOV     R2,R1           ;SAVE PL.CRP ADD. IN R1
                        MOV     PLC1AD,R2               ;GET ADD. OF PLCBIP IN R2
                        MOV     (R3),(R2)+      ;SET PLCBIP
                        MOV     (R3),(R2)       ;SET PLWDIP
                        ADD     #4,(R2)
                        BR      5$              ;SEND WRITE REQ IF NOT SHUT DOWN
                3$:     MOV     PLWDAD,R2               ;GET ADD OF PLWDIP IN R2
                        MOV     @(R2),-(SP)
                        ADD     #5,(SP)         ;EVEN BYTE COUNT
                        BIC     #177401,(SP)
                        ADD     (SP),(R1)       ;BUMP CRP
                        ADD     (SP)+,(R2)      ;BUMP LPWDIP
                5$:     BIT     #40000,@#SPOLSW ;SHUT DOWN?
                        BEQ     2$
                        BIT     #4,@#SPOLSW     ;SHUT PL?
                        BEQ     2$
                        BIT     #10000,@#SPOLSW ;SHUT DESPOOLER
                        BEQ     2$
                        TST     @(R2)           ;LAST RECORS?
                        BNE     13$
                        CMP     -2(R1),4(R1)    ;YES. ANY MORE DATA?
                        BNE     14$
                        CALL    12$             ;NO. SET TABLE ENTRIES
                        BR      11$
                14$:    MOV     PLONAD,R2       ;SK-124 GET PLBUFS ADDRESS
                        ADD     #2,R2           ;SK-124
                        CMPB    #1,(R2)         ;SK-124 ONE FREE BUFFER?
                        BNE     15$             ;SK-124
                        TSTB    -1(R2)          ;SK-124 YES. BLOCK IN MOTION
                        BNE     15$             ;SK-124
                        CALL    9$              ;SK-124 NO. GET NEXT BLOCK
                        BR      15$             ;SK-124 WAIT FOR BLOCK TO COME IN

                13$:    MOV     @R2,R5          ;NO. SAVE BUFF ADD ON STACK
                        CALL    STUPPT          ;SET UP TCB TO UNTI A LINE
                        MOV     PC,R1           ;GET PL.CRP ADD. IN R1
                        ADD     #TABLE+PLTEOF-.+4,R1
                        MOV     (R2),R4         ;CHECK FOR BUFFER EMPTY
                        MOV     @(R2),-(SP)     ;GET BYTE COUNT
                        ADD     #5,(SP)         ;EVEN BYTE COUNT
                        BIC     #177401,(SP)
                        ADD     (SP)+,R4        ;BUMP R4 TO POINT TO PT WORD OF NEXT
                        MOV     PC,R2           ;NO. GET ADD OF PLBUFS IN R2
                        ADD     #PLBUFS-.,R2
                        TST     (R4)            ;LAST RECORD?
                        BEQ     6$
                        CMP     #-1,(R4)
                        BEQ     6$
                        CMPB    #1,(R2)         ;PLBUFS=1
                        BNE     50$
                        TSTB    -(R2)           ;YES. BLOCK IN NEXT?
                        BNE     50$
                        CMP     -2(R1),4(R1)    ;NO. MORE TO DOE (CBN=LSB)
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

```
SPOL11.141          MAC11 XVM V1A000  PAGE 28
ADDRESS TABLE
1                              .SBTTL  ADDRESS TABLE
2                      ;
3 005160               ADRTBL:
4 005160 002556 RKCAD:   .WORD    RKTCBP
5                        .IFDF    $LP
6 005162 003555 LPONAD:  .WORD    LPONCE
7                        .ENDC
8 005164 006304 TABPLA:  .WORD    TABLE+PLTEOF
9                        .IFDF    $PL
10              PLONAD:  .WORD    PLONCE
11                       .ENDC
12 05166 005276 BTMPAD:  .WORD    BTMPST
13 05170 005272 STBKNA:  .WORD    STBKNM
14 05172 006254 TABLAD:  .WORD    TABLE
15 05174 006256 TABPCB:  .WORD    TABLE+CBN
16 05176 006306 TABPLC:  .WORD    TABLE+PLTEOF+CBN
17 05200 006272 TABCDC:  .WORD    TABLE+CDTEOF+CBN
18 05202 006364 TCBK1A:  .WORD    TCBDK1
19              .IFDF    $CD
20              CDCPAD:  .WORD    CDCBIP
21              CDCBAD:  .WORD    CDCBCP
22                       .ENDC
23                       .IFDF    $LP
24 05204 004322 LPCBAD:  .WORD    LPCBCP
25 05206 003562 LPCWAD:  .WORD    LPWDIP
26                       .ENDC
27                       .IFDF    $PL
28              PLCBAD:  .WORD    PLCBCP
29              PLWDAD:  .WORD    PLWDIP
30                       .ENDC
31 05210 006412 TCBK3A:  .WORD    TCBDK3
32 05212 001440 AFNDBK:  .WORD    FINDBK
33 05214 002124 ASPLFU:  .WORD    SPLFUL           ;##139##
34 05216 006742 BUFLAD:  .WORD    BUFLHD
35                       .IFDF    $LP
36 05220        LPCPAD:
37 05220 003560 LPCZAD:  .WORD    LPCBIP
38 05222 004321 LPBMSA:  .WORD    LPBMS
39                       .ENDC
40 05224 006270 TABCDT:  .WORD    TABLE+CDTEOF
41 05226 006260 TABCRT:  .WORD    TABLE+CRP
42 05230 006310 TABPDT:  .WORD    TABLE+PLTEOF+CRP
43                       .IFDF    $PL
44              PLCIAD:  .WORD    PLCBIP
45              PLOIAD:  .WORD    PLOBIP
46              PLBMSA:  .WORD    PLBMS
47                       .ENDC
48                       .IFDF    $CD
49              CDBMSA:  .WORD    CDBMS
50              CDINTA:  .WORD    CDINT
51                       .ENDC
52 05232 006274 TABDCT:  .WORD    TABLE+CDTEOF+CRP
53 05234 005070 CDCAAD:  .WORD    CDCALL
```

Figure 5-1 (Cont.)
UNICHANNEL Spooler Components

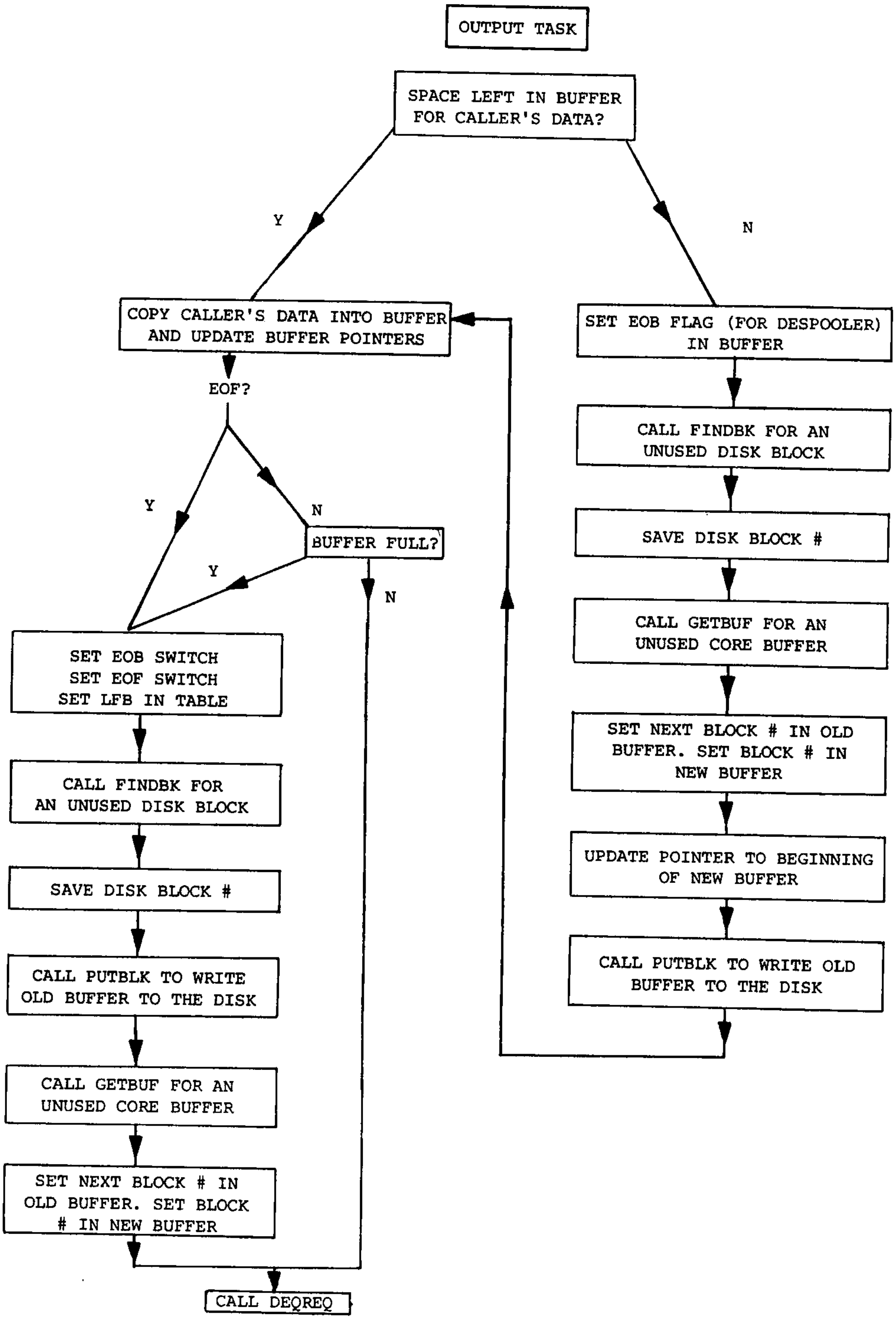

OUTPUT TASK
SPACE LEFT IN BUFFER FOR CALLER'S DATA?
Y
N
COPY CALLER'S DATA INTO BUFFER AND UPDATE BUFFER POINTERS
EOF?
Y
N
BUFFER FULL?
Y
N
SET EOB SWITCH
SET EOF SWITCH
SET LFB IN TABLE
CALL FINDBK FOR AN UNUSED DISK BLOCK
SAVE DISK BLOCK #
CALL PUTBLK TO WRITE OLD BUFFER TO THE DISK
CALL GETBUF FOR AN UNUSED CORE BUFFER
SET NEXT BLOCK # IN OLD BUFFER. SET BLOCK # IN NEW BUFFER
CALL DEQREQ
SET EOB FLAG (FOR DESPOOLER) IN BUFFER
CALL FINDBK FOR AN UNUSED DISK BLOCK
SAVE DISK BLOCK #
CALL GETBUF FOR AN UNUSED CORE BUFFER
SET NEXT BLOCK # IN OLD BUFFER. SET BLOCK # IN NEW BUFFER
UPDATE POINTER TO BEGINNING OF NEW BUFFER
CALL PUTBLK TO WRITE OLD BUFFER TO THE DISK

Figure 5-2
Task Call Service Routine

Set the SPOOLER task control registers	lines 19-23
Setup the disk TCB pointer table	lines 25-33
Setup and initialize BITMAP	lines 35-54
Initialize and setup TABLE	lines 55-64
Set the SPOOLER switches	lines 65-67

LINE PRINTER OPERATIONS:

Initialize the LP call service routine switches and pointers	lines 94-95, 101-104
Clear all pending LP task requests in PIREX get a free block on disk, get a buffer.	lines 96-98
Set the NBN entry in TABLE.	line 100
Process the next SPOOLER request	line 120

5.5.2 LP SPOOLING

All requests issued to spooled tasks (TCN = 0-177) after a 'BEGIN' directive to the SPOOLER, are processed by the SPOOLER. This is effected by PIREX. When the LP handler in the XVM issues a request to the LP driver task in PIREX, the SPOOLER processes this request. The 'request dispatcher' transfers control to the 'LP call service routine' and the following operations are performed (refer to Figure 5-1):

Get the current word pointer address	page- 22, line 20
Check if spooling operations are disabled and, if disabled, exit	lines 26, 22
Point to the current word	lines 26, 25
Get the caller's buffer address and relocate that address	lines 26-28
Get the byte count of the current record, add the header word byte count, and make the byte count even	lines 29-31
Move ahead the current word pointer by the size of the current record	line 32
Compute the space remaining in the current buffer	line 33-36
Is the buffer full?	lines 37-38

Copy the caller's buffer	lines 39, 123-127
Check for a .CLOSE record	lines 41, 105-108
The record is not a .CLOSE; one more record can fit. Process the next request	lines 42, 48-54
The record is a .CLOSE record; save the old Last File Block (LFB) in TABLE	lines 109, 110, 112
Set the new LFB in TABLE	Line 113
Set the old LFB in Header word 2 of the buffer	lines 114, 115
Set an end of file indicator in the buffer	line 116
Go to line 55	
The buffer is full. Set an indicator to this effect in the buffer	lines 55-57
Get a free block on disk (FINDBK)	line 58
Set a pointer to the next block in trailer word 1	lines 59-61
Set the "write block in motion" switch	lines 63, 64
Put the buffer on disk (PUTBLK)	lines 62, 65
Get another buffer (GETBUF)	line 67
Set the "current buffer" pointer for the new buffer	lines 66, 68
Set the block number in the current buffer	line 69
Set the current word pointer to word 2 in the buffer	lines 70, 71
Process the next request	line 72

As disk blocks are written on the disk the Last Spooled Block (LSB) entries in TABLE are updated when the completion of I/O interrupt is processed by the 'disk interrupt service routine' in the SPOOLER (RKINT).

5.5.3 LP Despooling

When the LP device is idle and the first spooled data block is written onto the disk the despooling operations are started in the RKINT routine as follows (refer to Figures 5-1 and 5-3).

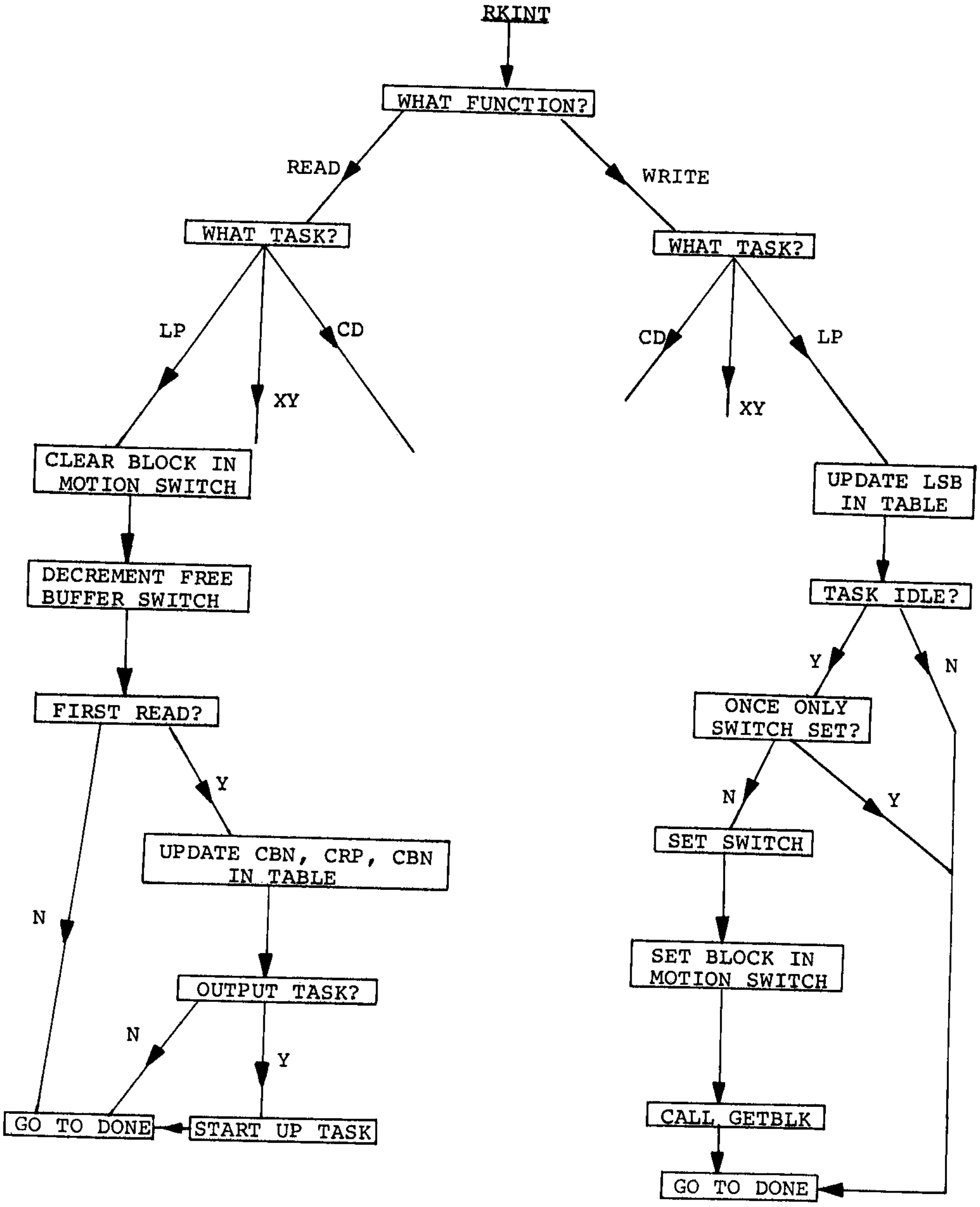


Figure 5-3
Device Interrupt Servicing Logic (For LP)

WRITE PROCESSOR:

Reset the "write block in motion" switch	page 19, lines 20, 21
Set the LSB in TABLE	lines 22, 23
LPONCE = 0, first time through set LPONCE = 1	lines 24-27
Set the "read block in motion" switch	line 28
Get a buffer (GETBUF)	line 29
Get a disk TCB (GETRKT)	line 35
Read a block from disk (GETPUT)	lines 32-34, 36, 37
Return the disk TCB and then EXIT	line 38

READ PROCESSOR:

Is the block read = LFB?	page 23, lines 43-45
Yes, set LFB = 1	line 46
Reset the "read block in motion" switch	line 48
Decrement the LP free buffer count	line 49
LPONCE = 1, first time through, start up LP	lines 50-53
Set Current Block Number (CBN) in TABLE	line 66
Set the current despooling buffer pointer	lines 67-68
Set the current despooling word pointer	lines 69-70
Set the Next Block Number (NBN) in TABLE	lines 71-72
Set Current Record Pointer (CRP) in TABLE	line 73
Set LPONCE = 2	line 54
LP despooling is not shut down; send the LP write request	lines 55-58
Set the LP busy switch	line 60
Return the disk TCB and then EXIT	

Once despooling operations are started the 'LP interrupt service routine' continues the despooling operations until there is no more data to be despooled.

The following operations are performed here (refer to Figure 5-1):

Protect against a disk interrupt	page 21, line 24
There's nothing more to do; reset LPONCE	lines 25-28
Reset LPBMD and increment the free buffer count	lines 29, 30
Return the buffer (GIVBUF)	lines 31, 32
Set the LP idle switch and return	lines 33, 34
There's more to do; a block is in motion	lines 35, 36
Release the buffer (GIVBUF)	lines 37-39
Increment the free buffer count	line 40
Wait for a block to be read in	lines 41-44
Set CBN - NBN in TABLE	line 47
Set CRP in TABLE	line 48
Set NBN in TABLE	lines 49-52
Set the current despooling buffer and word pointer	lines 53-56
Shut down? Shut LP? Shut despooler?	lines 64-69
Current record in buffer is a .CLOSE record, check if more blocks to do	lines 70-72
There are no more blocks reset TABLE entries, switches and then exit	lines 74, 77, 121-123
One free buffer and no block in motion	lines 76-81
Get next block	line 82
Release buffer and wait to come in	lines 83, 37-44
The first record is not a .CLOSE, send an LP write request	lines 86-87
Point to the first word of the next record	lines 89-93
There are more records left and one free buffer	lines 96-101
There is no read block in motion and more blocks to do	lines 102-105
Get next block	lines 106, 126-137
Return from interrupt call	

5.5.4 SPOOLER Shutdown

All spooling operations can be terminated by issuing the 'END' directive to the SPOOLER. The following operations are performed (refer to Figure 5-1):

Protect shutdown routine	page 9, line 7
Clear any pending SPOOLER wakeup requests	line 8
Allow devices to run down	lines 13-18
Shut down LP task	lines 20-23
Turn off SEND11	lines 32-34
Test if shut down due to disk error	lines 35-36
If "END" shutdown, tell "SPOL15" that it has occurred	lines 37-39
Disconnect SPOOLER	lines 40-41

CHAPTER 6

SPOOLER TASK DEVELOPMENT

6.1 INTRODUCTION

This chapter discusses in detail the procedure for developing a spooled task, and, for integrating it into the SPOOLER software. The development of a spooled task[1] in the UC15 system begins with the development and installation of the task under the PIREX system, if not already present (see Chapters 4 and 5).

Once this has been done, the following summary describes the steps necessary to integrate it into the SPOOLER software:

1. Design and code the call service routine. (Refer to Figure 6-1.)

2. Design and code the interrupt service routine. (Refer to Figure 6-1.)

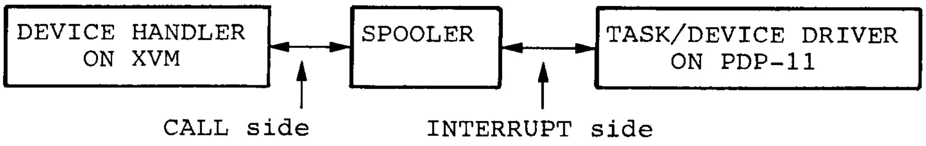


Figure 6-1
SPOOLER Schematic

NOTE

> The logical structure of the 'task call service routine' and the 'task interrupt service routine' depends upon whether the task is an input or an output task. The 'task call service routine' is the despooler for an input task and it is the spooler for an output task. The 'task interrupt service routine' is the spooler for input tasks and it is the despooler for output tasks.

[1] There is no program logic or coding connections between the device driver tasks under PIREX and the spooler task. All communication to the device driver is through the TCB only.

3. Add code in the RKINT routine to handle the disk read or write operations for this task.

4. Code a routine to setup TCB and issue request.

5. Add a TCB for this task.

6. Add code to the BEGIN directive processing routine to initialize, and, (if necessary) startup this task.

7. Add code to the END directive processing routine to clear up this task.

8. Add code to the 'request dispatcher' to dispatch calls to this routine.

9. Add code to the 'device interrupt dispatcher' to dispatch interrupts from this device.

10. Increase the size of TABLE by 6 words if not sufficient.

11. Add entries of frequently addressed tags to the central address table.

12. Update DEVCNT and DEVSPP to ensure sufficient buffers and TCBs.

13. Update FINDBK routine.

The remaining sections describe the above steps in more detail. The Line Printer spooler task is used as a descriptive example.

6.1.1 Call Service Routine

This is the routine that normally processes calls from the handler on the XVM. For an output task this routine spools data onto the disk as indicated in Section 5.3.3. The operations performed by this routine are discussed in detail in Section 5.4.2.

Normally, data from records are copied into a buffer until it is full. As soon as a buffer is full, it is written onto the disk with a pointer to the next block; and then a new buffer is obtained. This process is continued until a special record that indicates the end of the file is received. For the Line Printer, this is a record with form feed and carriage return characters only. On receipt of this record, the call service routine copies this record into the current buffer and writes it out; regardless of whether the buffer is full or not. This is done to ensure complete processing of a distinct logical entity, a file. The call service routine sets only the LFB entry in the TABLE. It uses the utility routines GETBUF, FINDBK, PUTBLK, and DEQREQ.

6.1.2 Interrupt Service Routine

Completion of I/O interrupts from the device driver in PIREX is processed by this routine. For an output task, this routine despools the data onto the device as indication in Section 5.3.5. The operations performed by this routine are discussed in detail in Section 5.4.3.

The interrupt service routine for the Line Printer despools data from the buffer onto the device by issuing requests to the task running under PIREX. This routine, like other despooling routines in the SPOOLER, is double buffered to increase throughput. Provision is made in the routine to wait for a block to be read into core during heavy disk utilization. This is done using the "block in motion" switch.

6.1.3 Code to Handle the Disk Read/Write Operations

All spooled tasks must perform certain functions on completion of a read/write block disk operation, as, Section 5.5.3 describes in detail.

On completion of a read disk block request the TABLE entries must be updated and the Line Printer started up if idle. If the Line Printer is busy, control is transferred to the "DONE" section of code where the disk TCB is returned to the pool and control is relinquished.

On completion of a "write block on disk" request, the buffer is returned and the LSB entry in TABLE is updated. If the Line Printer is idle, a request is issued for the Line Printer task to read in the next despooling block. This is done by supplying the NBN[1] entry in TABLE for the Line Printer. If the Line Printer is not busy or after issuing the read request as in read, control is transferred to the 'DONE' section of code.

6.1.4 Routine to Setup TCB and Issue Request

These operations are performed at several places in the SPOOLER. To optimize code this subroutine performs the TCB setup and request issuing functions.

[1] See Section 5.4.7.

The Line Printer routine performs the following operations (Figure 5-1) at tag STUPLT:

Get the address of the LP TCB	page 11, lines 18-19
Go to setup common	line 20
Set the buffer address specified in the TCB	line 31
Reset the REV in the TCB	lines 32-33
Issue the request	line 34
Return control	line 35

6.1.5 TCB

The format of the TCB used by spooler tasks is almost identical to the format of TCBs for tasks running under PIREX, except for the disk TCB which has an extra word. The extra word is used to store the TCN of the task for which the I/O transfer was requested. Another difference is that the TCN present in word '1' of all TCBs in the SPOOLER has the unspooled bit set, i.e., TCN' = 200_8 + TCN (0-177_8). This is to prevent the request from being queued to the SPOOLER. Also, word '0' of all TCBs contains the SPOOLER task code instead of the API information. This is to permit PIREX to transfer control to the 'device interrupt dispatcher' in the SPOOLER on receipt of an I/O completion interrupt from a SPOOLER request.

6.1.6 Initialization in the BEGIN Routine

All SPOOLER tasks have to be initialized before starting of spooling operations. The initialization normally consists of setting the pointers, switches and variables to the right value, obtaining buffers, block number on disk, etc. Section 5.5.1 explains these operations for the Line Printer in more detail.

6.1.7 Cleanup in the END Routine

All SPOOLER tasks have to be cleaned up before termination of spooling operations. The cleanup for the Line Printer consists of stopping the LP driver task in PIREX and clearing all pending requests in the task's TRL.

6.1.8 Updating the Request Dispatcher

The request dispatcher in the SPOOLER contains code to check the TCN of the current request being processed and to transfer control to the appropriate routine. For the Line Printer (Figure 5-1) this is done at:

page 6, lines 36-38, 73

6.1.9 Updating the Device Interrupt Dispatcher

The SPOOLER is informed of completion of I/O requests through the PIREX Software Interrupt facility. PIREX calls the device interrupt dispatcher, which determines the task that issued the request and transfers control to the tasks interrupt service routine.

For the Line Printer this is done at:

page 17, lines 12-13, 19

6.1.10 Updating TABLE

The TABLE contains the complete record of the data being spooled and despooled. Each task has a 6 word entry in this TABLE. TABLE size must be increased (change the 'BLOCK XXX' statement at page 33, line 73) based upon the number of tasks in the SPOOLER. Currently there is sufficient space in the TABLE for 3 additional tasks.

6.1.11 Updating the Central Address TABLE

Code optimization in a PIC program is done by maintaining a table of addresses for frequently used tags. This table contains the unrelocated addresses of tags at assembly time. These are converted to absolute addresses (by adding the SPOOLER first address) by the once only section of code in the SPOOLER (Figure 5-1, page 6, lines 12-26).

For the Line Printer (Figure 5-1) the following tags are present in this table:

LPONCE	page 28, line 6
TABPCB	line 15
LPCBCP	line 24
LPWDIP	line 25
LPCBIP	line 37
LPBMS	line 38

6.1.12 Update DEVCNT and DEVSPP

To facilitate automatic updating (increase or decrease) of buffers and disk TCBs in the SPOOLER based upon the number of tasks in it, a conditional parameter exists for each task.

DEVCNT and DEVSPP are modified for the Line Printer (Figure 5-1) at:

page 3, line 13-16

Tasks are assembled into the SPOOLER by defining the conditional parameters of the form:

```
$XX = ZZZZOO
```

where

```
  XX = mnemonic of the task (LP for Line Printer)
ZZZZ = a bit configuration (0400 for LP - there is a
       bit for each task)
```

6.1.13 Updating the FINDBK Routine

Code is present in this routine to prevent allocation of the disk block that is currently being despooled. This is necessary to insure proper operation of the spooler because despooling operations are halted when CBN = LSB. For the line printer task (Figure 5-1) this is done at:

page 12, lines 83-84, 91-92

6.2 ASSEMBLING THE SPOOLER

To assemble the SPOOLER with the required task in it, it may be necessary to edit the SPOL11 XXX source file to supply the appropriate assembly parameter. To assemble the SPOOLER with the Card Reader task also insert the line:

```
$CD = 20000 after the sub-title conditional assembly
      parameters.
```

(For Plotter insert: $PL = 10000)

An assembly of the above source (Figure 5-1) will produce a SPOOLER with Line Printer and Card Reader tasks.

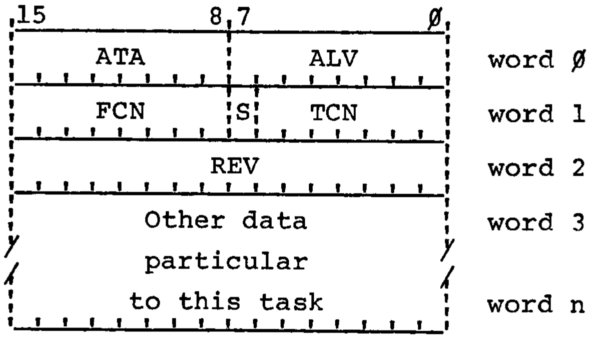
APPENDIX A
ABBREVIATIONS

API	Automatic Priority Interrupt
ATL	Active Task List
CAF	Clear All Flags
CAPIn	Clear APIn flag in DR15-C (CAPI0 = 706104, CAPI1 = 706124, CAPI2 = 706144, CAPI3 = 706164)
CBN	Current Block Numbers
CIOD	Clear Input/Output done (706002)
CRP	Current Record Pointer
XVM/DOS	XVM Disk Operating System
EV	Event Variable
LFB	Last File Block
LIOR	Load Input/Output Register (706006)
LSB	Last Spooled Block
PC	Program Counter
PIC	Position Independent Code (can be loaded anywhere in memory)
RDRS	Read Status Register (706112)
REV	Request Event Variable
XVM/RSX	XVM Real Time System Executive
SAPIn	Skip on APIn flag in DR11-C (SAPI0 = 706101, SAPI1 = 706121, SAPI2 = 706141, SAPI3 = 706161)
SIOA	Skip on Input/Output data Accepted (706001)
TCB	Task Control Block
TCBP	Task Control Block Pointer
TRL	Task Request List
UC15	PDP-11 Front End Processor and Interlace to XVM

APPENDIX B

CURRENTLY IMPLEMENTED TCBs

The general format for all task control blocks is as follows:



ATA XVM API interrupt vector address

ALV XVM API interrupt priority level. Must be 0, 1, 2, or 3 (unless FCN = 3).

FCN Function to perform upon completion of this request. Valid values are:

000 Interrupt XVM at location ATA, priority ALV.

001 Do nothing (except set REV)

003 Cause software interrupt to the PDP-11 task whose task code number is in ALV.

S 0 if this request may be spooled.

1 if this request may not be spooled.

TCN Task code number of the task which is to process this request

REV Request Event Variable. Initially zero, set to a non-zero value to indicate completion of the request. The meaning of the various return values is described below.

Returned REV value:

1 Successful (normal) completion.

-200 Non-existent task. The task code number (TCN) does not correspond to any task currently in the PIREX system.

-300 Illegal ALV value. The request may or may not have been performed - see individual request descriptions. The XVM is interrupted at API level 3.

-777 Node Pool empty. PIREX is temporarily out of nodes, and therefore is unable to insert this request into the appropriate list. Reissue the request after a brief delay.

Other The meanings of other returned REV values are given with the descriptions of the task control blocks to which they apply.

In the sections that follow, many of the task control block diagrams show S and TCN combined into a single 8-bit quantity. This is done to indicate that the particular task may never be spooled, and thus S is always 1.

B.1 STOP TASK (ST)

This task provides the capability to stop one or all tasks in PIREX. Stopping a task may immediately abort processing of the request the task is currently processing, and also any XVM originated requests on the task request list. The format of the task control block for the stop task is as follows (note that this is a non-standard task control block):

<table>
<tr><td colspan="2">15 8</td><td>7 0</td><td></td></tr>
<tr><td colspan="3">unused</td><td>word 0</td></tr>
<tr><td>A</td><td>TCN</td><td>200</td><td>word 1</td></tr>
<tr><td colspan="3">REV</td><td>word 2</td></tr>
</table>

TCN If zero, this is a stop all tasks directive.

A If set unconditionally, abort the current request for this (or all) task(s). If clear, allow the request currently being processed by this (or each) task to complete if and only if the request originated from the PDP-11. Only XVM requests on the task request list will be aborted regardless of the setting of this bit.

All requests which are aborted via this request will never complete; the request event variables (REVs) of such requests will never be set to a non-zero value. A permanent task which is stopped via this request will be placed in the wait state; a temporary task will be placed in the stopped state.

Returned REV values:

1	Successful completion
-600	Task to be stopped is not connected to PIREX. Only applicable when TCN ≠ 0.

B.2 SOFTWARE DIRECTIVE TASK (SD)

Descriptions of the software directives, including details of their task control block formats, are given in Section 3.6, Software Directive Processing. The general task control block format for all software directives is as follows:

15 8	7 0	
ATA	ALV	word 0
FCN	201	word 1
REV		word 2
OPR		word 3
Contents depend		word 4
upon		
directive		word n

OPR Indicate the exact operation (directive) to be performed. For details see Section 3.6.

Returned REV values:

1	Successful completion
-400	Invalid OPR (directive/operation code) values.
Other	See individual directive description in Section 3.6.

B.3 DISK DRIVER TASK (RK)

The disk driver task provides the capability of using the RK05 cartridge disk system. Task control blocks directed to this task have the following format:

Currently Implemented TCBs

15 8	7 0	
ATA	ALV	word 0
FCN	202	word 1
REV		word 2
Block Number		word 3
REL	64K MSMA	word 4
LSMA		word 5
Word Count		word 6
unused Unit	Function	word 7
RKCS		word 10
RKER		word 11
RKDS		word 12

ATA	Usually 047_8
ALV	Usually 000
REV	Set to 1 upon completion regardless of errors.
Block Number	Disk block number to transfer.
REL	0 if request comes from XVM 1 if request comes from PDP-11
64K[1]	When 1 causes an additional 64K words to be transferred.
MSMA	Core address at which to begin transfer - most significant bits.
LSMA	Core address at which to begin transfer - least significant bits.
Word Count	Two's complement of the number of words to transfer.
Unit	Disk drive (unit) number on which to perform the operation.
Function	Operation to be performed.

[1] A zero in the word count field (word 6) causes a 64K word transfer. The "64K" field (word 4) is used in conjunction with the word count to specify transfers greater than 64K words. Thus to transfer 65K words, the user would set the "64K" bit and place a minus -1024_{10} in the word count field.

Valid values are:

002	Write
004	Read
006	Write check
012	Read check
016	Write lock

For detailed descriptions of the functions, see the RK11-E Disk Drive Controller Manual (DEC-11-HRKDA-B-D).

RKCS
RKER
RKDS — Upon completion of the operation, these three words are loaded from the corresponding disk controller registers. See the RK11-E Disk Drive Controller Manual (DEC-11-HRKD-B-D) for a description of their meaning.

If the request originates from the PDP-11, LSMA is the 16-bit PDP-11 byte address at which the transfer is to begin. If the request originates from the XVM, MSMA and LSMA together are the 17-bit XVM word address at which the transfer is to begin. Upon completion of the transfer, REV is always set to 1, regardless of whether or not the transfer succeeded. RKCS, RKER, and RKDS must be examined to determine whether the transfer succeeded or an error occurred.

Returned REV Values:

1	Request complete. Request may or may not have succeeded.
-300	Illegal ALV value. Request complete.

B.4 LINE PRINTER DRIVER TASK (LP)

The task control block format is as follows:

15 8	7 0	
ATA	ALV	word 0
FCN	S 004	word 1
REV		word 2
REL		word 3
Buffer Address		word 4
unused		word 5
Status Flag		word 6

Currently Implemented TCBs

ATA — Usually 056_8

ALV — Usually 002

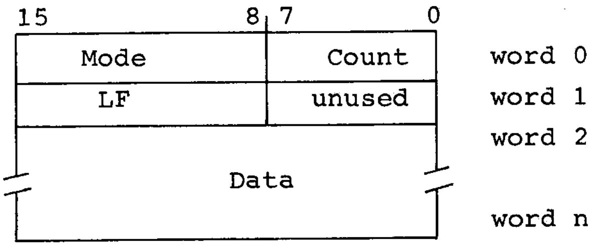
S — Usually 0 (indicating spooled operation)

REL — 0 if request originates from XVM
1 if request originates from PDP-11

Buffer Address — PDP-11 byte address, if request is from PDP-11
XVM word address, if request is from XVM

Status Flag — Unused if request is spooled.
Cleared to zero at beginning of request processing and set to 000001 at completion if request is not spooled.

The buffer address argument refers to a line buffer of the following format:



Count — The number of bytes of data in the buffer. Excludes the four byte header.

Mode — Indicates transfer mode. Legal values are:

0 IOPS ASCII

1 Image

LF — May be altered by the driver.

Data — One line of output for the line printer.

The data sent to the line printer driver is a series of independent bytes. If a byte is positive, it represents a 7-bit ASCII character. If a byte is negative, it represents some number of spaces, the number of spaces being equal to the absolute value of the byte. If a line is in image mode, only the characters represented by the data bytes are output. If a line is in IOPS ASCII mode, a line feed is output before the beginning of the line unless the first character of the line is a carriage return or form feed. A carriage return is always output at the end of lines in IOPS ASCII mode. A line containing just the characters carriage return followed by form feed causes no output in either mode, but rather represents a .CLOSE (end of file) operation.

Line printer errors are not reported via returned REV values. The only line printer error which can occur is for the printer to go off line (become not ready). The line printer driver reports this by placing the value 4 in the device error byte of its entry in the DEVST table (see Section 3.6.4 on the Error Status Report Directive). When the printer comes back on line the driver clears the device error byte and outputs the line. Upon completion the REV is set to 1.

Returned REV Values:

1	Successful completion
-300	Illegal ALV value. Action may or may not have been taken.
-600	Spooler shut down. No action has been taken.

B.5 CARD READER DRIVER TASK (CD)

The task control block format is as follows:

15	8,7	0	
ALA	ALV		word 0
FCN	S	005	word 1
REV			word 2
unused			word 3
Buffer Address			word 4

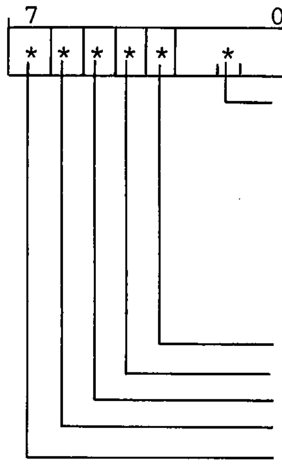
ATA	Usually 055_8
ALV	Usually 001
S	Usually 0 (Indicating spooled operation)
Buffer Address	PDP-11 byte address, if request is from PDP-11 XVM word address, if request is from XVM

The buffer address argument refers to a card buffer of the following format:

15 8,7 0	
Byte Count	word 0
Checksum	word 1
Data	word 2
	word n

Byte Count	Always 80_{10}
Checksum	Word checksum of the buffer (including the byte count)
Data	80_{10} bytes (40_{10} words) of data

The card data is not in ASCII. Each card column occupies one byte in the following format:



bits 0-2 Contents of rows 1-7 encoded as follows:

000	no punches in rows 1-7
001	row 1 punched
010	row 2 punched
011	row 3 punched
100	row 4 punched
101	row 5 punched
110	row 6 punched
111	row 7 punched

bit 3	Indicates row 8 punched
bit 4	Indicates row 9 punched
bit 5	Indicates zone 0 punched
bit 6	Indicates zone 11 punched
bit 7	Indicates zone 12 punched

NOTE

All combinations of punches which cannot be specified in this manner are illegal.

Any errors that occur are not reported by returned REV values. Instead the IOPSUC numeric error code is placed in the device error byte of the card reader's entry in the DEVST table (see Section 3.6.4, Error Status Report Directive). When the error condition is remedied, the driver clears the device error byte and the read operation continues. Ultimately the read completes and REV is set to 1.

Returned REV Values:

1	Successful completion
-300	Illegal ALV values. Action may or may not have been taken.
-700	Spooler shut down. (Despooling not enabled) No action taken.

B.6 PLOTTER DRIVER TASK (XY)

The task control block format is as follows:

<table>
<tr><th>15 8</th><th>7 0</th><th></th></tr>
<tr><td>ATA</td><td>ALV</td><td>word 0</td></tr>
<tr><td>FCN</td><td>S 006</td><td>word 1</td></tr>
<tr><td colspan="2">REV</td><td>word 2</td></tr>
<tr><td colspan="2">REL</td><td>word 3</td></tr>
<tr><td colspan="2">Buffer Address</td><td>word 4</td></tr>
</table>

ATA Usually 065_8

ALV Usually 003

S Usually 0 (indicating spooled operation)

REL 000000 If request is from XVM
If request is from PDP-11

Buffer Address PDP-11 byte address, if request is from PDP-11.
XVM word address, if request is from XVM.

The buffer address argument refers to a data buffer of the following format:

<table>
<tr><th>15 8</th><th>7 0</th><th></th></tr>
<tr><td>Mode</td><td>Count</td><td>word 0</td></tr>
<tr><td colspan="2">unused</td><td>word 1</td></tr>
<tr><td colspan="2" rowspan="2">Data</td><td>word 2</td></tr>
<tr><td>word n</td></tr>
</table>

Count The number of bytes of data in the buffer. Excludes the four byte header.

Mode Indicates the function to perform and/or the mode in which the data should be interpreted. Valid modes are:

Currently Implemented TCBs

1	Line mode
2	Character mode
3	Initialize
4	Pen select[1]
377	End of file

Line mode data takes the following form. Each line is represented by a pair of data words. The first word is the incremental change in the X coordinate from the beginning to the end of the line, the second word the change in the Y coordinate. If this is to be an invisible line - i.e., it is to be drawn with the pen raised - 100000_8 should be added to the first word (change in X).

Character mode data is a series of ASCII characters to be drawn, one character per byte. Initialize requires 8 words of data which specify the character size and orientation for character mode plotting. The pen select operation[1] takes two words of data. The first is the pen number for the XY311 plotter (1, 2, or 3). The contents of this word are destroyed by the pen select operation. The second word must be zero. An end of file merely raises the pen. (It also forces the XY data through the spooler buffers if spooling is enabled.)

Returned REV Values:

1	Successful completion
-300	Illegal ALV value. Action may or may not have been taken.
-600	Spooler shut down. No action taken.

[1] This is used only by the XY311 plotter.

APPENDIX C
UC15 RELATED ERROR MESSAGES

IOPSUC YYY XXXX

Where YYY denotes one of the following:

EST	Stop all I/O	Task
ESD	Software Driver	"
RKU	Disk Cartridge	"
DTU	DECTAPE	"
LPU	Line Printer	"
CDU	Card Reader	"
PLU	Plotter	"
ESP	Spooler	"
EMA	MAC11	"

XXXX denotes one of the following:

3	ILLEGAL INTERRUPT TO DRIVER
4	DEVICE NOT READY
12	DEVICE FAILURE
15	SPOOLER FULL WARNING MESSAGE
20	SPOOLER DISK FAILURE - SPOOLING DISABLED
45	GREATER THAN 80 COLUMNS IN CARD
55	NO SPOOLER BUFFERS AVAILABLE
72	ILLEGAL PUNCH COMBINATION

UC15 Related Error Messages

74 - TIMING ERROR - CARD COLUMN
LOST - RETRY CARD

75 - HARDWARE BUSY - DRIVER NOT

76 - HARDWARE ERROR BETWEEN
CARDS

77 - UNRECOGNIZED TASK REQUEST -
DEVICE NOT PRESENT

400 - SPOOLER EMPTY - PDR-15 INPUT
REQUEST PENDING

Standard format IOPS error messages:

Error Code	
25	XY plotter - value too large for plotting.
27	XY plotter - mode incorrect.
200	Non-existent task referenced.
300	Illegal API level given (illegal values are changed to level 3 and processed).
400	Illegal directive code given.
500	No free core in the PDP-11 local memory.
600	ATL node for this TCN missing.
777	Request node was not available from the POOL; i.e., the POOL was empty and the referenced task was currently busy or the task did not have an ATL node in the Active Task List.
601	System Memory Map Invalid This indicates that the memory map used by CONNECT/DISCONNECT is invalid. PIREX should be rebooted before any CONNECT/DISCONNECT attempt.
602	TCB Out of Range This indicates that the TCB address is not within the 28K word addressing range of the UNICHANNEL.

GLOSSARY

Active Task

An Active Task is one which:

1. is currently executing
2. has a new request pending in its queue
3. is in a wait state
4. has been interrupted by a higher priority task.

Active Task List

A priority-ordered linked list of Active Tasks used for scheduling tables. The ATL is a queue consisting of one node for each Active Task in the system.

Busy/Idle Switch

A two-word storage area used to save TCBP's when processing a request. Every task has a two-word Busy/Idle Switch. If the two words are zero, the task is currently not busy and is able to accept and process a new request. Bit 15 of the first word is used by the system to determine if the TCB came from an XVM or PDP-11 request. If zero, the request came from the XVM, otherwise it came from the PDP-11.

Call Side

All spoolers have a 'call side' where a set of data is passed by the caller to the spooler (for output spooled devices/tasks) or data is passed by the spooler to the caller (for input spooled devices/tasks). This is done only when a request is made to the spooler.

Context Save

The storing of all active registers, including the program counter (PC) and program status (PS), on the current task's stack. These saves are done when higher priority tasks interrupt lower priority ones and by device driver interrupt routines to allow them free use of the general purpose registers.

Context Switching

The process of saving the active registers belonging to the current task executing (a context save), determining a new task to execute, and finally restoring the registers belonging to it.

Deque

Deque, pronounced deck, is a double-ended queue consisting of a listhead and list elements, circularly linked by both forward and backward pointers. Deques (linked lists) are used, instead of tables, to store TCB pointers and ATL information. The list elements (commonly called nodes) are initially obtained from a pool of empty nodes called the POOL. Nodes consist of listhead and 2 words of data used to store the caller's TCB pointer or ATL information. When a node is needed, it is removed from the POOL and queued to the referenced task deque of the ATL. When a node is no longer needed, it is zeroed and returned to the POOL.

Dequeue

Remove a node from a queue.

Directive

A task which performs some specific operation under PIREX, e.g., connecting and disconnecting tasks.

Driver

A task which controls a hardware device. Drivers usually consist of necessary program only rudimentary operations (e.g., read, write or search). The more complex operations such as file manipulations and syntax checking are usually performed by handlers.

Event Variable

A word or variable used to determine the status of a request. The Event variable is set to indicate successful completion, rejection, status, or a request still pending condition.

Interrupt Side

All spoolers have an 'Interrupt Side' where data is passed by the spooler to the device/tasks (for output spooled device/tasks) or data is passed from the device/tasks to the spooler (for input spooler devices/tasks). This occurs whenever output of data is complete or input data is ready.

Linked List

A deque consisting of nodes and listhead used to store system information. An empty list consists of only a listhead.

Listhead

A two-word core block with forward and backward pointers pointing to the next and previous list node or to itself if empty. The listhead is a reference point in a circularly-linked list.

Local Memory

Core memory only addressable by the PDP-11. This is ordinary 16-bit PDP-11 core memory.

Node Manipulation

The process of transferring nodes from one deque structure to another.

Nodes

The list elements of a deque. All nodes consist of listhead, followed by 2 words of data (list elements).

Nul Task

The Nul Task is a task which runs when no other task can. It consists of only PDP-11 WAIT and BR Instruction to increase UNIBUS operations.

Permanent Task

A task in PIREX is said to be a permanent task if it is assembled into PIREX, has space in all PIREX system tables and has a fixed task code number.

POOL

A linked list of empty four-word nodes for use in any deque in the system. The POOL is generated at assembly time and currently has 20 decimal nodes available.

Pop

To remove an Item (word) from the current task's stack.

Push

To put an item (word) onto the current task stack.

Queue

To enter into a waiting list. Queues in PIREX consist only of deque structures.

Scheduling

The process of determing which task will be executed next. The operation is based on a priority ordered list of active tasks in the system (ATL).

Shared Memory

Core memory addressable by both the XVM and PDP-11. The shared memory is ordinary 18-bit XVM memory.

Spare Task

A task that runs under PIREX is said to be a temporary task if it is not assembled into PIREX, has space in all PIREX system tables, does not have a fixed task code number and its start address is not fixed.

The core occupied by the temporary tasks is not freed unless the tasks are disconnected in the order in which they were connected.

SPOLSW

This is a register in PIREX which contains the spooler control and status switches as indicated below.

BITS 0-7 Device busy Idle switch
'0' is idle and '1' busy

BIT 0	LP
1	CD
2	PL
3-7	UNUSED

BITS 8-15 Spooler State/Function switches
'0' if disabled and '1' if enabled

BIT 12	DESPOOLER
13	SPOOLER
14	SPOOLING
15=1	SPOL11 PROGRAM CONNECTED TO PIREX
=0	SPOL11 PROGRAM NOT CONNECTED TO PIREX

Task

A PDP-11 software routine capable of being requested by the XVM or PDP-11 through the PIREX software system. The task may be a device driver, a Directive, or just a software routine used to carry out a specified function. A task must have the format shown in Figure 2-1.

Task Code Number

All tasks in the PIREX system are differentiated by a numbering system rather than by name. Task Code Numbers are used in TCBs and are currently assigned as follows:

CODE	
-1	CL task
200	ST task
201	SD task
202	RK Driver task
203	DT Driver task
4	LP Driver task
5	CD Driver task
6	PL Driver task
7	SPOOLER task
11	currently not used
12	currently not used
13	currently not used

TCB - Task Control Block

A set of continguous memory locations (minimum of three) which contain all necessary information for a task to complete its request. The contents of the TCB must be defined prior to the request by the requesting program (e.g., a XVM program).

A pointer to the TCB (called a TCBP) is then passed to the PDP-11 via the LIOR instruction in the XVM or the IREQ macro in the PDP-11 to actually initiate the request.

TCBP - Task Control Block Pointer

A pointer to a TCB. This pointer is passed to the PDP-11 either via the LIOR instruction in the XVM or the IREQ macro in the PDP-11 when initiating a request to PIREX.

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